AVISTA

August 31, 2011

2011 Electric INTEGRATED Resource Plan

APPENDIX

Appendix Table of Contents

2011 Electric Integrated Resource Plan

Appendix A – Technical Advisory Committee Presentations

Avista's 2011 Electric Integrated Resource Plan
Technical Advisory Committee Meeting No. 1 Agenda
Thursday, May 27, 2010
Conference Room 130

Topic	Time	Staff
1. Introduction	10:30	Lafferty
2. Work Plan	10:35	Lyons
3. Load & Resource Balance Update	11:00	Shane
4. Resource Planning Environment	11:35	Lyons
5. Lunch	12:00	
6. 2011 IRP Topic Discussions	1:15	
• Analytical Process Changes		Gall
• Hydro Modeling		Shane
• Resource Adequacy		Kalich
• Loss of Load Probability		Gall
• Energy Efficiency		Hermanson
• Scoping the 2011 Plan		Kalich
7. Adjourn	3:30	

Work Plan

John Lyons

Technical Advisory Committee Meeting #1

2011 Electric Integrated Resource Plan

May 27, 2010

Technical Advisory Committee Meetings

May 27, 2010: Work plan, load & resource balance, resource planning environment, and 2011 IRP topic discussions (analytical process changes, hydro modeling, resource adequacy, loss of load probability, energy efficiency, and scoping the 2011 plan)

August 2010: Risk and resource assumptions, loss of load probability analysis, scenarios and futures, and energy efficiency

October 2010: Load forecast, preliminary electric and gas price forecasts, updated load & resource forecast balance, and transmission cost studies

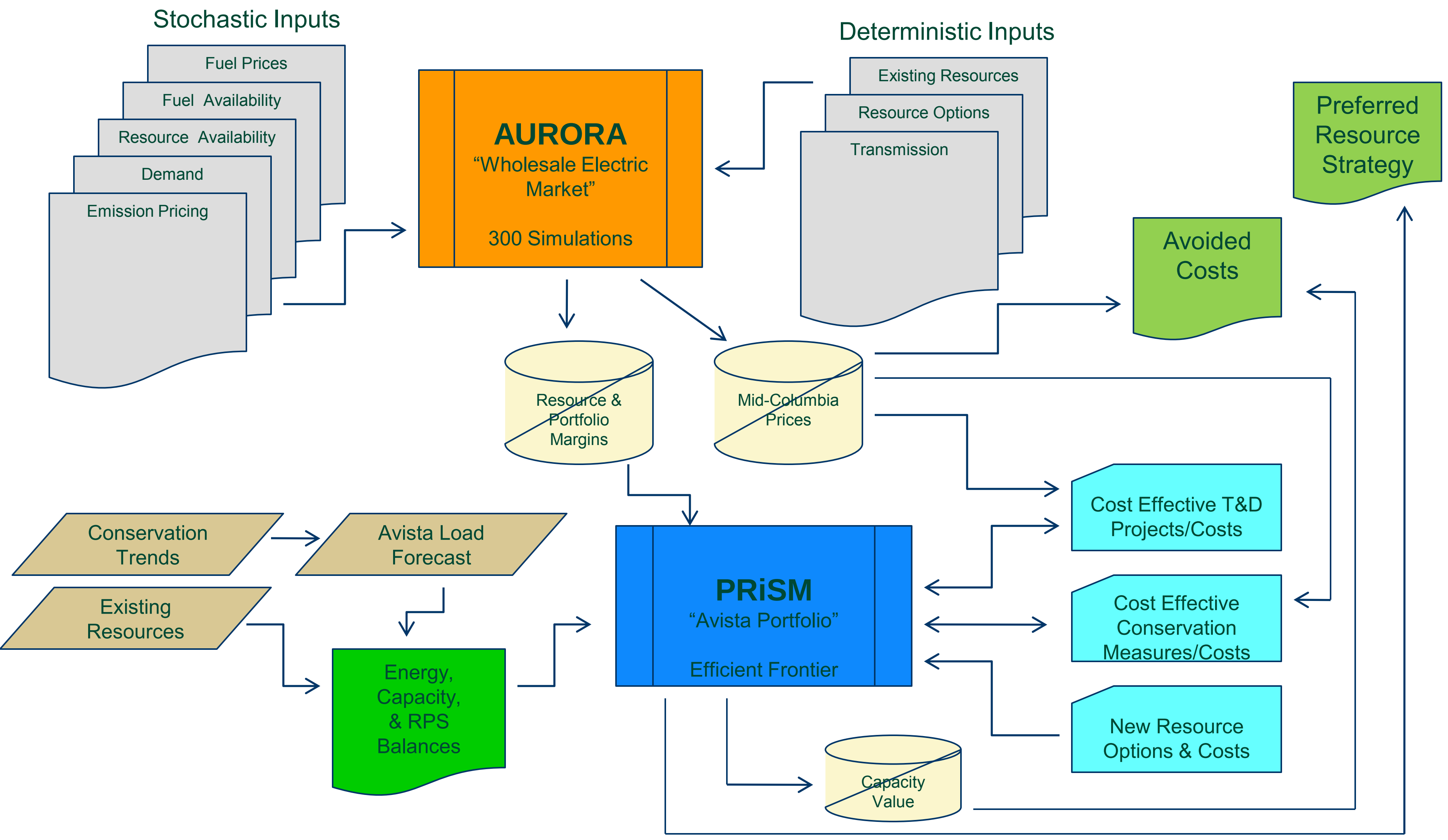
February 2011: Review of modeling and assumptions, and draft PRS

March 2011: Review of scenarios and futures, and portfolio analysis

April 2011: Review of final PRS and action items

June 2011: Review of the 2011 IRP

2011 Integrated Resource Plan Modeling Process



2011 Electric IRP Draft Outline

1. Executive Summary
2. Introduction and Stakeholder Involvement
3. Loads and Resources
   a) Load forecast and scenarios
   b) Existing resources
   c) Resource adequacy
4. Energy Efficiency and Demand Response
   a) Energy and capacity savings projections and methodology
   b) Two year energy savings target (I-937) & business planning process
   c) Demand response options and study results
   d) Risk and externalities
5. Environmental Issues
   a) Carbon emissions
   b) Other
6. Transmission Planning
   a) Resource integration
   b) Smart grid
   c) Other T&D efficiencies

2011 Electric IRP Draft Outline (cont)

7. Generation Resource Options
    a) New resource alternatives
    b) Thermal and hydro upgrades
8. Market Analysis
    a) Regional loads, transmission, resources
    b) Fuel price forecasts
    c) Risk modeling
    d) Market price forecasts
    e) Market scenario analysis
9. Preferred Resource Strategy
    a) The PRiSM Model and efficient frontier analysis
    b) Preferred Resource Strategy results and I-937 compliance
    c) Portfolio scenario analysis
10. Action Items

Load and Resource Balance Forecast

Xin Shane

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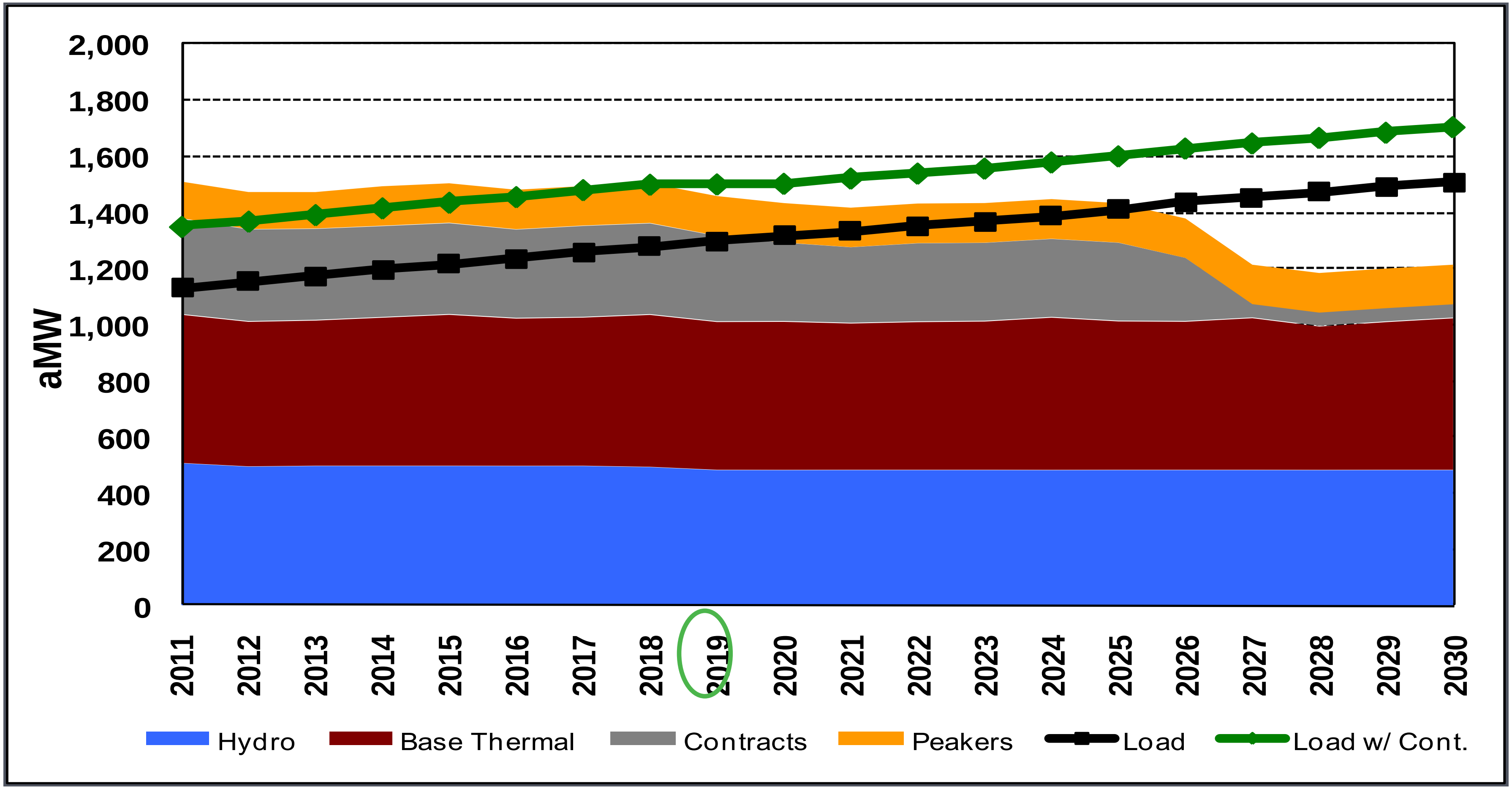
2011 Electric Integrated Resource Plan

May 27, 2010

L&R Changes From 2009 IRP

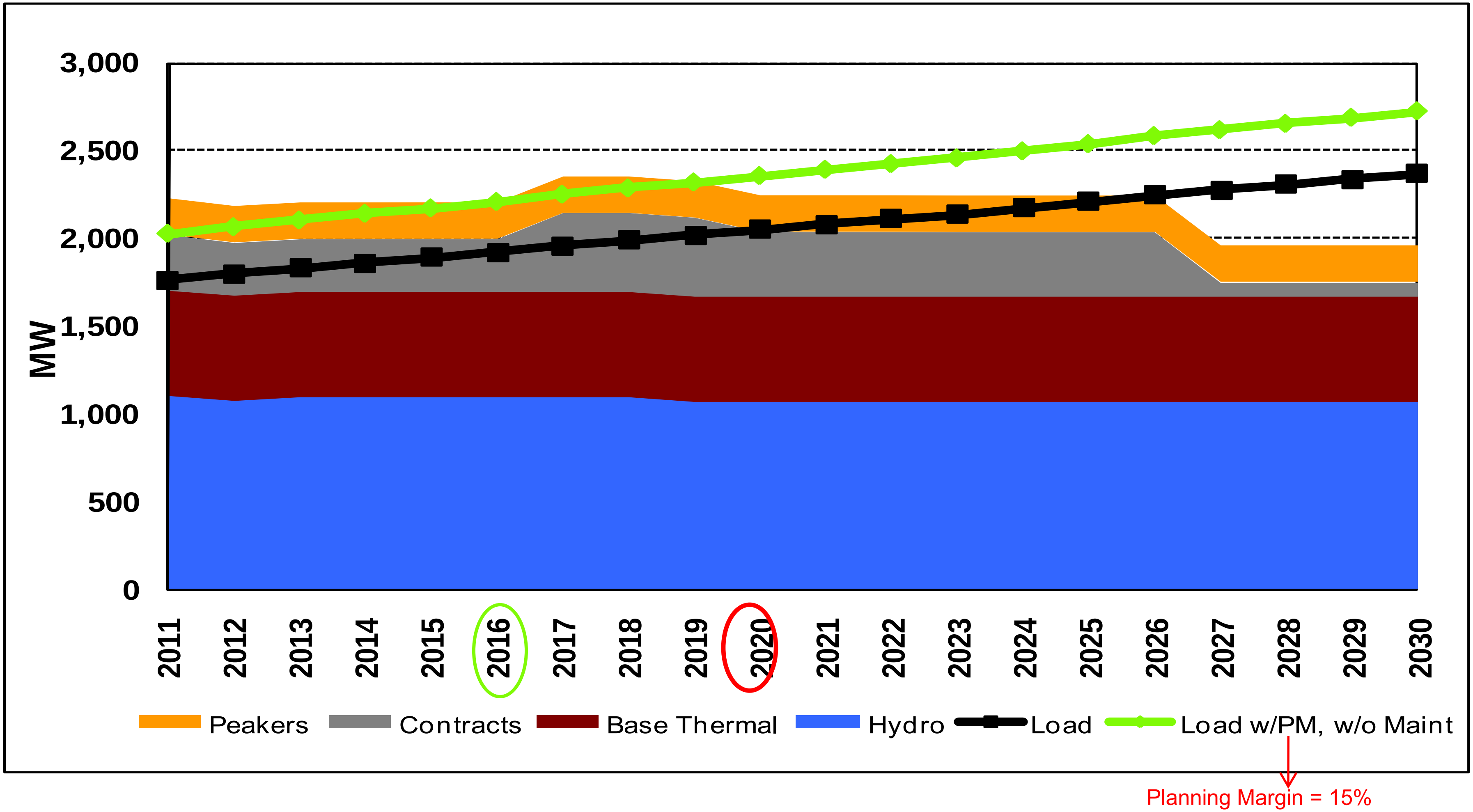
- **Load**- 10 year growth rate 1.8%, 20 year growth rate 1.6% for Peak and Energy. The forecast for year 2011 is 42 aMW lower than previous forecast or 3.6% lower
- **Hydro**- Uses Clark Fork Optimization Package Results
- **Thermal**- CS2 duct burner capacity is upgraded to 28 MW from 23 MW

Annual Average Energy Position
Base Case



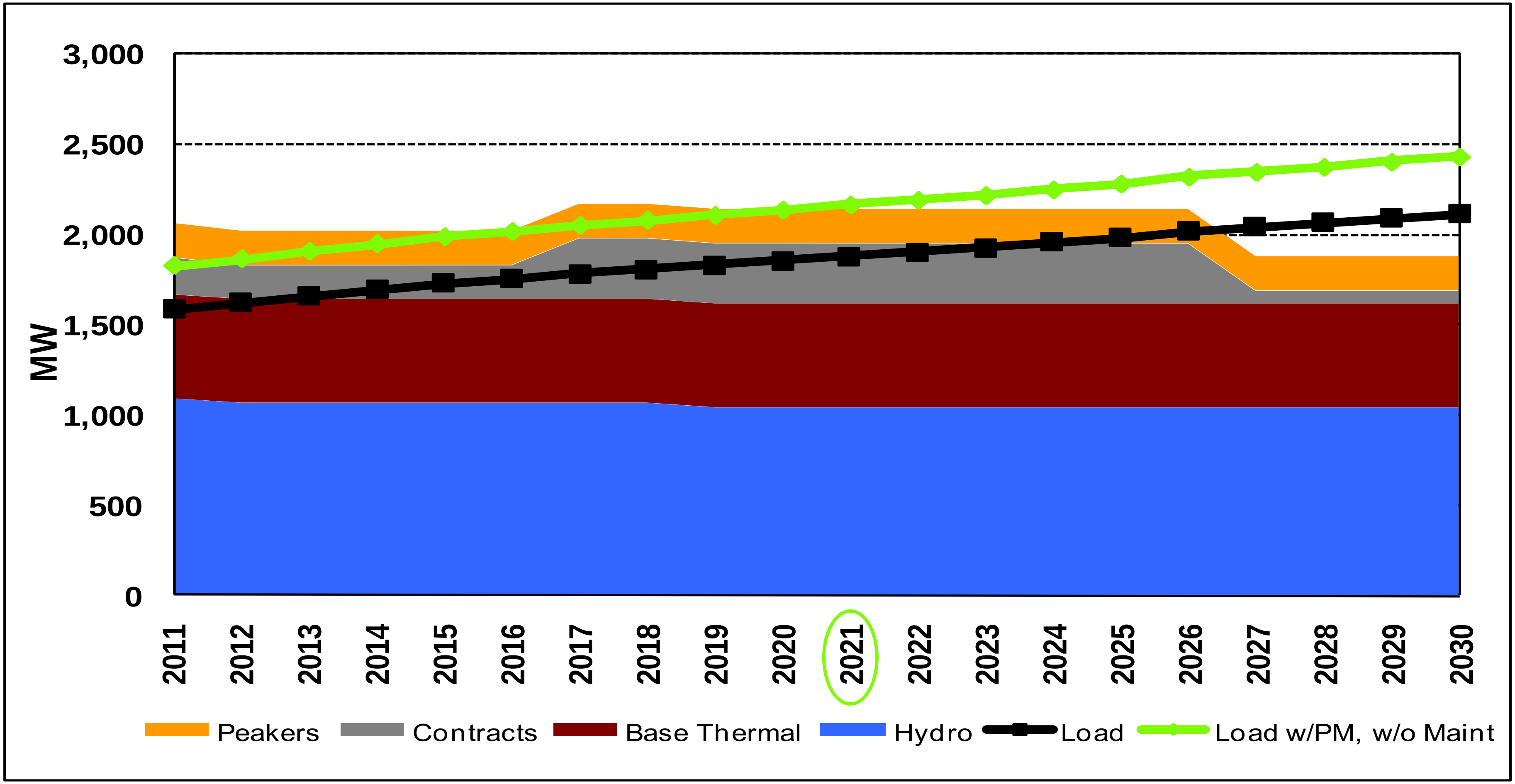
Winter Capacity Position

Base Case



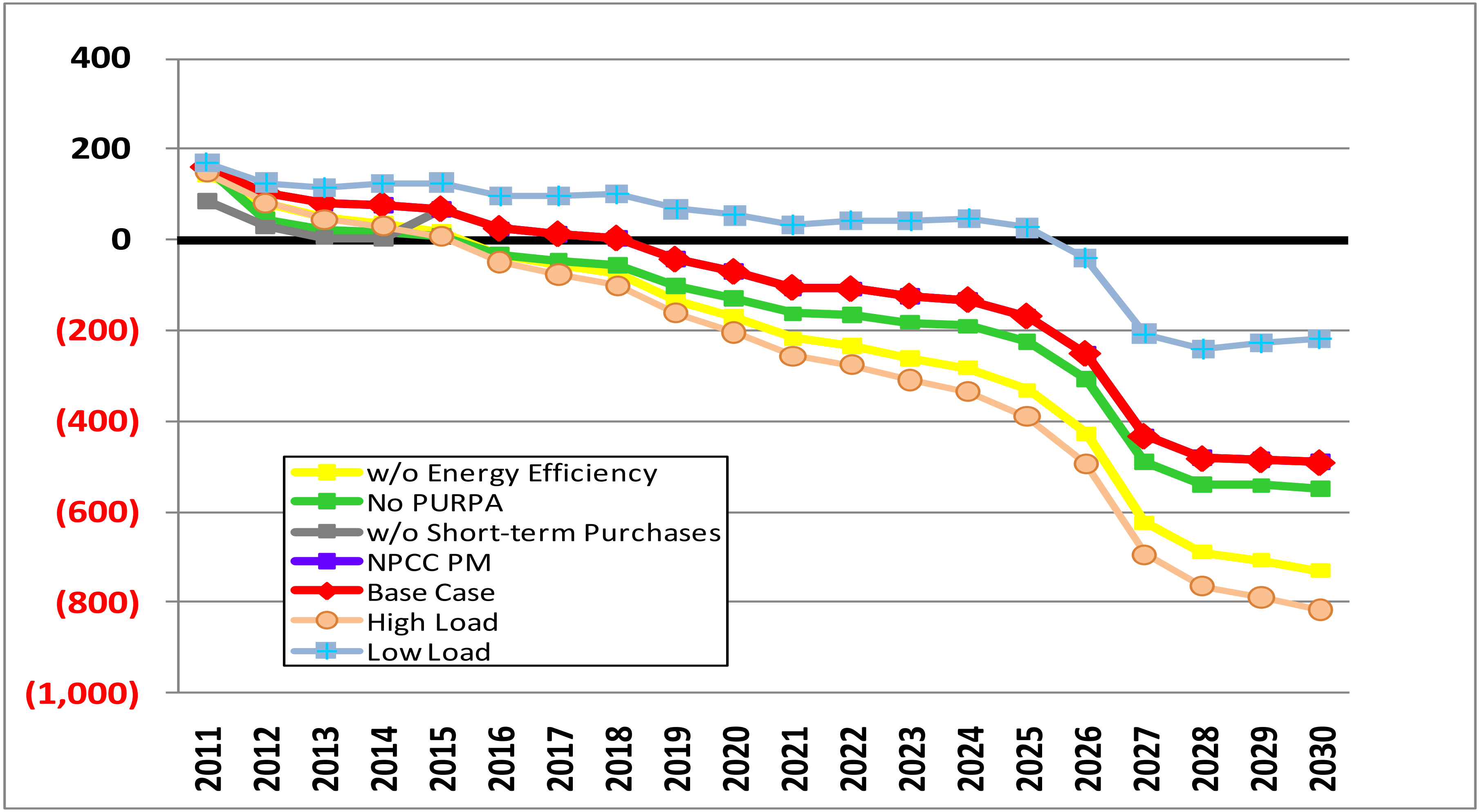
August Capacity Position

Base Case



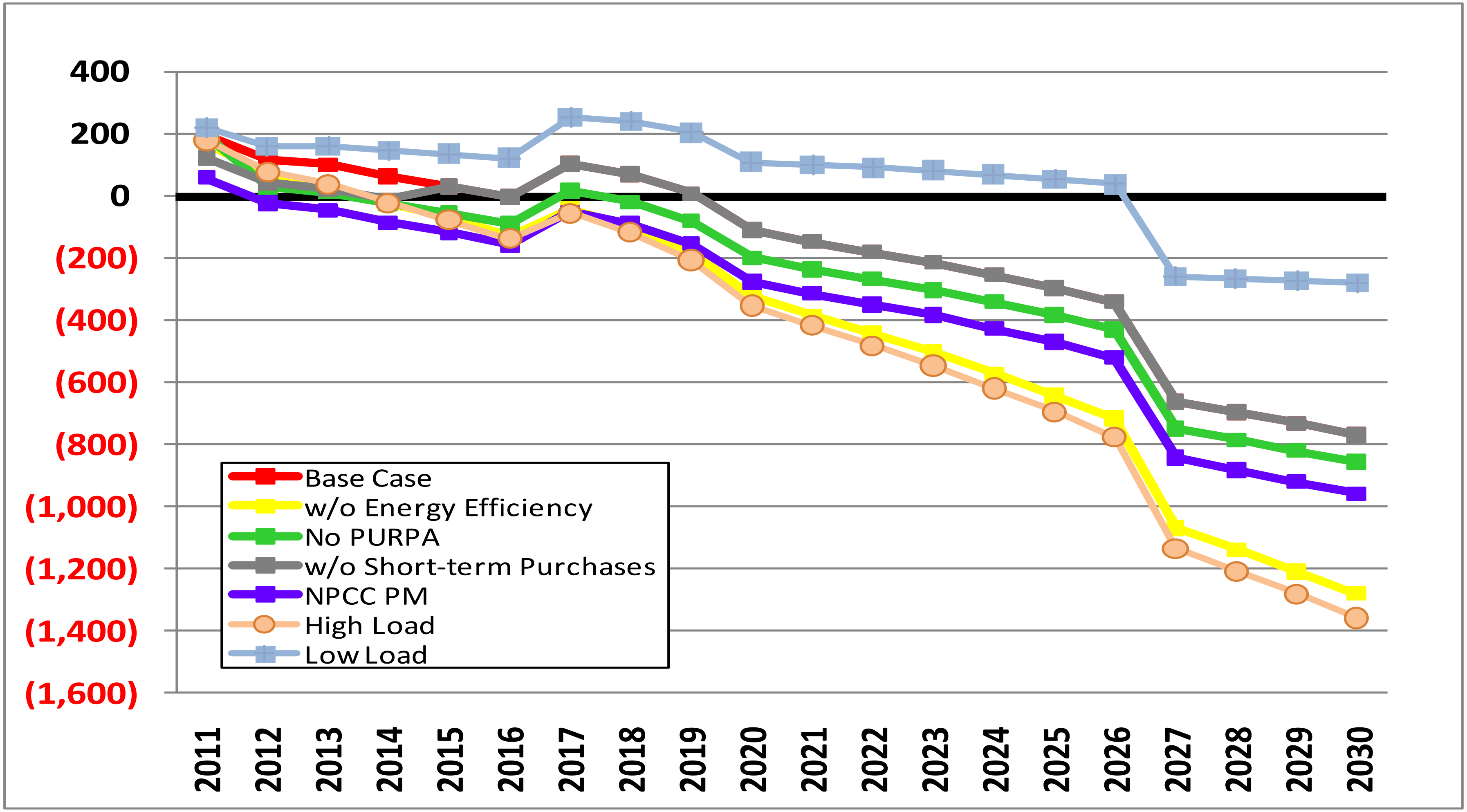
Energy Positions – 7 Scenarios

(aMW)



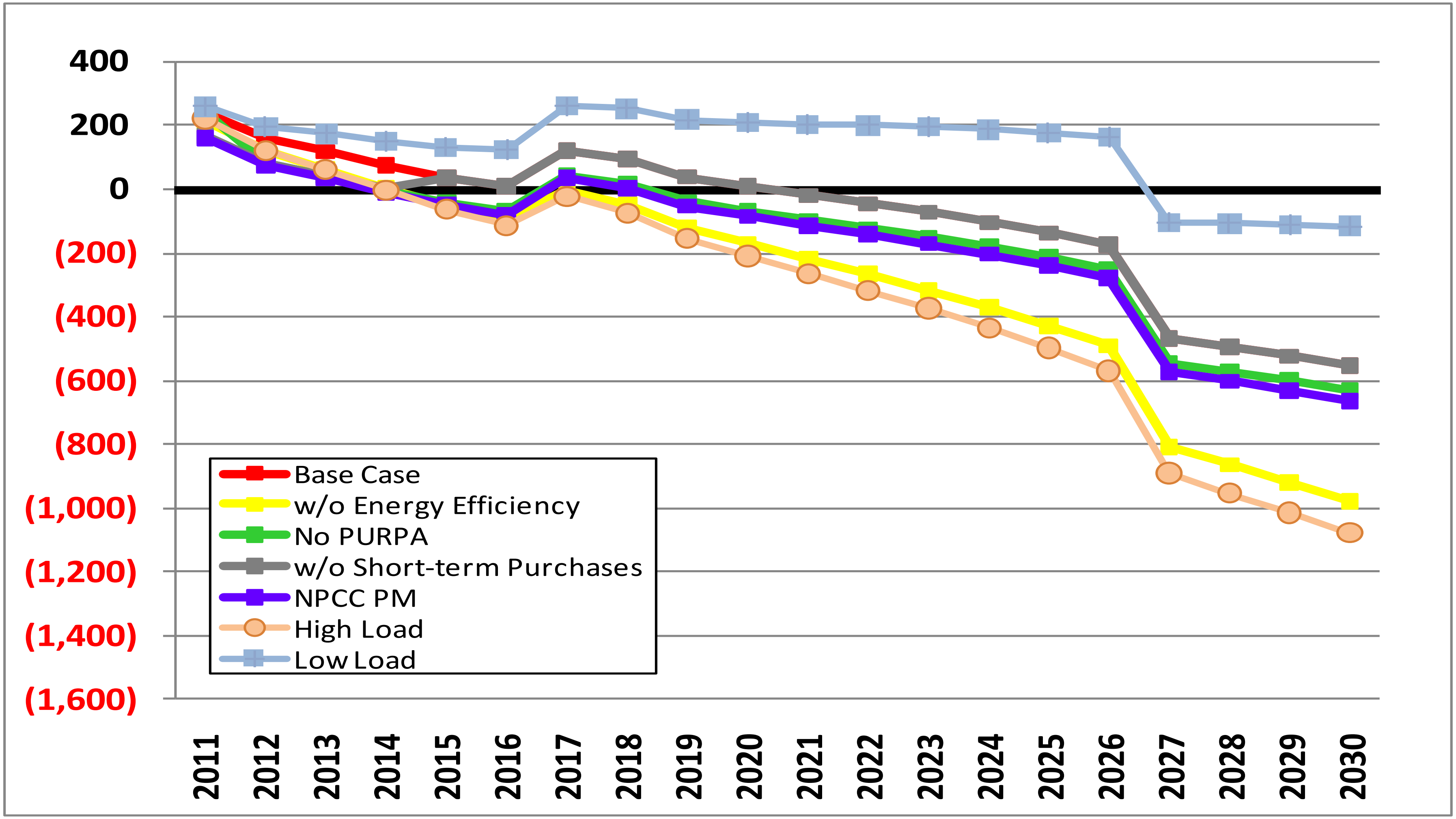
Winter Capacity Positions – 7 Scenarios

(MW)



August Capacity Positions – 7 Scenarios

(MW)



Washington State RPS (aMW)

	On-line Year	Apprentice Labor	Upgrade Energy	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
WA State Retail Sales Forecast				656	668	681	693	702	712	721	730	740	751
Load 10% Chance of Exceedance				29	30	30	31	31	32	32	33	33	34
Planning RPS Load				685	698	711	724	733	744	753	763	773	785
RPS %				0%	3%	3%	3%	3%	9%	9%	9%	9%	15%
Required Renewable Energy				**0.0**	**20.3**	**20.8**	**21.1**	**21.5**	**65.6**	**66.5**	**67.4**	**68.2**	**115.2**
Renewable Resources													
Purchased RECs				0.0	5.7	5.7	5.7	5.7	0.0	0.0	0.0	0.0	0.0
Kettle Falls	1983			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stateline	1999			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Lake 3	1999			2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Little Falls 4	2001			0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Cabinet 2	2004			2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Cabinet 3	2001			4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Cabinet 4	2007	1.0	1.99	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Noxon 1	2009	1.0	2.90	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Reardan				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hydro 10% Chance of Exceedance				(4.2)	(4.2)	(4.2)	(4.2)	(4.2)	(4.2)	(4.2)	(4.2)	(4.2)	(4.2)
Total Qualifying Resources				***10.9***	***16.5***	***16.6***	***16.6***	***16.6***	***10.9***	***10.9***	***10.9***	***10.9***	***10.9***
Net REC Position (Completed)				**10.9**	**(3.8)**	**(4.2)**	**(4.6)**	**(5.0)**	**(54.7)**	**(55.6)**	**(56.5)**	**(57.4)**	**(104.4)**
Budgeted Hydro Upgrades													
Noxon 2	2011	1.0	1.00	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Noxon 3	2010	1.0	1.30	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Noxon 4	2012	1.0	1.20	0.0	0.6	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Nine Mile	2012	1.2	3.80	0.0	2.3	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
Hydro 10% Chance of Exceedance				(0.5)	(1.3)	(2.0)	(2.0)	(2.0)	(2.0)	(2.0)	(2.0)	(2.0)	(2.0)
Total Budgeted Hydro Upgrades				***1.3***	***3.8***	***6.1***	***6.1***	***6.1***	***6.1***	***6.1***	***6.1***	***6.1***	***6.1***
Rollover Credits				0.0	12.1	12.2	14.1	15.6	16.7	0.0	0.0	0.0	0.0
Net REC Postion (Budgeted Upgrades)	**with Rollover**			**12.1**	**12.2**	**14.1**	**15.6**	**16.7**	**(31.9)**	**(49.5)**	**(50.4)**	**(51.3)**	**(98.3)**
Net REC Postion (Budgeted Upgrades)	**w/o Rollover**			**12.1**	**0.1**	**1.9**	**1.5**	**1.1**	**(48.6)**	**(49.5)**	**(50.4)**	**(51.3)**	**(98.3)**

Planning Environment

John Lyons

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2011 Electric Integrated Resource Plan

May 27, 2010

Major Planning Issues

1. Renewable Portfolio Standards
   – State and federal
2. Greenhouse Gas Regulations
   – State, regional, and federal
   – Emissions performance standards and reporting
3. Energy Efficiency Requirements
4. Reliability Planning
5. Variable Resource Integration
6. Electric Vehicles
7. Smart Grid
8. PURPA

State & Federal Greenhouse Gas Reduction Goals

Percentage goals below 2005 greenhouse gas emissions

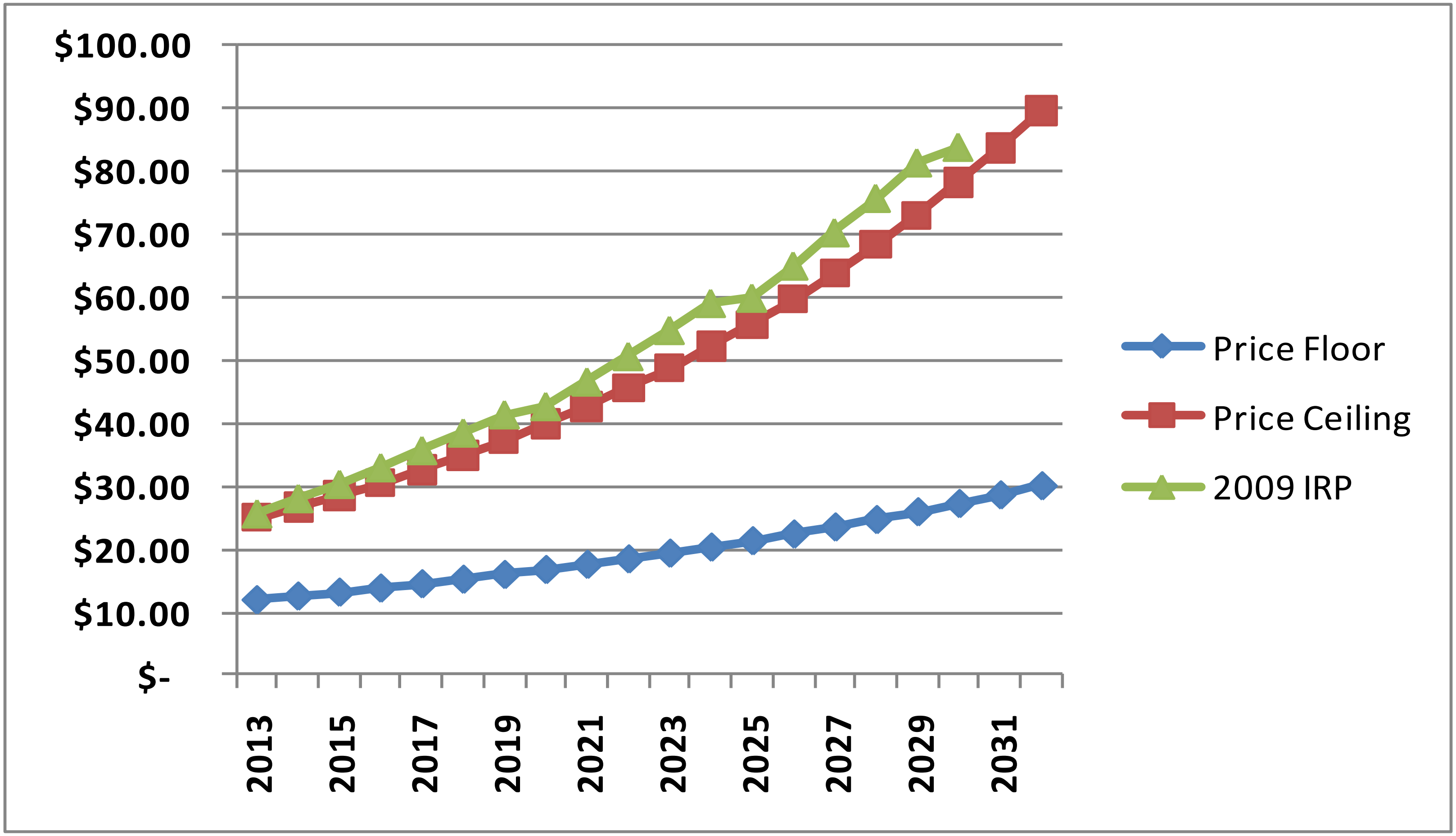
	Kerry-Lieberman	Waxman-Markey
2013	4.75%	3% (2012)
2020	17%	17%
2030	42%	42%
2050	83%	83%

	Washington Goals
2020	1990 emissions
2035	25% below 1990
2050	50% below 1990

Key Components Kerry-Lieberman (American Power Act)

- Allowances:
  - 75% emissions based and 25% load based
  - Prohibition from receiving excess allocations
  - Electricity sector begins in 2013, natural gas in 2016
  - Increased levels of free allocations
- Preemption of state cap-and-trade programs
- Preempt EPA regulation through Clean Air Act
- Carbon fees for petroleum
- Emissions credit limitations
- Emissions credit banking and borrowing

American Power Act – Price Collars



EPA Tailoring Rule

- Clean Air Act permitting requirements for greenhouse gas (GHG) emissions from large stationary sources
- January 2, 2011: Prevention of Significant Deterioration (PSD) requirements for GHG emissions for new and modified facilities needing non-GHG PSD permits and increasing GHG emissions 75,000 tons CO_2-e or more per year
- July 1, 2011: PSD requirements on new facilities emitting 100,000 tons CO_2-e and modifications increasing GHG emissions 75,000 tons
- Rulemaking in 2011 setting emission thresholds and permitting requirements for 2013

Analytical Process Changes

James Gall

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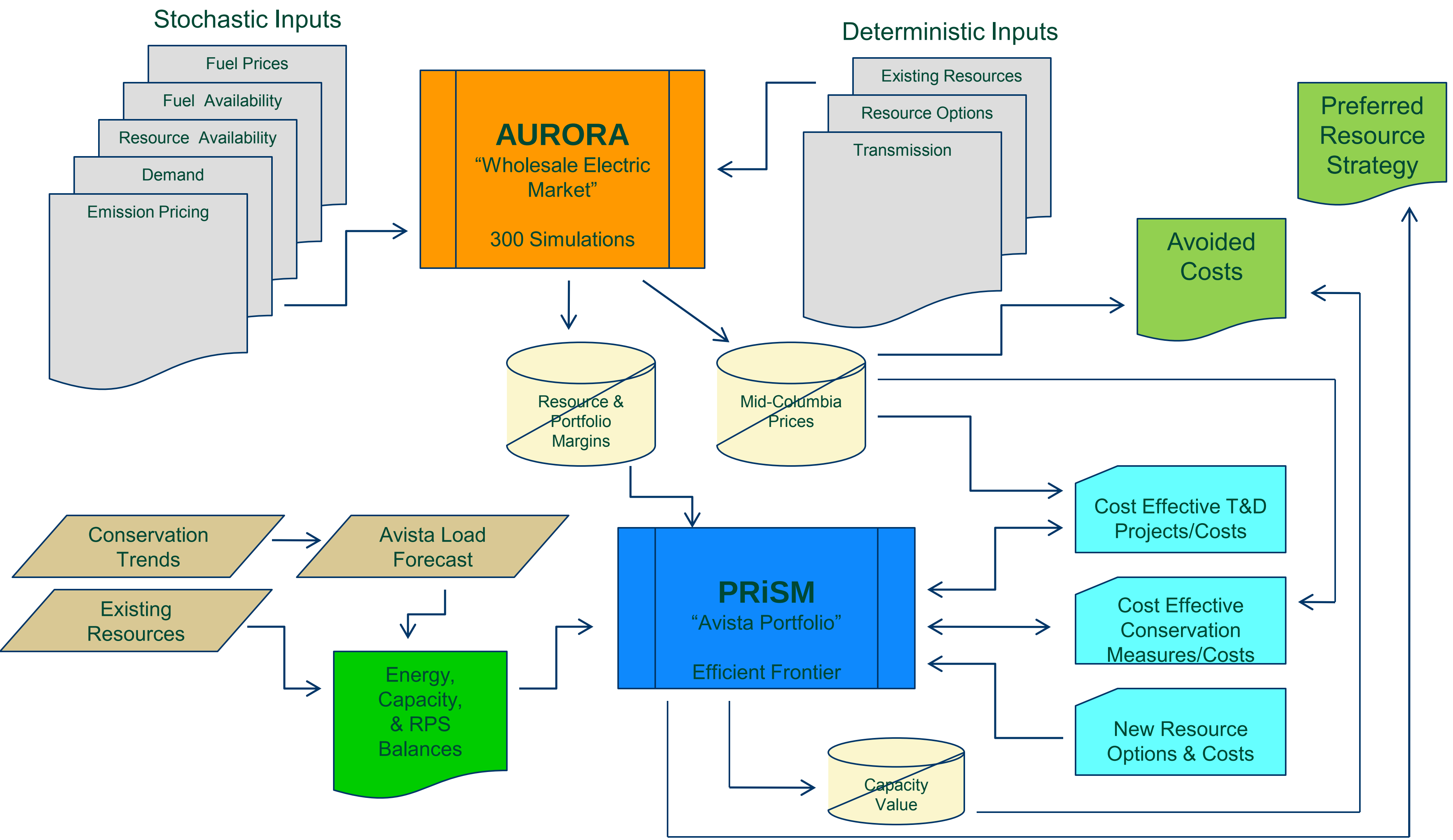
2011 Electric Integrated Resource Plan

May 27, 2010

2011 Integrated Resource Plan Modeling Process



Modeling Enhancements and Questions/Feedback

Modeling Enhancements

- Study period 2012 – 2031
- Use Loss of Load Probability/Expectation to target planning margins
- Resource retirements as an option in PRiSM
- Add other matrices to evaluate portfolio risk (i.e. Tail Var, CoVar, CO_2)
- Increased number of resource upgrades as options (thermal and hydro)
- Increased number of distribution efficiency programs
- Evaluate demand response programs
- Further enhance relationships of regional market variables (i.e. correlations)

Questions/Feedback

- Real versus nominal costs/prices reporting
- Market analysis (more, less, same- stochastic or scenario focused)
- Portfolio analysis (more, less, or same)
- Other requests

Hydro System Optimization Modeling

Xin Shane

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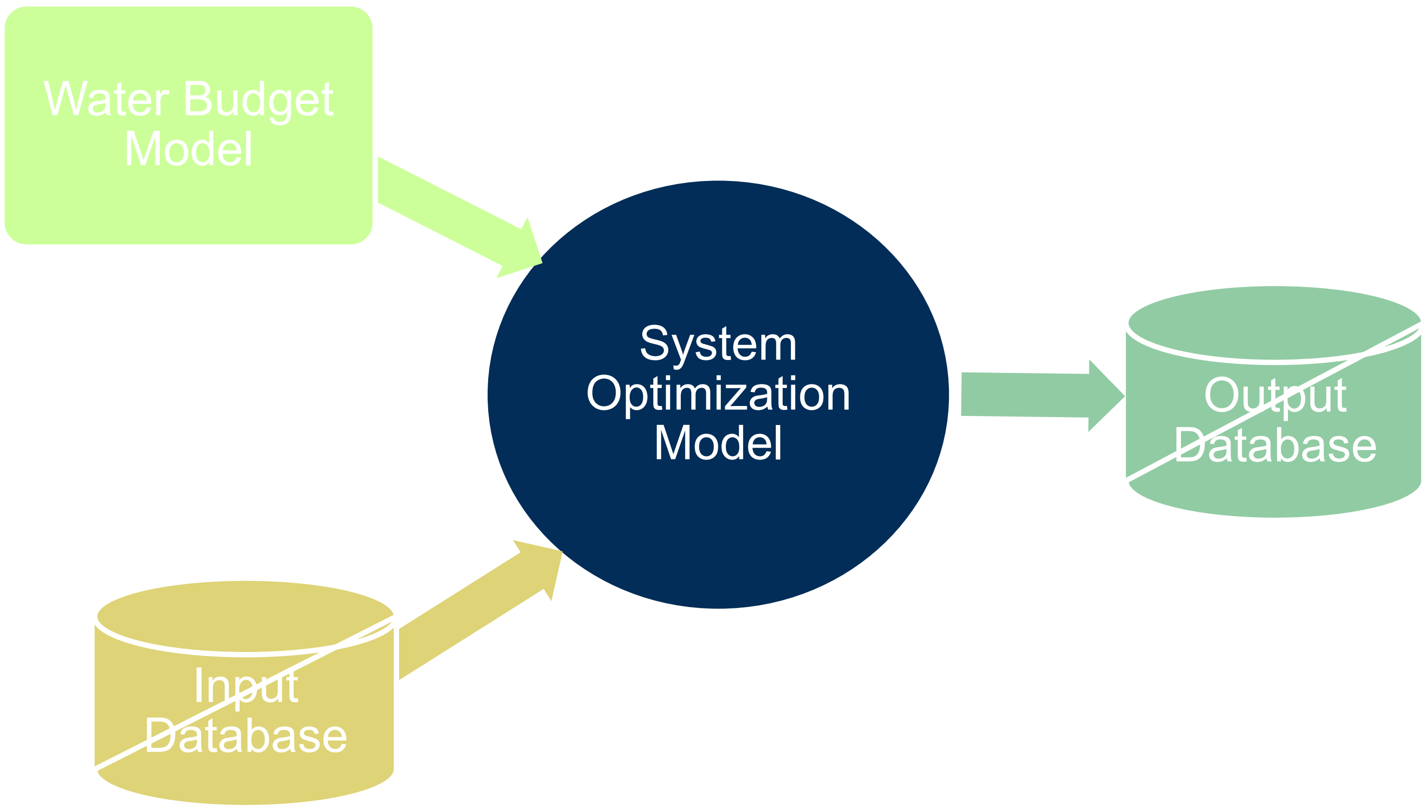
2011 Electric Integrated Resource Plan

May 27, 2010

Structure of Hydro System Optimization Package



Water Budget Model Overview

The Water Budget Model's primary goal is to recognize the storage capabilities inherent in system reservoirs, optimizing water releases to maximize generation values while enforcing project constraints.

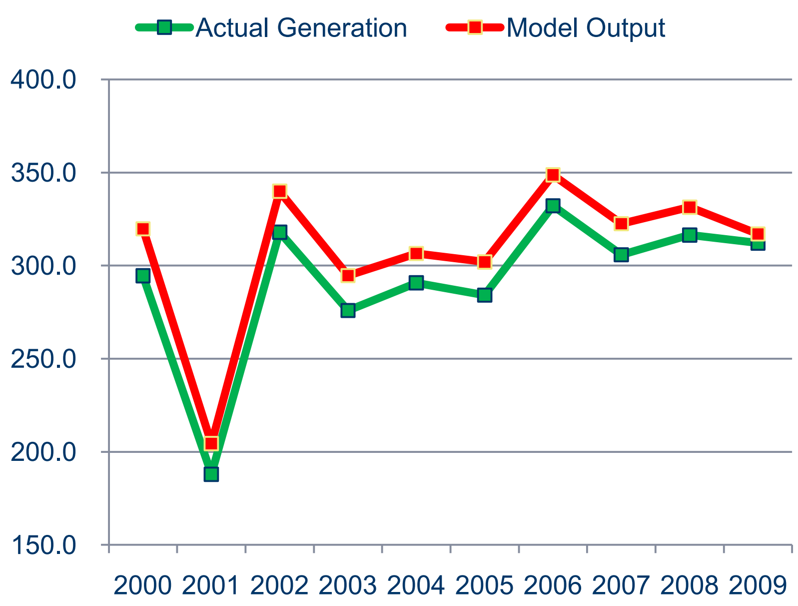
- Today's computers cannot optimize at an adequate detail level to extend the hourly Optimization Model to annual or multi-year timeframes
- Water Budget Model simplifies certain aspects, allowing optimization across many weeks to years
- Approach is a best practice, "industry standard"

System Optimization Model Overview

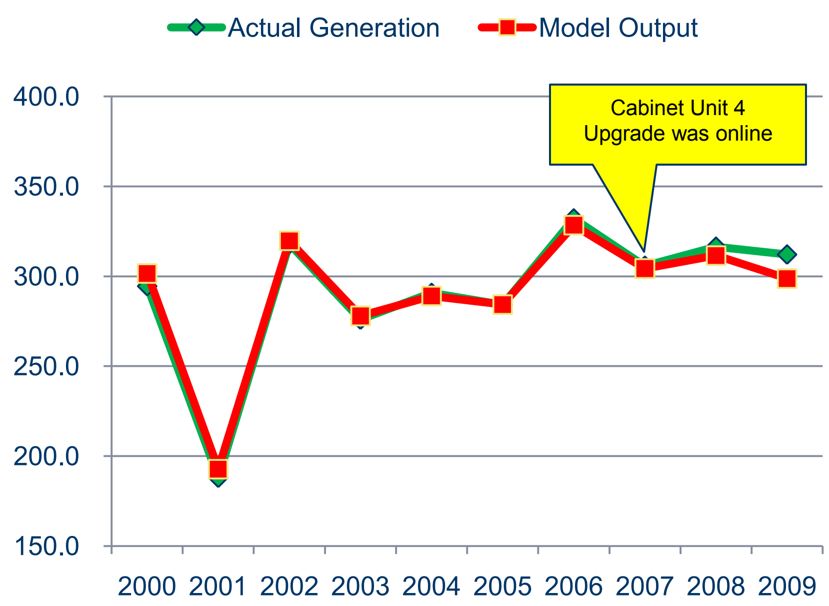
- Hourly model, with potential for more granularity (i.e., intra-hour analyses)
- Each project is represented in detail, including:
  - Accurate (piece-wise) reflection of individual turbine efficiency curves;
  - Physical and license-constrained reservoir elevations;
  - Tailrace elevations;
  - Minimum and maximum flow constraints; and
  - Other regulation constraints
- Shapes generation into the most beneficial (i.e., most economic) time periods using storage reservoirs
- Maximizes generation by flowing water through the most efficient points on each turbine's power curve

Model vs Actual Generation- Clark Fork Example (aMW)

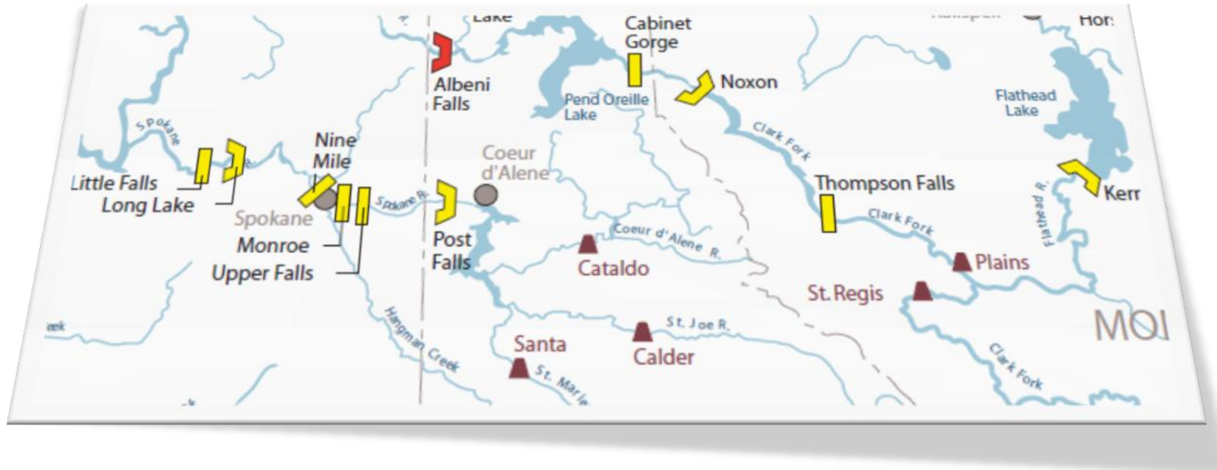
Before Benchmarking



After Benchmarking



Next Steps



- **Complete Spokane River Model**
- **Complete Upgrade Analyses for the Following Projects**
  - Long Lake–new power house with 1 or 2 new units (30-120 MW, pumped storage)
  - Post Falls–replace powerhouse with between 1 and 3 new units (25-40 MW)
  - Monroe Street–one additional unit (~45 MW capacity)
  - Cabinet Gorge–one or 2 new units (60-120 MW, help with total dissolved gas mitigation)

Resource Adequacy

Clint Kalich

Technical Advisory Committee Meeting #1

2011 Electric Integrated Resource Plan

May 27, 2010

Concepts

- Generator Capacity Services
  - Energy
  - Reserve for forced outages and extended load (i.e., hot and cold weather) excursions
  - Regulating
  - Load following
  - Energy imbalance (mismatches between scheduled and actual generation)

- Traditional Resource Planning Methodologies
  - Energy L&R
    - Average forecast
    - Plus contingency energy
  - Capacity L&R
    - Average peak load
    - Plus planning margin

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Capacity Services Definitions

- Energy
  - Average capability to do work over a given time horizon
  - Conversion of fuel (water, wind, coal, gas, wood, etc.) to electricity

- Planning Reserves
  - Operating Reserve – capacity held back to cover forced outages and non-firm imports
    - 5%-7%-5% of online capacity for hydro-thermal-wind
    - at minimum half must be “spinning;” the remaining can be “non-spinning”
    - first hour of system contingency met through NWPP Reserve Sharing Group
  - Regulating Reserve – spinning reserve immediately responsive to AGC
    - generally a seconds-to-5-minute product

Capacity Services Definitions, Cont.

- Planning Reserves, Cont.
  - Load Following
    - Reserve-like product to follow variations in load and resources across the trading hour
      - beyond 5 minutes
      - can be spinning or non-spinning (traditionally spinning in the NW)
  - Energy Imbalance
    - "Make-up energy"
    - Covers variations between hourly scheduled and actual generation levels

Potential Changes to L&R Planning Margin

- Operating Reserve
  - 5% hydro and wind
  - 7% thermal
- Regulating Reserve: ~25 MW
- Load Following: TBD
- Energy Imbalance
  - Wind and solar ~10-15%
  - Load ~2%
- Weather Variation: TBD

Key Considerations by Resource

- All Resources
  - Abilities to provide individual capacity services discussed above
  - Potential maintenance schedules
  - Forced outage characteristics

- Hydro
  - Sustained peaking capabilities
  - Run-of-river vs. reservoir storage vs. pumped storage
  - Upstream inflows during critical events

- Gas-Fired Thermals
  - Weather impacts
  - Resource type (peaking versus base-load, etc.)
  - Fuel availability over peak events

Key Considerations by Resource, Cont.

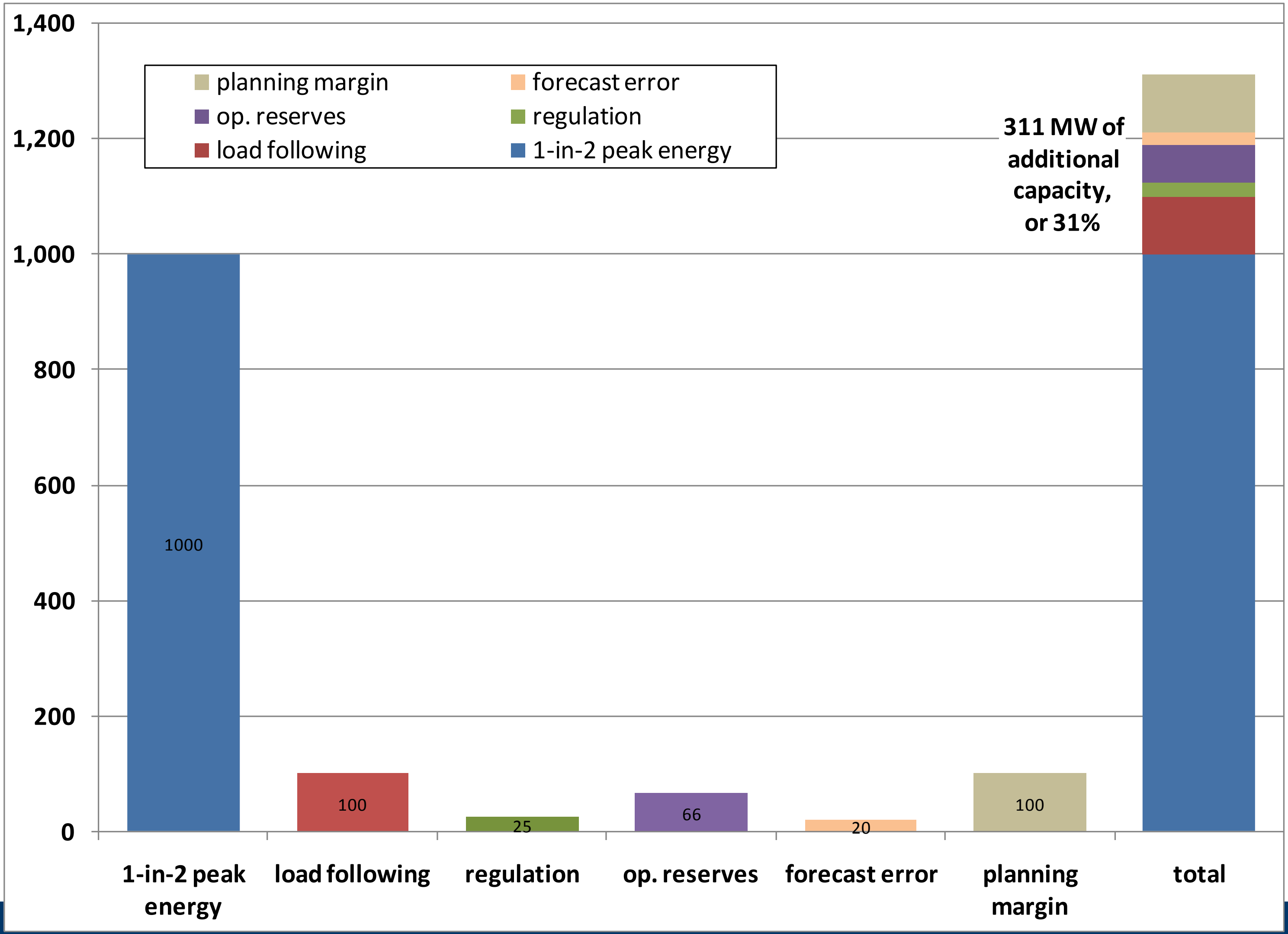
- Coal
  - Ramp rates

- Load Interruption (aka demand-side management)
  - Coincidence of measure with system peaking periods
  - Frequency of interruption rights
  - Duration of interruption rights
  - Sustainability of interruption savings
    - Especially when looking outside of industrial/large commercial classes

Key Considerations by Resource, Cont.

- Market Purchases
  - How much is available during critical events
    - Transmission constraints
    - Surpluses on 3rd party systems
  - "Firmness" of anticipated deliveries
    - Is 3rd party "firming" the sale?
    - In other words, will purchases be cut during critical events to serve 3rd-party system?

Illustration of Capacity Obligation



Metrics to Measure Resource Adequacy

- Loss of Load Probability (LOLP)
  - Percent of iterations that have at least one loss of load event
- Loss of Load Expectation (LOLE)
  - Days with an event; units are the number of days per year
- Loss of Load Hours (LOLH)
  - Hours with an event; units are the number of hours per year
- Expected or Equivalent Unserved Energy (EUE)
  - Average quantity of energy not served in each iteration (MWh)

Planning Margin Perspectives

- Avista Margin History
  - 10% of peak load, plus 90 MW (1980s-2008)
  - 15% of peak load (2009)

- FERC Standard Market Design: 12-18%

- Northwest Power and Conservation Council: 23% winter (January) , 24% summer (July)

- Avista 2011 IRP Margin
  - Based on probabilistic reliability study
    - LOLP, LOLE, LOLH, EUE metrics
      - 5% LOLP (proposed)
      - 1 day in 10 years LOLE (proposed)
      - LOLH and EUE (TBD)

Loss of Load Probability

James Gall

Technical Advisory Committee Meeting #1

2011 Electric Integrated Resource Plan

May 27, 2010

Overview

Why

Avista's capacity planning margin is 15% of peak load. Without conducting a statistical analysis regarding probability of no serving all customer load due to lack of generation, the 15% should be questioned- especially as additional variable generation is added.

Modeling

- 8,760 hours for ~1,000 potential outcomes (draws, games, iterations, etc)
- Study 2012, '16, '20, '24, and '28
- Randomizes: forced outages, temperature, loads, wind generation, and hydro conditions
- Takes into account hydro constraints, market purchases, and reserves including: within hour load variation, variable resource reserves, and operating reserves
- Can illustrate benefits using demand response and federal emergency hydro

For the Next TAC meeting

- Detailed presentation on how model works
- Finalize 2012 study (final load & wind modules)
- Market reliance scenarios
- Test 2009 IRP’s Preferred Resource Strategy for later years

Energy Efficiency & Demand Response

Lori Hermanson

Technical Advisory Committee Meeting #1

2011 Electric Integrated Resource Plan

May 27, 2010

Energy Efficiency Progress Since Last IRP

- **Targets and Year-to-Date Achievement**
- **I-937 Plan for Washington accepted with conditions**
  - Target for Washington electric only
  - Year-to-date results toward I-937 targets
- **Demand Response Pilot**
  - Tested and improved equipment capability on Avista's system
  - Initiated 10 successful events of either cycling heating or AC or shutting off water heaters for 2-4 hrs
  - Proved customers' strong willingness to participate with few opt-outs
  - Low northwest on/off-peak price differentials makes these programs not cost effective

Next Steps for 2011 IRP

Conservation Potential Assessment (all states, gas/electric)

- Issue RFP in June
- Complete RFP by October
- Evaluate TRC cost-effectiveness with draft IRP electric price forecast in November
- Establish energy efficiency placeholder levels in early January
- Update with finalized IRP electric price forecast in late January
- Finalize energy efficiency levels in early February
- Draft energy efficiency and demand response section of IRP document

Avista's 2011 Electric Integrated Resource Plan

Technical Advisory Committee Meeting No. 2 Agenda

September 8th and 9th, 2010
Avista Headquarters – Spokane, Washington

Wednesday, September 8th

Leave from Avista	**8:30 am**
Lancaster Tour	**9:30 am**
Rathdrum CT & Boulder Park Stops	
Lunch – Sawtooth Grill	**12:30 pm**
Upper Falls & Monroe Street	**1:45 pm**
Return to Avista	**4:00 pm**

Thursday, September 9, 2010
Avista Conference Room 130

Topic	Time	Staff
1. Introduction	10:00	Storro
2. Resource Assumptions	10:05	Lyons
3. Reliability Planning	10:35	Gall
4. Lunch	11:30	
5. Sustainability Report	12:30	Wuerst
6. Combined Heat and Power Generation	1:30	Dempsey
7. Energy Efficiency	2:30	Hermanson
8. Adjourn	3:30	

Resource Assumptions

John Lyons

Technical Advisory Committee Meeting #2

2011 Electric Integrated Resource Plan

September 9, 2010

Supply Side Resource Data Sources

- Power Council – 6th Power Plan
- Resource lists developed internally from:
  - Trade journals
  - Press releases from other companies
  - Engineering studies and models
  - State commission announcements
  - Proposals from developers
- Consulting firms/reports
- State and federal resource studies
- Data sources are used to check and refine generic resource assumptions

Resource Updates from 2009 IRP

- Focusing on resource options identified in the 6th Power Plan
- Lancaster PPA began serving Avista Utilities load on January 1, 2010
- 150 MW of Northwest based wind in the 2009 Preferred Resource Strategy has been postponed
- Noxon Rapids Unit #3 upgrade completed in April 2010; Unit #2 and #4 upgrades scheduled for April 2011 and April 2012
- Started work on the Nine Mile upgrade

Natural Gas-Fired Resources

Resource Type	First Year	Size (MW)	Levelized Overnight Costs (2012 $/MWh) *	Capital Cost Excludes AFUDC (Nominal 2012)
SCCT (aero)	2014	46	$106	$1,033/kW
SCCT (frame)	2014	83	$114	$591/kW
Hybrid SCCT	2014	94	$103	$1,107/kW
CCCT (air)	2016	270	$88	$1,105/kW
CCCT (water)	2016	275	$85	$1,053/kW
Small Cogeneration	2015	5	$112	$3,472/kW
Reciprocating Engine	2014	99	$111	$1,139 /kW

* Prices are based on a preliminary gas price forecast

Other Thermal Resources

Resource Type	First Year	Size (MW)	Levelized Overnight Costs (2012 $/MWh)	Capital Cost Excludes AFUDC (Nominal 2012)
Coal (Ultra-critical)	2018	300	$123	$3,250/kW
Coal (IGCC)	2014	300	$138	$3,252/kW
Coal (IGCC w/sequestration)	2018	250	$156	$4,722/kW
Nuclear	2021	500	$150	$5,802/kW

Renewable Resources

Resource Type	First Year	Size (MW)	Levelized Overnight Costs (2012 $/MWh)	Capital Cost Excludes AFUDC (Nominal 2012)
Wind	2016	50	$106	$1,951/kW
Geothermal	2017	15	$110	$4,463/kW
Wood Biomass	2015	25	$166	$3,710/kW
Landfill Gas	2014	3.2	$60	$2,023/kW
Manure Digester	2013	0.85	$111	$4,304/kW
Waste Water Treatment	2014	0.85	$114	$4,304/kW
Solar Photovoltaic	2014	5	$429	$7,140/kW
Solar Thermal	2016	25	$195	$4,751/kW

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Avista Hydro Upgrades

Resource Type	Year	Size (MW)
Little Falls 1 Upgrade	2014	1.0
Little Falls 2 Upgrade	2015	1.0
Little Falls 3 Upgrade	2016	1.0
Little Falls 4 Upgrade	2017	1.0
Post Falls New Powerhouse	TBD	TBD
Upper Falls Upgrade	2019	2.0
Long Lake Second Powerhouse / Pumped Storage	2020	60
Long Lake Second Powerhouse	2020	50 – 60
Cabinet Gorge Unit 5	2015	50
Monroe Street Unit 2	TBD	37.5

Cost estimates for these potential Avista resource upgrades will be presented at a later TAC meeting after the estimates are further developed

Reliability Planning

James Gall

Technical Advisory Committee Meeting #2

2011 Electric Integrated Resource Plan

September 9, 2010

Overview

Objective

Develop a planning tool to help quantify the amount of resources need above expected peak load

Why

A 15% capacity planning margin is currently added to forecast peak load. Without conducting a statistical analysis regarding the probability of not serving all customer load and reserve requirements, the 15% should be questioned- especially as variable generation is added.

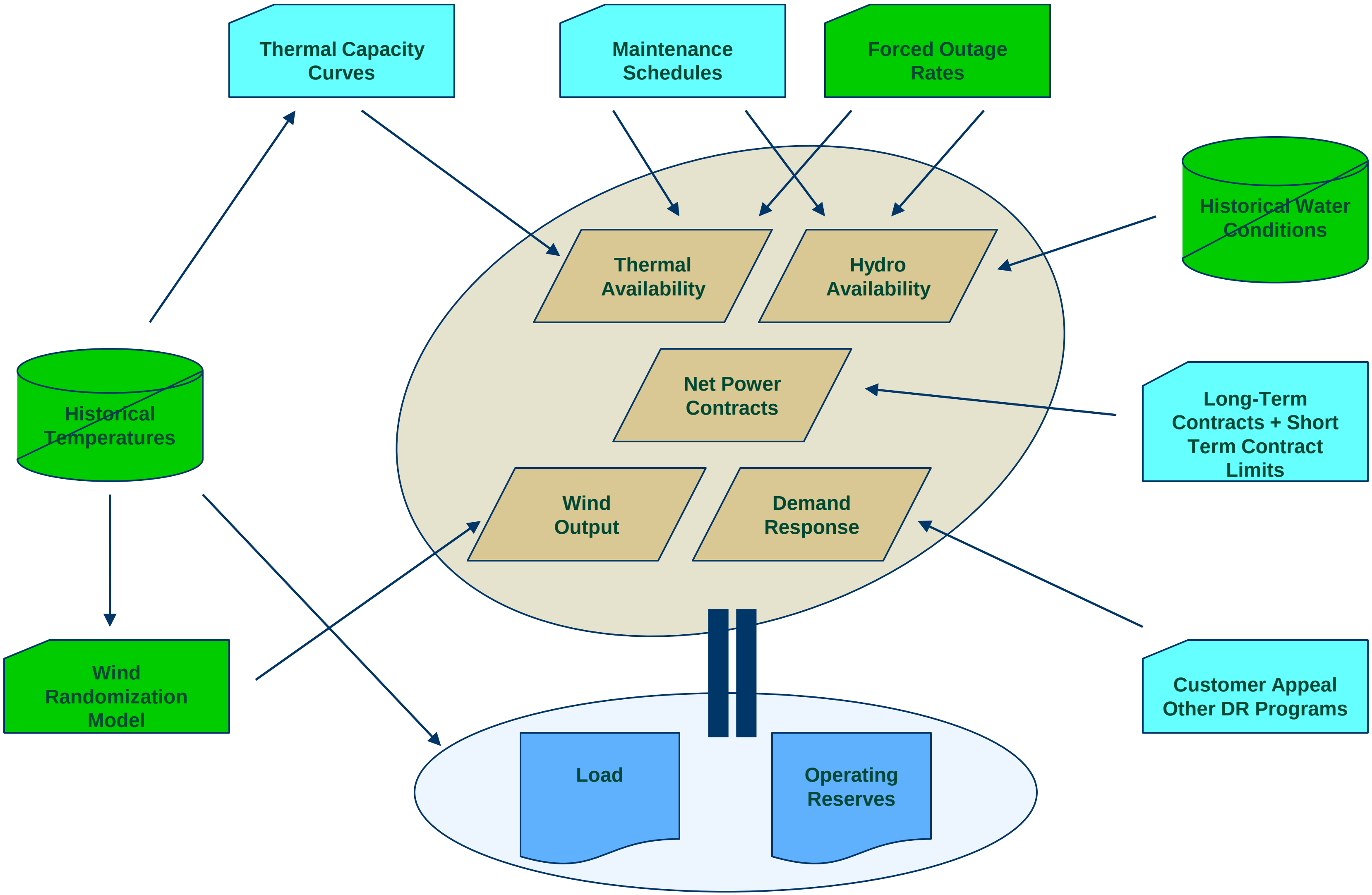
End Result

Determine load variation adder to include in long-term load & resource balance (In addition to regulating reserves and regulating margin)

Modeling

- 8,760 hours for 800 potential outcomes (draws, games, iterations, etc)
- This presentation includes 2012 and 2017
- Other years of interest 2016, 2020, 2025, 2027
- Randomizes: forced outages, temperature, loads, wind generation, and hydro conditions
- Includes hydro constraints, short-term market purchases, and reserves including: within hour load variation, variable resource reserves, and operating reserves
- Can illustrate benefits of using demand response and federal hydro

Reliability Model



Loads

- Load shapes are derived from historic daily high and low temperatures
- Uses 120 years of Spokane temperatures
- The average load of all iterations matches the energy load forecast
- The average of the peak load is within the standard error of the peak load forecast
- Hourly load forecast uses monthly regression model with coefficients:
  - hour, day, temperature, and major weather event triggers

Hydro

- Randomly selects a hydro year between 1928 and 1999
- Each hydro year includes monthly energy averages
- Run-of-river facilities
  - Monthly energy average is used for all hours of the month
  - No shaping or reserves are assumed to be available
- Storage facilities
  - Monthly average generation equals the “drawn” hydro level
  - In case of planned/forced outage, water can be spilled
  - Linear program moves energy into hours needed to meet load
  - Reservoir min and max levels, ramping rates, and daily limits are enforced
  - Unused capacity is held as operating reserves

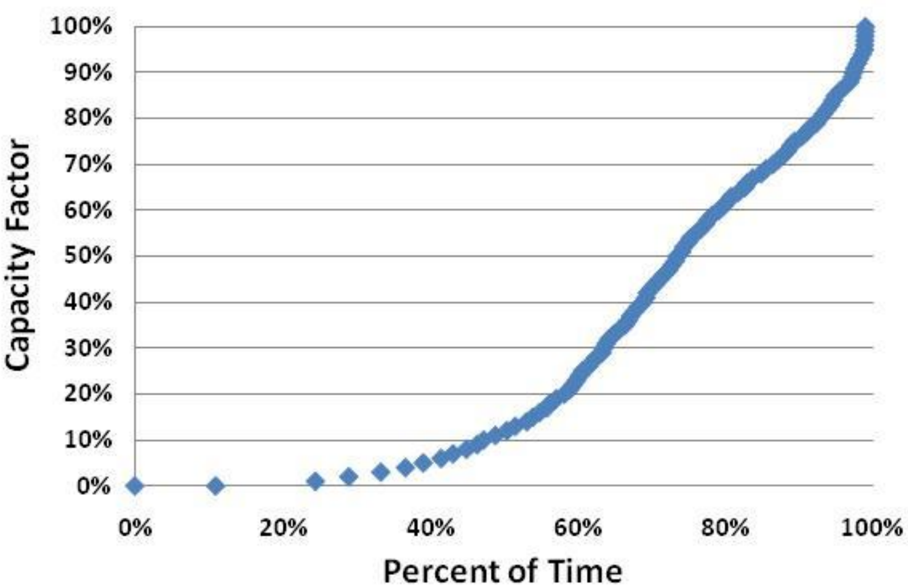
Thermal

- Plants are considered available rather than dispatched
- Temperature dependency
  - Gas-fired facilities use capacity based upon location temperature
  - Temperatures are randomly drawn and are the same as the temperatures used in the load calculation
- Forced outages
  - Input forced outage rate and mean-time-to-repair
  - Outages occur randomly using a frequency and duration method
  - Ramp rates are used following outages
- Maintenance schedules
  - Planned maintenance schedules are assumed
  - Typical outages are in April though June

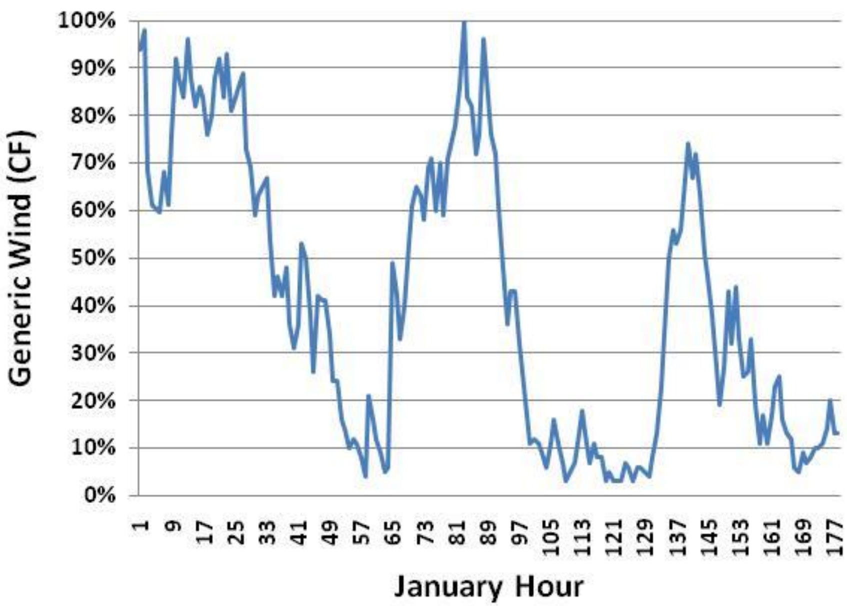
Wind

- Uses monthly on/off peak duration curves *(see chart on left of January on-peak hours)*
- Random number selects position on curve
- Following hour is correlated to previous hour using a correlation factor and variation

January On-Peak Wind Duration Curve



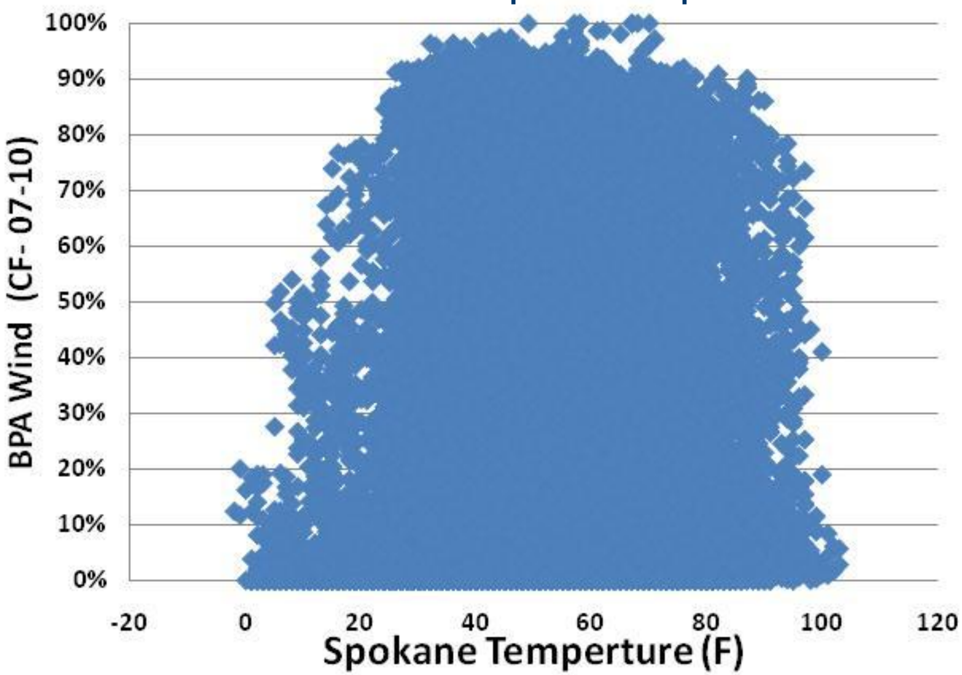
January Hourly Simulated Wind Generation



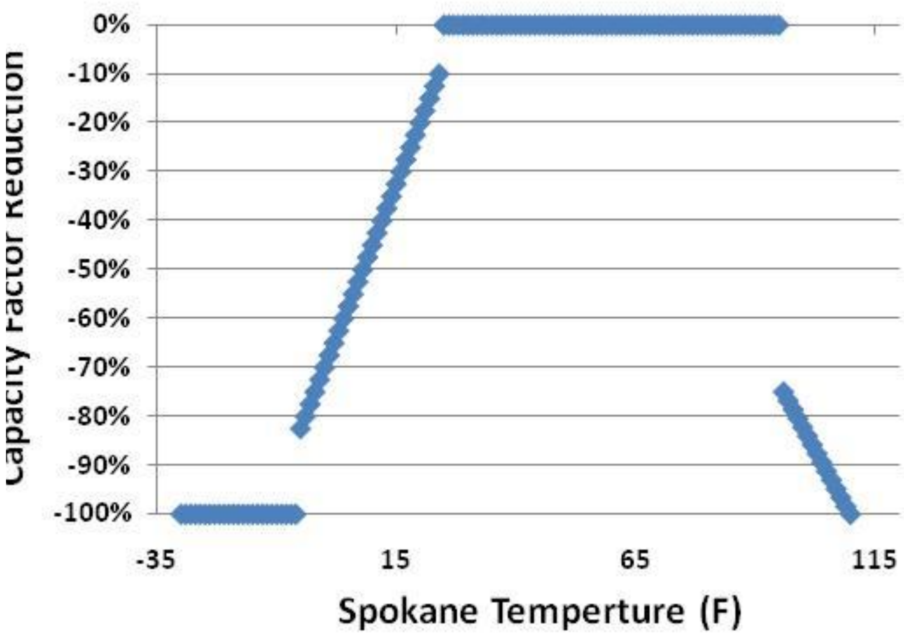
Wind *(continued)*

- Historical data from BPA control area shows generation is mitigated in below 32° F and above 95° F. *(see chart below on left)*
- Capacity factors are reduced at specified temps to model this phenomenon, *(see chart on right)*

BPA Wind CF vs Spokane Temperatures



Capacity Factor Adjustments for Specific Temperatures



Demand Curtailment

- Customer appeal
  - Public appeal to all customers to conserve energy, radio/TV broadcasts
  - Base case includes 25 MW reductions up to two times per year for hours across the peak
- Industrial process
  - Not included in base case
  - Designed to shift load from peak hours
- Sensitivities studies can help determine value of programs

Reserves

- Operating Reserves:
  - 5% hydro and 7% thermal are simplified to 6% of load minus market purchases
  - Simplification allows linearization of the objective function
- Regulating Margin:
  - 1.6% of average hourly load level (based on historical average of max load within hour versus average load)
  - Capacity is for within hour load variations
- Intermediate (Wind) Resource Regulation:
  - Lesser of 10% of nameplate capacity or generation amount
- Reserves are met by excess hydro capacity and thermal generation in excess of load

Third Party Transactions

- Long term firm power agreements are considered in the objective function
- Short-term transactions are treated as available market purchase, no short-term sales are considered
- In tight market conditions (low or high temperatures) market availability is limited to 300 MW on-peak and 500 MW off-peak.
- In other market conditions the market availability is limited to 500 MW on-peak and 750 MW off-peak.
- Scenario analysis will be performed to understand the change in loss of load given these assumptions

Objective Function

Load Serving

- Load [SM]

+ Available thermal capacity [RM]

+ Dispatched hydro capability [LP]

+ Wind generation [SM/RM]

+/- LT Contracts

+ Federal Hydro (optional)

+ Demand Curtailment (optional) [LP]

+ Market Purchases

>= 0 or event triggered

Operating Reserves

- Operating Reserve Requirement

- Intra-hour load regulation

- Wind regulation

+ Available thermal capacity

+ Unused hydro capacity

>= 0 or event triggered

SM: Stochastic Model
RM: Randomization Model
LP: Linear Program

Metrics

- Monthly and Annual Data
- Loss of Load Probability (LOLP): percent of iterations with a reserve or load loss
  - Calculation: iterations with event / # of iterations
  - Metric: 5% or less
- Loss of Load Hour (LOLH): expected number of hours each year with a load loss
  - Calculation: total hours with event / (# of iterations)
  - Metric: 0.24 (24 hours per 10 years)
- Loss of Load Expectation (LOLE): expected number of days each year with a load loss
  - Calculation: Days with event / # of iterations
  - Metric: 1 day in 10 years or 0.10 or less [or do we want 0.05, 1 in 20?]
- Equivalent Unserved Energy (EUE): average MWh of lost load over a year

2012 Assumptions

- Noxon Rapids 4 is on maintenance Jan – mid March
- 300 MW on-peak market
- No Federal hydro release

2012 Draft Results

Item	Annual Results	Target
LOLP	4.8%	Below 5%
LOLH	0.255	Not below 0.24
LOLE	0.066	Below 0.10
EUE	38.47	TBD

Results	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Iterations												
Load loss w/o reserves	7	2	3	0	0	0	2	1	0	0	0	1
Load loss w/ reserves	5	2	3	0	0	0	2	1	0	0	0	1
Reserve violatons	16	3	0	0	0	0	7	4	0	0	0	0
Total Load Loss or Reserve Violatons	**20**	**5**	**3**	**0**	**0**	**0**	**7**	**5**	**0**	**0**	**0**	**1**
LOLP	**2.5%**	**0.6%**	**0.4%**	**0.0%**	**0.0%**	**0.0%**	**0.9%**	**0.6%**	**0.0%**	**0.0%**	**0.0%**	**0.1%**
Hours at Loss												
Load loss w/o reserves	79	31	22	0	0	0	7	6	0	0	0	10
Load loss w/ reserves	64	27	20	0	0	0	6	6	0	0	0	8
Reserve violations	37	7	0	0	0	0	29	9	0	0	0	0
Total Load Loss or Reserve Violations	**98**	**34**	**20**	**0**	**0**	**0**	**29**	**15**	**0**	**0**	**0**	**8**
LOLH	**0.12**	**0.04**	**0.03**	**-**	**-**	**-**	**0.04**	**0.02**	**-**	**-**	**-**	**0.01**
Other Data												
Reserves Used (MWh/Iterations)	12	8	5	-	-	-	1	1	-	-	-	2
Unserved Energy (MWh/Iterations)	14	8	6	-	-	-	1	1	-	-	-	3
Reserve Violations (MWh/Iterations)	3	0	-	-	-	-	2	0	-	-	-	-
Unserved Energy (MWh/Iterations)	2	0	1	-	-	-	0	0	-	-	-	0
EUE: Unserved Energy/Reserves (MWh/Iteratons)	**4.7**	**0.7**	**1.2**	**0.0**	**0.0**	**0.0**	**2.2**	**0.3**	**0.0**	**0.0**	**0.0**	**0.1**
Market used (iterations)	286	120	39	6	518	548	349	374	92	56	91	37
Market used (hours)	5,100	1,450	968	19	5,785	6,136	4,072	8,246	1,179	727	2,055	332
Probability of market	35.8%	15.0%	4.9%	0.8%	64.8%	68.5%	43.6%	46.8%	11.5%	7.0%	11.4%	4.6%

2012 Draft Results

(What if Noxon 4 was not on Maintenance?)

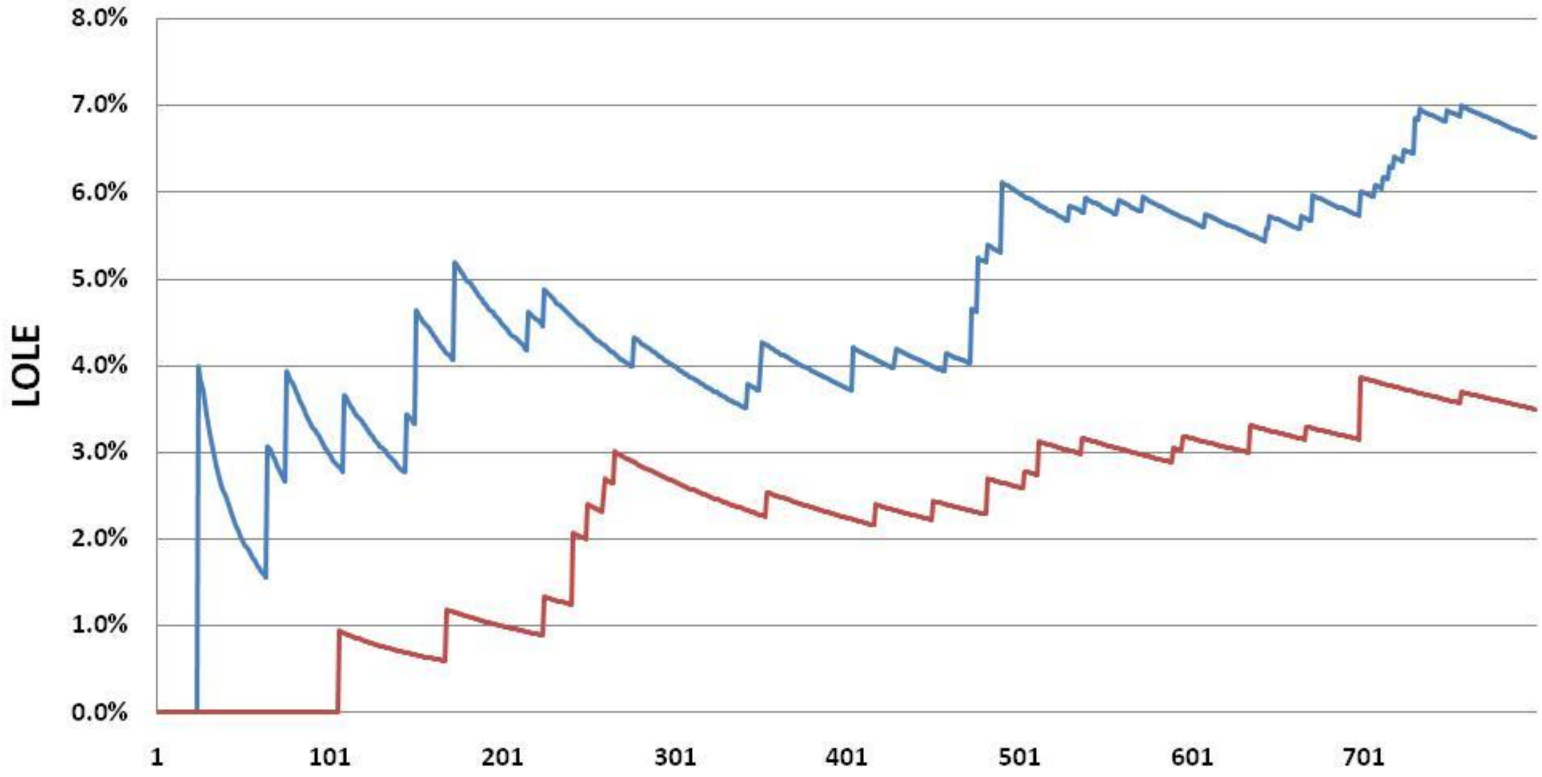
Item	Annual Results	Target
LOLP	2.5%	Below 5%
LOLH	0.14	Below 0.24
LOLE	0.035	Below 0.10
EUE	18.99	TBD

Results	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Iterations												
Load loss w/o reserves	1	1	0	0	0	0	0	0	0	0	2	0
Load loss w/ reserves	1	1	0	0	0	0	0	0	0	0	2	0
Reserve violatons	7	0	0	0	1	0	4	2	1	0	0	2
Total Load Loss or Reserve Violatons	**8**	**1**	**0**	**0**	**1**	**0**	**4**	**2**	**1**	**0**	**2**	**2**
LOLP	**1.0%**	**0.1%**	**0.0%**	**0.0%**	**0.1%**	**0.0%**	**0.5%**	**0.3%**	**0.1%**	**0.0%**	**0.3%**	**0.3%**
Hours at Loss												
Load loss w/o reserves	54	13	0	0	0	0	0	0	0	0	9	0
Load loss w/ reserves	51	12	0	0	0	0	0	0	0	0	6	0
Reserve violations	15	0	0	0	2	0	10	8	2	0	0	6
Total Load Loss or Reserve Violations	**66**	**12**	**0**	**0**	**2**	**0**	**10**	**8**	**2**	**0**	**6**	**6**
LOLH	**0.08**	**0.02**	**-**	**-**	**0.00**	**-**	**0.01**	**0.01**	**0.00**	**-**	**0.01**	**0.01**
Other Data												
Reserves Used (MWh/Iterations)	12	2	-	-	-	-	-	-	-	-	1	-
Unserved Energy (MWh/Iterations)	13	2	-	-	-	-	-	-	-	-	1	-
Reserve Violations (MWh/Iterations)	1	-	-	-	0	-	0	0	0	-	-	0
Unserved Energy (MWh/Iterations)	1	0	-	-	-	-	-	-	-	-	0	-
EUE: Unserved Energy/Reserves (MWh/Iteratons)	**2.1**	**0.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.5**	**0.4**	**0.0**	**0.0**	**0.4**	**0.2**
Market used (iterations)	203	83	49	6	539	560	352	382	82	41	95	34
Market used (hours)	3,954	1,110	985	8	5,712	5,971	3,822	8,183	1,039	485	2,353	267
Probability of market	25.4%	10.4%	6.1%	0.8%	67.4%	70.0%	44.0%	47.8%	10.3%	5.1%	11.9%	4.3%

Results (DRAFT)

Study	LOLP (% of draws)	LOLH (Avg un-served hours)	LOLE (Avg un-served days)	EUE (Avg Un-served MWh)
2012	4.8%	0.255	0.066	38.47
2012 (Noxon Available all Year)	2.5%	0.140	0.035	18.99
2017 (with 150 MW wind)	1.5%	0.099	0.019	20.75
2017 (No Wind)	1.9%	0.110	0.028	20.17

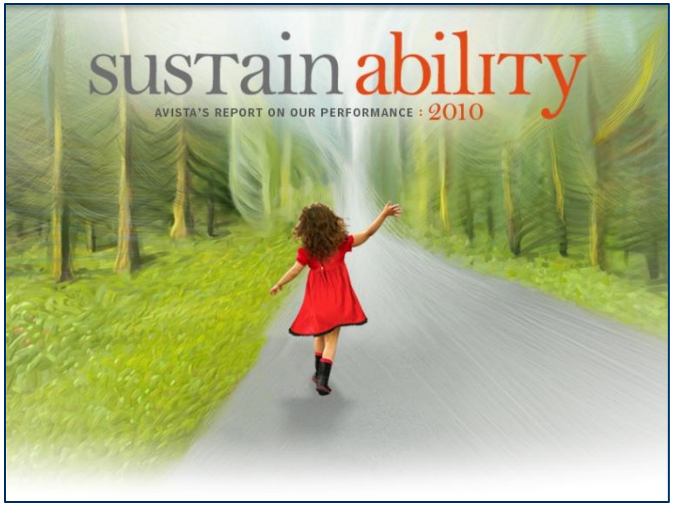
How Many Iterations Is Enough?



Next Steps For Reliability Planning

- Study additional years
- Re-evaluate number of draws
- Run scenarios for different market availability amounts, demand curtailment, and wind penetration
- Evaluate moving model from Excel/WB to a different platform to increase speed
- Lock down acceptable metrics for load loss
- Develop new planning margin based upon results of the study
- More to come at a future TAC meeting

AVISTA



Avista's 2010 Sustainability Report

TAC Presentation

SEPT. 9, 2010

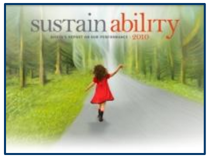
"To be persuasive, we must be believable; to be believable, we must be credible; to be credible, we must be truthful."

Edward R. Murrow

Our commitment to sustainability:

Avista's goal is to provide energy for today's customers while preserving the ability of future generations to do the same.

We strive to engage our stakeholders -- customers, investors, employees, communities and others – in achieving this goal.



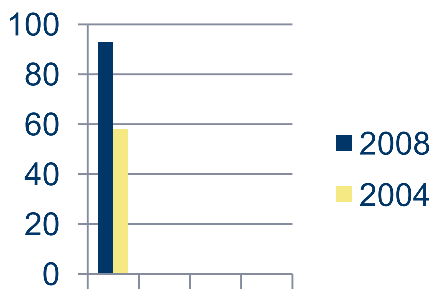
Why do a Corporate Sustainability Report?

"The time has come to usher in a new era…of responsibility."
President Barak Obama

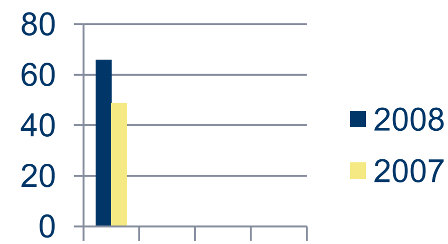
- Trust and transparency have been found to be as important to corporate reputation as service quality.

- CSR is a means to provide enterprise-wide information in a single location about our company's strategies and actions impacting ***people, planet and performance*** – topics key to building trust.

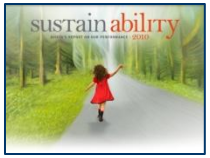
- An increasing number of investors, customers and other stakeholders and prospective employee are looking for this information.



# of S&P 100 companies including web-based sustainability information



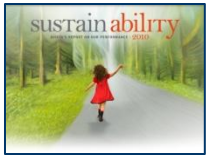
# of S&P 100 companies producing formal sustainability reports



Source: Social Investment Forum, Dec. 2009)

Objectives of Avista's Sustainability Report:

- Be a launch pad for initiating stakeholder conversations and enhancing engagement, internally and externally
- Provide information about Avista's environmental, operations, governance and socially responsible programs and actions and business practices
- Act as a catalyst for internal strategy and goal setting



What goes into a sustainability report?

- Sustainability Action Team – Internal, cross-enterprise

Environmental, Safety, Production & Generation, DSM/Energy Solutions, Power Supply, Facilities, Supply Chain, Human Resources, Finance, Corporate Communications

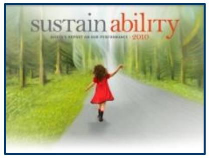
- Prioritizing topics for inclusion
  - Assess stakeholder interest
  - Assess society's interest
  - Determine business position
  - Determine impact on reputation
  - Public or reportable information

Global Reporting Initiative™

113 Performance indicators reported on

- Structure of the report

- Distribution of the report



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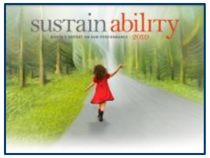
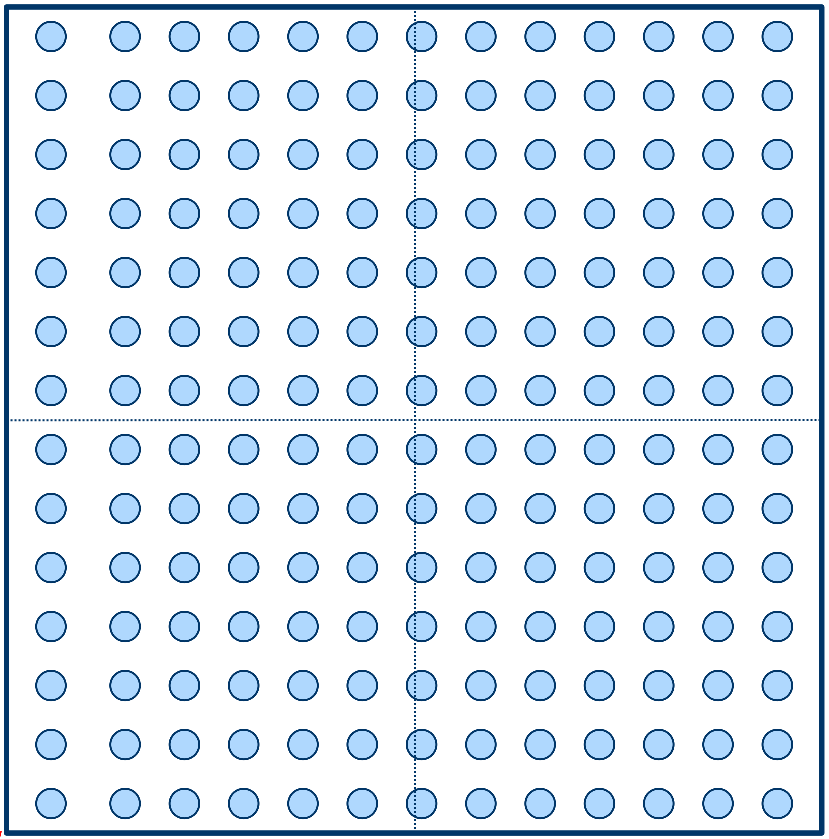
Considerations for Future Sustainability Reporting

- Review of 2010 report by GRI
- Determine project’s scope and direction and align these with Avista’s strategic direction
- Initiate in-depth conversations with departments across the company to determine additional reporting and data assurance opportunities
- Expand the number of external stakeholders who give feedback on the report
- Increase the visibility of Avista’s sustainability report and practices across stakeholders and other audiences without “green washing”



AVISTA

Materiality: Which information to Include?



Topics to Consider

- Avista's Energy Efficiency
- Biodiversity
- Corporate Citizenship
- Customer Satisfaction
- Direct Use of Natural Gas
- DSM Programs
- Employee Satisfaction
- Energy Security
- Environmental Performance
- Ethical Business Practices
- Executive Compensation
- Financial Performance
- GHG Footprint
- Global Climate Change
- Governance
- Human Resources
- NGO Relations
- Public Policy
- Rates
- Resource Planning
- Safety
- Stakeholder Engagement
- System Reliability
- Supply Chain
- Waste Discharge
- Water use
- Work Force Diversity

Others??

Cogeneration Case Study

Thomas C. Dempsey, PE
Manager Generation Joint Projects

Technical Advisory Committee Meeting #2

2011 Electric Integrated Resource Plan

September 9, 2010

Cogeneration

"Cogeneration is the use of a heat engine or a power station to simultaneously generate both electricity and useful heat."- Wikipedia

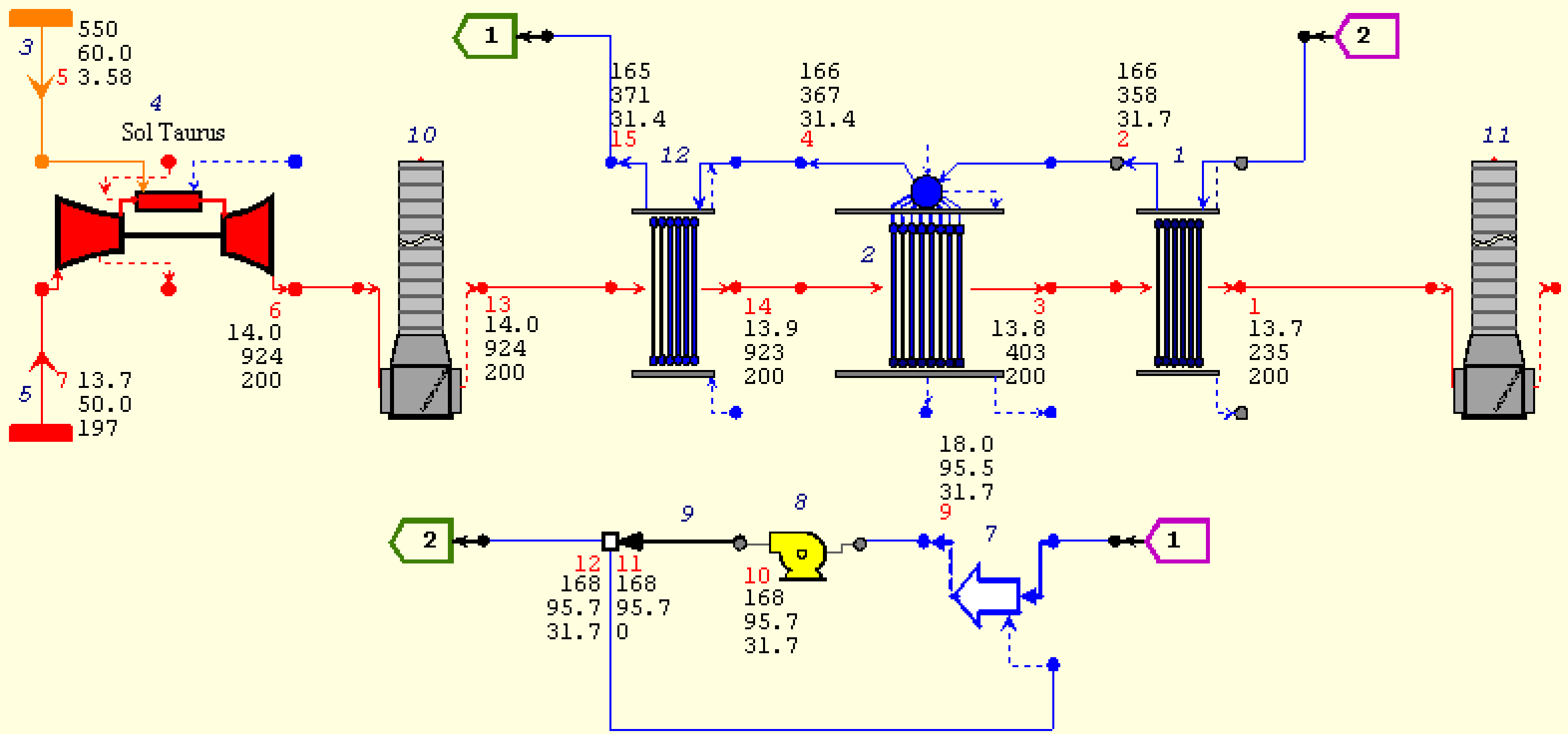
"A combined cycle is characteristic of a power producing engine or plant that employs more than one thermodynamic cycle"- Wikipedia

Cogeneration= Power [kW]+ Heat [Btu/hr]

Combined Cycle = Gas Turbine Power [kW] + Steam Turbine Power [kW]

Cogeneration Design

Solar Taurus 70 Combined Heat and Power



Net power	6801	kW
Net process output	35606	kBTU/h
CHP efficiency	82.62	%
PURPA efficiency	57.61	%
Net heat rate(HHV)	11587	BTU/kWh
Net fuel input(HHV)	78808	kBTU/h
Energy chargeable to power	32897	kBTU/h
Electric efficiency on chargeable energy	70.55	%

Efficiency of a Combined Cycle Plant

Efficiency = What you get/What you pay for
Heat Rate = What you pay for/What you get
Heat Rate = 1/Efficiency

How does the efficiency of a combined cycle plant compare with that of a cogeneration facility? Shown below are numbers typical to advanced combined cycle combustion turbine facilities. What we pay for is the fuel expressed in terms of British Thermal Units [Btu's]. What we "get" is *electrical* energy expressed in terms of kilowatt-hours [kWh's]. **Advanced combined cycle turbines have higher heating value net efficiencies around 50%.**

$$CombinedCycleEfficiency = \frac{1}{NetHeatRate}$$

$$CombinedCycleEfficiency = \frac{1}{6800\,\frac{Btu}{kWh}} \times 3412\,\frac{Btu}{kWh} = 50\%$$

NOTE: Btu's and kWh's are both units of "energy". We multiply by the unit conversion factor of 3412 in order to arrive at a dimensionless number which we can express as percent.

Efficiency of a Cogeneration Facility

Efficiency = What you get/What you pay for

There are many ways of looking at the efficiency of a cogeneration facility. The calculation below is calculated strictly in terms of useful energy divided by fuel energy. **For the example turbine modeled, the thermal efficiency as calculated below is much higher than the thermal efficiency for my example combined cycle plant.**

$$CogenEfficiency = \frac{Electricity + Heat}{Fuel}$$

$$CogenCycleEfficiency = \frac{6801kW \times \frac{3.412kBtu}{kWh} + 35606\frac{kBtu}{h}}{78808\frac{kBtu}{h}}$$

$$CogenCycleEfficiency = 75\%$$

NOTE: Solar Taurus 70, Spokane Elevation, 150 psig steam, no duct firing

Comparing Combined Cycle with Cogen on Equivalent Terms

3.5 Energy Accounting

In a pure power plant, efficiency is simply defined as:

Electric Efficiency = Power Out/Fuel In

In most cases, this is expressed as a percentage, requiring that the numerator and denominator be quantified in the same units. Distinctions are made as to whether the ´power out´ is the gross power (at the generator terminals) or the net power (that available to the grid after deducting plant auxiliary loads and transformer losses). Separate distinctions indicate whether the energy flow rate cited as ´fuel in´ is the LHV or HHV fuel energy flow rate.

An alternate comparison of output power with fuel energy consumption is the heat rate, essentially the reciprocal of the efficiency.

Heat Rate = Fuel In/Power Out

Unlike efficiency, heat rate is generally left in a dimensional form, Btu/kWhr or kJ/kWhr.

The efficiency of a cogeneration plant, that produces useful heat as well as electric power, may be expressed as a *Total Efficiency*, also called the *CHP Efficiency* (Combined Heat & Power), or as a *PURPA Efficiency* (Public Utilities Regulatory Policy Act of 1979, a US regulatory measure of efficiency):

Total (CHP) Efficiency = (Power Out + Net Process Heat Out)/Fuel In

PURPA Efficiency = (Power Out + 1/2 Net Process Heat Out)/Fuel In

Comparing Combined Cycle with Cogen on Equivalent Terms

Assumptions

1. The boiler efficiency of the auxiliary boiler is assumed based on typical industry values.
2. Thermoflex 20 model of a Solar Taurus 70, 150 psig steam, Spokane Elevation

Constants:

Cogen simple cycle net heat rate $CGSS_{HR} := 11587 \frac{BTU}{kW \cdot hr}$ $SteamEnergy := 35.606 \cdot \frac{MillionBTU}{hr}$

Auxiliary boiler efficiency $B_{eff} := 82 \cdot \%$ $Power := 6801 \cdot kW$

Case 1 COMBINED CYCLE- In this case we are using a combined cycle unit to generate our electrical needs and a separate auxiliary boiler to generate the steam we need.

Combined cycle net heat rate $CC_{HR} := 6800 \frac{BTU}{kW \cdot hr}$

Combined cycle fuel consumption $CC_{gasin} := CC_{HR} \cdot Power$ $CC_{gasin} = 46.2 \cdot \frac{MillionBTU}{hr}$

AUXILIARY BOILER:

$$SteamEnergy = 35.6 \cdot \frac{MillionBTU}{hr}$$

$$AuxBoiler_{gasin} := \frac{SteamEnergy}{B_{eff}} \qquad AuxBoiler_{gasin} = 43.4 \cdot \frac{MillionBTU}{hr}$$

$$TotalGas := CC_{gasin} + AuxBoiler_{gasin} \qquad CCE\% := \frac{1}{CC_{HR}}$$

Case 2 COGENERATION- In this case we are using a COGEN unit to meet both power and steam needs.

Cogen turbine fuel consumption $CG_{gasin} := CGSS_{HR} \cdot Power$ Equivalent Electric Heat Rate $EEHR := \frac{CG_{gasin} - AuxBoiler_{gasin}}{Power}$

Cogen Equivalent Electric Efficiency $CGEE\% := \frac{1}{EEHR}$

Comparing Combined Cycle with Cogen on Equivalent Terms

Summary: Although the efficiency of the Cogeneration facility is higher than that of the combined cycle, the equivalent efficiency of the cogen facility is significantly lower than its apparent thermal efficiency. Overall thermal efficiency is not comparable to combined cycle efficiency because steam energy is not equivalent to electric energy.

Combined Cycle Turbine

$$\boxed{\mathrm{TotalGas} = 89.7\,\frac{\mathrm{MillionBTU}}{\mathrm{hr}}}$$

$$\boxed{\mathrm{CC}_{\mathrm{HR}} = 6800\,\frac{\mathrm{BTU}}{\mathrm{kW \cdot hr}}}$$

$$\boxed{\mathrm{CCE\%} = 50.2\,\%}$$

Cogen Facility

$$\boxed{\mathrm{CG}_{\mathrm{gasin}} = 78.8\,\frac{\mathrm{MillionBTU}}{\mathrm{hr}}}$$

$$\boxed{\mathrm{EEHR} = 5202\,\frac{\mathrm{BTU}}{\mathrm{kW \cdot hr}}}$$

$$\boxed{\mathrm{CGEE\%} = 65.6\,\%}$$

For this example, the cogen facility uses only 87.8% if the gas that would be used by a combined cycle plant in conjunction with an auxiliary boiler to produce steam. At a gas price of $4.00 per Million Btu, the combined cycle would incur an additional $6.40 per MWh in fuel costs. In most cases this magnitude of reduction in costs is not enough to overcome the low economies of scale and other costs associated with cogen.

Cogeneration Fuel Savings in Context

• At $4.00 per MMBtu, this cogen case shows a reduction of $6.40/MWh in fuel costs.

• For an 80% capacity factor, maintaining 5 additional employees to operate the cogen facility around the clock will cost approximately $10.00/MWh (only 1 employee on shift most of the time). Labor costs for the combined cycle facility will be on the order of $2.50 per MWh due to enormous economies of scale effects.

• Maintenance costs for the cogen facility will be on the order of $4-$7 per MWh more than that of the combined cycle facility.

• Capital cost recovery on a per MWh basis is significantly higher for the cogen facility due to economy of scale effects.

• In the Pacific Northwest there are significant periods every year where it is uneconomic to run due to hydro run-off. A cogen facility would either have to run during uneconomic times or the plant would have to have complete redundancy with gas fired boilers.

Energy Efficiency Approach for the 2011 Electric Integrated Resource Plan

Lori Hermanson

Technical Advisory Committee Meeting #2

2011 Electric Integrated Resource Plan

September 9, 2010

Evolvement of Energy Efficiency

- Growth in annual tariff rider funding and program offerings over the last 10 years
  - Five times more electric funding
  - Nearly 12 times more natural gas funding
- Heightened regulatory requirements and increasing amounts of Evaluation, Measurement & Verification (EM&V)
  - Annual electric (I-937 conditions) and natural gas verification of savings (Washington decoupling)
  - EM&V Collaborative as required by the Washington Utilities and Transportation Commission (WUTC) – final paper filed 9/1/10
  - WUTC required 3-6% of conservation budget on EM&V
- IRP action item and one of the I-937 conditions – potential studies every two years

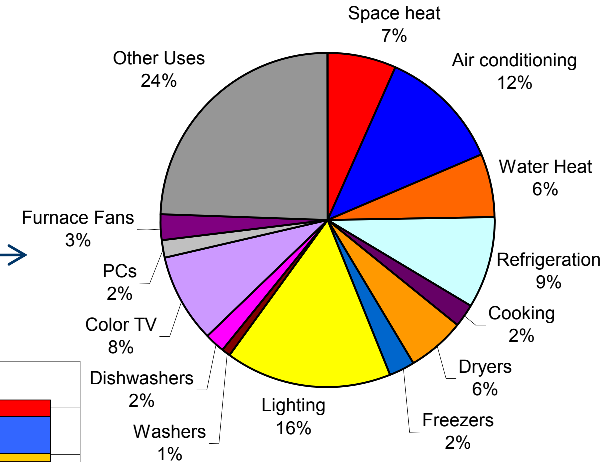
Approach for Estimating Energy Efficiency Potential

Utility data → **Base-year Energy Consumption** by state, fuel and sector

Customer surveys
Utility data
Secondary data

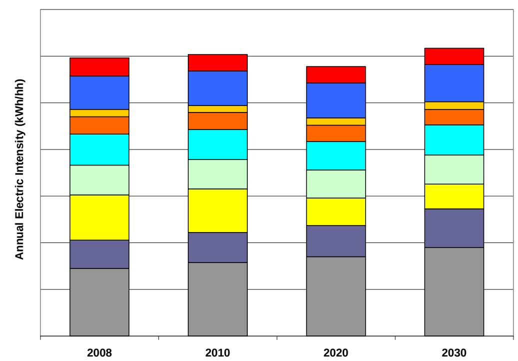
Develop prototypes and perform energy analysis

→ **Energy Market Profiles** by end use, fuel, segment and vintage



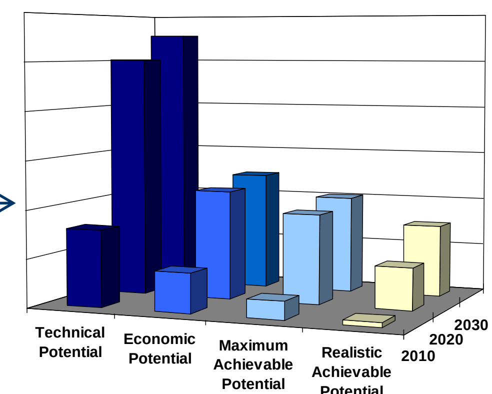
Forecast data:
Customer growth
Price forecast
Purchase shares
Codes and standards

→ **Baseline Forecast by End Use**



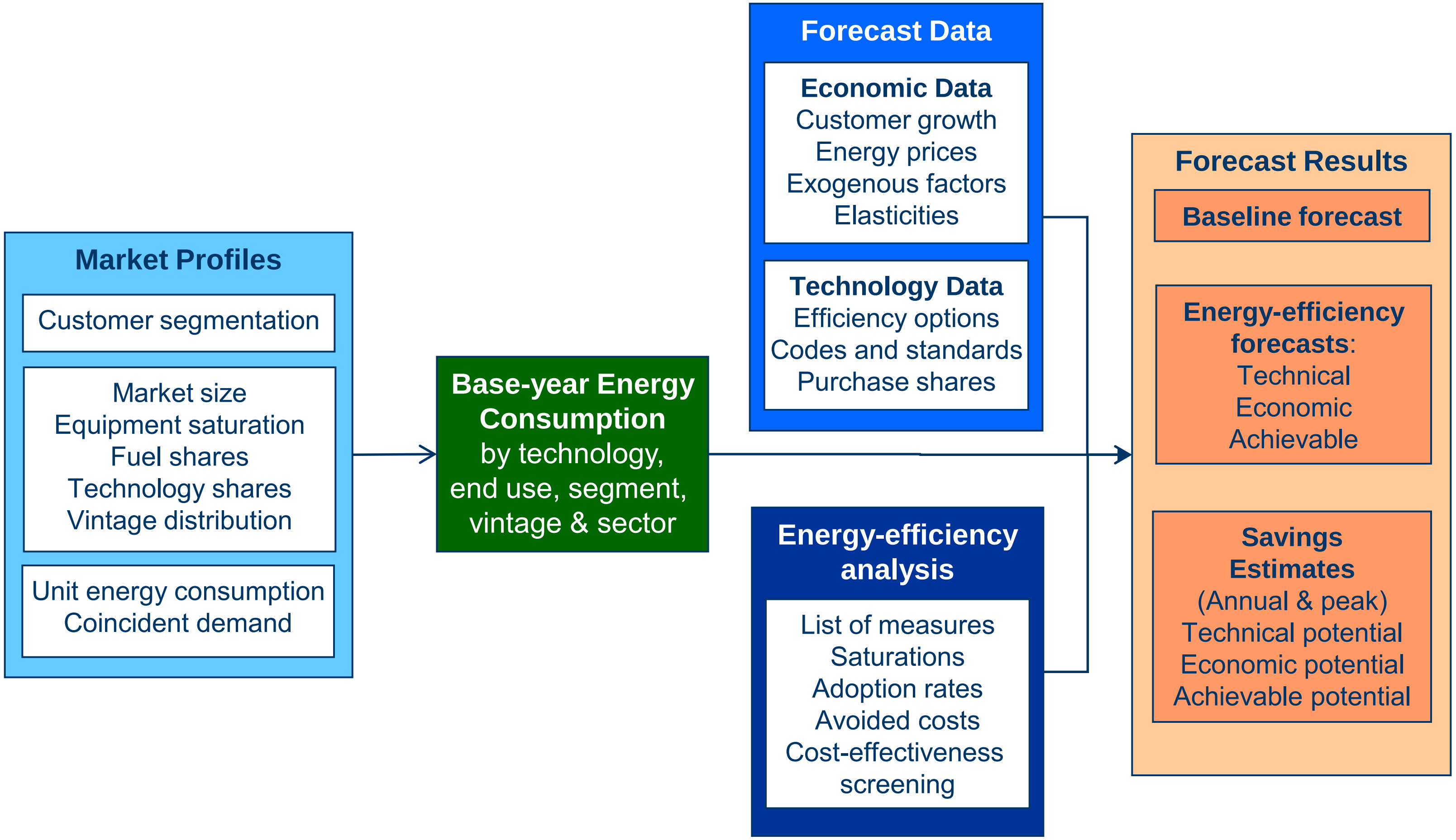
EE measure list
Measure costs
Energy analysis to estimate savings

→ **EE Potential**



Global Energy Partners LoadMAP^{TM} Analysis Framework

(Load Management Analysis and Planning tool)



Market Segmentation for Energy Efficiency

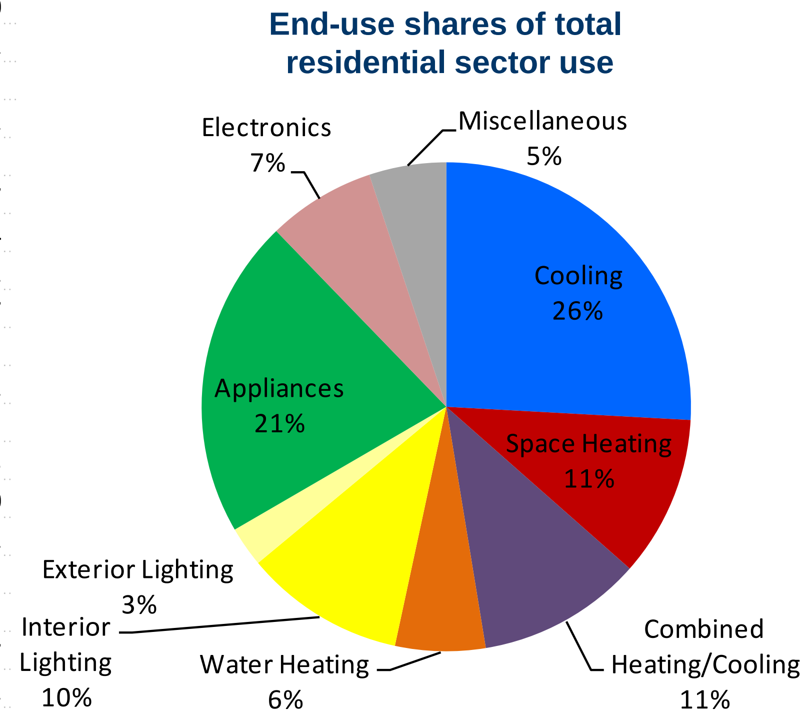
- State and fuels
- By sectors
  - Residential
    - Limited Income
    - Single-family housing
    - Multifamily housing
    - Mobile homes and manufactured housing
  - Commercial and industrial by rate class
  - Pumping
- Vintage (retrofit vs. lost-opportunity)
- Appliances/end uses (space heat, cooling, lighting, water heat, motors) and technologies (lamps, chillers, color TVs, etc)
- Equipment efficiency (old, standard, high efficiency)

Market Segmentation for Demand Response

- State
- Energy metric (peak demand) for annual, summer and winter
- Sector
  - Residential
  - Commercial and industrial combined
- Appliances/end uses (space heat, cooling, water heat, process, other)
- Enabling technology (with and without enabling technology)

Energy Market Profile Example: Residential

End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)
Cooling	Central AC	86%	3,985	3,433	1,587
Cooling	Room AC	13%	3,188	410	190
Space Heating	Electric Resistance	5%	18,214	910	421
Space Heating	Electric Furnace	0%	18,943	-	-
Combined Heat/Cool	Air Source Heat Pump	13%	14,004	1,820	842
Combined Heat/Cool	Geo-Thermal Heat Pump	0%	9,242	-	-
Water Heating	Water Heater	24%	2,793	663	307
Interior Lighting	Screw-in	100%	1,242	1,242	574
Interior Lighting	Linear Fluorescent	100%	243	243	112
Exterior Lighting	Screw-in	85%	374	318	147
Exterior Lighting	Linear Fluorescent	85%	73	62	29
Appliances	Refrigerator	100%	891	891	412
Appliances	Freezer	42%	376	157	73
Appliances	Second Refrigerator	20%	1,326	265	123
Appliances	Clothes Washer	96%	561	540	250
Appliances	Clothes Dryer	84%	821	693	321
Appliances	Combined Washer/Dryer	0%	786	-	-
Appliances	Dishwasher	61%	173	105	49
Appliances	Cooking	71%	750	533	247
Electronics	Personal Computer	65%	470	306	142
Electronics	Color TV	96%	313	300	139
Electronics	Other Electronics	100%	343	343	159
Miscellaneous	Pool Pump	13%	2,671	339	157
Miscellaneous	Furnace Fan	68%	431	293	136
Miscellaneous	Other Miscellaneous	100%	194	194	90
	Total			**14,069**	**6,505**



Baseline End-Use Forecast

Definition of **baseline forecast**:

- Comprehensive end-use forecast
- Forecast without future utility programs
- Incorporates appliance standards and building codes already on the books
- Typically includes naturally occurring efficiency (consistent with 6th Plan)

Process for developing the baseline forecast

1. End-use segmentation
2. Energy market profiles – snapshot of current energy use
3. Technologies/efficiency options available today and in the future
4. Forecast data and assumptions
5. Assess and compare with existing forecasts

End-Use Segmentation Example

Residential	Commercial	Industrial
Cooling	**Cooling**	**Process Heating**
Central AC	*Central Chiller*	*Electric resistance*
Room AC	*Packaged AC*	*Radio frequency*
Space Heating	*PTAC*	**Process Cooling and Refrigeration**
Electric Resistance	**Space Heating**	**Machine Drive**
Electric Furnace	*Electric Resistance*	*1-5 hp motors*
Combined Heating/Cooling	**Combined Heating/Cooling**	*5-20 hp motors*
Air Source Heat Pump	*Air Source Heat Pump*	*20-50 hp motors*
Geothermal Heat Pump	*Geohermal Heat Pump*	*50-100 hp motors*
Water Heating	**Water Heating**	*100-200 hp motors*
Interior Lighting	**Interior Lighting**	*200-500 hp motors*
Screw-in	*Screw-in*	*500-1,000 hp motors*
Linear Fluorescent	*Linear Fluorescent*	*1,000-2,500 hp motors*
Exterior Lighting	**Exterior Lighting**	*>2,500 hp motors*
Screw-in	*Screw-in*	**Facility HVAC**
Linear Fluorescent	*Linear Fluorescent*	**Facility lighting**
Appliances	**Refrigeration**	*Incandescent*
Refrigerator	*Walk-in Refrigeration*	*Fluorescent*
Freezer	*Reach-in Refrigeration*	*HID*
Clothes Washer	**Office Equipment**	
Clothes Dryer	*PC*	
Combined Washer/Dryer	*Server*	
Dishwasher	*Monitor*	
Cooking	*Printer/Copier*	
Electronics	**Food Service**	
Personal Computer	**Ventilation**	
Color TV	**Miscellaneous**	
Other Electronics		
Miscellaneous		
Pool Pump		
Furnace Fan		
Other Miscellaneous		

Energy Market Profiles

Description

Energy market profiles describe how customers use energy in a recent base year

Market profile elements

- Market size
- Fuel shares/saturations by end use
- Unit energy consumption (UECs, EUIs) by end use/tech
- Peak factors

Profile elements are calibrated to match customer segments' use in base year from billing system

Key data sources

Market characterization data

Previous potential studies

Global's previous customer surveys

Prototypes and BEST™ analysis

Forecast Data and Assumptions

Forecast drivers

Customer growth

Other exogenous variables

- Energy prices
- Income

Usage elasticities by end use for each exogenous variable

Technology forecasts

Equipment purchase shares by decision type

- Replace on burnout
- New construction
- Non-owner acquisition

Shares are user defined

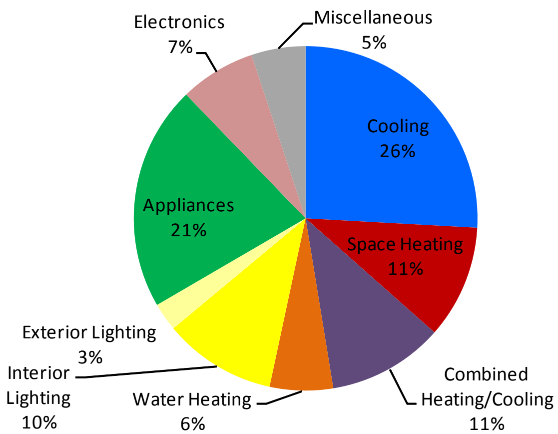
- Defaults based on trends in EIA's Annual Energy Outlook
- Incorporate existing appliance/equipment standards
- Will be refined using PNW and Avista data

Sample Baseline Forecast for Residential Sector

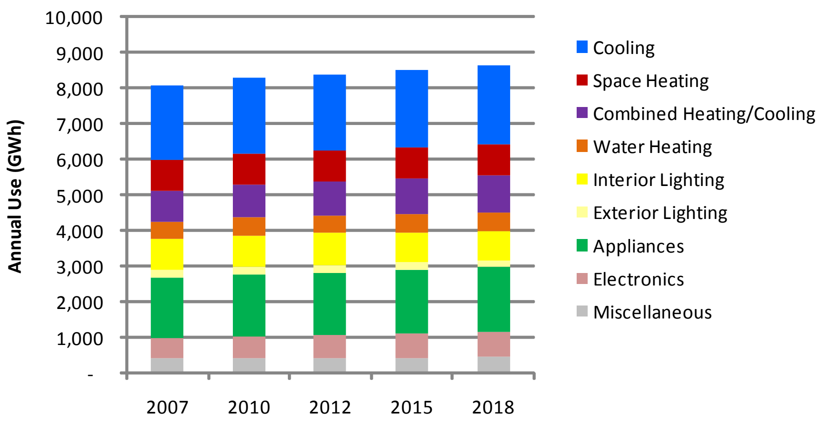
Residential Use by End Use (GWh)

	2007	2010	2012	2015	2018	% Change	Avg. growth rate
Cooling	2,093	2,128	2,151	2,186	2,227	6.4%	0.56%
Space Heating	862	863	864	867	871	1.1%	0.10%
Combined Heating/Cooling	883	923	951	989	1,029	16.5%	1.39%
Water Heating	482	495	503	515	528	9.7%	0.84%
Interior Lighting	858	872	880	840	802	-6.6%	-0.62%
Exterior Lighting	215	215	215	202	189	-11.8%	-1.14%
Appliances	1,711	1,741	1,760	1,787	1,816	6.1%	0.54%
Electronics	578	616	641	679	718	24.2%	1.97%
Miscellaneous	412	423	430	441	453	9.9%	0.86%
Total	**8,093**	**8,274**	**8,395**	**8,506**	**8,633**	**6.7%**	**0.59%**

Residential Use in the Base Year (2007)



Residential Forecast (GWh)



Energy Efficiency Potential

1. Characterize energy efficiency measures
2. Perform economic screen
3. Assemble data for estimating achievable potential
4. Calculate potential
5. Develop supply curves based on levelized costs of each individual measure (low, medium, high-case potential differentiations)

Definitions of Energy Efficiency Potential

Technical Potential – most efficient measures are adopted, regardless of cost or customer acceptance

Economic Potential – only cost-effective measures are adopted by customers

- Apply TRC test
- Avista avoided costs + 10% conservation adder (consistent with 6^{th} Plan)

Achievable Potential

- Council's definition – 85% of economic potential at the end of ten years
- Other definition?

Estimate Demand Response Potential

- Develop revised peak demand forecast
  - After savings from EE are applied
- Identify capacity-constraint time period
  - Winter peak day (cold weather)
  - Summer peak day (hot weather)
- Identify and characterize relevant DR options (e.g., direct load control, curtailable/interruptible tariffs, demand bidding)
- Estimate potentials

Estimating Demand Response Potential

- Develop baseline forecast by segment
  – Peak by segment
  – Customer by segment
- Program data
  – Participants in base year
  – Forecast of participants
  – Per customer impacts in base year
- Assess cost effectiveness
- Compute peak reduction

Deliverables that Feed IRP Process

- Report documenting entire study and presentation to Avista (electric – October, natural gas 2011)
- LoadMAP, fully populated for future updates
- Updated avoided costs from Aurora available in November as well as updated load and price forecasts
- Updated potentials for energy efficiency and demand response for final input in model

Potential Study Timeline

Month	August				September				October				Nov	Dec	Jan	Feb	March	April
Week	1	2	3	4	1	2	3	4	1	2	3	4						
Kick-off meeting		M																
Final work plan				♦														
Gather data																		
Electricity Analysis																		
Market characterization					♦													
Baseline forecasts						♦												
EE measure list						♦												
Preliminary potential estimates								M										
Final potential estimates									♦									
Draft report w/supply curves										R								
Demand Response Analysis																		
Market characterization						♦												
Baseline forecasts							♦											
Identify DR programs								M										
Preliminary potential estimates									♦									
Draft report										R								
Natural Gas Analysis																		
EE measure analysis													♦					
Baseline forecasts														♦				
EE measure list															♦			
Preliminary potential estimates															♦M			
Final potential estimates																♦		
Draft report																	R	
Final Report (on all analyses)																		R, M

Meetings (in-person or webcast) M
Memos, interim deliverables ♦
Reports R

Avista's 2011 Electric Integrated Resource Plan
Technical Advisory Committee Meeting No. 3 Agenda
Avista Headquarters – Spokane, Washington

Thursday, December 2, 2010
Avista Conference Room 428

Topic	Time	Staff
1. Introduction	9:00	Storro
2. Transmission (costs & issues)	9:05	Waples
3. Potential Hydro Upgrades	10:00	Wenke
4. Potential Thermal Upgrades	10:45	Graham
5. Lunch	11:30	
6. Load Forecast	12:30	Barcus
7. Stochastic Modeling	1:30	Gall
8. Adjourn	2:30	

To participate by phone:
1. Please join my meeting.
https://www2.gotomeeting.com/join/271248826

2. Join the conference call:

Dial +1 805 309 0016
Access Code: 271-248-826
Audio PIN: Shown after joining the meeting

Meeting ID: 271-248-826

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New Resource Integration – Transmission

Executive Level Summary of Avista 2010 Resource Integration Study Work

Scott Waples, Reuben Arts, and the Avista System Planning Group

Technical Advisory Committee Meeting #3

2011 Electric Integrated Resource Plan

December 2nd, 2010

Federal Standards of Conduct

- Mandatory Federal Standards of Conduct Require That:
  - No non-public transmission information be shared with the Avista Merchant Function.
  - Please note that there are Avista Merchant Personnel in attendance at this meeting.

- Meeting Notices:
  - This meeting was Posted on the Avista OASIS website on 11/19/2010.

Federal Standards, Requirements, and Risks

- Mandatory Federal Standards Include:
  - No overloads all lines and equipment in service (N-0).
  - No overloads or loss of load for one element out of service (N-1).
  - Some relaxation of the above for two elements out (N-2).
  - Resource Integration requirements (Avista or 3rd party generation) are the same as those for the general system – all Standards must be met.
- Potential Sanctions:
  - Up to $1M Per Day Per Occurrence.
  - Mitigation Plan must be provided and progress demonstrated.

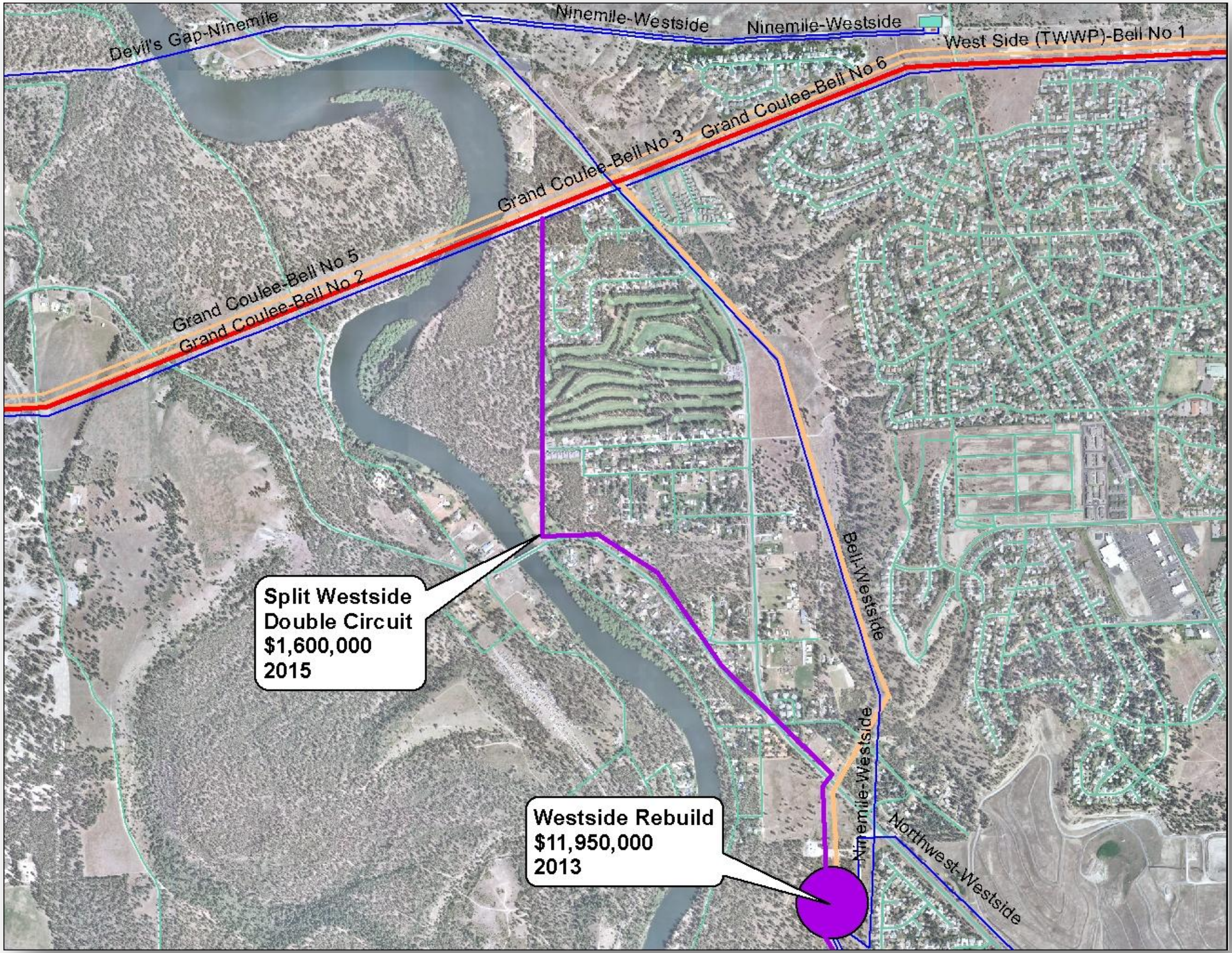
Recent Examples of Avista Construction

- <u>Benewah Station</u>:
  - 230 / 115 kV Station with a Single 125 MVA Transformer.
  - 230 kV Connections between the North and South Avista Load Centers.
  - 230 kV Double Breaker / Double Bus Configuration for increased reliability.
- <u>Benewah – Shawnee 230 kV line</u>:
  - Completes transmission required for both load service and the West of Hatwai transfer requirements.
  - Allows for resource integration in the center and south areas of the Avista system.

Examples of Future Construction Required to Meet NERC / WECC Reliability Standards

- Moscow Station:
  - 230 / 115 kV Station, single 250 MVA transformer.
  - Increases capacity to the Moscow / Pullman area and relieves loading on the Shawnee transformer.
- Westside Station:
  - 230 / 115 kV Station, two 250 MVA transformers.
  - Increases capacity and security to the West Plains area of Spokane County, and relieves heavy loading on large transformers in the central Spokane area.
- Irvin 115 kV and Associated 115 kV Reconductoring:
  - 115 kV Switching Station and other upgrades to meet additional load growth in the Spokane Valley.

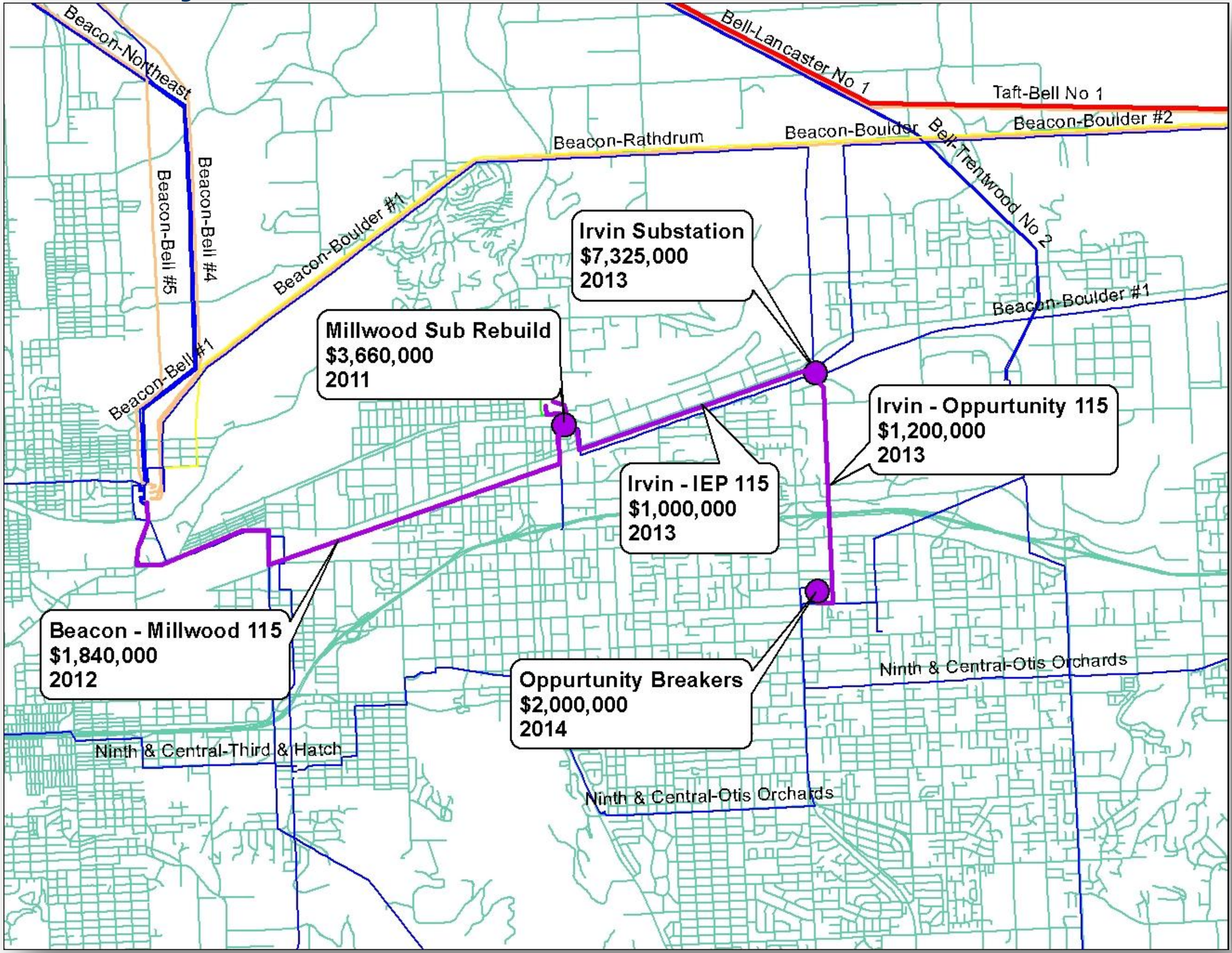
Westside Rebuild – 2 x 250 MVA Transformers



Moscow 230/115 kV Estimate and Schedule

	2010	2011	2012	2013	2014	total
Transmission				$575,000	$575,000	$1,150,000
Substation	$500,000	$1,500,000	$3,000,000	$4,775,000	$2,750,000	$12,525,000
Distribution					$25,000	$25,000
total	$500,000	$1,500,000	$3,000,000	$5,350,000	$3,350,000	$13,700,000

Irvin Project

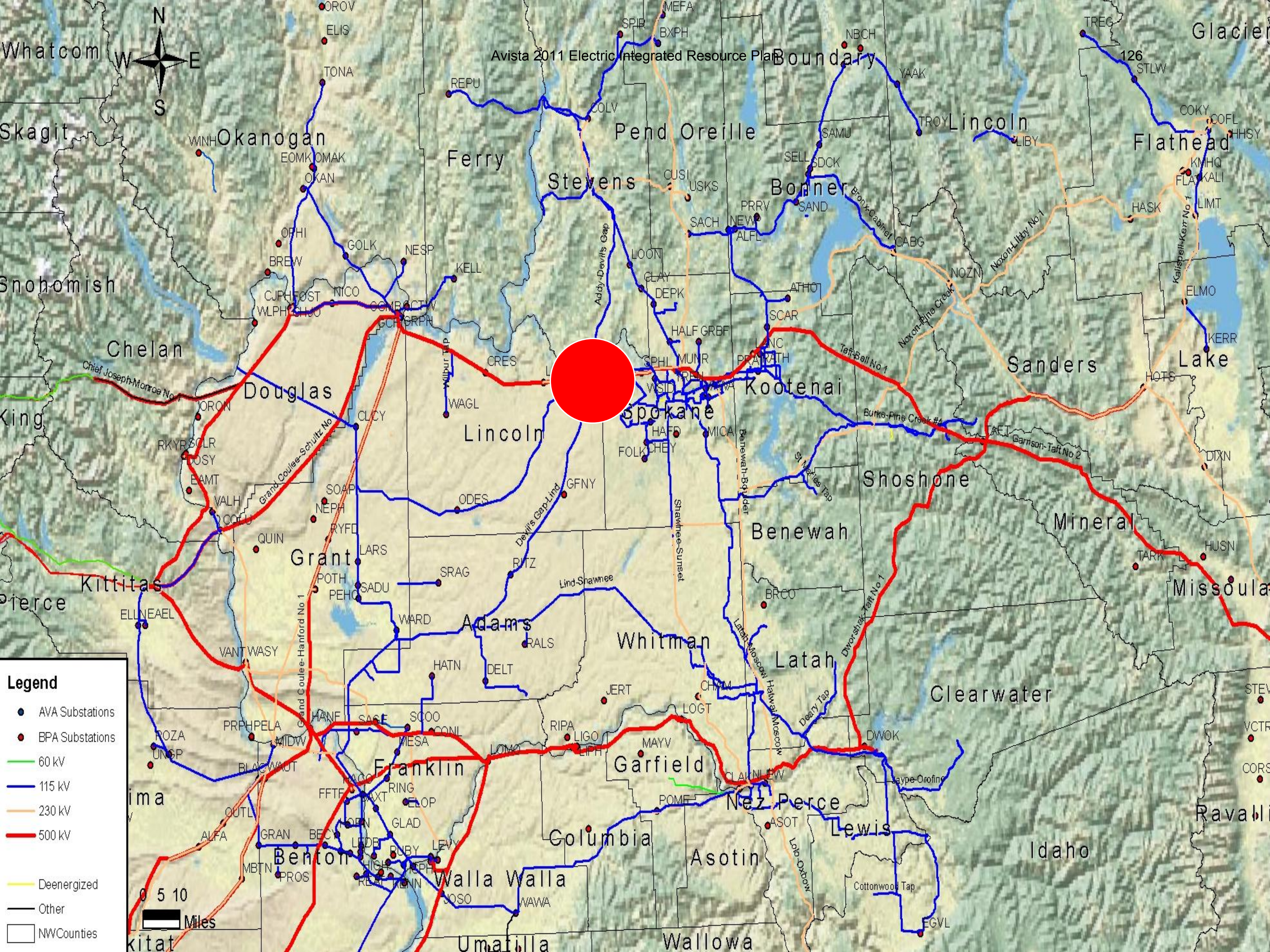


Avista Non-IRP Generation Queue

- **Active (see http://www.oatioasis.com/avat/index.html) :**
  - **Project # 08**:
    - 75 MW, in Facility Study Stage.
  - **Project # 14**:
    - 210 MW, in System Impact Study Stage (SIS).
  - **Project #17:**
    - 100 MW, in Facility Study Stage.
  - **Project # 26**:
    - 42MW, in SIS Stage.
  - **Project # 27**:
    - 10 MW, in SIS Stage.
  - **Project # 29**:
    - 6.5 MW, in SIS Stage.

Non-coincident IRP Interconnection Requests

- **Potential West Plains / Devils Gap Integration :**
  - **Reardan**:
    - 90 MW, 2014
    - +60 MW (150 MW total), 2014
  - **Long Lake**:
    - + 30 MW (118 MW total), 2018
    - + 60 MW (148 MW total), 2018
    - + 100 MW (188 MW total), 2018
  - **Little Falls**:
    - + 4MW (40 total), 2014-2017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Whitman
Pend Oreille
Boundary
Bonner
Kootenai
Benewah
Latah
Shoshone
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Nez Perce
Lewis
Idaho
Lincoln
Flathead
Glacier
Lake
Sanders
Mineral
Missoula
Ravalli
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Columbia
Garfield
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Umatilla
Wallowa
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Grand Coulee-Schultz No
Grand Coulee-Hanford No 1
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Devil's Gap-Lind
Lind-Shawnee
Shawnee-Sunset
Benewah-Boulder
Latah-Moscow
Hatwai-Moscow
Taft-Bell No 1
Garrison-Taft No 2
Noxon-Libby No 1
Noxon-Pine Creek
Bronx-Cabinet
Kalispell-Kerr No 1
Dworshak-Taft No 1
Burke-Pine Creek #4
St Maries Tap
Deary Tap
Cottonwood Tap
Lolo-Oxbow
Legend
AVA Substations
BPA Substations
60 kV
115 kV
230 kV
500 kV
Deenergized
Other
NWCounties
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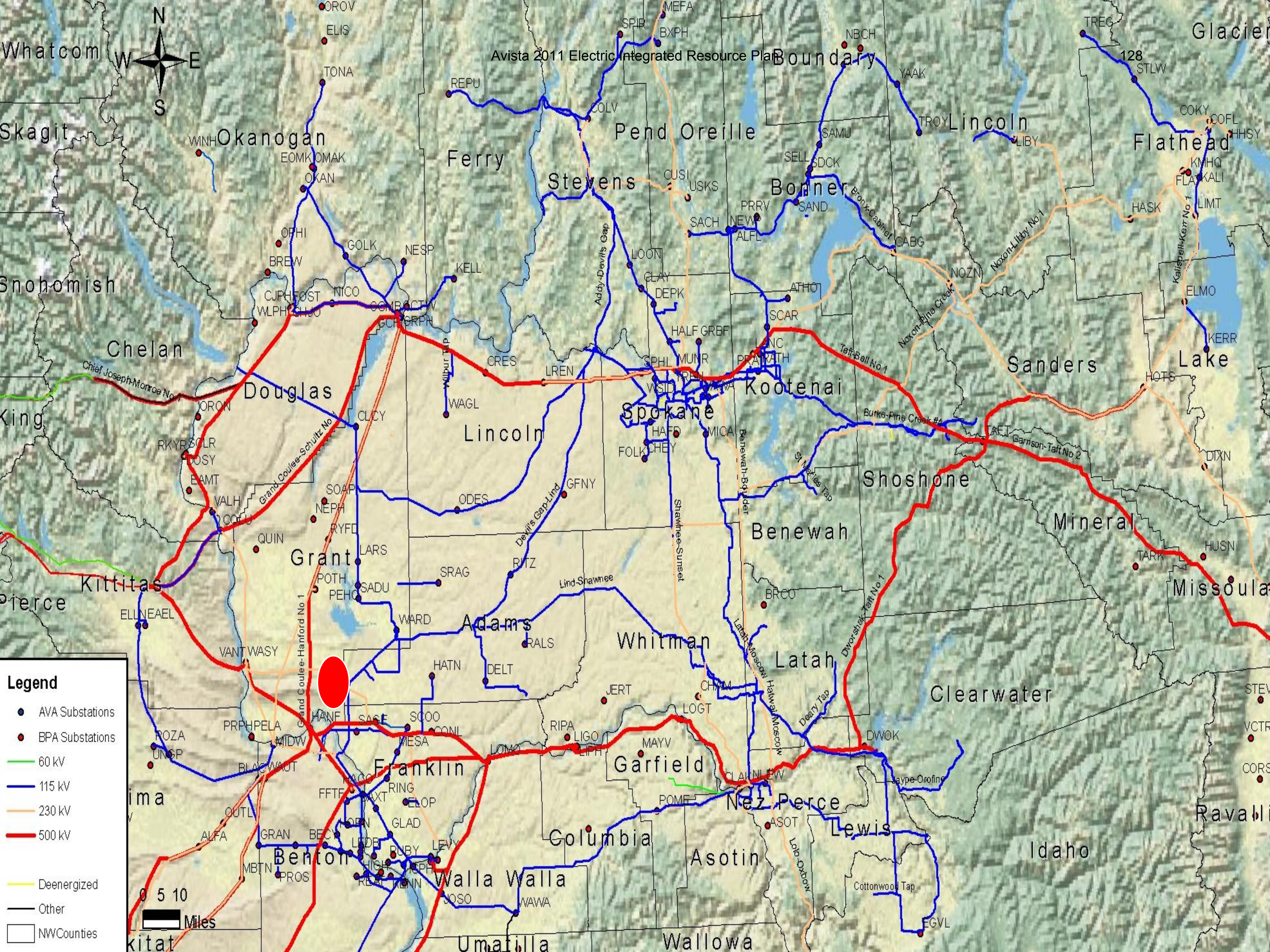
Non-coincident IRP Interconnection Requests

- **Potential "Far West" (Big Bend) Area Integration :**
  - **Othello Area**:
    - Up to 100 MW in 2014, 2015, or 2019 (2015 energization is the most probable)

AVISTA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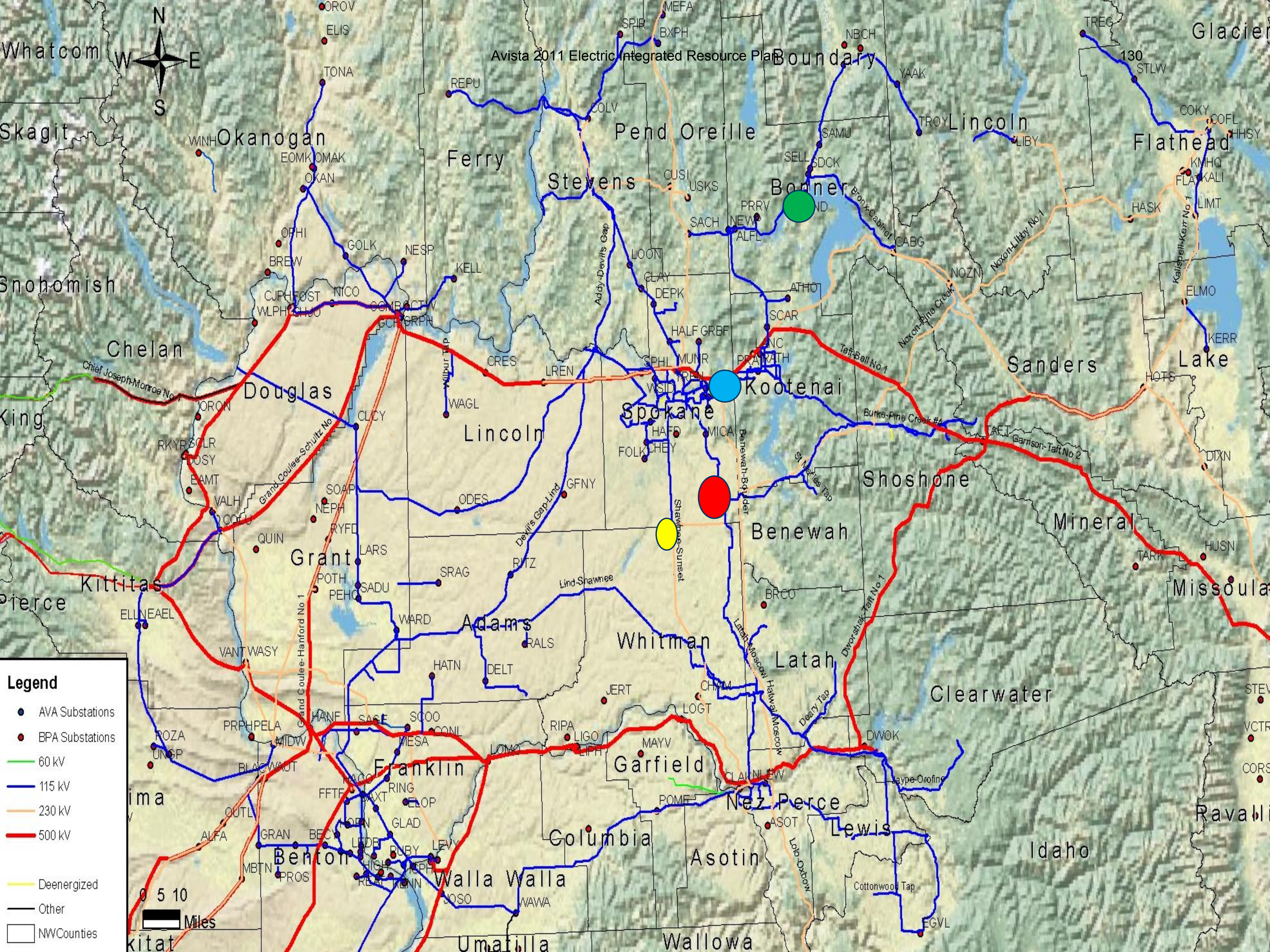
Non-coincident IRP Interconnection Requests

- **Potential "Central Area" Thermal or Wind Integration** :
  - **Benewah**:
    - 300 MW 2018
  - **Rosalia**:
    - 300 MW, 2018
- **Potential "East & North Area" Thermal or Wind Integration** :
  - **Rathdrum**:
    - 300 MW, 2018
    - + 100 MW (400 MW total), 2018
  - **Sandpoint**:
    - 100-300 MW, 2018



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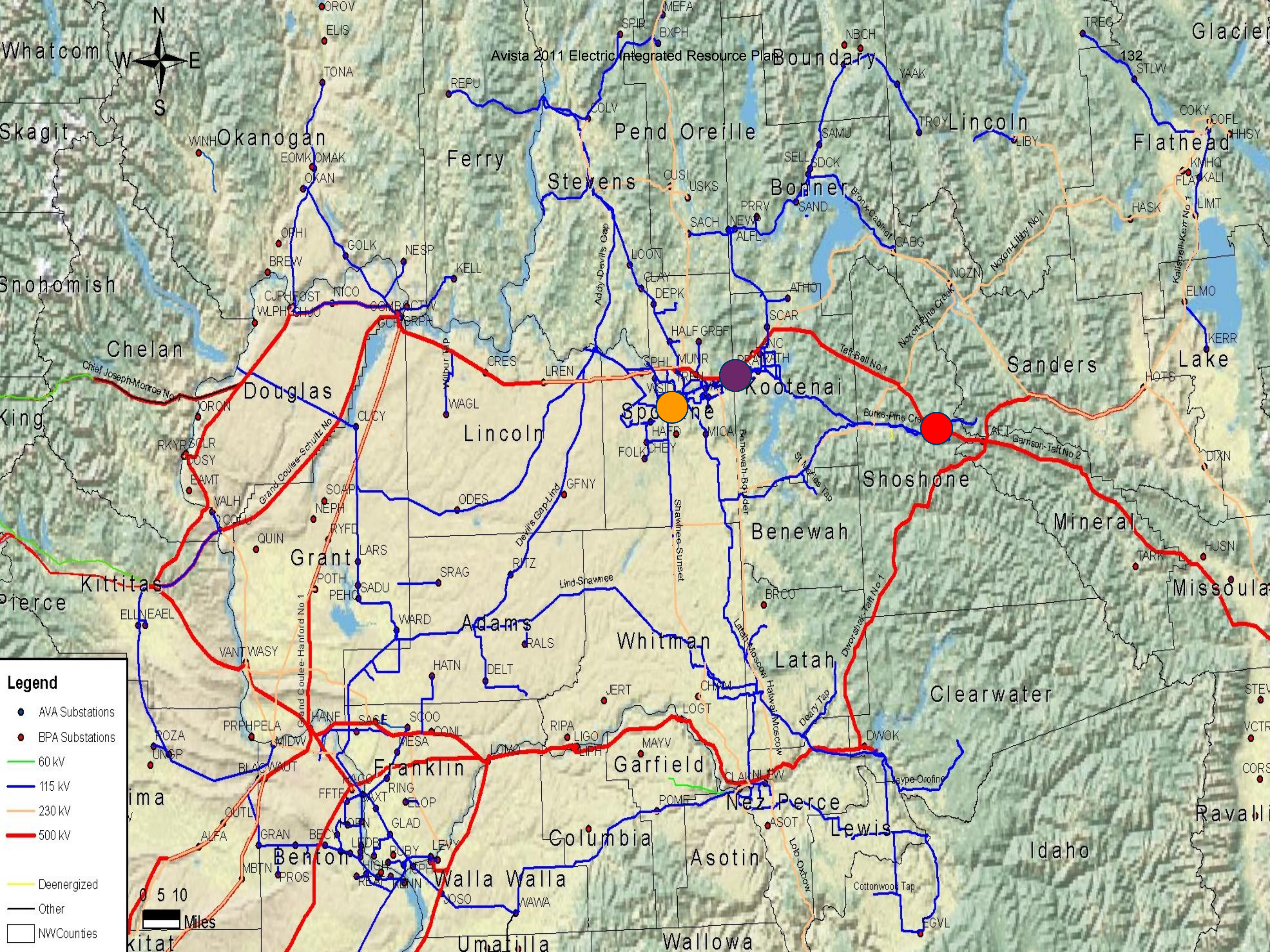
Glacier

Non-coincident IRP Interconnection Requests

- **Other "Large" Hydro Integration** :
  - Cabinet Gorge ("East"): + 60 MW, 2018
  - Monroe Street (Spokane): + 20MW, 2018 or +60 MW, 2018
  - Post Falls (Coeur d' Alene): + 14 MW, 2018

- **"Small" Hydro Integration** :
  - Upper Falls (Spokane): + 2 MW, 2019



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ELIS
TONA
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BREW
CJPH
FOST
NICO
WLPH
CHJO
GCPH
COMB
CTTV
GRPH
CRES
LREN
WAGL
CLCY
CUSI
USKS
SACH
NEWP
ALFL
PRRV
SAND
SAMU
SELL
SDCK
CABG
NOZN
ATHO
SCAR
LOON
CLAY
DEPK
HALF
GRBF
MUNR
SPHL
LINC
RATH
KOOTENAI
MICA
HAFO
FOLK
CHEY
GFNY
ODES
SOAP
NEPH
RYFD
LARS
QUIN
SRAG
RITZ
POTH
PEHO
SADU
WARD
RALS
DELT
HATN
JERT
LOGT
CHMM
BRCO
DWOK
RIPA
LIGO
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MAYV
CLAK
NLEW
POME
ASOT
EGVL
JORON
RKYR
SCLR
DOSY
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POZA
UNGP
PRPH
PELA
MIDW
BLACK
HANF
SAGE
SCOO
CONL
MESA
LOMO
FFTF
RING
ELOP
GLAD
GRAN
ALFA
OUTL
MBTN
PROS
LEVY
JOSO
WAWA

Study Process and Cost Estimates

- **Study Process:**
  - Avista System Planning does transmission system analysis using WECC approved "study cases" (which we modify) for all analyses and uses approved software tools (PTI, GE, PowerWorld) to "do the math" on various alternatives.
- **Pre-Engineering Cost Estimates:**
  - Avista Engineering does pre-engineering cost estimation.
  - Estimates are generally plus or minus 50% accuracy (no rights-of-way, soils analysis, firm quotes for equipment, etc.).
  - Transmission integration is often about 10% of total project costs (but can be much higher depending on where the resource is integrated).

Transmission Study Process With Respect to Resource Type

- **"We (Transmission) Don't Care"!**
  - **Transmission Analysis is "Resource Blind":**
    - Wind
    - Water
    - Gas
    - Pumped Storage
    - Other
  - **Transmission Integration Costs Will be the Same for ANY Resource.**

West Plains / Devils Gap Area

- Necessitates a “Tipping Point” Analysis:
  - Total potential generation is 4 MW to 254 MW – lots of options!
  - Voltage Level Analysis:
    - How much can be integrated at 115 kV:
      - At no cost?
      - At a “max 115 kV development” cost?
    - How much can be integrated at 230 kV:
      - Can it be done with only one 230 kV line?
      - What are the costs for one versus two lines?
  - What are the $/MW costs for the various options?

West Plains / Devils Gap Area

- **115 kV Analysis**:
  - 4 MW requires no transmission additions (one bookend).
  - 75 MW can be integrated for about $15M.
  - Requires new 115 kV line and station upgrades.
- **230 kV Analysis**:
  - 254 MW can be added for about $30-$55M (2-230 kV lines).
  - These costs don’t include the planned 230 kV Spokane Loop.
- **“All Things Being Equal” $$/MW Comparison**:
  - 75 MW @ 115 kV @ $15M => $200/kW
  - 254 MW @ 230 kV @ $30-$55M => $118-$217/kW

"Central" and "East" Areas

- **230 kV Integration**:
  - Benewah: 300 MW @ about $5M
  - Rosalia: 300 MW @ about $8M
  - Rathdrum:
    - 300 MW @ about $5M (Will require Gen Dropping).
    - 400 MW @ about $5M (Will require Gen Dropping).
    - A concern is "too many eggs" on the Rathdrum Prairie:
      - Existing Rathdrum – 160 MW.
      - Existing Lancaster – 270 MW.
      - New Rathdrum – 300-400 MW.
  - All studies are post integration of the Lancaster generation into the Avista 230 kV system.

“Far West” (Big Bend) Area

- **Othello 115 kV Analysis**:
  - 17 MW requires no transmission additions (one bookend).
  - 100 MW can be integrated for between $13-$25M.
  - Requires new 115 kV line, local 115 kV line reconductor, and a new POI 115 kV substation (the lower costs require generator dropping).
- **230 kV Analysis**:
  - 250 MW can be added for about $8M.
  - Requires a new POI 230 kV substation.
  - Does not consider contractual constraints on the Walla Walla – Wanapum 230 kV line

“North” and Other Hydro

- **Sandpoint, Idaho**:
  - Sandpoint: 50 MW @ about $2-5M (depending on BPA).
  - More than 50 MW is probably cost prohibitive.
- **Other “Large” Hydro**:
  - Cabinet Gorge: 60 MW @ about $2-$10M (Cabinet Gorge – Rathdrum @ 100 Degrees Centigrade & 115 kV reconductor).
  - Monroe Street: 20 MW @ about $3M (does not include Metro).
  - Monroe Street: 60MW @ about $3M (as above).
  - Post Falls: 14 MW @ about $1M
- **Other “Small” Hydro Integration** :
  - Upper Falls: 2 MW @ about $1M

"Off System" Resources

- **Integration of 100-300 MW:**
  - Potential at Bell, Hatwai, Hot Springs, or Mid Columbia:
  - Wheeling over the BPA system presently costs $4.4M/year plus $2.5M/year for losses (@$50/MW-hr) for 300 MW of BPA transmission service (if it is available). The BPA rate is expected to increase by about 9% in 2013. A BPA "Lines and Loads" Study (funded by AVA) is required to determine capacity in the BPA Grid.
  - A study similar to the FERC "Market Power Study" is used to determine at what cost these resources could be integrated into the Avista Grid. Recent studies have indicated that as much as $50M could be required for 300 MW of integration from BPA into the Avista system.

Future Work?

- **<u>Generic Break Point Studies for IRP / 3rd Party Developers:</u>**
  - "How many MW can we integrate where for about what $$?"
    - Main Grid 230 kV Stations.
    - Select 115 kV Stations.
- **<u>Potential Open Seasons:</u>**
  - "Does anyone want to get to the Mid Columbia?"
  - "Does anyone want to get out of Montana?"
  - "Does anyone want to get to PAC or IPC?"
- **<u>Canada – Northwest – California Transmission Project:</u>**
  - "If this project is built, how should we interconnect?"
  - "What other markets would this project access?"

Finis

Questions?

Hydro Upgrade Opportunities

Steve Wenke

Technical Advisory Committee Meeting #3

2011 Electric Integrated Resource Plan

December 2, 2010

Presentation Outline

- Background of Avista's Hydro System
- Looking Back on What has Been Done
- Current Upgrade Projects
- Other Opportunities
- Issues

Background

- Aging hydro system
- Advancements in hydro turbine technology
- Hydraulic size of facilities

Avista's Hydro Portfolio

- First project was Monroe Street that came on line in 1891.
- "Newest" Spokane River plant is Upper Falls which came on line in 1920.
- The larger Clark Fork River projects were developed in the mid to late 1950's

Aging Technology

Modern turbine designs convert the energy of falling water at a rate of about 94% efficiency

- Combined Cycle Gas Plant – 52%
- Wind Turbine 40-50%

1960 and earlier vintage hydro plants have efficiencies of abut 88% or lower

- Estimate 80% at Upper Falls
- Estimate 85% at Little Falls

Plant Hydraulic Designs

The older Spokane River Plants were sized based on the needs of the day

- Base loaded energy
- Ability to swing output to make loads (i.e. regulation)
- Generator island areas (i.e. generator were not networked together)

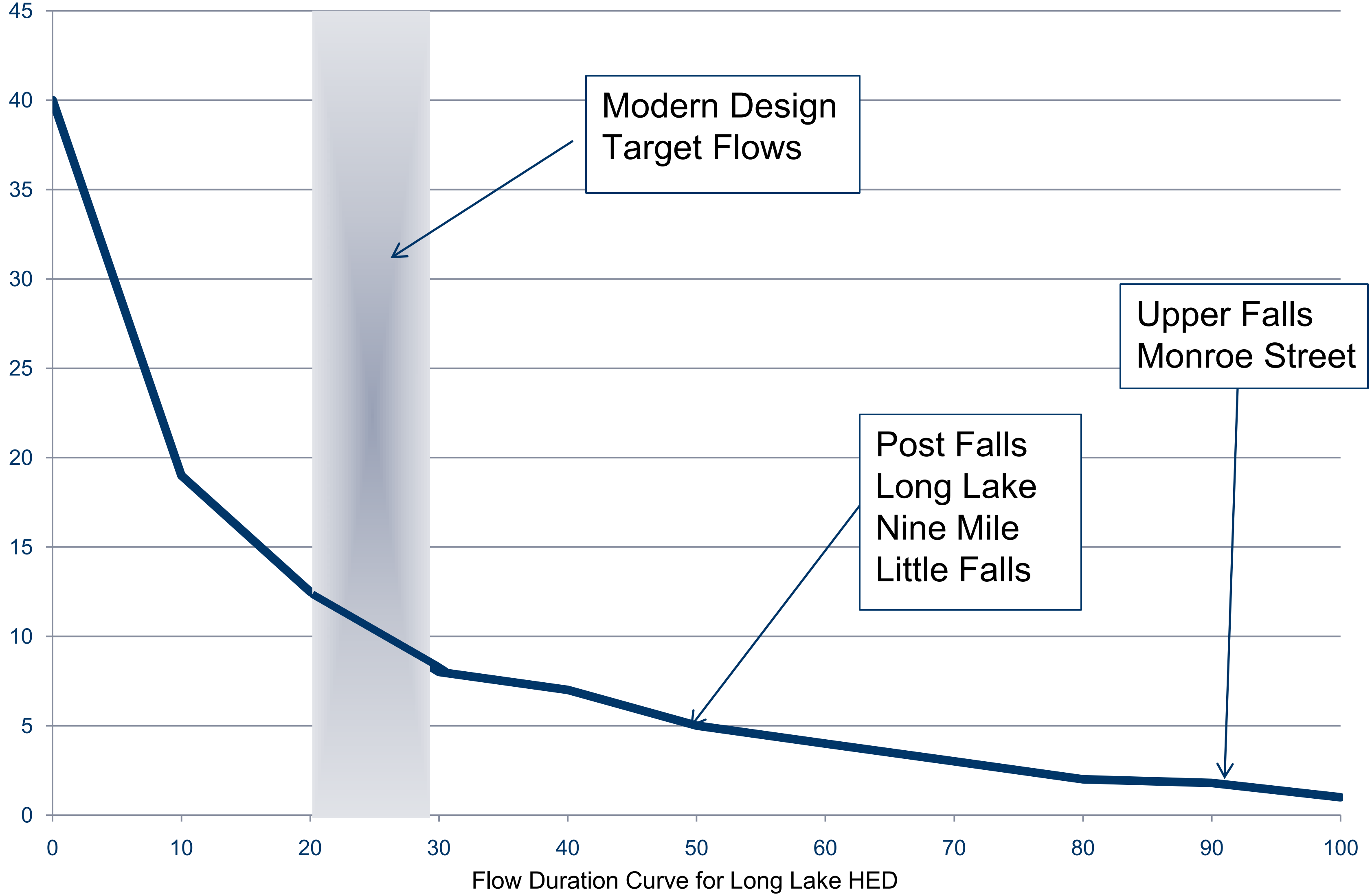
The result are plants that are relatively high on the flow exceedence curves

The Opportunity

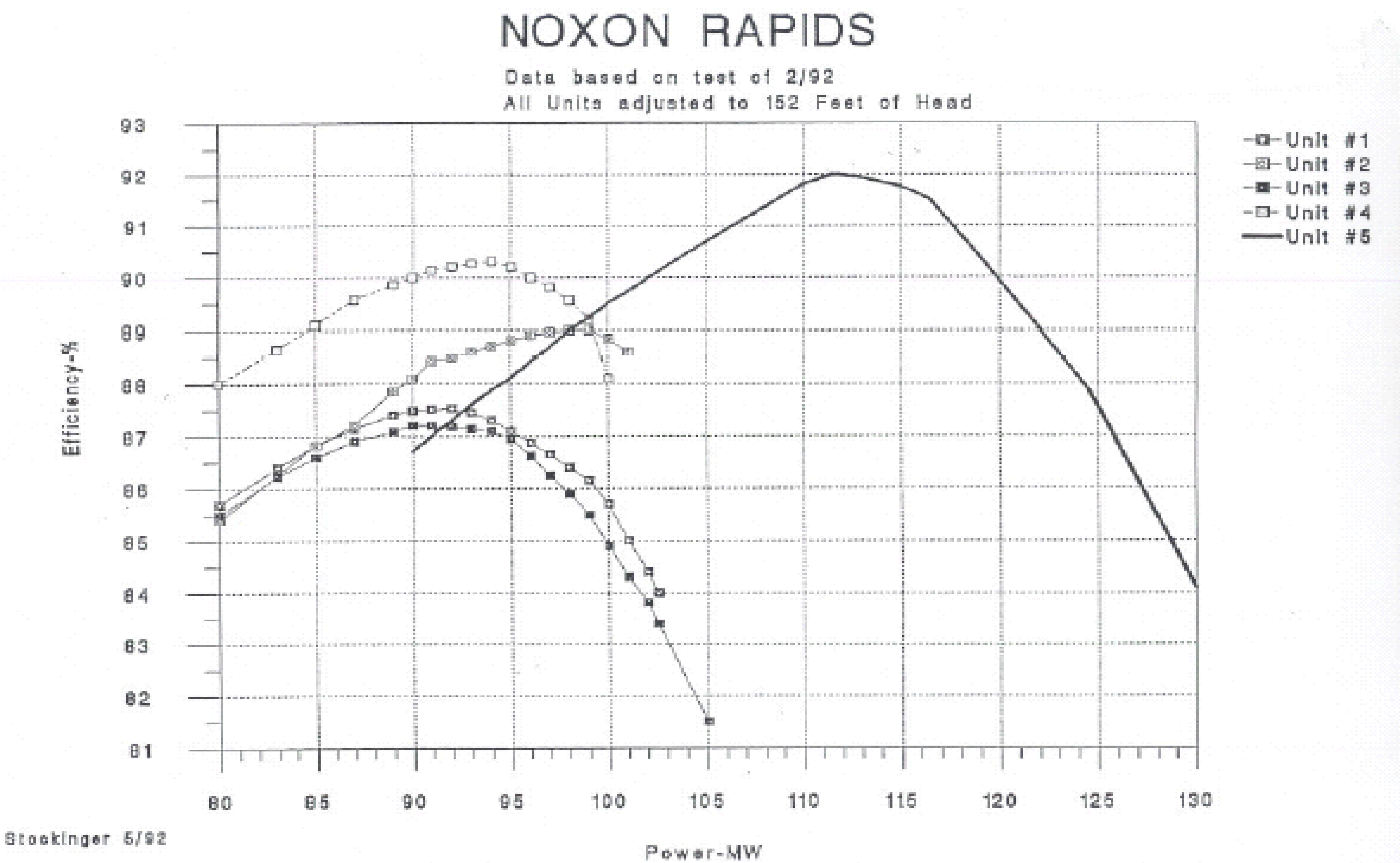
In simple terms, with unit flow capacity (cfs) and plant head (height of dam) the same, we should be able to improve the energy output of an older hydro unit by as much as 6% by replacing the old turbine with a modern designed unit.

- In fact, this does vary for each particular site based on the civil works of the specific dams

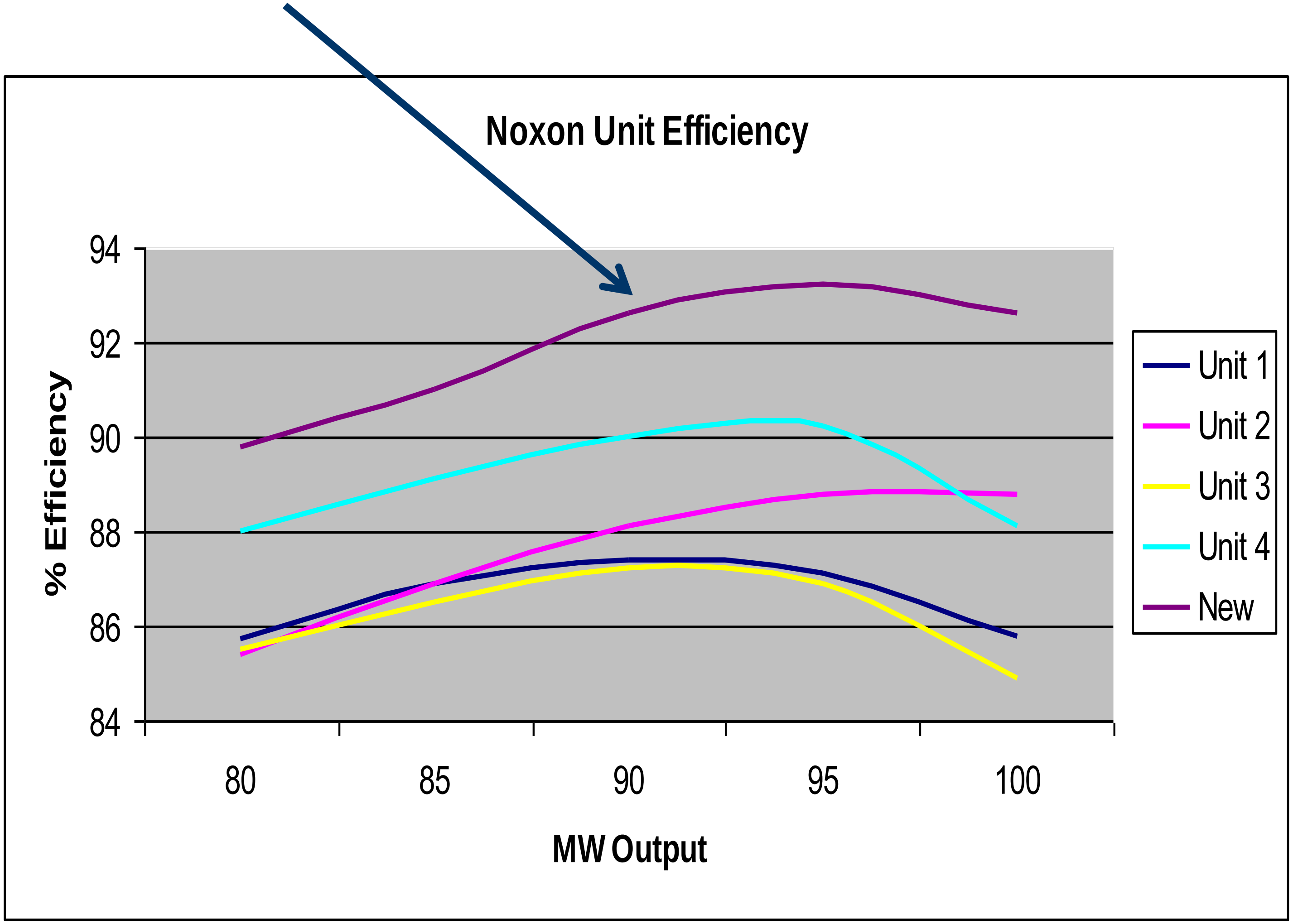
Plant Hydraulic Designs



Noxon Rapids Upgrades Variable Efficiency Curves



New Runner Comparison



Looking Back

We have been actively pursuing hydro upgrades since 1989

- Monroe Street - 1992
- Nine Mile Units 3 and 4 - 1994
- Cabinet Gorge Unit 1 -1994
- Long Lake Units 1, 2, 3, and 4 – 1994 - 1999
- Little Falls Units 2 and 4 – 1994, 2001
- Cabinet Gorge Units 2, 3, and 4 – 2001 – 2004
- Noxon Rapids Units 1, 3 2009, 2010

Character of the Upgrades

Powerhouse Replacement

Powerhouse Refurbishment and Unit Replacement

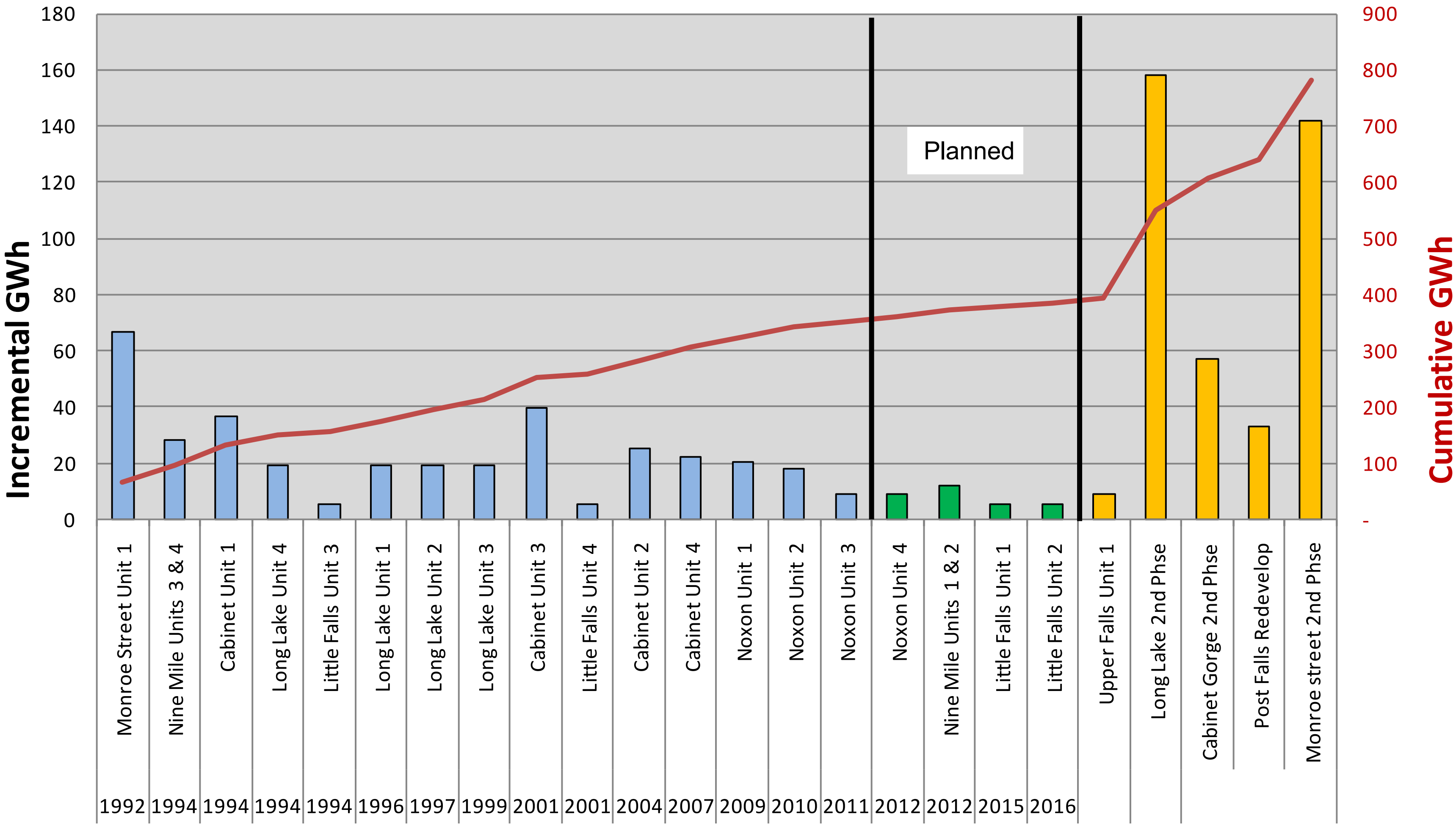
Runner Replacement

Unit Replacement

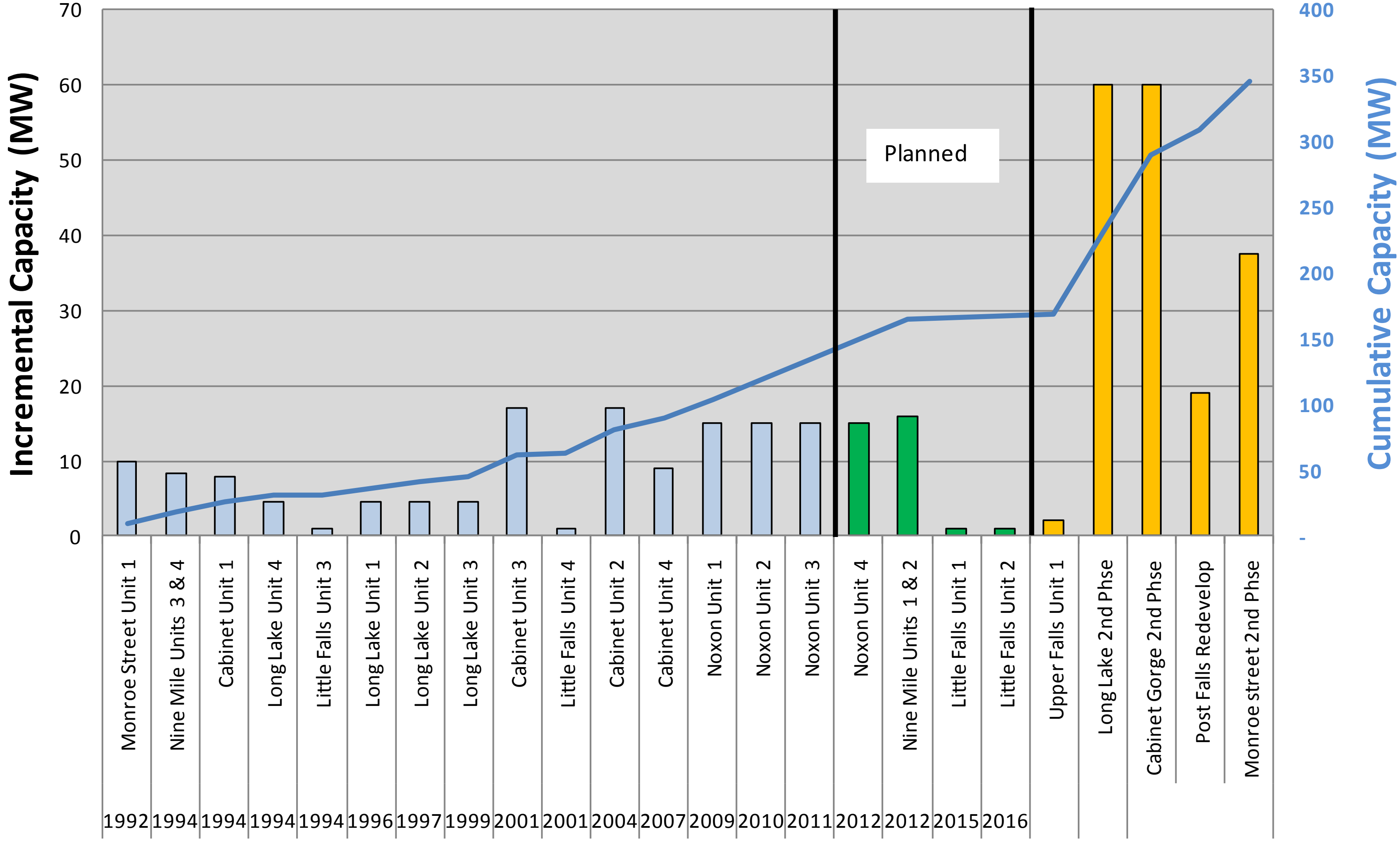
Powerhouse Additions

- To this point in time, we have not added new powerhouse additions to existing facilities

What we have done to date: Energy (GWh's)



What we have done to date: Added Hydro Capacity (MW's)



Summary

- Over the past 20 years, we have added 334,000 MWh's and 120 MW's of hydro to our system
- We are currently planning to add an estimated 49,000 MWh's and 48 MW's
- There are considerations for an additional 116,000 MWh's and 176 MW's

Current Projects

- Little Falls Refurbishment
- Nine Mile Redevelopment

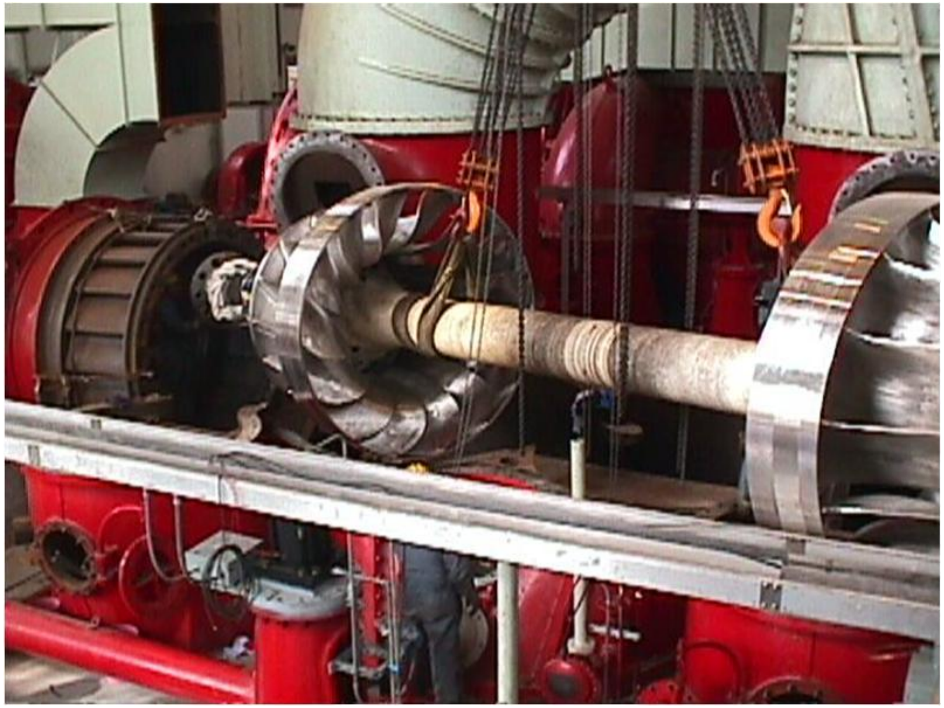
Little Falls Upgrade

- Seeking an increase in turbine efficiency
- Current estimated efficiency is 80%
- Upgraded runners are expected to be 85%
- Approximately 2 MW improvement expected

Little Falls Upgrade

General Scope of work would include replacement of all of the old equipment at the plant – a major undertaking

Photo Showing New Turbine Runners Being installed in Unit 4 in 2001



Little Falls Upgrade

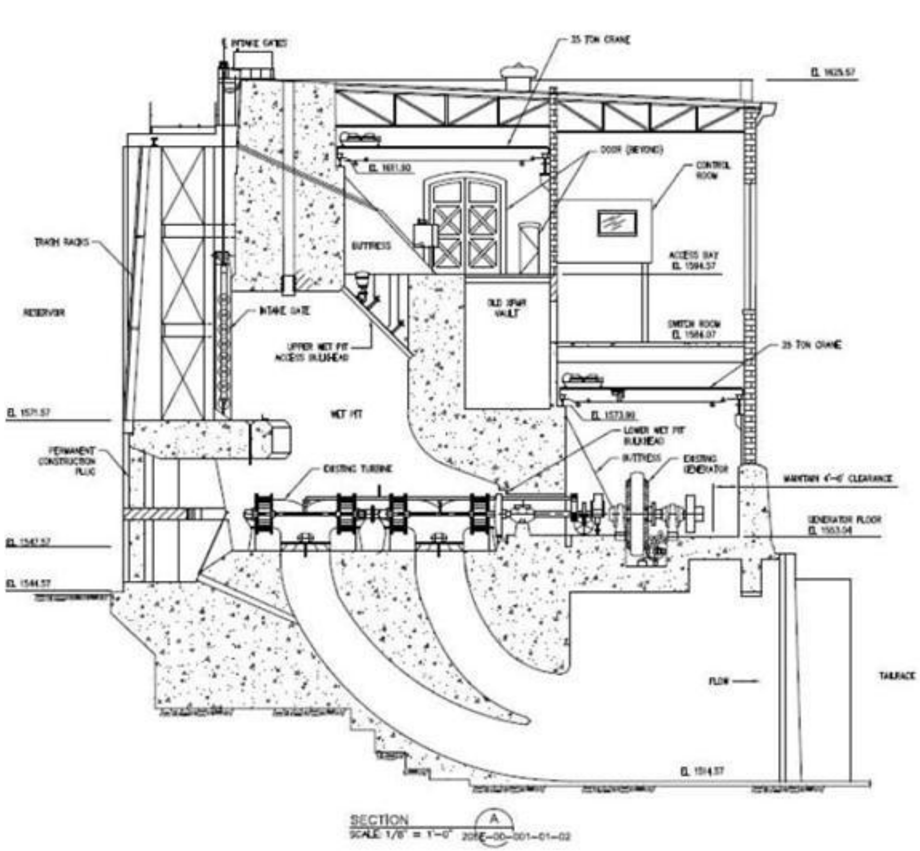
DRAFT

- Expected additional Capacity – 2 MW
- Expected additional Energy – 8,760 MWh
- Estimated Costs - $1.5 million
- Other Considerations:
  - Much of the existing equipment is at the end of its service life and will likely be replaced, significantly increasing the scope of this project work.
  - We have yet to explore expansion plans for this site, and may elect to do so.

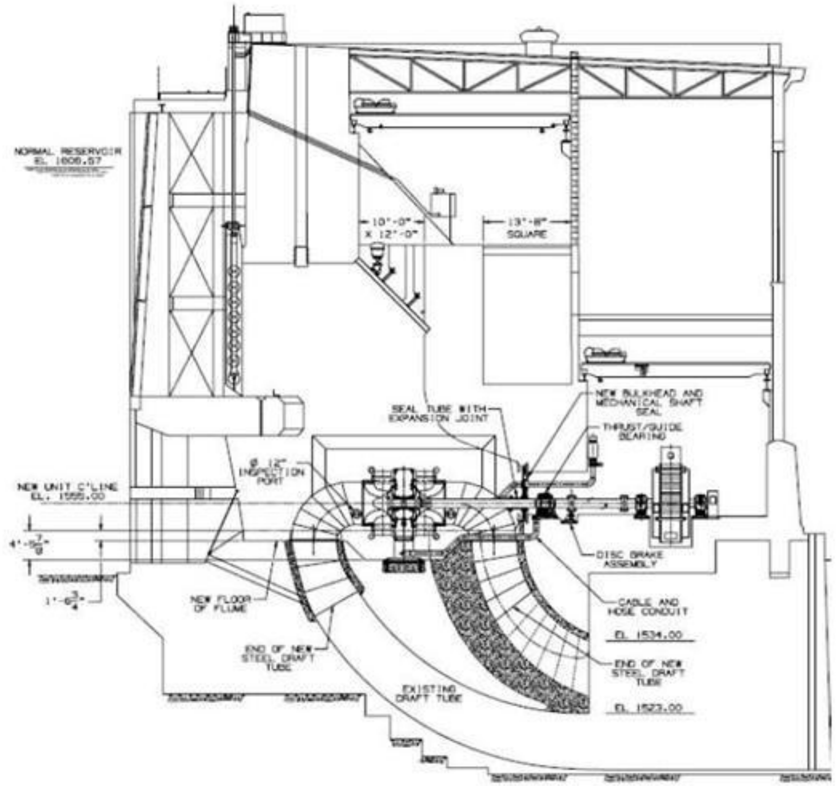
Nine Mile Redevelopment

This project is to replace Units 1 and 2. These are original 1908 machines and are no longer repairable. The basic scope is to remove the old systems and install new turbines, generators, switchgear, and controls to update the plant.

Nine Mile Redevelopment



Existing Units – Horizontal Quad Runner



Proposed American Hydro Seagull Units

Nine Mile Redevelopment

DRAFT

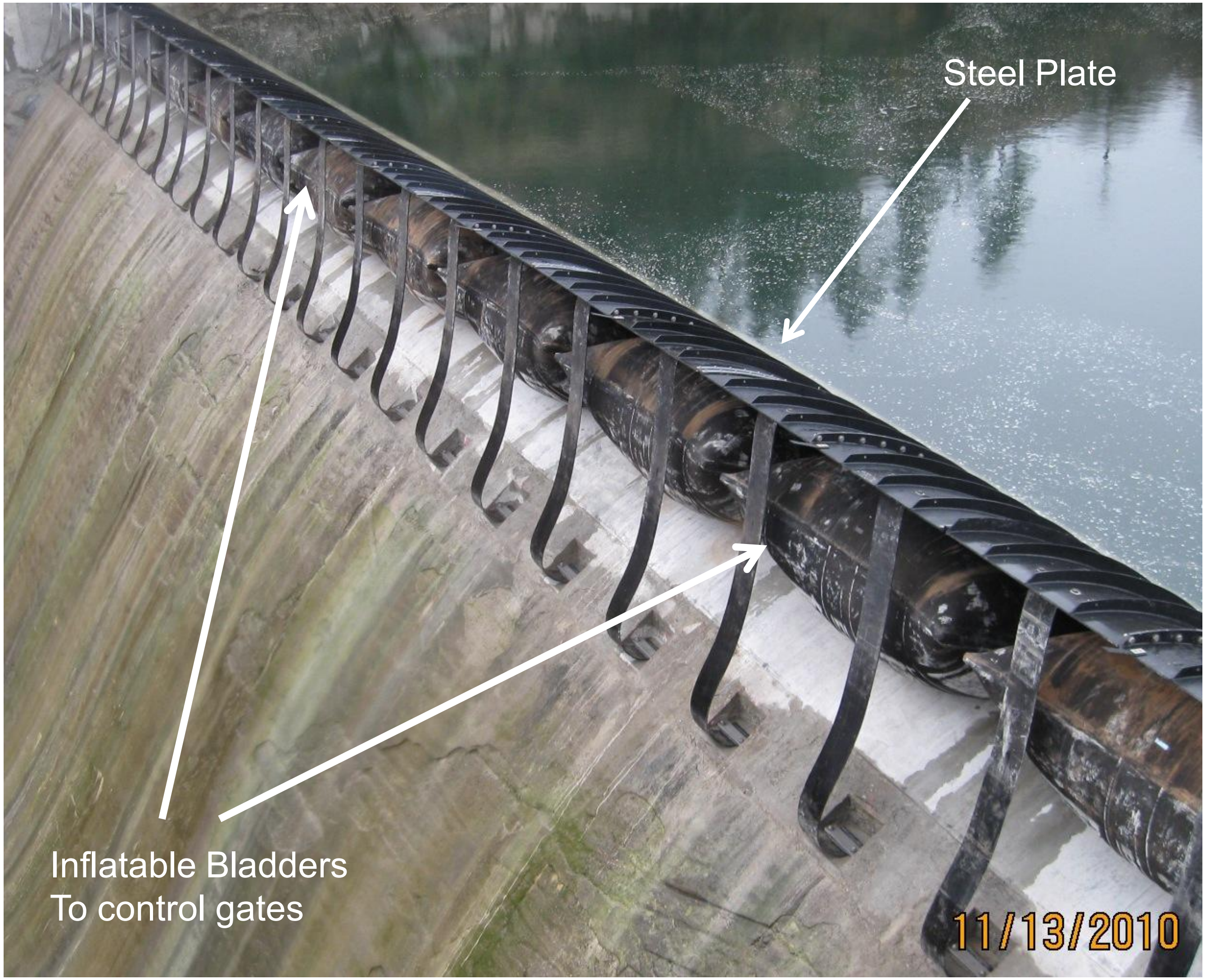
- Expected additional Capacity – 16 MW
- Expected additional Energy – 11,800 MWh
- Estimated Costs - $38 million
- Other Considerations:
  - This addresses Units 1 and 2. Units 3 and 4 were replaced in the 1994.
  - Sediment buildup in the river needs to be addressed.
  - Existing balance of plant equipment is also to be replaced with this project work
  - We just completed a “Obermeyer Gate” installation to eliminate the flashboard system

Nine Mile Sediment Impacts

Nine Mile Flashboard Replacement

From the 1940's until last year, we Would install wooden flashboards On the dam to get an additional 10 Feet of head. Each spring these Would be released and have to be Replaced each year.

Nine Mile Obermeyer Gate

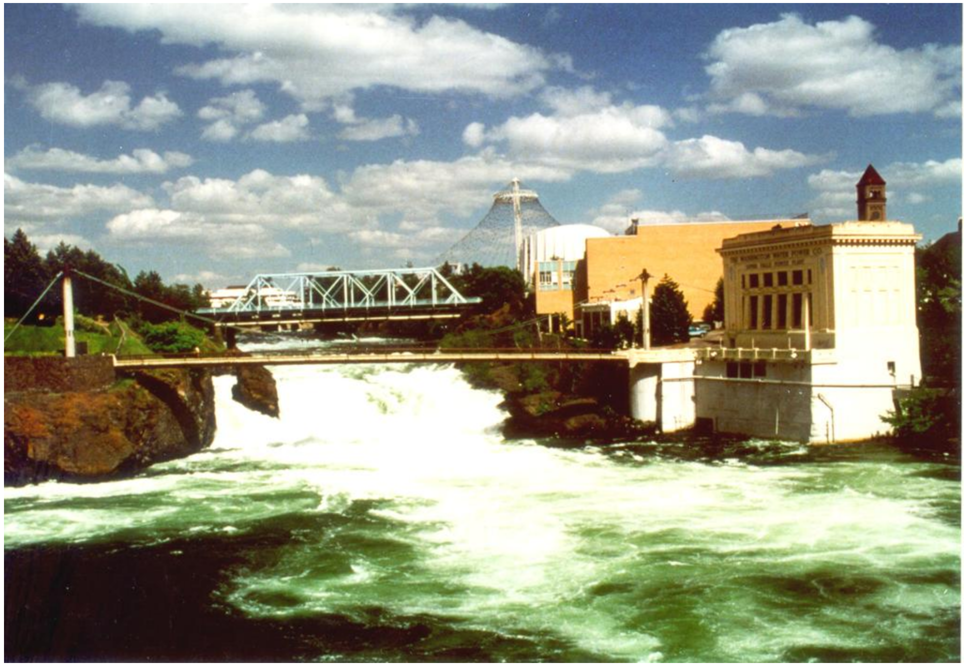


Other Opportunities

- Upper Falls Runner Replacement
- Long Lake Second Powerhouse Addition
- Cabinet Gorge Second Powerhouse Addition
- Post Falls Refurbishment
- Monroe Street Second Powerhouse Addition

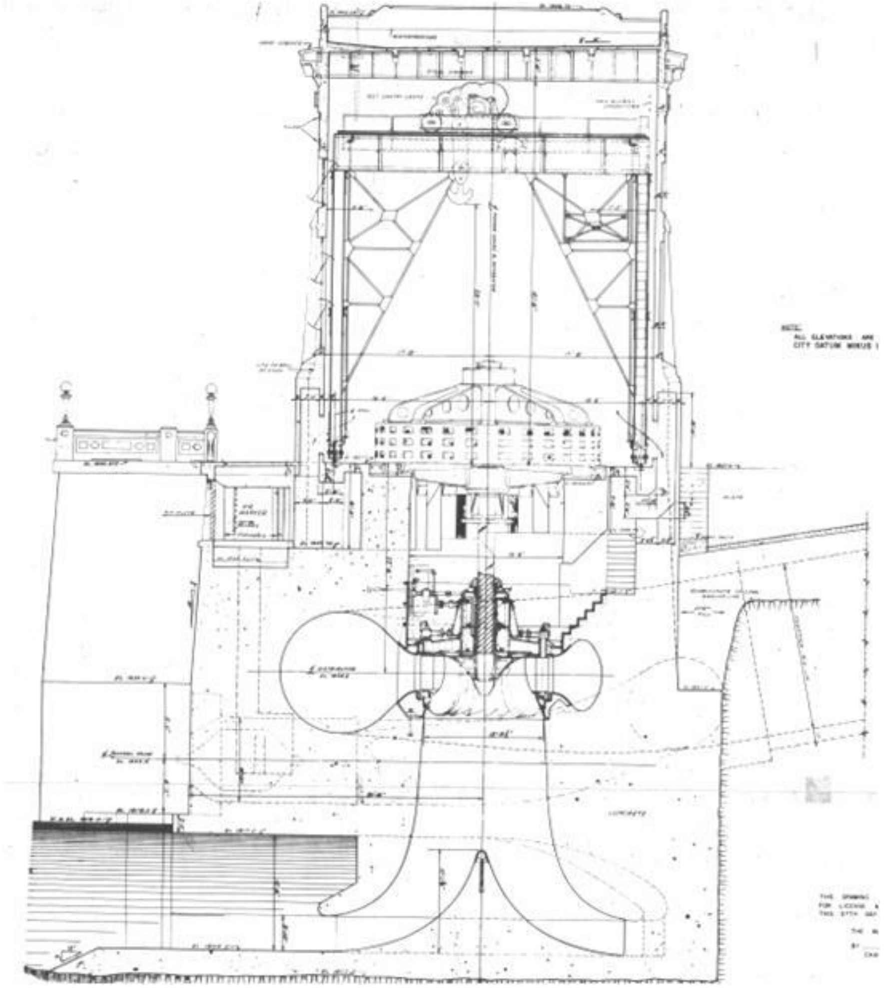
Upper Falls Runner Replacement

Seeking to increase the output of the unit by replacing the turbine runner and modifying the existing draft tube to improve efficiency.



Upper Falls Runner Replacement

General Scope of Work would be to remove the old runner, modify the draft tube, stay vanes, and discharge area, and install a new runner



Upper Falls Runner Replacement

DRAFT

- Expected additional Capacity - 2 MW's
- Expected additional Energy 8,600 MWh's
- Estimated Costs - $6.8 million
- Other Considerations:
  - New license conditions have not yet been considered in this options.
  - Would require considerable modification to the existing draft tube system

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Long Lake Second Powerhouse

Seek to increase plant capacity by the addition of a second powerhouse and large capacity unit

Long Lake Second Powerhouse

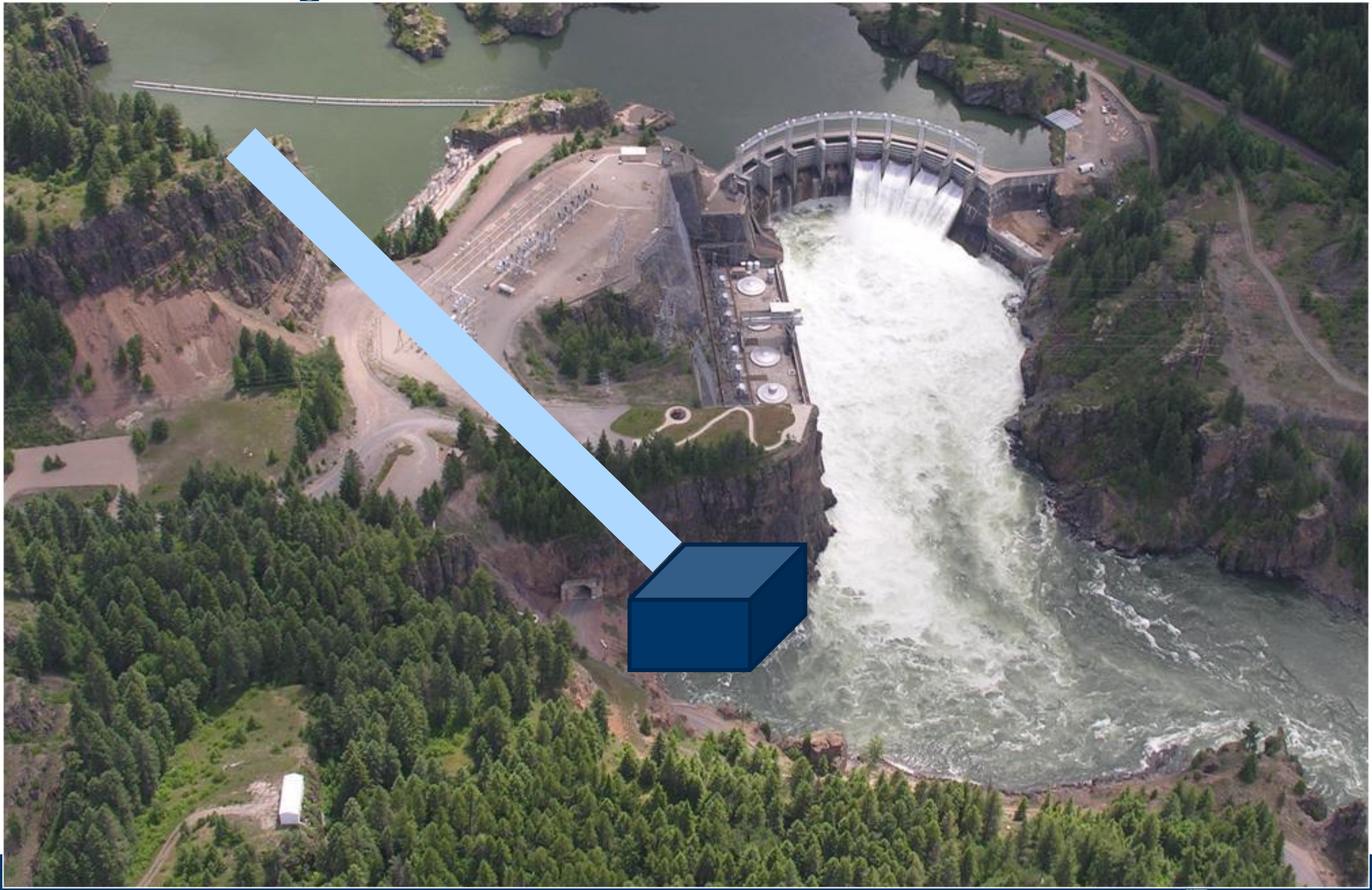
Long Lake Second Powerhouse

- Expected additional Capacity – 60 - 120 MW
- Expected additional Energy – 158,000 – 178,000 MWh
- Estimated Costs - $120+ million
- Other Considerations:
  – Impacts of construction to the existing plant
  – Condition of small arch dam to be used as a cofferdam

Cabinet Gorge Second Powerhouse

Seek to increase plant capacity by the addition of a second powerhouse and match Noxon Rapids flow capacity

Cabinet Gorge Second Powerhouse



Cabinet Gorge Second Powerhouse

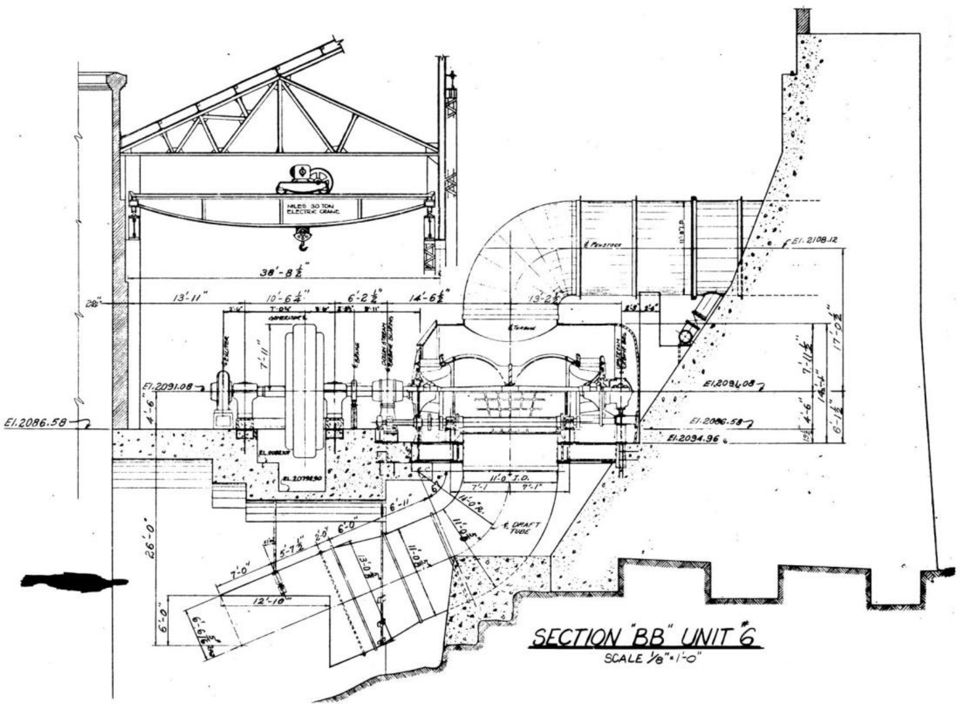
- Expected additional Capacity – 50 MW
- Expected additional Energy – 57,000 MWh
- Estimated Costs - $115 million
- Other Considerations:
  - This project would favorably impact the Total Dissolved Gas (TDG) issue at Cabinet Gorge and is currently under consideration by the Clark Fork License team.

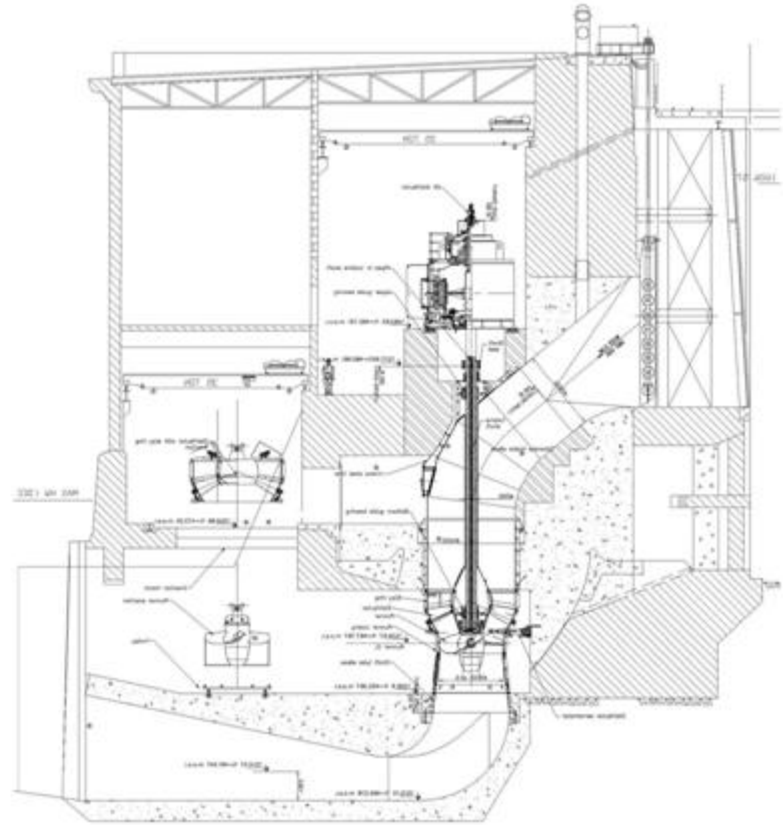
Post Falls Refurbishment

This would involve removing all of the old station equipment and replacing it with new units. The building exterior would remain intact

Post Falls Upgrade

The Scope is to remove the old horizontal units and replace them with high efficiency and higher capacity vertical units





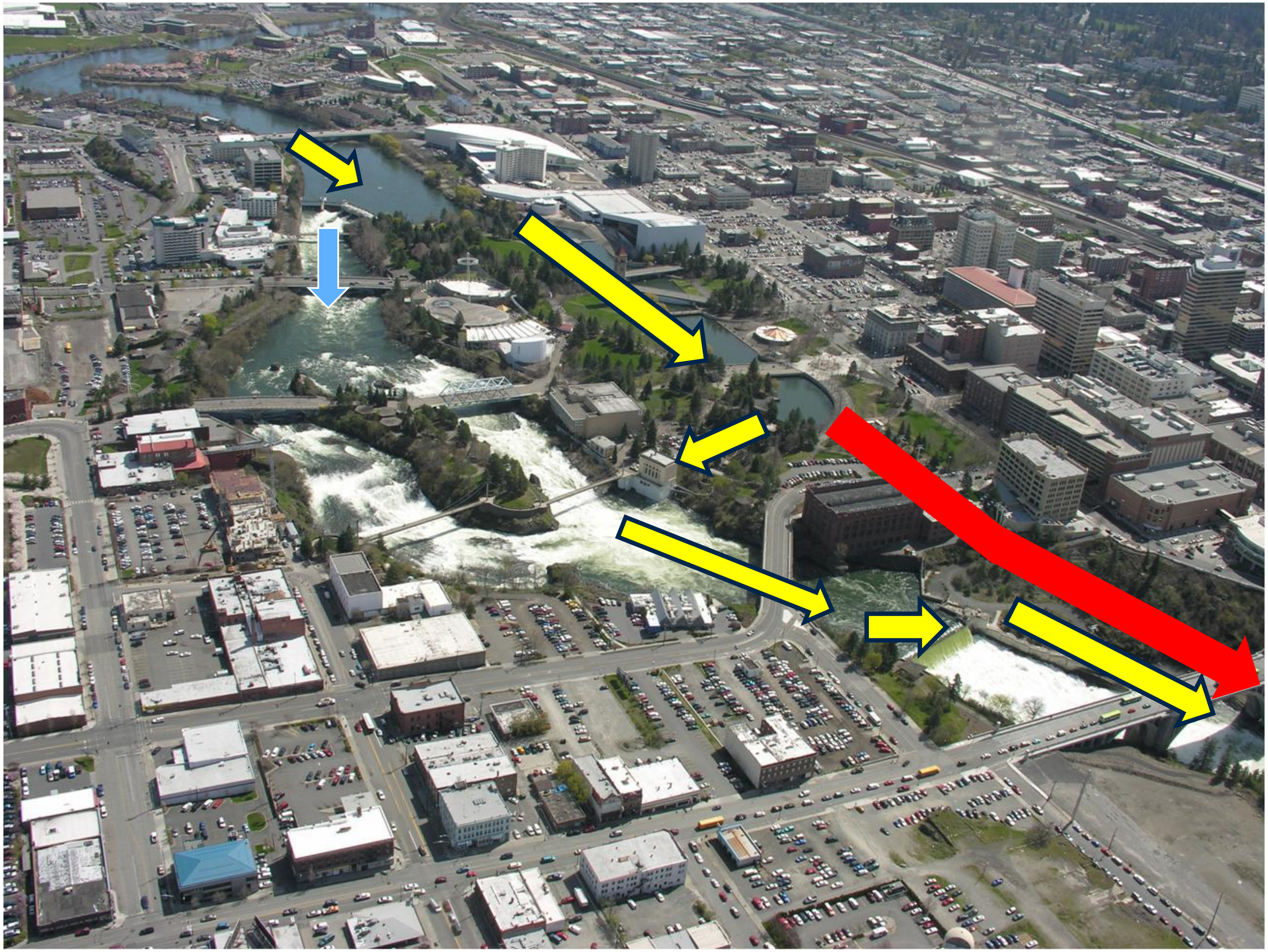
Post Falls Upgrade

- Expected Additional Capacity – 19 MW's
- Expected additional Energy – 33,000 MWh's
- Estimated Costs - $75 million
- Other Considerations:
  - Need to evaluate this plan against new license conditions

Monroe Street Second Powerhouse

The basic project here is to harness the capacity of the 140 waterfall that the Spokane River drops in downtown Spokane

Monroe Street Second Powerhouse



Monroe Street Second Powerhouse

- Expected Additional Capacity – 37.5 MW's
- Expected additional Energy – 142,000 MWh's
- Estimated Costs - $95 million
- Other Considerations:
  - Downtown Spokane and Riverfront Park locations make this a challenging option
  - Would require a significant make over of the western edge of Riverfront Park, and channel dredging

Hydro Upgrades – Other Issues

- Aging equipment is driving much of the work.
- Gaining valuable experience for our work force
- Current incentives for REC's and tax incentives are playing a part
- Needs for future capacity
- Environmental Drivers
  - Total Dissolved Gas – desire to reduce spill at some sites
  - Needs for more modern plants with appropriate systems to avoid possible releases
  - Licenses have provided some certainty around investment opportunities.
  - Significant permit time for second powerhouse projects

Potential Thermal Upgrades

Jason Graham
Generation Engineer

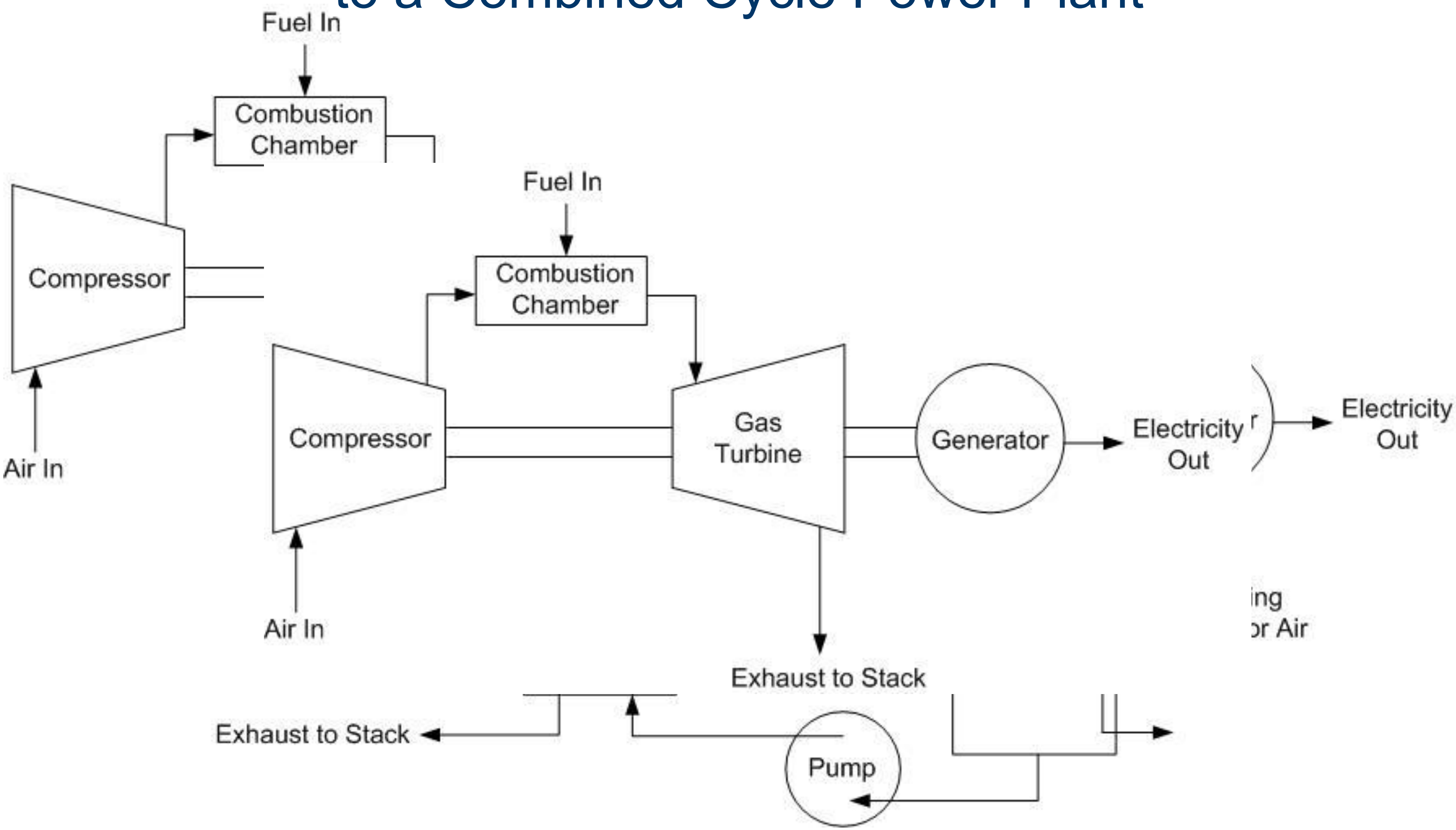
Overview

- Conversion of Rathdrum CT to a Combined Cycle Power Plant
- Water Demineralization System for Inlet Fogging at Rathdrum CT
- Inlet Chiller at Coyote Springs 2
- Cold Day Performance Software Upgrade at Coyote Springs 2
- Advanced Hot Gas Path Hardware Upgrade at Coyote Springs 2
- Cooling Optimization Hardware Upgrade at Coyote Springs 2
- Wood Fuel Gasification at Kettle Falls Generation Site

Rathdrum Combustion Turbine
Rathdrum, Idaho

- Two General Electric 7EA Combustion Turbines
- On Line in 1994
- Simple Cycle Configuration
- Approximately 160 MW Combined Output
- Heat Rate of 11,612 Btu/kWh (HHV)

Conversion of Rathdrum CT to a Combined Cycle Power Plant



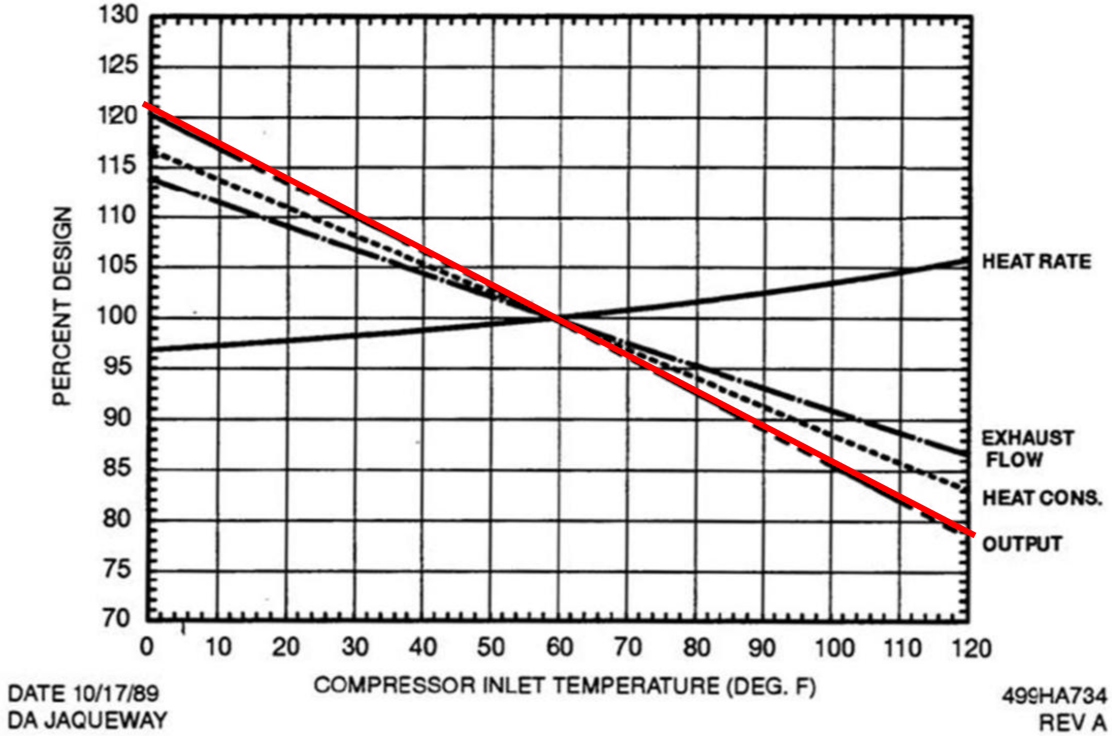
Conversion of Rathdrum CT to Combined Cycle Water Cooled Condenser

Incremental Output Increase:	78.4 MW At 5°F
	85.2 MW at 55°F
	91.4 MW at 100°F
Overall Plant Heat Rate Change:	-3782 Btu/kWhr (HHV)
Variable Operating Costs:	$1.50/MWh
Fixed Operating Costs:	$15/kWyr
Capital Cost:	$71M
Plant Unavailable Time:	6 Months

Conversion of Rathdrum CT to Combined Cycle Air Cooled Condenser

Incremental Output Increase:	77.9 MW At 5°F
	79.9 MW at 55°F
	82.4 MW at 100°F
Overall Plant Heat Rate Change:	-3626 Btu/kWhr (HHV)
Variable Operating Costs:	$1.30/MWh
Fixed Operating Costs:	$15/kWyr
Capital Cost:	$81.5M
Plant Unavailable Time:	6 Months

Water Demineralizer at Rathdrum CT for Inlet Fogging



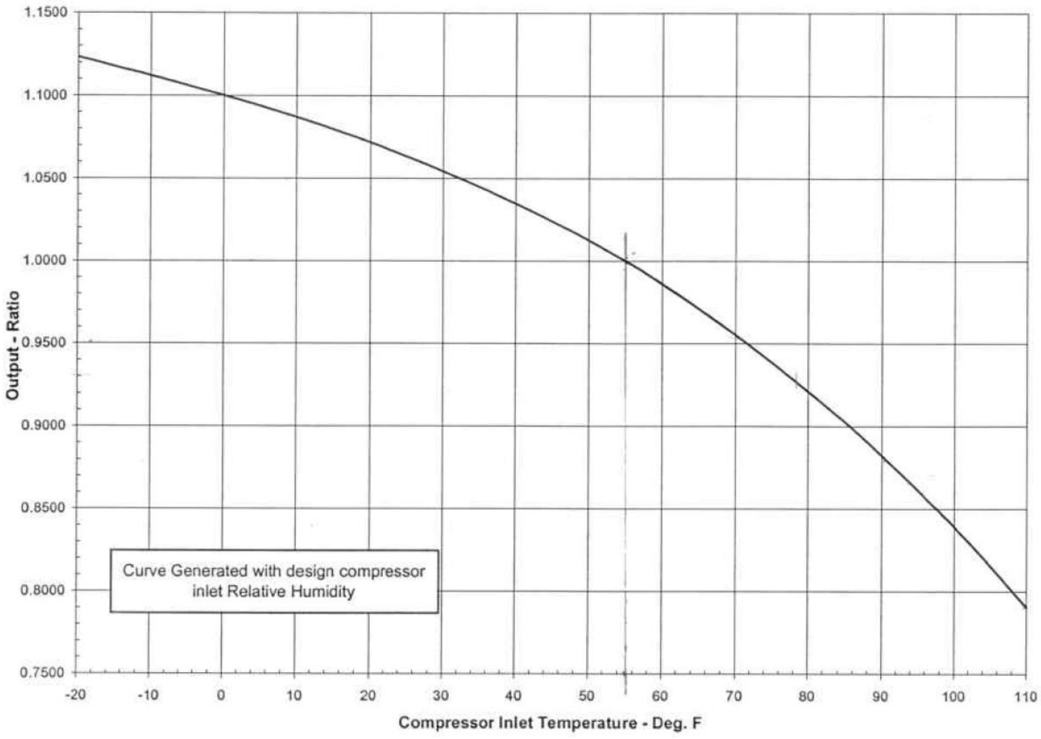
Water Demineralizer at Rathdrum CT for Inlet Fogging

Incremental Output Increase:	N/A At 5°F
	4.4 MW at 55°F
	17.6 MW at 100°F
Overall Plant Heat Rate Change:	-67 Btu/kWhr (HHV)
Variable Operating Costs:	$1.00/MWh
Fixed Operating Costs:	Insignificant
Capital Cost:	$1M
Plant Unavailable Time:	2 Months

Coyote Springs 2
Boardman, Oregon

- One General Electric 7FA Combustion Turbine
- Combined Cycle Configuration
- On Line in 2003
- Approximately 279 MW Combined Output (Duct Fired)
- Heat Rate of 6229 Btu/kWh (HHV)

Inlet Chiller at Coyote Springs 2



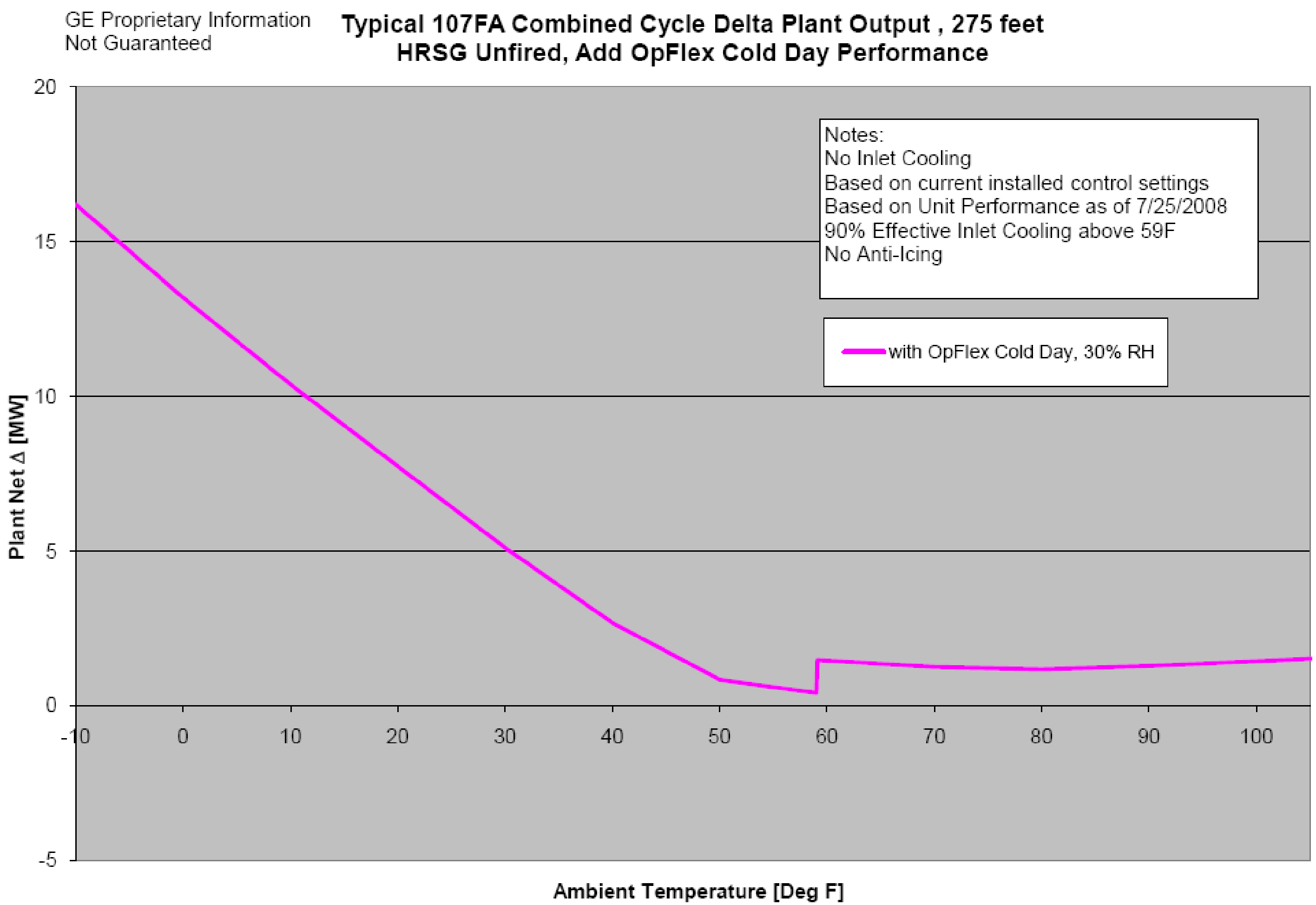
Inlet Chiller at Coyote Springs 2 w/o Thermal Storage

Incremental Output Increase:	N/A At 5°F
	0 MW at 55°F
	29.8 MW at 100°F
Overall Plant Heat Rate Change:	Insignificant
Variable Operating Costs:	Insignificant
Fixed Operating Costs:	Insignificant
Capital Cost:	$10M
Plant Unavailable Time:	3 Months

Inlet Chiller at Coyote Springs 2 With Thermal Storage

Incremental Output Increase:	N/A At 5°F
	0 MW at 55°F
	32.2 MW at 100°F
Overall Plant Heat Rate Change:	Insignificant
Variable Operating Costs:	Insignificant
Fixed Operating Costs:	Insignificant
Capital Cost:	$10M
Plant Unavailable Time:	3 Months

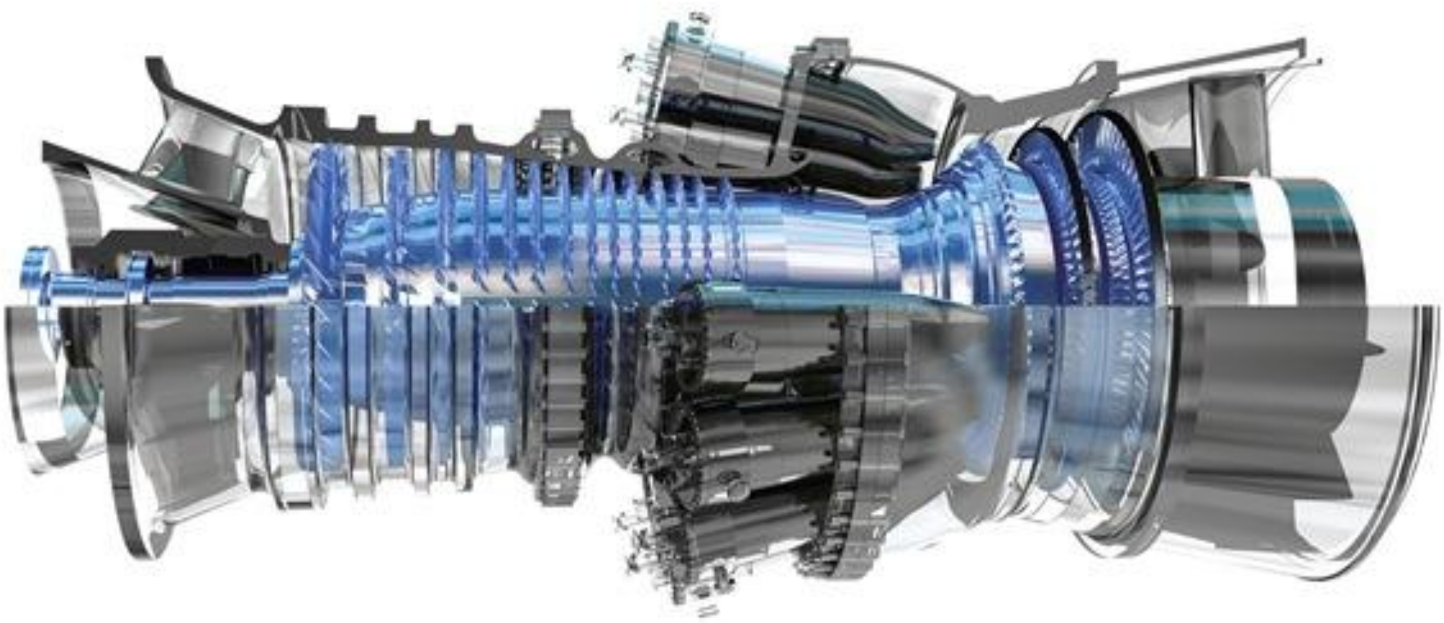
Cold Day Performance Software Upgrade at Coyote Springs 2



Cold Day Performance Software Upgrade at Coyote Springs 2

Incremental Output Increase:	17.6 MW At 5°F
	0.8 MW at 55°F
	1.2 MW at 100°F
Overall Plant Heat Rate Change:	Insignificant
Variable Operating Costs:	None
Fixed Operating Costs:	None
Capital Cost:	$4.5M
Plant Unavailable Time:	2 Months

Advanced Hot Gas Path Hardware Upgrade at Coyote Springs 2



Source: General Electric

Advanced Hot Gas Path Hardware Upgrade at Coyote Springs 2

Incremental Output Increase:	8.6 MW At 5°F
	8.0 MW at 55°F
	7.1 MW at 100°F
Overall Plant Heat Rate Change:	-76 Btu/kWhr
Variable Operating Costs:	None
Fixed Operating Costs:	$3.9M
Capital Cost:	$18M
Plant Unavailable Time:	None

Cooling Optimization Hardware Upgrade at Coyote Springs 2

7FA Cooling Optimization Package,
Image removed, GE Proprietary

Source: General Electric

Cooling Optimization Hardware Upgrade at Coyote Springs 2

Incremental Output Increase:	2.8 MW At 5°F
	2.6 MW at 55°F
	2.3 MW at 100°F
Overall Plant Heat Rate Change:	-35 Btu/kWhr
Variable Operating Costs:	None
Fixed Operating Costs:	None
Capital Cost:	$7.2M
Plant Unavailable Time:	2 Months

Kettle Falls Generating Station
Kettle Falls, Washington

•Wood Fired Boiler with General Electric Steam Turbine

•On Line in 1983

•Approximately 48 MW Output

Gasification of Wood Fuel at Kettle Falls Generation Site

Nexterra Gasification System

1. Fuel In-Feed System
2. Gasifier
3. Automatic Ash Removal System
4. Syngas

AVISTA

Gasification of Wood Fuel at Kettle Falls Generation Site

- Gasification of wood fuel for use in turbines is in it’s infancy
- Difficulty with adequately cleaning the syngas for use in a turbine
- No reliable data on expected costs or operational characteristics

Questions?

Load Forecast

Randy Barcus

Technical Advisory Committee Meeting #3

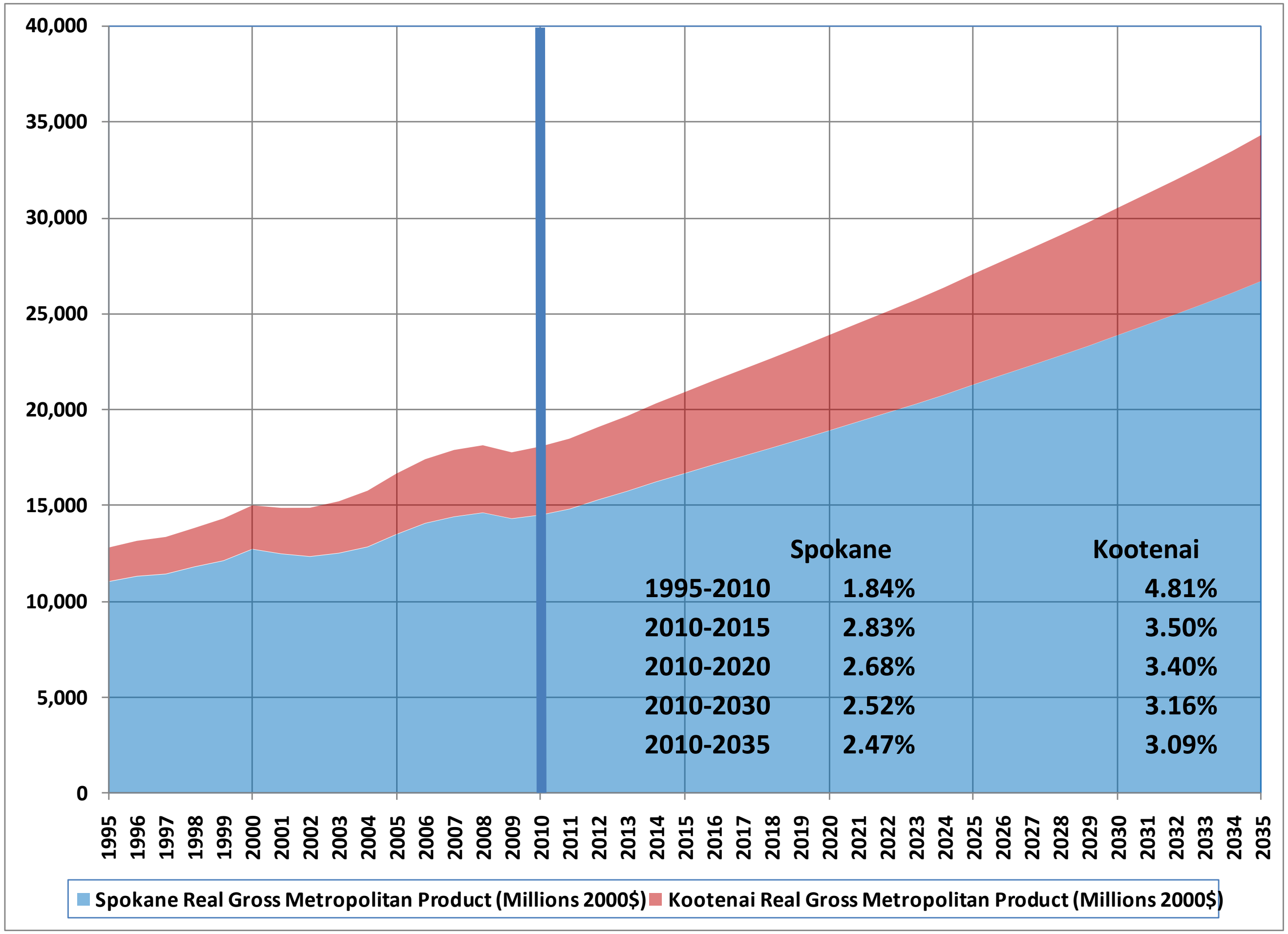
2011 Electric Integrated Resource Plan

December 2, 2010

Load Forecast 2011-2035 Outline

- Economy
- Weather
- Price Elasticity
- Customer Regressions
- Small Sector Forecasts
- Large Customer Forecasts
- Irrigation and Pumping Sales
- Sales Forecast
- Load Forecast
- Expected Peak Forecast
- Load Forecast Scenarios

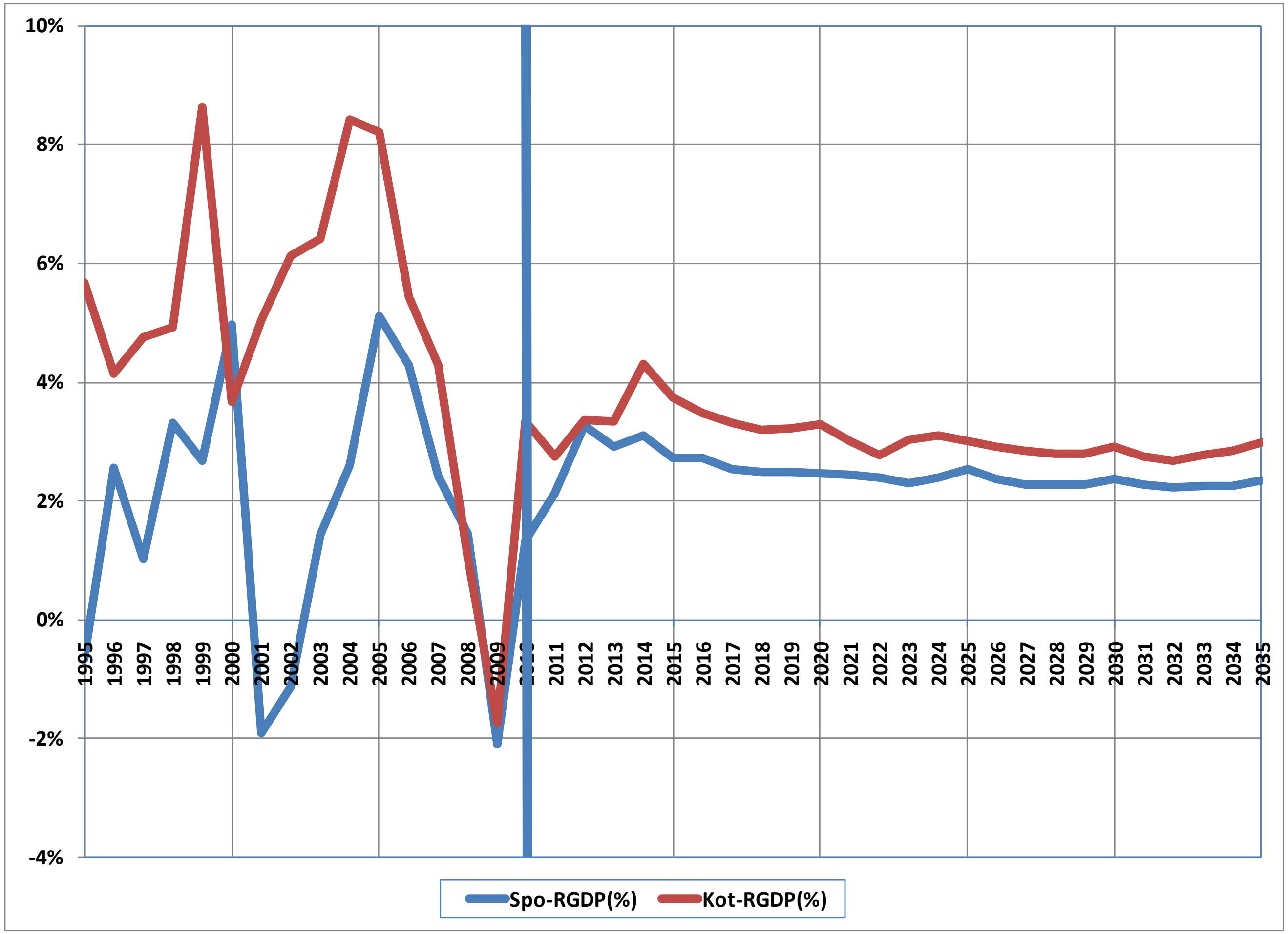
Real Gross Metropolitan Product ($millions) History 1995-2010, Forecast 2010-2035



GLOBAL INSIGHT

AVISTA

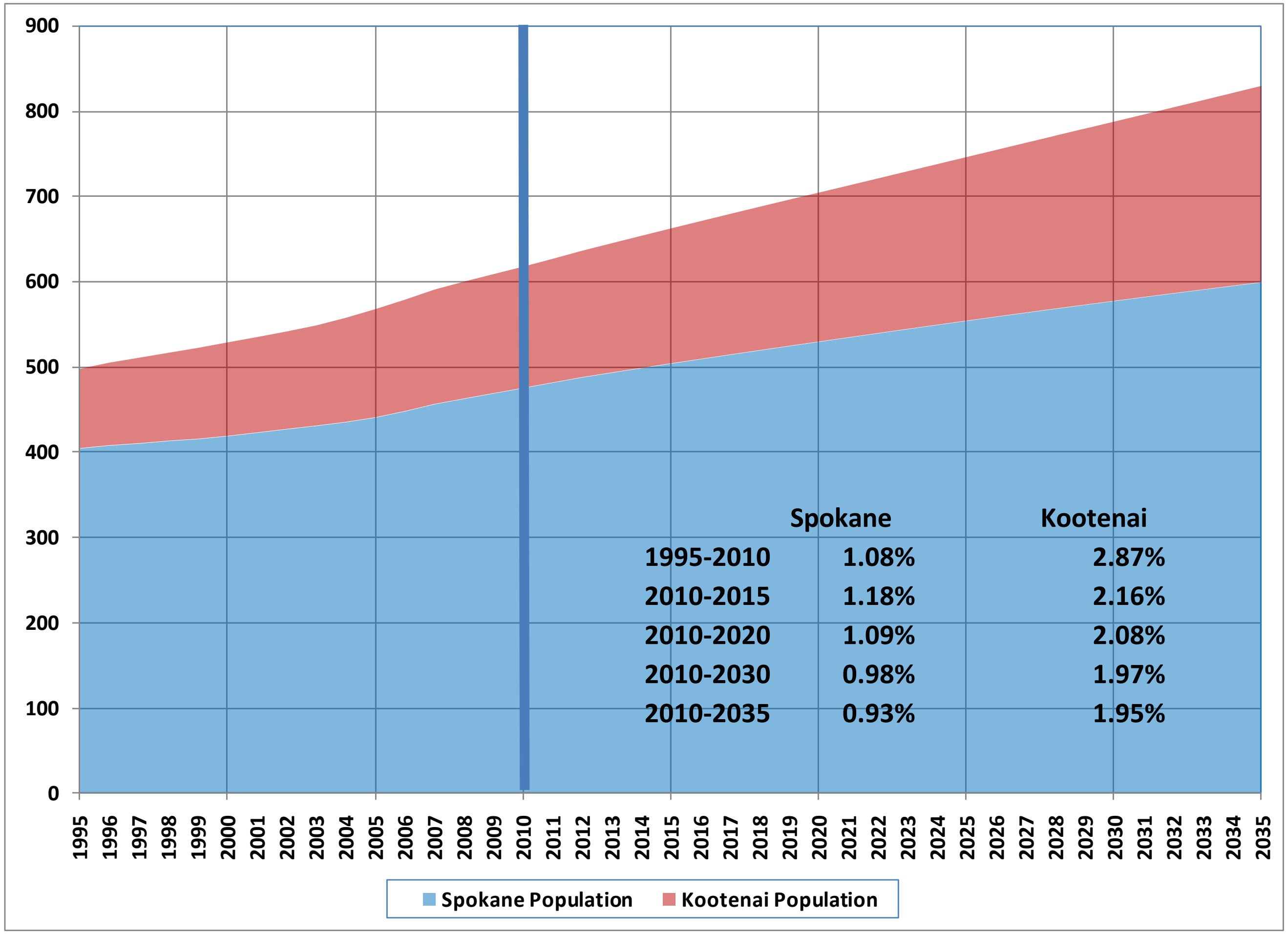
Real Gross Metropolitan Product Annual Percent Change



IHS GLOBAL INSIGHT

AVISTA

Annual Population—thousands of persons History 1995-2010, Forecast 2010-2035

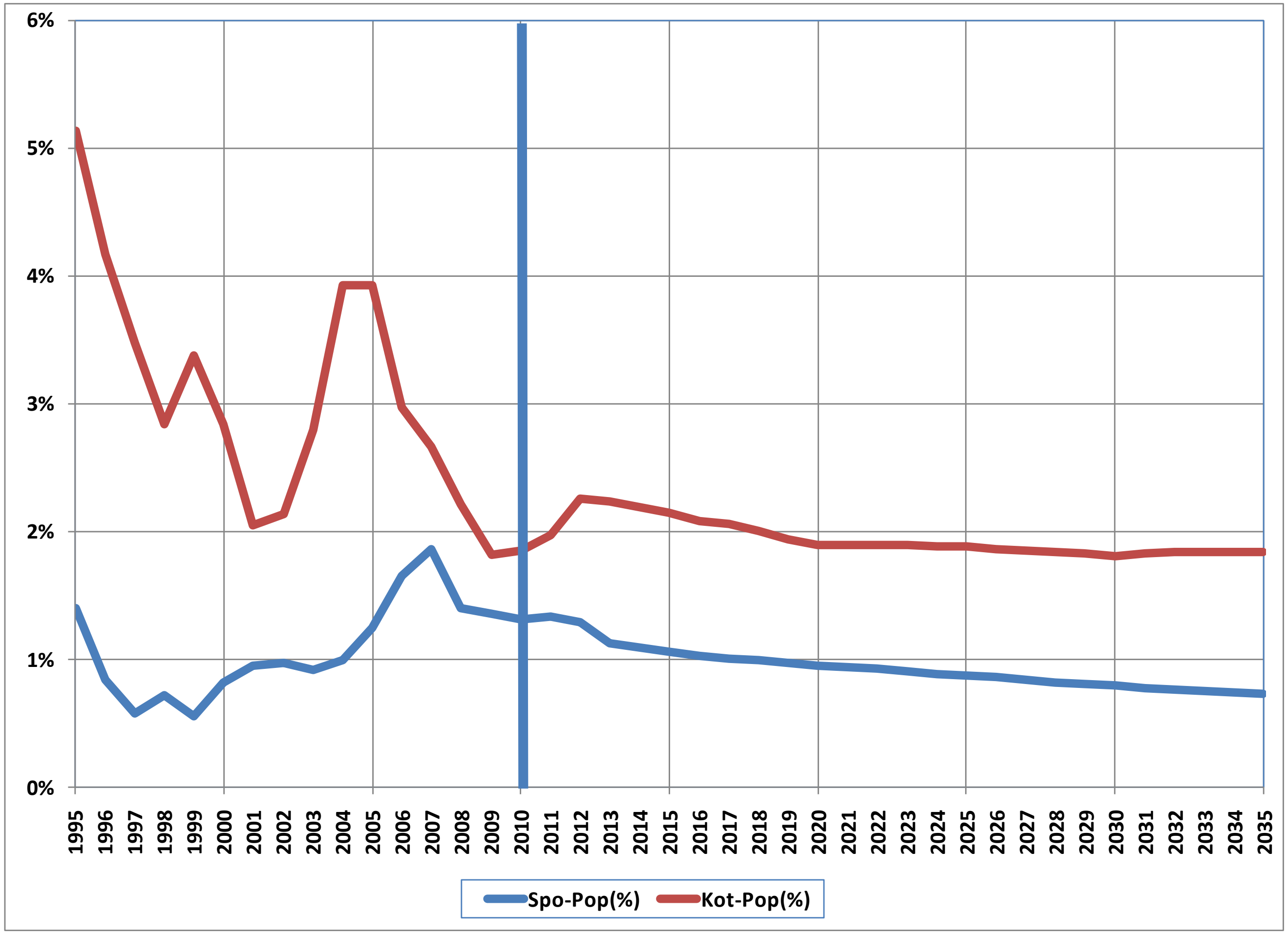


	Spokane	Kootenai
1995-2010	1.08%	2.87%
2010-2015	1.18%	2.16%
2010-2020	1.09%	2.08%
2010-2030	0.98%	1.97%
2010-2035	0.93%	1.95%

IHS GLOBAL INSIGHT

AVISTA

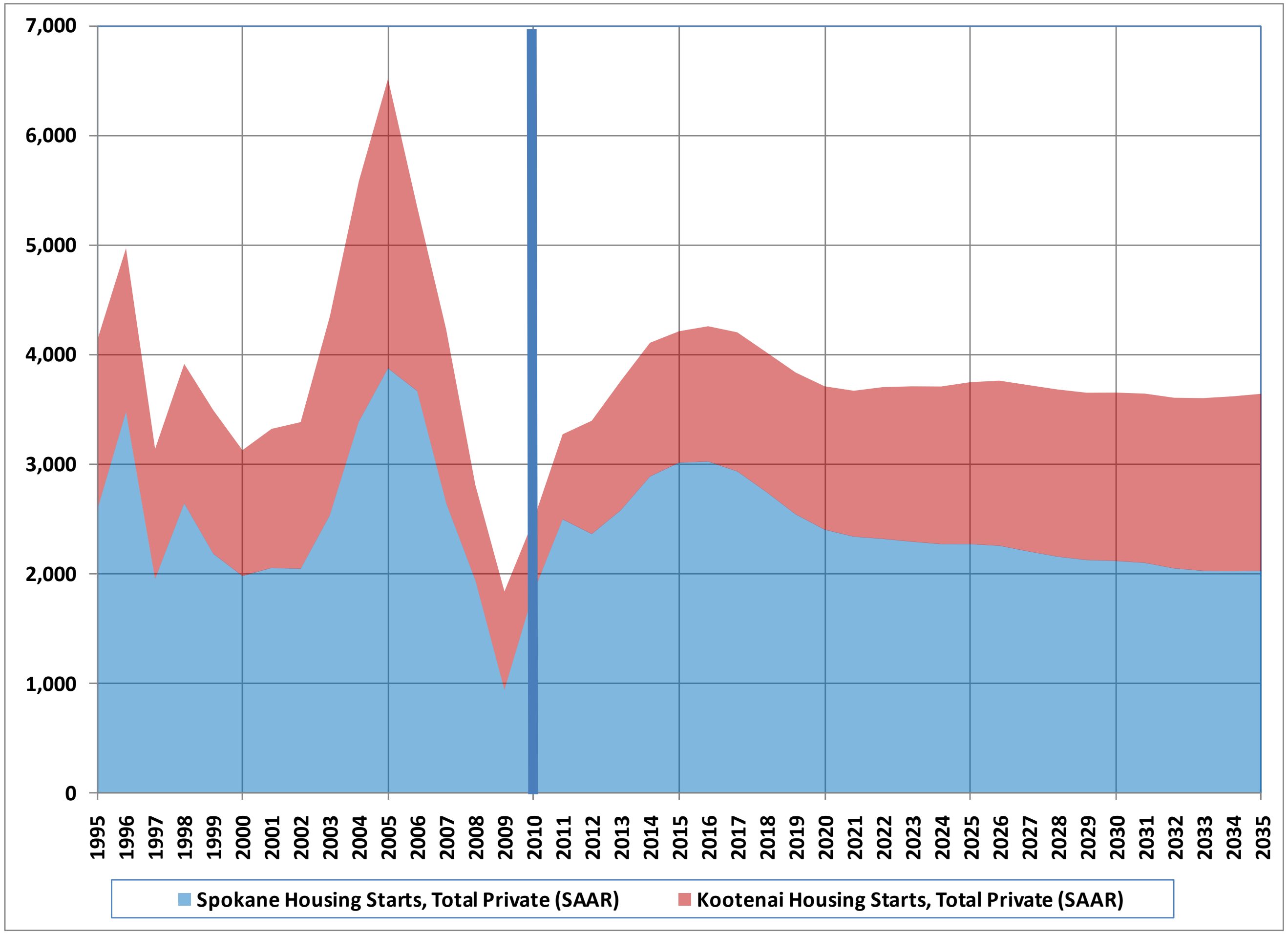
Population
Annual Percent Change



GLOBAL INSIGHT

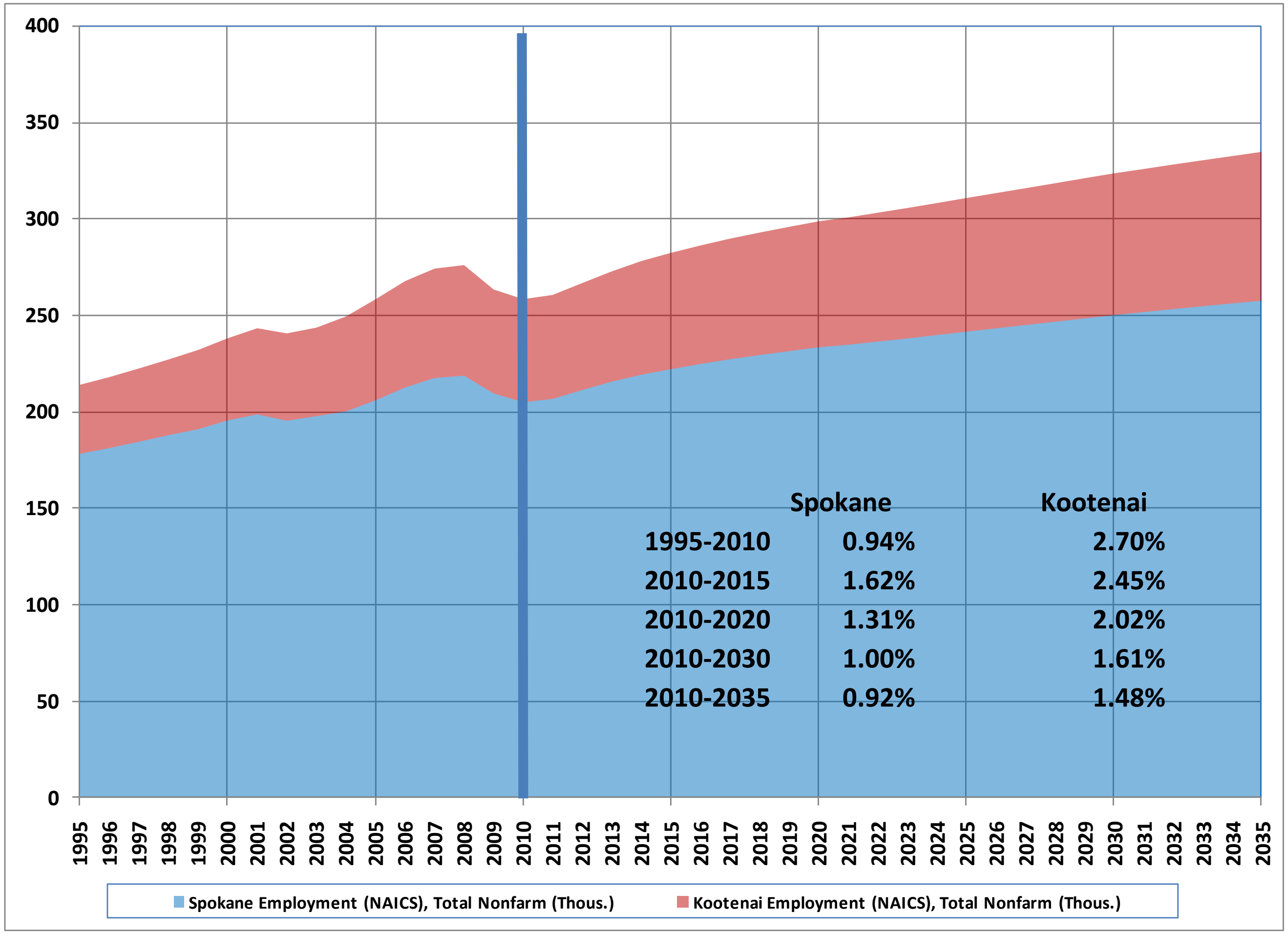
AVISTA

Annual Housing Starts
History 1995-2010, Forecast 2010-2035



IHS GLOBAL INSIGHT
AVISTA

Average Annual Non-Ag Employment—thousands History 1995-2010, Forecast 2010-2035

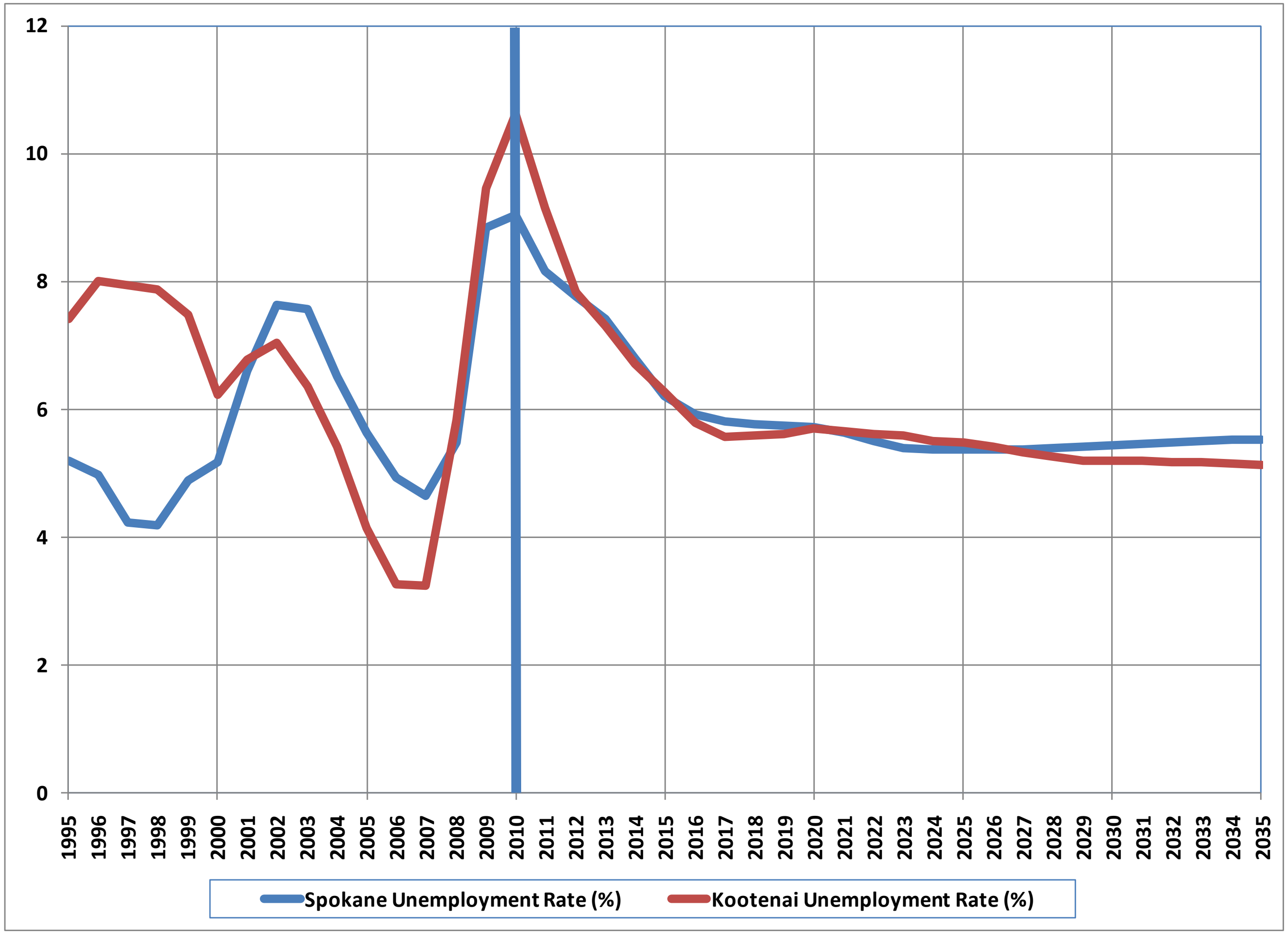


Non-Ag Employment
Annual Percent Change

IHS GLOBAL INSIGHT

AVISTA

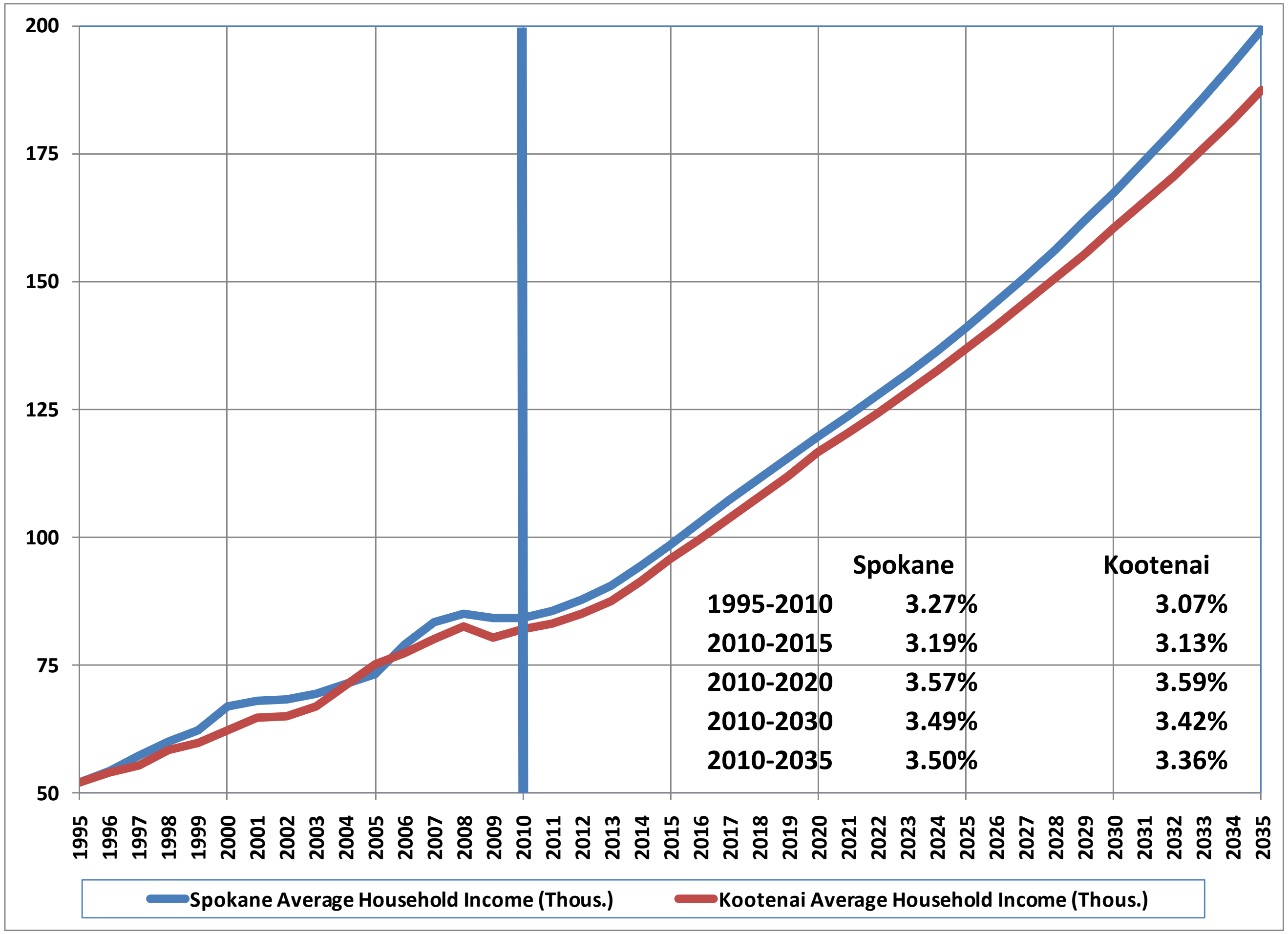
Average Annual Unemployment Rate--Percent



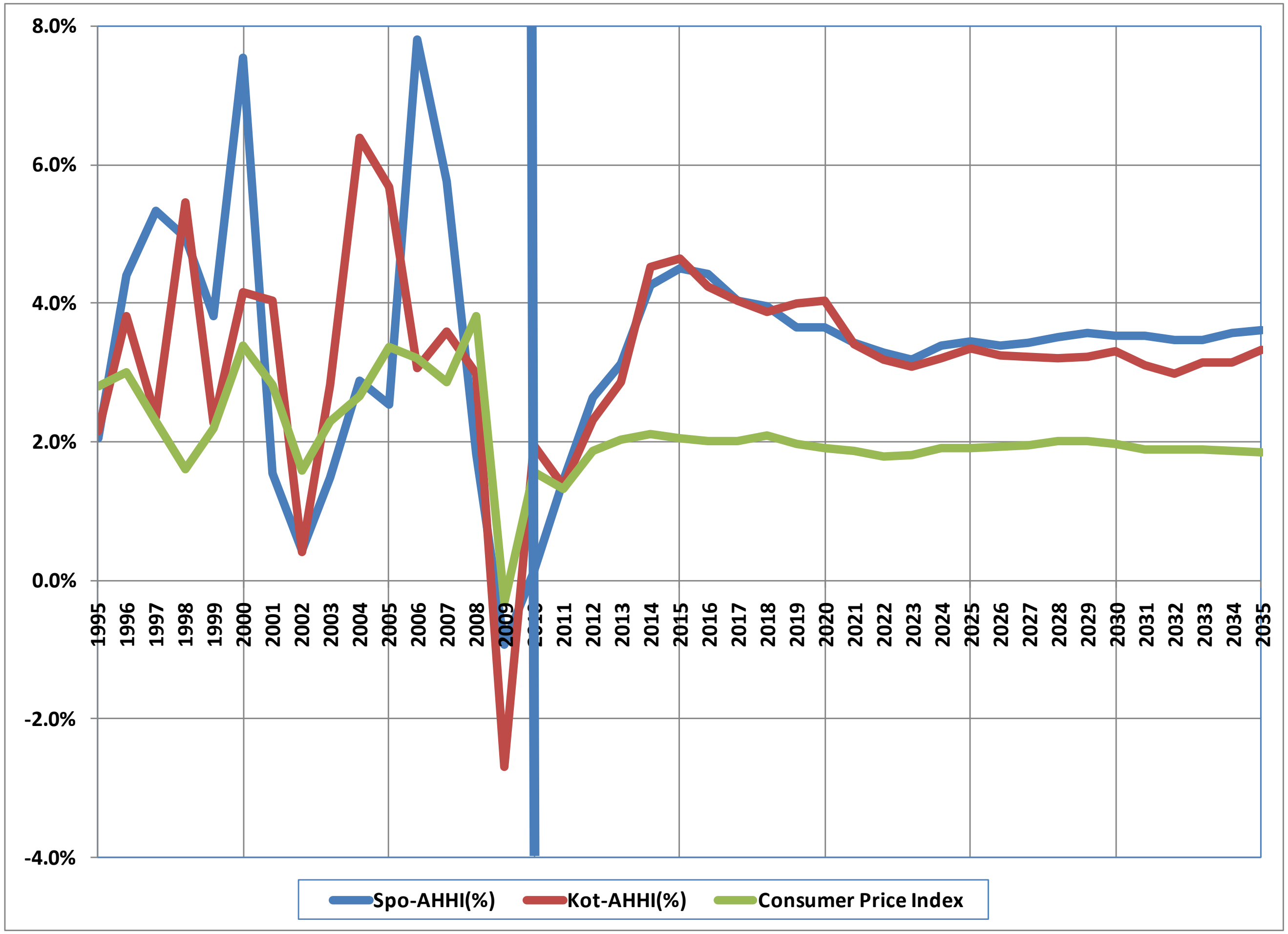
IHS GLOBAL INSIGHT

AVISTA

Average Annual Household Income—Thousands $



Average Household Income—Percent Change Compared to U.S. Consumer Price Index (CPIU)



Weather Assumptions

- We use degree days (heating and cooling) base 65 degrees
- We define "normal" as the average of the last 30 years of actual data; for this forecast, the period is 1980-2009
- We assume the first year (2011) of the forecast is "normal"
- A gradual warming trend in temperature equal to the University of Washington "Climate Change Scenarios" 2008 study Average case converted by us to heating and cooling degree days
- http://cses.washington.edu/cig/fpt/ccscenarios.shtml

Spokane HDD 1970-1999 Average			6,848	
	Low	1.1	6,547	95.6%
2025 Computation	Average*	2.0	6,300	92.0%
	High	3.3	5,944	86.8%
	Low	1.5	6,437	94.0%
2045 Computation	Average*	3.2	5,971	87.2%
	High	5.2	5,423	79.2%
	Low	2.8	6,081	88.8%
2085 Computation	Average*	5.3	5,396	78.8%
	High	9.7	4,190	61.2%

Spokane CDD 1970-1999 Average			411	
	Low	1.1	511	124.3%
2025 Computation	Average*	2.0	593	144.3%
	High	3.3	711	173.0%
	Low	1.5	548	133.2%
2045 Computation	Average*	3.2	702	170.8%
	High	5.2	884	215.1%
	Low	2.8	666	162.0%
2085 Computation	Average*	5.3	893	217.3%
	High	9.7	1,294	314.7%

Price Elasticity

- The price elasticity assumptions are unchanged from the prior IRP
  - Residential -0.15
  - Commercial -0.10
  - Cross-price +0.05
  - Income +0.75
- We monitor price elasticity estimates for consistency
  - Energy Information Administration
  - Itron Energy Forecasting Group
  - American Gas Association/Gas Forecasters Forum

Customer Regressions

- We use annual housing starts forecasts from Global Insight, Inc. to forecast residential customers—this method is new
  - The dependent variable is annual residential customer additions, the independent variable is annual housing starts
  - We forecast Idaho and Washington Schedule 1 customers using separate models
- We use annual residential customer additions to forecast commercial customer additions.
  - The dependent variable is annual commercial customer additions, the independent variable is residential customer additions
- For very large commercial customers, we add one in 2017, 2021, and 2028 in Washington and one in Idaho in 2025

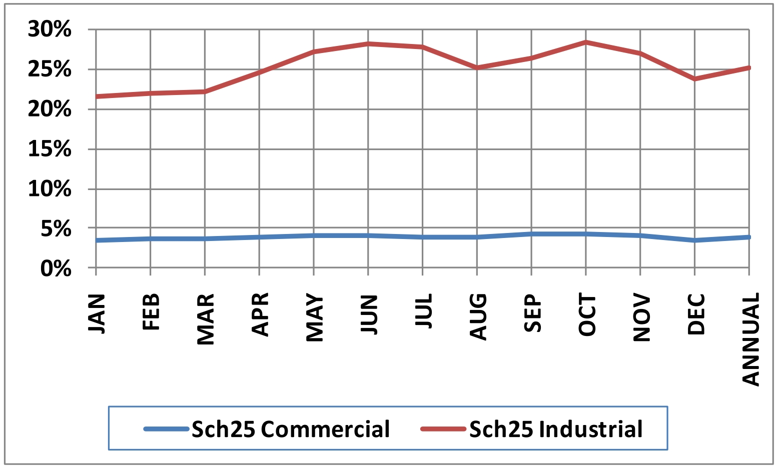
Small Sector Forecasts

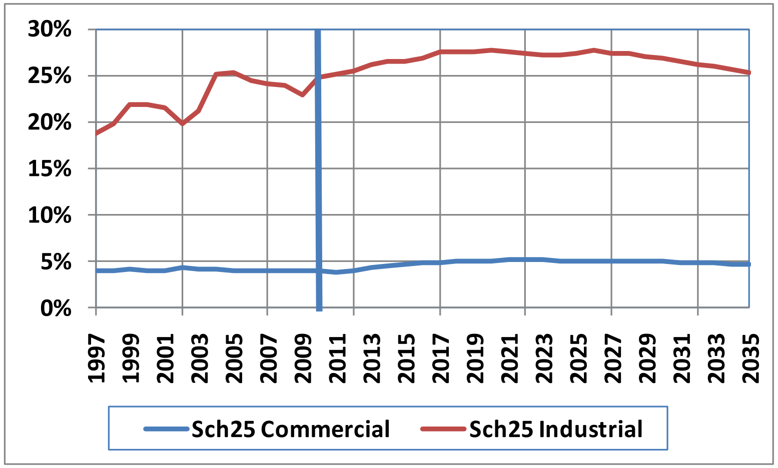
- We forecast electricity sales by state, by rate schedule
- We produce monthly sales forecasts until 2015, annual to 2035
- We define small sector sales in Washington as:
  - Residential schedule 1, 12, 22, 32 and 48
  - Commercial schedule 11, 21, 28, 31 and 47
  - Industrial schedule 11, 21, 31, 32 and 47
  - Street Lighting schedule 41, 42, 44, 45 and 46
- We define small sector sales in Idaho as:
  - Residential schedule 1, 12, 22, 32, 48 and 49
  - Commercial schedule 11, 21, 31, 47 and 49
  - Industrial schedule 11, 21, 31, 32, 47 and 49
  - Street Lighting schedule 41, 42, 43 44, 45 and 46
- *We define large sector sales as schedule 25 commercial and industrial in both states*

Large Customer Forecasts

- We are prohibited from disclosing individual large customer sales
- Sector groupings
  - Paper Manufacturers
  - Potato Processors
  - Lumber and Wood Producers
  - Hospitals
  - Aircraft Parts Manufacturers
  - Universities
  - Wastewater Treatment Facilities
  - Ammunition Manufacturers
  - Cabinetry Manufacturers
  - Foundries
  - Mines
  - Hotels
  - Electronic Equipment Manufacturers
  - Courthouse/Office Building
- All together there are 13 commercial and 18 industrial meter points

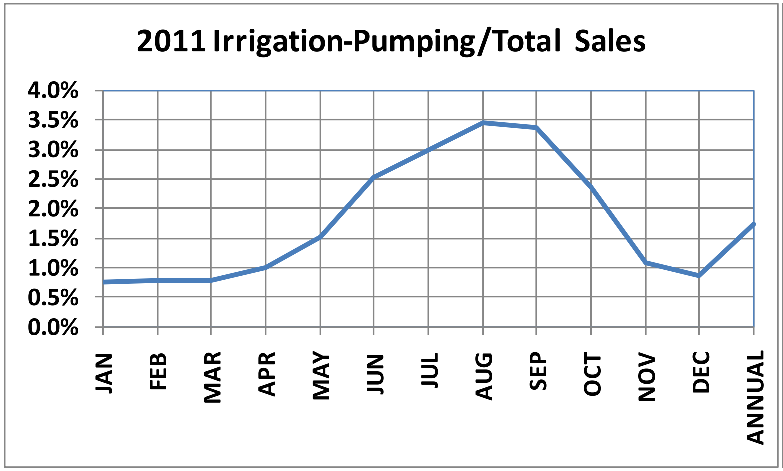
Large Customer Share of Total kWh Sales Commercial and Industrial Schedule 25

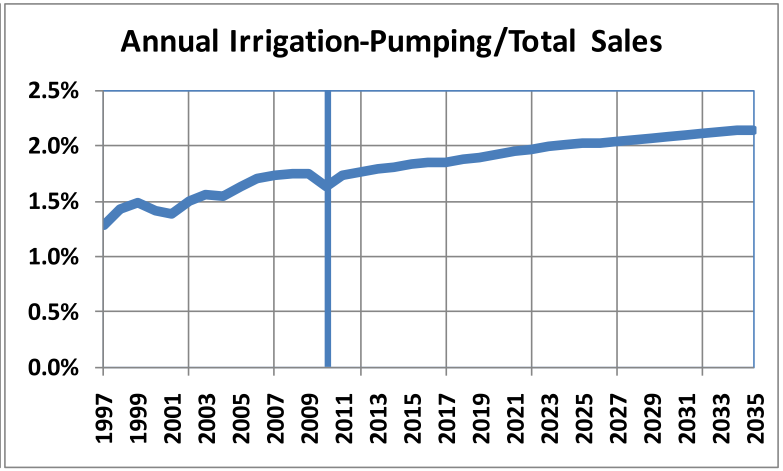




Note—the above charts are stacked line

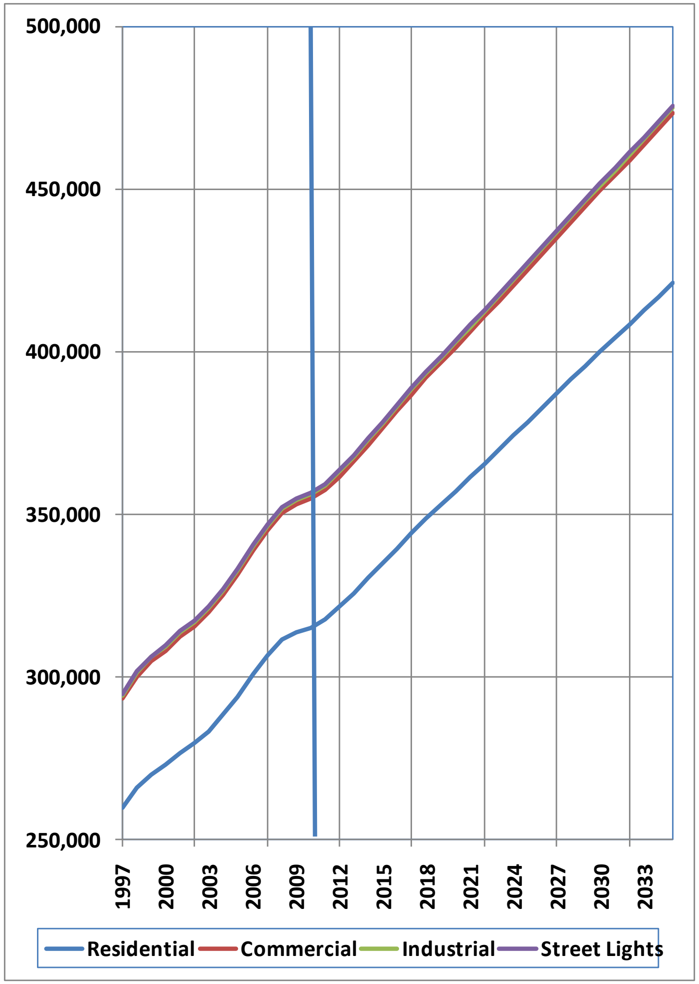
Irrigation and Pumping Sales Special Load Analysis

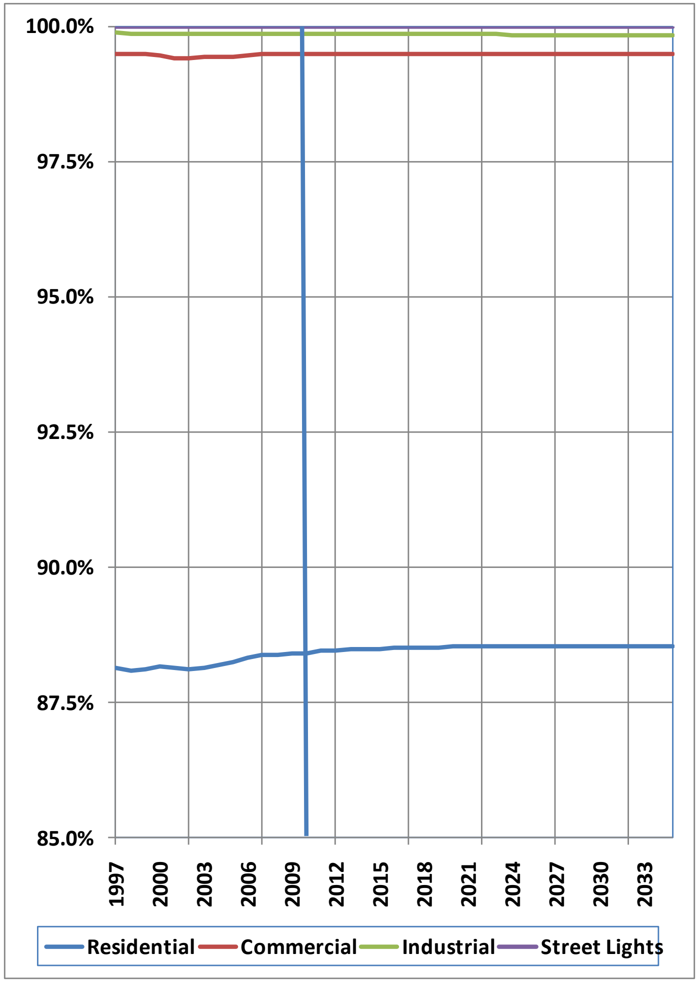




Customer Forecasts

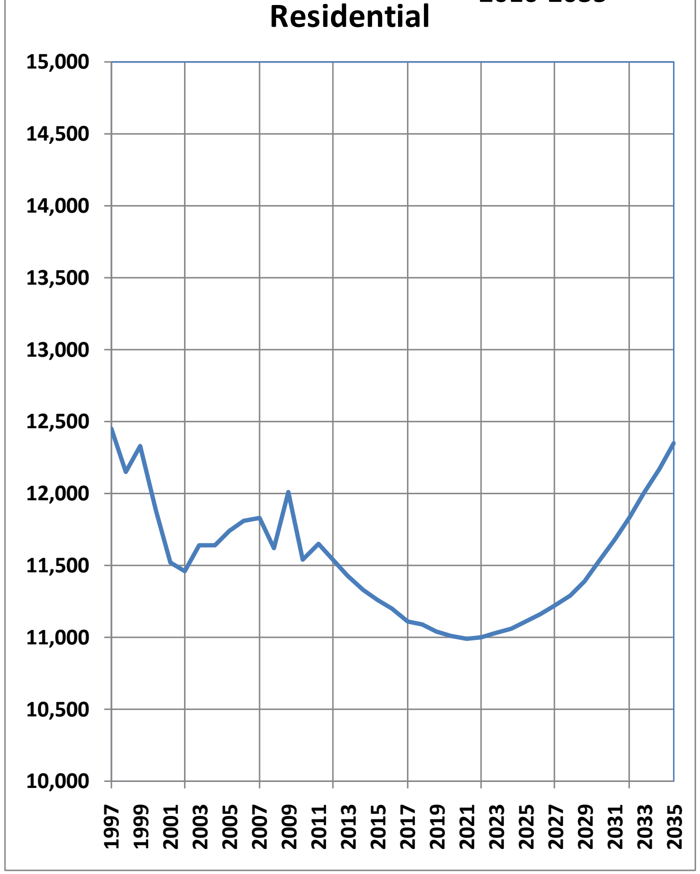
	Residential	Commercial	Industrial	Street Lights	Total Customers
2000-2010	1.44%	1.19%	0.94%	1.37%	1.41%
2010-2015	1.22%	1.06%	0.90%	2.63%	1.20%
2010-2020	1.26%	1.14%	0.85%	2.49%	1.24%
2010-2030	1.20%	1.14%	0.72%	2.27%	1.19%
2010-2035	1.17%	1.12%	0.69%	2.18%	1.16%

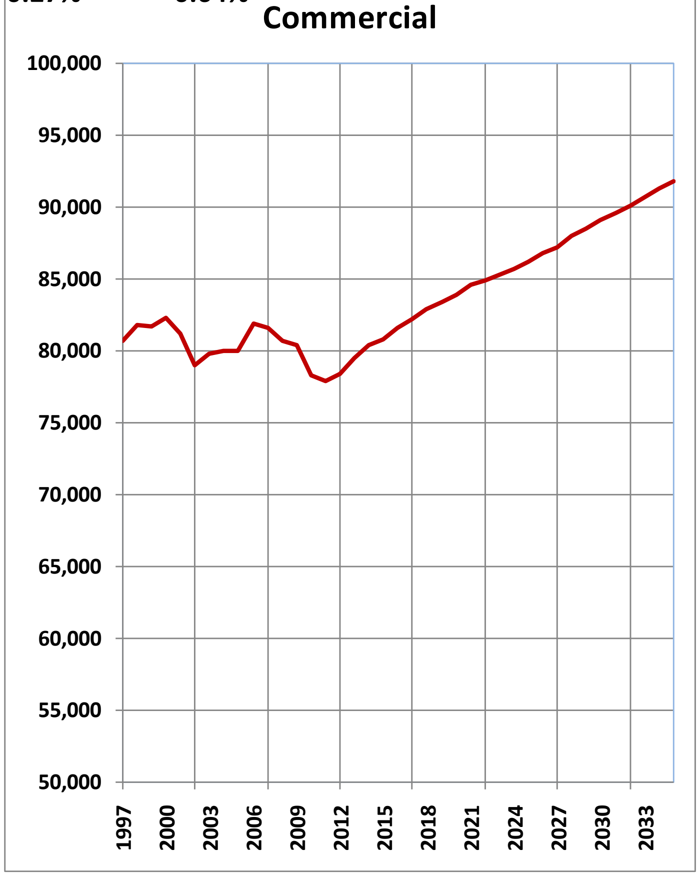




kWh Use per Average Residential Customer

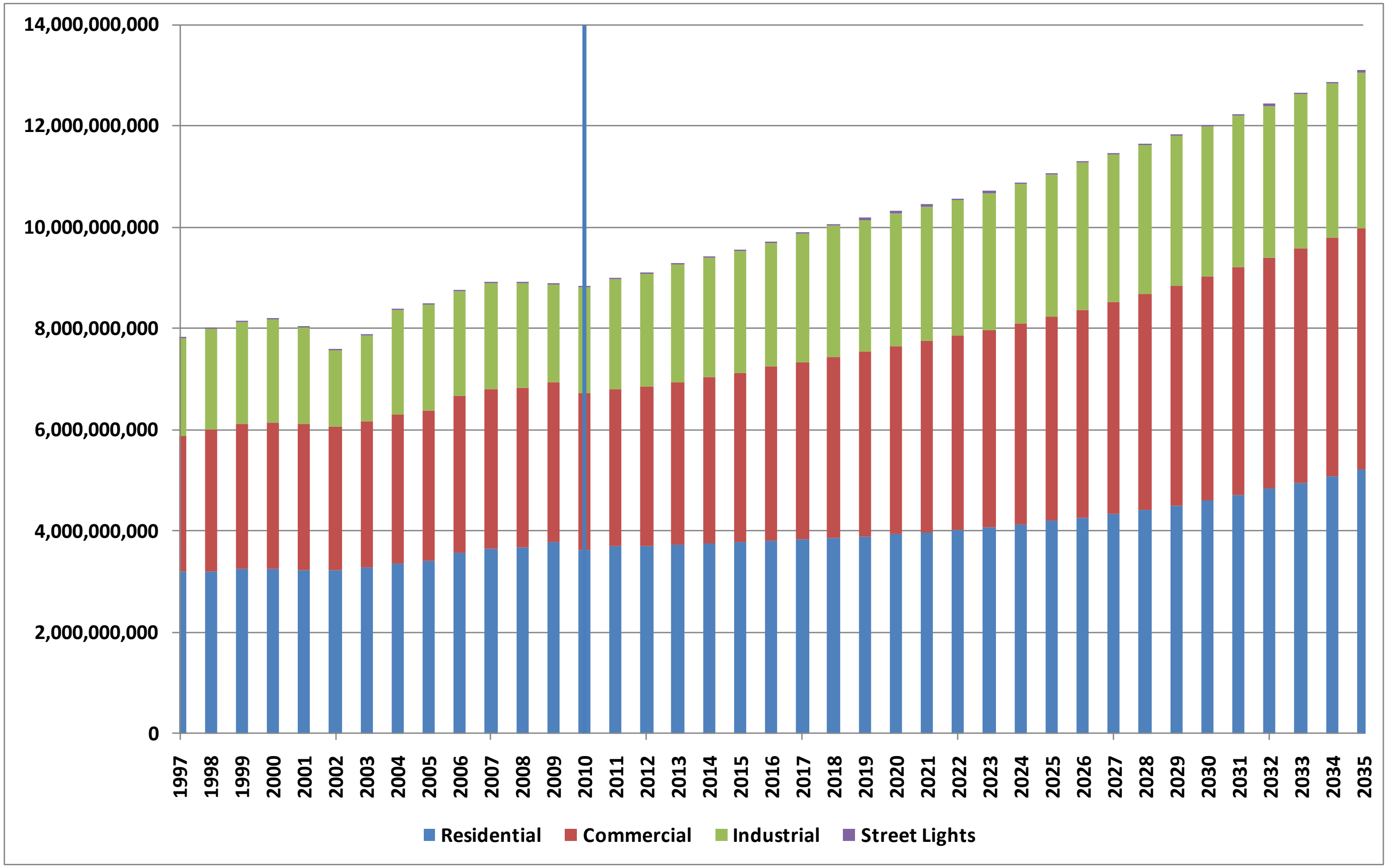
	Residential	Commercial
2000-2010	-0.29%	-0.50%
2010-2015	-0.49%	0.65%
2010-2020	-0.47%	0.70%
2010-2030	0.00%	0.65%
2010-2035	0.27%	0.64%



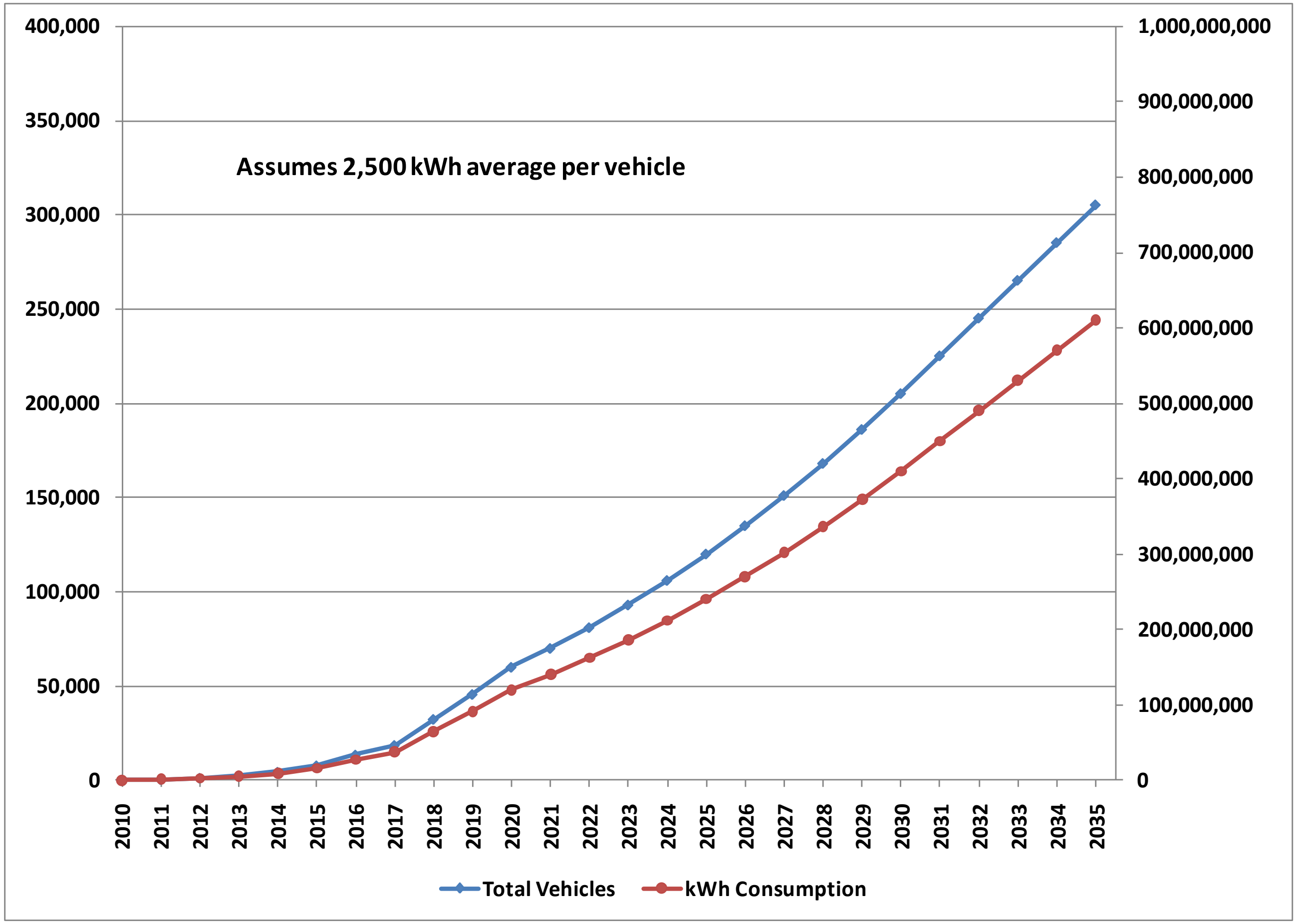


kWh Sales Customer Class

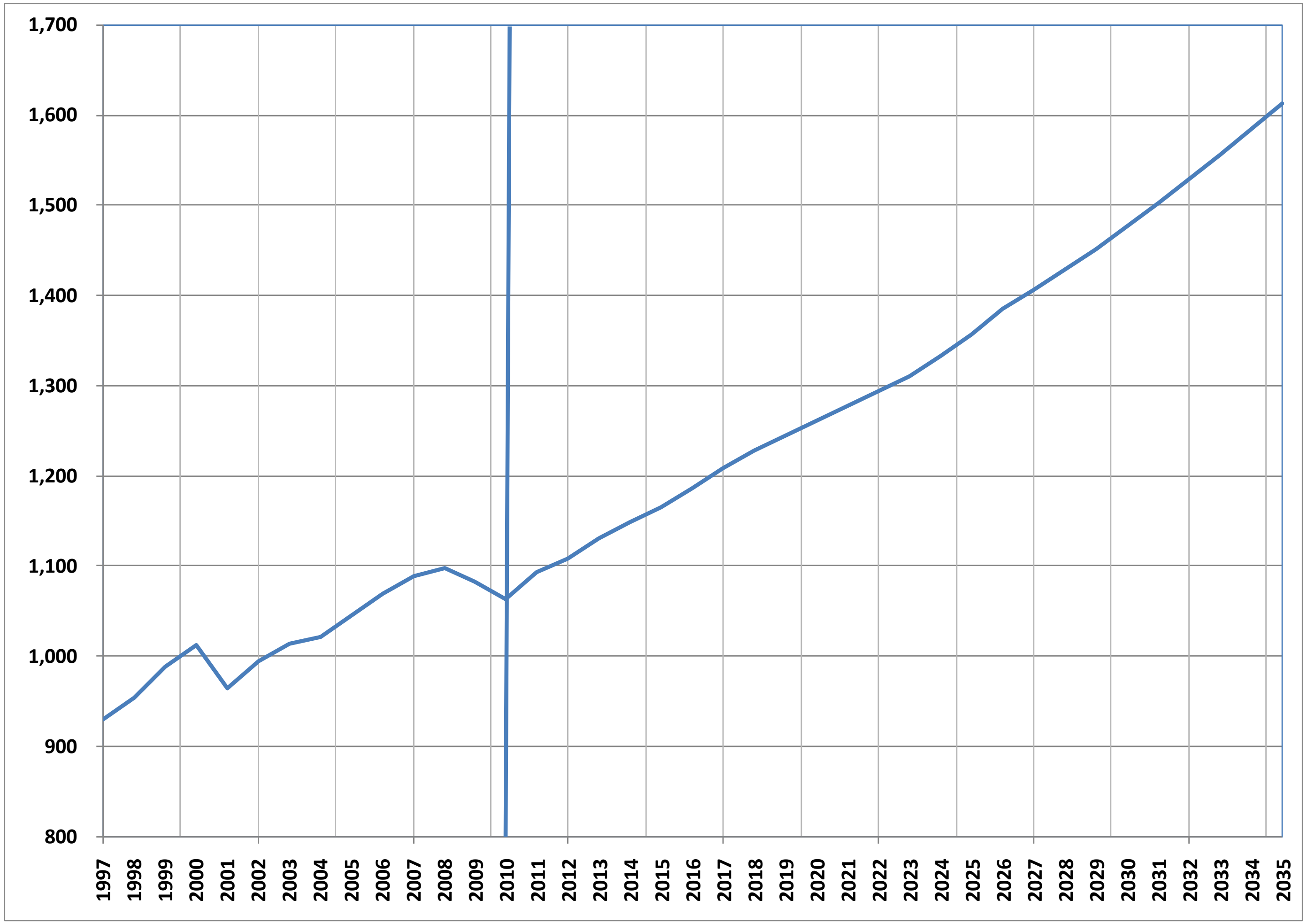
	Residential	Commercial	Industrial	Street Lights	Total Sales
2000-2010	1.11%	0.69%	0.23%	0.53%	0.75%
2010-2015	0.72%	1.71%	2.74%	2.49%	1.56%
2010-2020	0.79%	1.84%	2.38%	2.32%	1.56%
2010-2030	1.19%	1.79%	1.78%	2.03%	1.55%
2010-2035	1.44%	1.77%	1.56%	1.94%	1.59%



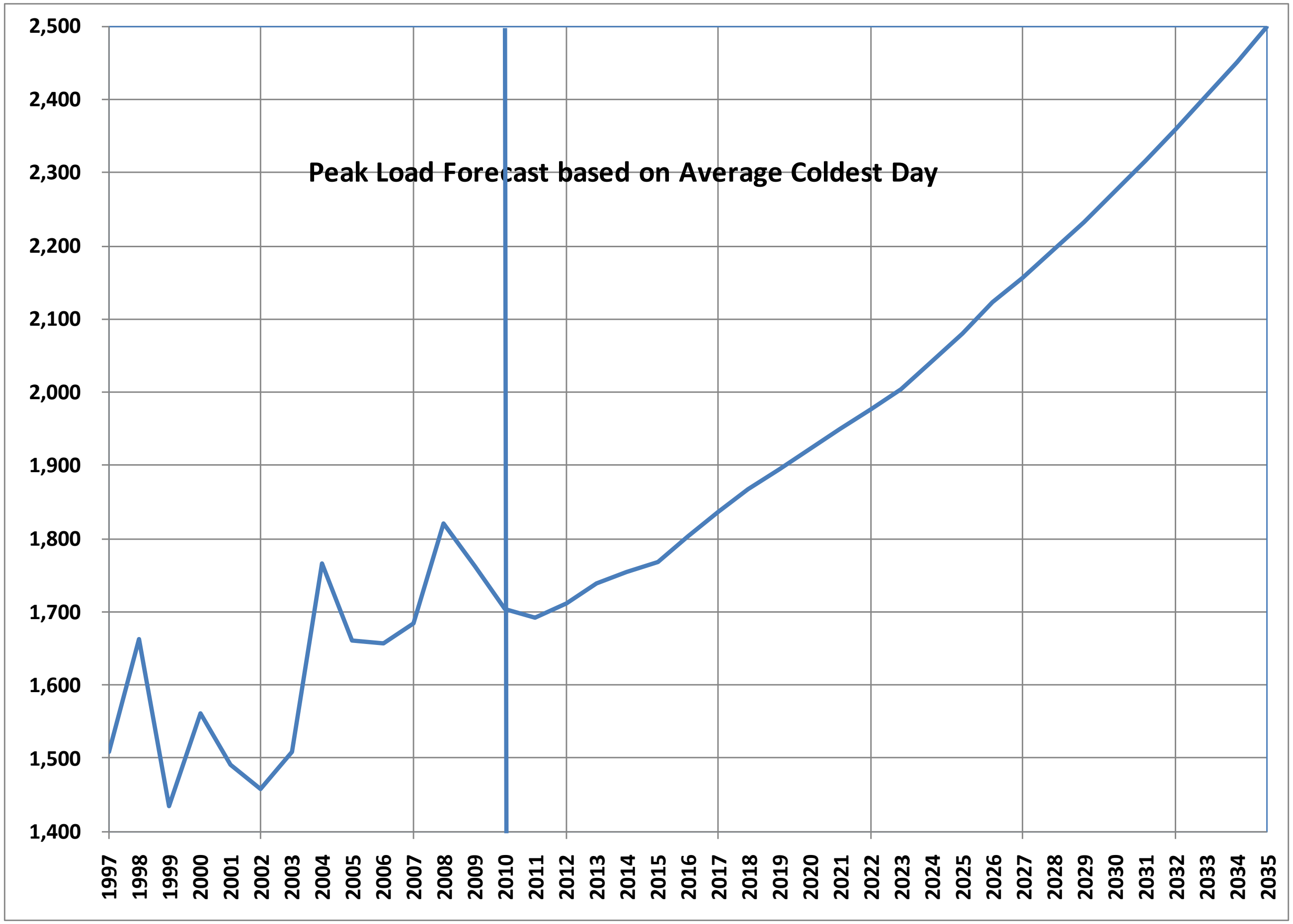
Electric Car Forecast (PIH & PEV)



Load Forecast in Average MW



Peak Demand in Megawatts



AVISTA

Medium Scenario Growth Rates

	Energy	Peak Demand
2000-2010	0.48%	0.87%
2010-2015	1.85%	0.76%
2010-2020	1.72%	1.22%
2010-2030	1.66%	1.46%
2010-2035	1.68%	1.55%

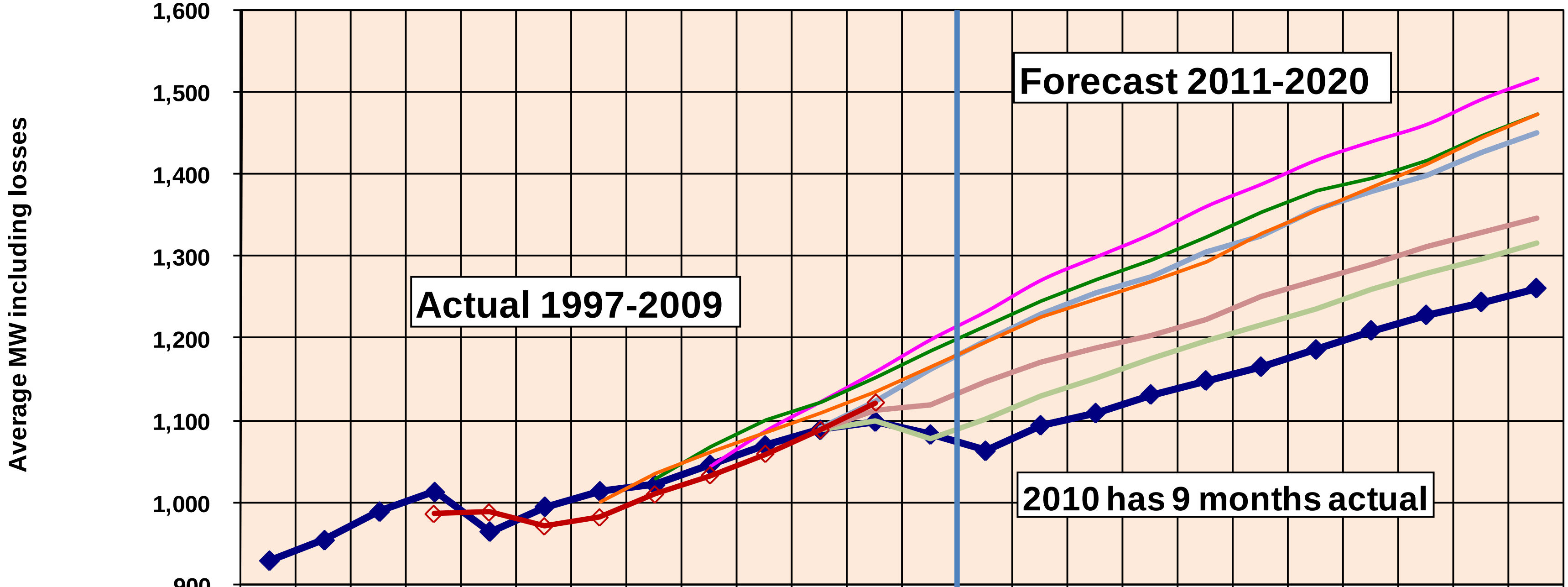
Load Forecast Prepared 10 Years Ago

For		Forecast aMW	Days	Forecast MWH	Actual aMW	Days	Actual MWH	Percent Difference
2009	Jan	1,362	31	1,013,121	1,272	31	946,653	-6.6%
	Feb	1,266	28	850,592	1,186	28	796,895	-6.3%
	Mar	1,145	31	851,634	1,121	31	833,848	-2.1%
	Apr	1,080	30	777,278	980	30	705,751	-9.2%
	May	1,068	31	794,688	952	31	708,039	-10.9%
	Jun	1,089	30	783,858	979	30	704,569	-10.1%
	Jul	1,070	31	796,388	1,057	31	786,248	-1.3%
	Aug	1,074	31	798,938	1,034	31	769,272	-3.7%
	Sep	986	30	709,832	968	30	697,305	-1.8%
	Oct	1,109	31	825,286	1,014	31	754,464	-8.6%
	Nov	1,217	30	875,980	1,106	30	796,630	-9.1%
	Dec	1,335	31	993,573	1,321	31	982,507	-1.1%
				10,071,167			9,482,181	-5.8%

Forecast Comparisons

Net Native Load
with Electric Cars

2011 Forecast Growth Rates Base 2011
5 =1.63%, 10 =1.56%, 20 =1.60%, 24 =1.63%



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
F2011	929	954	989	1,013	965	995	1,013	1,021	1,046	1,069	1,088	1,098	1,082	1,063	1,094	1,109	1,131	1,148	1,165	1,186	1,209	1,228	1,244	1,260
F2010											1,088	1,098	1,076	1,101	1,130	1,151	1,174	1,197	1,216	1,235	1,260	1,278	1,296	1,315
F2009											1,088	1,113	1,119	1,148	1,171	1,188	1,202	1,222	1,252	1,270	1,289	1,311	1,329	1,347
F2007IRP											1,091	1,124	1,163	1,196	1,229	1,255	1,274	1,306	1,325	1,358	1,379	1,399	1,426	1,449
F2006									1,043	1,086	1,122	1,159	1,198	1,232	1,270	1,299	1,327	1,360	1,388	1,417	1,440	1,461	1,491	1,516
F2005								1,029	1,067	1,099	1,122	1,152	1,185	1,215	1,246	1,270	1,296	1,323	1,354	1,379	1,395	1,417	1,447	1,472
F2004							1,000	1,035	1,061	1,085	1,109	1,135	1,164	1,196	1,225	1,247	1,270	1,293	1,327	1,356	1,384	1,412	1,444	1,474
F1999				986	988	971	982	1,009	1,033	1,059	1,088	1,121												

F2011 F2010 F2009 F2007IRP F2006 F2005 F2004 F1999

Population Forecasts—Then and Now

		July 1st Estimates						
	Spokane County Census April 1st	OFM 1995	OFM 2007	Avista 2000	Avista 2010	Decade Medium Growth Rate	Decade Low Growth Rate	Decade High Growth Rate
1960	278,333							
1970	287,487					0.32%		
1980	341,835					1.75%		
1990	361,333	361,333		361,333		0.56%		
2000	417,939		417,939			1.47%		
2010*	470,300	476,400	466,724	449,300	475,646	1.19%		
2020			529,451		530,003	1.09%	0.54%	1.63%
2030			589,623		577,829	0.87%	0.43%	1.30%
2035					599,873			

Low, Medium and High Growth Scenarios

- Global Insight provides us with Medium Scenario economic forecasts
- We plan to overlay the 6th Power Plan range for Low and High
- NPPC Low 0.8%, Medium 1.4%, High 1.8% for 2010-2030
  - http://www.nwcouncil.org/energy/powerplan/6/final/SixthPowerPlan_Ch3.pdf page 3-5
- Avista's 2010-2030 growth rate medium scenario 1.66%
- Overlay Low 0.95%, Overlay High 2.13% by ratio method

Stochastic Modeling Assumption & Methodology Discussion

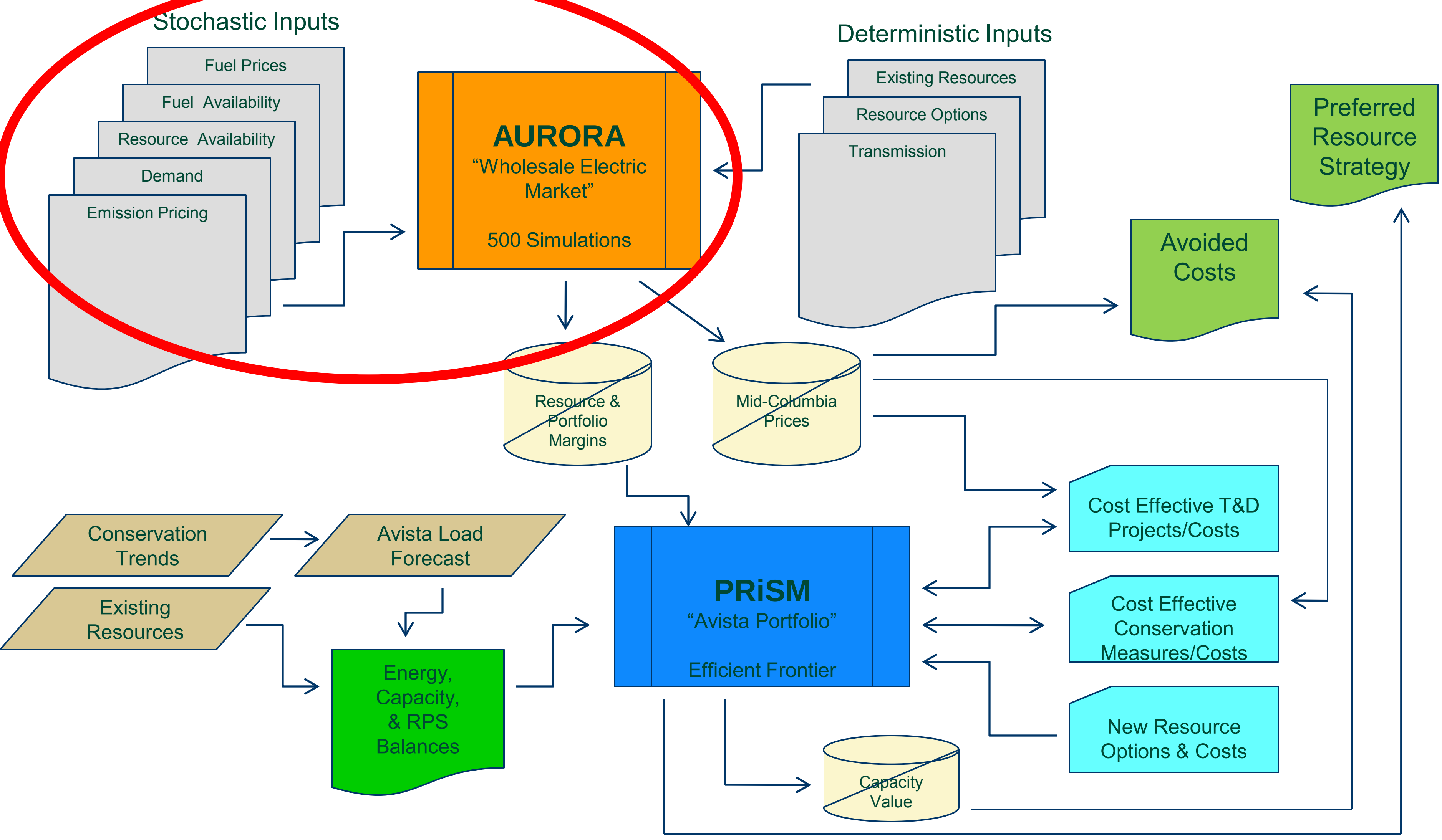
James Gall

Technical Advisory Committee Meeting #3

2011 Electric Integrated Resource Plan

December 2, 2010

2011 Integrated Resource Plan Modeling Process



Why Conduct a Stochastic Study

- Quantifies the risk (range in prices/costs) of the wholesale electric market.
- Determines range in potential market value of each resource option.
- Determines the range in potential cost to serve customers over the IRP time period.

IRP's objective is plan on a resource portfolio that is not only least cost but at an acceptable level of risk.

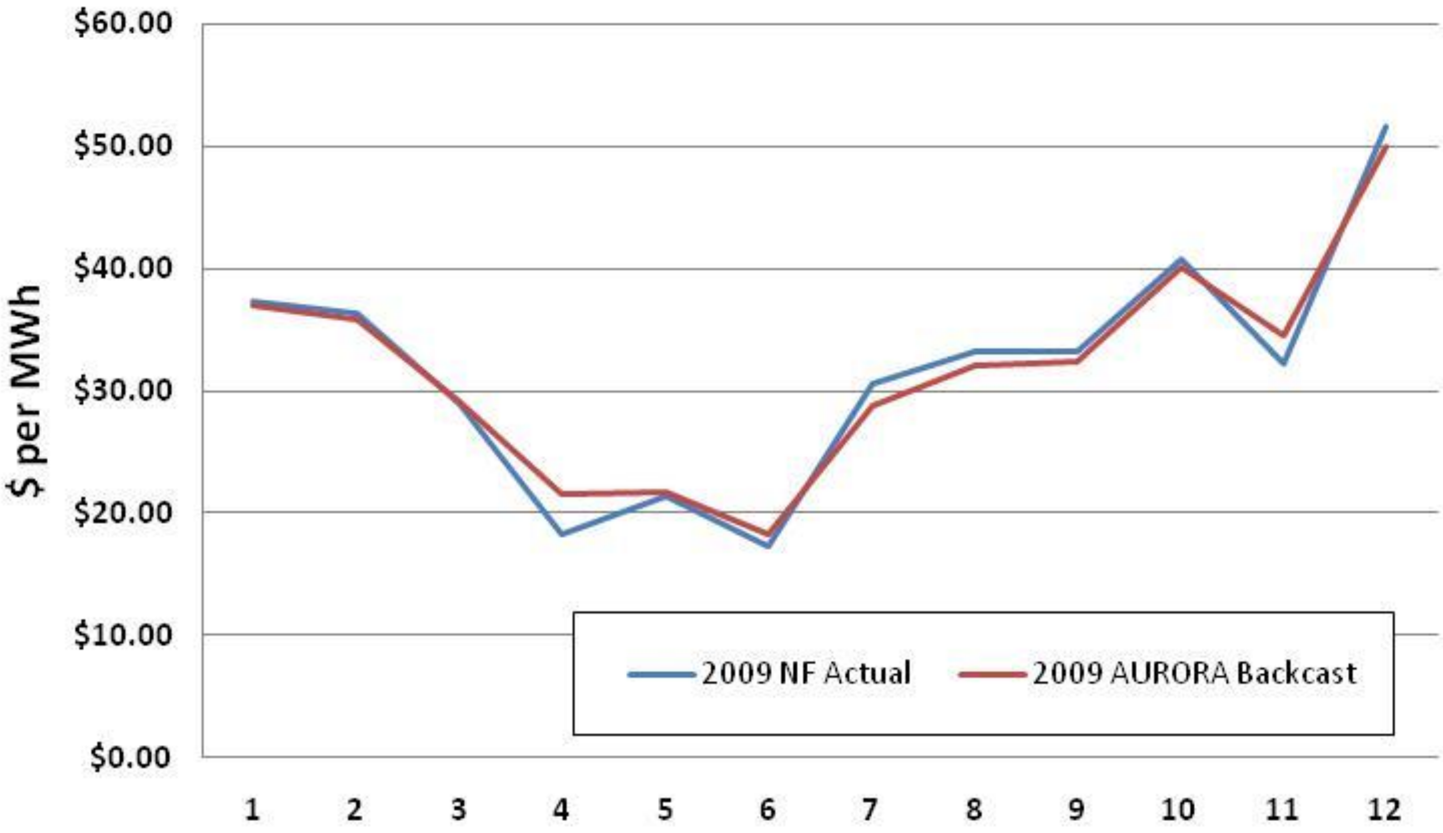
Measurements of Risk

- Standard Deviation
- Mean Absolute Error
- Value at Risk
- Tail Var “90”
- Percentile
- Probability

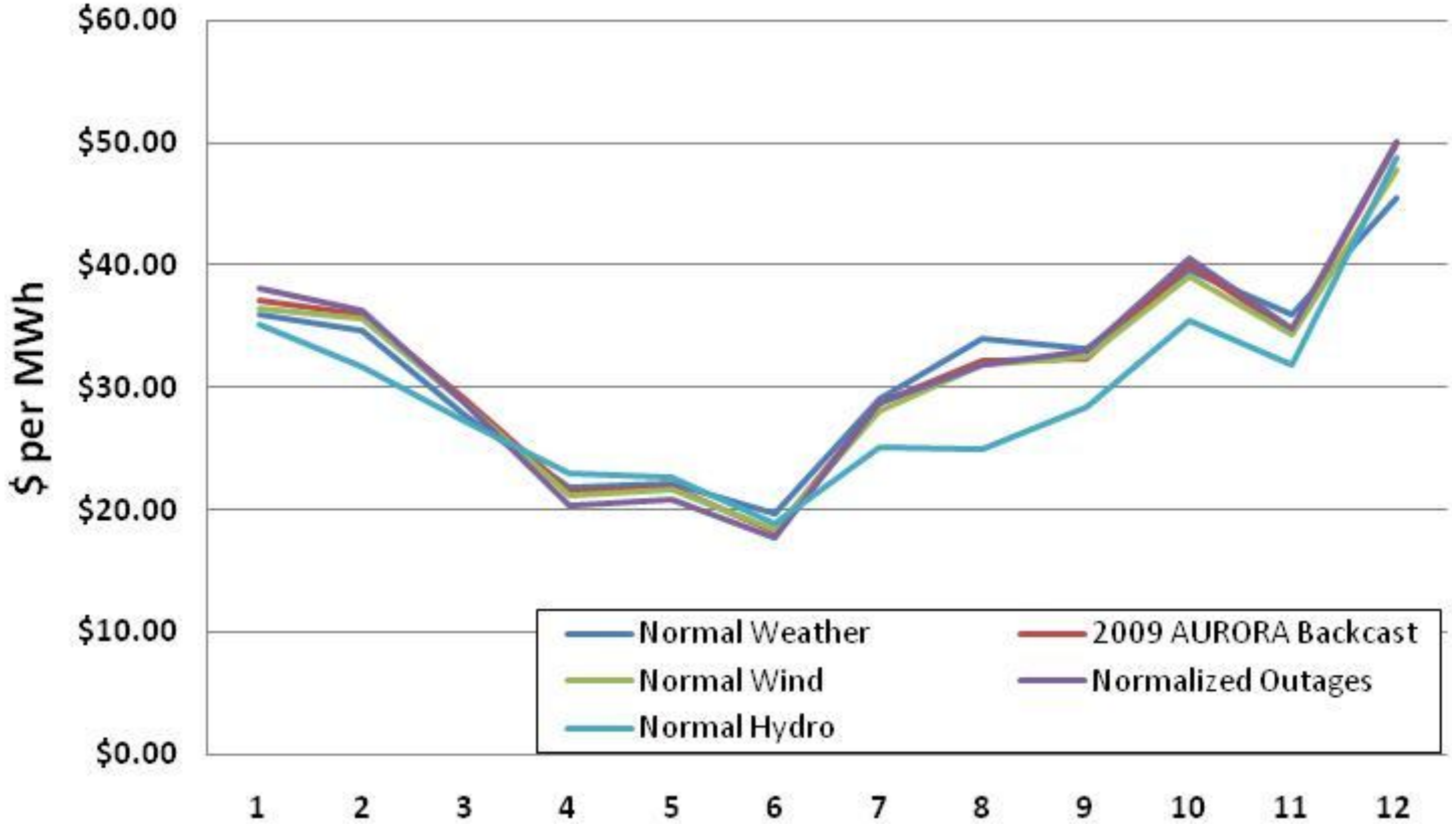
Market Stochastic Study Variables

- Hydro availability
- Wind availability
- Coal prices
- Wood prices
- Oil prices
- Inflation
- Forced outages
- Natural gas prices
- Weather (load)
- Economic growth (load)
- Conservation (load)
- Carbon legislation
- Resource Capital Costs (?)

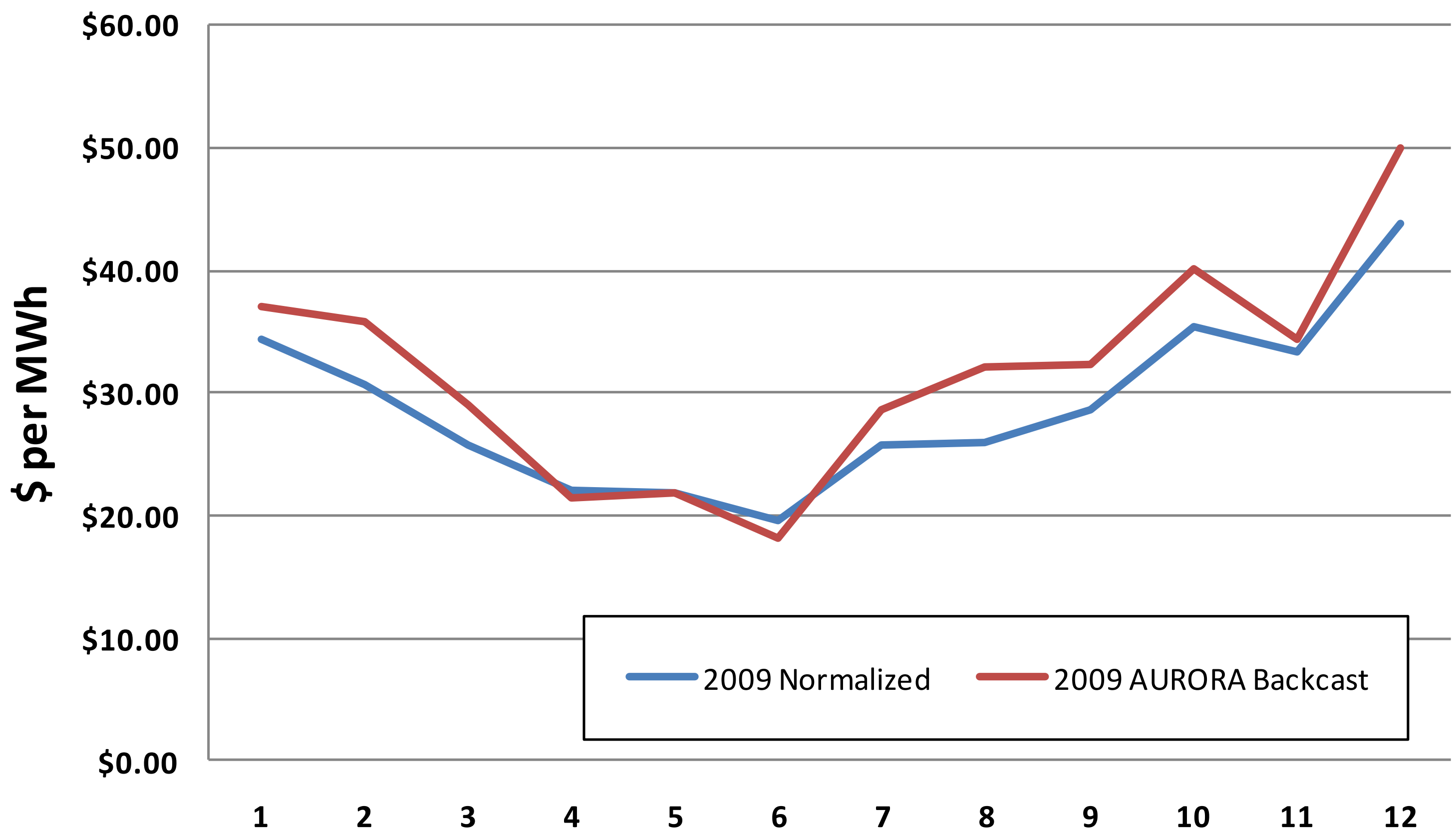
2009 Mid-Columbia Flat Electric Prices



2009 Mid-Columbia Flat Electric Prices with Individual Normalized Inputs

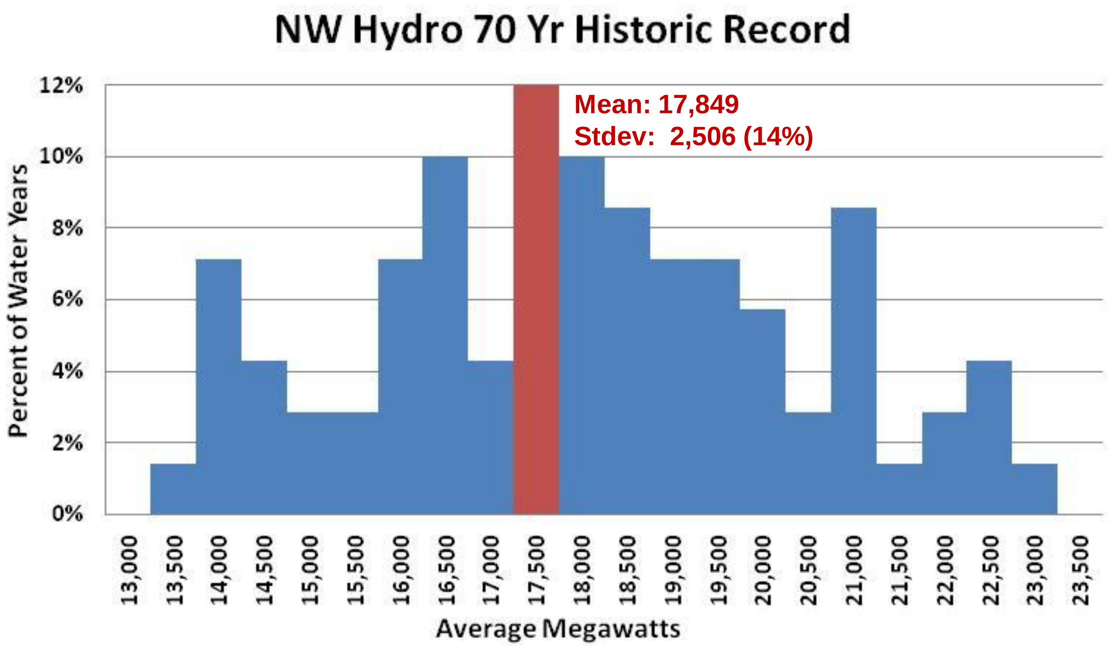


2009 Mid-Columbia Flat Normalized Electric Price

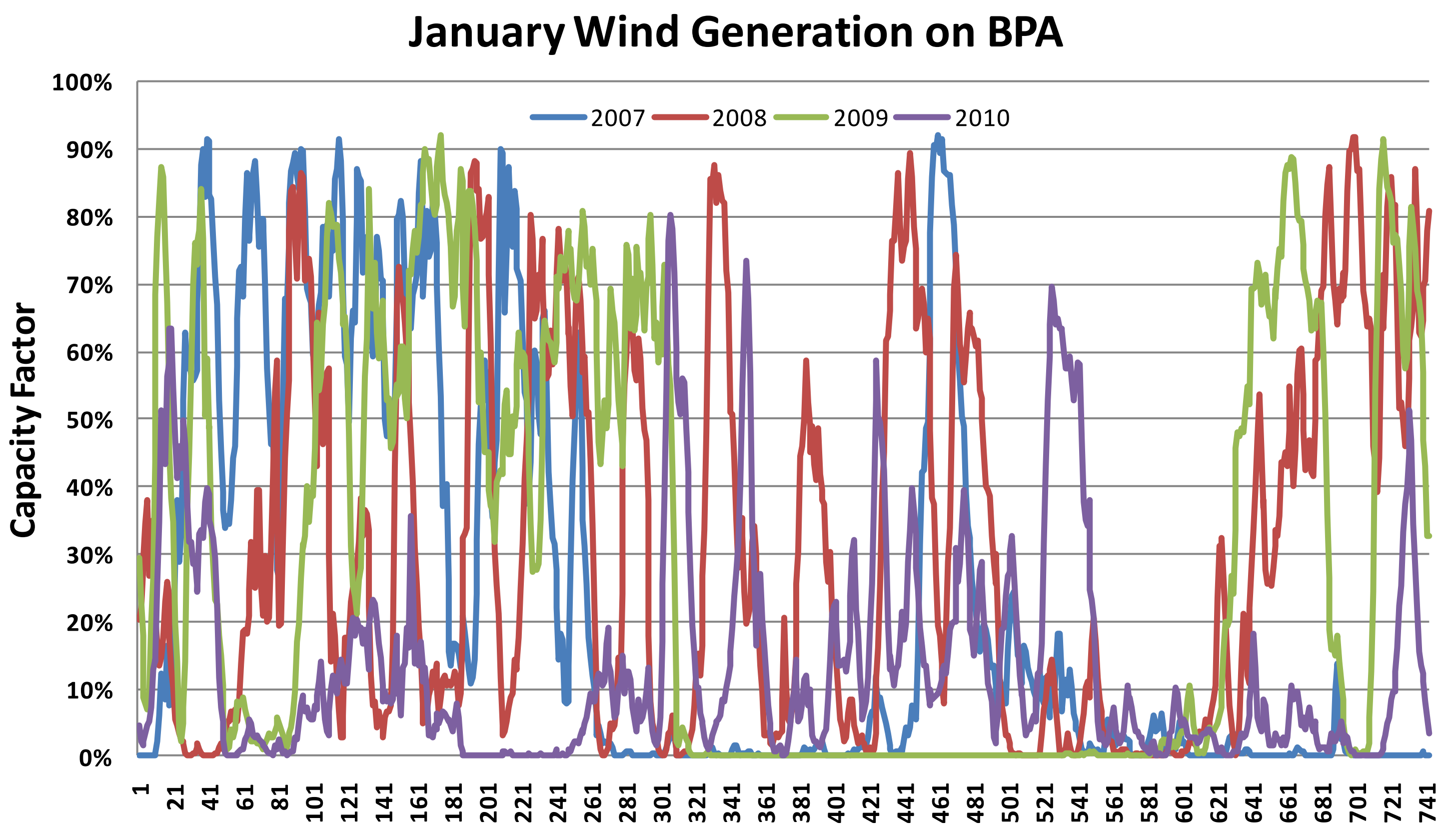


Hydro

- Random draw of 70 historical hydro years.
- Avista projects use results of Avista hydro model
- Regional projects uses Northwest Power Pool model



Historical Wind Generation



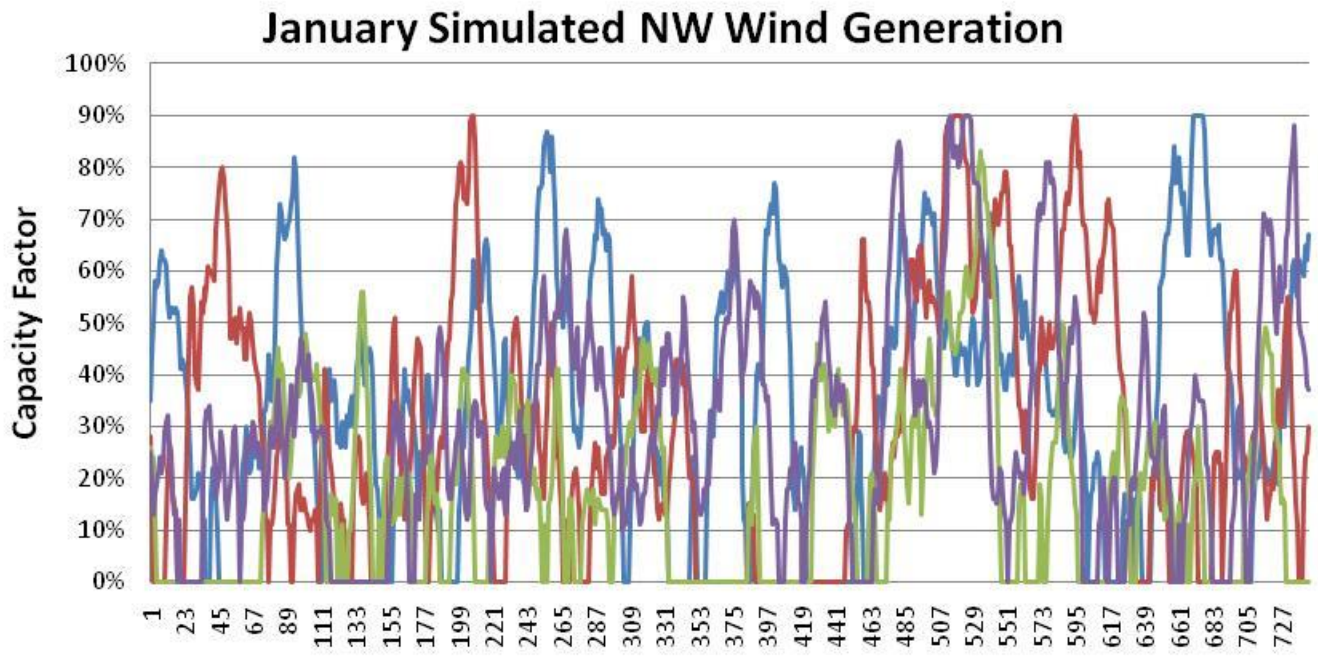
Wind

- Use 50 potential wind draws
- Each draw will be 8,760 hour shape
- Use separate wind shape available for most of the Western states and provinces
- NREL hourly simulated generation data (2004-06) is used to estimate capacity factors and correlations for non-NW areas

Area	CF		Area	CF
Northwest	31.8%		Southwest	28.8%
California	30.6%		Utah	29.0%
Montana	37.2%		Colorado	32.2%
Wyoming	38.2%		British Columbia	33.2%
Eastern WA	30.6%		Alberta	34.3%

Wind (Continued)

- Regression model using BPA/NREL data
  - Uses hour type, month, hour -1, hour -2 for the coefficients
  - Northwest: 97.5% R^2, 4.7% (CF standard error)
  - Random error with normal distribution to create variability



Coal, Oil, and Wood Prices

- Assume normal distribution of annual change in price
- Mean prices are based on Wood Mackenzie for oil and coal
- Standard Deviations:
  - Coal: 10%
  - Oil: 25%
  - Wood: 10%

Inflation

- Based on Global Insights forecast for average and standard deviation
- Average inflation is assumed to be 1.70%, w/ standard deviation of 1% (59% of mean)

Forced Outages

- Historical Outage rates are available from NERC's GAR Report
  - GADS- Generation Availability Report
- Data available for Coal, Nuclear, NG, and Oil by size of plant
  - Both planned and unplanned outages are tracked
  - Data is only available for all plants (no drill down option)
- AURORA's has random forced outage logic
  - Uses mean time to repair and annual forced outage rate
  - Both matrices can be derived from GADS data

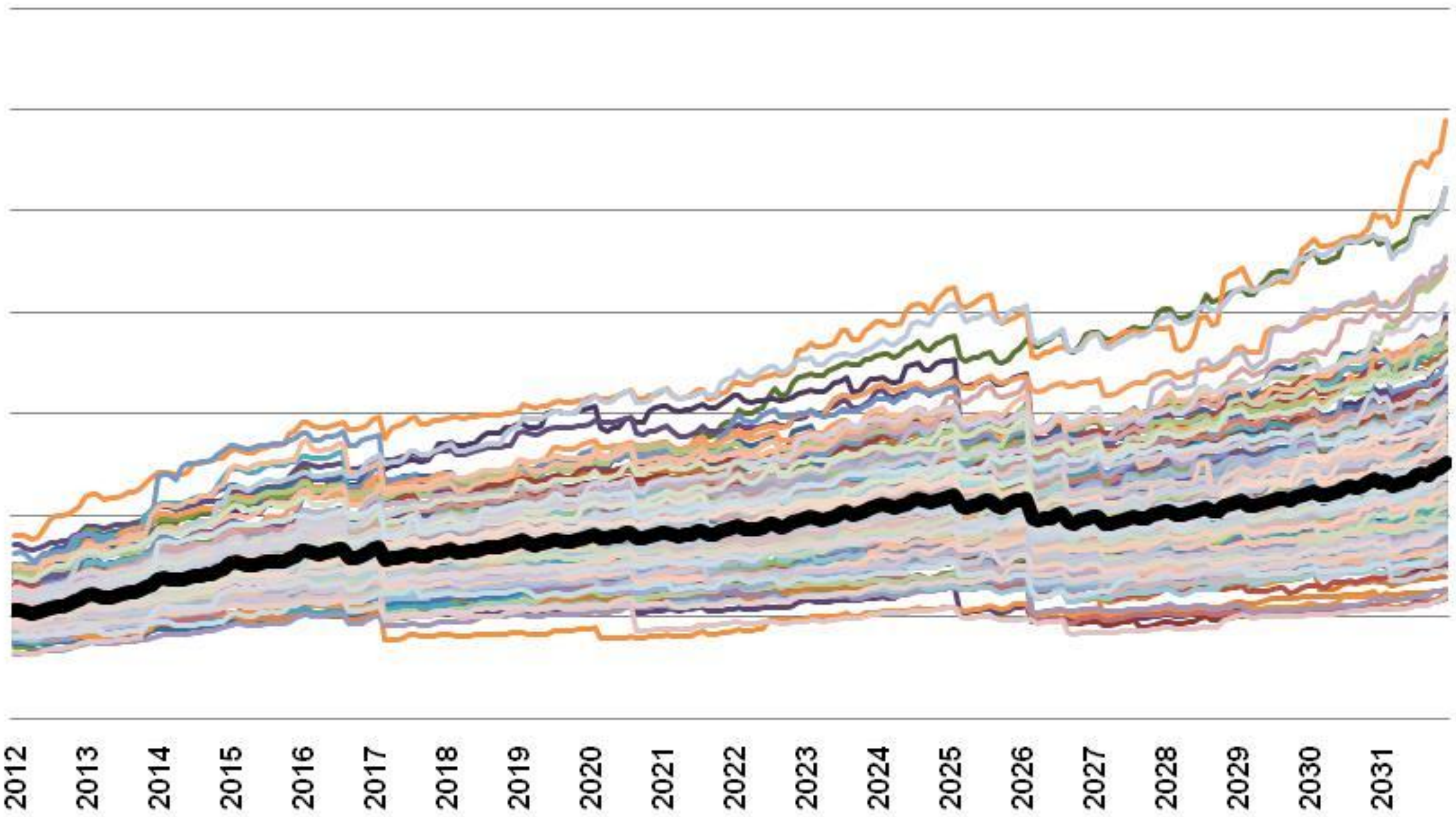
Historical Monthly AECO Natural Gas Prices

- Historical prices have been volatile
- Will volatility continue, or will shale gas flatten volatility?
- Will there still be boom/bust in natural gas prices?

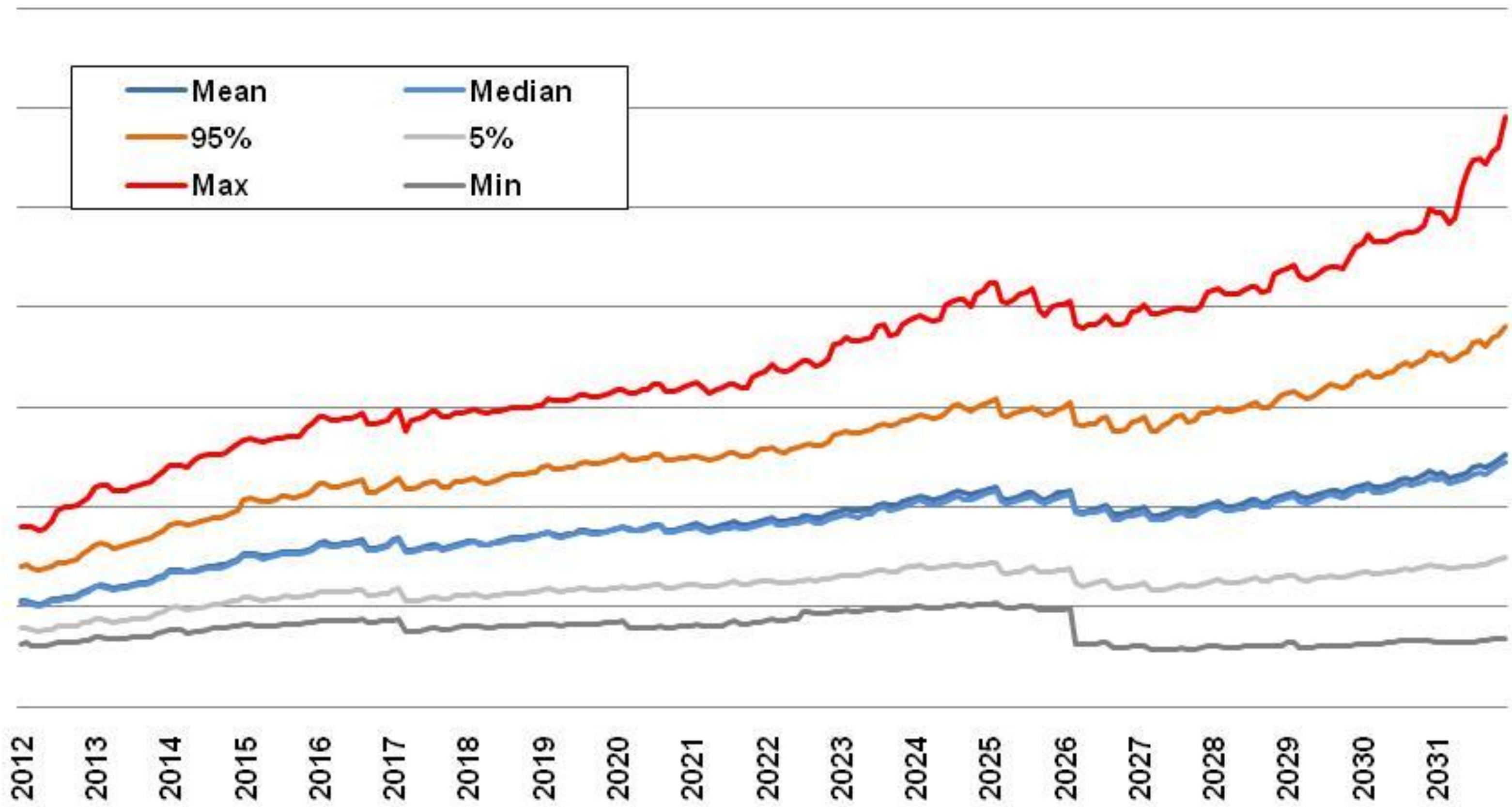
Natural Gas Prices

- Mean natural gas prices are yet to be finalized. Prices will be finalized by end of 2010 to take into account best available information for the plan
- To model the variability of prices will use a new method for this IRP.
  - Randomize the percent change between month to month prices based on a lognormal distribution
  - This method provides high month to month correlations as history demonstrates (90%+)

Natural Gas Forecast (individual draws)



Natural Gas Forecast (Statistics 500 draws)

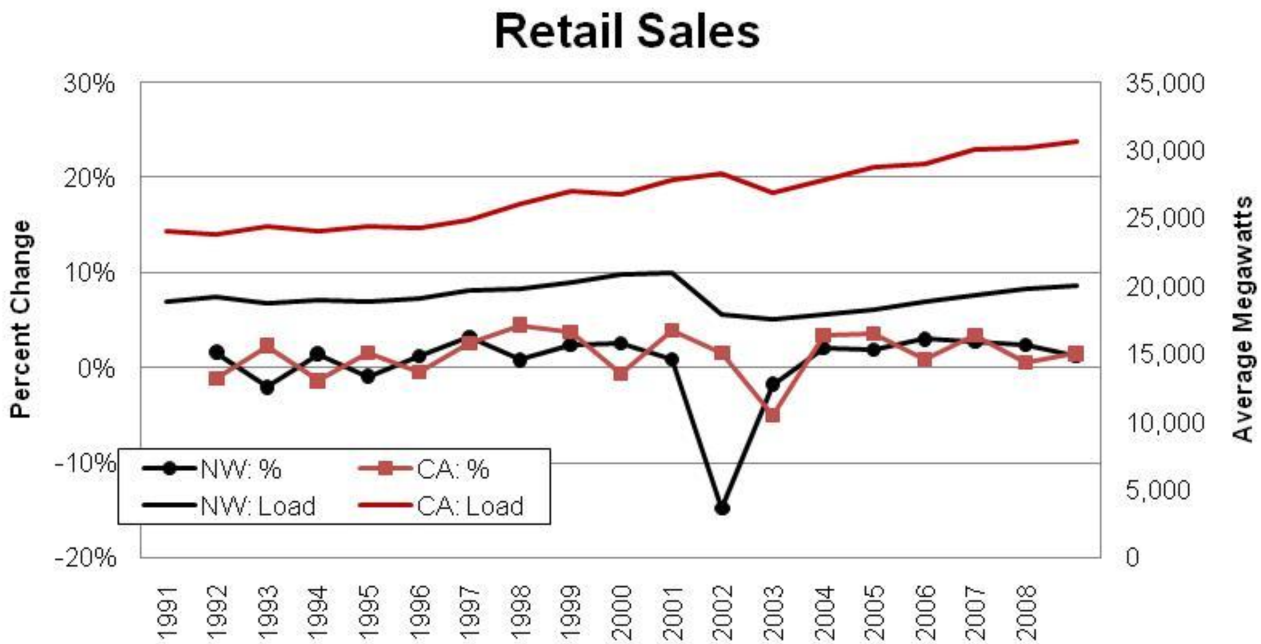


Load (Weather)

- Weather variation will be modeled in AURORA with monthly load variances for 2005 through 2009
- Weather is assumed to be normally distributed with standard deviation for each load area and a correlation to the Northwest area based on FERC Form 714 hourly load profiles
- Further detail on this methodology can be found in prior IRPs

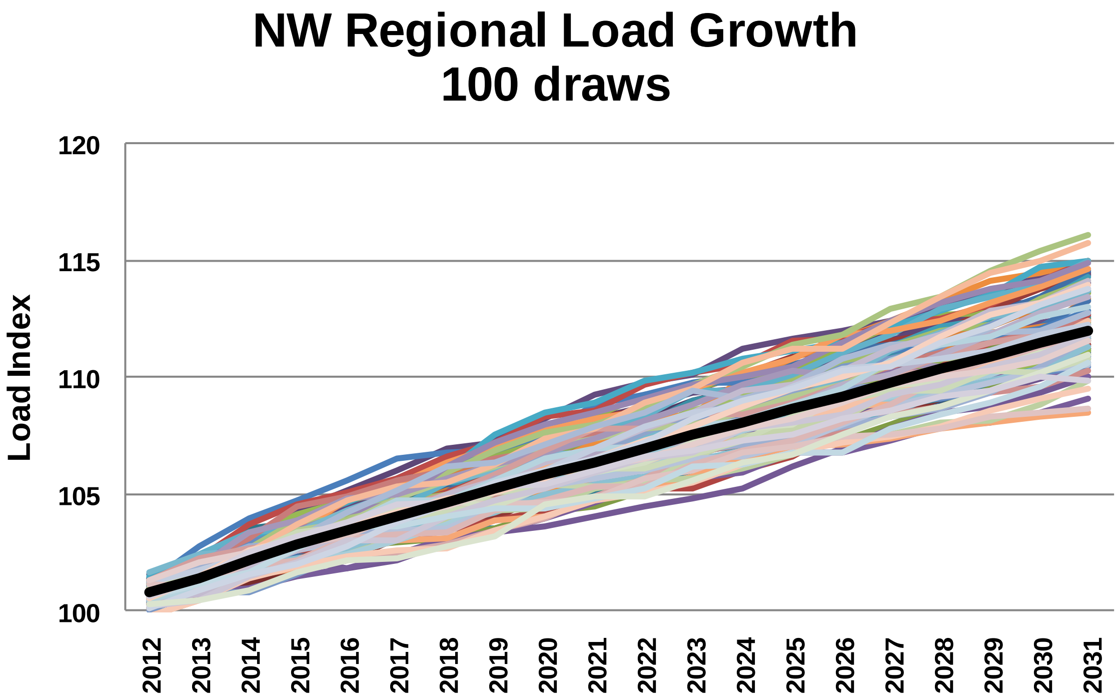
Load (Economic & Conservation)

- Weather is not the only driver in future loads, economic growth, electric cars, and conservation will affect energy demand
- Historical load growth is highly volatile (see chart below)



Load (Economic & Conservation)…. continued

- Expected load growth will assume Wood Mackenzie forecast
- Standard deviation is assumed to be 50% (same as last plan)



Carbon Legislation

- No national carbon legislation has been passed
- Many western states/provinces have passed some type of carbon reduction scheme
- For this plan..
  - 5 scenarios are developed based on potential outcomes.
  - Each scenario is assigned a weighting
  - The weighted average of the scenarios will be the base forecast
  - Natural gas prices and carbon prices will be correlated for national policy scenarios

Carbon Legislation Scenarios

1. Western Climate Initiative "WCI" (20% probability)
   - No federal legislation, carbon reduction in CA, OR, WA, NM only
   - 15% below 2005 levels by 2020
   - Begins in 2012, regional trading allowed
2. Regional Greenhouse Gas Initiative "RGGI" (20% probability)
   - No federal legislation, carbon reduction in CA, OR, WA, NM only
   - 187 million tons per year through 2014, then 10% reduction by 2018
   - Begins in 2012, within state trading only
3. National Climate Policy (20% probability)
   - Federal legislation only applies
   - 17% below 2005 levels by 2020, 42% below 2005 levels by 2030
   - Begins in 2015, national trading allowed
4. National Carbon Tax (15% probability)
   - Federal legislation only applies
   - $33 per short ton, than 5% per year escalation
   - Begins in 2015
5. No Carbon Reductions (5% probability)
   - No carbon reduction scheme
   - State level emission performance standards apply and no new coal in US West

Next Meeting

1. Finalize mean key driver assumptions
2. Implement stochastic modeling methodologies with AURORA
3. Simulate the market future 500 times between 2012-2031
4. Present results for electric market prices and other key results
5. Evaluate the potential of modeling capital costs stochastically

Avista's 2011 Electric Integrated Resource Plan
Technical Advisory Committee Meeting No. 4 Agenda
Avista Headquarters – Spokane, Washington

Thursday, February 3, 2011
Avista Conference Room 130

Topic	Time	Staff
1. Introduction	9:30	Storro
2. Natural Gas Price Forecast	9:35	Rahn
3. Electric Price Forecast	10:30	Gall
4. Lunch	12:00	
5. Resource Requirement Projections	1:00	Kalich
6. Portfolio and Market Scenario Planning	2:30	Lyons
7. Adjourn	3:00	

Conference Call Instructions:
1. Please join my meeting.
https://www2.gotomeeting.com/join/717354547

2. Join the conference call:

Dial +1 (714) 551-0020
Access Code: 717-354-547
Audio PIN: Shown after joining the meeting

Meeting ID: 717-354-547

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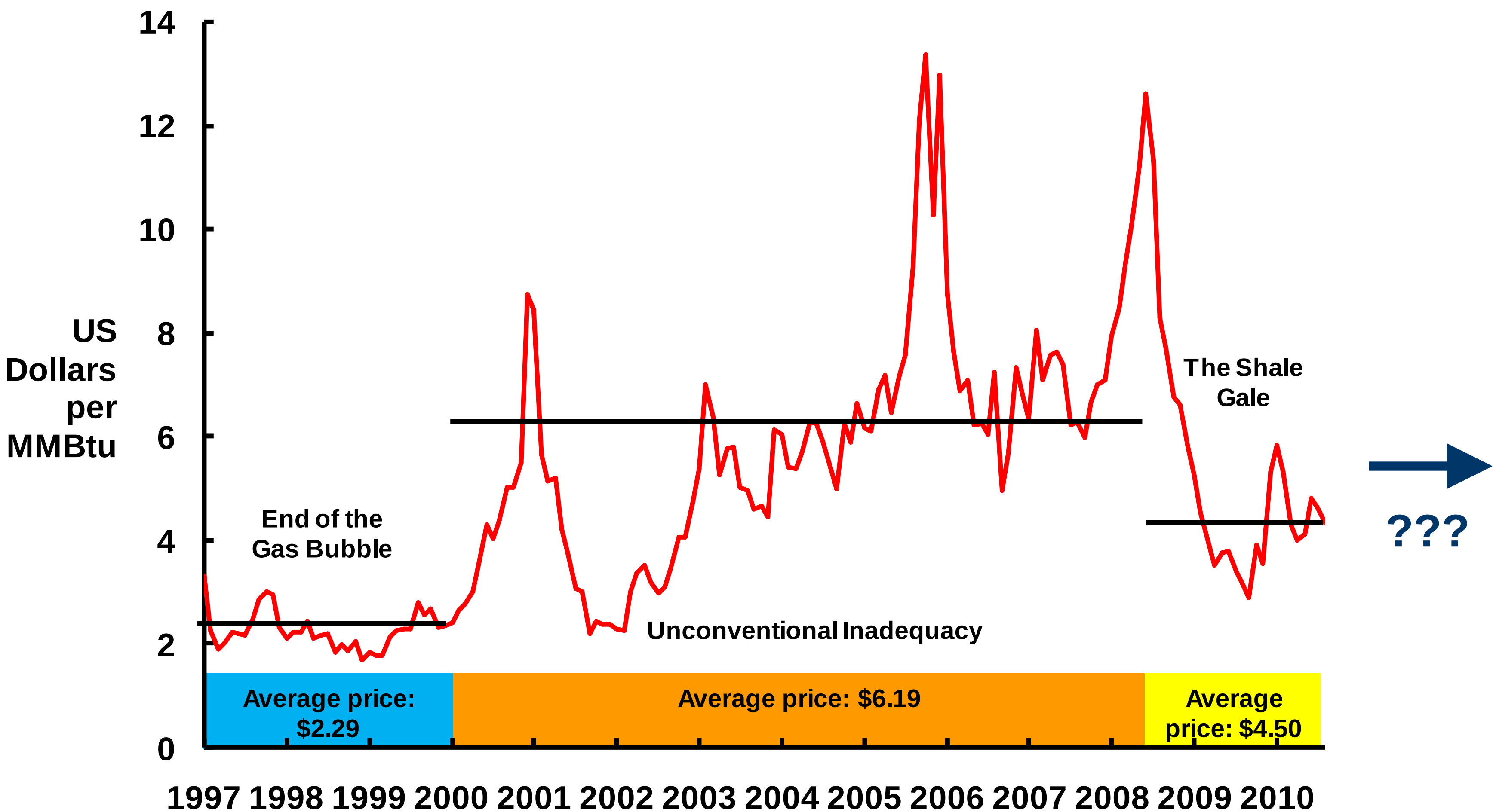
Avista Electric IRP
Natural Gas Price Forecast

Technical Advisory Committee Meeting

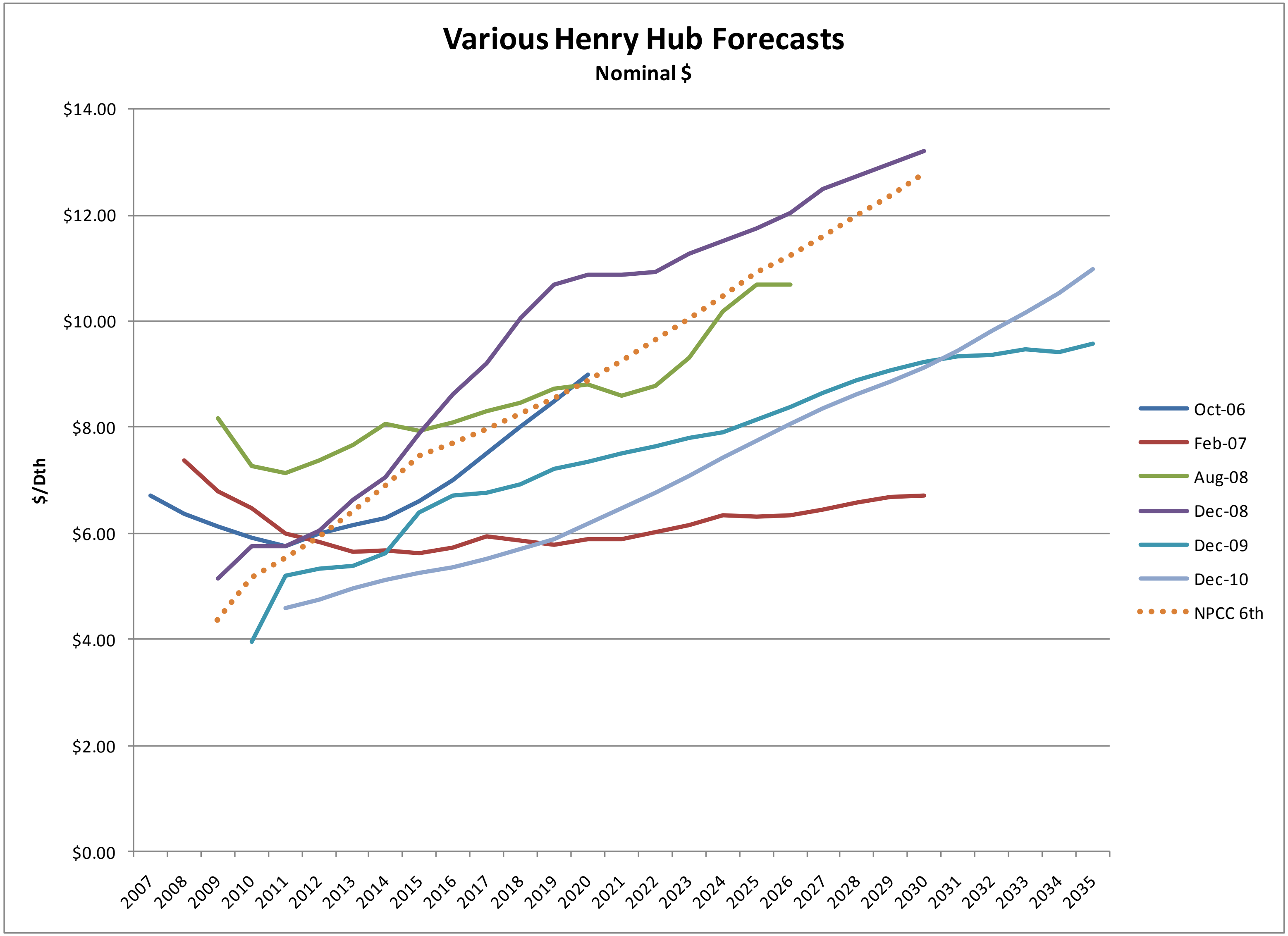
February 4, 2011

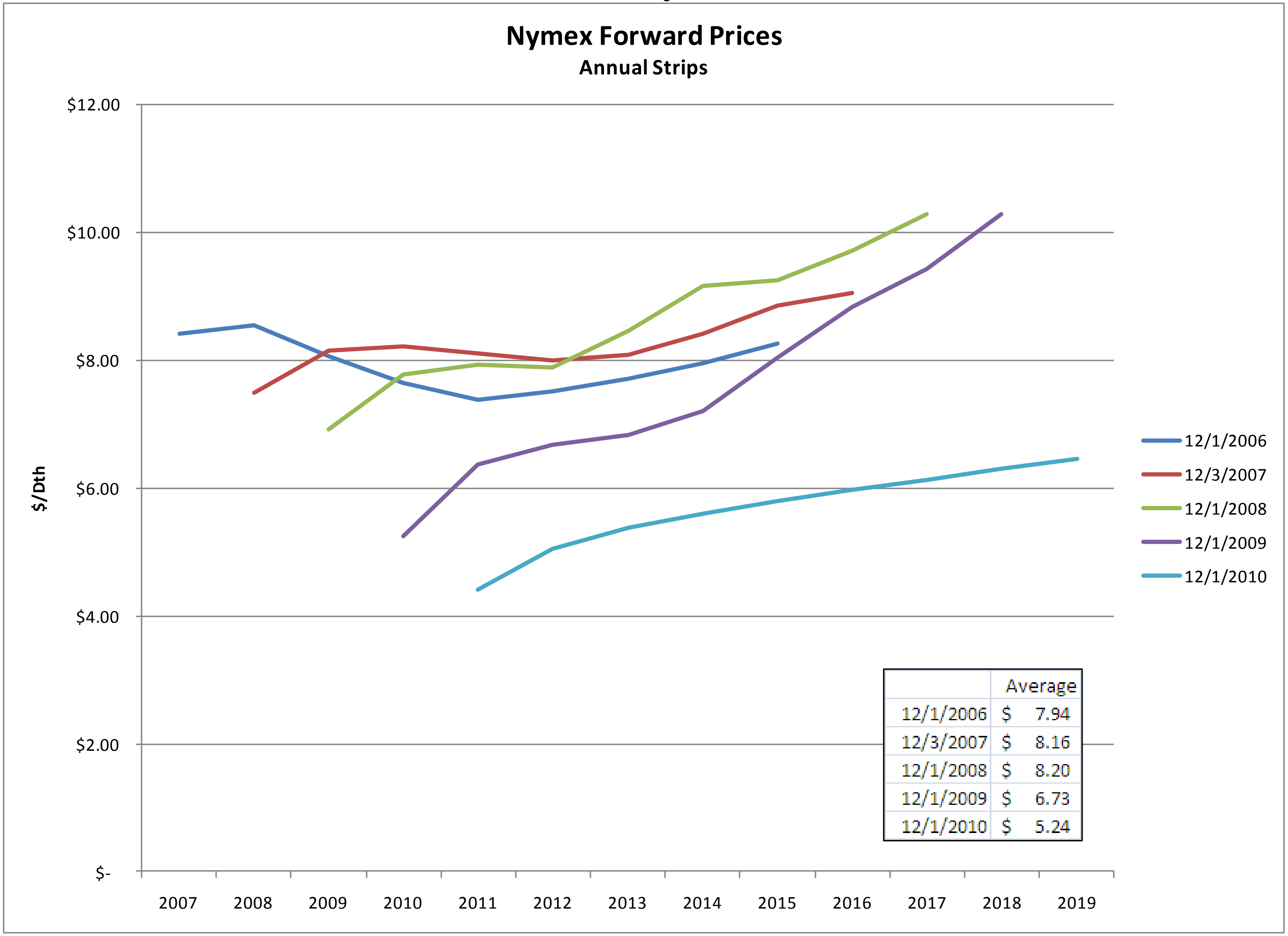
Henry Hub Historical Price Trend



Source: Platts.

Brief History of Forecasts




Nymex Forward Prices
Annual Strips
$12.00
$10.00
$8.00
$6.00
$4.00
$2.00
$-
$/Dth
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019
12/1/2006
12/3/2007
12/1/2008
12/1/2009
12/1/2010
Average
12/1/2006 $ 7.94
12/3/2007 $ 8.16
12/1/2008 $ 8.20
12/1/2009 $ 6.73
12/1/2010 $ 5.24

Long Term Natural Gas Price Drivers

DEMAND

- Economy
  - Industrial
  - Power Generation

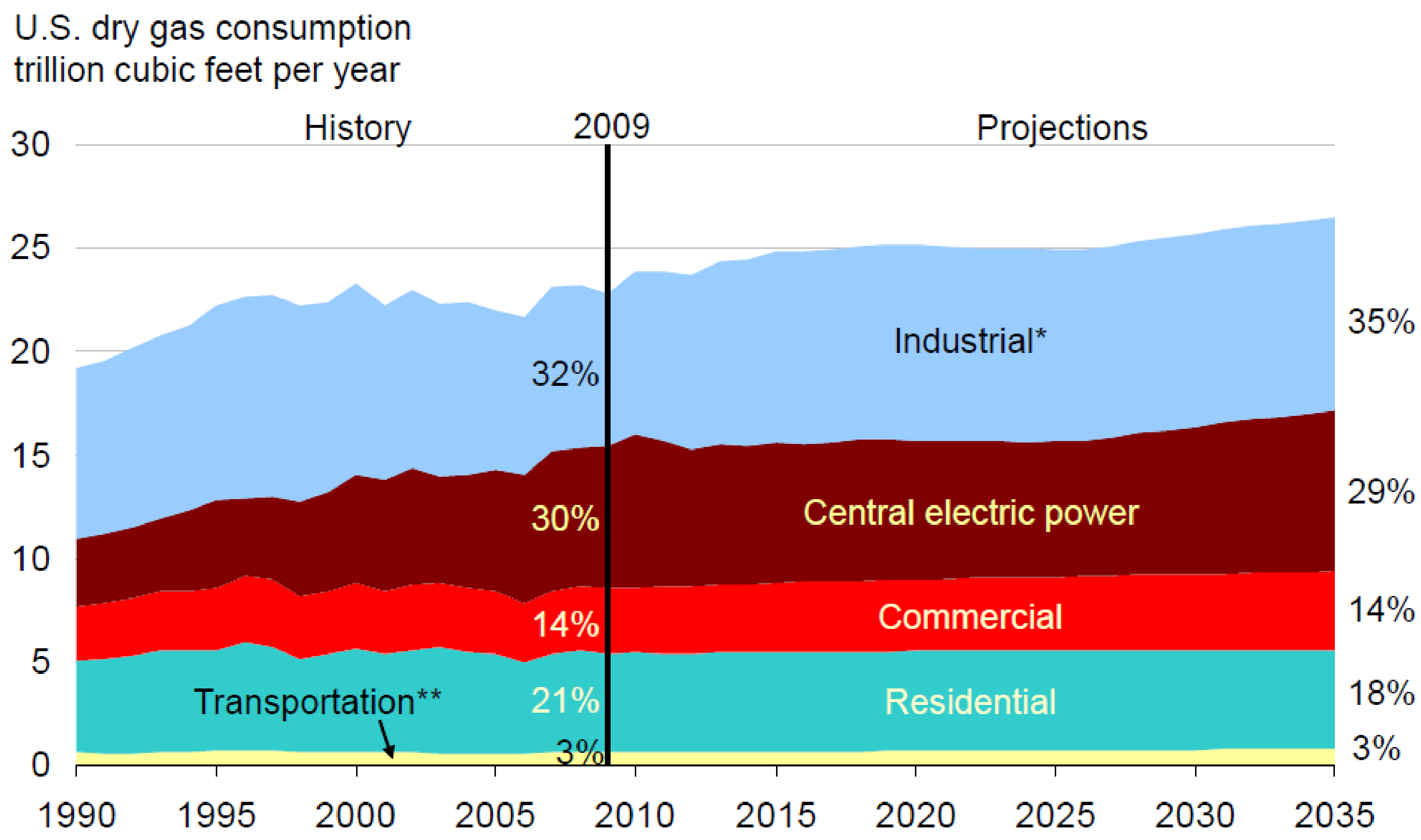
SUPPLY

- US Natural Gas Production
- Imports from Canada

OTHER FACTORS

- Oil and Coal Prices
- Carbon Legislation/Renewable Portfolio Standards
- Global Dynamics; LNG Imports (Exports?)

US Natural Gas Demand Forecast

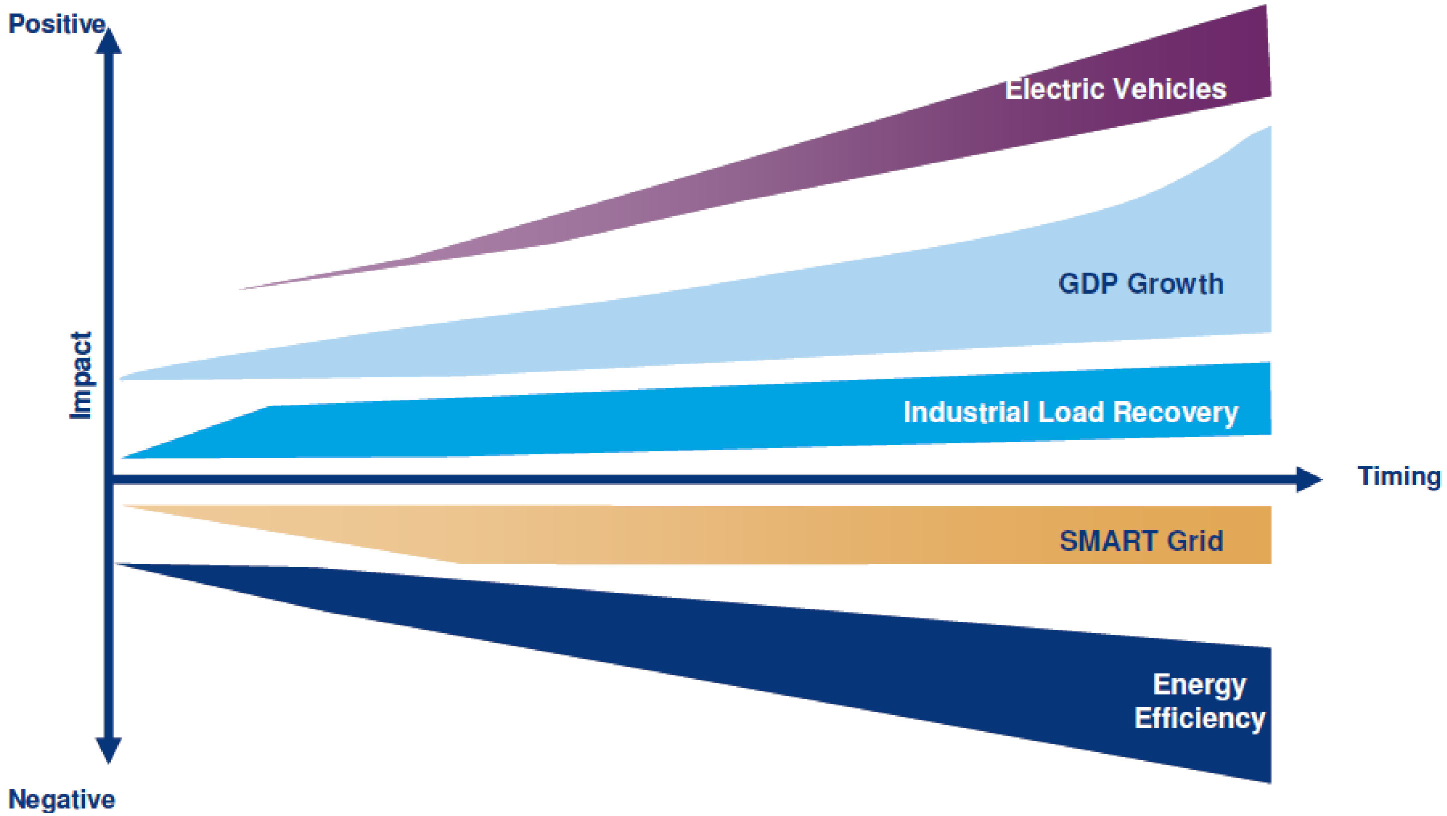


* Includes combined heat-and-power and lease and plant fuel. ** Includes pipeline fuel.

Richard Newell, December 16, 2010

Source: EIA, *Annual Energy Outlook 2011* www.woodmac.com

Power demand risks: a multitude of uncertainties

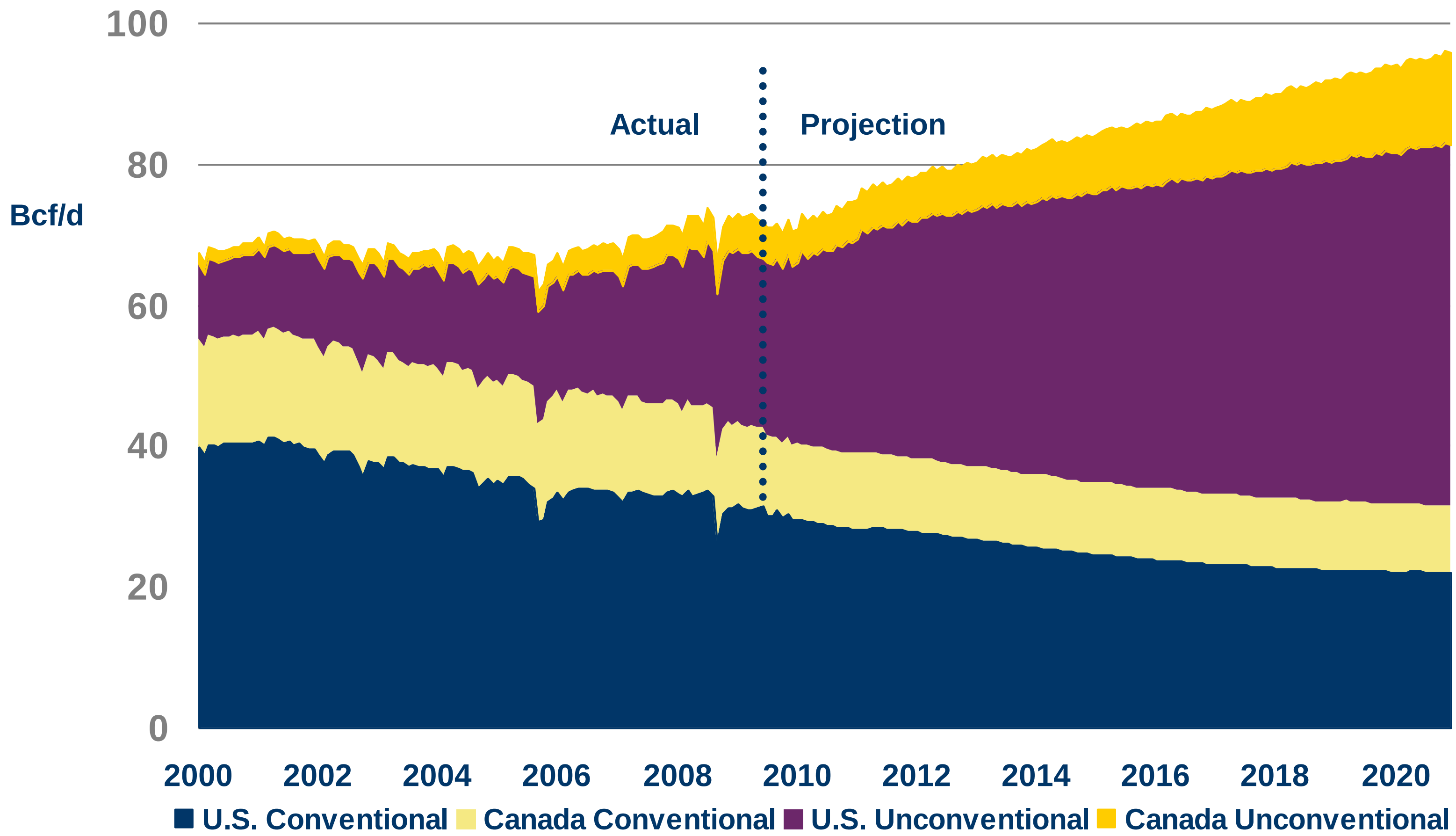


Wood Mackenzie

Delivering commercial insight

AVISTA

North American Natural Gas Production



Source: EIA & NEB historic data; Encana forecasts

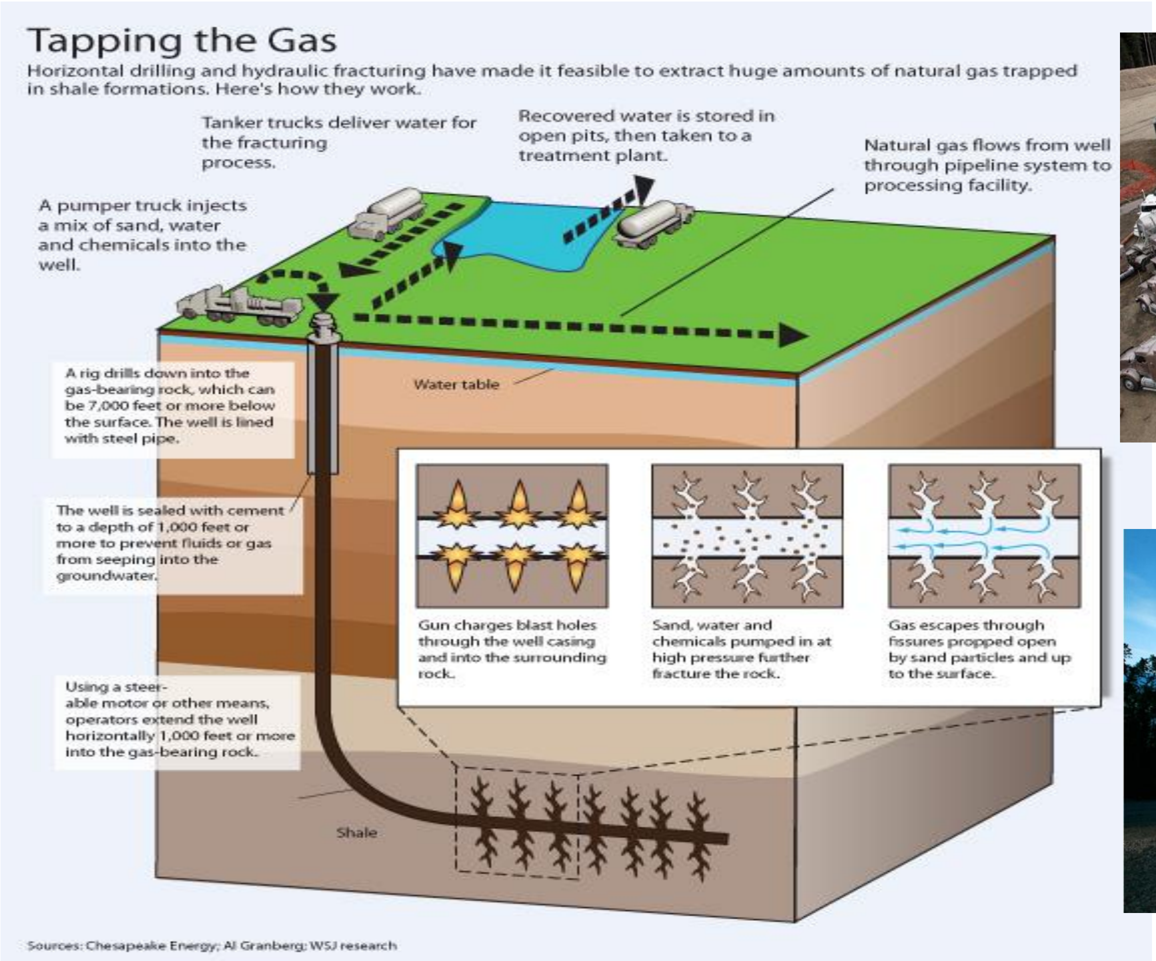
Shale Gas Economics 101

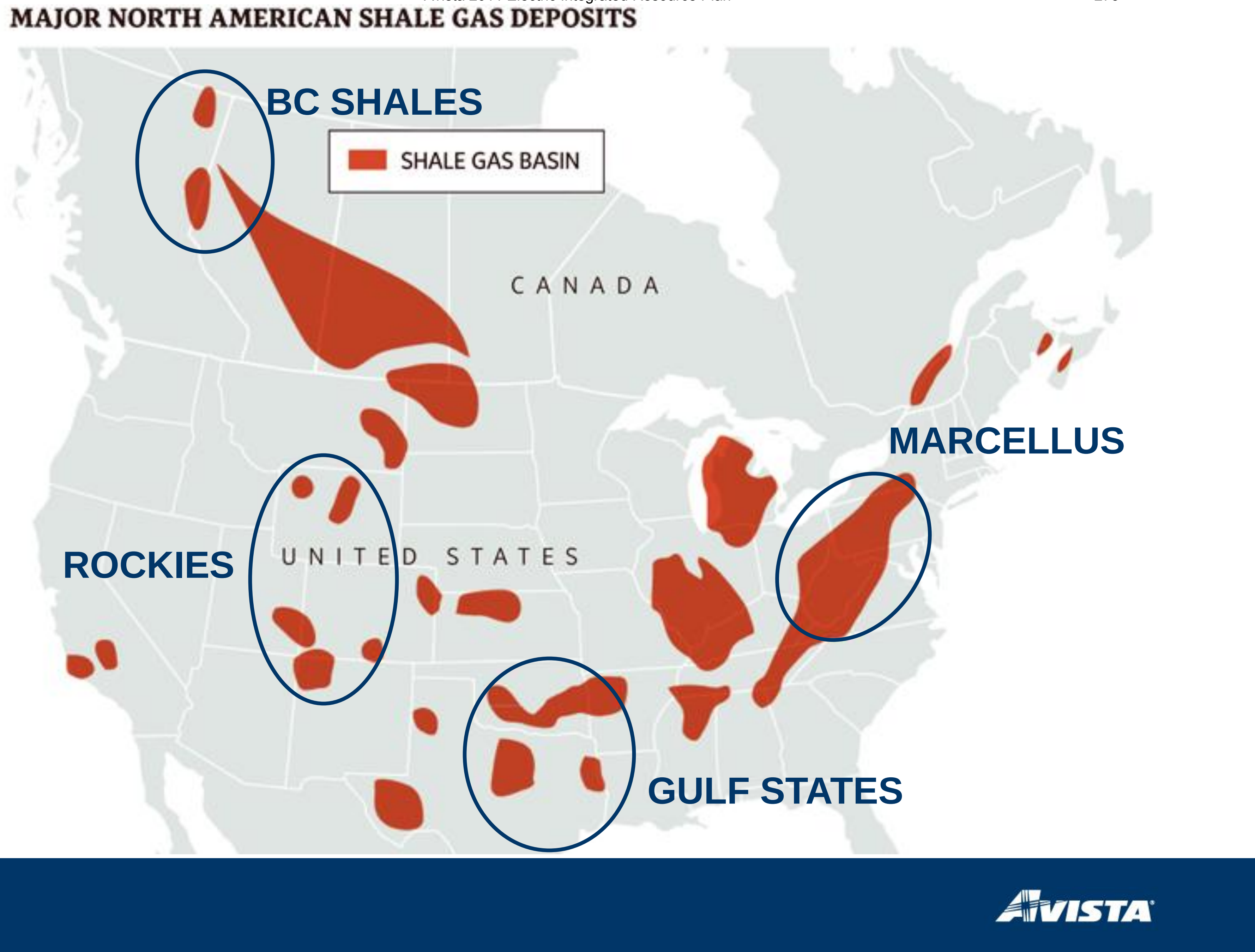
Bigger Costs. Bigger Volumes.

Conventional Vertical Drilling

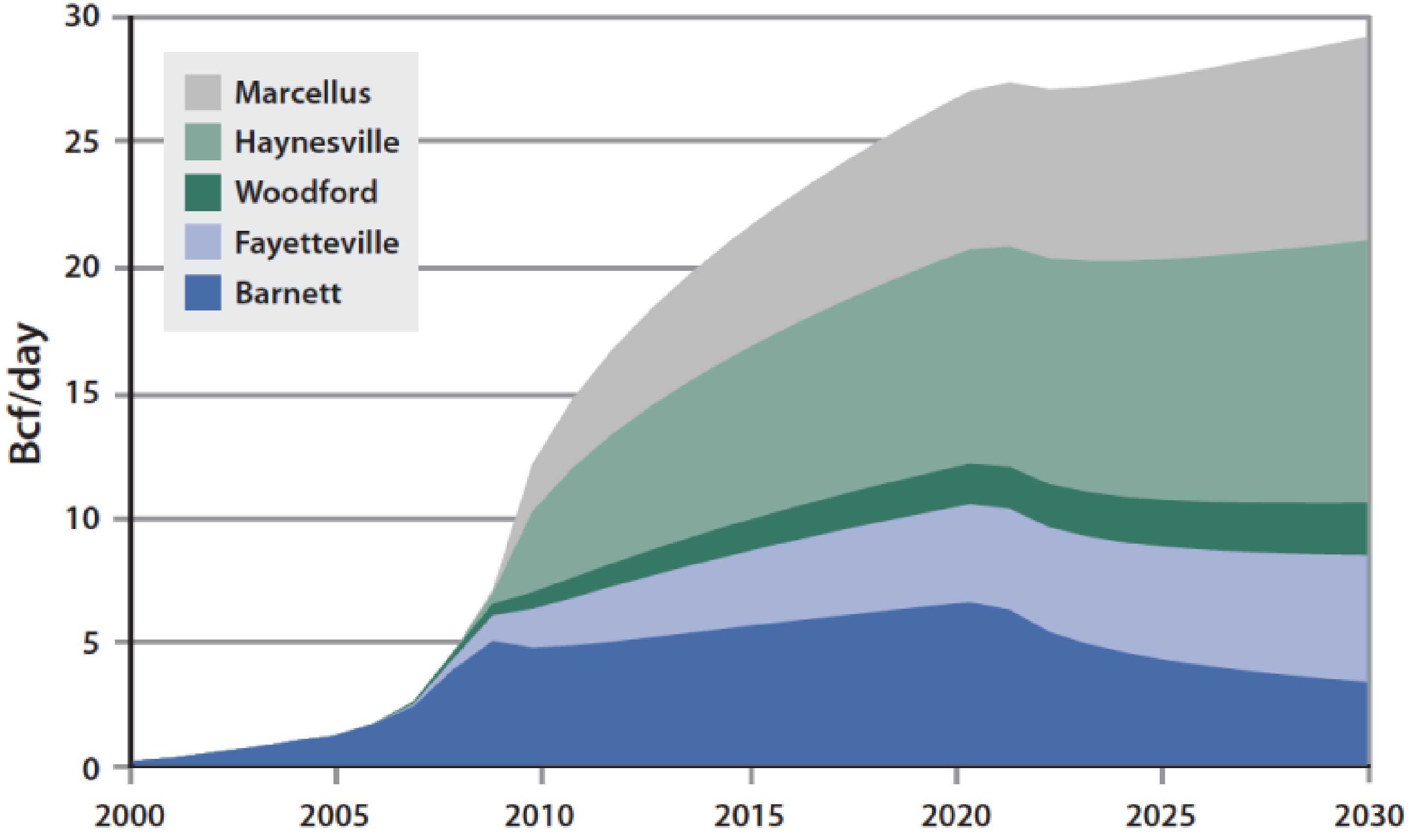
Unconventional Horizontal Drilling and Hydraulic Fracturing

The Shale Drilling Process



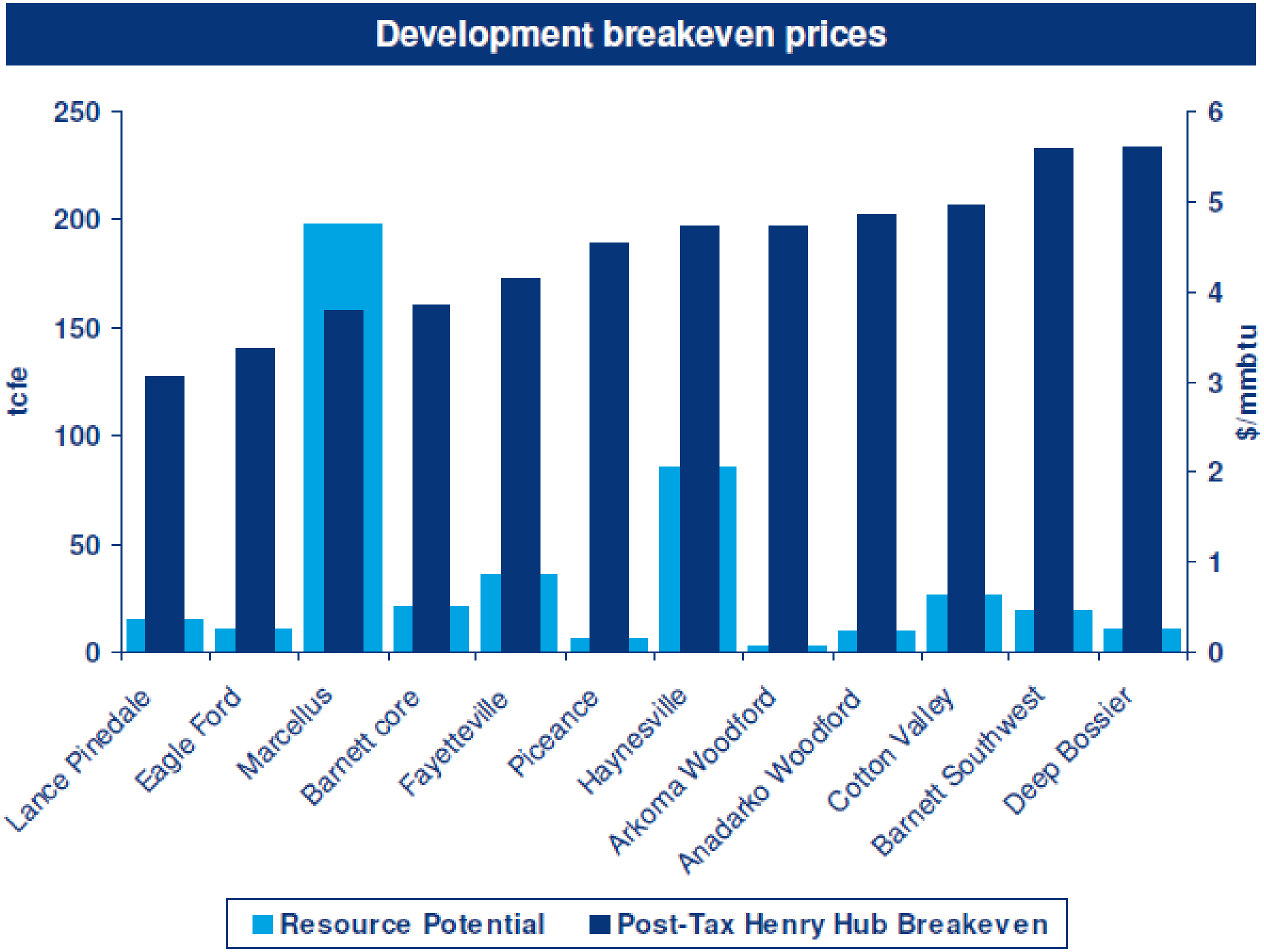

MAJOR NORTH AMERICAN SHALE GAS DEPOSITS
BC SHALES
SHALE GAS BASIN
CANADA
MARCELLUS
ROCKIES
UNITED STATES
GULF STATES
AVISTA

Growth in U.S. Shale Gas Production



Source: MIT Study The Future of Natural Gas

Costs and Volumes – Selected Gas Plays

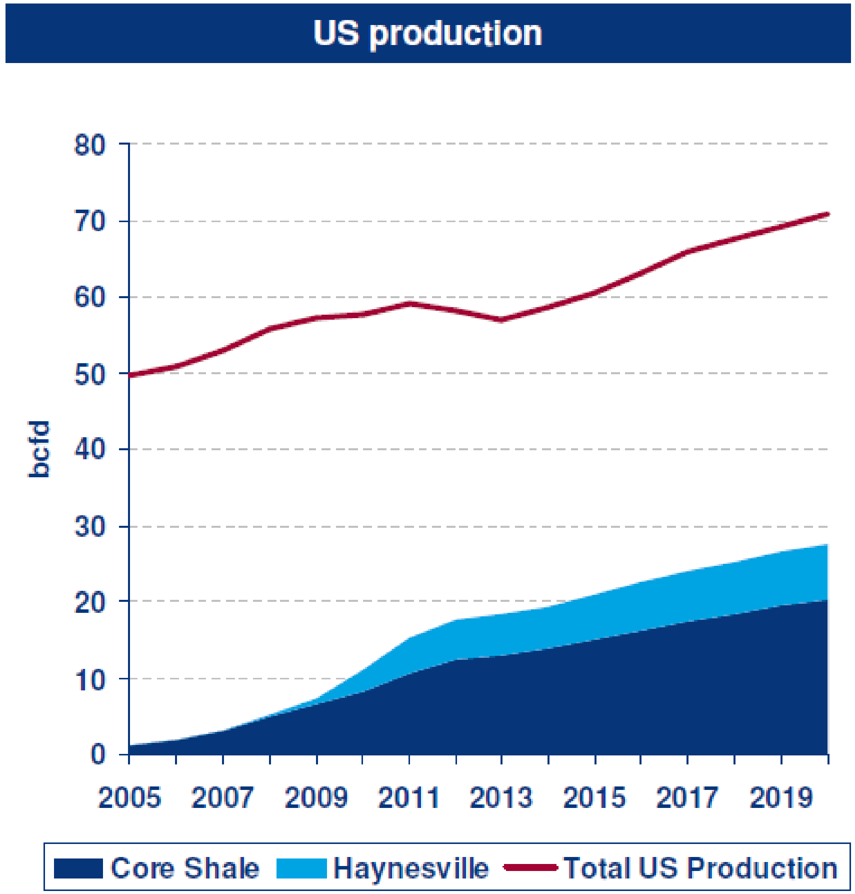


Source: Wood Mackenzie

The Gas Factory
Technology and Efficiency

1. **Drilling Days** - depending on vertical depth and lateral length, a typical 90-100 day turnaround has been reduced down to 18–45 days
2. **Lateral Length** - commonly going to about 4,000+ feet horizontal, pushing beyond 10,000 feet in some wells
3. **Wells per Pad/Simultaneous Operations -** each pad has up to 8 wells; simultaneous well work on multiple wellbores
4. **Number of Fracturing Stages** – 1 or 2 stage jobs in the past; now 8-10 stages or more
5. **Simultaneous Fracturing** – fracturing simultaneous wellbores to achieve acute stresses and more effective fracs

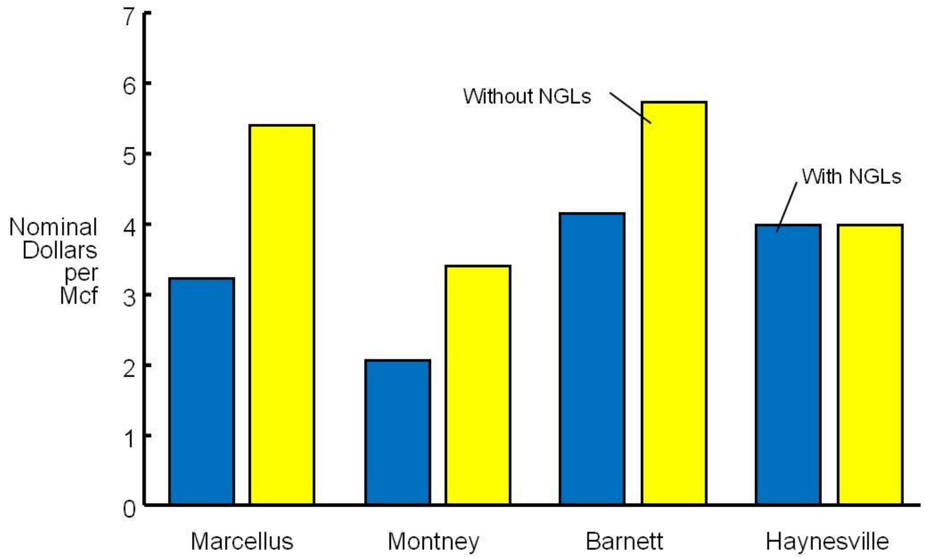
Shale Gas and US Production



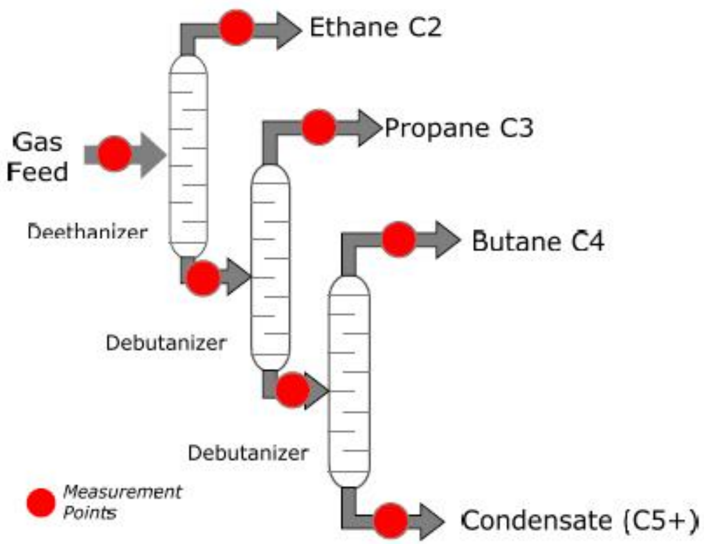
Source: Wood Mackenzie

Natural Gas Liquids (NGLs)
What are they?

Natural gas liquids (NGLs) are hydrocarbons often found resident with natural gas. They are recovered as liquids through a purification process at processing plants. They include ethane, propane, and butane and condensate (natural gasoline).

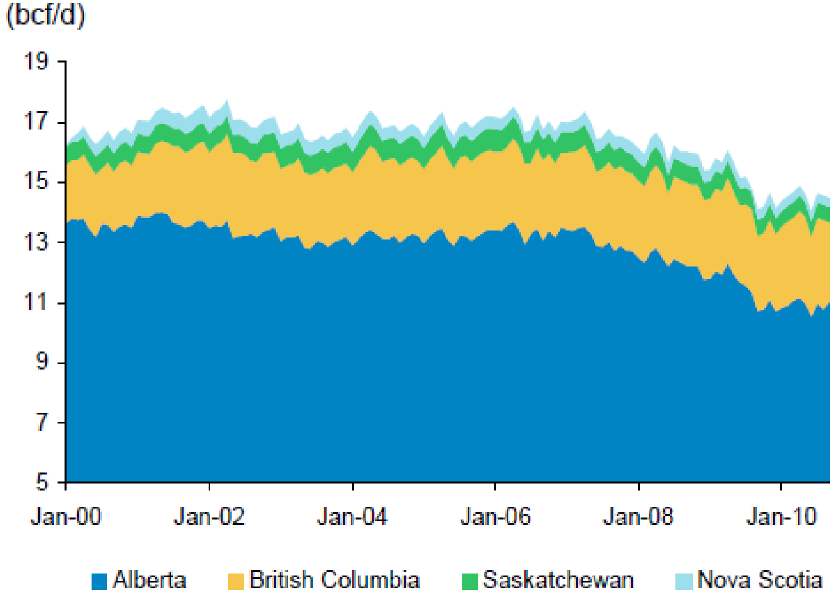


Source: IHS CERA.



Canada Exports

Historical Trend – Declining Exports



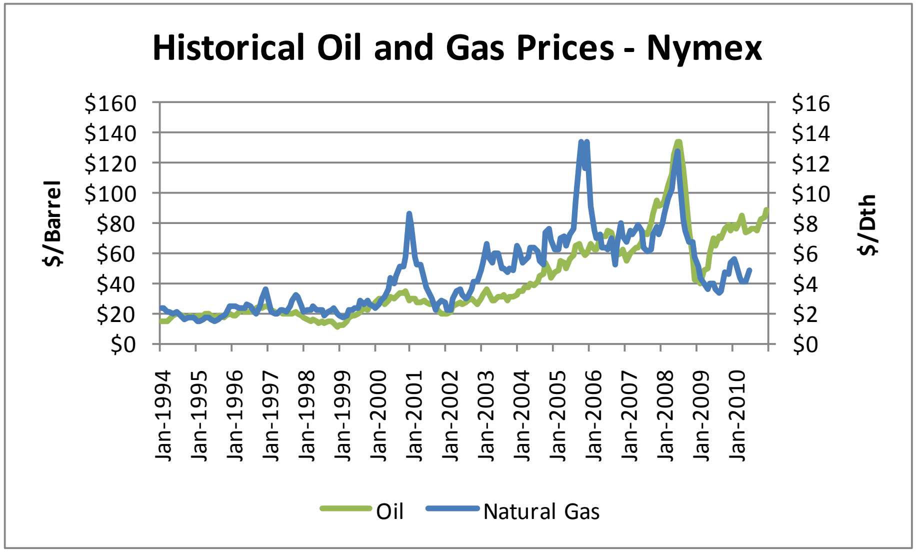
Source: National Energy Board, Morgan Stanley Commodity Research

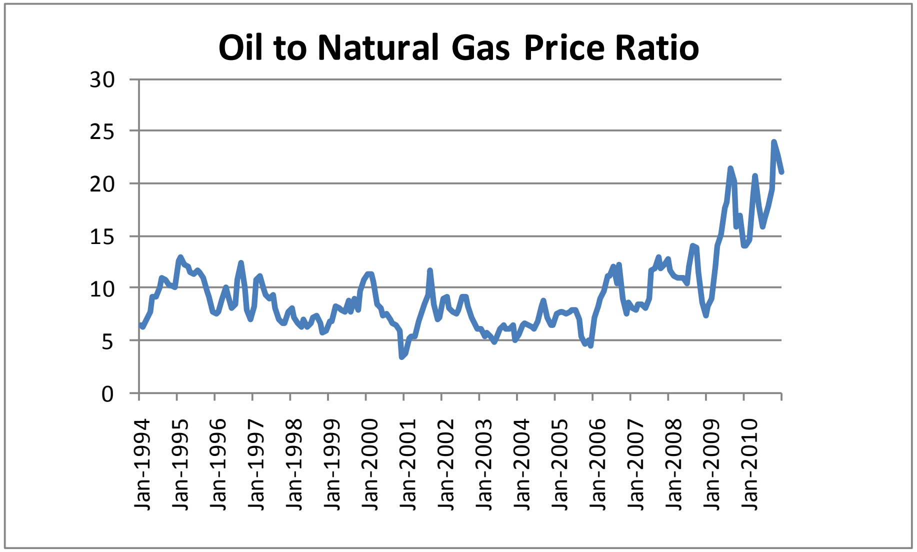
Recent Trends

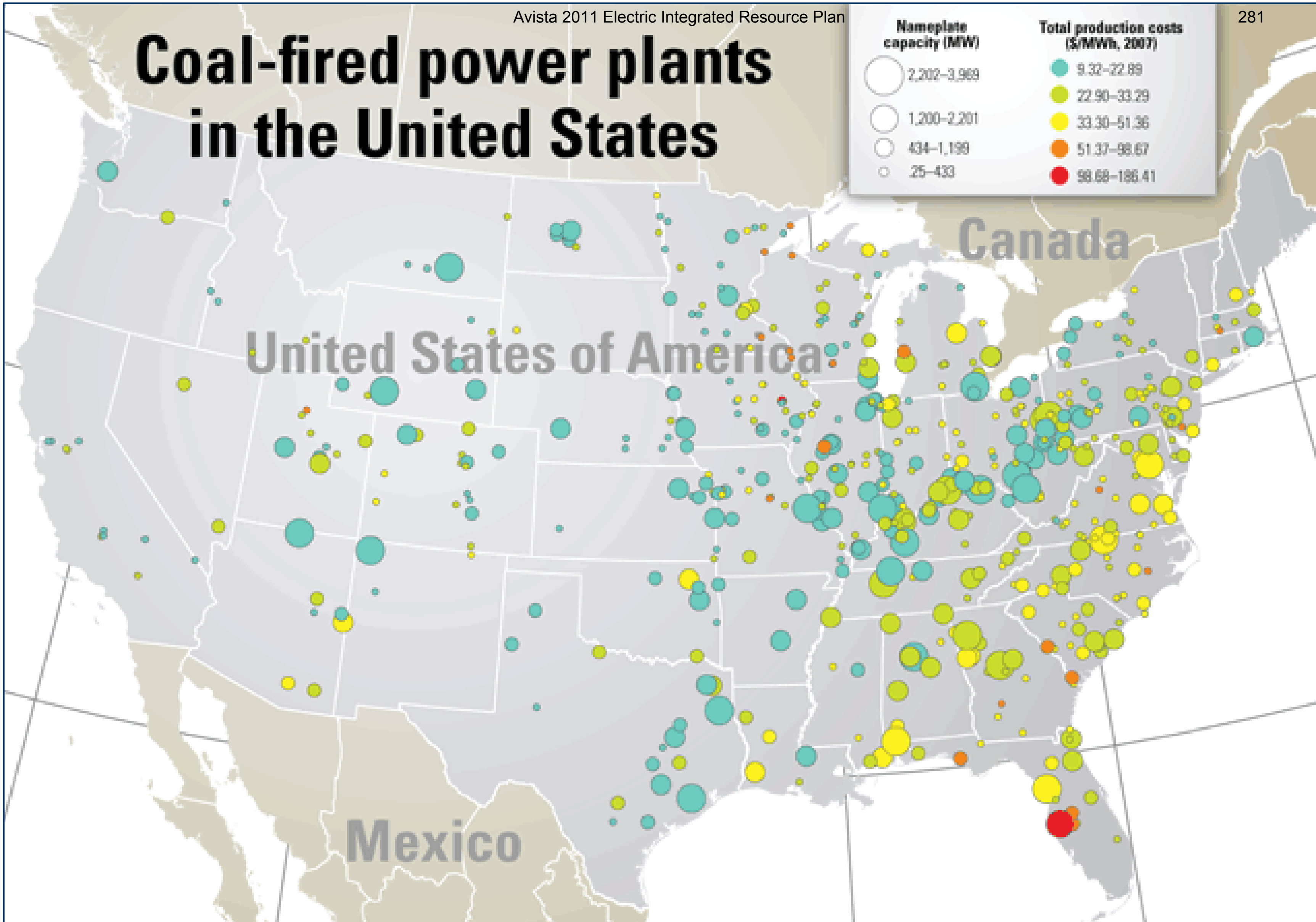
- **Imports declining slower than anticipated**
- **BC Shale larger and faster than anticipated**
- **Alberta royalties renegotiated**
- **Lower oil prices have slowed demand for oil sands production**

Oil vs. Natural Gas Relationship

- Strong long term price correlation historically
- Long term ratio of approx. 8 to 1 (1994-2008)
- Since Jan 2009 ratio has **doubled** to approx 17 to 1
- Shale gas could fundamentally and permanently change historic ratio
- Alternatively, increased demand from low prices could cure low prices






Coal-fired power plants in the United States
Nameplate capacity (MW)
2,202–3,969
1,200–2,201
434–1,199
.25–433
Total production costs ($/MWh, 2007)
9.32–22.89
22.90–33.29
33.30–51.36
51.37–98.67
98.68–186.41
Canada
United States of America
Mexico

Carbon Policy/Renewable Portfolio Standards

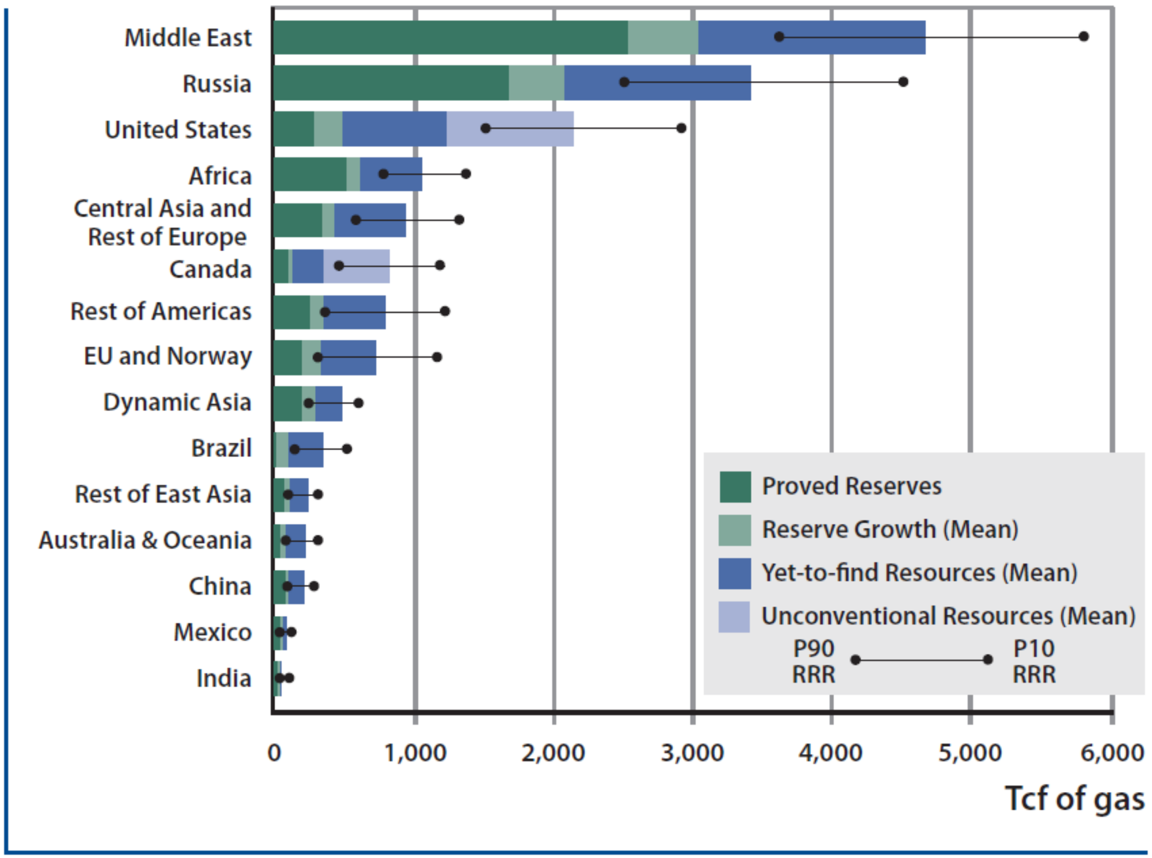
Natural Gas has a critical yet complex role in carbon policy creation and implementation.

- Numerous complex issues and uncertainties
- Need to balance economic challenges with policy objectives
- Complex issues within cap and trade vs. simpler carbon tax
- Long term role or interim bridge?

Natural Gas also has an important backup role for intermittent renewable generation sources

Global Natural Gas Estimates

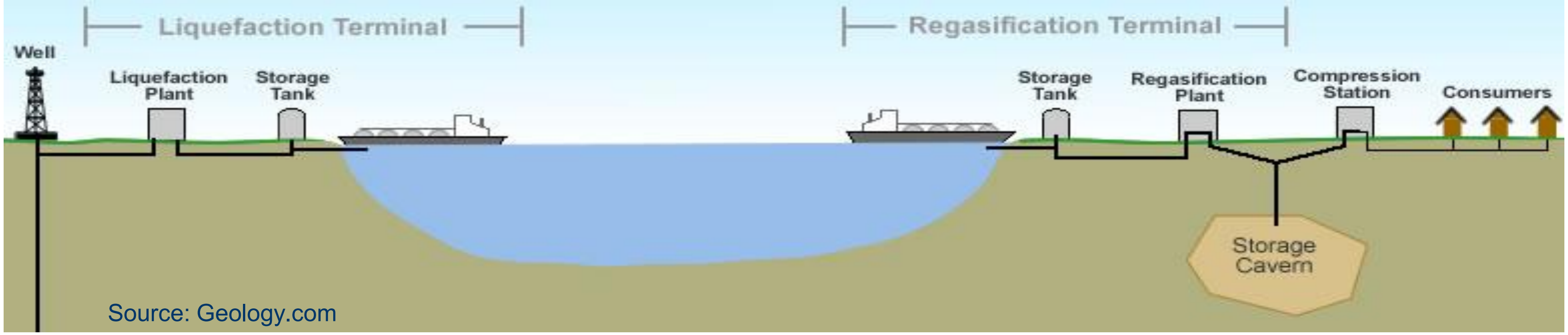
Figure 2.2 Global Remaining Recoverable Gas Resource (RRR) by EPPA Region, with Uncertainty[2] (excludes unconventional gas outside North America)



Source: MIT Study The Future of Natural Gas

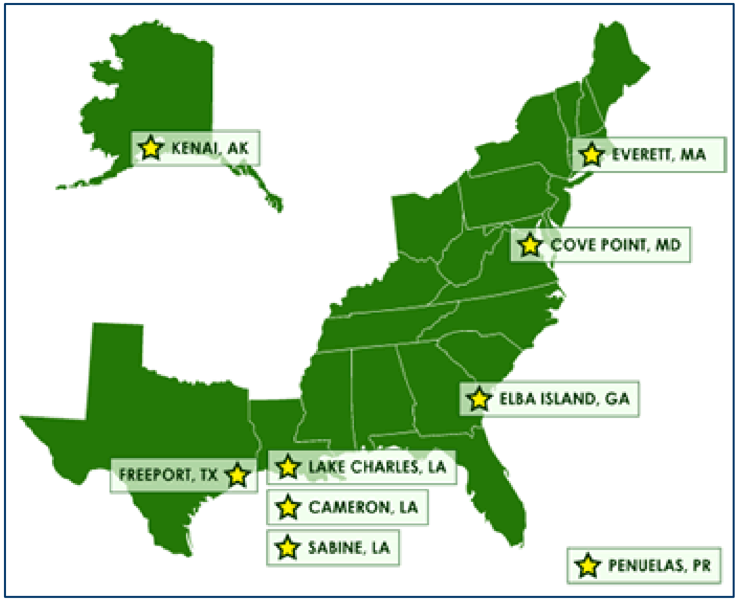
LNG Imports…or Exports?

LNG traditionally flows to North America after other higher-priced markets receive their share



Source: Geology.com

Source: Apache LNG

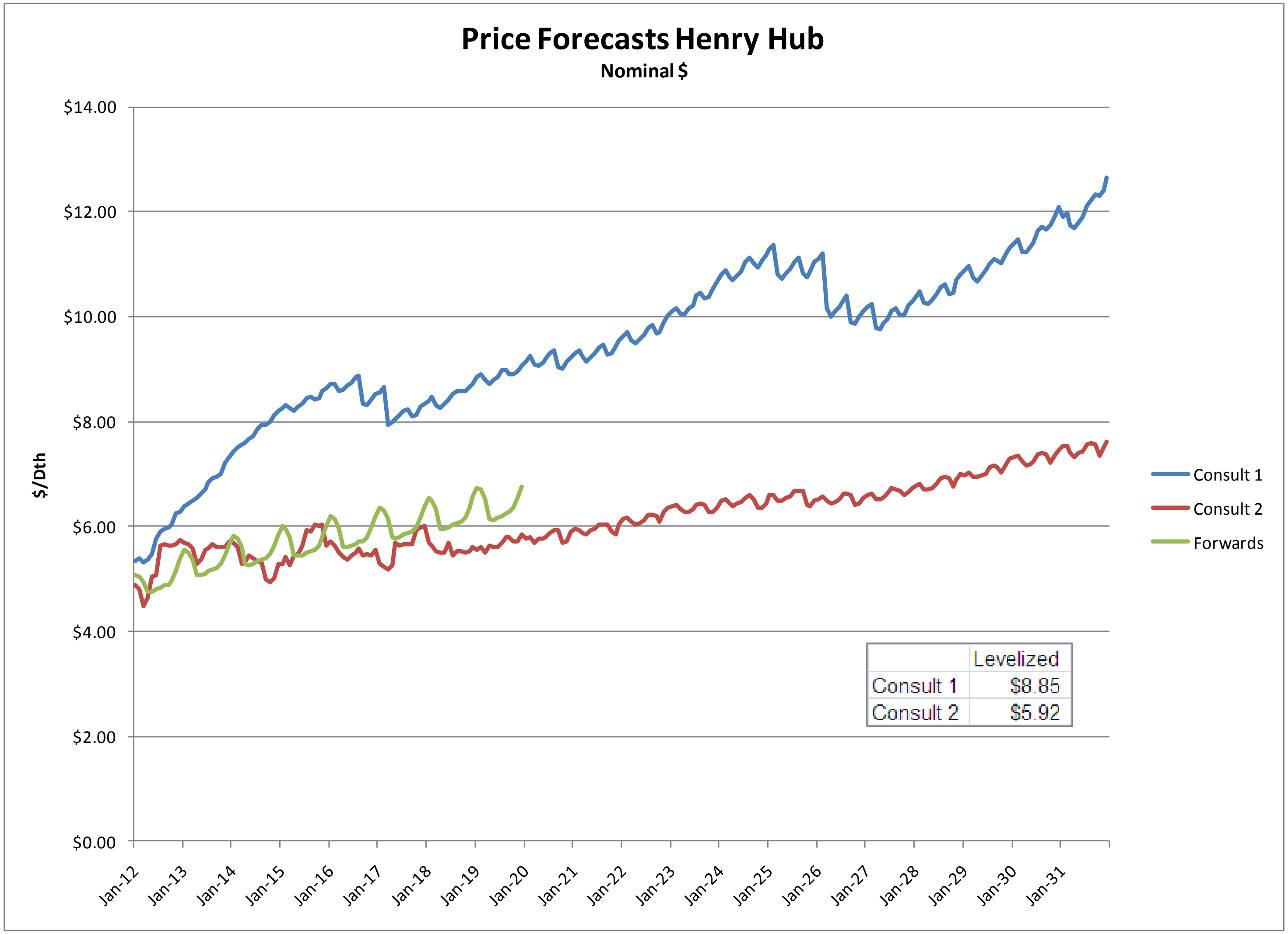


Source: Federal Energy Regulatory Commission

IRP Price Forecast Methodology

1. Two fundamental forecasts (Consultant #1 & Consultant #2)
2. Forward prices
3. 50/50 weighting fundamental and forwards year 1
4. Reduce forwards weighting 10% each year thereafter
5. By year 6, forecast is 50% Consultant #1, 50% Consultant #2

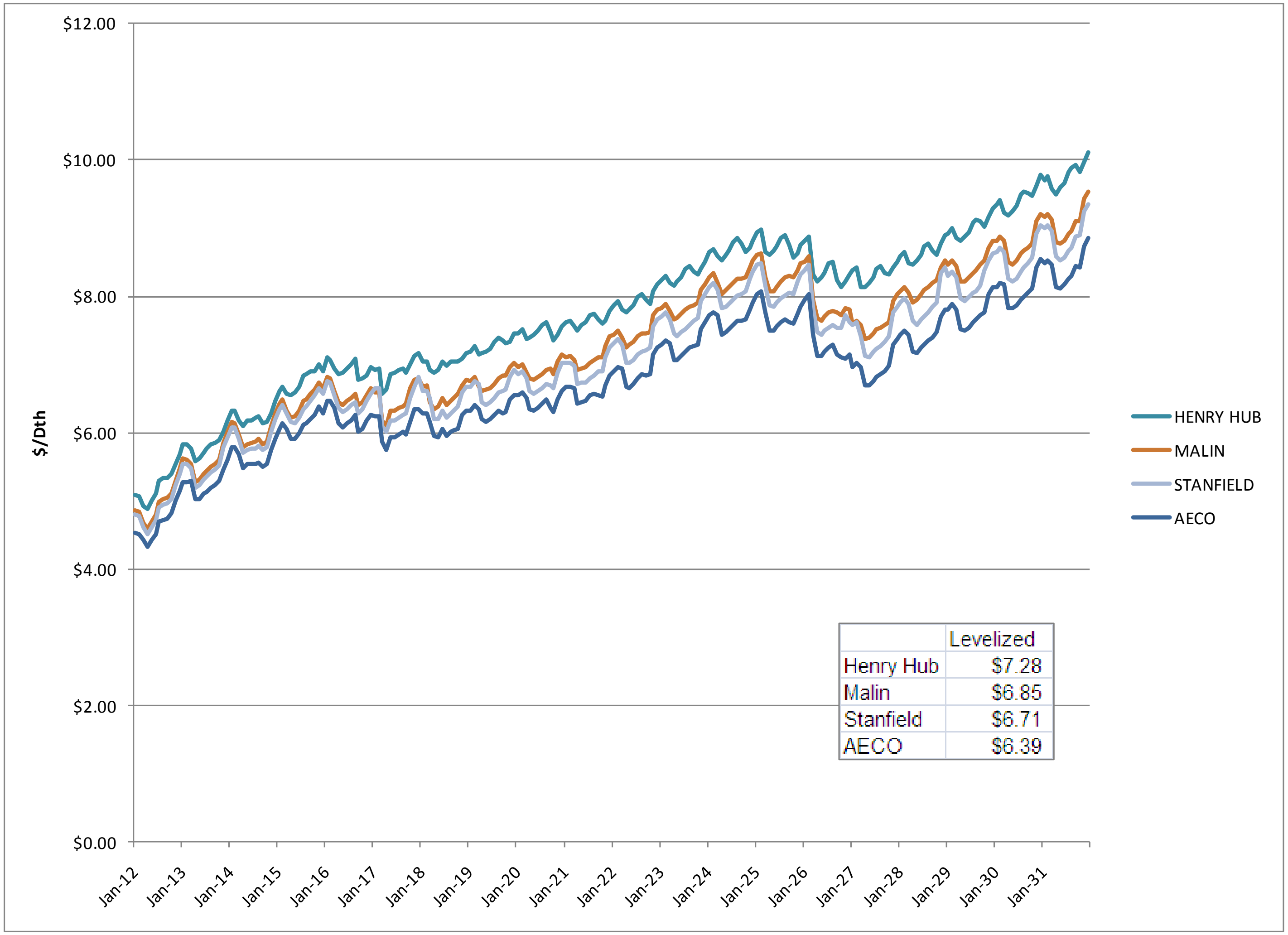
IRP Price Forecast Components



	Levelized
Consult 1	$8.85
Consult 2	$5.92

IRP Price Forecast – Selected Hubs

Nominal $



	Levelized
Henry Hub	$7.28
Malin	$6.85
Stanfield	$6.71
AECO	$6.39

Electric Market Forecast

(Preliminary Draft)

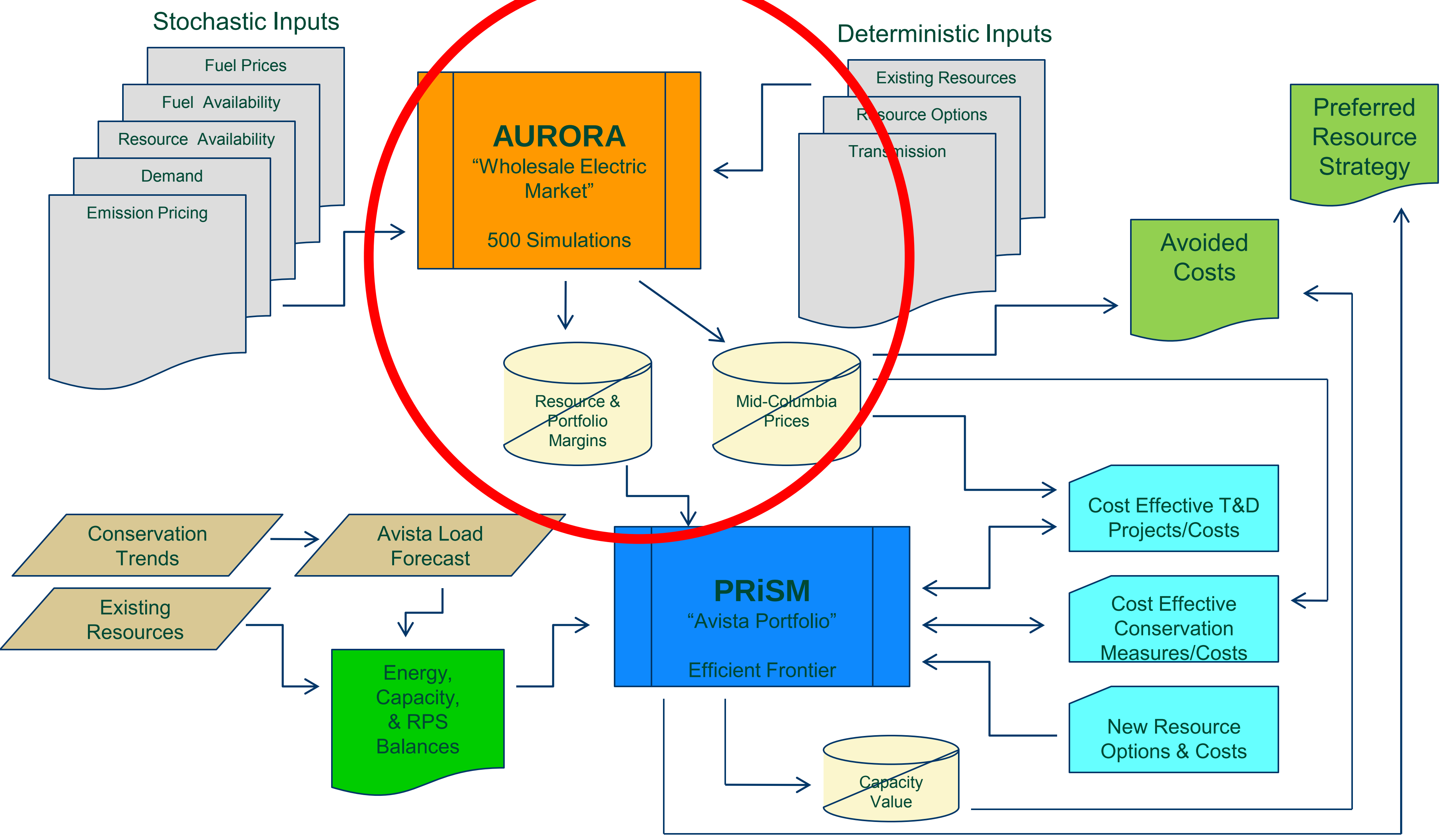
James Gall

Technical Advisory Committee Meeting #4

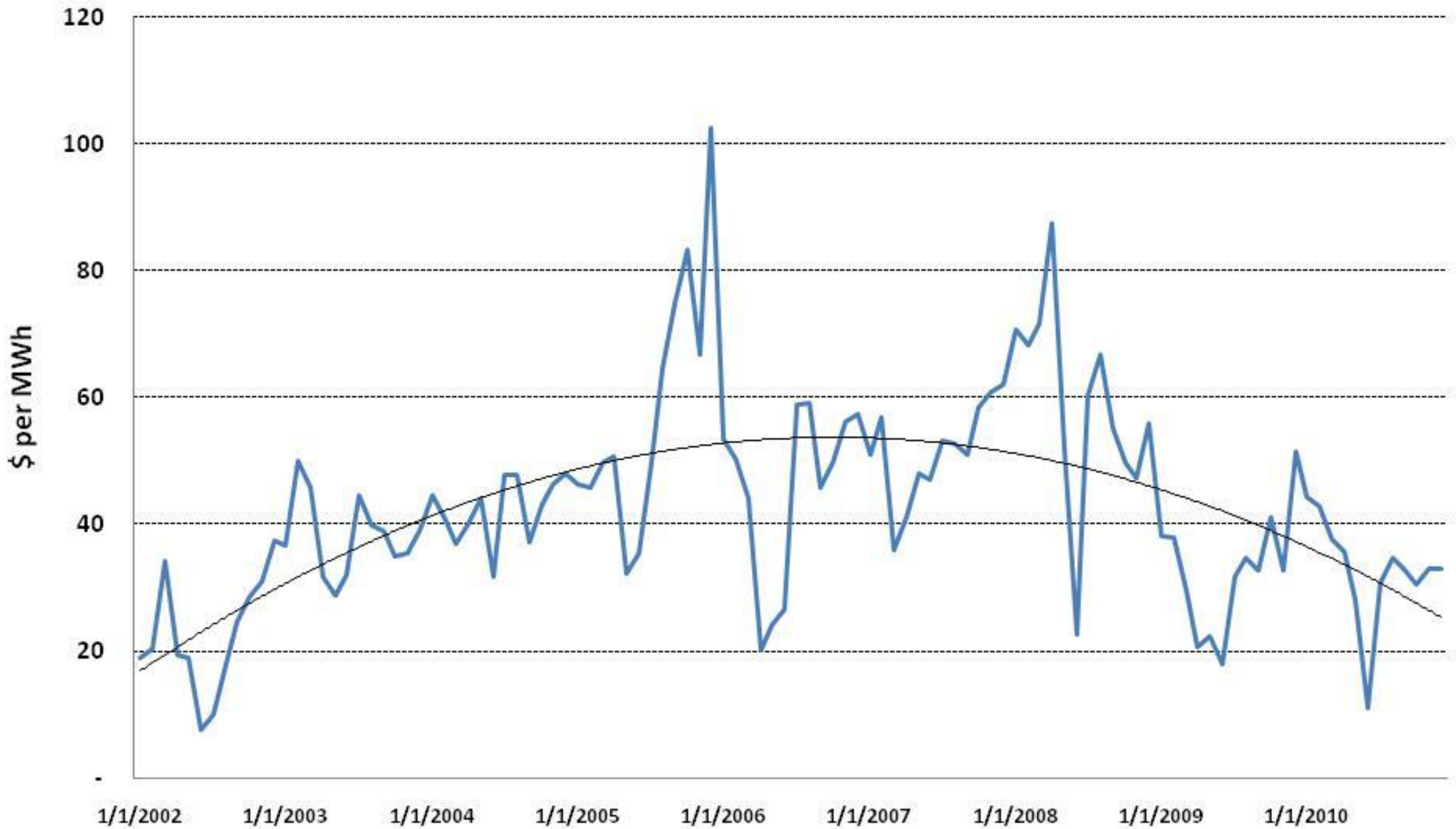
2011 Electric Integrated Resource Plan

February 3, 2011

2011 Integrated Resource Plan Modeling Process

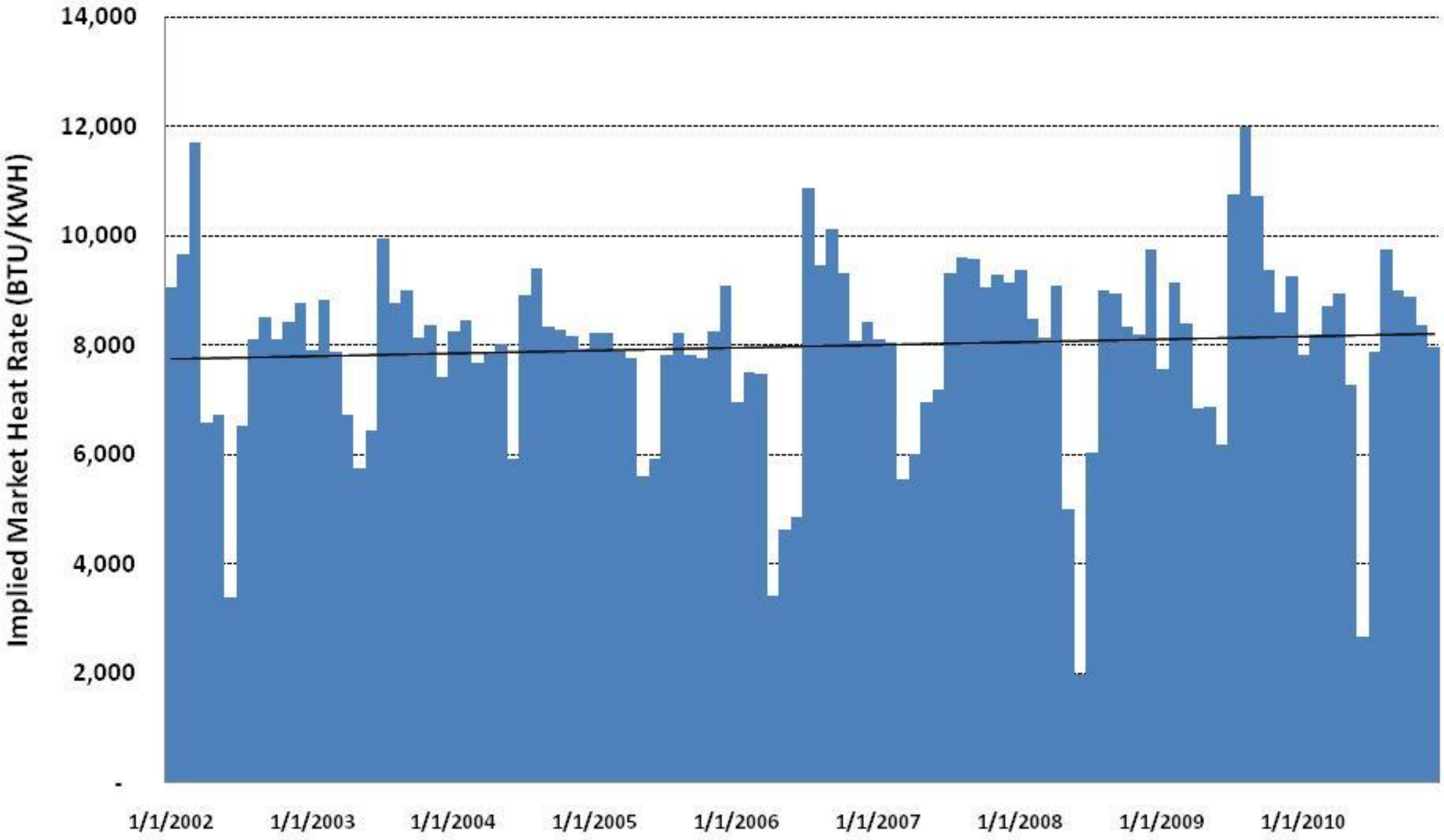


Historical Monthly Flat Mid-Columbia Prices

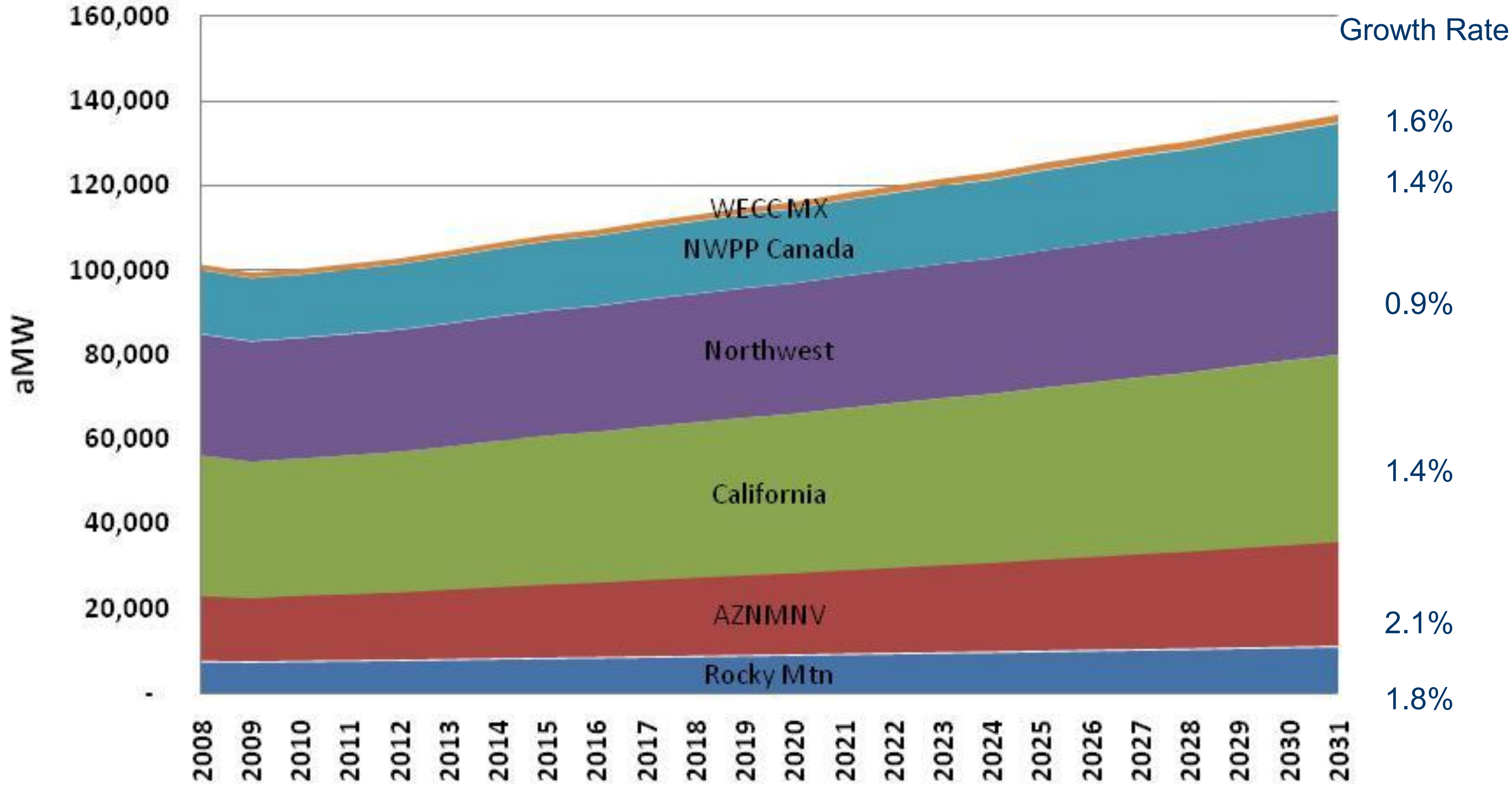


Historical Monthly Implied Market Heat Rates

(Mid-Columbia/Stanfield x 1,000)

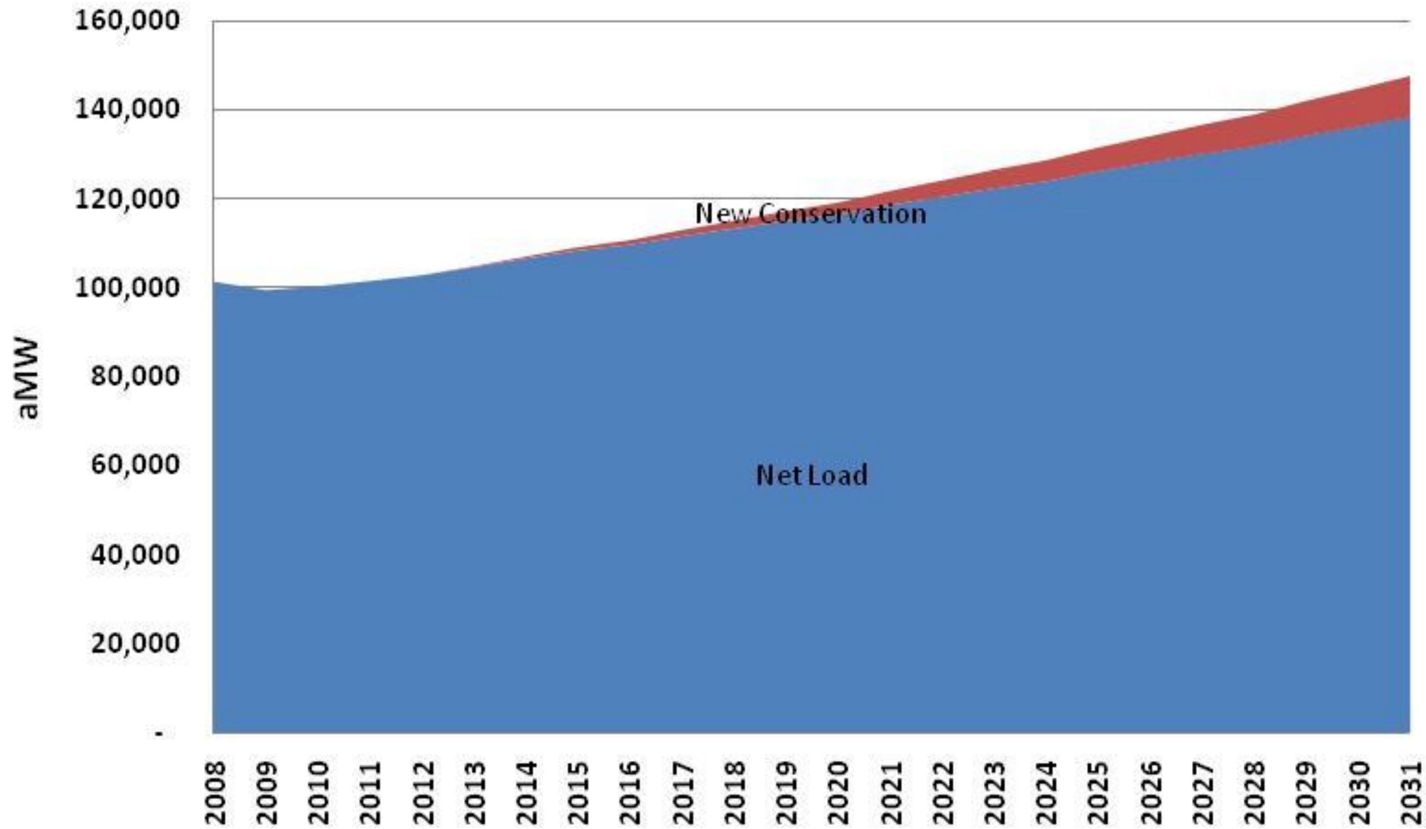


Western Interconnect Load Growth



Regional Load Growth Source: Wood Mackenzie

New Western Interconnect (WECC) Conservation



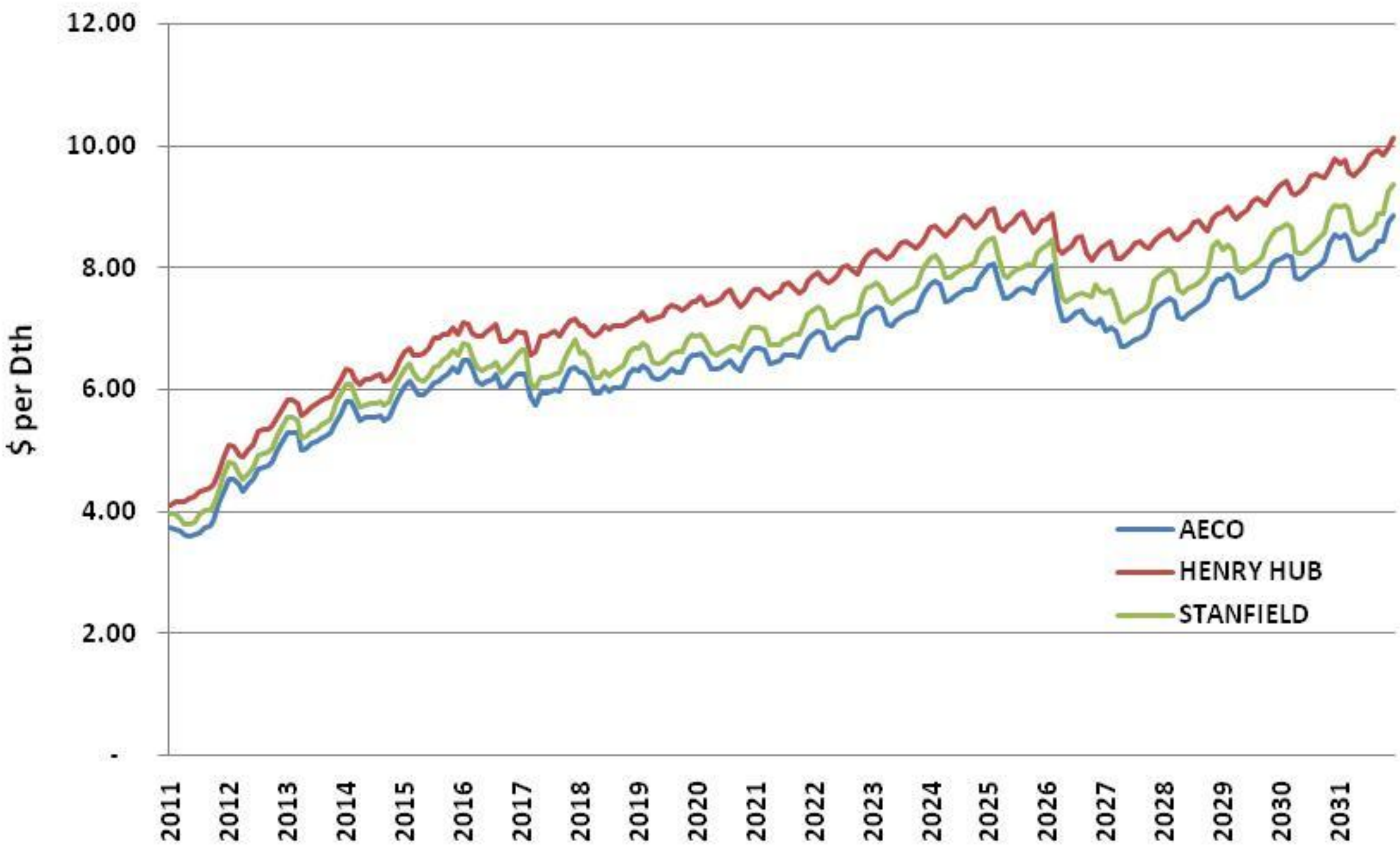
New conservation meets 21% of Load Growth

Regional Load Growth/Conservation Source: Wood Mackenzie

Western Interconnect Plug-in Electric Hybrid Vehicles Assumption

- Electric Cars are assumed to be adopted at the Northwest Power & Conservation Council estimate per the "Case 2" of the 6th Power Plan
  - 18% of cars by 2020 and 28% by 2030
- 95% of cars will charge at night and 5% during on-peak hours
- PHEV are not assumed to meet electric capacity needs

Natural Gas Price Re-Cap



2012-2031
Nominal
Levelized Price

$7.28- Henry Hub

$6.71- Stanfield

$6.39- AECO

Western Interconnect Transmission Additions

- Additional regional transmission additions are assumed to take place in the future, these are the additions assumed in the Base Case market analysis (MW)
  - Idaho - NW: 1,500 (2019)
  - Canada - NW - California: 3,000 (2018)
  - Wyoming - Utah: 3,000 (2015)
  - Wyoming - Idaho: 1,500 (2016)
  - Wyoming - Colorado: 900 (2013)
  - Idaho - Utah: 1,320 (2016)
  - N. Nevada - S. Nevada: 1,600 (2015)
  - New Mexico - Arizona: 3,000 (2016)

New Resource Alternatives

Western Interconnect

Resource alternatives to meet Renewable Portfolio Standards

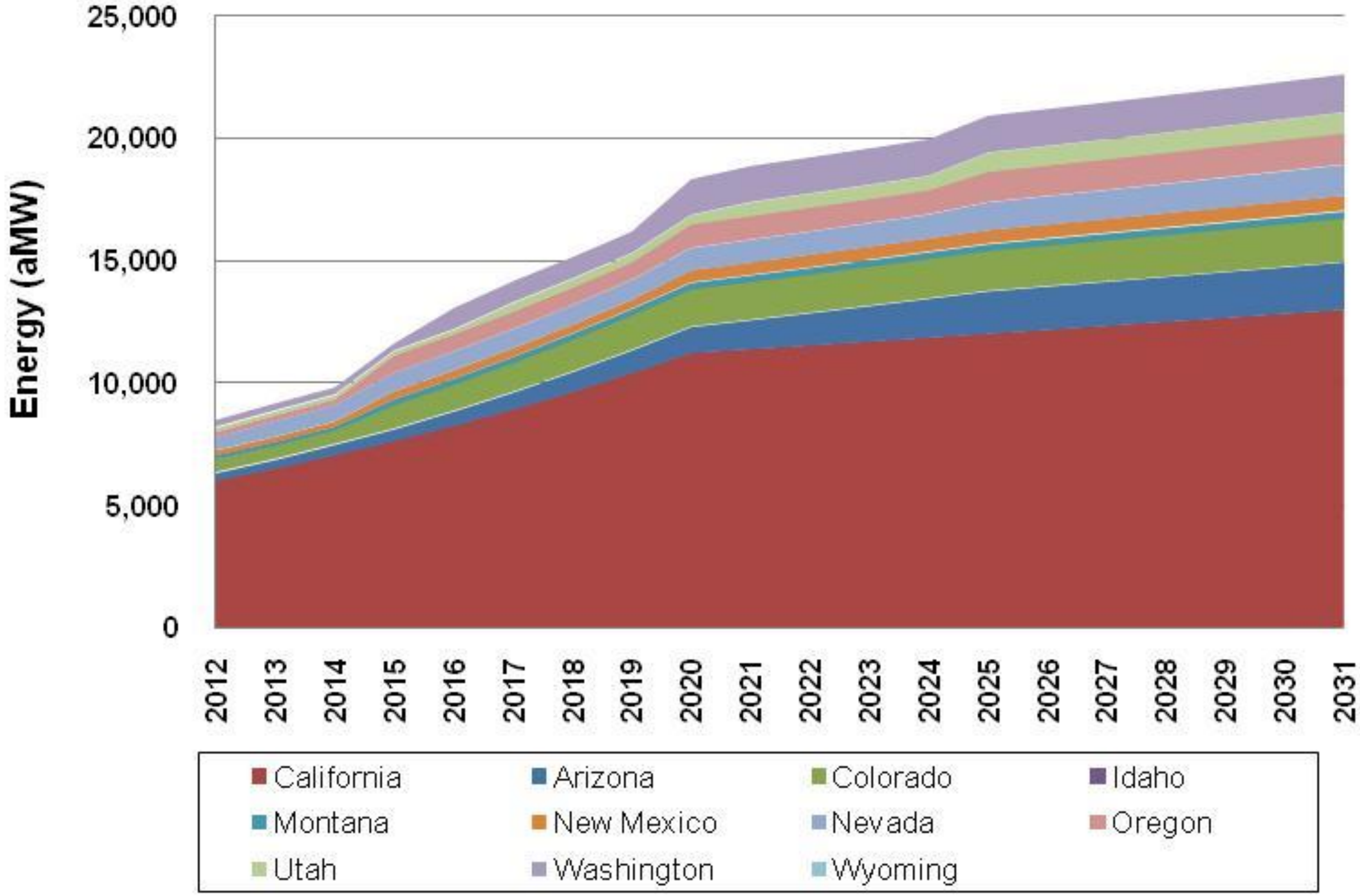
- Wind
- Solar
- Biomass
- Geothermal
- Hydro Upgrades

Resource alternatives to meet regional capacity requirements

- Combined Cycle
- Simple Cycle (Aero, Frame, Hybrid)
- Solar
- Wind (non RPS states)
- Nuclear
- Coal Pulverized
- Coal IGCC
- Coal IGCC with Sequestration

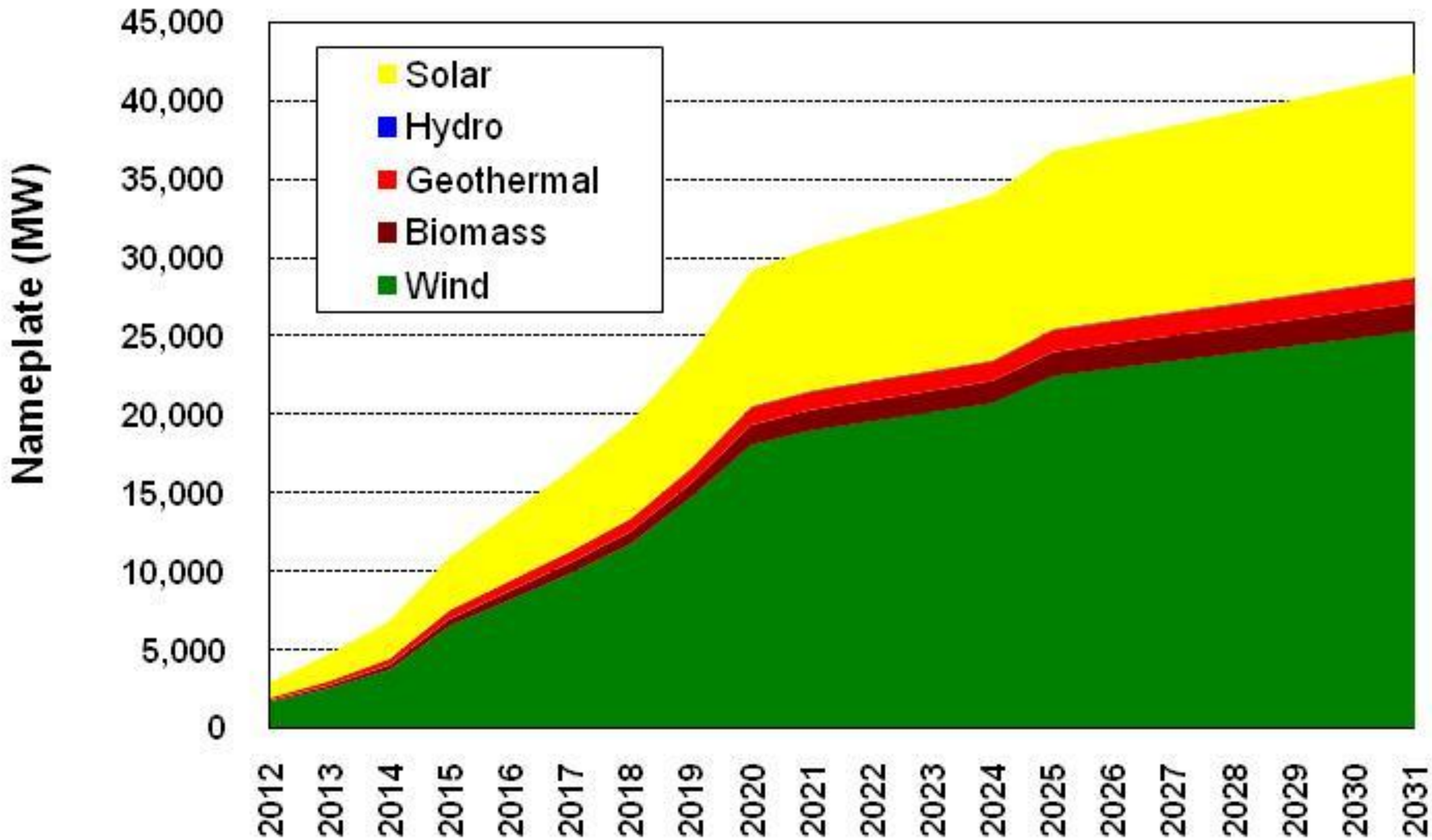
State Renewable Energy Requirements

Western Interconnect



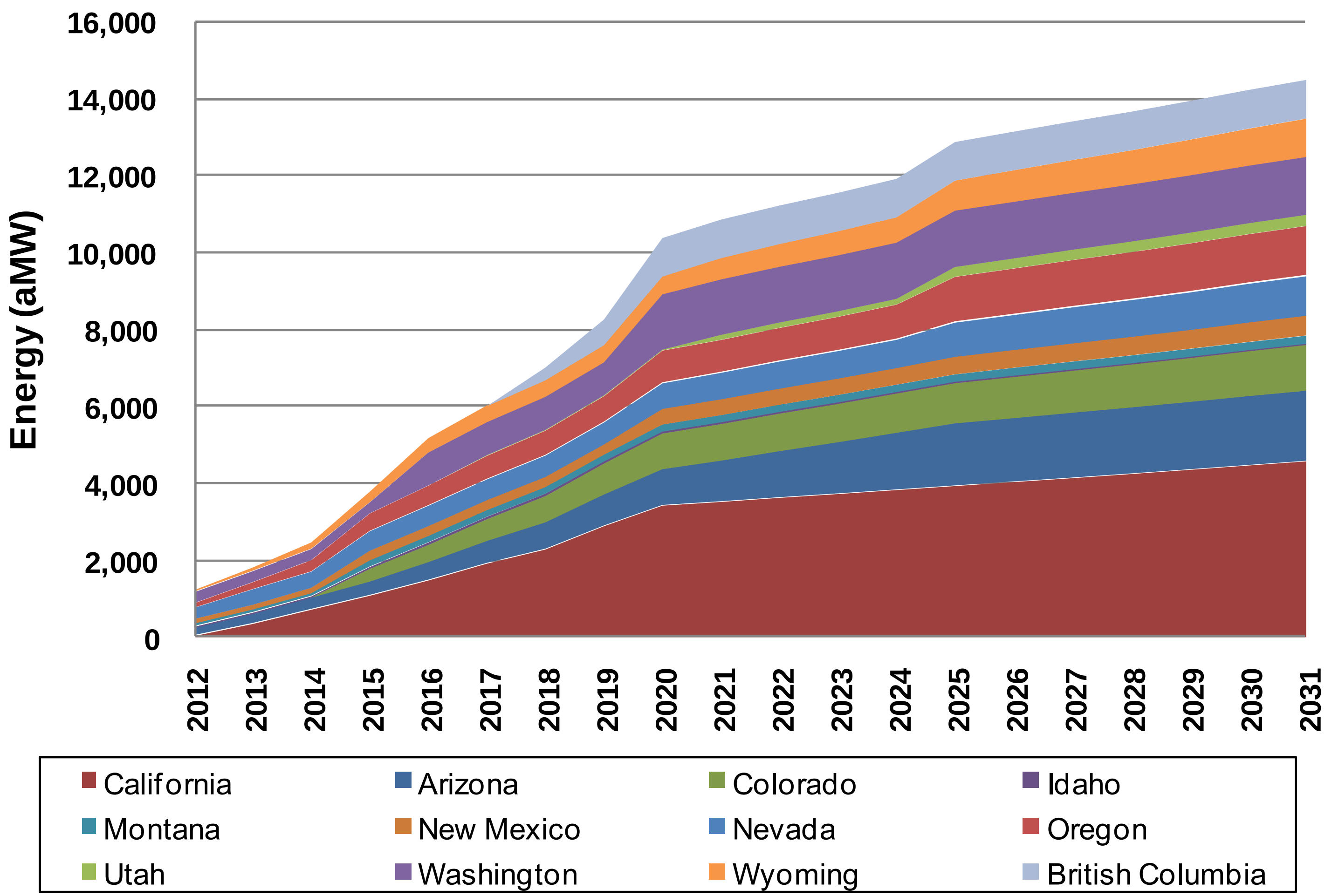
New Renewable Resources Added for RPS by Type

Western Interconnect

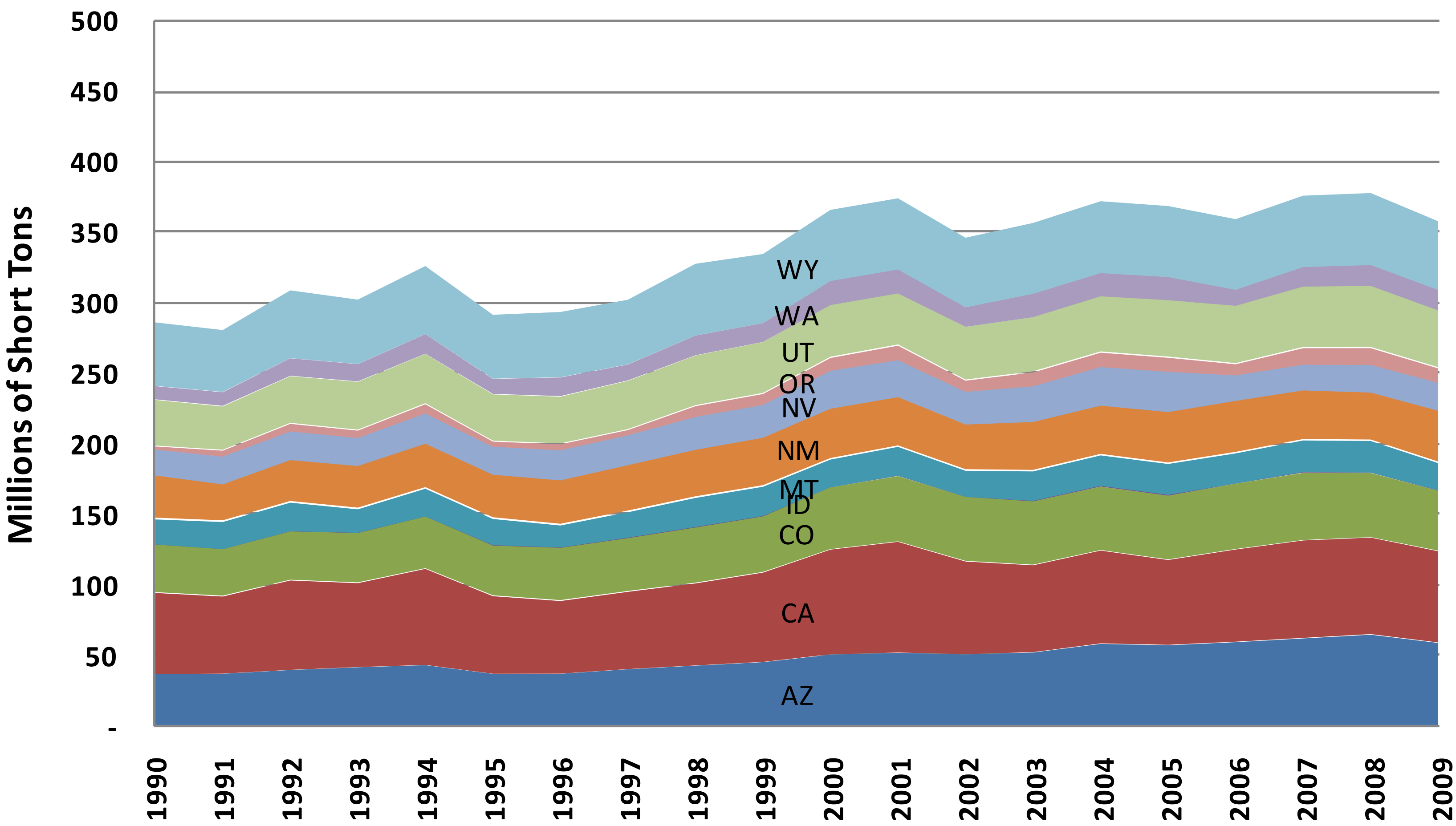


Location of New Renewable Resources

Western Interconnect



Generation Greenhouse (CO_2) Gas Emissions by State in the Western Interconnect



Source: EPA

Greenhouse Gas (CO_2) Reduction Schemes

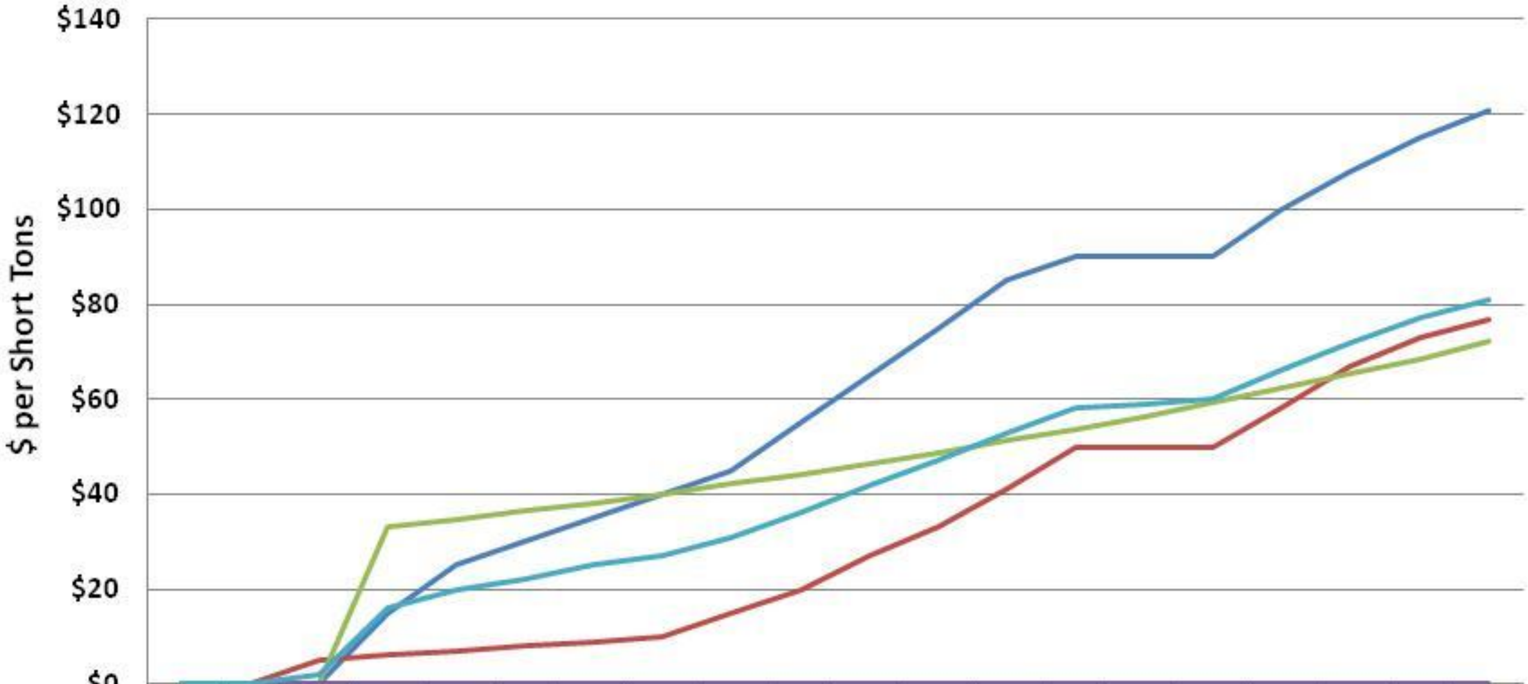
Stochastic Case

1. Regional Greenhouse Gas Policies (30% probability)
   - State carbon reduction in CA, OR, WA, NM between 2014 and 2019
   - ~10% reduction below 2005 levels by 2020
   - Beginning in 2020 shift to National Climate Policy with 15% below 2005 levels by 2030
2. National Climate Policy (30% probability)
   - Federal legislation only applies beginning in 2015
   - ~15% below 2005 levels by 2020, ~35% below 2005 levels by 2030
3. National Carbon Tax (30% probability)
   - Federal legislation only applies
   - $33 per short ton, than 5% per year escalation
   - Begins in 2015
4. No Carbon Reductions (10% probability)
   - No carbon reduction scheme
   - State level emission performance standards apply and no new coal in US West

Deterministic Case

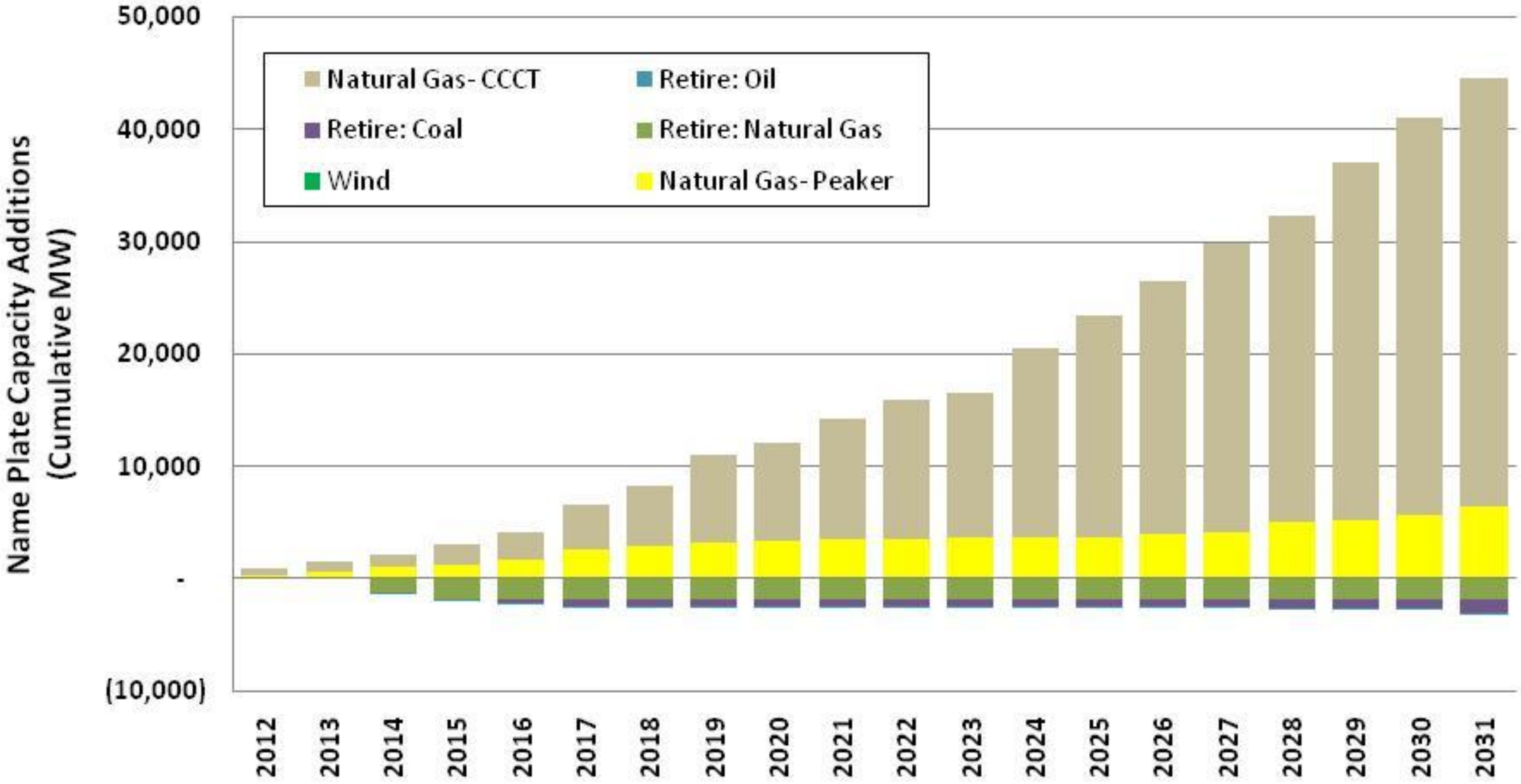
- Emissions reduced to the weighted average of four cases above

Resulting Greenhouse Gas (CO_2) Reduction Prices

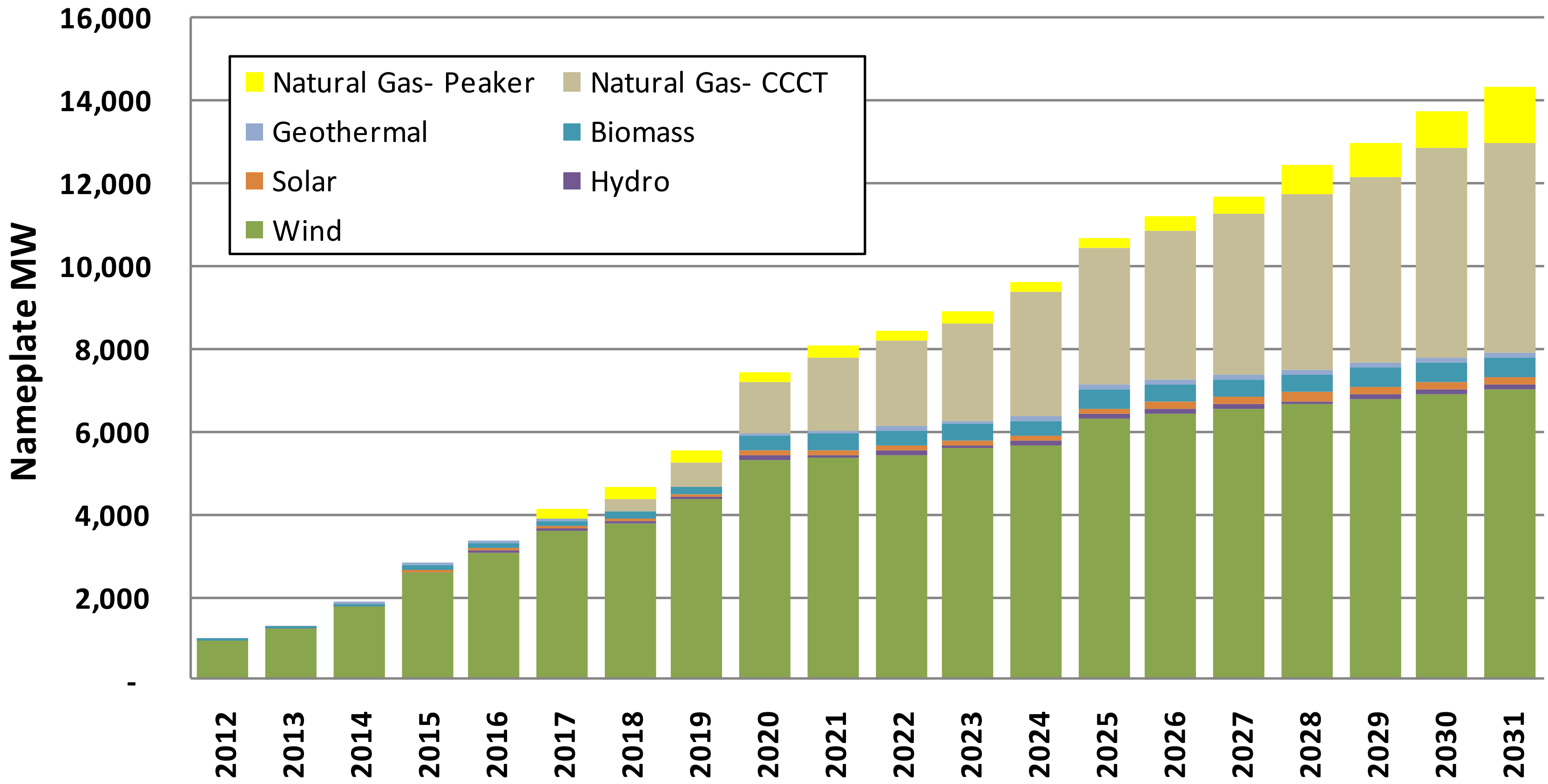


2015-2031 Levelized Price per Short Ton		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
$59.36	National Climate Policy	0	0	0	15	25	30	35	40	45	55	65	75	85	90	90	90	100	108	115	121
$28.02	Regional GHG Policies	0	0	5	6	7	8	9	10	15	20	27	33	41	50	50	50	58	67	73	77
$46.48	National Carbon Tax	0	0	0	33	35	36	38	40	42	44	46	49	51	54	56	59	62	65	69	72
$00.00	No GHG Reductions	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
$40.20	Expected Case	0	0	2	16	20	22	25	27	31	36	42	47	53	58	59	60	66	72	77	81

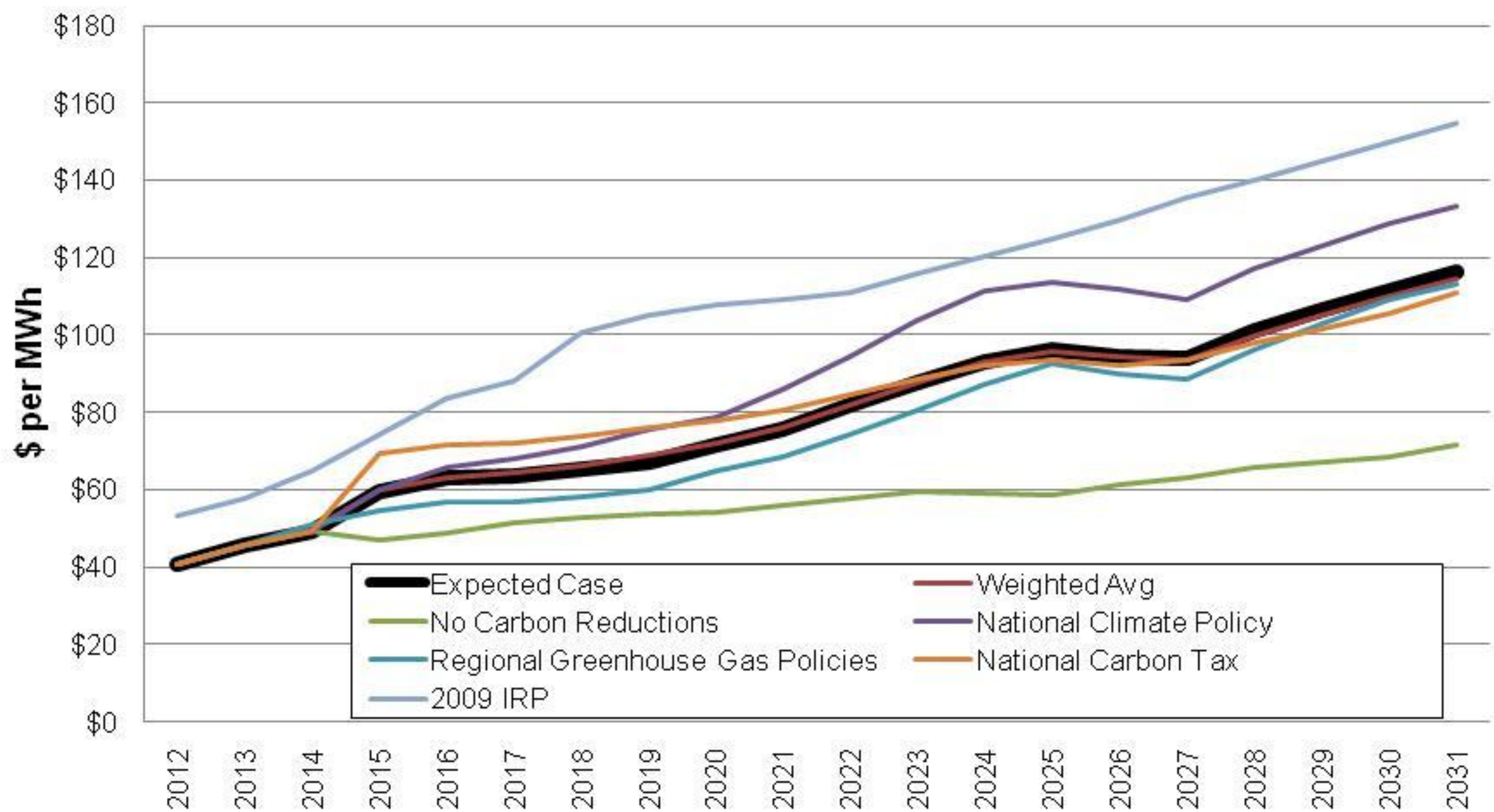
New Resource Selected to Meet Capacity Requirements in Western Interconnect



Northwest New Resources (RPS, Export, & Capacity)



Deterministic Mid-Columbia Annual Average Price Forecast



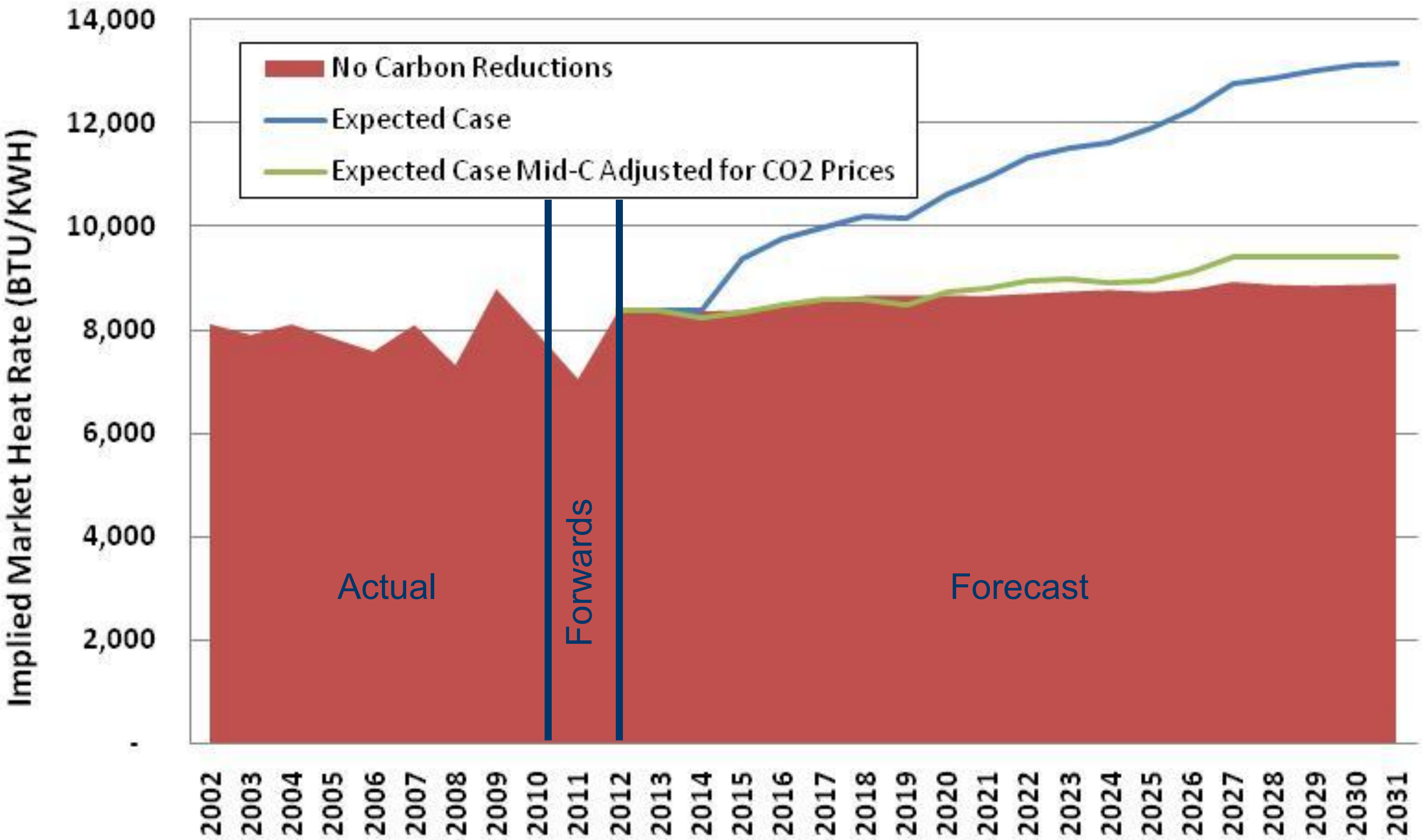
Deterministic Mid-C Annual Avg Price Forecast

Levelized Nominal Prices

Scheme	Levelized Price $/MWh 2012-31
2009 IRP Expected Case (Adjusted)	97.60
2011 IRP Expected Case	71.22
Scenarios	
Regional Greenhouse Gas Policies	66.91
National Climate Policy	78.94
National Carbon Tax	73.98
No Carbon Reductions	53.70
Weighted Average	71.32

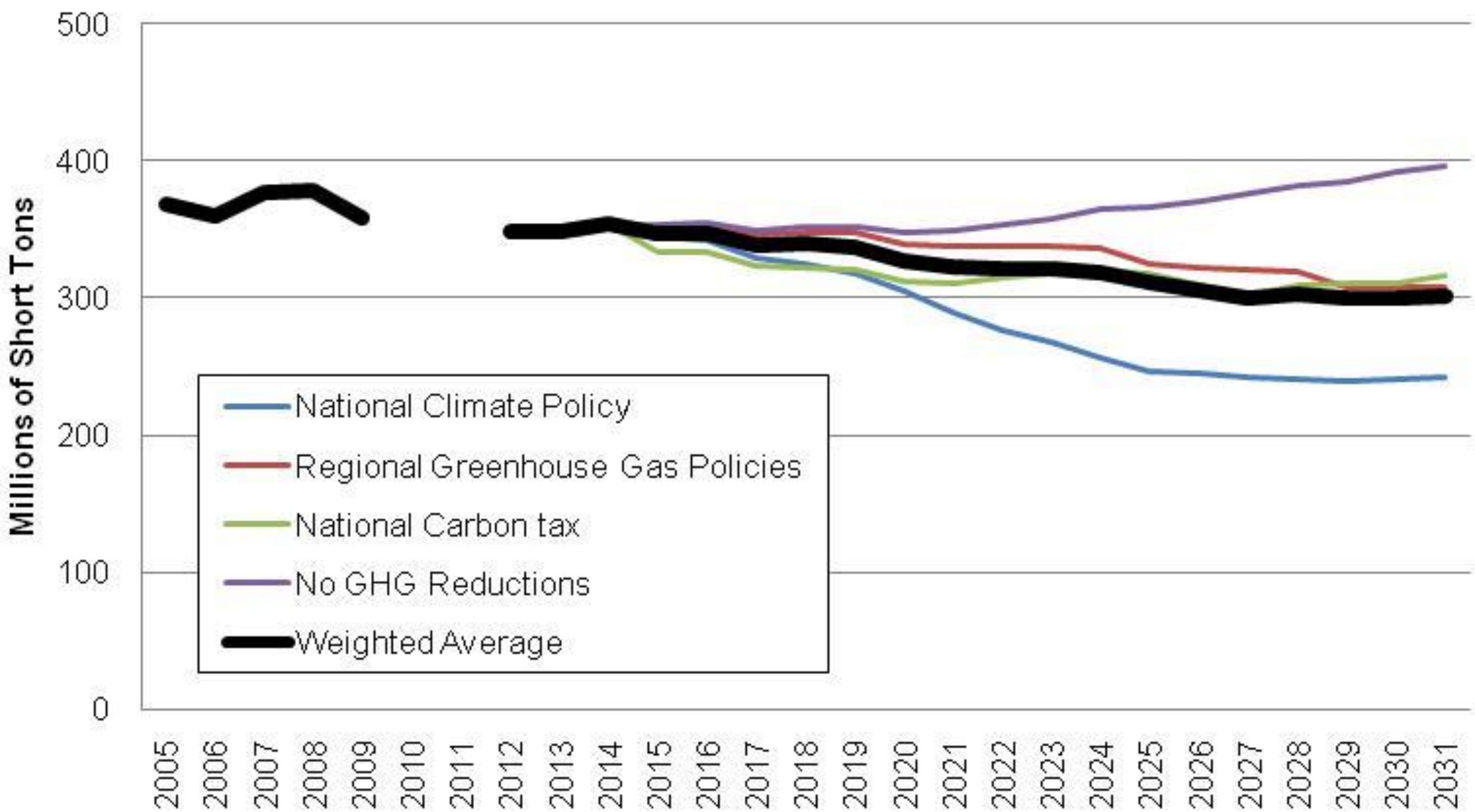
Deterministic Implied Market Heat Rates

(Mid-Columbia / Stanfield x 1,000)



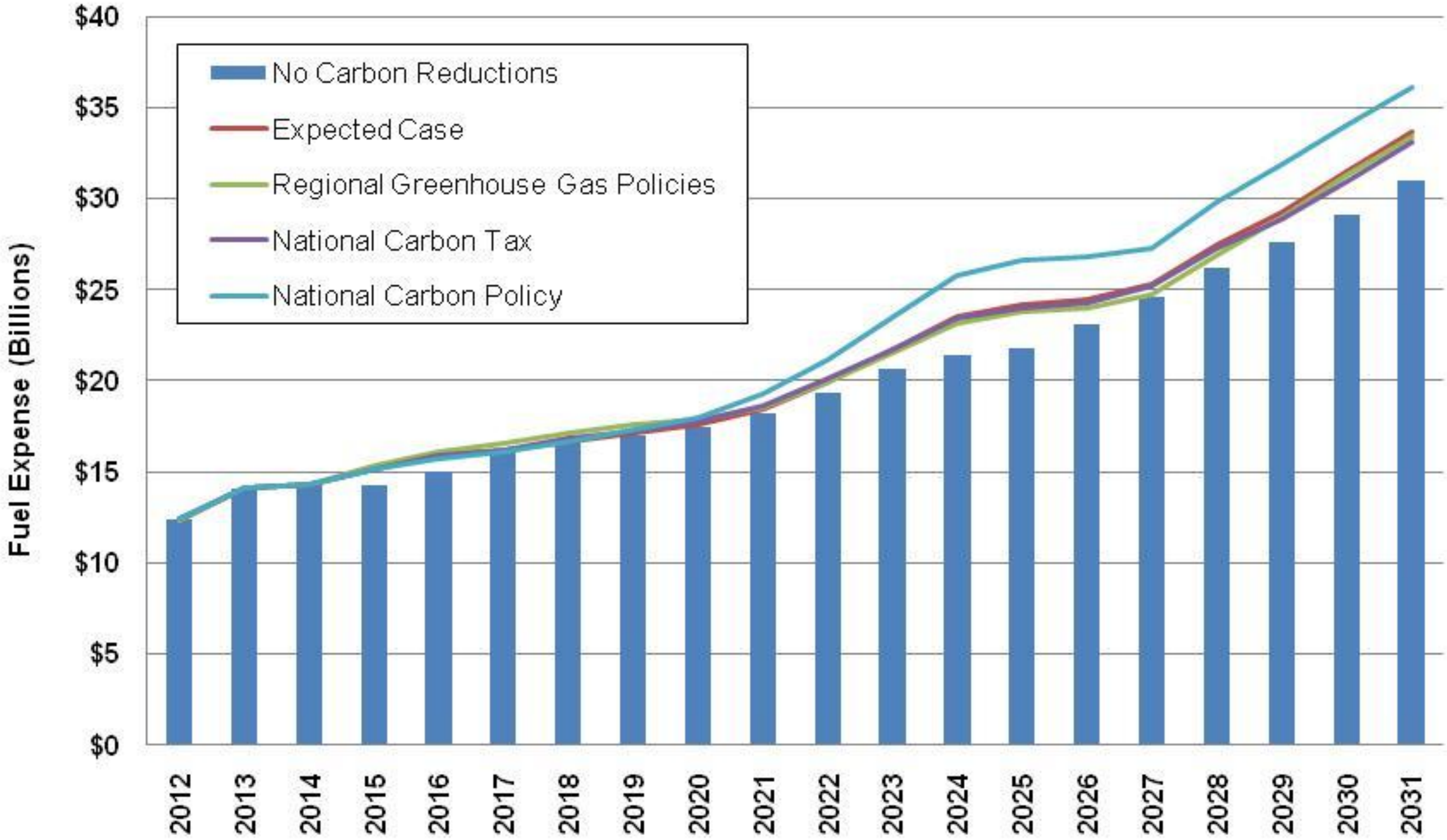
Deterministic Greenhouse Gas (CO_2) Levels

(US Western Interconnect)



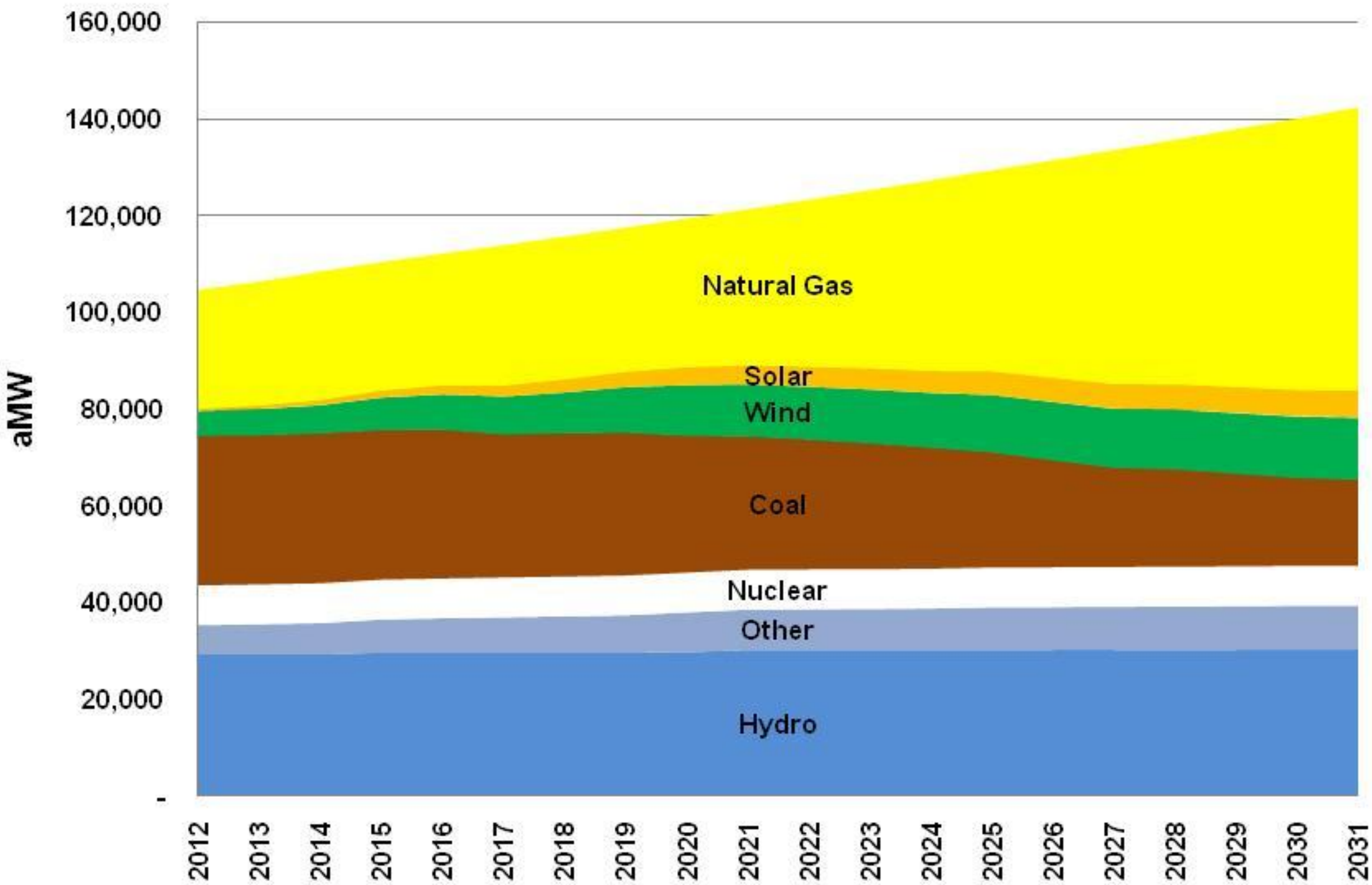
Total Generation Fuel Costs

US Western Interconnect



“Expected Case” Resource Energy Mix

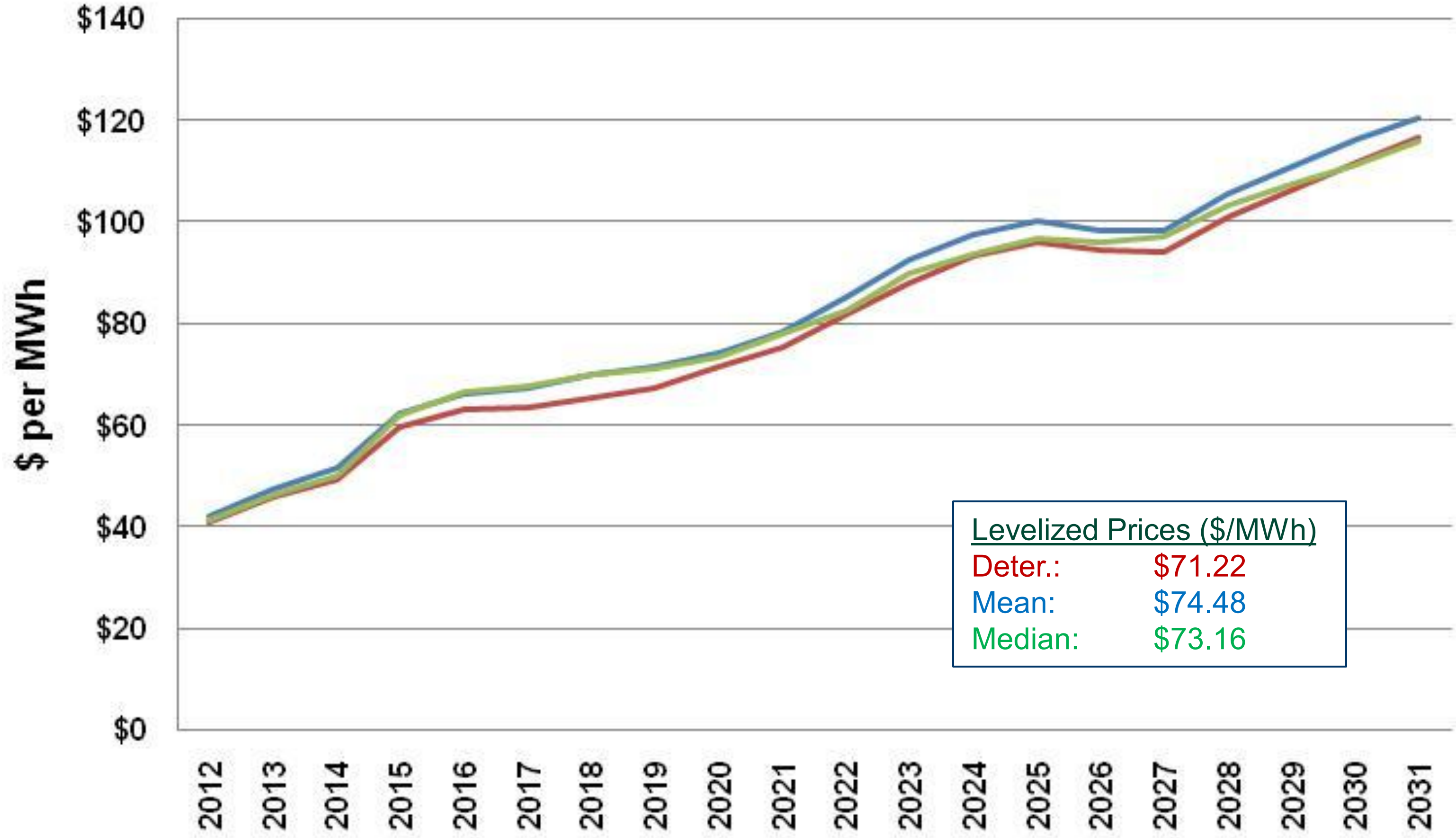
US Western Interconnect



Stochastic Modeling Changes From Last TAC Meeting

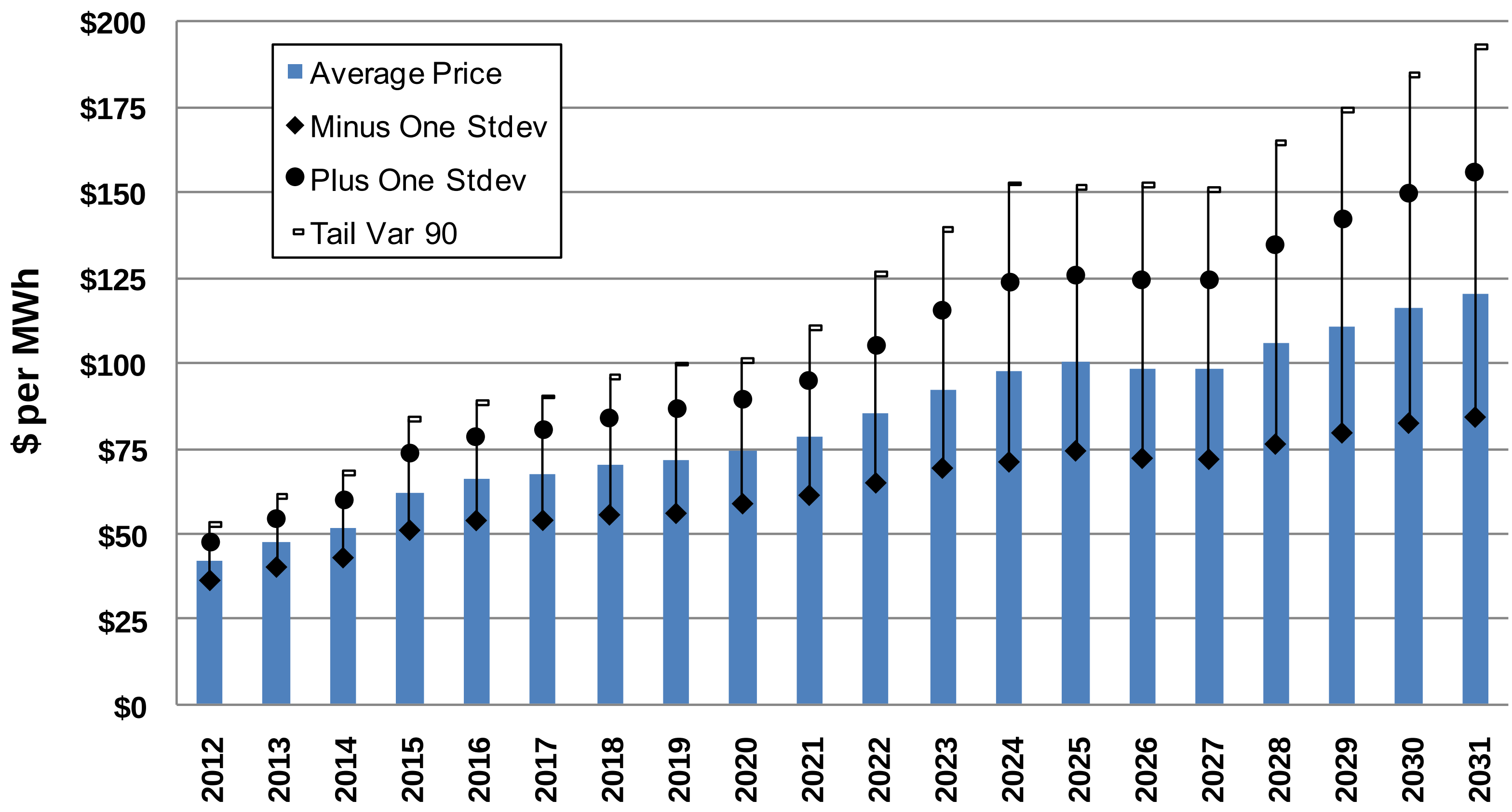
- Assumptions based on methodologies discussed in last TAC meeting, with some exceptions.
- Wind model randomly draws from 15 wind years for each study year, previous TAC discussed drawing from 50 wind years for the entire 20 years of each iteration.
- Oil and wood price escalation will use lognormal distributions.
- Natural gas price methodology is the same but will use historical month-to-month standard deviation.
- Adjustment developed for linking carbon prices to natural gas prices, no carbon reduction case will have ~10% reduction to natural gas prices

Stochastic Electric Market Prices Compared to Deterministic

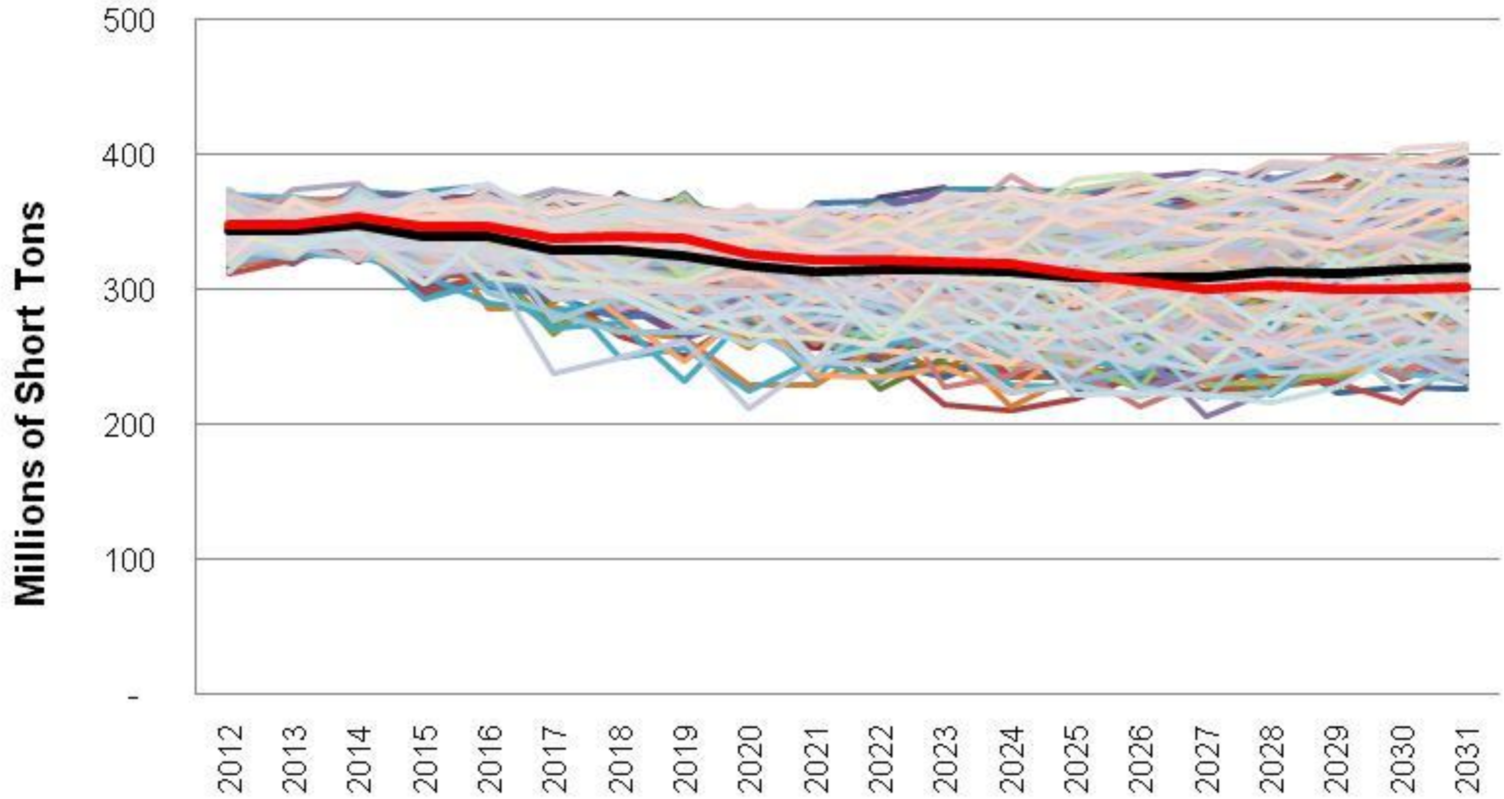


Range in Market Prices

Annual Flat Mid-Columbia

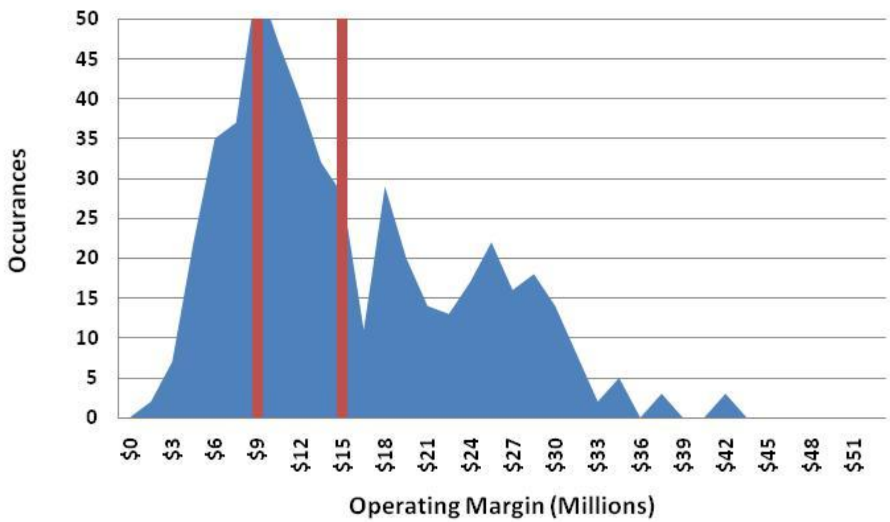


Range in US-Western Interconnect Carbon Emissions

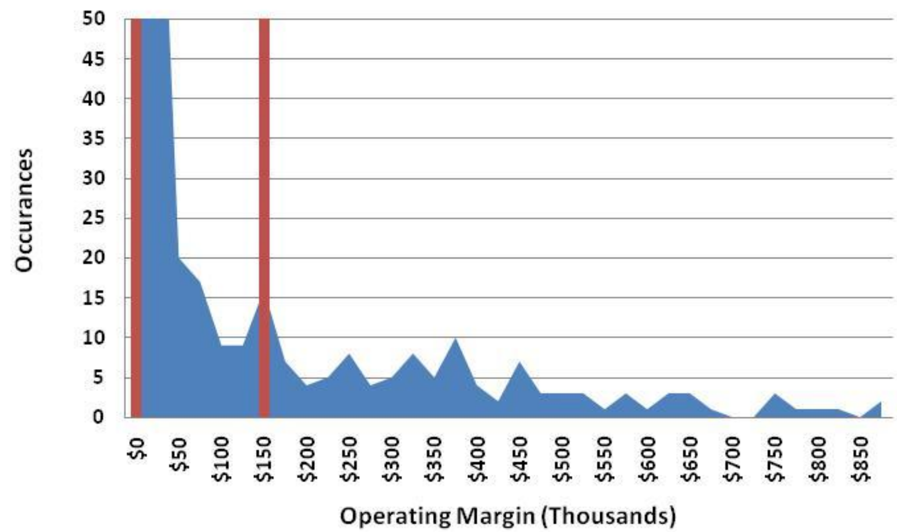


Resource Valuations Deterministic vs Stochastic Example

Combined Cycle 2012 Operating Margin



Simple Cycle 2012 Operating Margin



Next Steps

1. Finalize "Expected Case" study
2. Portfolio Analysis
   - Preferred Resource Strategy
   - Efficient Frontier
   - Resource cost/availability sensitivities
3. Deterministic Market Scenario Studies
   - Resource portfolio scenario analysis
4. Stochastic Market Scenario Studies
   - Alternative "risk" markets; i.e. no carbon case, gas volatility
   - Alternative Efficient Frontier results

Resource Requirement Projections

Clint Kalich

Technical Advisory Committee Meeting #4

2011 Electric Integrated Resource Plan

February 3, 2011

Agenda

- Reliability Modeling Update
- Avista Reliance on Wholesale Marketplace
- Shift from 1-Hour to 18-Hour Peaking Period
- Regional Capacity Position
- Avista Reliance on Wholesale Marketplace
- Avista Resource Positions
- Conclusions

Reliability Modeling Update

- Completed Advanced Model Late 2010
  - Sophisticated hydro logic
  - Weather-dependent thermal logic
  - Robust representation of hourly loads
  - Time-series representation of data
- Numerous Runs of Reliability Model
- Results Indicate Key Assumption is Market Availability
  - More important than hydro, load, thermal resources
- Yet Don’t Really Know What The Broader Market Looks Like
- Negates Most Benefits (at least for IRP) of Reliability Model
- Therefore a Simpler Approach Was Followed

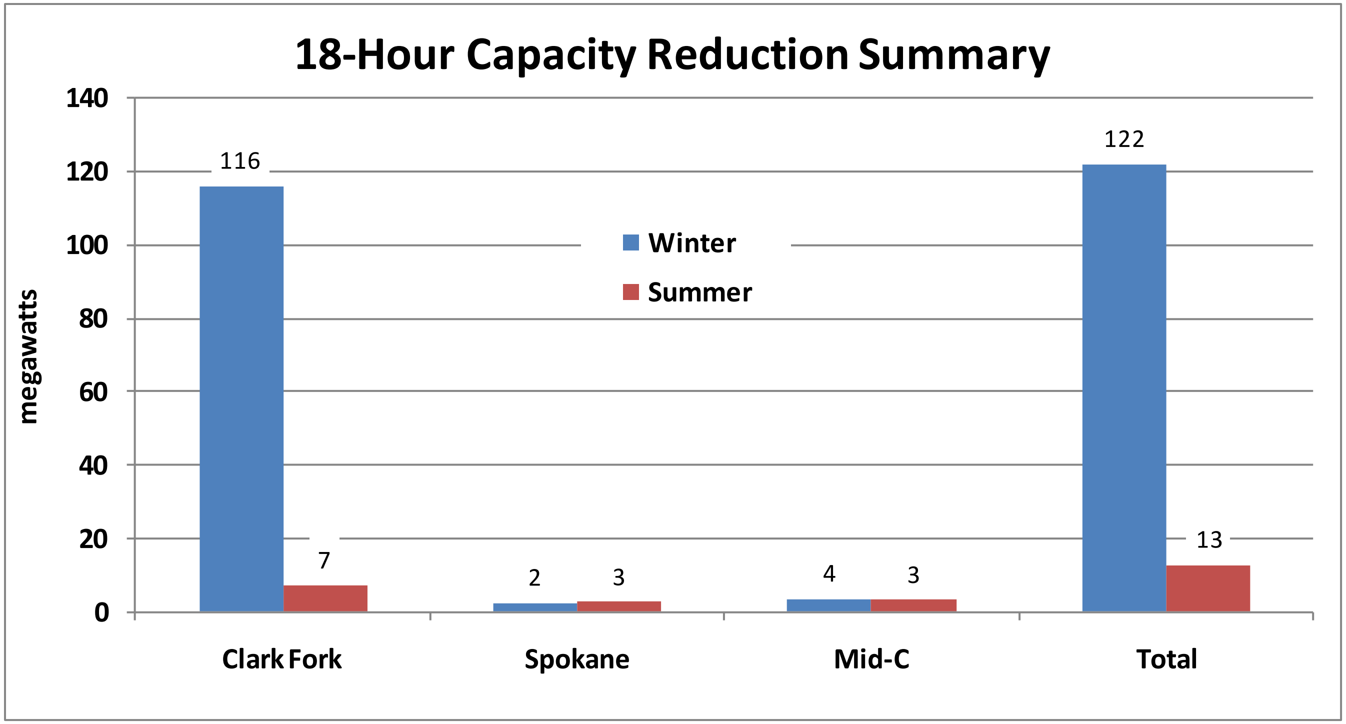
One-Hour vs. 18-Hour Sustained Peak

- Historically Region (and Avista) Has Planned on One-Hour Peak Demand Scenarios
- Similar to Other Regions in WECC & NERC
- Works Great for Thermal Systems Without Fuel Limits
- Doesn’t Work As Well for Hydro Systems with a Limited Fuel Source
- Region Has Shifted from a One-Hour Peak to a 3-Day, 6 Hours Per Day Sustained Demand Event
- AKA 18-Hour Sustained Peak Event

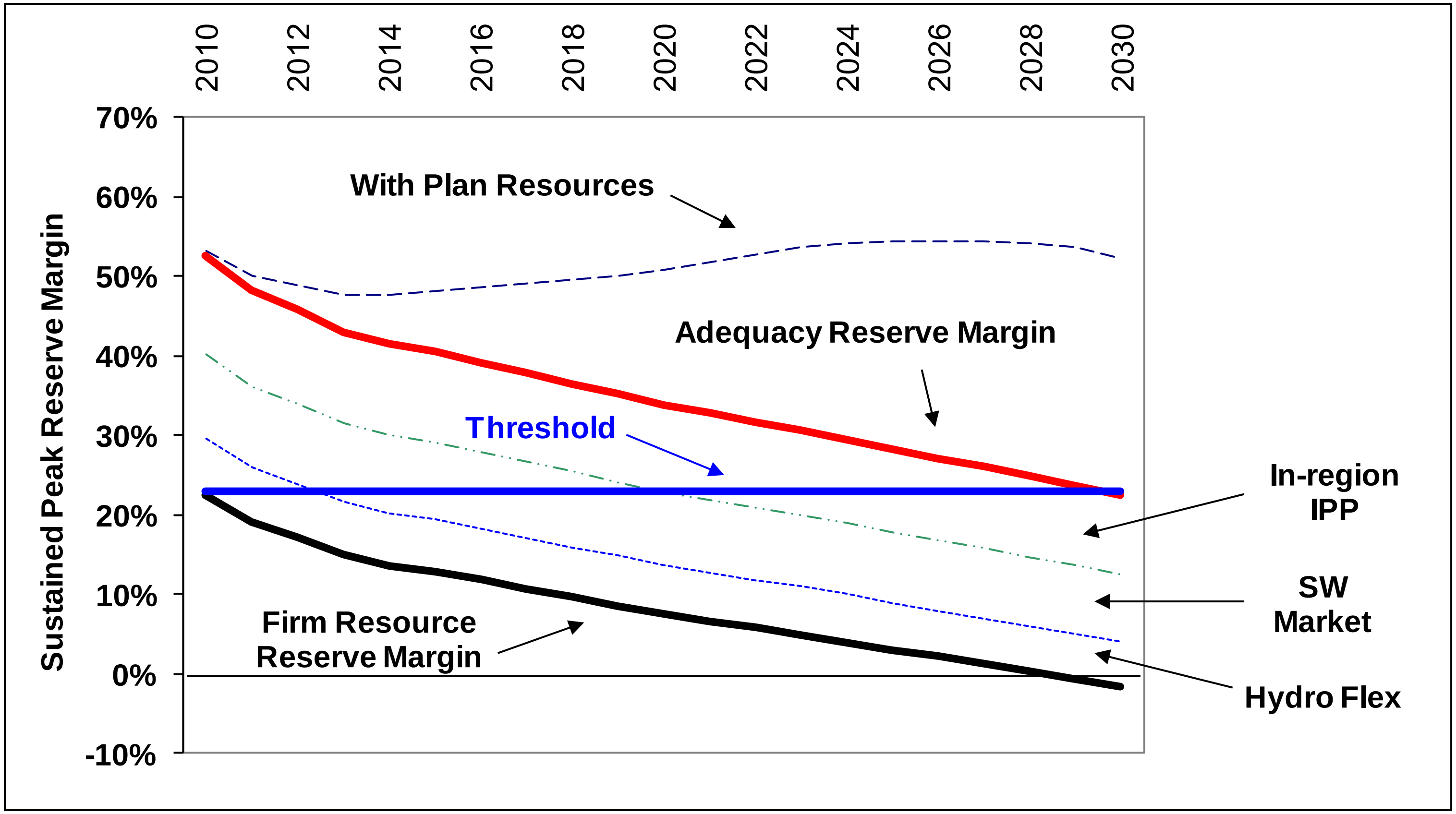
One-Hour vs. 18-Hour Sustained Peak

- Affects (Lowers) Hydro Resource and Load Capabilities
- No Assumed Impact on Thermal Operations
    - Except output is affected by assumed peak condition ambient temperatures
- Avista’s Method Relies Substantially on Northwest Power and Conservation Council’s (“NWPP”) Work
    - 24% Winter and 23% Summer Planning Margin
    - Compares to 15% assumption in 2009 IRP
    - Essentially the same as 2009 IRP assumption but operating reserves are added

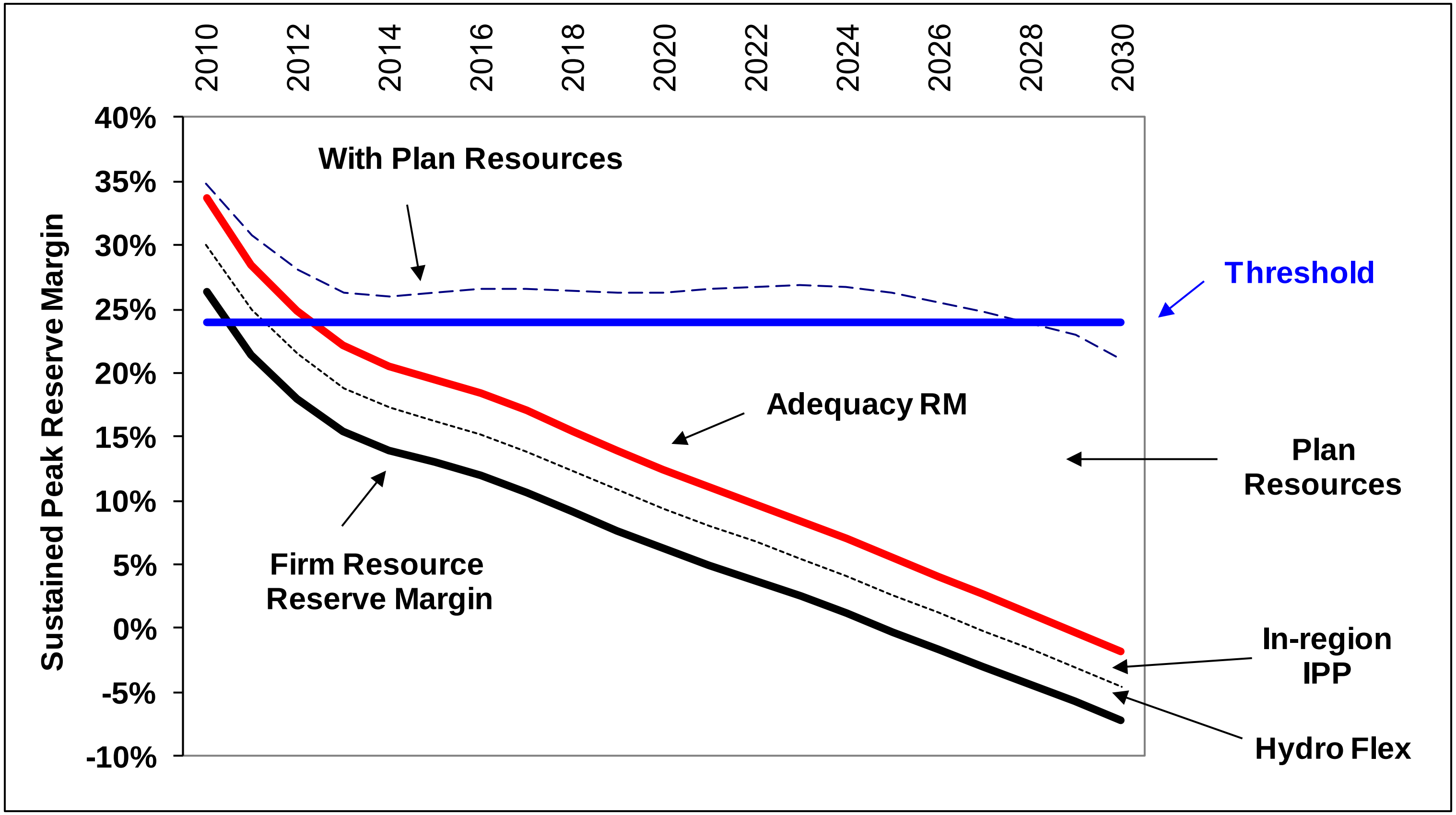
Hydro 18-Hour Sustained Capacity Impacts Avista's System



Regional Capacity Position
NPCC Winter Assessment



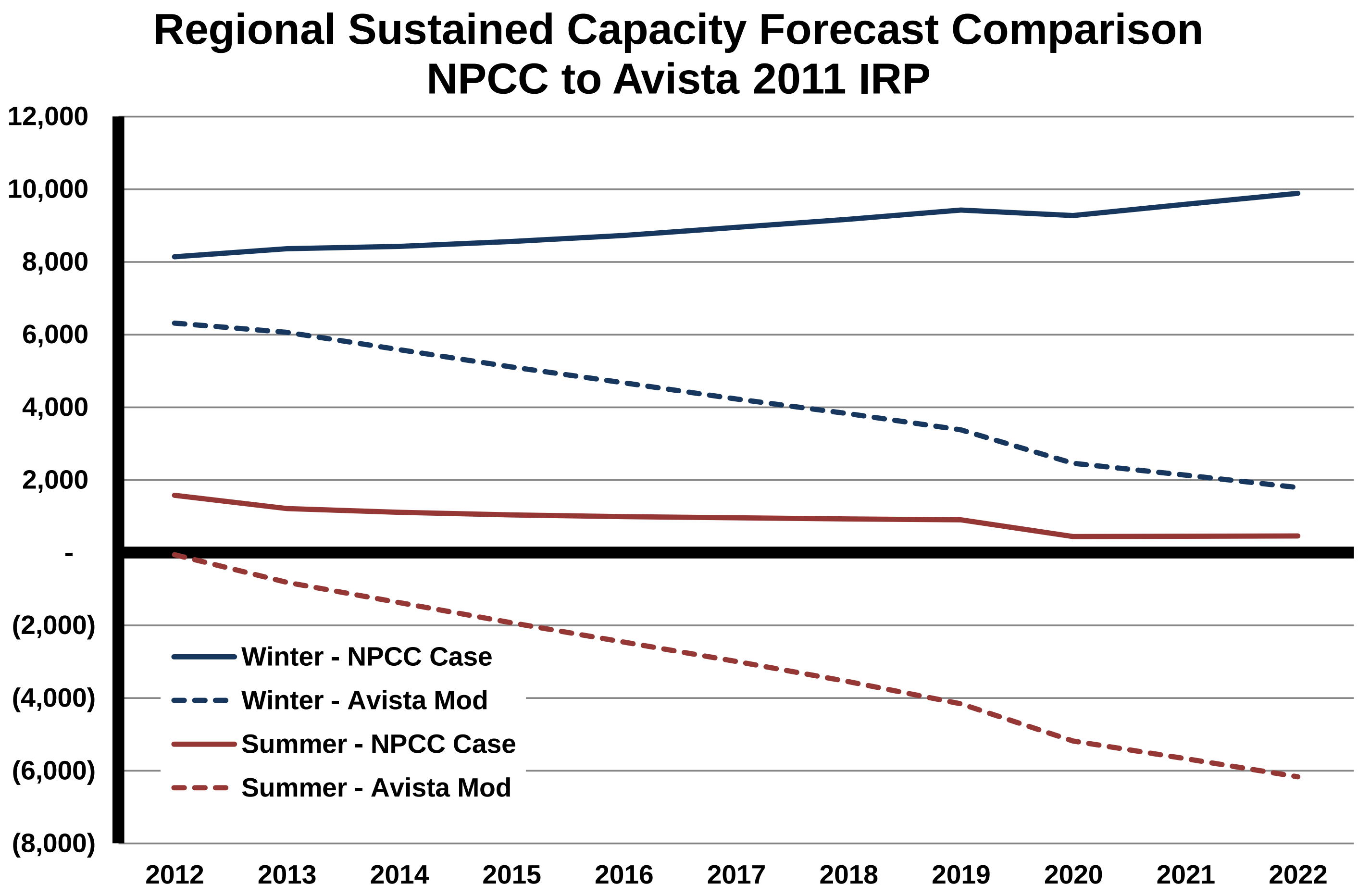
Regional Capacity Position
NPCC Summer Assessment



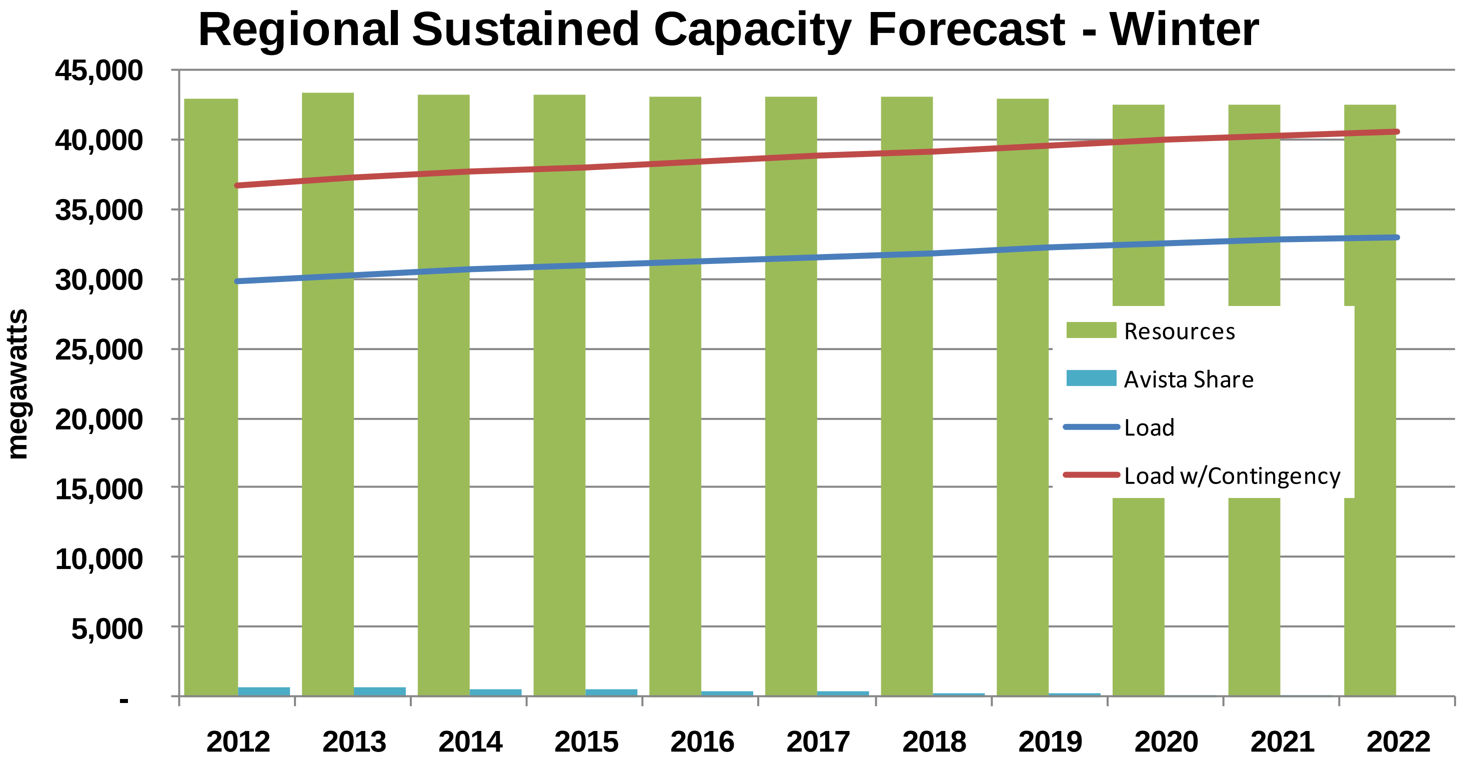
Avista Reliance On Wholesale Market

- Avista Relies on a “Modified” NWPP Load and Resource Balance
  - Ignore aggressive conservation assumption
    - use Wood-Mac forecast of 0.9% regional load growth
  - No capacity contribution for wind (-250 MW)
  - 10% wind capacity reserves (-500 MW)
    - Do not plan to interrupt wind at peak
- 5.5% of Regional Surplus is Available to Avista
  - Phased out over 10 years
    - 10% reduction per year

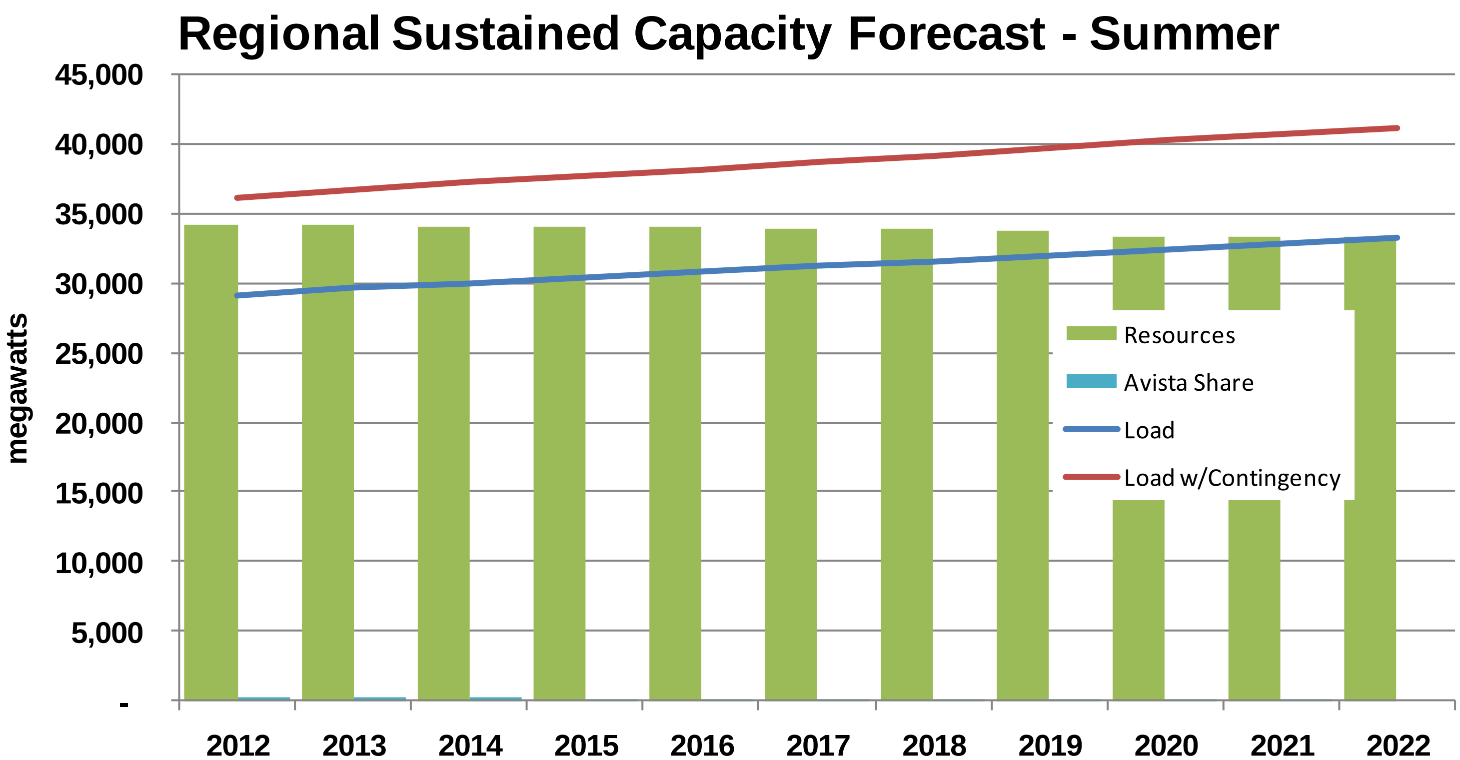
Regional Capacity Position Comparison



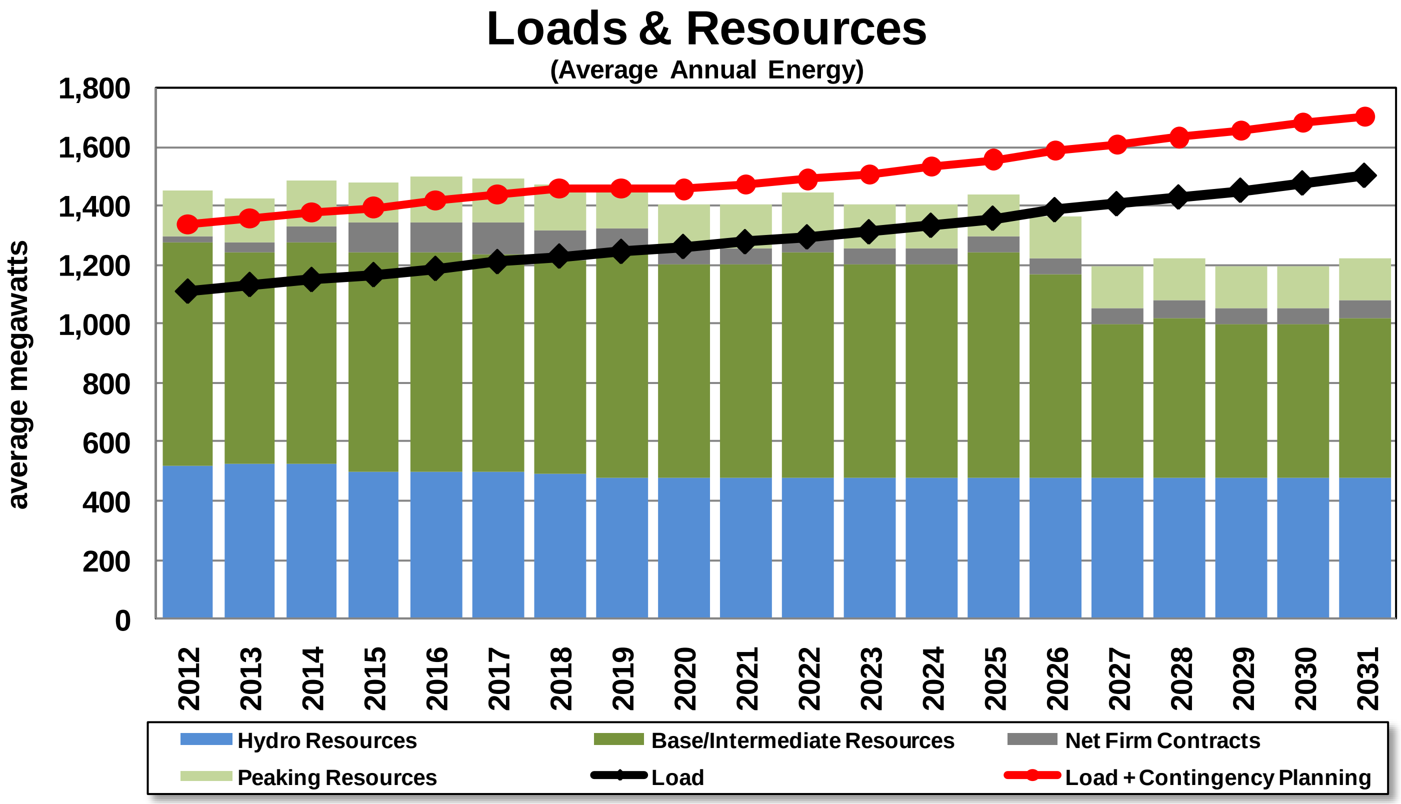
Regional Capacity Position
Winter



Regional Sustained Capacity Position Summer



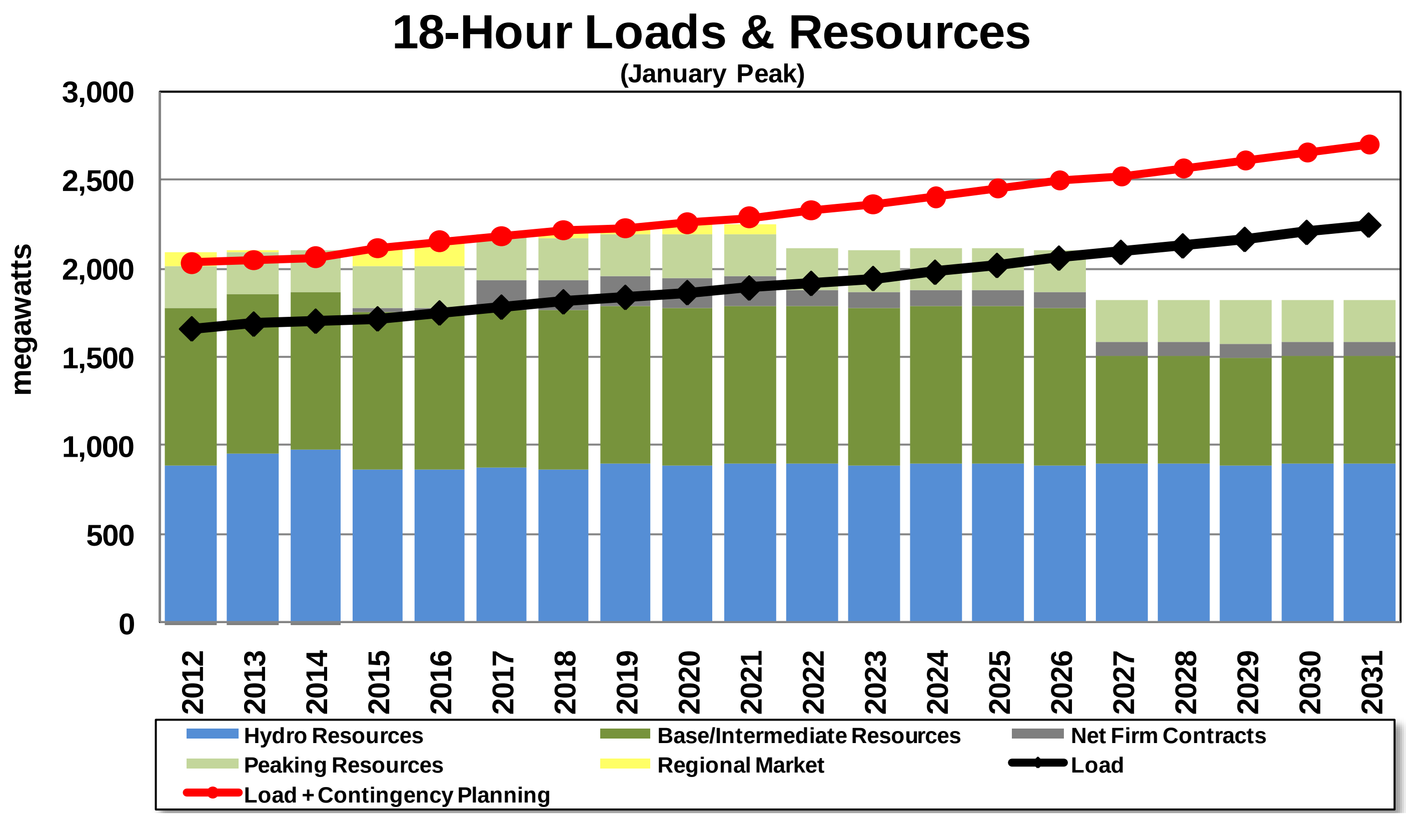
Avista Energy Position



Avista Energy Position

		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
	REQUIREMENTS																				
1	Native Load	-1,109	-1,131	-1,148	-1,165	-1,186	-1,209	-1,228	-1,244	-1,260	-1,277	-1,293	-1,310	-1,333	-1,357	-1,386	-1,406	-1,429	-1,452	-1,477	-1,502
2	Firm Power Sales	-138	-124	-107	-57	-57	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5
3	**Total Requirements**	**-1,247**	**-1,256**	**-1,255**	**-1,222**	**-1,243**	**-1,214**	**-1,233**	**-1,249**	**-1,266**	**-1,282**	**-1,298**	**-1,316**	**-1,338**	**-1,362**	**-1,391**	**-1,411**	**-1,434**	**-1,457**	**-1,482**	**-1,508**
	RESOURCES																				
4	Firm Power Purchases	160	160	160	160	160	109	108	88	62	62	61	61	61	61	61	61	61	61	61	61
5	Hydro	519	525	528	496	496	496	492	481	481	481	481	481	481	481	481	481	481	481	481	481
6	Baseload/Intermediate Resources	755	714	751	744	746	741	724	758	721	721	758	721	721	758	684	515	541	515	515	541
7	Wind Resources	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	**Total Resources**	**1,435**	**1,399**	**1,439**	**1,401**	**1,402**	**1,346**	**1,324**	**1,327**	**1,264**	**1,264**	**1,301**	**1,263**	**1,263**	**1,300**	**1,226**	**1,057**	**1,083**	**1,057**	**1,057**	**1,083**
9	**POSITION**	**188**	**144**	**184**	**179**	**159**	**131**	**91**	**78**	**-2**	**-18**	**2**	**-53**	**-75**	**-62**	**-165**	**-354**	**-351**	**-400**	**-425**	**-425**
	CONTINGENCY PLANNING																				
10	Peaking Resources	153	153	153	138	153	154	153	147	146	145	147	146	145	147	146	145	147	146	145	147
11	Contingency	-227	-228	-228	-229	-230	-231	-232	-214	-195	-196	-197	-198	-199	-200	-201	-202	-203	-203	-204	-199
12	**CONTINGENCY NET POSITION**	**113**	**69**	**109**	**88**	**82**	**54**	**12**	**11**	**-51**	**-69**	**-48**	**-105**	**-128**	**-115**	**-221**	**-411**	**-407**	**-458**	**-484**	**-476**
	Energy Margin	**15%**	**11%**	**15%**	**15%**	**13%**	**11%**	**7%**	**6%**	**0%**	**-1%**	**0%**	**-4%**	**-6%**	**-5%**	**-12%**	**-25%**	**-24%**	**-27%**	**-29%**	**-28%**

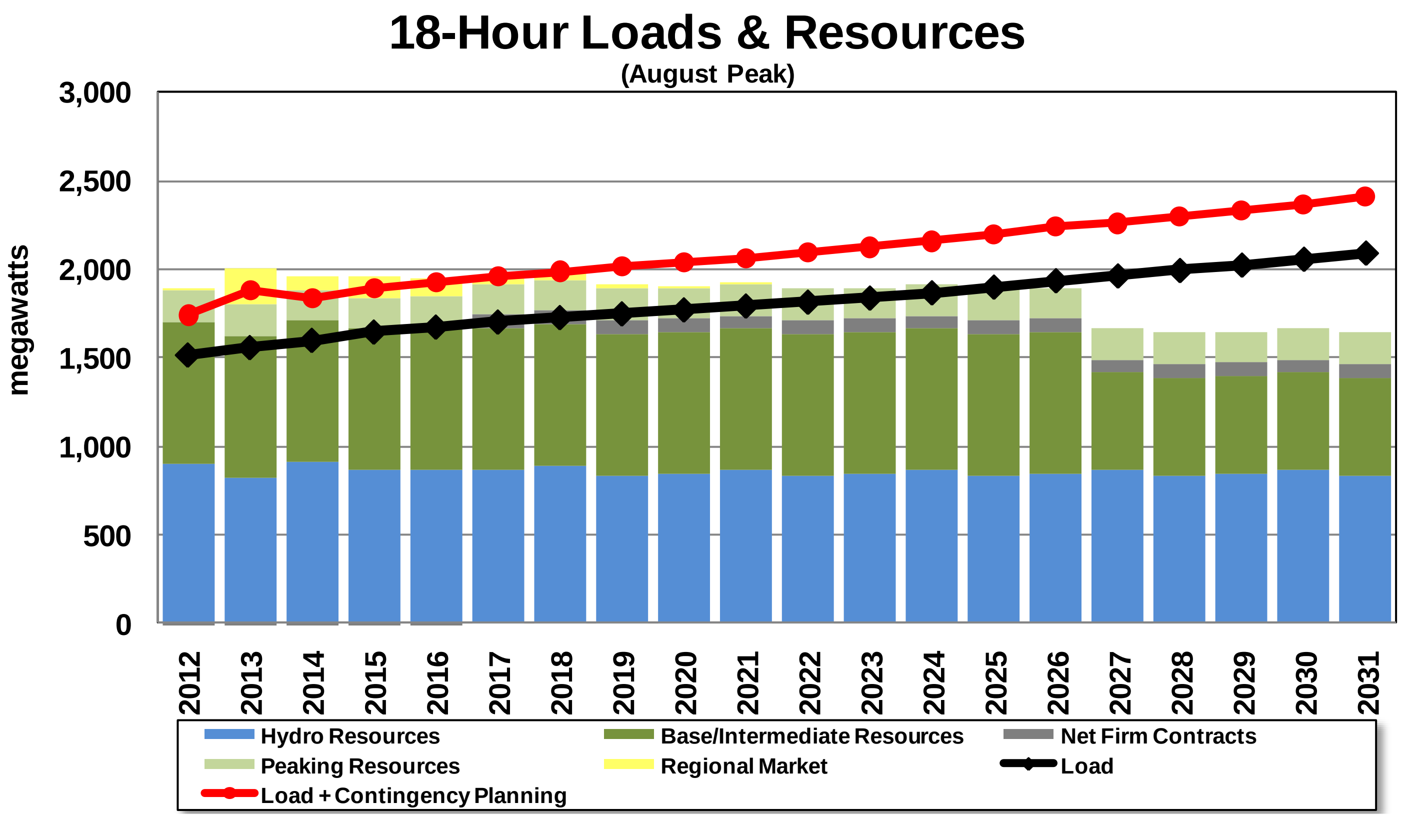
Avista Winter Capacity Positions



Avista Winter Capacity Positions

		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
	REQUIREMENTS																				
1	Native Load	-1,661	-1,688	-1,704	-1,718	-1,751	-1,784	-1,814	-1,839	-1,866	-1,892	-1,919	-1,946	-1,982	-2,020	-2,062	-2,094	-2,131	-2,168	-2,208	-2,249
2	Firm Power Sales	-238	-237	-207	-157	-157	-7	-7	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6
3	**Total Requirements**	**-1,899**	**-1,925**	**-1,911**	**-1,874**	**-1,908**	**-1,790**	**-1,821**	**-1,846**	**-1,873**	**-1,899**	**-1,925**	**-1,953**	**-1,988**	**-2,027**	**-2,068**	**-2,101**	**-2,138**	**-2,174**	**-2,214**	**-2,256**
	RESOURCES																				
4	Firm Power Purchases	175	175	175	175	175	175	175	173	173	173	90	90	90	90	90	90	90	90	90	90
5	Hydro Resources	882	957	973	861	861	872	868	896	887	896	896	887	896	896	887	896	896	887	896	896
6	Base Load Thermals	895	895	895	895	895	895	895	895	895	895	895	895	895	895	895	606	606	606	606	606
7	Wind Resources	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Peaking Units	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242	242
9	**Total Resources**	**2,194**	**2,269**	**2,285**	**2,173**	**2,173**	**2,185**	**2,180**	**2,206**	**2,197**	**2,206**	**2,124**	**2,114**	**2,123**	**2,123**	**2,114**	**1,833**	**1,833**	**1,825**	**1,833**	**1,833**
10	**PEAK POSITION**	**295**	**344**	**374**	**299**	**266**	**394**	**360**	**360**	**325**	**307**	**199**	**162**	**135**	**96**	**46**	**-267**	**-304**	**-350**	**-381**	**-422**
	RESERVE PLANNING																				
11	Required Operating Reserves	-162	-164	-163	-162	-165	-158	-160	-163	-164	-167	-173	-176	-179	-182	-186	-170	-171	-171	-172	-173
12	Available Operating Reserves	23	42	42	8	8	8	8	34	34	34	34	34	34	34	34	34	34	34	34	34
13	Planning Margin	-233	-236	-239	-240	-245	-250	-254	-258	-261	-265	-269	-272	-277	-283	-289	-293	-298	-304	-309	-315
14	**Total Reserve Planning**	**-372**	**-358**	**-360**	**-394**	**-402**	**-399**	**-406**	**-387**	**-391**	**-398**	**-408**	**-414**	**-422**	**-431**	**-441**	**-429**	**-435**	**-441**	**-447**	**-454**
15	**Peak Position**	**-76**	**-14**	**14**	**-95**	**-136**	**-5**	**-46**	**-26**	**-67**	**-91**	**-209**	**-253**	**-288**	**-335**	**-395**	**-697**	**-739**	**-790**	**-828**	**-876**
16	**Planning Margin**	**16%**	**18%**	**20%**	**16%**	**14%**	**22%**	**20%**	**20%**	**17%**	**16%**	**10%**	**8%**	**7%**	**5%**	**2%**	**-13%**	**-14%**	**-16%**	**-17%**	**-19%**
17	**Avista Share of Excess NW Capacity**	737	656	565	477	400	326	255	186	115	56	0	0	0	0	0	0	0	0	0	0
18	**Peak Position Net Market**	**661**	**642**	**579**	**382**	**264**	**321**	**209**	**159**	**48**	**(35)**	**(209)**	**(253)**	**(288)**	**(335)**	**(395)**	**(697)**	**(739)**	**(790)**	**(828)**	**(876)**

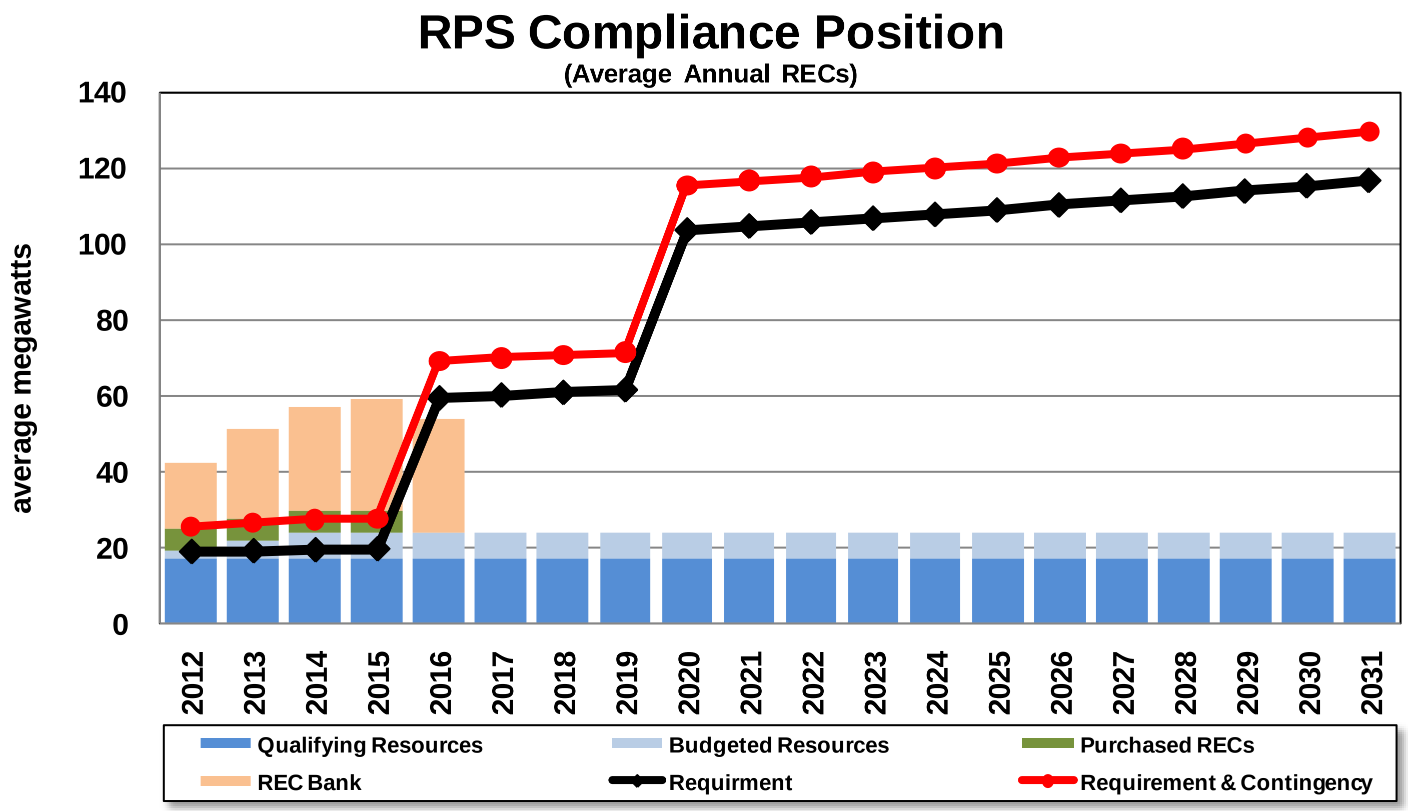
Avista Summer Capacity Positions



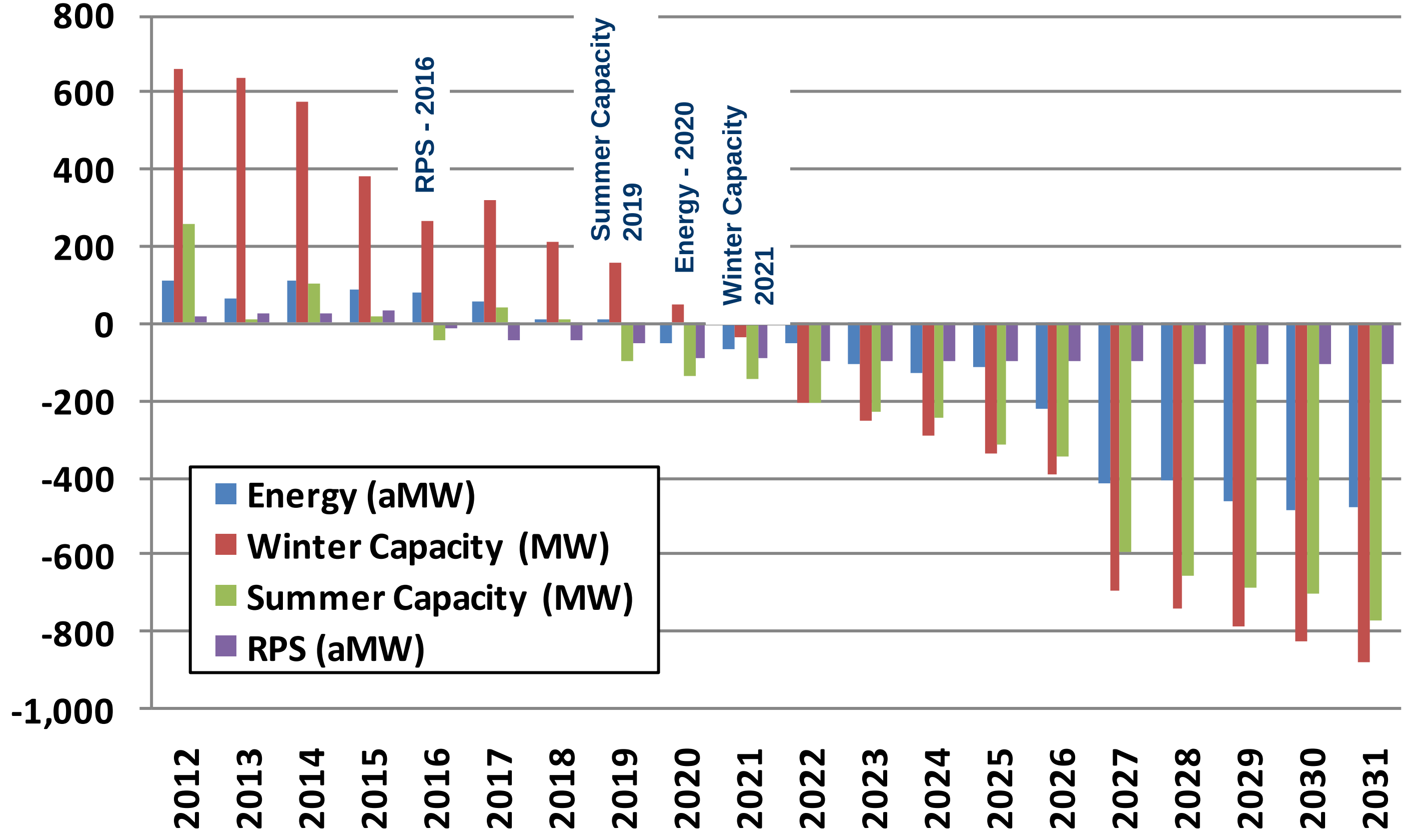
Avista Summer Capacity Positions

		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
	REQUIREMENTS																				
1	Native Load	-1,514	-1,556	-1,597	-1,644	-1,673	-1,701	-1,727	-1,748	-1,771	-1,793	-1,815	-1,838	-1,868	-1,900	-1,937	-1,964	-1,995	-2,026	-2,059	-2,094
2	Contracts Obligations	-239	-214	-208	-158	-158	-8	-8	-8	-8	-8	-8	-8	-8	-8	-8	-8	-8	-8	-8	-8
3	**Total Requirements**	**-1,753**	**-1,770**	**-1,805**	**-1,802**	**-1,831**	**-1,709**	**-1,735**	**-1,756**	**-1,778**	**-1,800**	**-1,822**	**-1,846**	**-1,876**	**-1,908**	**-1,944**	**-1,972**	**-2,002**	**-2,033**	**-2,067**	**-2,102**
	RESOURCES																				
4	Contracts Rights	86	86	86	86	86	86	86	82	82	82	82	82	82	82	82	82	82	82	82	82
5	Hydro Resources	904	823	907	864	871	866	887	837	845	864	837	845	864	837	845	864	837	845	864	837
6	Base Load Thermals	799	799	799	799	799	799	799	799	799	799	799	799	799	799	799	551	551	551	551	551
7	Wind Resources	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Peaking Units	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176	176
9	**Total Resources**	**1,964**	**1,884**	**1,968**	**1,925**	**1,932**	**1,927**	**1,948**	**1,895**	**1,903**	**1,922**	**1,895**	**1,902**	**1,921**	**1,894**	**1,902**	**1,673**	**1,646**	**1,653**	**1,673**	**1,646**
10	**PEAK POSITION**	**212**	**114**	**163**	**123**	**101**	**218**	**213**	**139**	**124**	**121**	**72**	**56**	**46**	**-14**	**-42**	**-299**	**-357**	**-380**	**-394**	**-456**
	RESERVE PLANNING																				
11	Required Operating Reserves	-153	-156	-159	-160	-162	-155	-157	-160	-161	-163	-165	-167	-169	-172	-173	-157	-156	-157	-159	-158
12	Available Operating Reserves	155	66	171	159	159	159	161	158	158	161	158	158	161	158	158	161	158	158	161	158
13	Planning Margin	-227	-233	-240	-247	-251	-255	-259	-262	-266	-269	-272	-276	-280	-285	-290	-295	-299	-304	-309	-314
14	**Total Reserve Planning**	**-227**	**-324**	**-240**	**-248**	**-255**	**-255**	**-259**	**-264**	**-269**	**-271**	**-279**	**-285**	**-289**	**-298**	**-305**	**-295**	**-299**	**-304**	**-309**	**-314**
15	**Peak Position**	**-16**	**-211**	**-77**	**-125**	**-154**	**-38**	**-46**	**-125**	**-144**	**-150**	**-207**	**-228**	**-244**	**-312**	**-348**	**-593**	**-656**	**-684**	**-703**	**-770**
16	**Planning Margin**	**12%**	**6%**	**9%**	**7%**	**6%**	**13%**	**12%**	**8%**	**7%**	**7%**	**4%**	**3%**	**2%**	**-1%**	**-2%**	**-15%**	**-18%**	**-19%**	**-19%**	**-22%**
17	**Avista Share of Excess NW Capacity**	275	221	178	141	107	78	52	31	10	3	0	0	0	0	0	0	0	0	0	0
18	**Peak Position Net Market**	**259**	**10**	**102**	**16**	**(47)**	**40**	**6**	**(94)**	**(134)**	**(147)**	**(207)**	**(228)**	**(244)**	**(312)**	**(348)**	**(593)**	**(656)**	**(684)**	**(703)**	**(770)**

Avista I-937 (Renewable Energy) Position



Deficits Summary



Avista 2011 IRP Positions Summary

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Energy (aMW)	113	69	109	88	82	54	12	11	(51)	(69)
Winter Capacity (MW)	661	642	579	382	264	321	209	159	48	(35)
Summer Capacity (MW)	259	10	102	16	(47)	40	6	(94)	(134)	(147)
RPS (aMW)	17	25	30	32	(16)	(46)	(47)	(47)	(92)	(93)

Impact of Resource Positions

- Positions Determine Future Resource Needs
  - Targets are 2016 RECs and 2019 summer capacity
- PRiSM Model Selects Resources Necessary to Fill Gaps That Meet Various Criteria
- Each New Resource Option Has Unique Capacity and Energy Characteristics
  - e.g., wind “consumes” 10% of nameplate
  - Gas-fired plants generate monthly based on ambient temperatures during peak weather events
- High and Low Cases Indicate Impacts of Varying Load Conditions

Portfolio and Market Scenario Planning

John Lyons

Technical Advisory Committee Meeting #4

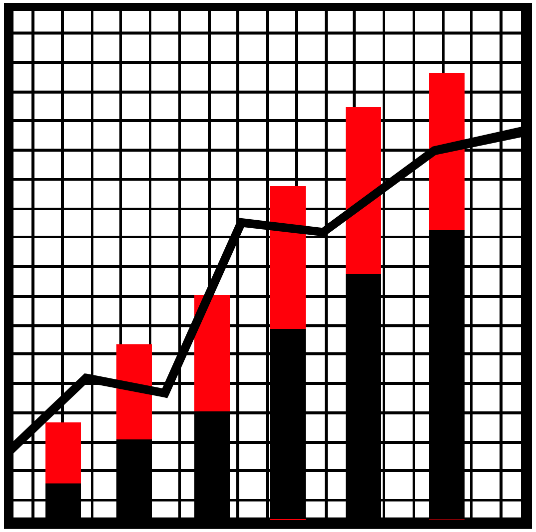
2011 Electric Integrated Resource Plan

February 3, 2011

Use of Scenarios in the IRP

Scenarios provide details about the impacts of different planning assumptions

- Avista’s current load and resource portfolio
- Preferred Resource Strategy
- Wholesale electric market
- Different resource options



Scenario Types for the 2011 IRP

1. Deterministic Market Scenarios
2. Stochastic Market Scenarios
3. Portfolio Scenarios

2011 IRP Deterministic Market Scenarios

Deterministic scenarios test the Preferred Resource Strategy (PRS) across several different futures

- Low and High Gas Scenarios
- High Wind Penetration Scenarios
- Carbon Scenarios
- Western Coal Plant Phase Out Scenario

2011 IRP Stochastic Market Scenarios

- Expected Case – assumes average hydro, load, gas prices, wind, emissions prices and forced outages
- Volatile Fuel Scenario – test higher gas price volatility
- Unconstrained Carbon Scenario – determines the cost of different greenhouse gas emissions programs
- Mandatory Coal Retirement Scenario – Western coal plants automatically retired after 40 years of service

AVISTA

Portfolio Scenarios

- Market Reliance Only
- Capacity Only
- All CCCT and Wind
- All SCCT and Wind
- CO_2 Credit Allocations
- Nuclear Availability (2025)
- 2009 PRS
- National Renewable Energy Standard
- CT& CCCT Tipping Point
- Wind & Solar Tipping Point
- Nuclear Tipping Point Analysis
- Carbon Sequestration
- Colstrip Scenarios:
  - Different O&M charges;
  - Early Retirement;
  - Incremental Pollution Control, (sequestration); and
  - Railed coal
- Others?

Avista's 2011 Electric Integrated Resource Plan

Technical Advisory Committee Meeting No. 5 Agenda

Avista Headquarters – Spokane, Washington

Tuesday, April 12, 2011
Avista Conference Room 130

Topic	Time	Staff
1. Introduction	9:30	Storro
2. Conservation Avoided Cost Methodology	9:35	Gall
3. Conservation	9:45	Hermanson/ Global Energy Partners
4. Draft Preferred Resource Strategy Portfolio Alternatives & Scenarios	11:15	Gall
5. Lunch	12:15	
6. Draft Preferred Resource Strategy Portfolio Alternatives & Scenarios	1:00	Gall
7. Smart Grid	2:30	Kirkeby
8. Adjourn	3:30	

Conservation Avoided Costs

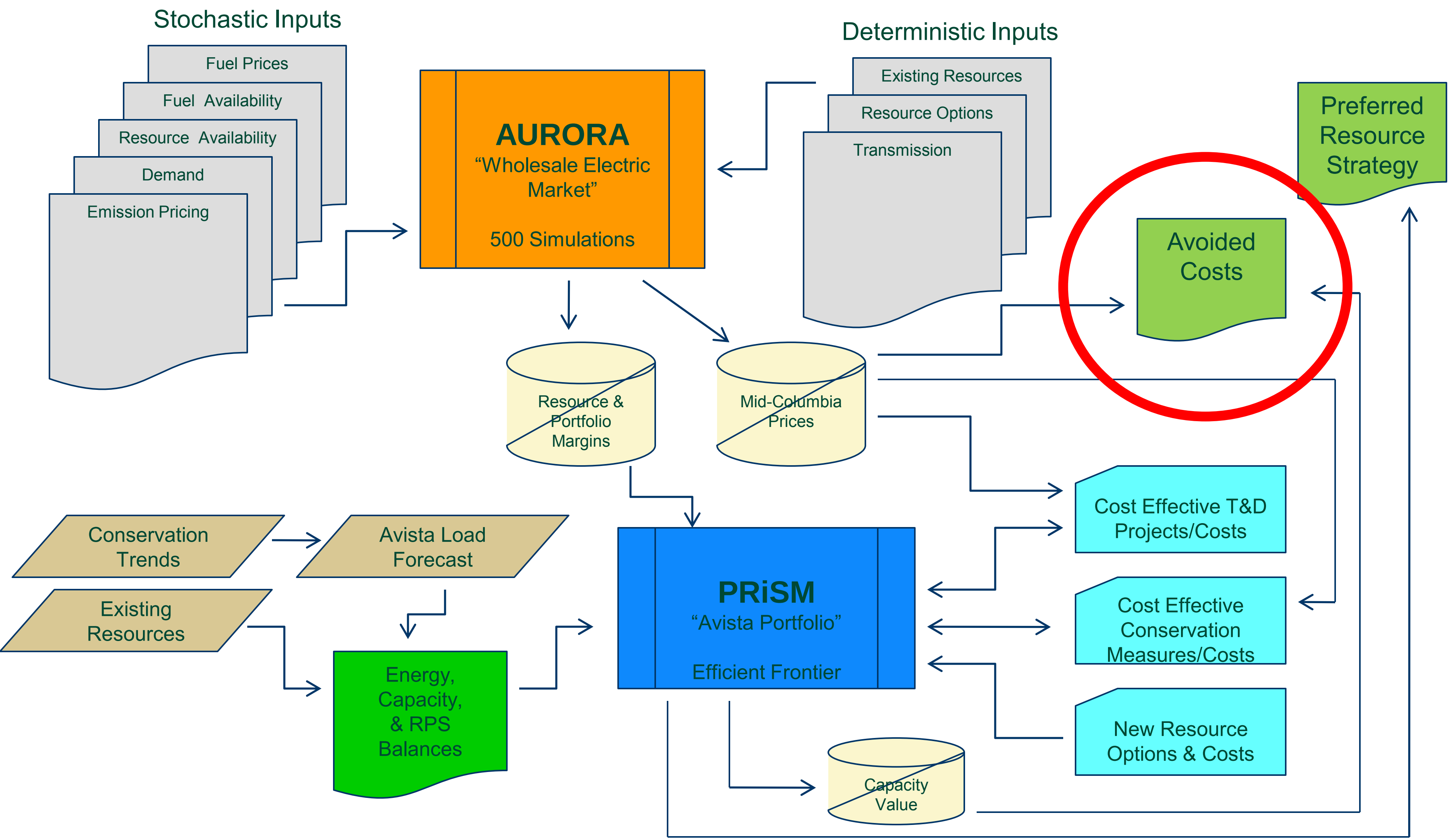
James Gall

Technical Advisory Committee Meeting #5

2011 Electric Integrated Resource Plan

April 12, 2011

2011 Integrated Resource Plan Modeling Process



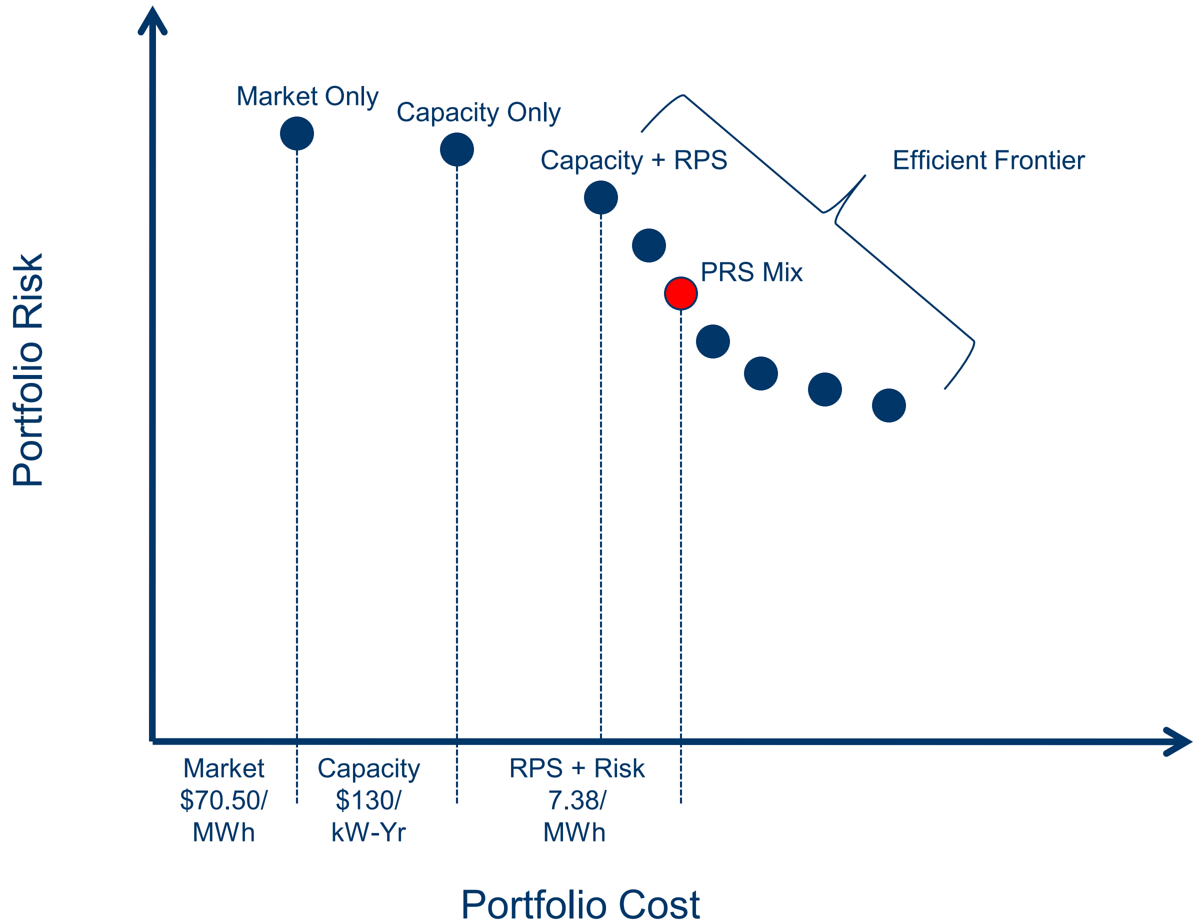
How to Value Conservation

$$\{(E + PC + R) * (1 + P)\} * (1 + L) + DC * (1 + L)$$

Where:
E = market energy price (calculated by Aurora, including forecasted CO2 mitigation)
PC = new resource capacity savings (calculated by PRISM)
R = Risk premium to account for RPS and rate volatility reduction (calculated by PRISM)
P = Power Act preference premium (10% assumption)
DC = distribution capacity savings (~$10/kW-year based on Heritage Project calculation)
L = transmission and distribution losses (6.1% assumption based on Avista's system average losses)

Efficient Frontier Approach

Assumes no additional Conservation Resources



Avoided Cost Calculation

For 1 MW Measure With Flat Delivery

Item	$/MWh
Energy Price	70.50
Capacity Savings	10.51
Risk Premium	7.38
Subtotal	**88.39**

Item	$/MWh
10% Preference	8.84
Distribution Capacity Savings	1.14
T&D losses	6.02
Subtotal	**16.00**

Avoided Cost:
$104.39
per
MWh

Avista Conservation Potential Assessment Electricity

Prepared for
Avista Utilities Technical Advisory Committee
by
Global Energy Partners
April 12, 2011

Global Energy Partners™
An EnerNOC Company

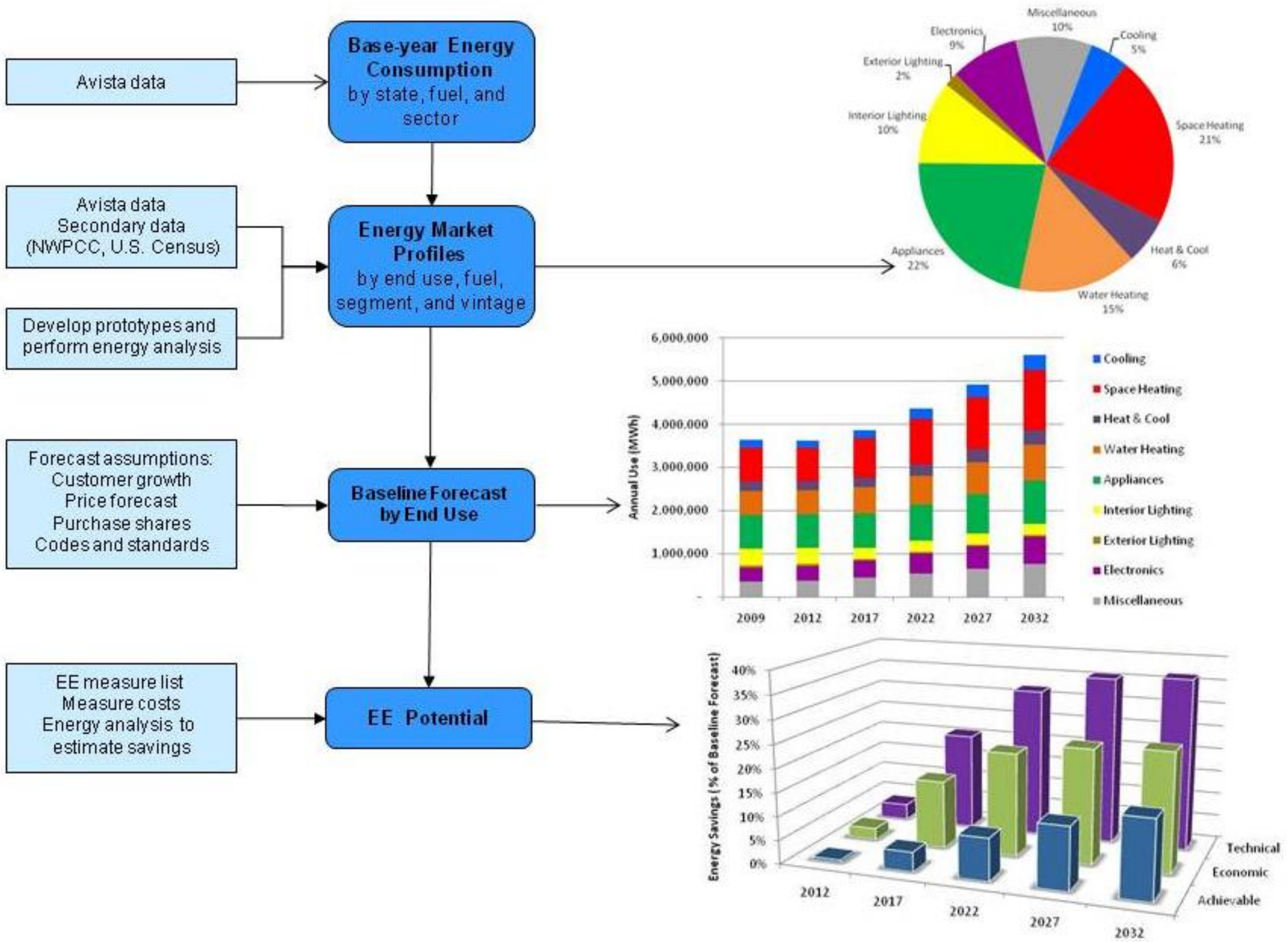
Topics

- Background and objectives
- Study approach
- Energy efficiency analysis results (electricity)
- Demand response analysis

Background and general objectives

- Assess and analyze 20-year cost-effective energy efficiency (EE) potentials
  - Support Avista IRP development
  - Meet Washington I-937 Conservation Potential Assessment requirements
- EE Potential assessment considers
  - Impacts of existing programs
  - Naturally occurring energy savings
  - Impacts of codes and standards
  - Technology developments and innovation
  - The economy and energy prices
- Assess and analyze DR potentials

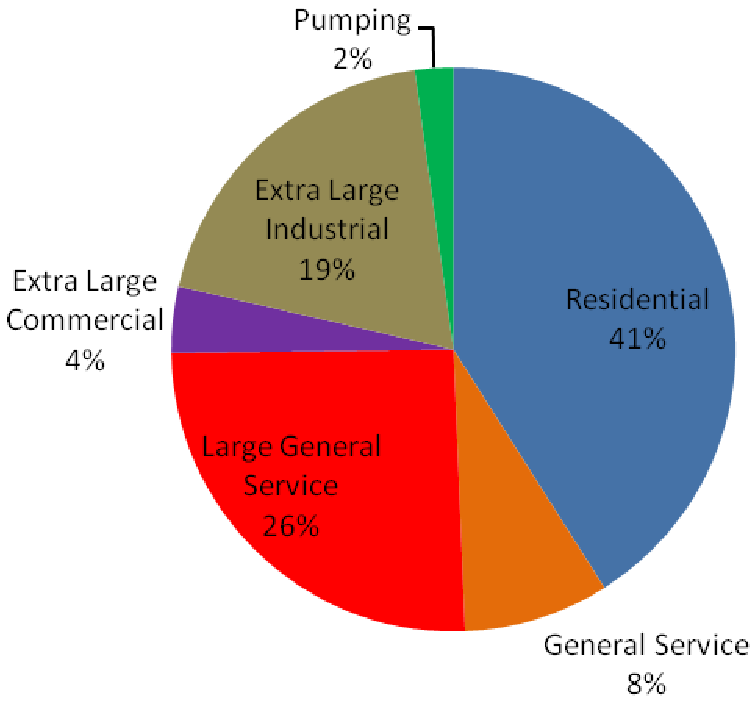
Overview of EE analysis approach

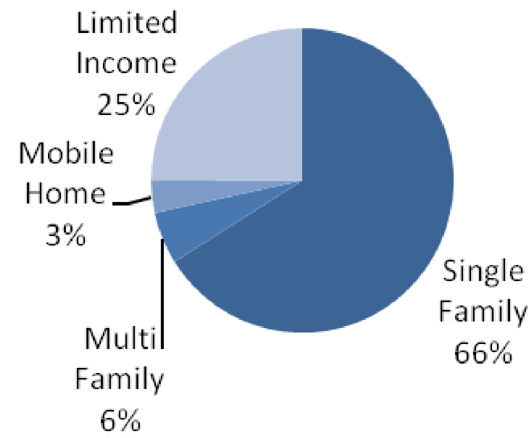


Base-year Energy Consumption

- Base year is 2009
  - Most recent year with complete sales and customer data when study began
  - 2009 also base year for Avista load research study
- Market segmentation, based on rate classes
  - Residential (rate class 001), segmented by housing type and income
    - Single Family
    - Multi Family
    - Mobile Home
    - Limited Income
  - Commercial and Industrial
    - General Service (rate classes 011, 012)
    - Large General Service (rate classes 021, 022)
    - Extra Large Commercial GS (rate class 025C)
    - Extra Large Industrial GS (rate class 025C)
  - Pumping (rate classes 031, 032)

Base-year Energy Consumption 2009 % of sales, Washington and Idaho

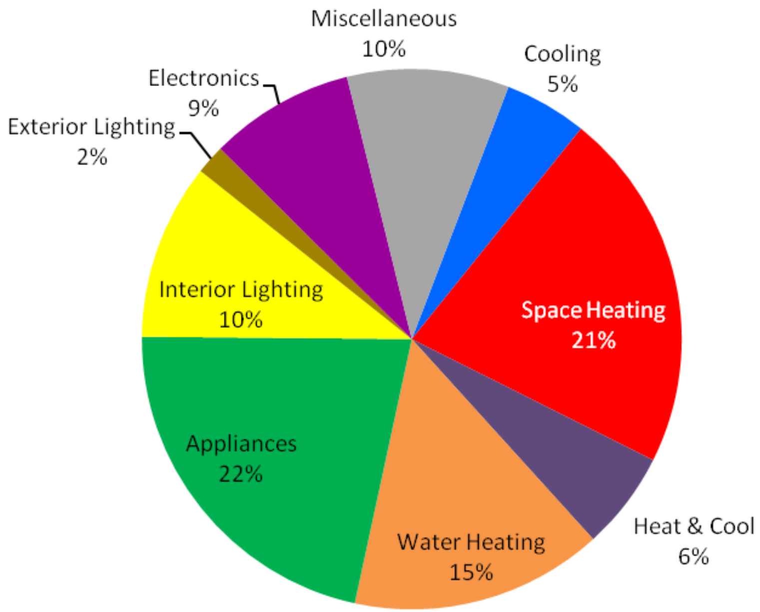




Energy Market Profiles

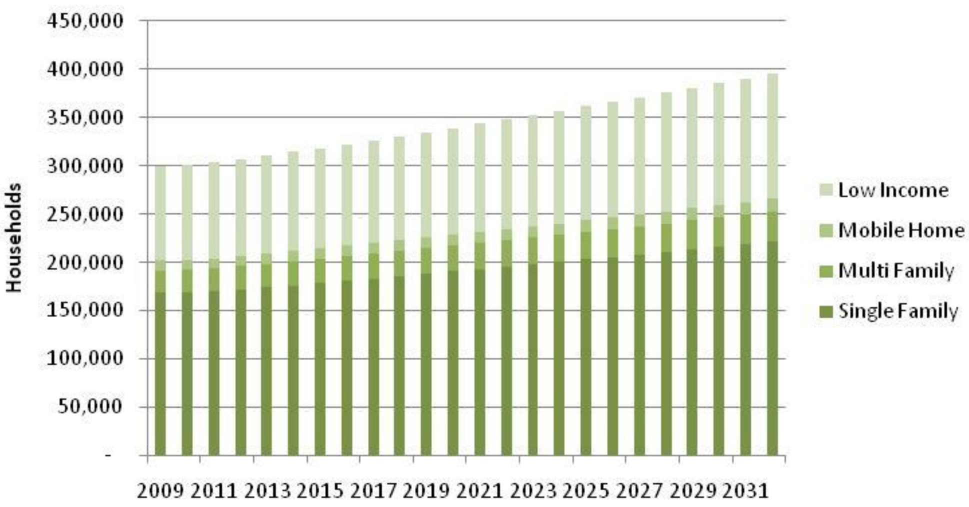
- Characterize energy use by sector, segment, end use, and technology
- Existing, replacement, and new construction
- Accounts for
  - Naturally occurring conservation
  - Codes and standards
  - Previous DSM results
  - Equipment saturation and fuel shares

Residential Energy Use by End Use, 2009

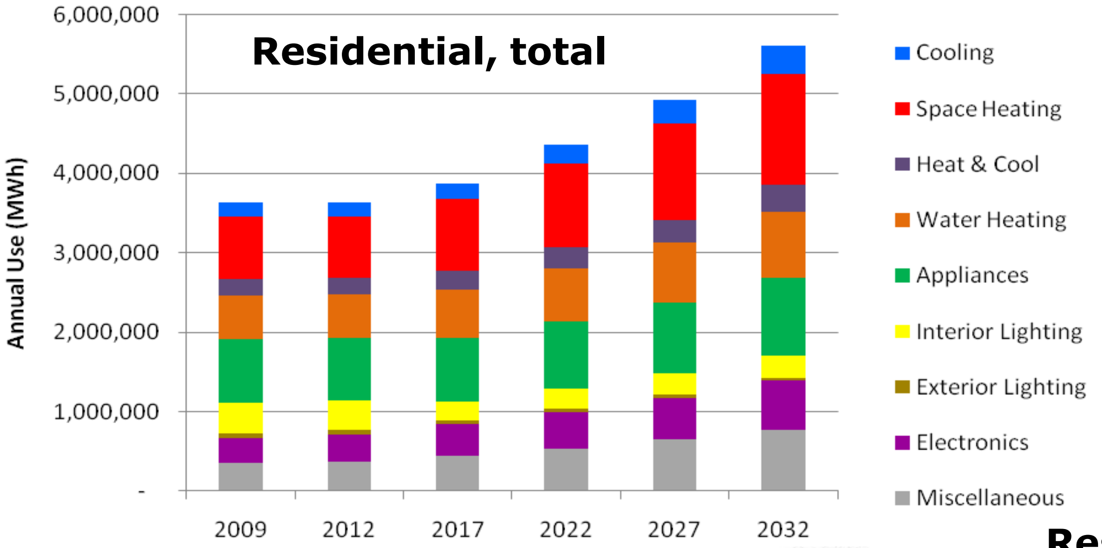


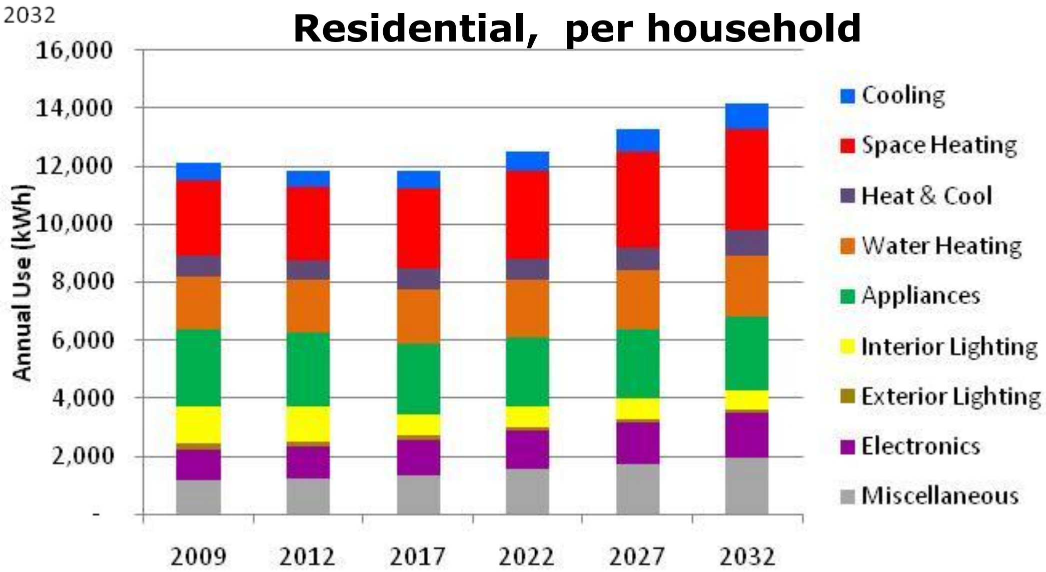
Baseline Forecast

- Incorporates
  - Customer / market growth
  - Income growth
  - Avista retail rates forecast
  - Trends in end-use/technology saturations
  - Equipment purchase decisions
  - Elasticities for retail rates, income, persons per household
- Accounts for
  - Naturally occurring conservation
  - Codes and standards
  - Previous DSM



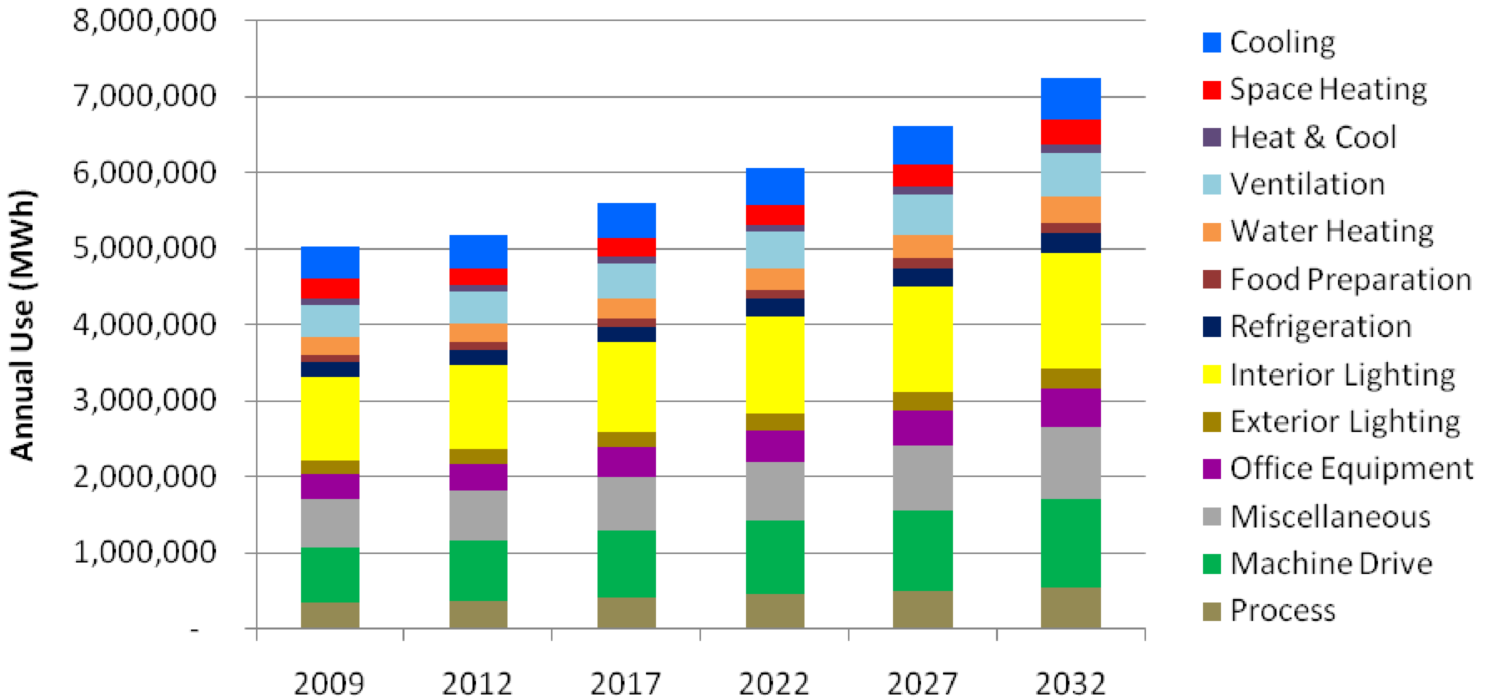
Baseline Forecast





Baseline Forecast

Commercial & Industrial



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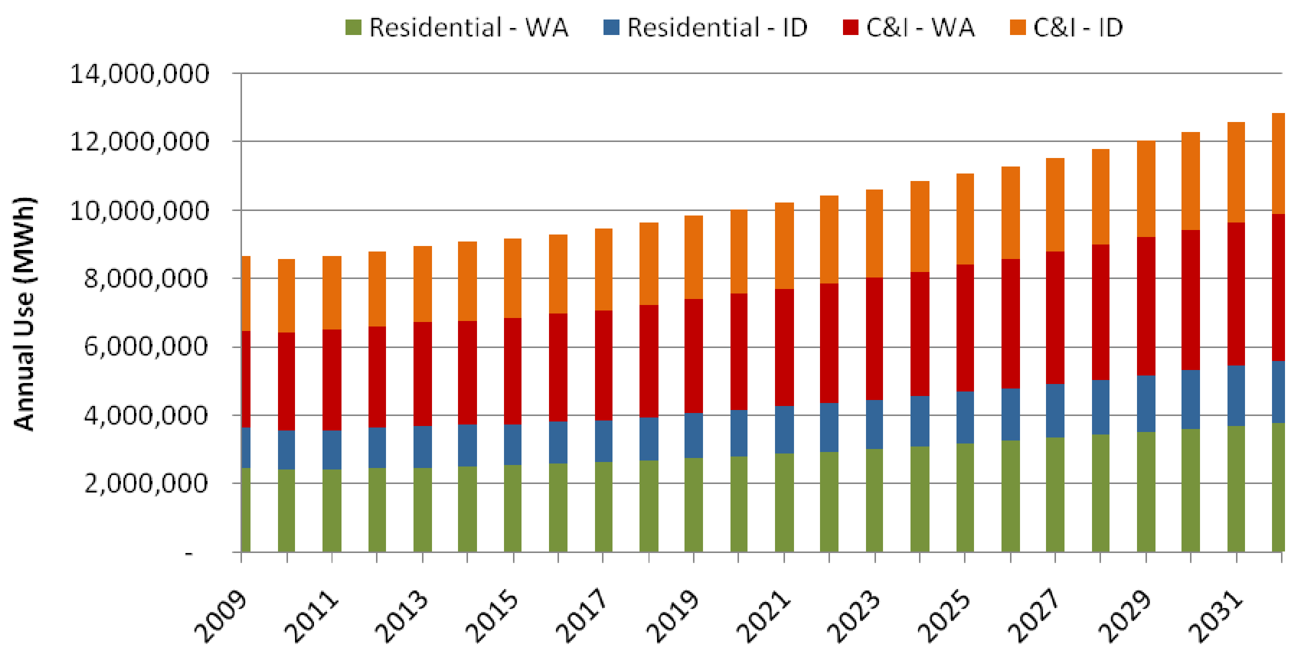
Baseline Forecast

- Overall 48% growth in electricity use.
- Average annual growth rate of 1.7%
- Comparable with Avista 2009 IRP



Energy Efficiency Potential

- Energy Efficient Equipment and Measures
  - 2,808 equipment options and 1,524 other measures
  - Avista existing DSM programs
  - NEEA RTF
  - Sixth Power Plan database
  - Other utility programs
- Measure characterization
  - Life
  - Energy and demand savings
  - Cost
  - Year off market (Standards)
  - Saturation
  - Applicability / Feasibility

Efficiency Level	Useful Life	Equipment Cost	Energy Usage (kWh/yr)	On Market	Off Market
SEER 13	15	$3,794	$1,619	2009	2014
SEER 14 (ENERGY STAR)	15	$4,072	$1,485	2009	2032
SEER 15 (CEE Tier 2)	15	$4,350	$1,435	2009	2032
SEER 16 (CEE Tier 3)	15	$4,628	$1,393	2009	2032
Ductless Mini-split System	20	$8,193	$1,214	2009	2032

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Consistency with Sixth Plan

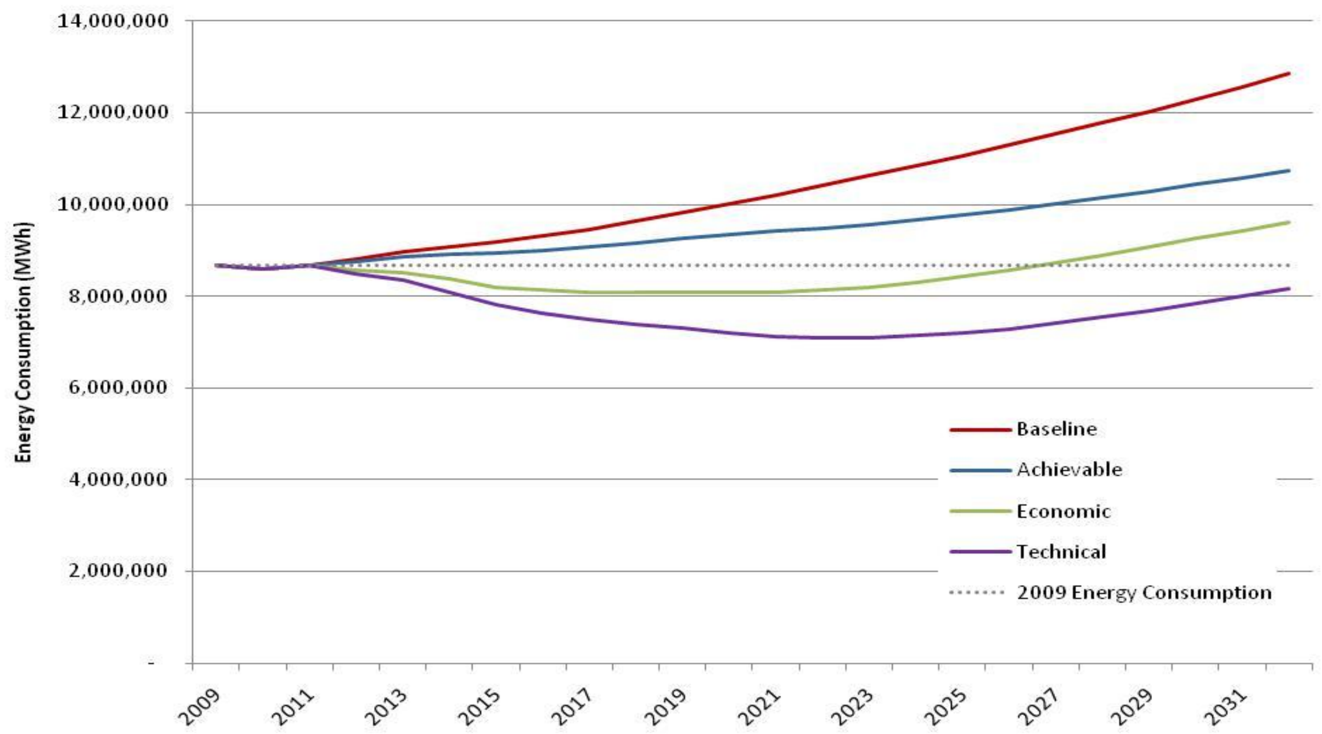
- End-use model — bottom-up approach to understanding savings
  - Measure life
  - Stock accounting
  - Measure saturation and applicability
- Accounts for
  - Naturally occurring conservation
  - Codes and standards
- Measures include those in Sixth Plan (other measures also)
- Considers both lost opportunity and non-lost opportunity
- Economic potential, based on Total Resource Cost (TRC) test
- Achievable potential considers realistic rate at which technologies can be deployed
- Maximum potential in 20 years is 85% of economic potential

Energy Efficiency Potential

- Savings could be acquired through a variety of means
  - Market transformation, including NEEA
  - Utility programs

Summary of EE results

- Baseline forecast — 48% growth (2032 vs. 2009)
- Achievable potential — 24% growth (2032 vs. 2009)
- Energy efficiency offsets 50% of growth



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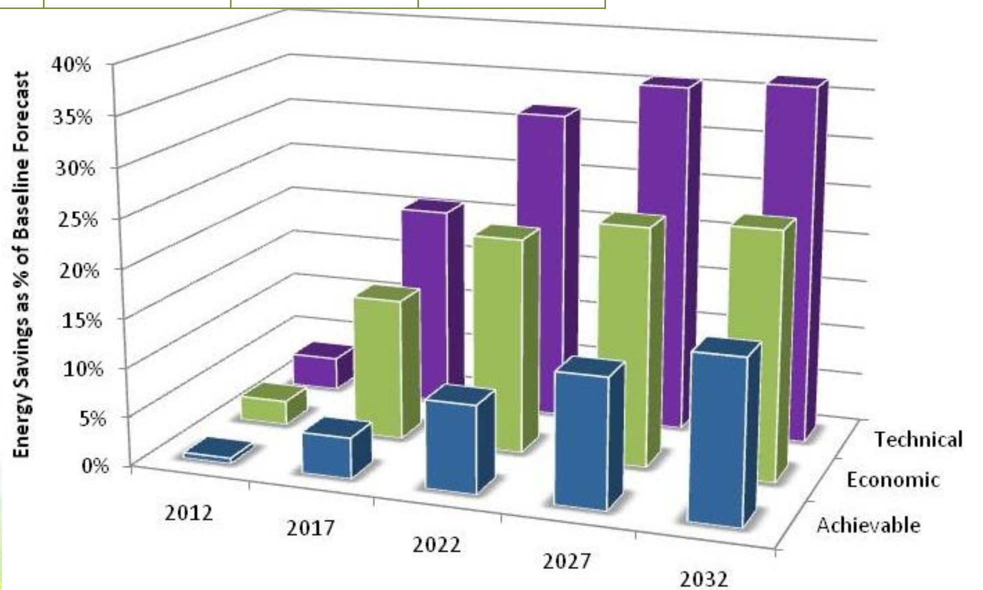
Summary of EE results (continued)

Summary of Energy Savings from Energy Efficiency

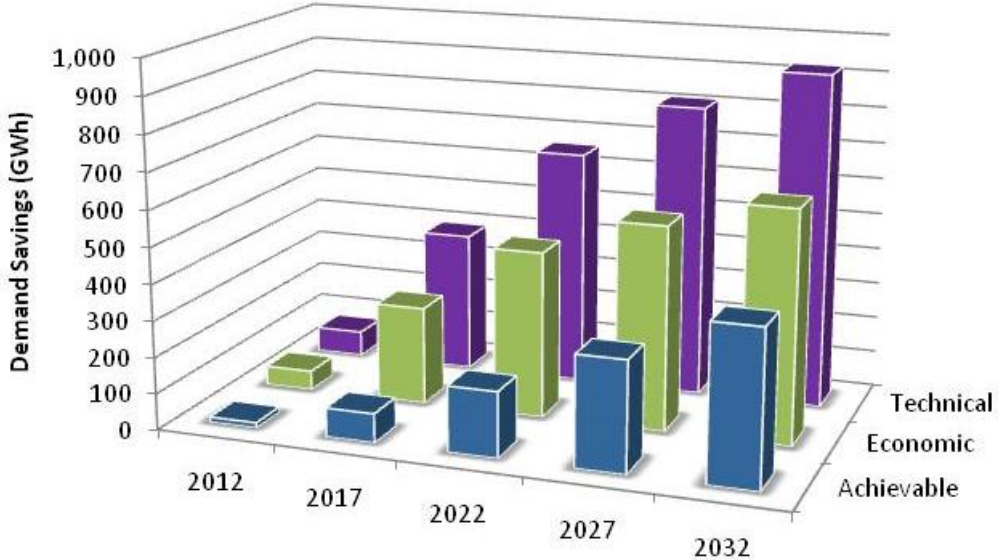
	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	8,799,079	9,464,078	10,417,644	11,537,369	12,852,394
Cumulative Energy Savings (MWh)					
Achievable	49,428	393,796	931,744	1,514,569	2,105,572
Economic	219,482	1,371,691	2,289,256	2,802,046	3,228,731
Technical	301,070	1,967,390	3,327,203	4,116,738	4,697,328
Cumulative Energy Savings (% of Baseline)					
Achievable	0.6%	4.2%	8.9%	13.1%	16.4%
Economic	2.5%	14.5%	22.0%	24.3%	25.1%
Technical	3.4%	20.8%	31.9%	35.7%	36.5%



Summary of EE results (continued)

Summary of Peak Demand Savings from Energy Efficiency

	2012	2017	2022	2027	2032
Baseline Forecast (MW)	1,780	1,881	2,080	2,306	2,567
Peak Savings (MWh)					
Achievable	14	80	180	303	424
Economic	53	271	459	563	638
Technical	70	391	654	810	923
Peak Savings (% of Baseline)					
Achievable	0.8%	4.3%	8.7%	13.1%	16.5%
Economic	3.0%	14.4%	22.1%	24.4%	24.8%
Technical	3.9%	20.8%	31.5%	35.1%	35.9%



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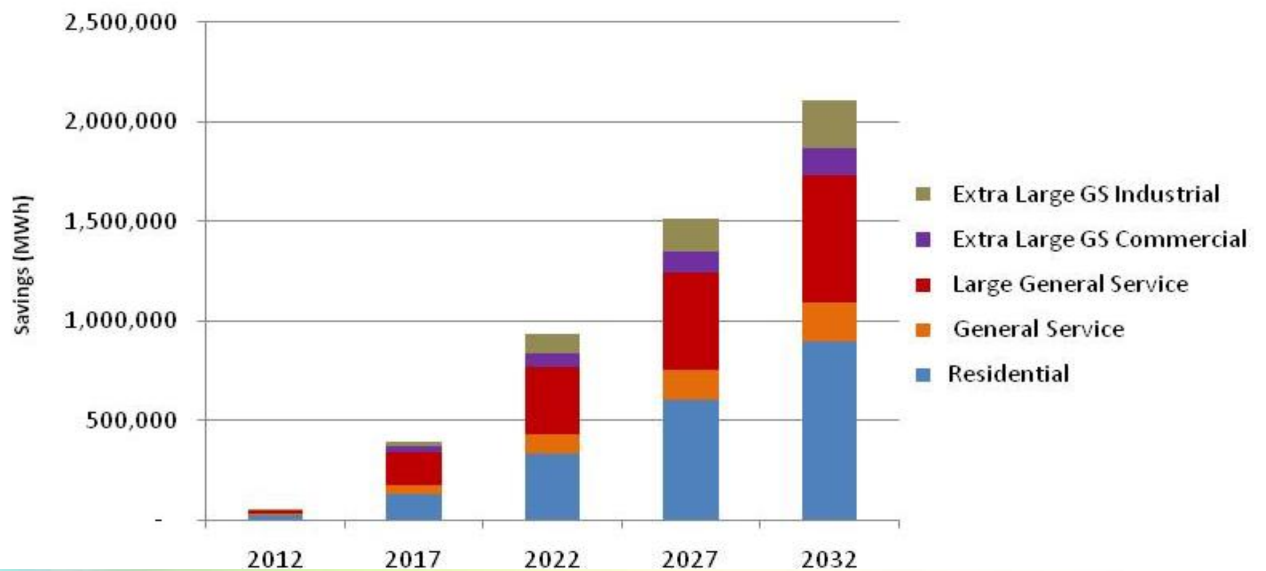
Savings by Sector

	2012	2017	2022	2027	2032
Cumulative Energy Savings (MWh)					
Residential	25,651	127,984	331,874	606,994	896,296
C&I Total	23,777	265,812	599,870	907,575	1,209,276
Cumulative Energy Savings (% of total)					
Residential	**52%**	**33%**	**36%**	**40%**	**43%**
General Service	9%	12%	10%	10%	9%
Large General Service	30%	42%	36%	32%	30%
Extra Large GS Commercial	7%	8%	8%	7%	7%
Extra Large GS Industrial	3%	5%	10%	11%	11%
C&I Total	**48%**	**67%**	**64%**	**60%**	**57%**



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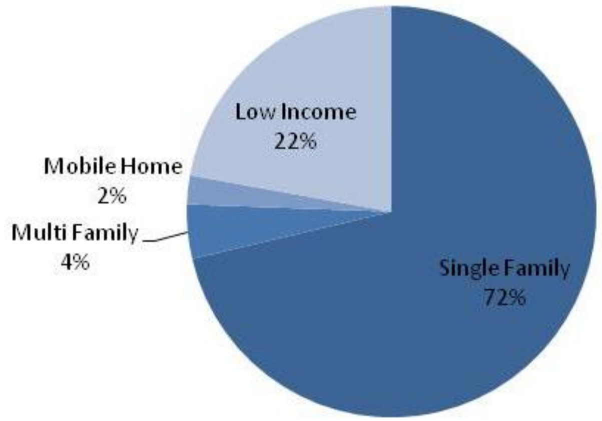
Residential EE Results

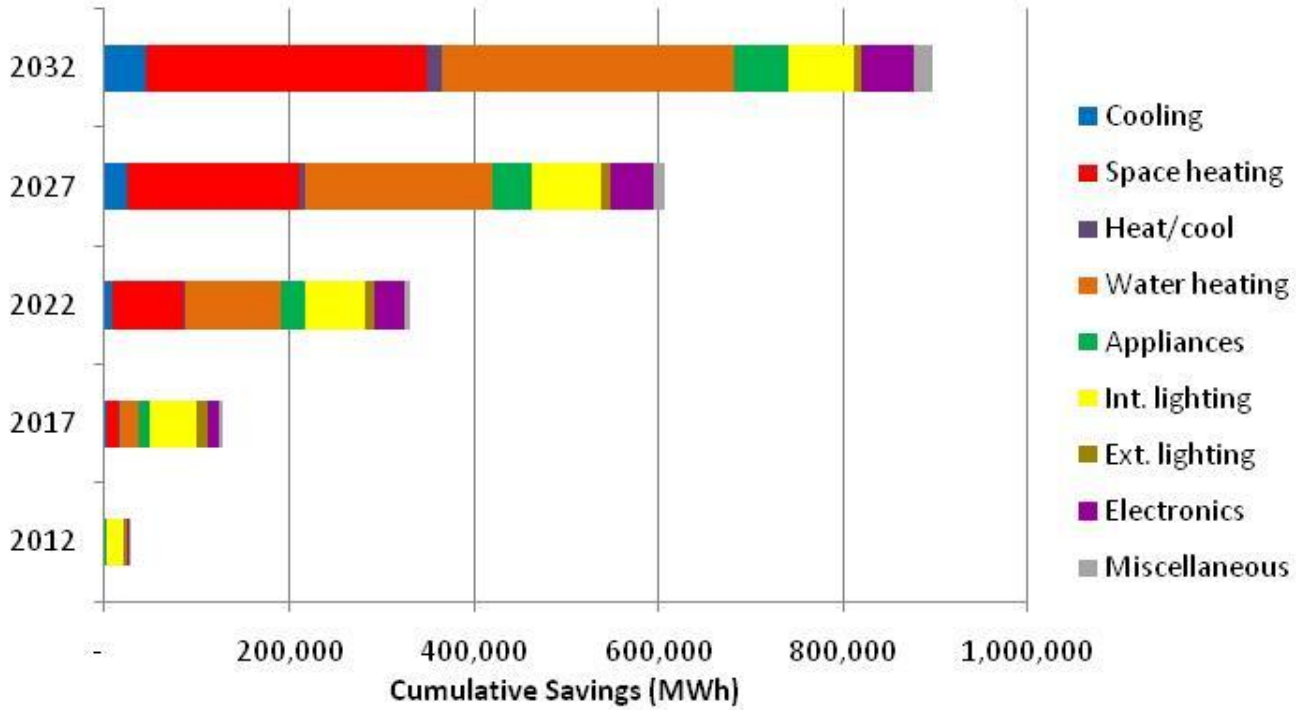
	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	3,626,735	3,871,491	4,356,537	4,919,347	5,601,421
Cumulative Energy Savings (MWh)					
Achievable	25,651	127,984	331,874	606,994	896,296
Economic	89,611	516,797	955,211	1,193,716	1,373,565
Technical	135,783	857,178	1,468,391	1,831,465	2,114,488
Cumulative Energy Savings (% of Baseline)					
Achievable	0.7%	3.3%	7.6%	12.3%	16.0%
Economic	2.5%	13.3%	21.9%	24.3%	24.5%
Technical	3.7%	22.1%	33.7%	37.2%	37.7%

Savings by housing type, 2022



Residential EE Results

Cumulative Energy Savings by End Use (MWh), Selected Years



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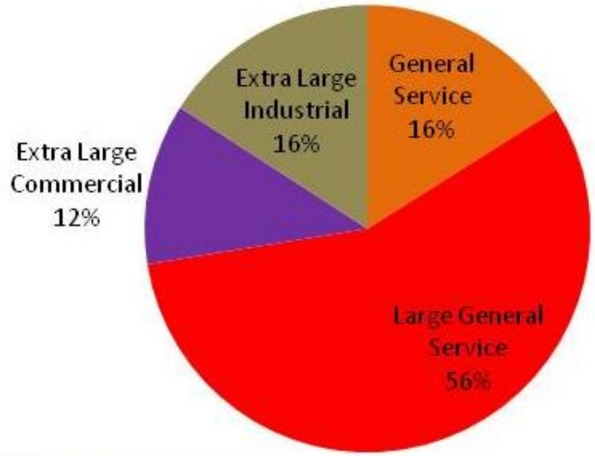
C&I EE Results

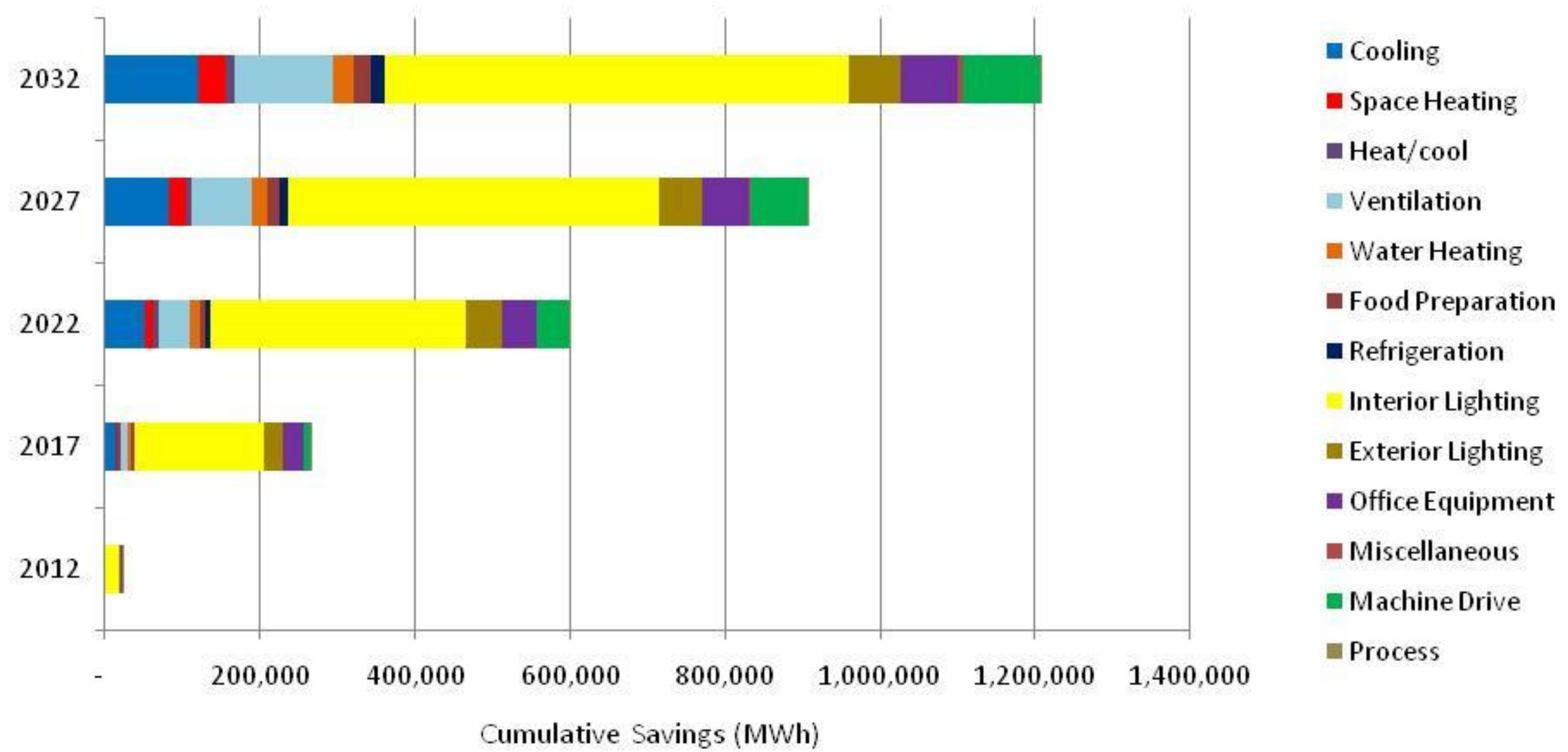
	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	5,172,344	5,592,586	6,061,107	6,618,022	7,250,973
Cumulative Energy Savings (MWh)					
Achievable	23,777	265,812	599,870	907,575	1,209,276
Economic	129,871	854,893	1,334,045	1,608,330	1,855,166
Technical	165,288	1,110,212	1,858,812	2,285,273	2,582,839
Cumulative Energy Savings (% of Baseline)					
Achievable	0.5%	4.8%	9.9%	13.7%	16.7%
Economic	2.5%	15.3%	22.0%	24.3%	25.6%
Technical	3.2%	19.9%	30.7%	34.5%	35.6%

Savings by rate class, 2022



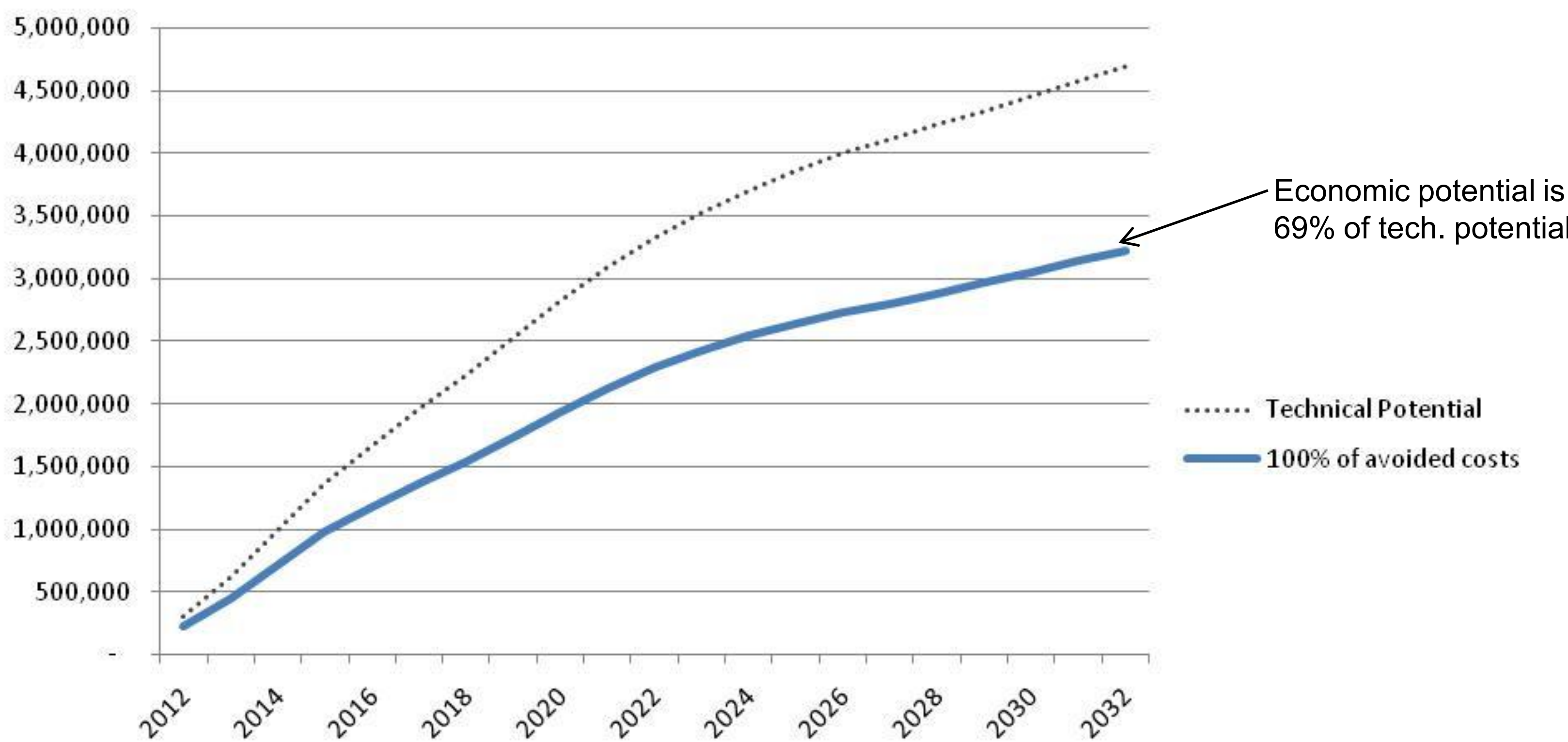
C&I EE Results

Cumulative Energy Savings by End Use (MWh), Selected Years



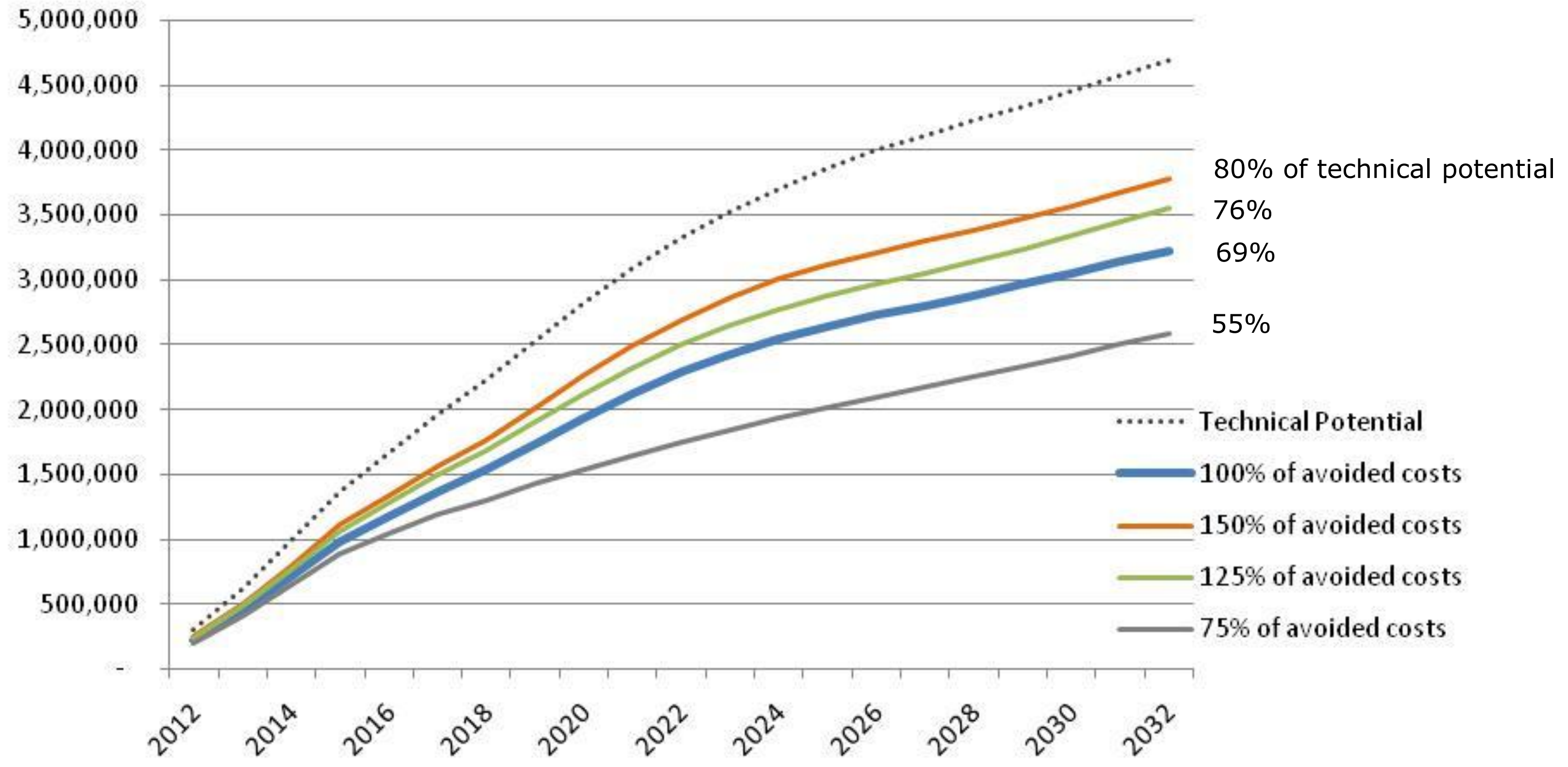
Avoided Cost Scenarios

Economic Potential, Cumulative Savings (MWh)



Avoided Cost Scenarios

Economic Potential Case, Cumulative Savings (MWh)



Demand Response Analysis

- Define the types of DR programs most suitable for Avista
- Determine DR potential

Demand Response Program	Residential	General Service	Large General Service	Extra Large General Service	Pumping
Direct Load Control					
Mass Market Direct Load Control	x	x			
Direct Load Control			x	x	x
Other Programs					
Demand Bidding / Buyback			x	x	
Curtailable/Interruptible			x	x	
Auto DR / Fast DR	x	x	x	x	

Deliverables from CPA analysis

- Final report electricity
  - EE approach and results
  - DR approach and results
  - Appendices
- LoadMAP models
- Gas potential study

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Preferred Resource Strategy & Scenario Analysis

(Preliminary Draft)

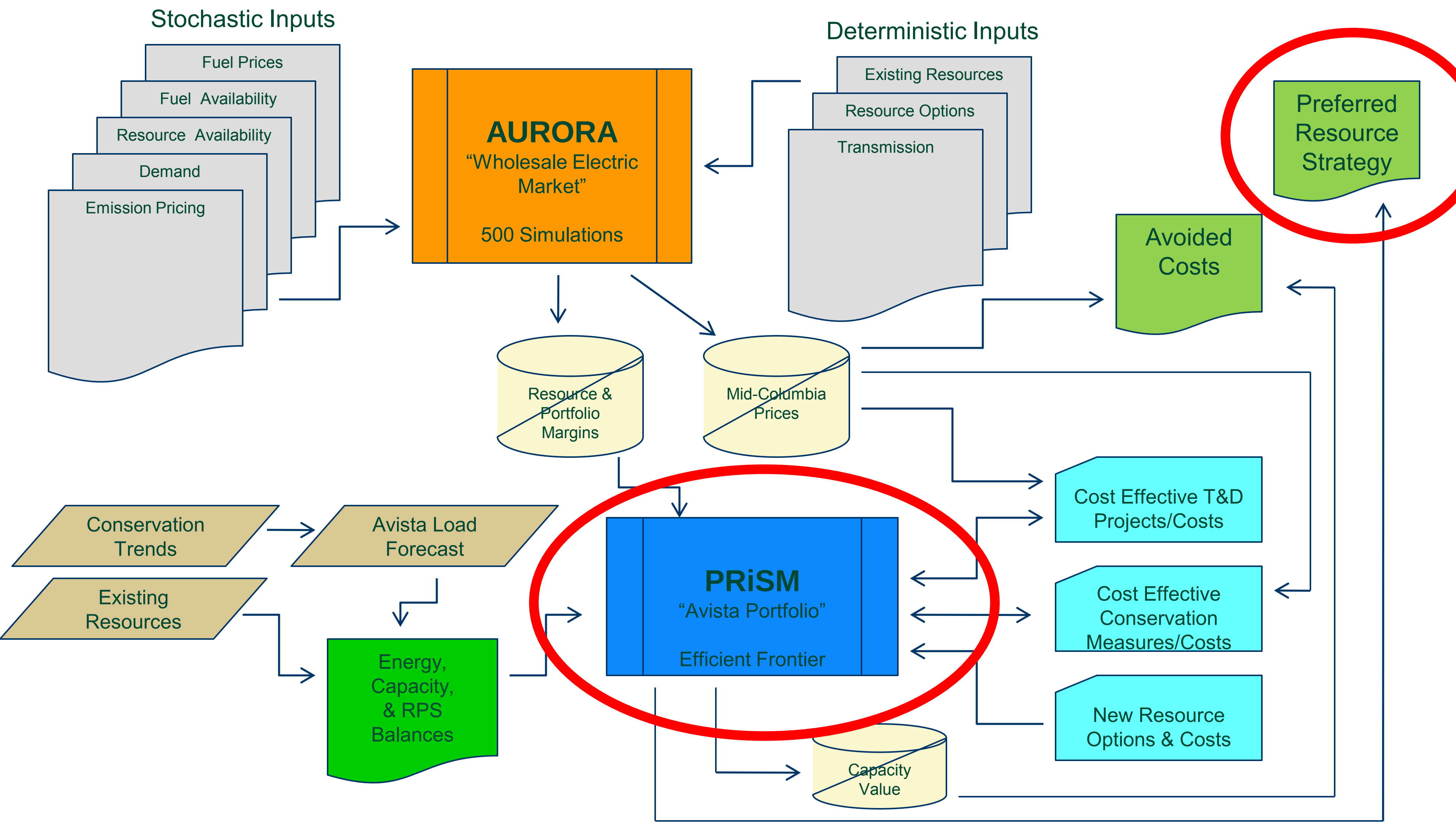
James Gall

Technical Advisory Committee Meeting #5

2011 Electric Integrated Resource Plan

April 12, 2011

2011 Integrated Resource Plan Modeling Process



PRiSM Objective Function

- Linear program solving for the optimal resource strategy to meet resource deficits over planning horizon.
- Model selects its resources to reduce cost, risk, or both.

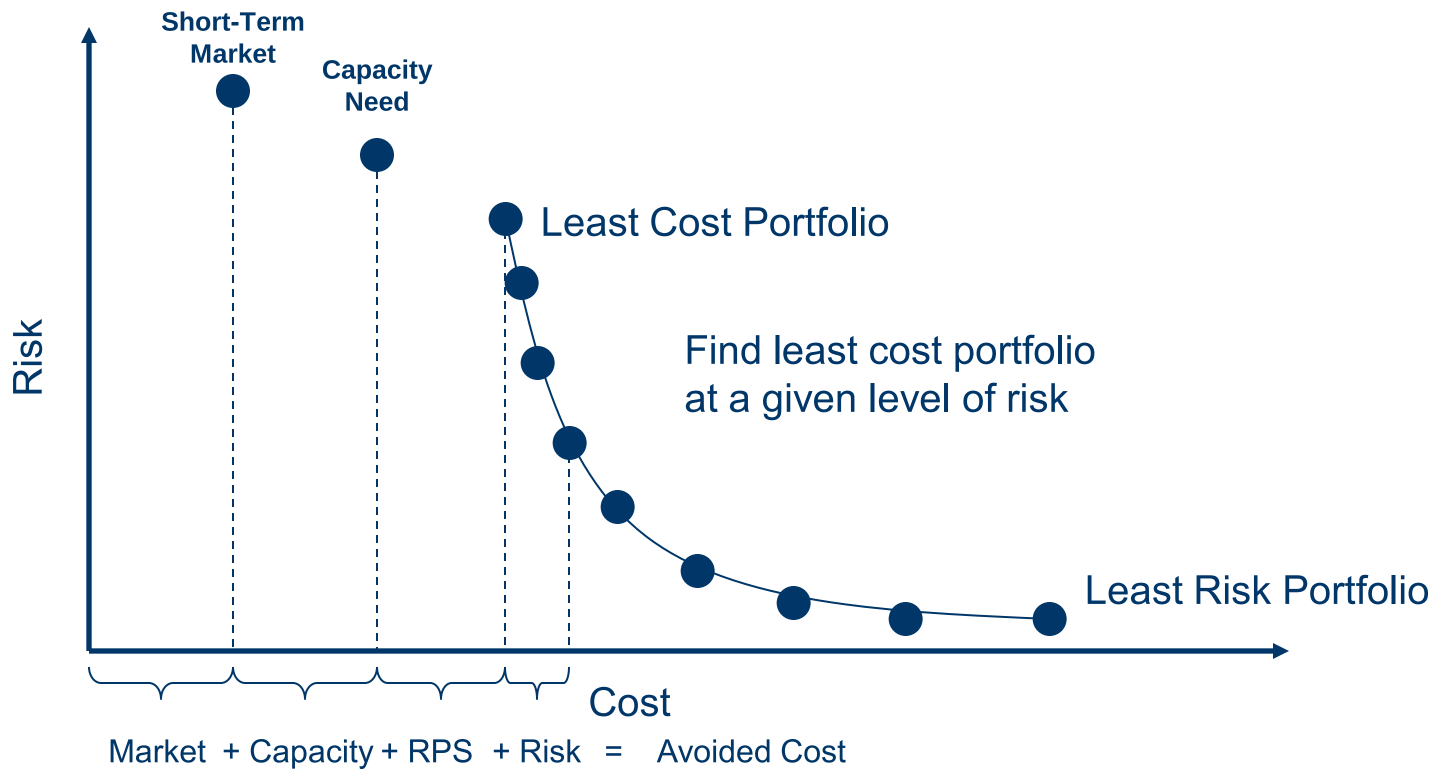
Minimize: Total Power Supply Cost on NPV basis (2012-2052 with emphasis on first 11 years of the plan)

Subject to:

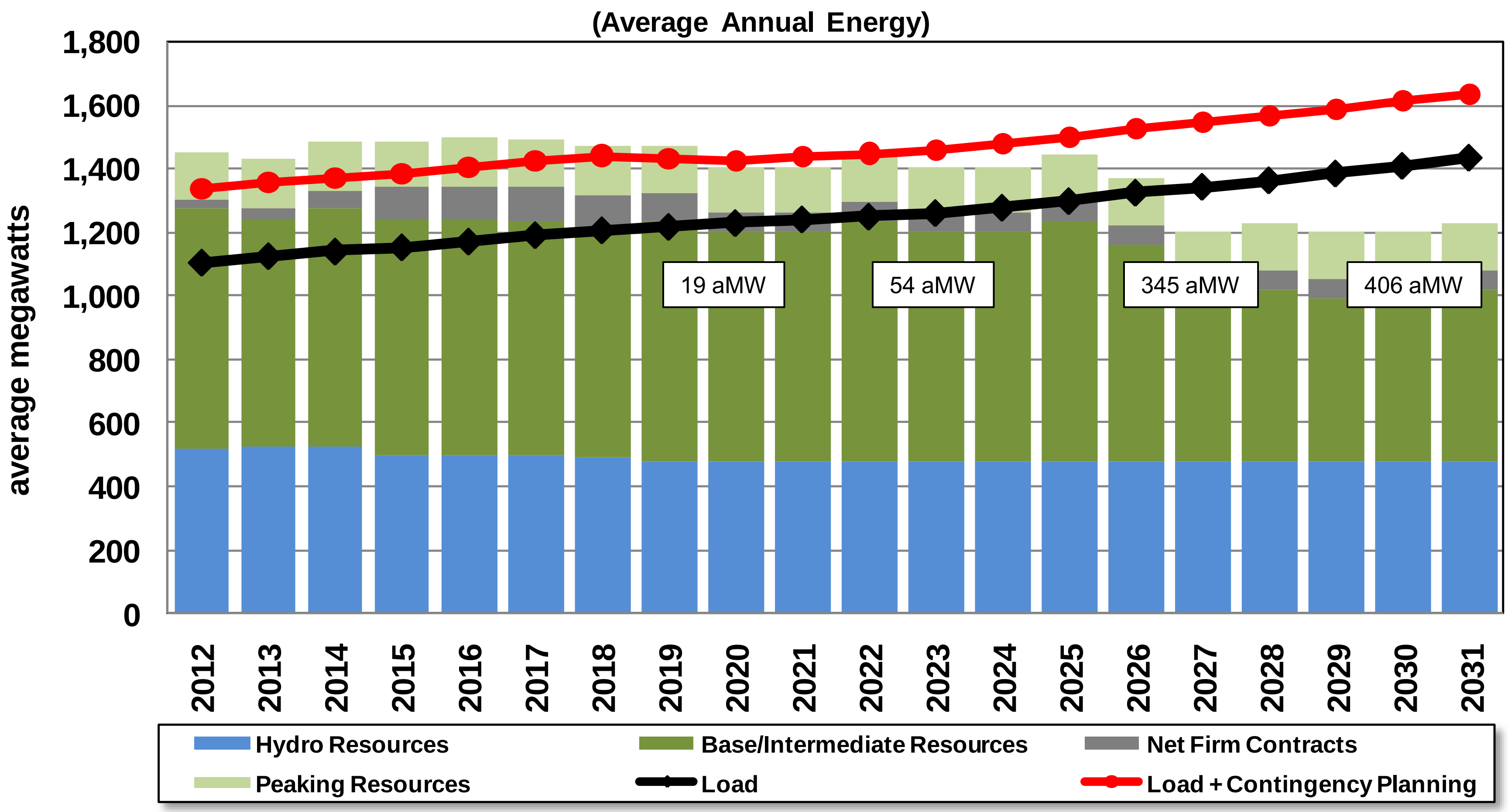
- Risk Level
- Capacity Need +/- deviation
- Energy Need +/- deviation
- Renewable Portfolio Standards
- Resource Limitations and Timing

Efficient Frontier

- Demonstrates the trade off of cost and risk
- Avoided Cost Calculation

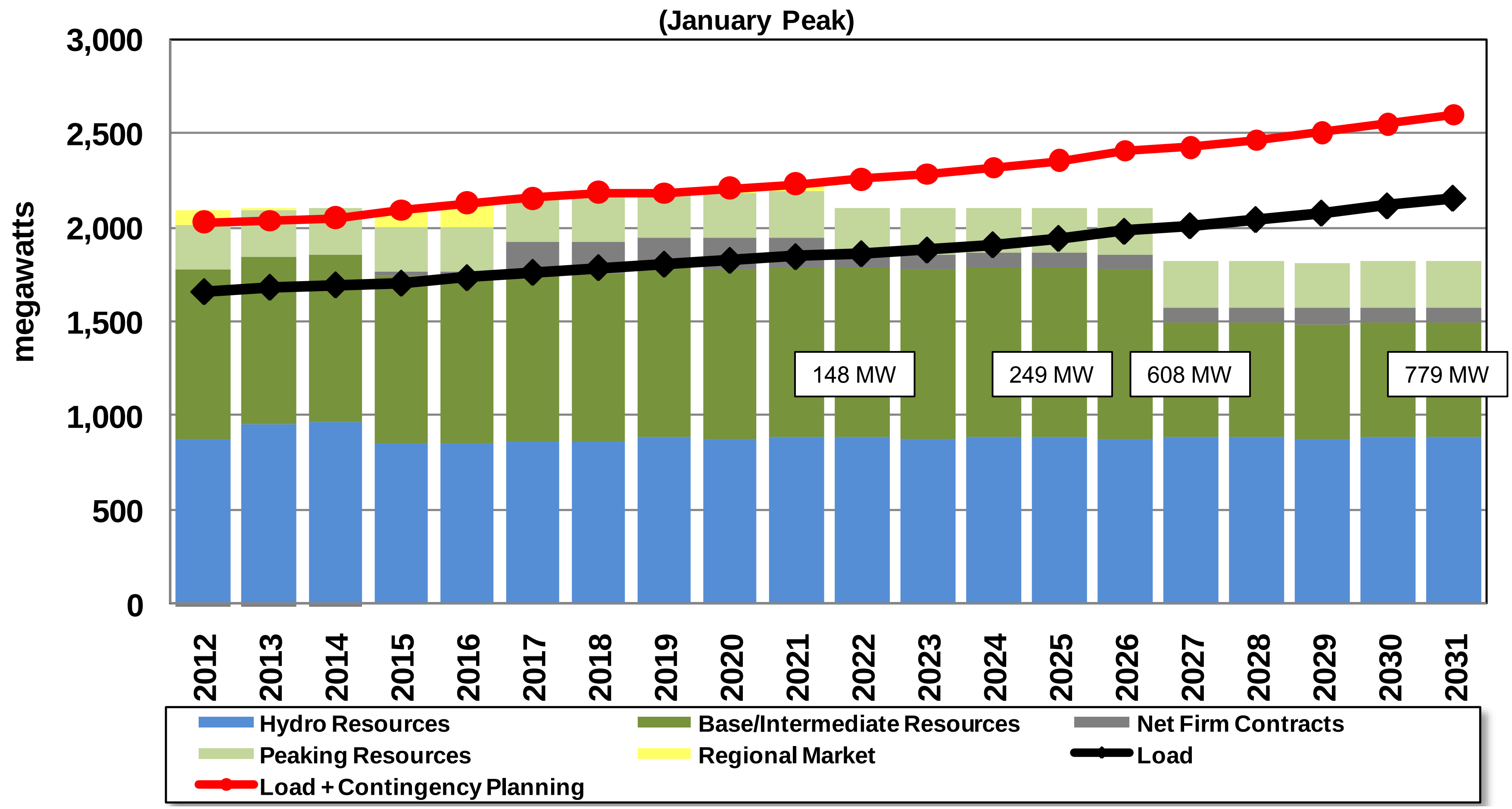


Energy Load & Resource Balance (Includes Conservation)



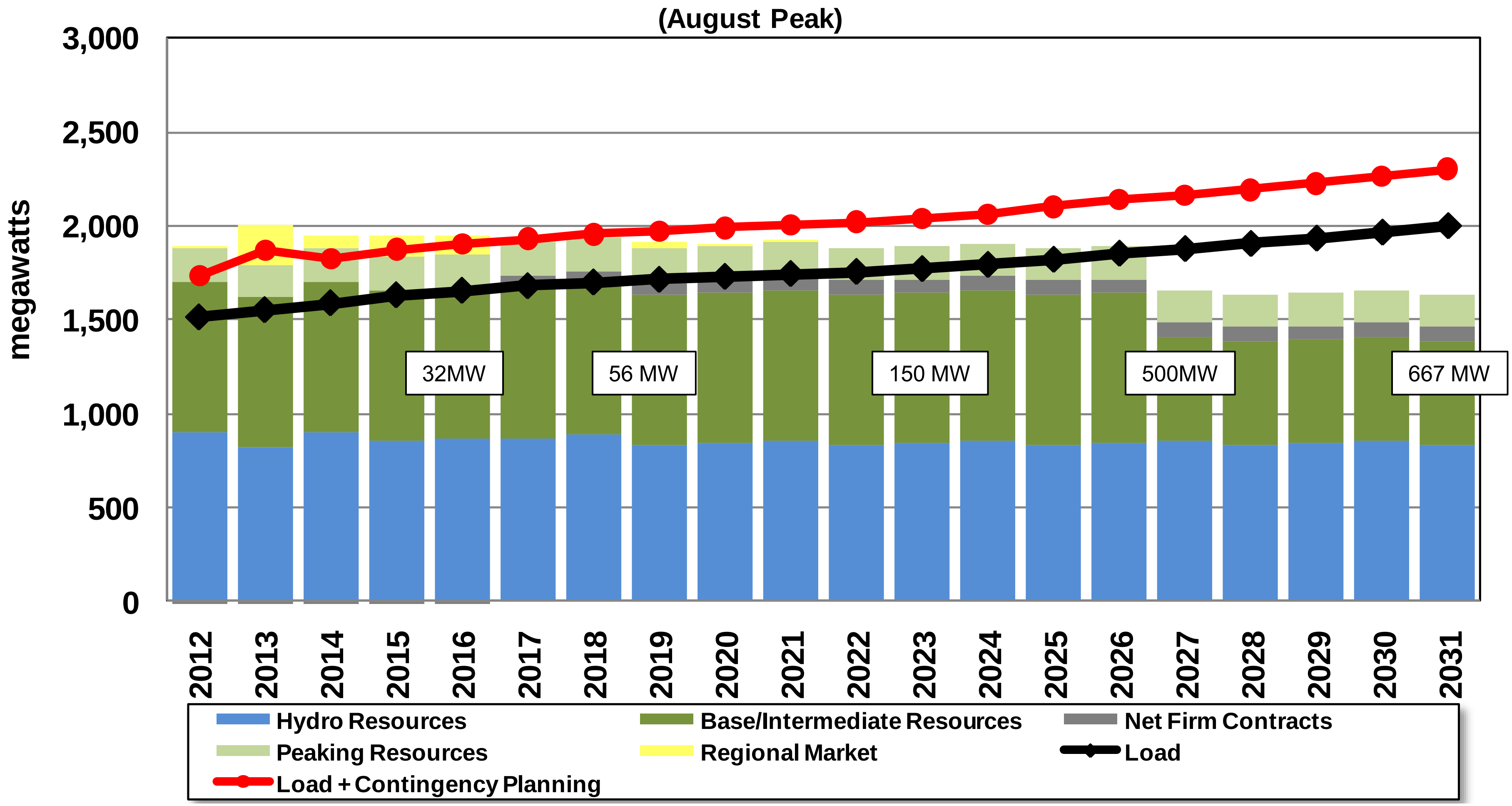
Winter 18 Hr Peak Load & Resource Balance

(Includes Conservation)



Summer 18 hr Peak Load & Resource Balance

(Includes Conservation)

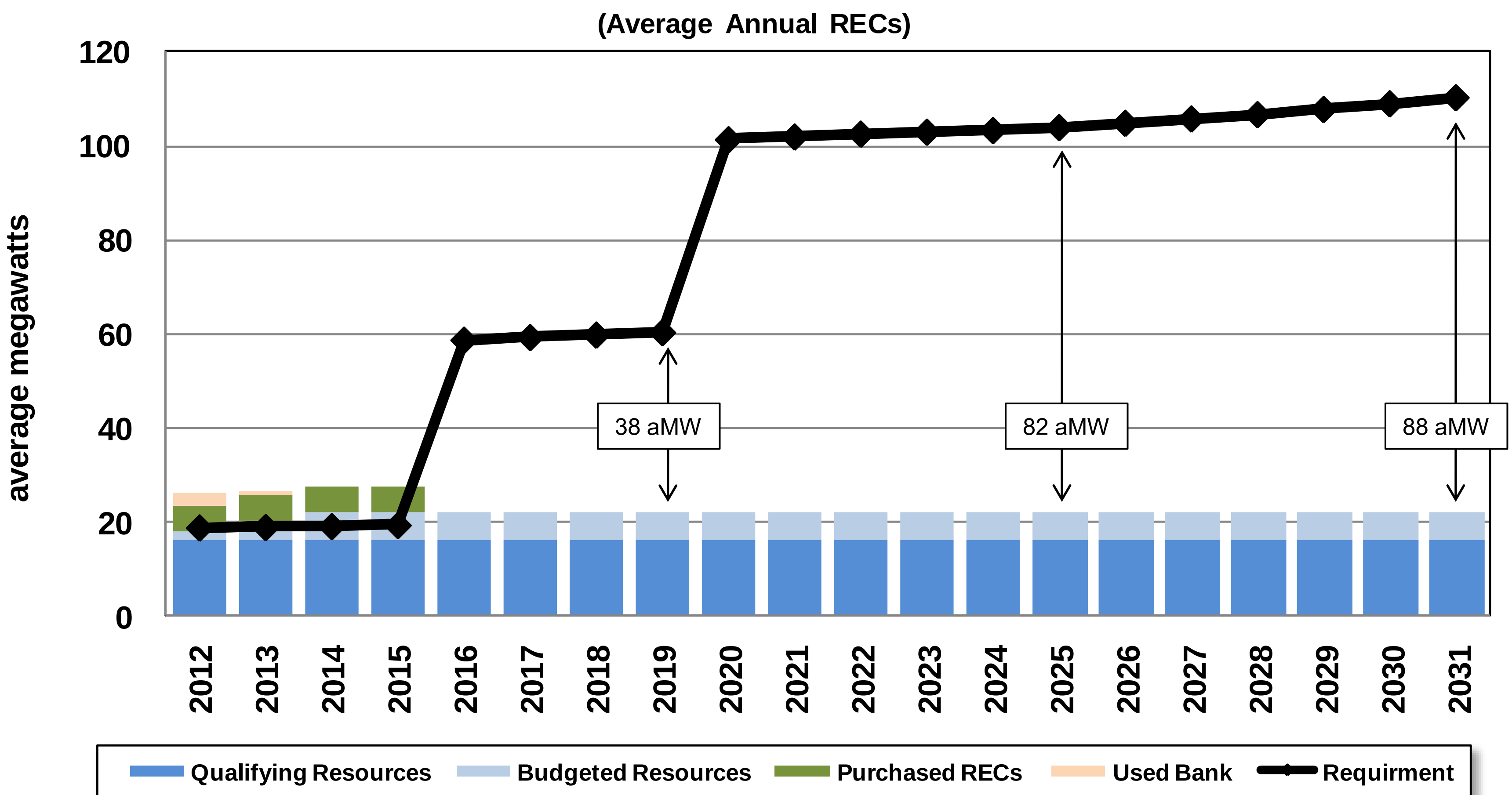


REC Contingency & Banking

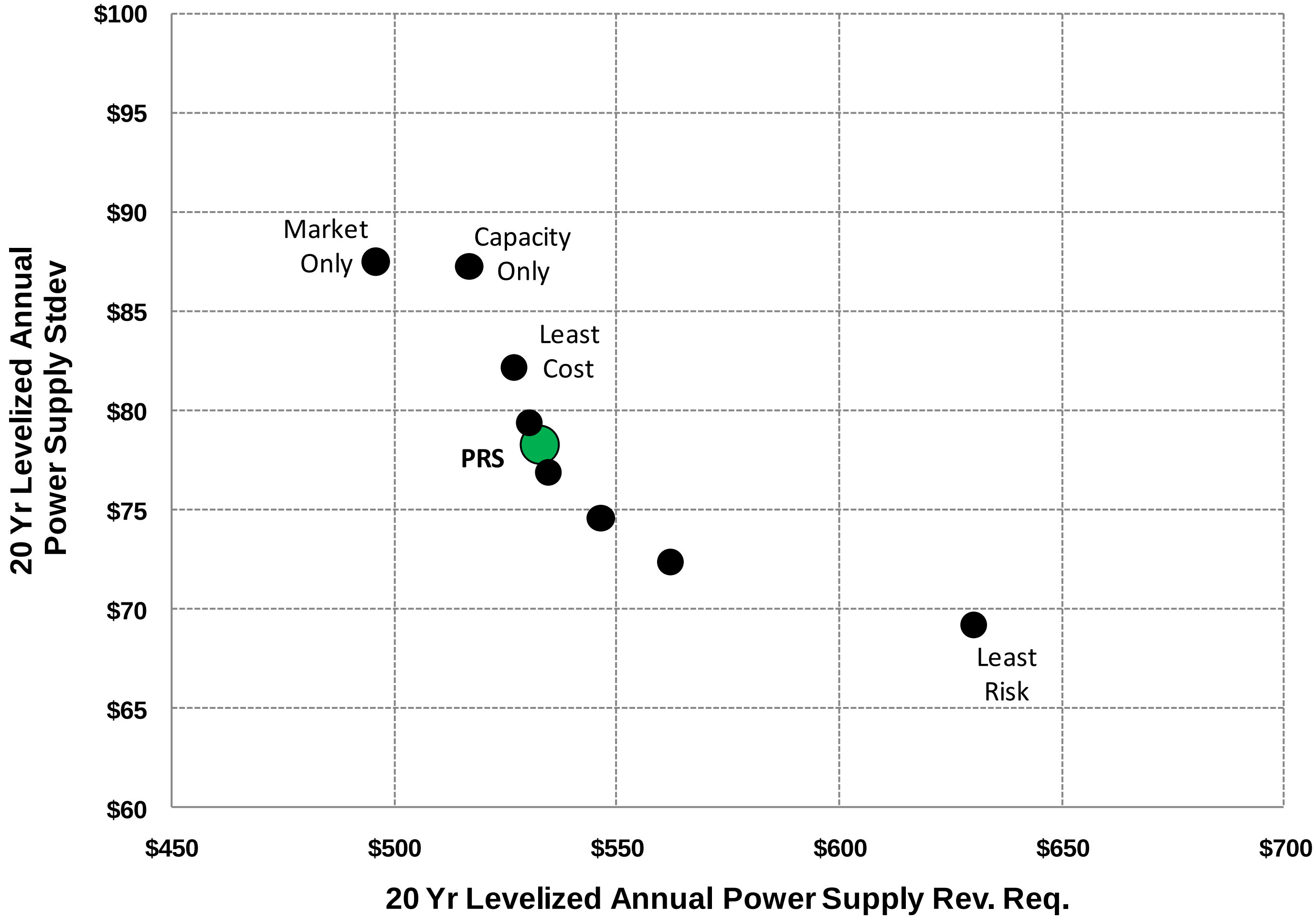
- Reserve requirement- Must hold REC reserves in “REC Bank” each year.
  - Sales uncertainty (5%)
  - Hydro uncertainty (26%)
  - Wind uncertainty (30%)
  - Currently 8 aMW
- Roll over rights- RECs can be used for prior year or future year. Plan is to use 2011 REC for 2012, then excess 2012 RECs can be used for 2013.

WA State Renewable Portfolio Standard Compliance

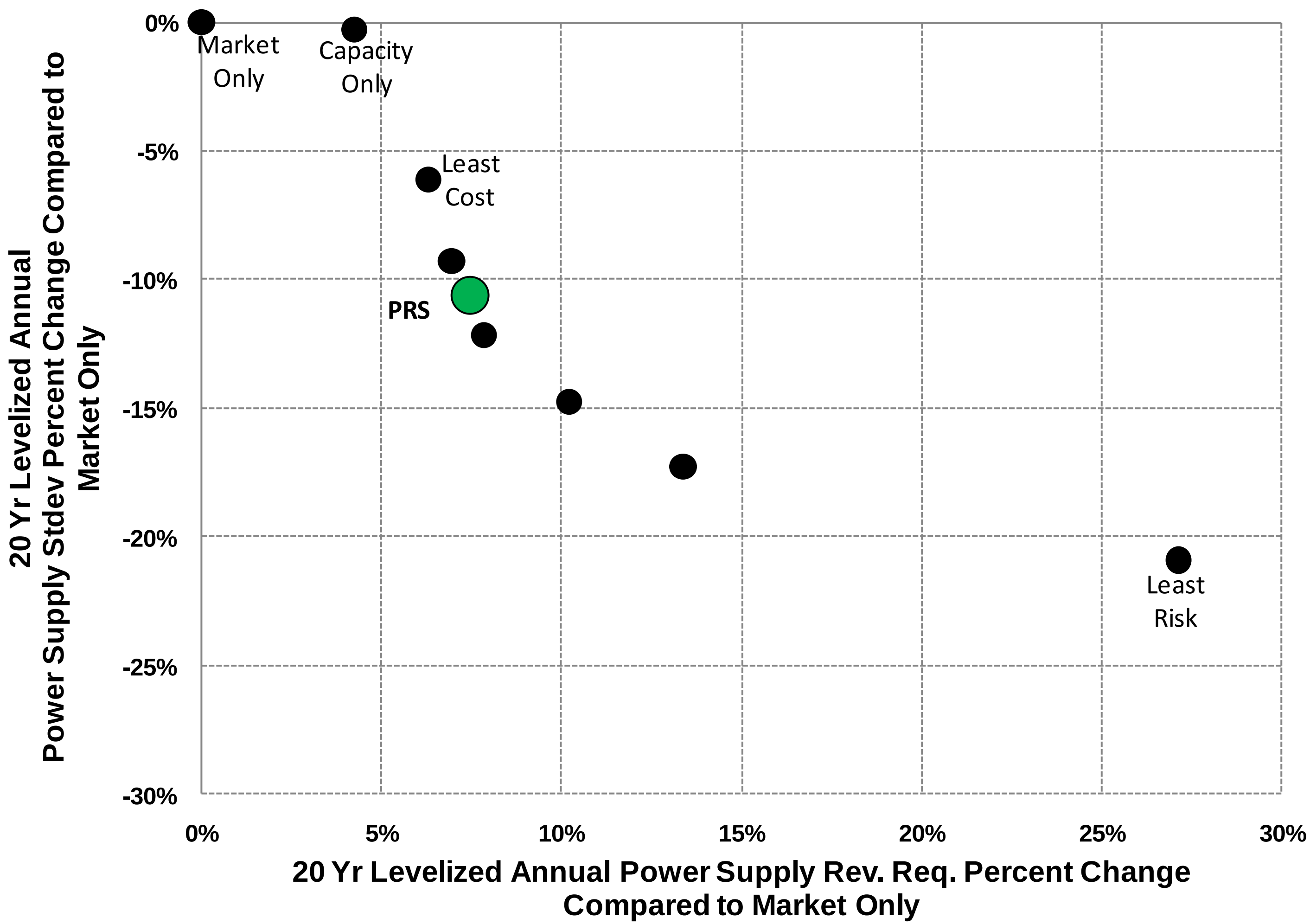
(Does Not Include Contingency)



Actual Efficient Frontier Results



Actual Efficient Frontier Results As a Percent of Market Only Portfolio



2009 Draft Preferred Resource Strategy

Year Ending	Resource
2012	150 MW NW Wind (48 aMW)
2013-2015	Little Falls Unit Upgrades (0.9 aMW)
2019	150 MW NW Wind (50 aMW)
2019	Combined Cycle CT (250 MW)
2020	Upper Falls Upgrade (1 aMW)
2022	50 MW NW Wind (17 aMW)
2024	Combined Cycle CT (250 MW)
2026/27	Combined Cycle CT (250 MW)
2010+	Distribution Feeder Upgrades (2.7 aMW by 2029)
2010+	Conservation (226 aMW by 2029)

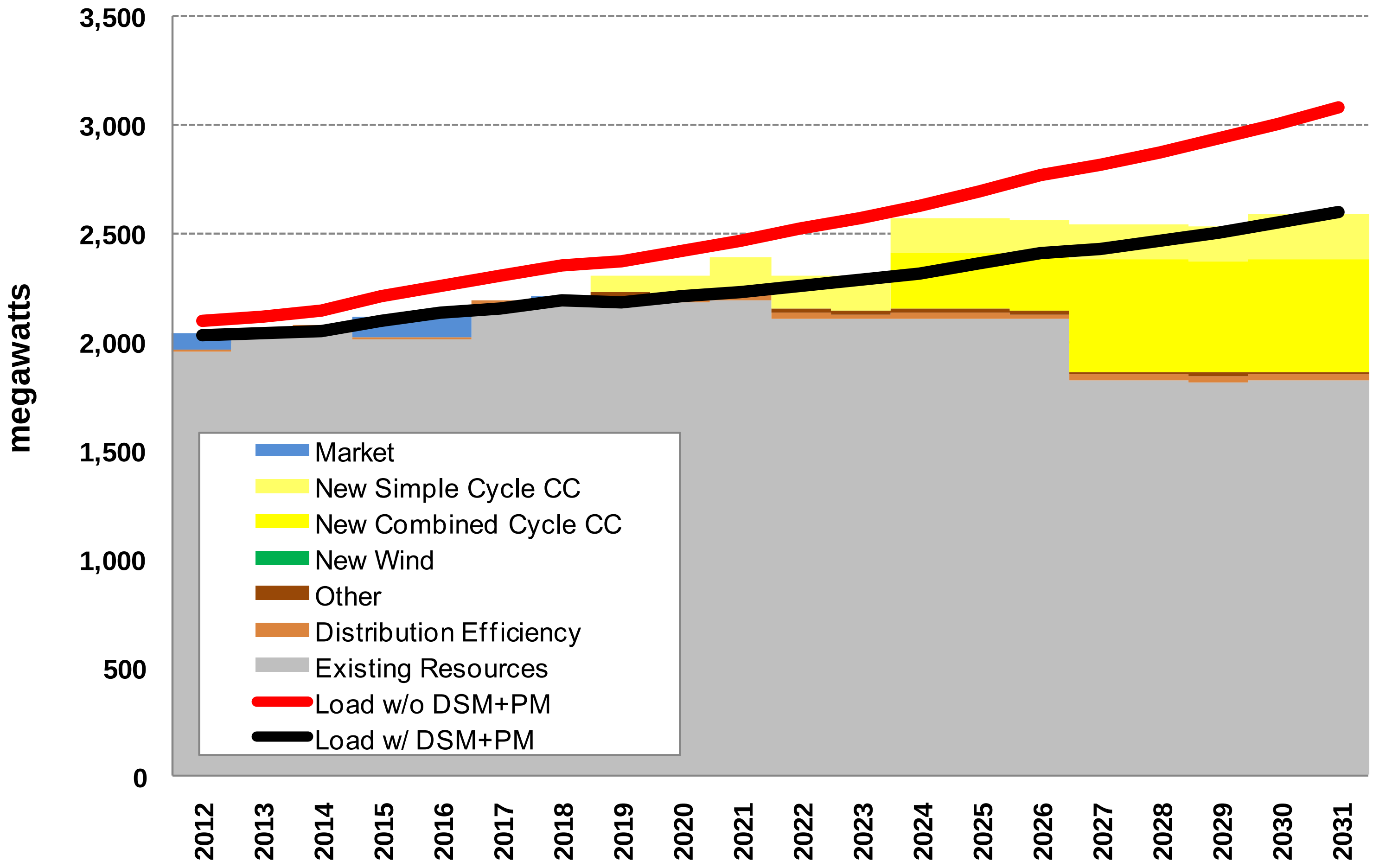
2011 Draft Preferred Resource Strategy

Year Ending	Resource
2012	Wind (~ 42 aMW REC)
2018	Simple Cycle CT(~ 83 MW)
2020	Simple Cycle CT (~ 83 MW)
2018-2019	Thermal Upgrades (~ 7 MW)
2018-2019	Wind (~ 43 aMW REC)
2023	Combined Cycle CT (~ 270 MW)
2026/27	Combined Cycle CT (~ 270 MW)
2029	Simple Cycle CT (~ 46 MW)
2012+	Distribution Feeder Upgrades (13 aMW by 2031)
2012+	Conservation (310 aMW by 2031)

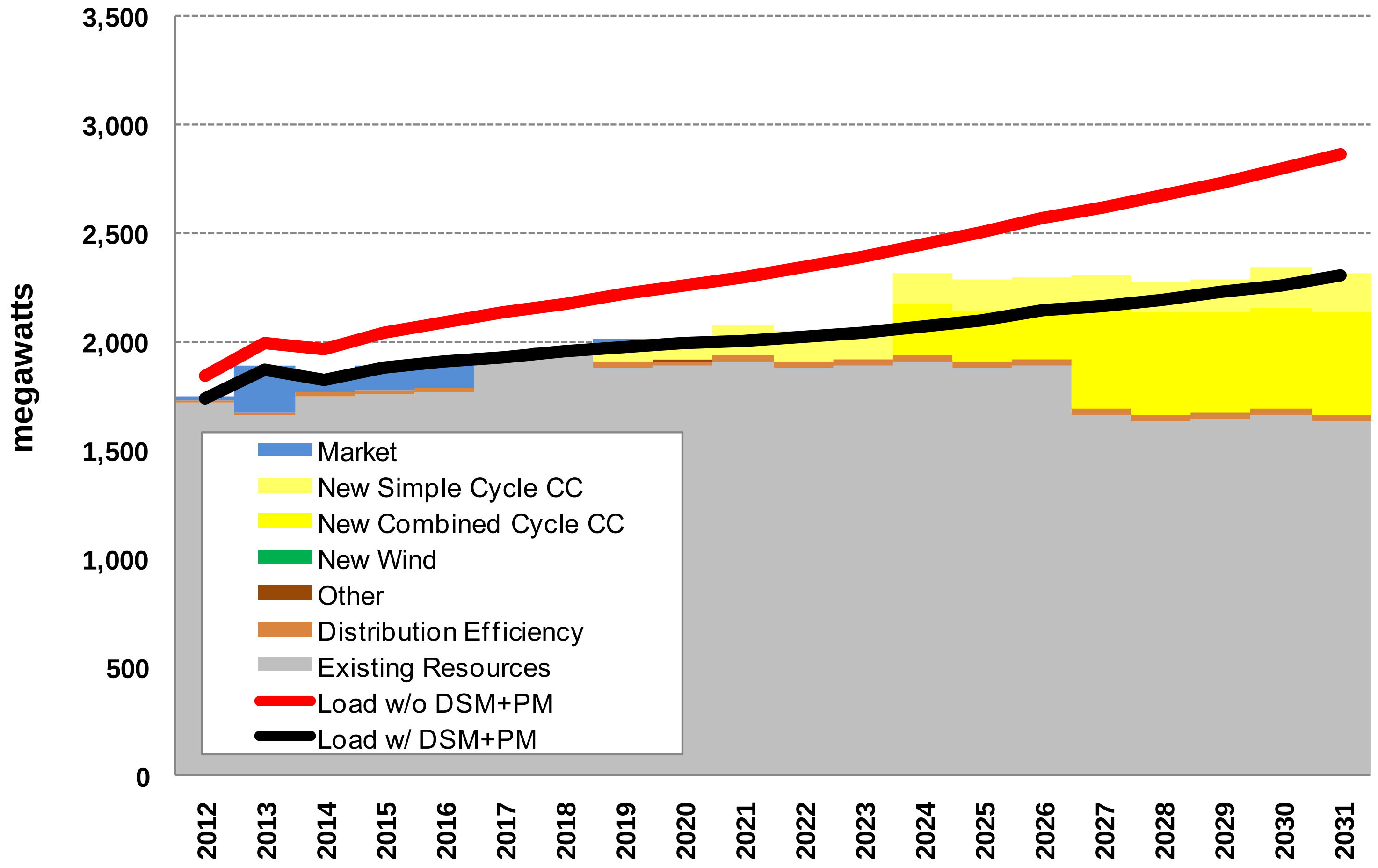
2011 IRP Comparison to 2009 IRP

- 2019: CCCT Replaced With Two CTs Over 3 Years
- 2012: Less Wind (42 aMW vs. 48 aMW)
- 2024/2027: CCCT Need Remains
- 2020: Less Wind (43 aMW vs. 50 aMW)
- 2022: Wind Need Eliminated (-17 aMW)
- 2030: Additional 46 MW CT
- 84 aMW Increased Conservation Over 20 Years
- 10 aMW Increased Distribution Losses Savings over 20 years
- Changes in Hydro Upgrade Assumptions
  - Little Falls in-kind replacement instead of upgrade
  - Upper Falls upgrade removed pending further study

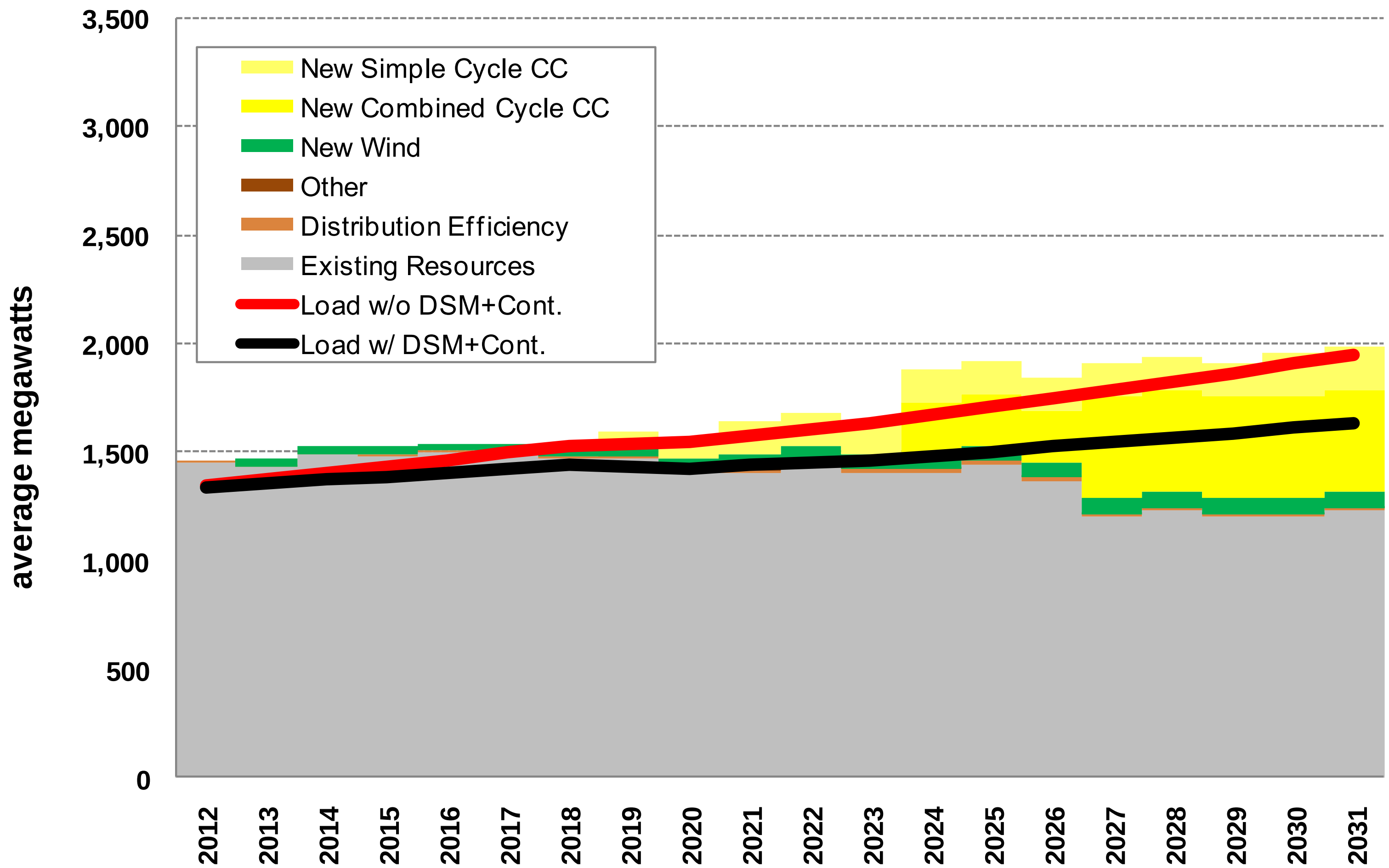
Winter Capacity Load and Resources



Summer Capacity Load and Resources



Annual Average Energy Load and Resources



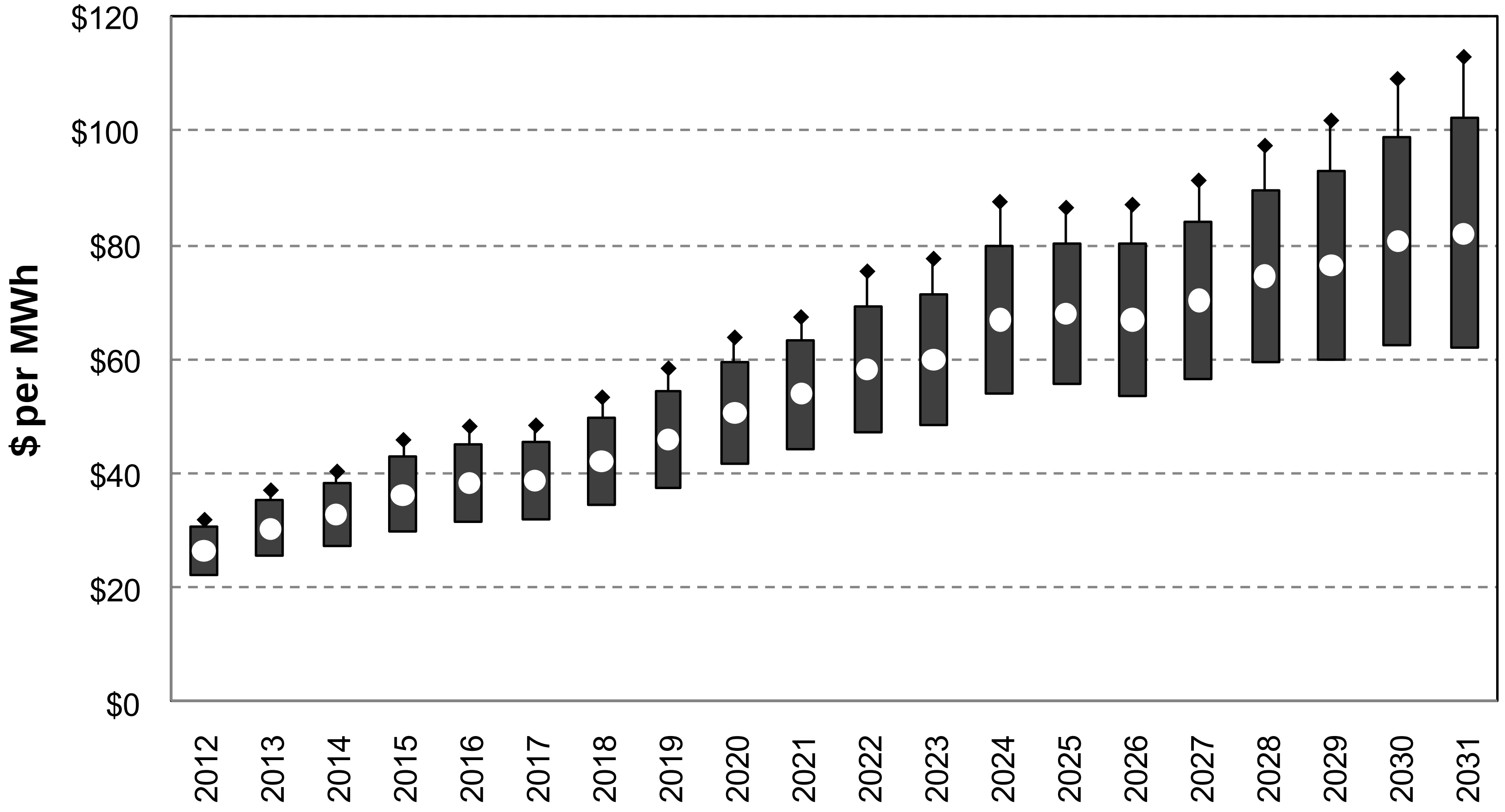
I-937 Table (aMW REC)

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Beginning Bank		17	7	19	19	42	47	51	55	59	36
Requirement	**0**	**(19)**	**(19)**	**(19)**	**(19)**	**(59)**	**(59)**	**(60)**	**(60)**	**(101)**	**(102)**
Current Available	17	23	26	28	28	22	22	22	22	22	22
New Qualifying RECs	0	0	42	42	42	42	42	42	42	57	85
Sold Qualifying RECs	0	(14)	(37)	(50)	(28)	0	0	0	0	0	(5)
End Bank	**17**	**7**	**19**	**19**	**42**	**47**	**51**	**55**	**59**	**36**	**36**
Contingency Bank	**0**	**7**	**8**	**8**	**8**	**23**	**23**	**23**	**23**	**36**	**36**

		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Beginning Bank		36	36	36	36	39	42	43	44	43	42
Requirement		**(103)**	**(103)**	**(103)**	**(104)**	**(105)**	**(106)**	**(107)**	**(108)**	**(109)**	**(110)**
Current Available		22	22	22	22	22	22	22	22	22	22
New Qualifying RECs		85	85	85	85	85	85	85	85	85	85
Sold Qualifying RECs		(5)	(4)	(4)	(0)	0	0	0	0	0	0
End Bank		**36**	**36**	**36**	**39**	**42**	**43**	**44**	**43**	**42**	**39**
Contingency Bank		**36**	**36**	**36**	**36**	**37**	**38**	**38**	**38**	**39**	**39**

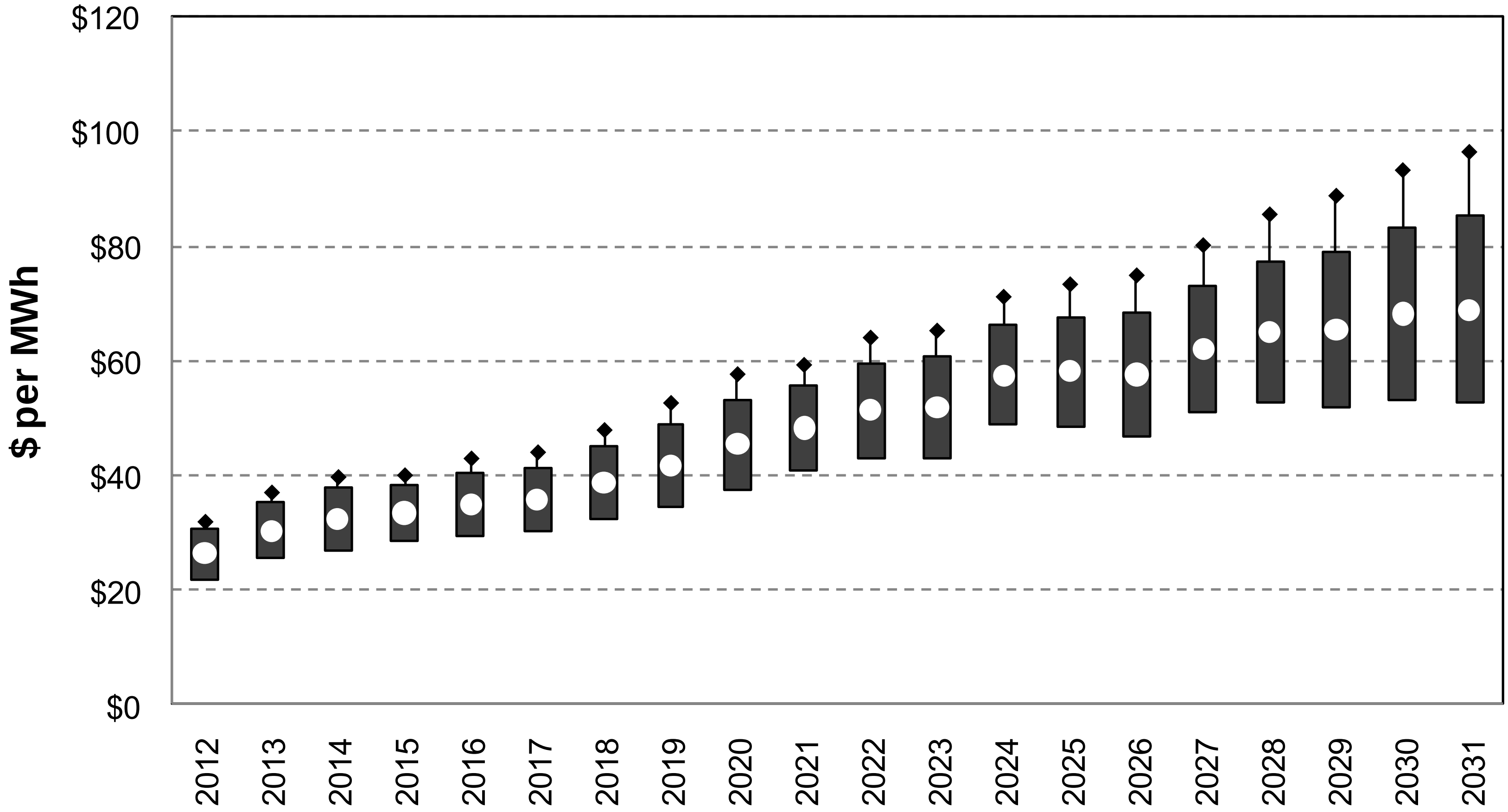
Preferred Resource Strategy Annual Costs per MWh Expected Market Conditions (80% Credit Allocation)

(Includes all Power Supply Costs except Capital Plant in Rate Base)



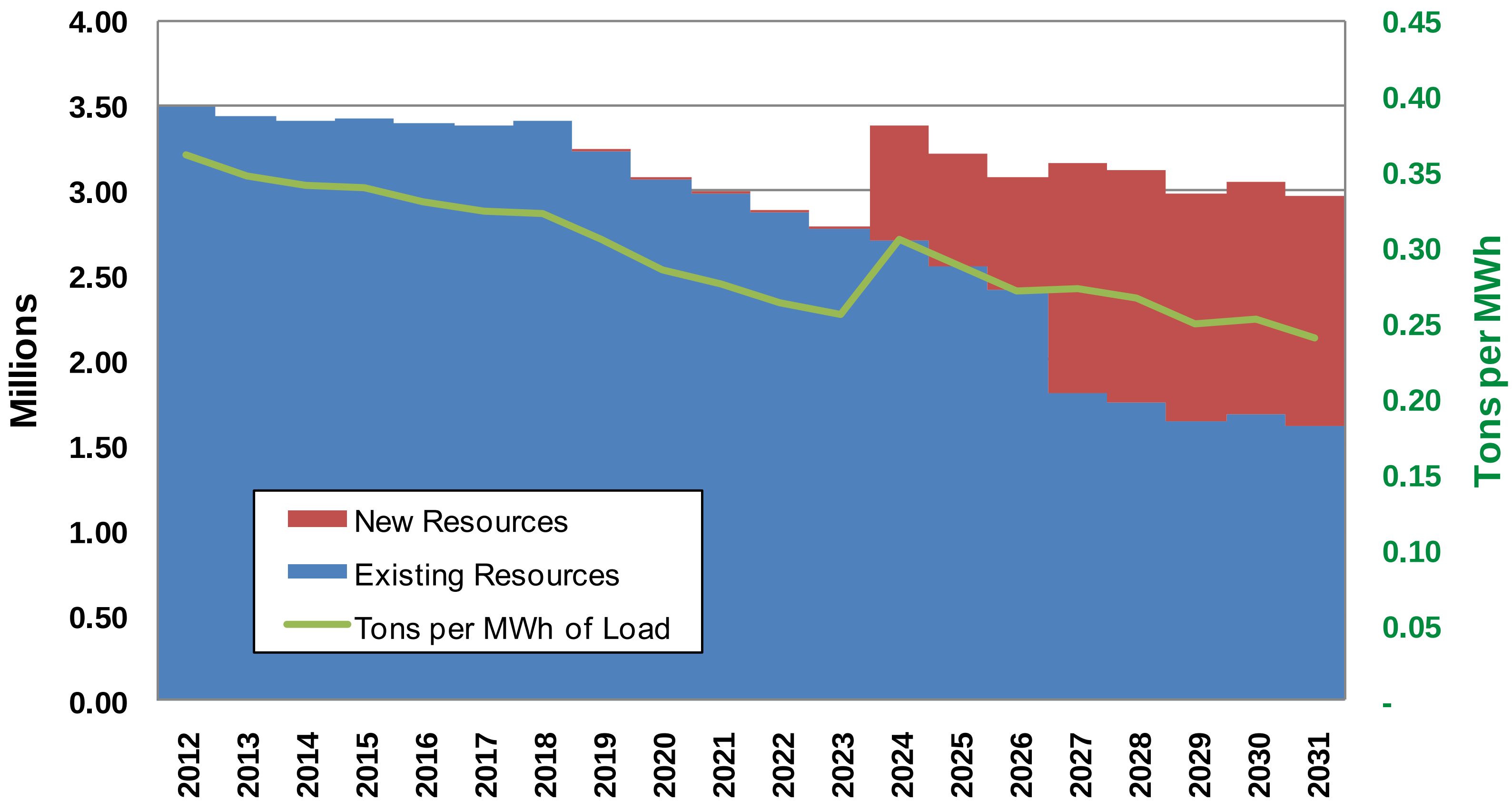
Preferred Resource Strategy Annual Costs per MWh No Carbon Legislation

(Includes Power Supply Costs except Capital Plant in Rate Base)

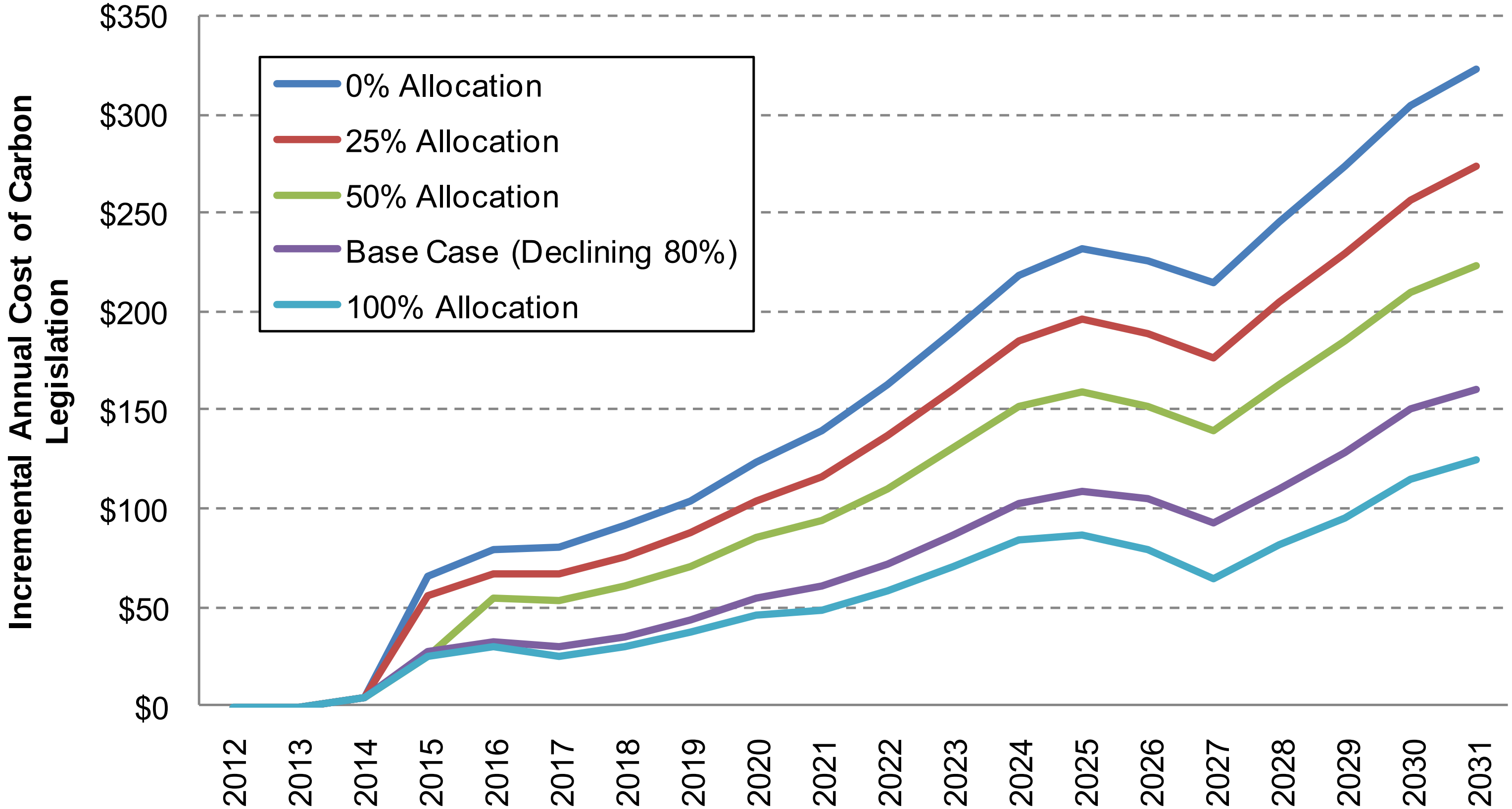


DRAFT

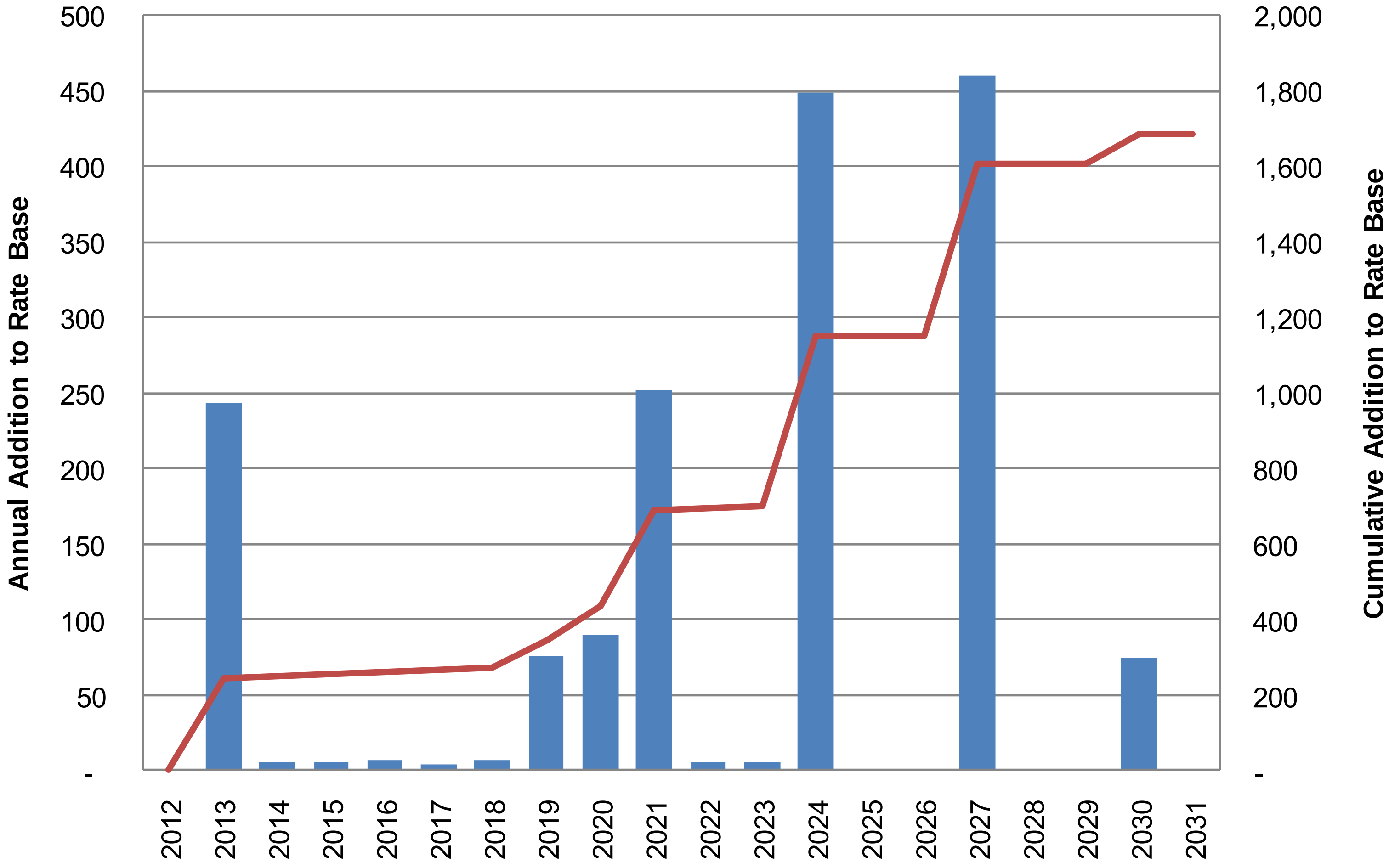
Greenhouse Gas Emissions (millions of short tons)



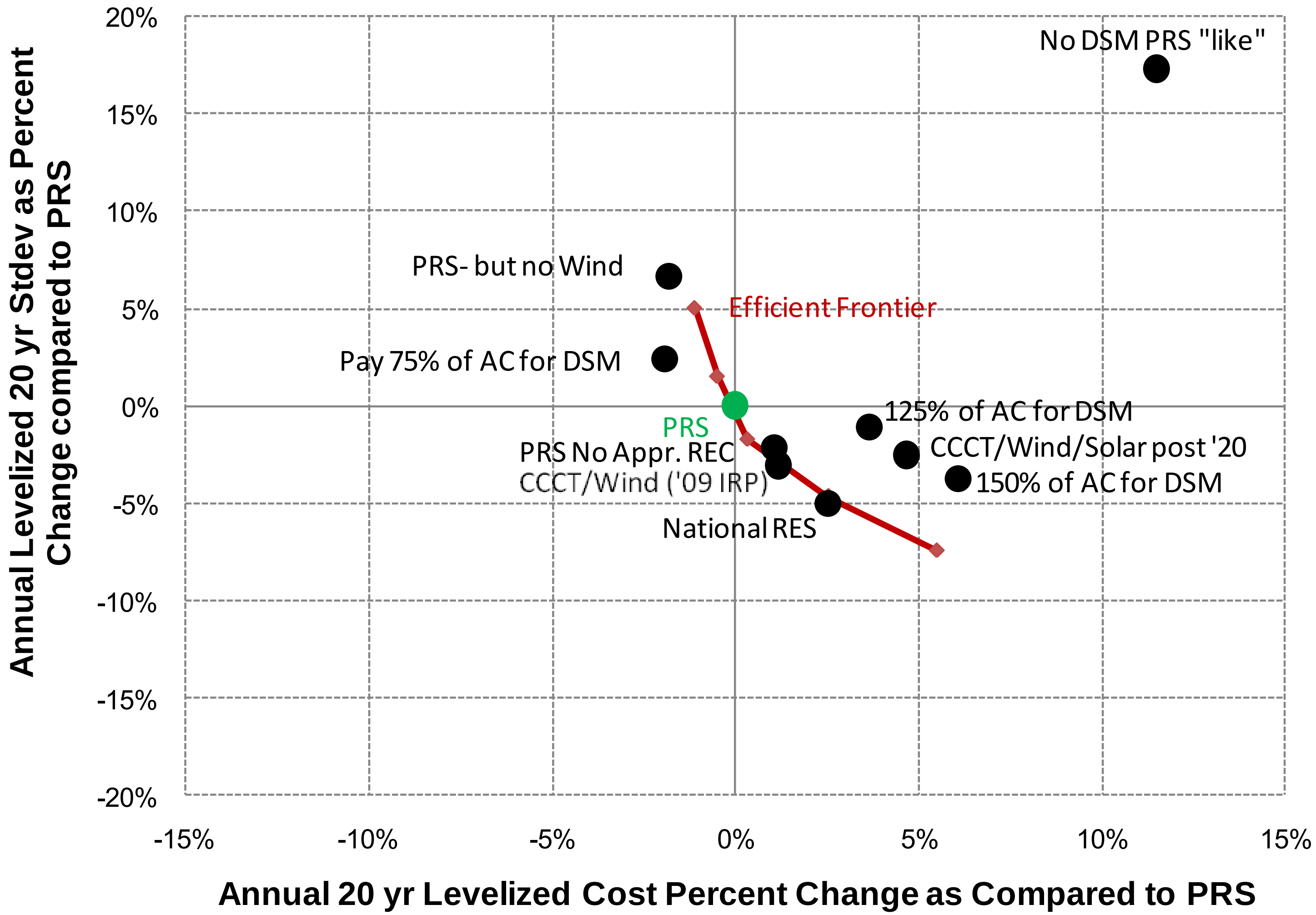
Greenhouse Gas Cost



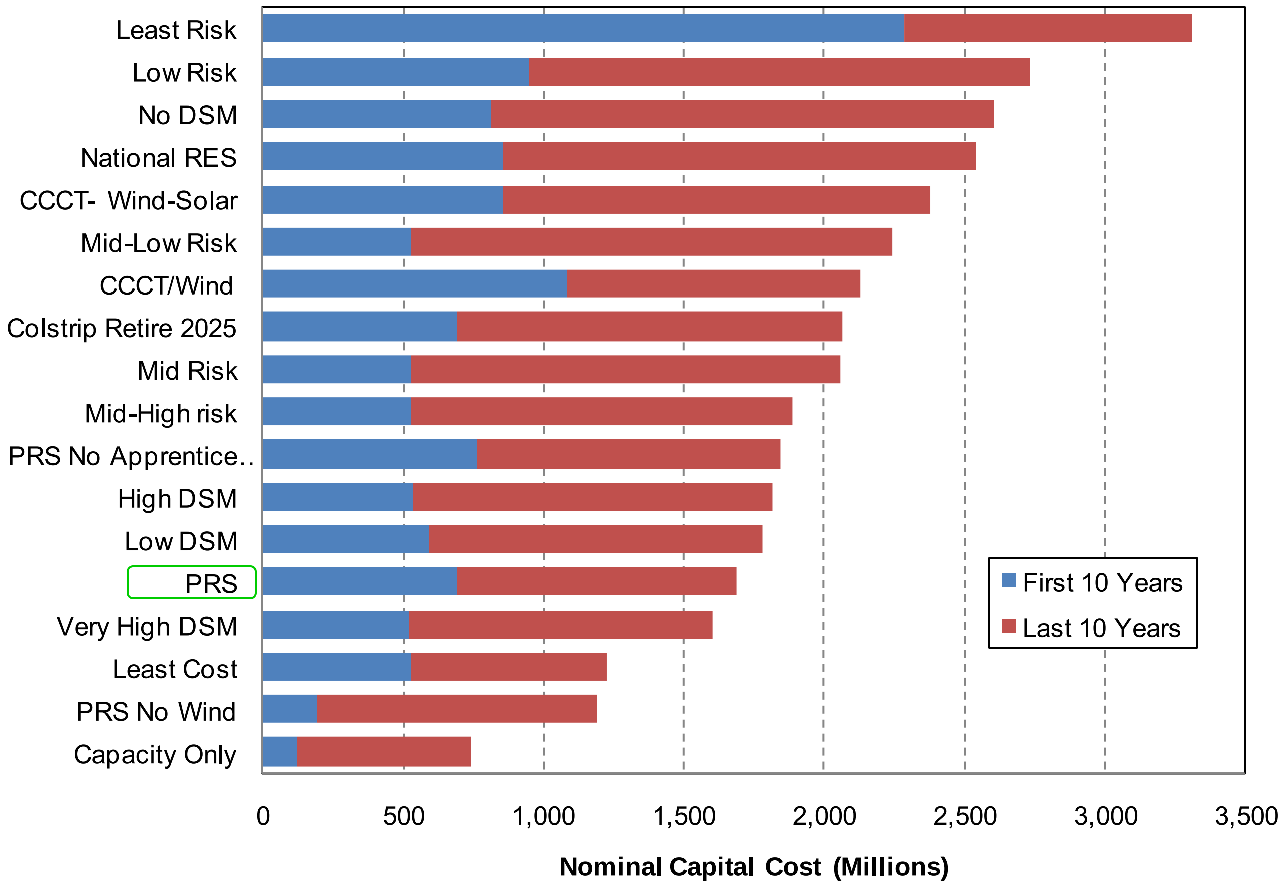
PRS Capital Requirements (millions $)



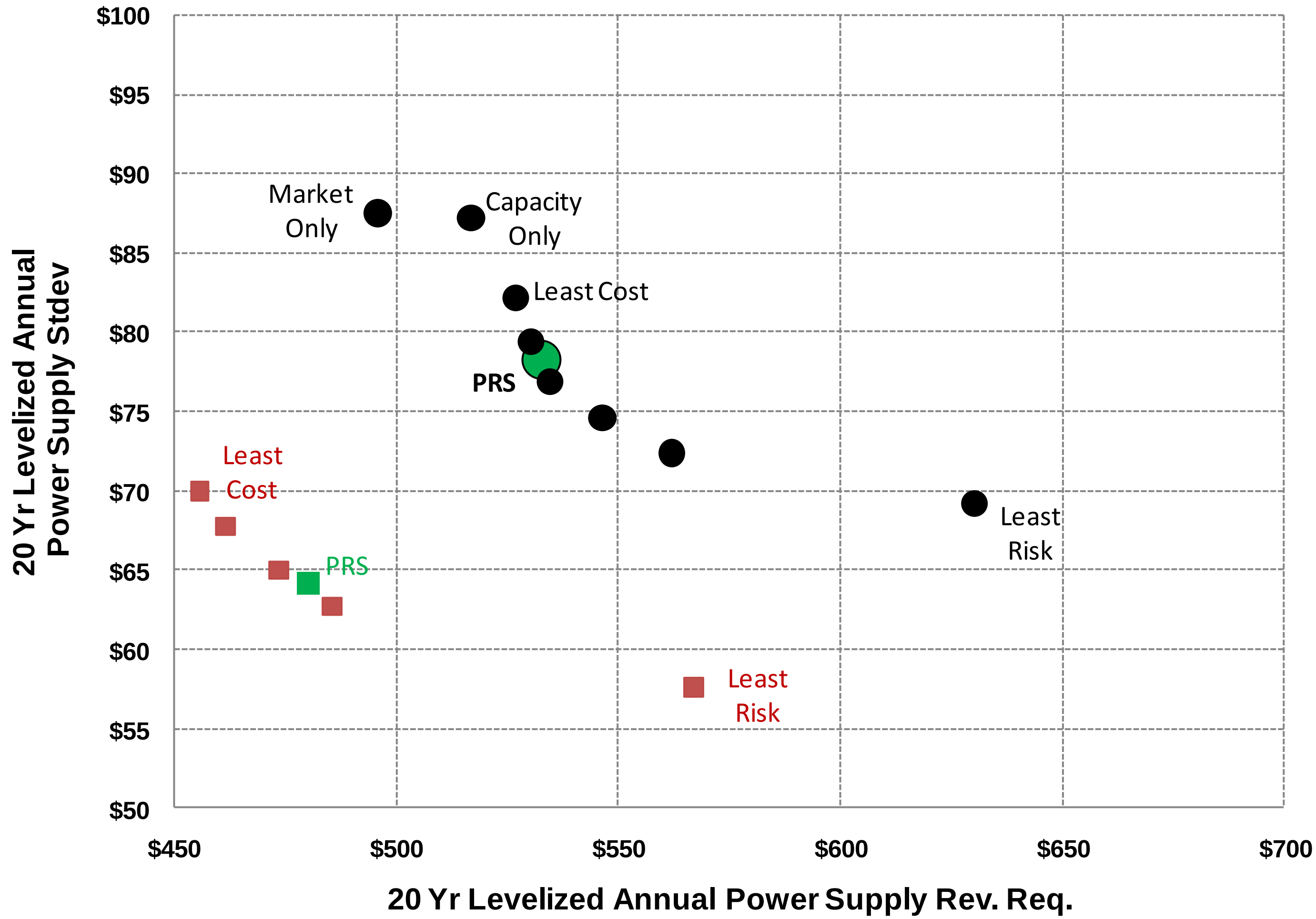
Alternative Strategies Comparison



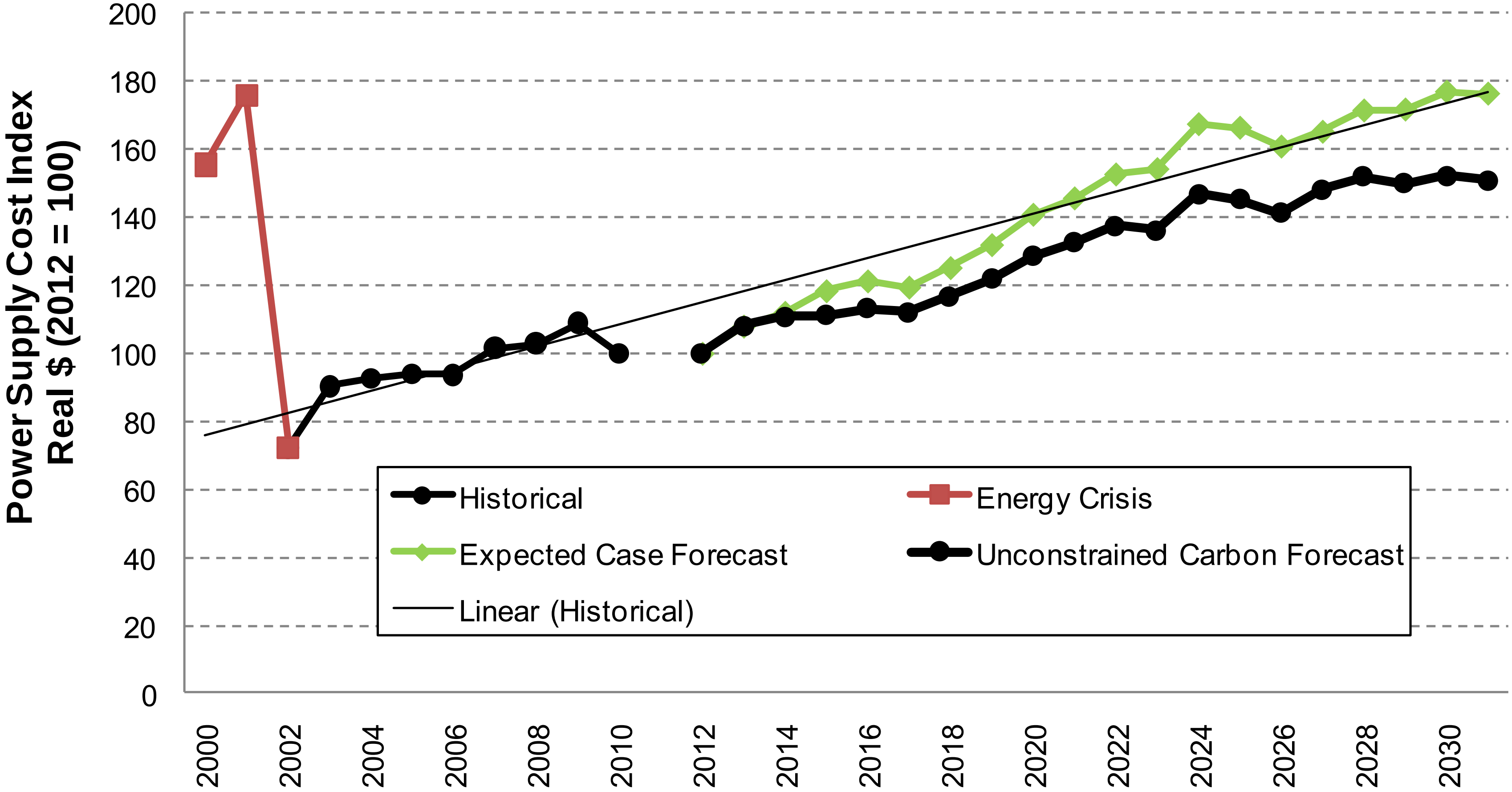
Capital Expenditures (Alternative Portfolios)



Base Case Efficient Frontier Compared to No Carbon Costs Efficient Frontier



Power Supply Cost Expected and Historical Growth Index

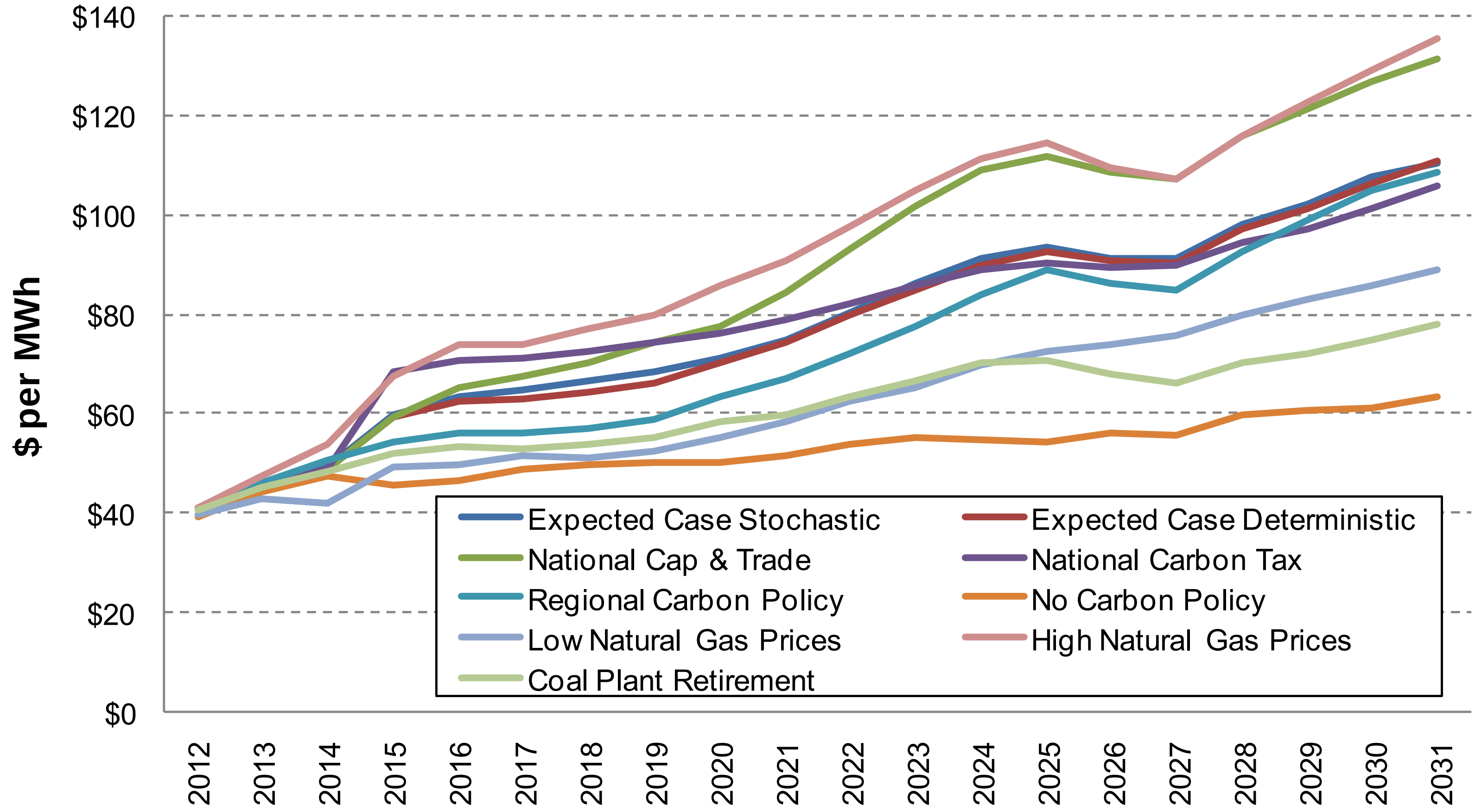


Resource Cost Tipping Point Analysis

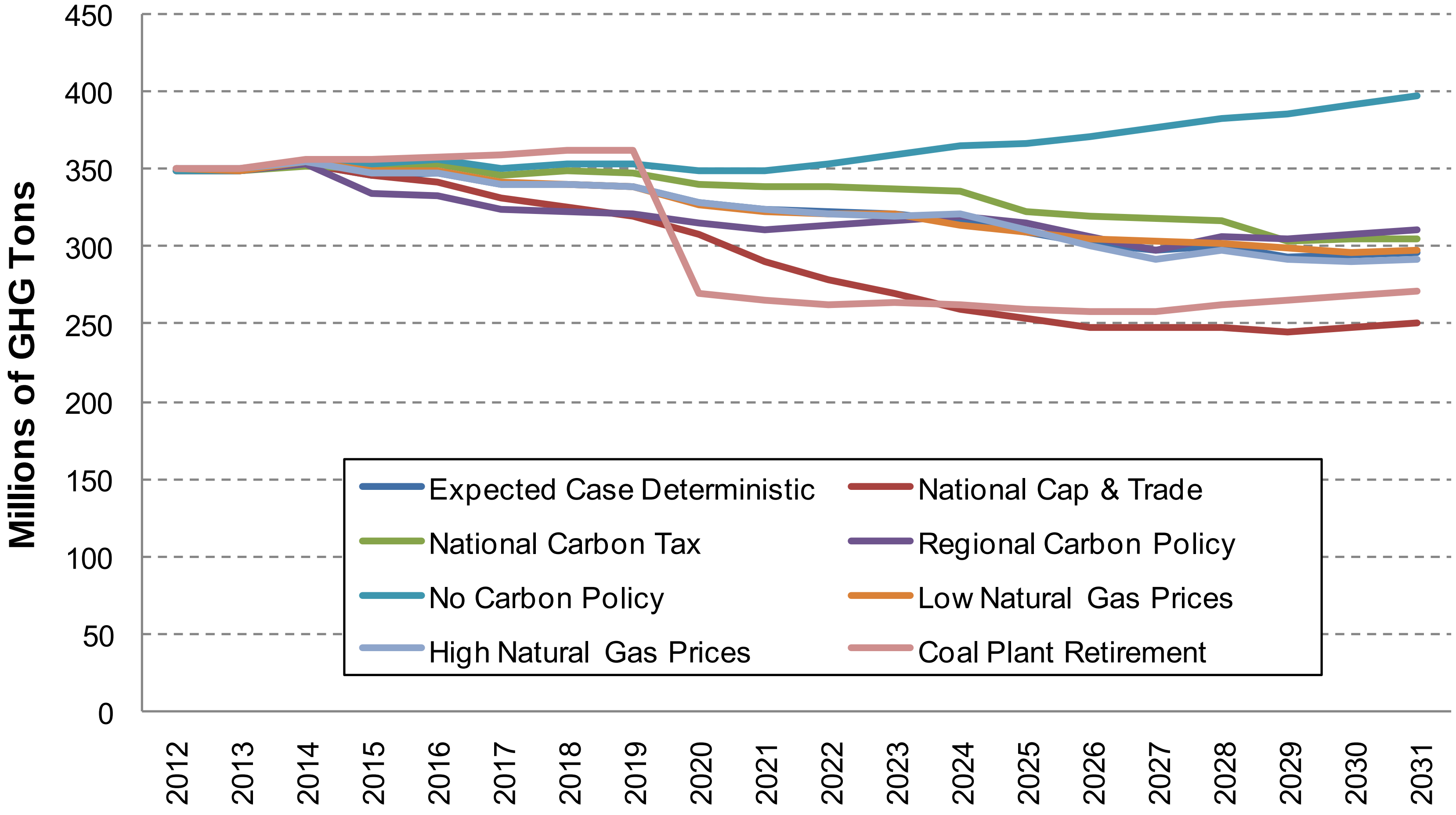
	Target Resource Capital Cost ($/kW)	Required Cost to be Selected ($/kW)	Percent Reduction
CCCT to replace SCCT to be least cost (2024)	$1,609	$1,255	-22%
Wind shift to Solar (2020) (2x REC included)	$4,371	$2,052	-53%

Market Scenario Analysis Update

Mid-Columbia Electric Price Forecast



US WECC GHG Emissions



Next Steps

- Obtain internal feedback and approvals of Preferred Resource Strategy
- Compare alternative resource portfolios using alternative market conditions
- Compare efficient frontier analysis with additional stochastic market analysis (i.e. coal plant retirement/Volatile NG)
- Further investigate Demand Response cost/benefits

Smart Grid Project Overview

TAC Meeting – April 12, 2011

Curtis Kirkeby, P.E.
Sr. Electrical Engineer – SGDP Principal Investigator

Avista Smart Grid Grants

Smart Grid Investment Grant (SGIG)

Spokane, WA

Smart Grid Demonstration Project (SGDP)

Pullman, WA

Smart Grid Workforce Training Grant

Jack Stewart Training Center - Spokane, WA

Smart Grid Workforce Training Grant

Five state partnership: Industry, Education, Labor

Benefits to Our Region –

- Local facility to train on new technology
- Leverage training needs of other Avista grants; build new curriculum
- Federal dollars to update existing training and facilities to up-skill current and future workers

Award:	$5.0 m over 3 years
Avista portion of award:	$1.3 m over 3 years
Grant Partner match	$6.8 m over 3 years

Grant Objectives

- Smart Grid Training Delivery
- Smart Grid Training Portal
- Share Best Practices on Smart Grid Training

"Create an effective and efficient electric power workforce proficient in smart grid competencies"

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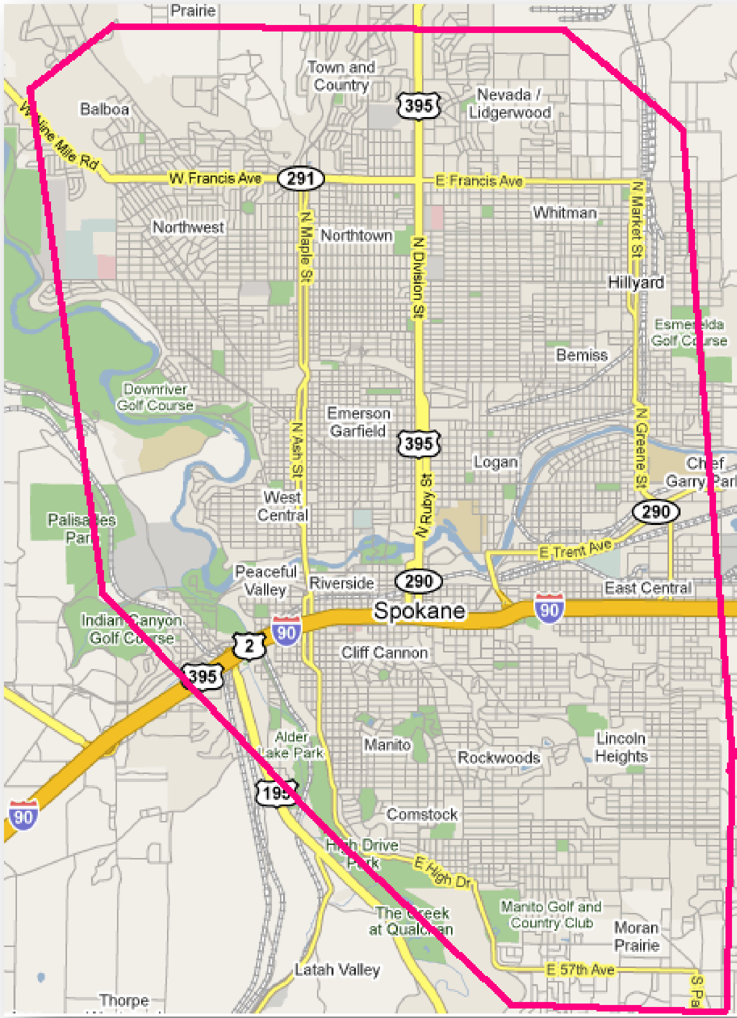
Avista Objectives

- Construct a training substation for training on smart grid technology
- Update training programs to incorporate smart grid technology
- On-line curriculum to be shared by utilities and colleges

SGIG – Spokane, WA



- Target
- 59 Distribution Circuits
- 110,000 Electric Customers
- 14 Substations

Loss Reduction – 42,000 Mega watt hours/Year

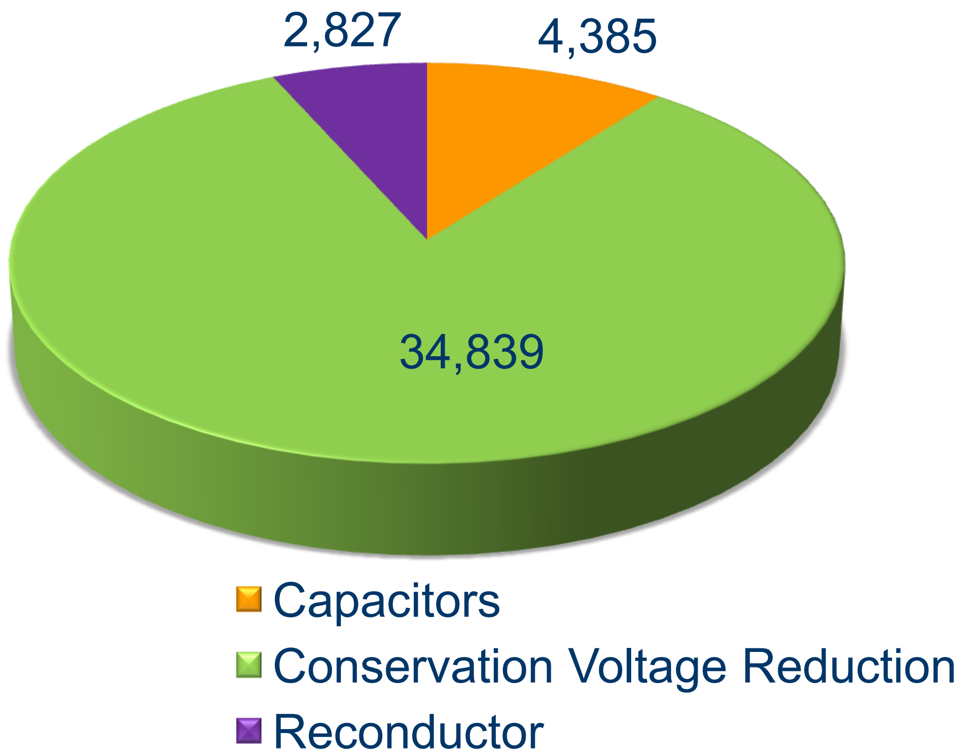
2500 Homes/Year

Green House Gas Reduction: 14,000 Tons

SGIG – Benefits

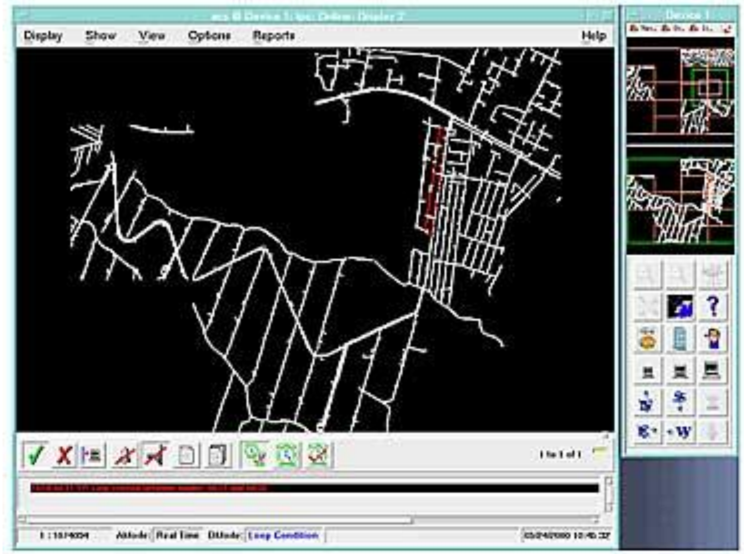
Carbon Reduction: 14,360 Tons a year.
- $50/Ton to Sequester
- $718,000/year.

Savings (MWh)

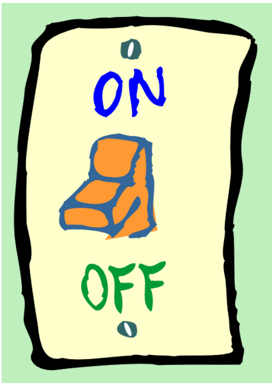


SGIG – Enabling Technologies

Communication:
- Wireless to Field Devices
- Fiber to Substations

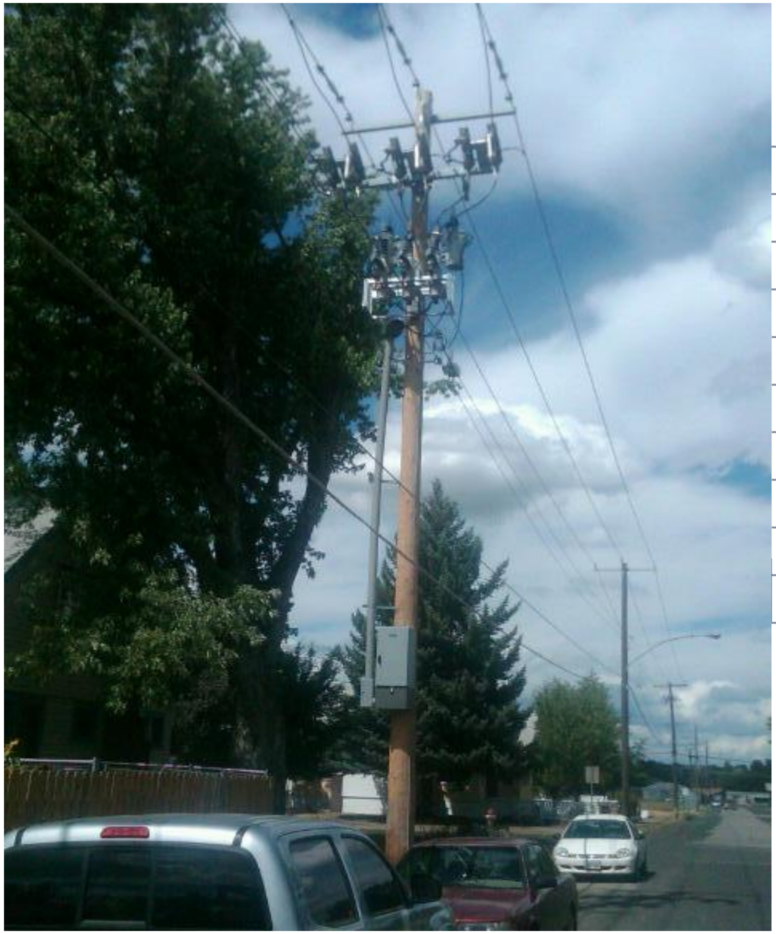


Field Equipment
- Switches and Reclosers
- Capacitor Banks
- Voltage Regulators



Distribution Management System (DMS)
- Remotely Control and Operate Distribution Equipment
- Continually Analyzing the System for Optimization
- Automated Fault Detection Isolation and Restoration

SGIG – Construction



Substation

Cap

■ Complete ■ To Be Completed

AVISTA

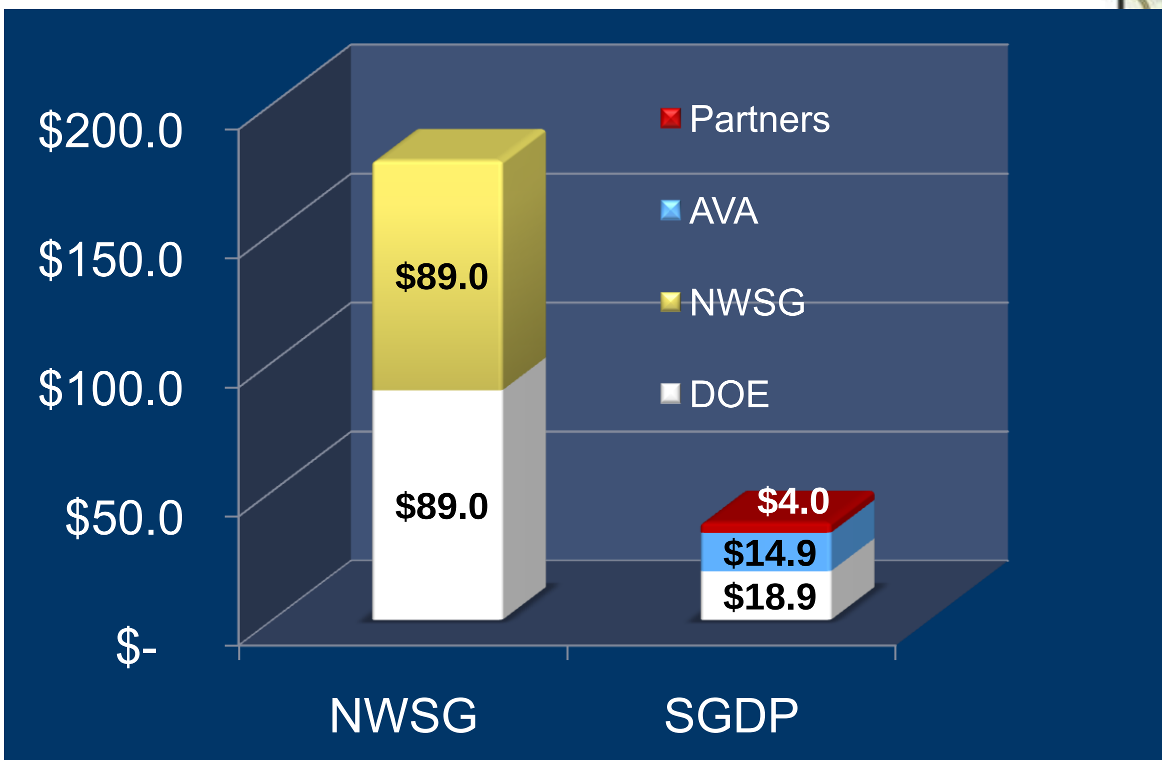
SGDP – Demonstration Project

Itron

hp

Washington State University
World Class. Face to Face.

Spirae



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SGDP – Regional Players

National Energy Technology Laboratory

Battelle NW

Bonneville Power Administration

3 Tier
Areva
IBM
Netezza
Quality Logic

Utility Partners

Avista
Benton PUD
City of Ellensburg
Flathead Electric
Idaho Falls Power
Lower Valley Energy
Milton-Freewater
Northwestern Energy
Peninsula Light
PGE
Seattle City Light (UW)

SGDP – System Elements

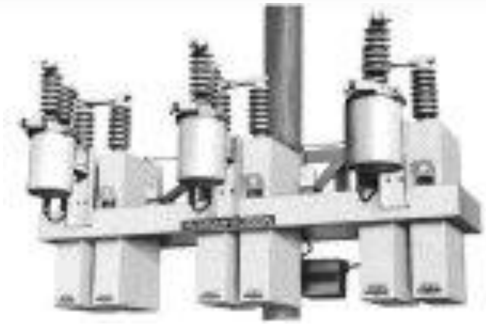
3 substations

- Regulator controls
- Reclosers/relays

13 circuits

- 45 automated line switches & reclosers
- 20 switched and fixed capacitor
- Fault Indicators
- Low loss transformers w/ communications

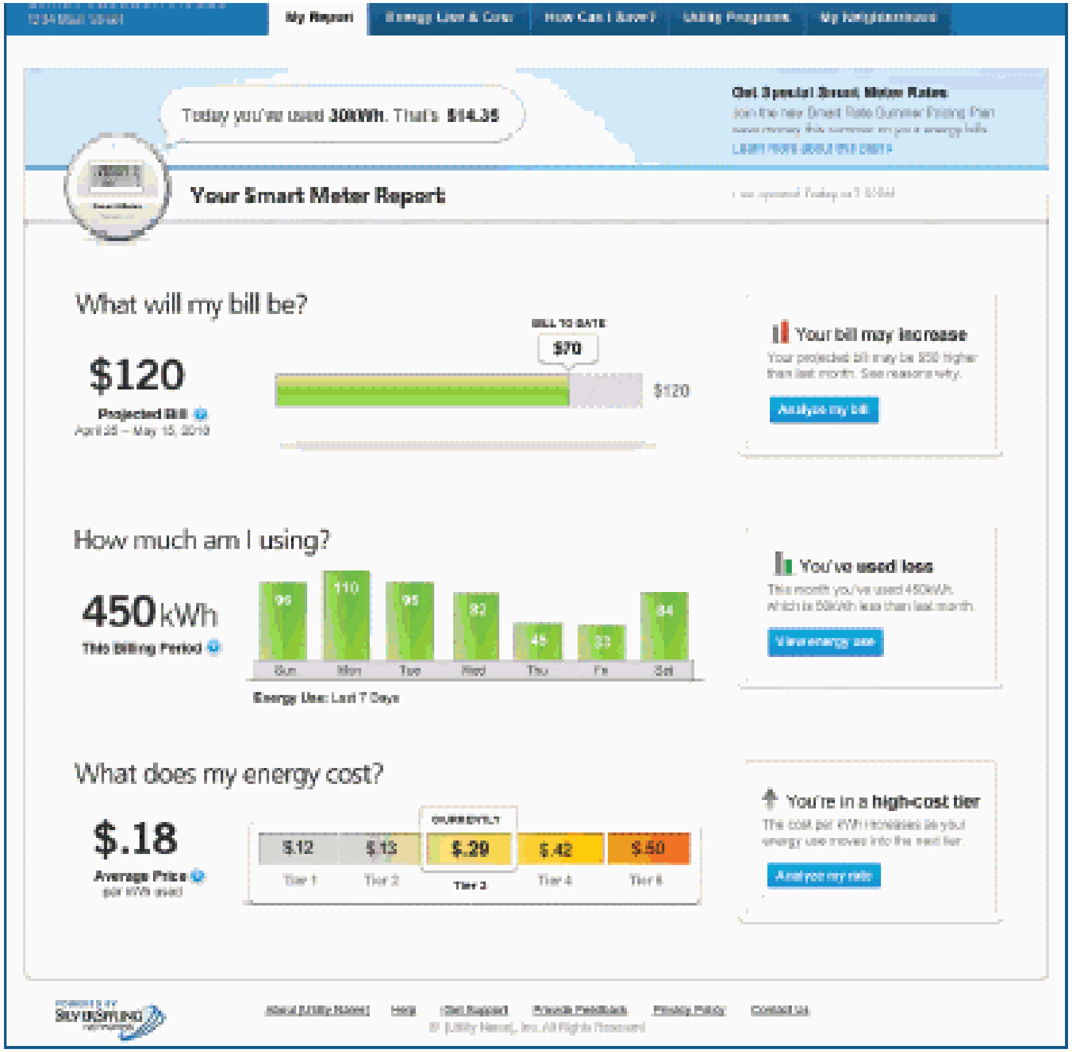
Wireless & fiber communications



SGDP – Itron Open Way AMI

- ≈ 14,000 Residential / Commercial Electric Meters
- ≈ 6000 Residential / Commercial Gas Meter Registers
- Wireless Communication w/ Fiber Backhaul
- Remote Service Switch
- Back Office Software Systems

Customer Web Portals



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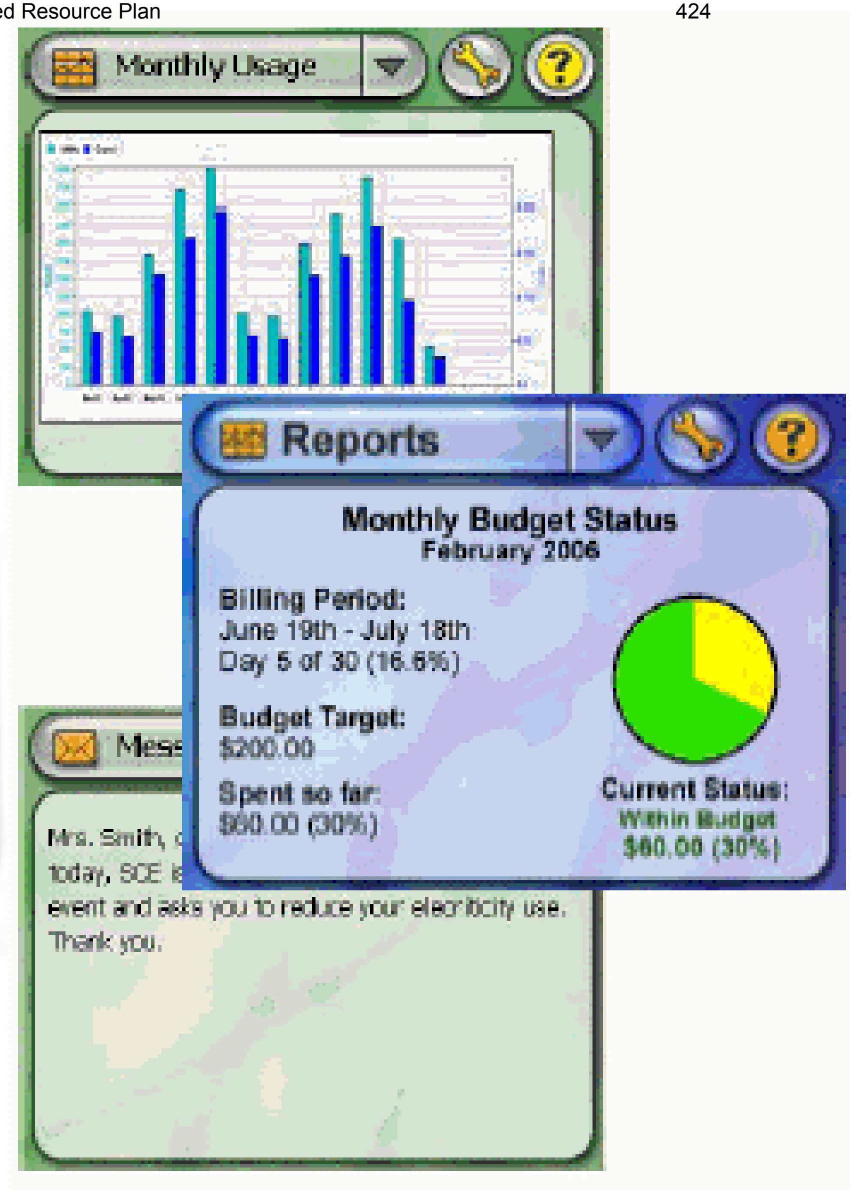
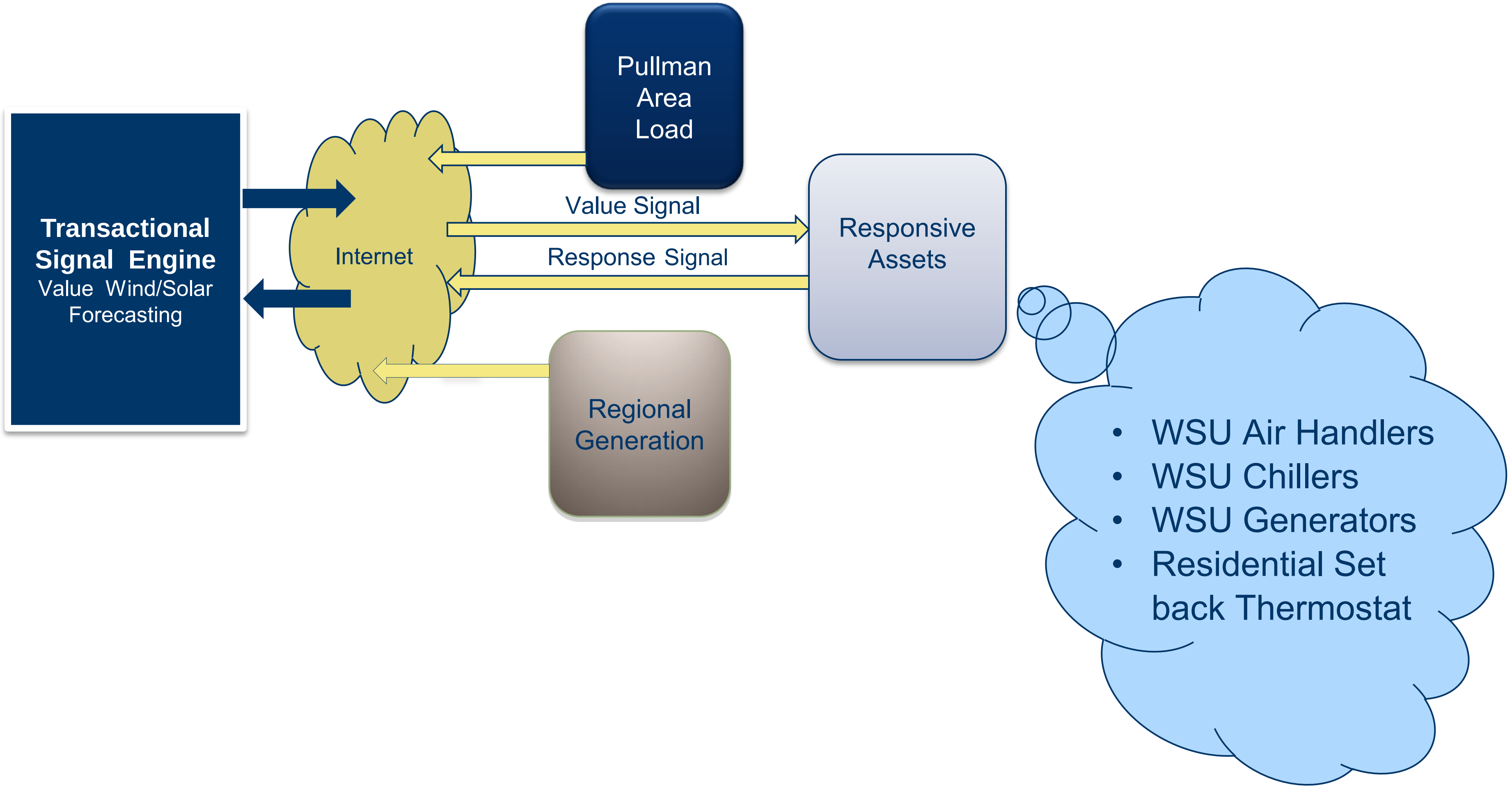
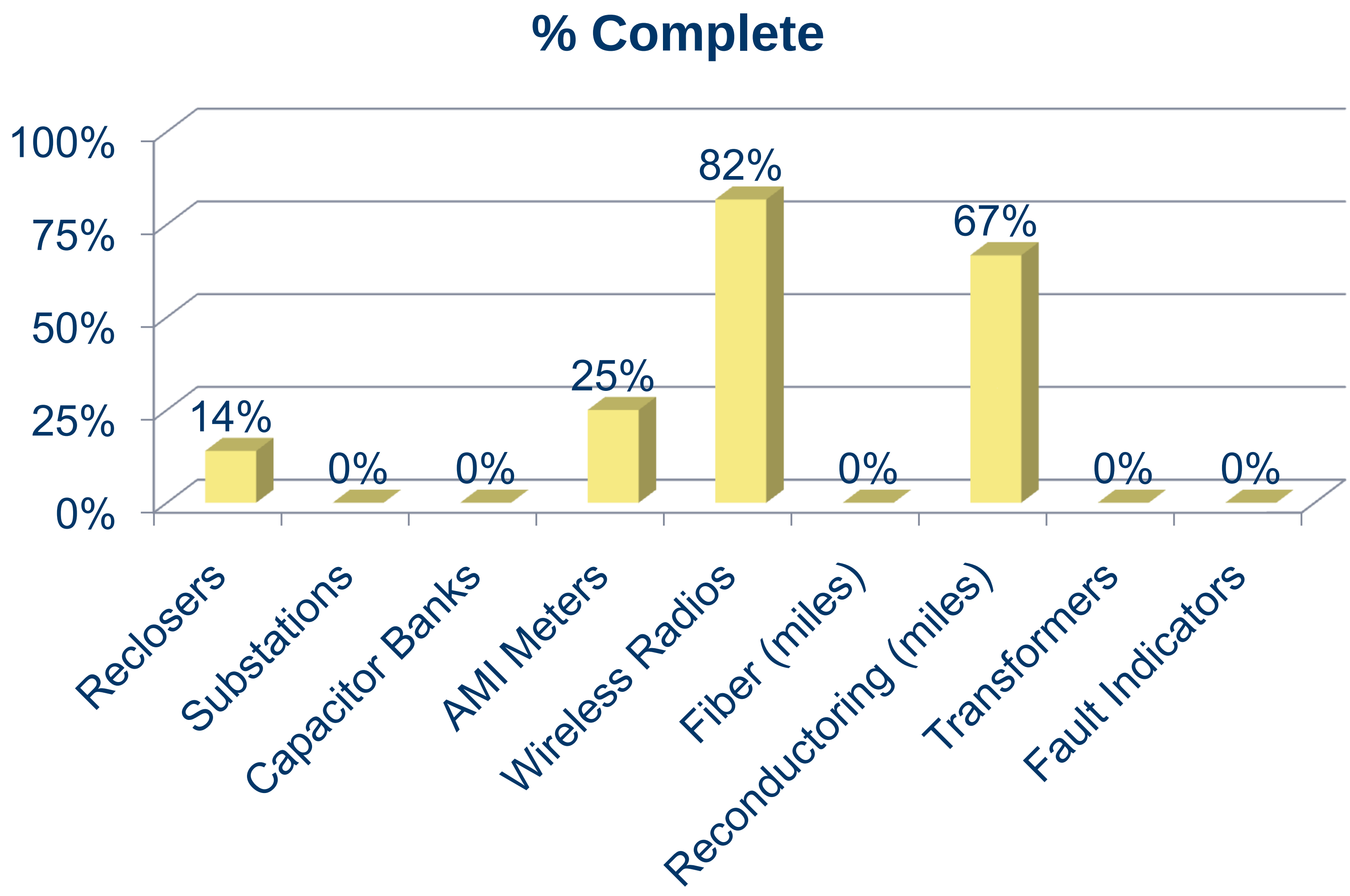
In-Home Displays



SGDP – Transactional Signal



SGDP – Construction



Smart Grid Energy Impacts

	SGIG (MWh)		SGDP (MWh)	
Year	Cumulative	I-937	Cumulative	I-937
2010	1500	1500	0	0
2011	7212	5712	286	286
2012	42051	34839	286	0
2013	42051	0	6763	6477

Future Programs

FEEDER REBUILDS

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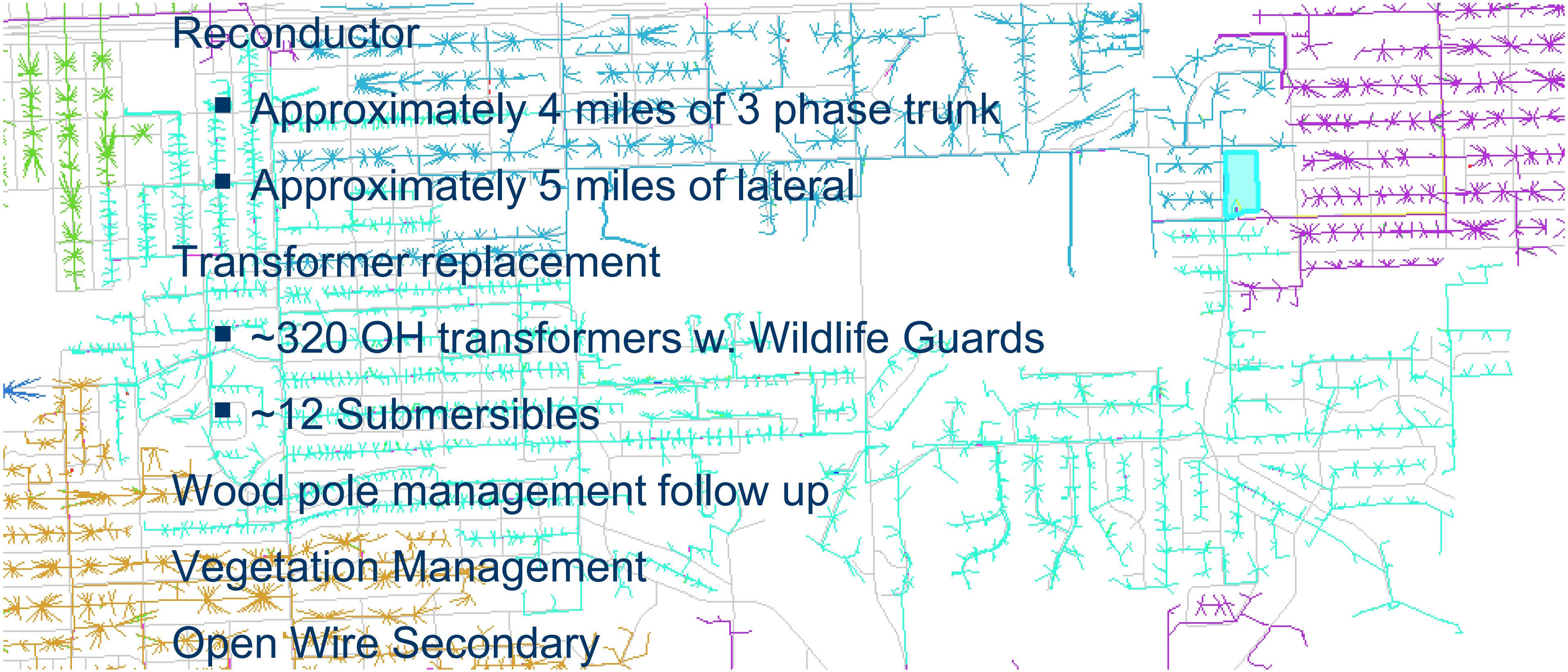
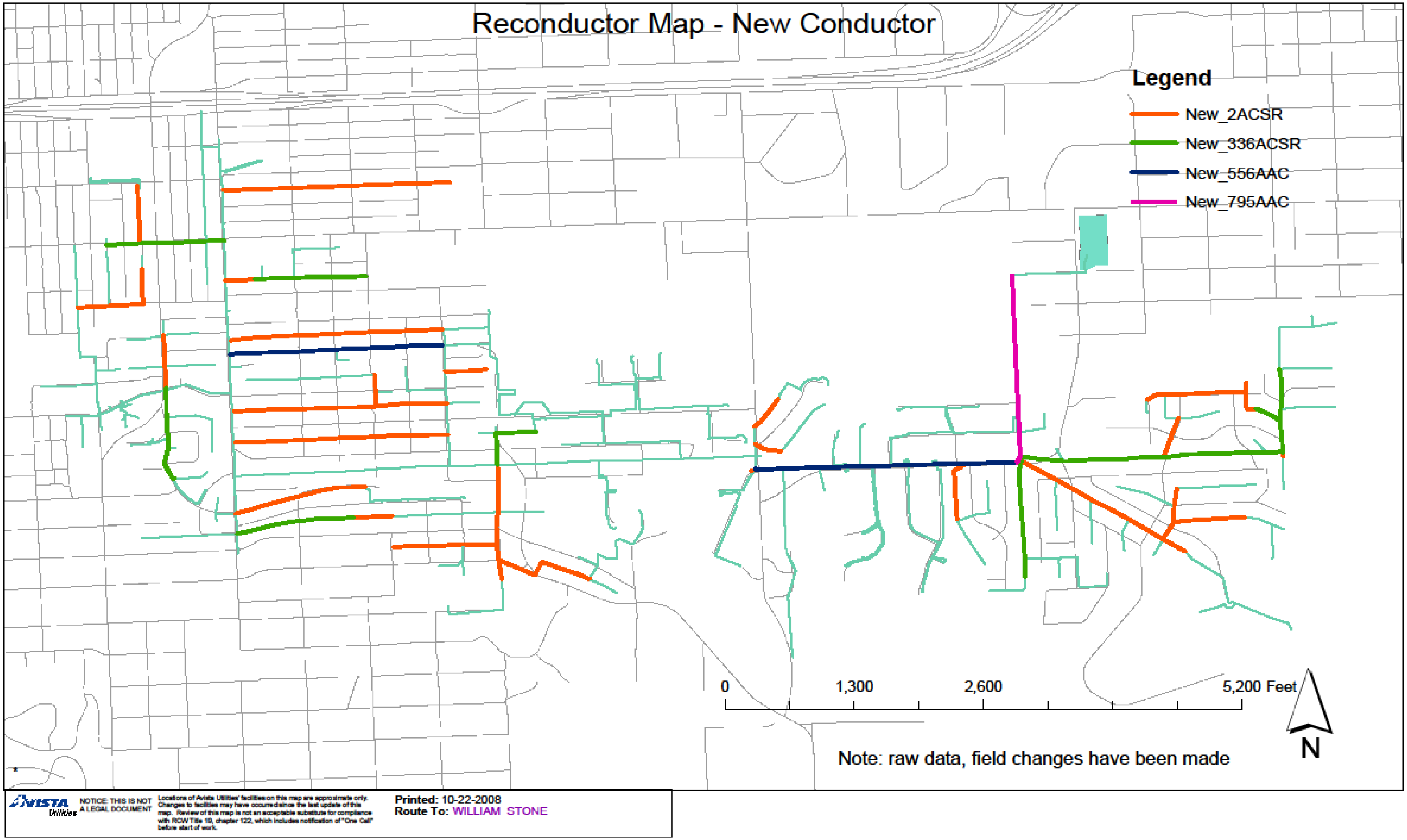
9th and Central 12F4 (9CE12F4) - 2009

Primary Goals



- Reconductor
  - Approximately 4 miles of 3 phase trunk
  - Approximately 5 miles of lateral
- Transformer replacement
  - ~320 OH transformers w. Wildlife Guards
  - ~12 Submersibles
- Wood pole management follow up
- Vegetation Management
- Open Wire Secondary

9CE12F4 Reconductor



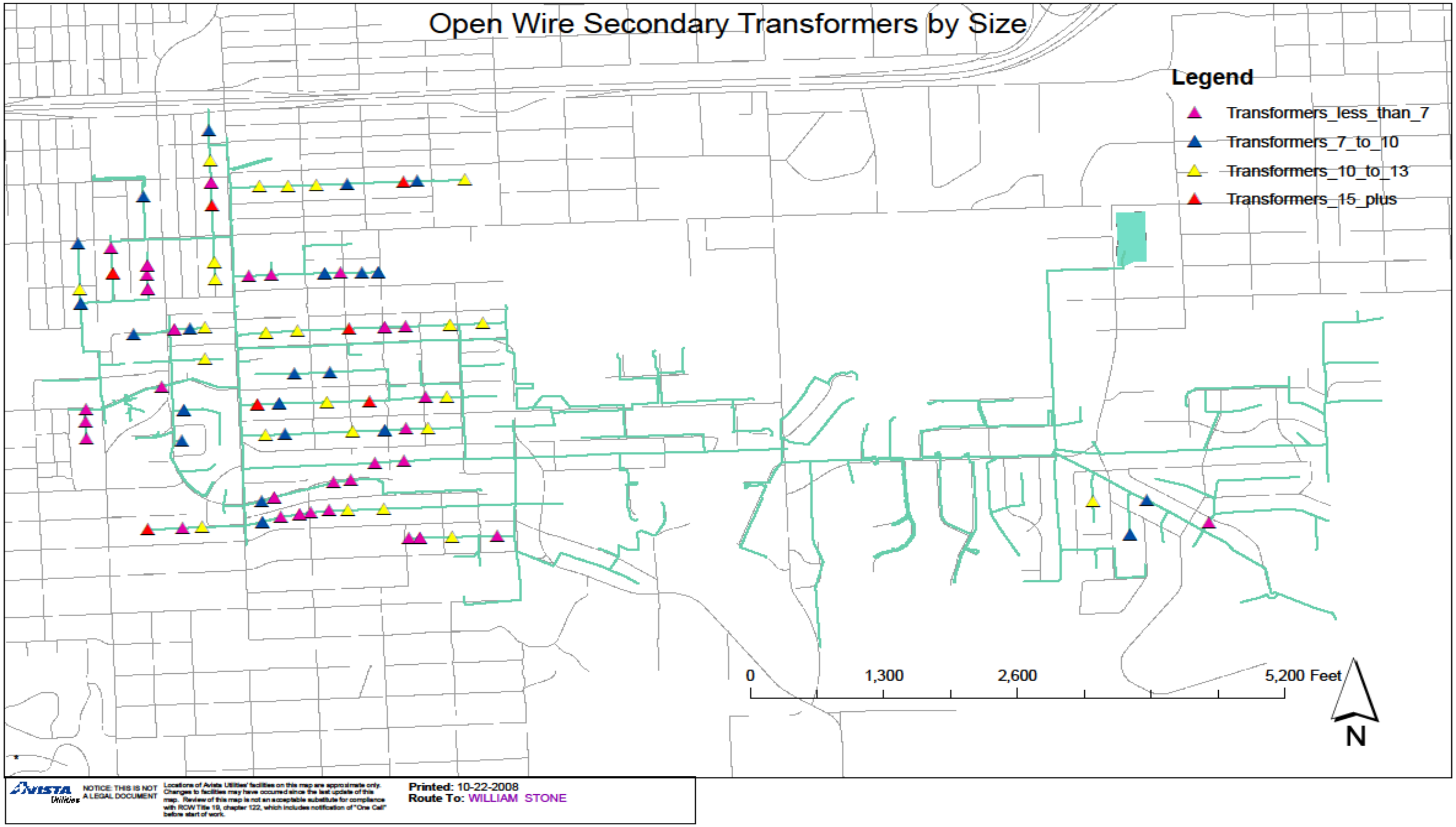
9CE12F4 Realignment

Good opportunity to move facilities where it makes sense for reliability and future maintenance and access

9CE12F4 Transformer Replacement

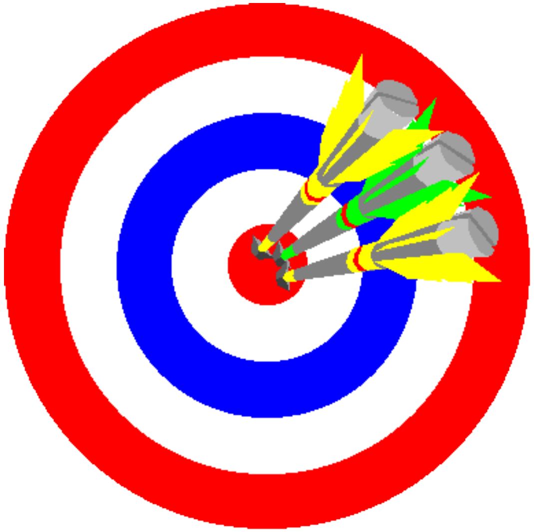
- All pre-2004 OH transformers replaced with new high efficiency units
- Lower core losses account for ~31 ave. kW

9CE12F4 Open Wire Secondary



9CE12F4 Outcome

- Clear understanding of the state of facility
- Understanding of work & resource staging
- Understanding of volt/var and voltage reduction opportunity
- Baseline for savings validation
- Future rebuilds are warranted

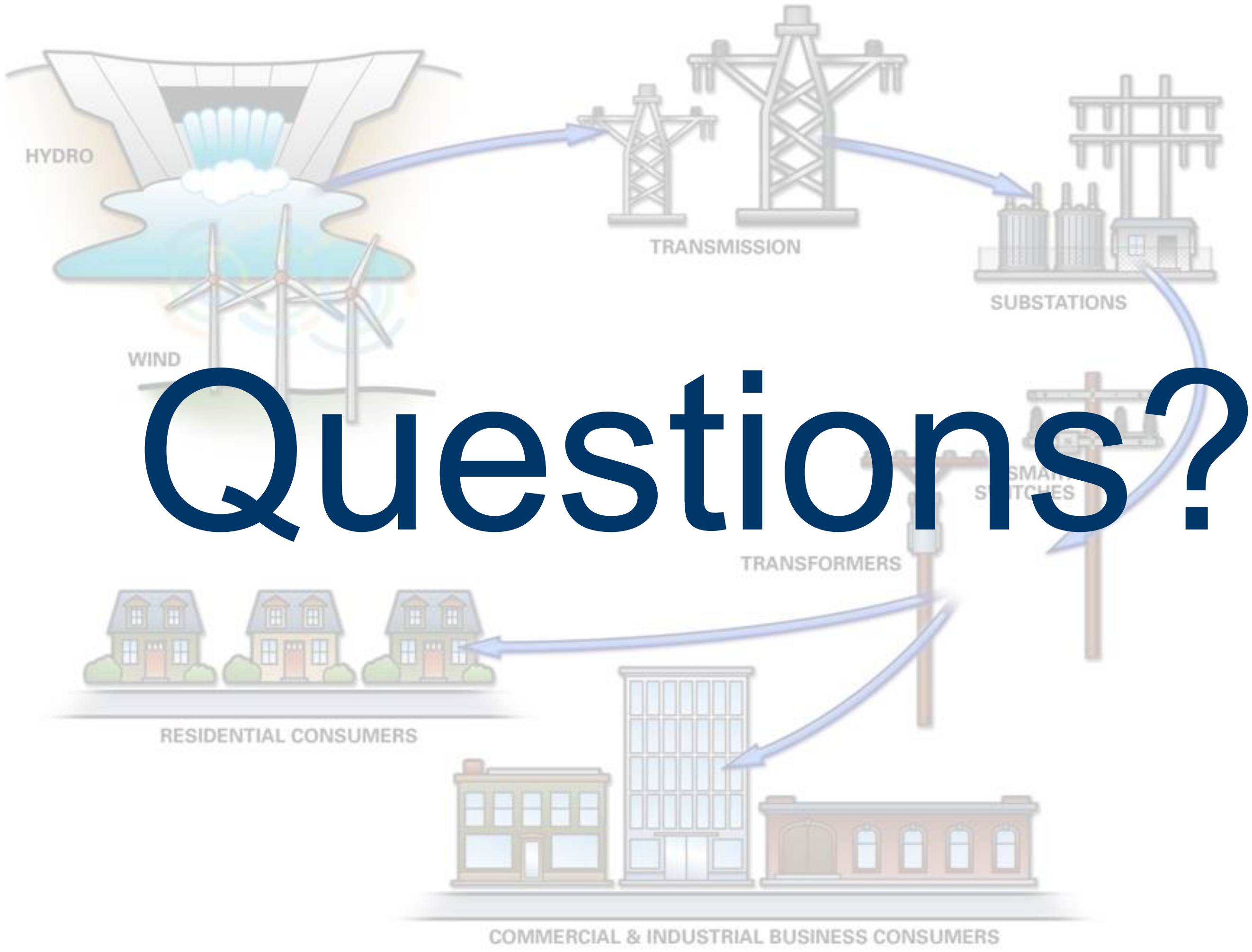


Future Programs

FEEDER REBUILDS

Feeder Rebuilds

- Detailed analysis has been completed for six feeders
- Results extrapolated to the remaining feeders
- The top 60 feeders targeted for energy savings in IRP
- Schedule is being developed based on resource availability
- Rebuilds to begin in 2013


HYDRO
WIND
TRANSMISSION
SUBSTATIONS
TRANSFORMERS
RESIDENTIAL CONSUMERS
COMMERCIAL & INDUSTRIAL BUSINESS CONSUMERS

Questions?

Avista's 2011 Electric Integrated Resource Plan
Technical Advisory Committee Meeting No. 6 Agenda
Avista Headquarters – Spokane, Washington

Thursday, June 23, 2011
Avista Conference Room 130

Topic	Time	Staff
1. Introduction	9:30	Storro
2. High Wind Market Analysis	9:35	Kalich
3. PRS & Scenario Analysis	10:15	Gall
4. IRP Action Items	11:15	Lyons
5. IRP Section Highlights	11:45	Kalich
6. Lunch	12:15	
7. Adjourn		

High Wind Market Analysis

James Gall

Technical Advisory Committee Meeting #6

2011 Electric Integrated Resource Plan

June 23, 2011

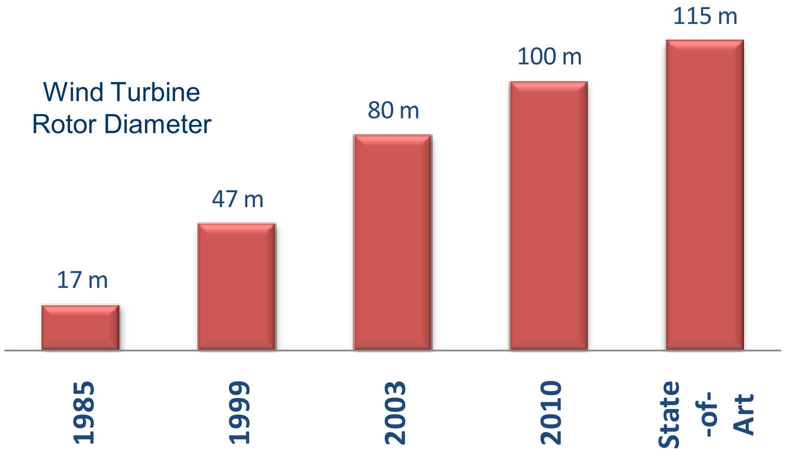
Northwest Wind Facts

- Pacific Northwest wind fleet by balancing authority (~5,200 MW)

Bonneville	~3,500 MW
PacifiCorp	~1,400 MW
Puget Sound Energy *	275 MW
Avista	35 MW

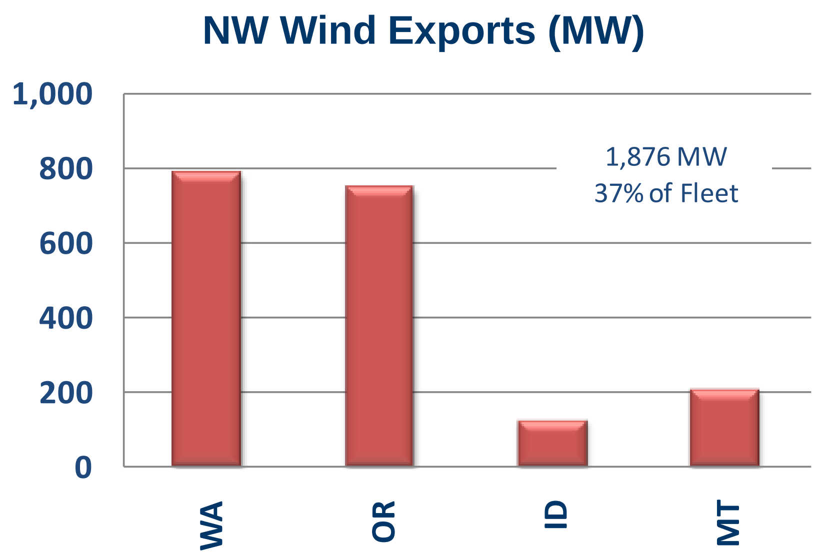
- 2/3 of NW wind fleet is on BPA system
  - 10,500 MW peak load
  - 80% exported to other utilities
  - BPA balance authority forecast
    - 5,250 MW in 2012
    - 8,700 MW in 2020

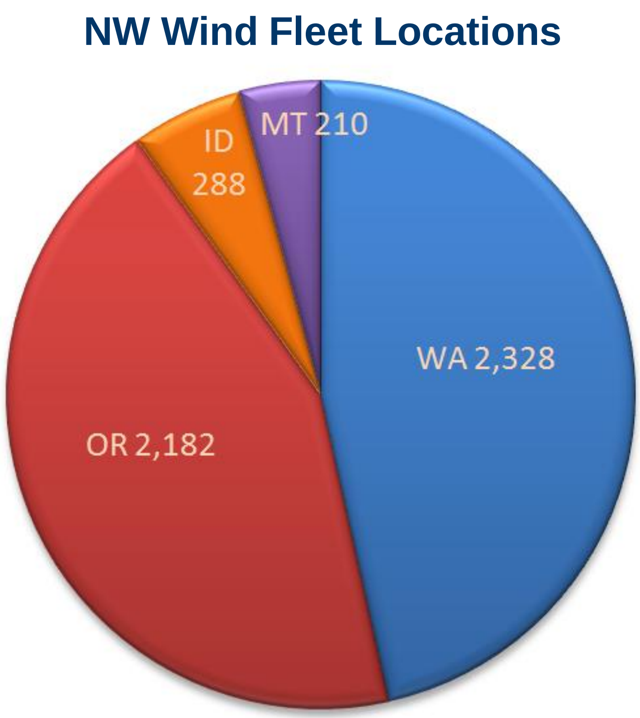
Wind Turbines Are Getting Bigger



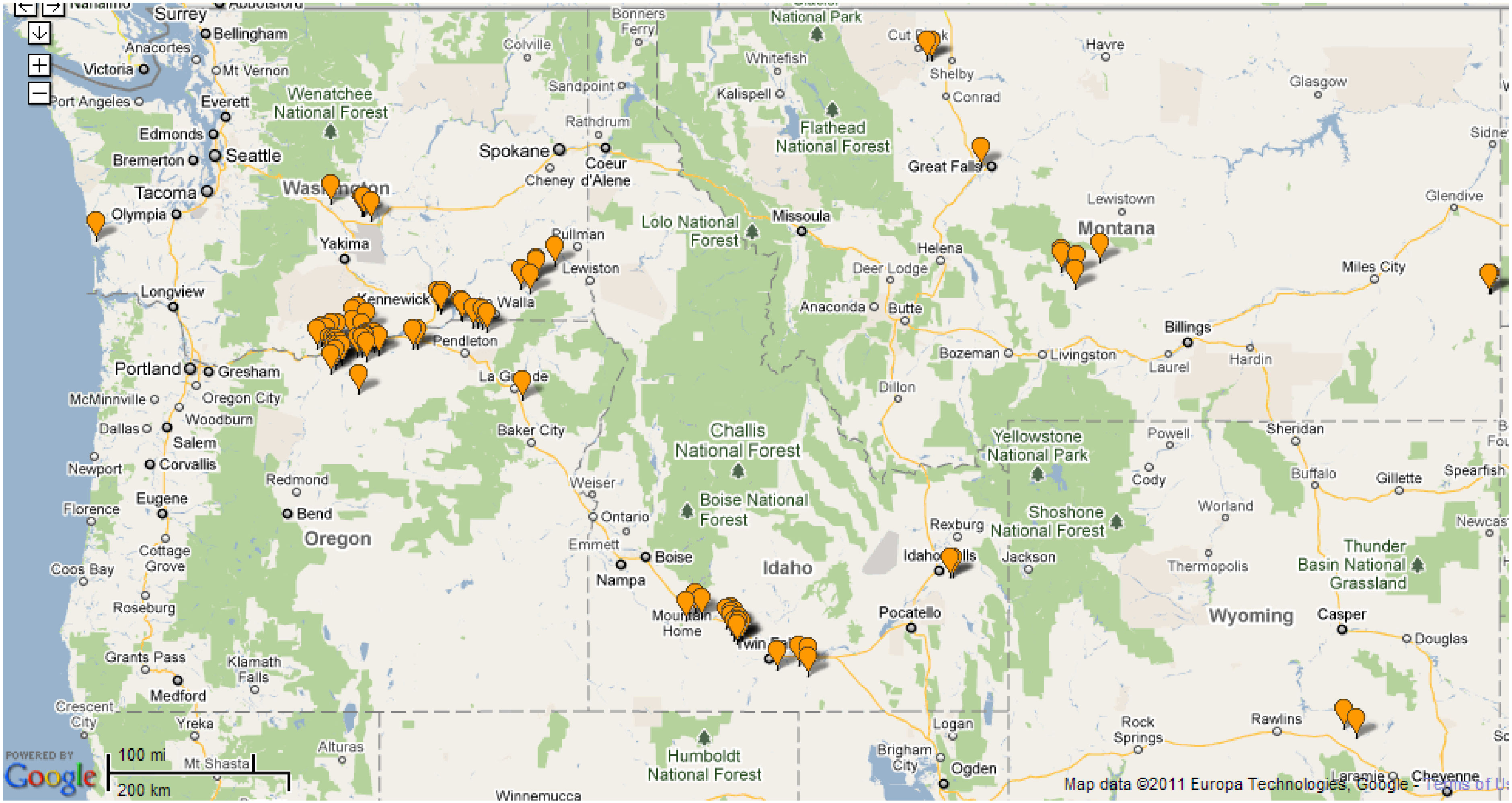
* PSE has 430 MW of wind, 155 MW is in Bonneville's balancing area

Northwest Wind Resource Locations & Exports



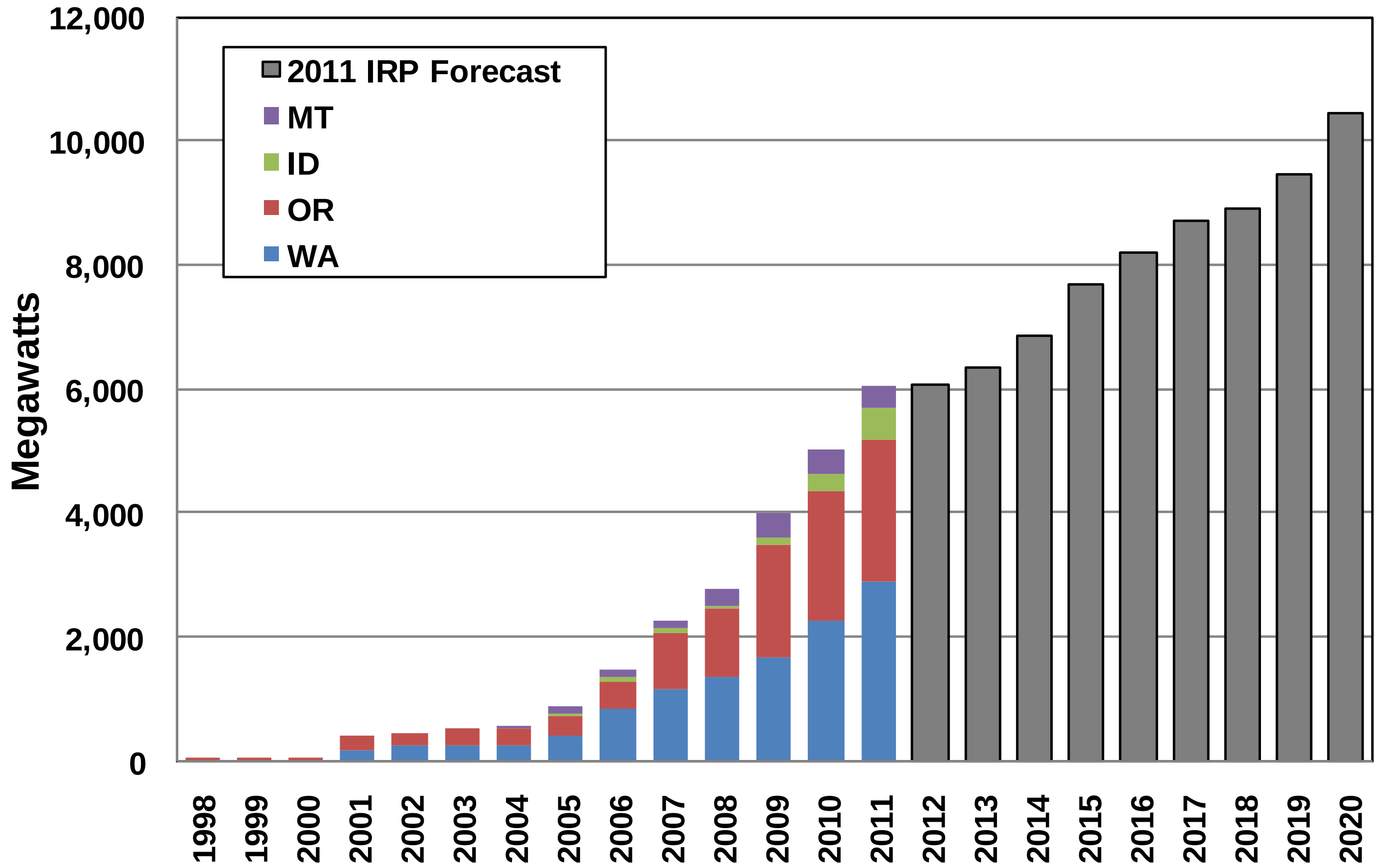


Northwest Wind Fleet Locations



Source: RNP.org

Northwest Wind Capacity Past and Future



Historical data provided by RNP website

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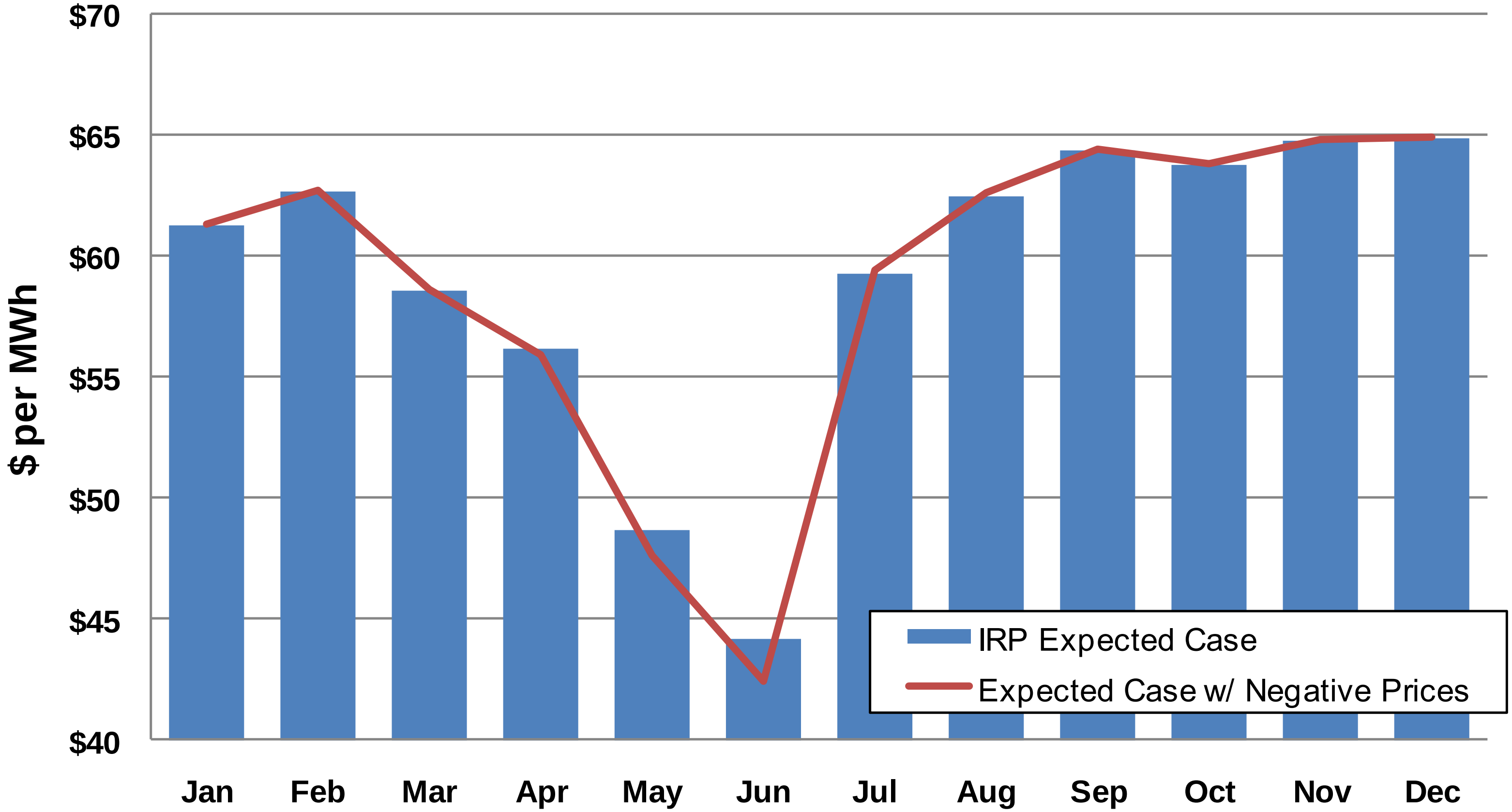
Study Scope

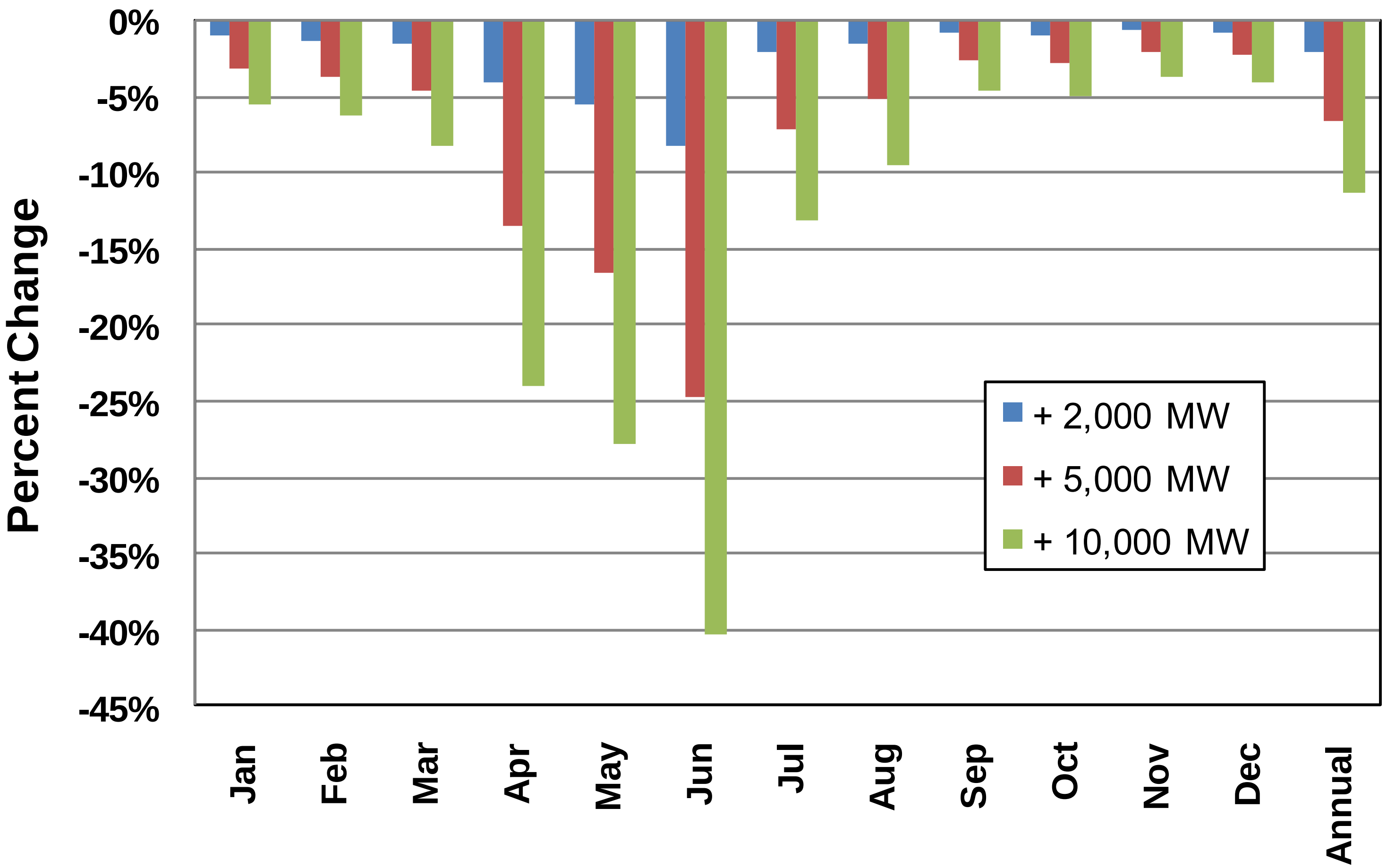
- Understand impact to the power system with more than forecasted amount of wind generation
- Uses IRP Expected Case for 2015
- Adjust model to allow for negative pricing using -$40/MWh for Northwest hydro projects and -$10 to -$30/MWh for wind projects
- Run 100 iterations for each of these scenarios
  - Add 2,000 MW of wind
  - Add 5,000 MW of wind
  - Add 10,000 MW of wind

Negative Price Impact to IRP Expected Case Market Forecast

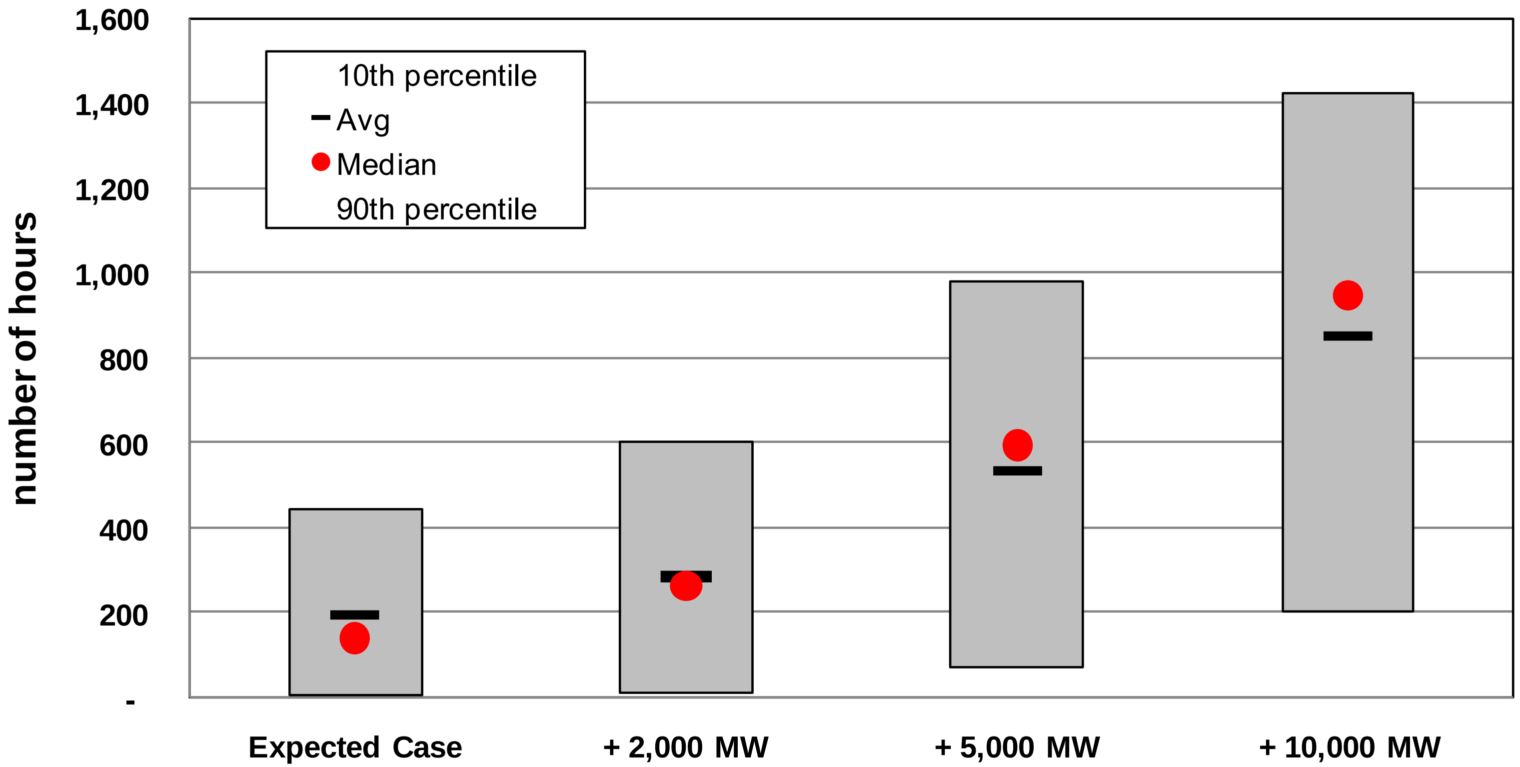


Annual price change is -0.3%, Q2 would be 2.2% lower

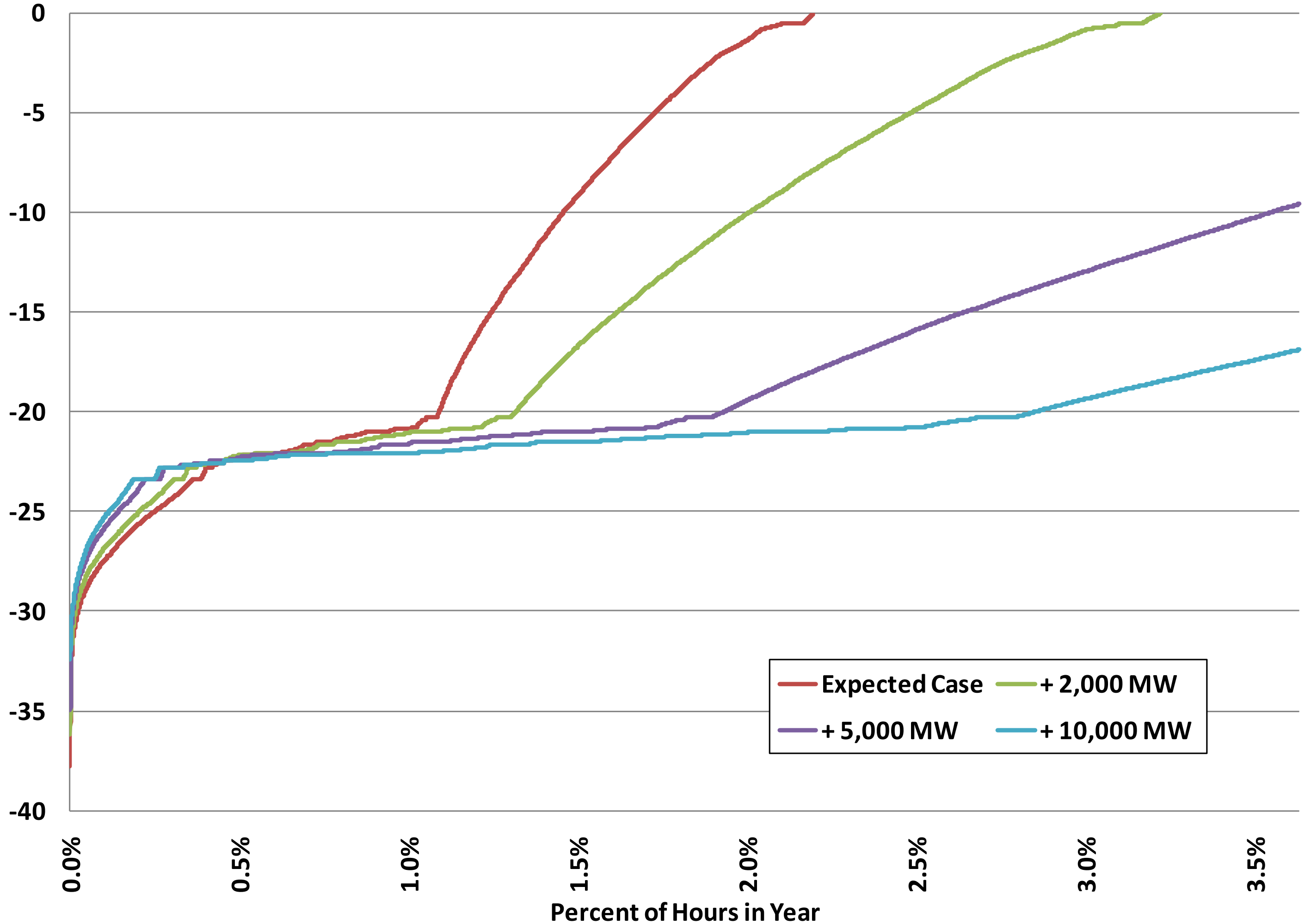
Wind Scenarios: Change to Monthly Average Mid-Columbia Electric Prices



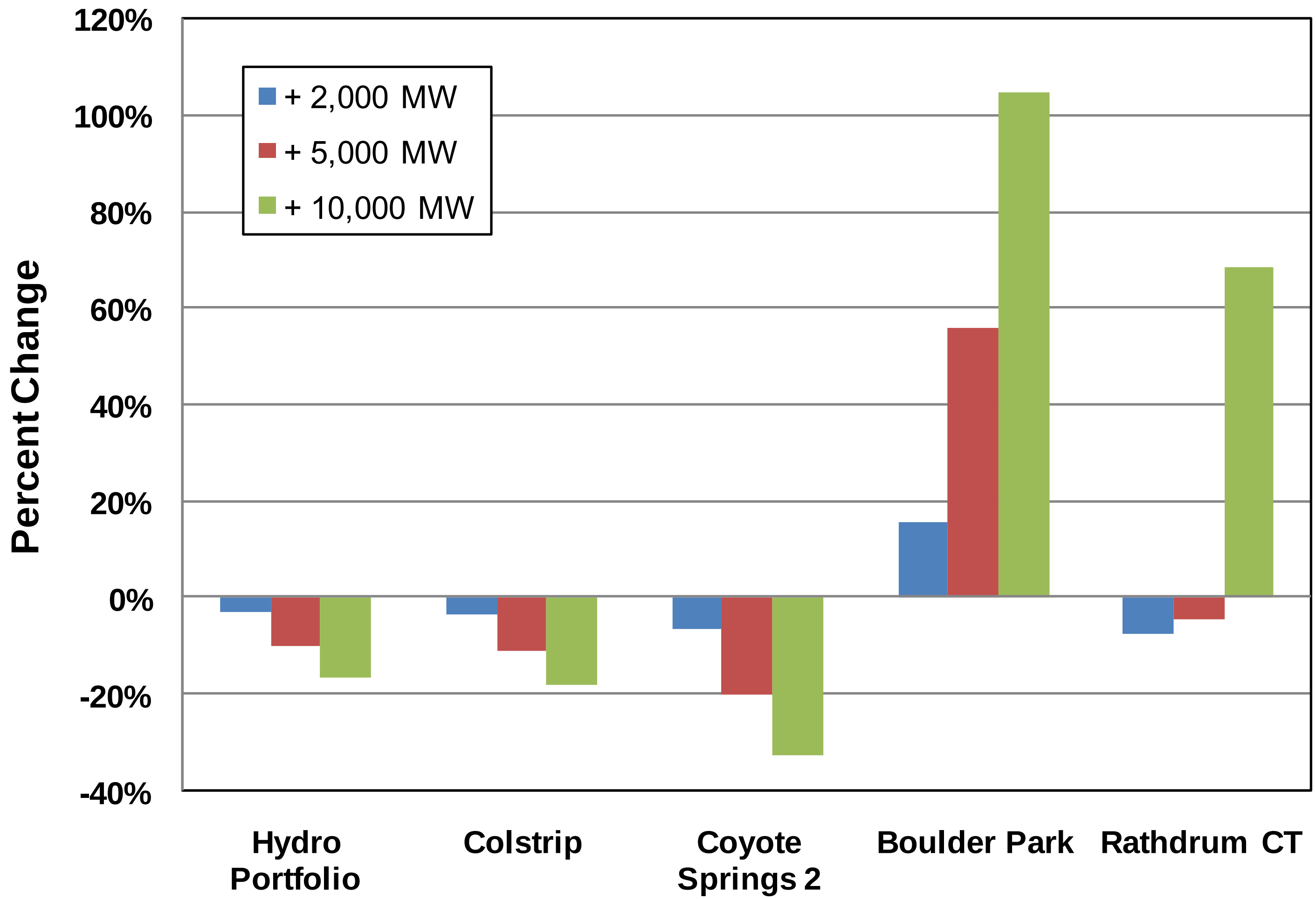
Wind Scenarios: Change to Occurrences of Negative Prices



Wind Scenarios: Negative Price Duration Curve



Wind Scenarios: Change to Avista Plant Operating Margins



Preferred Resource Strategy & Scenario Analysis

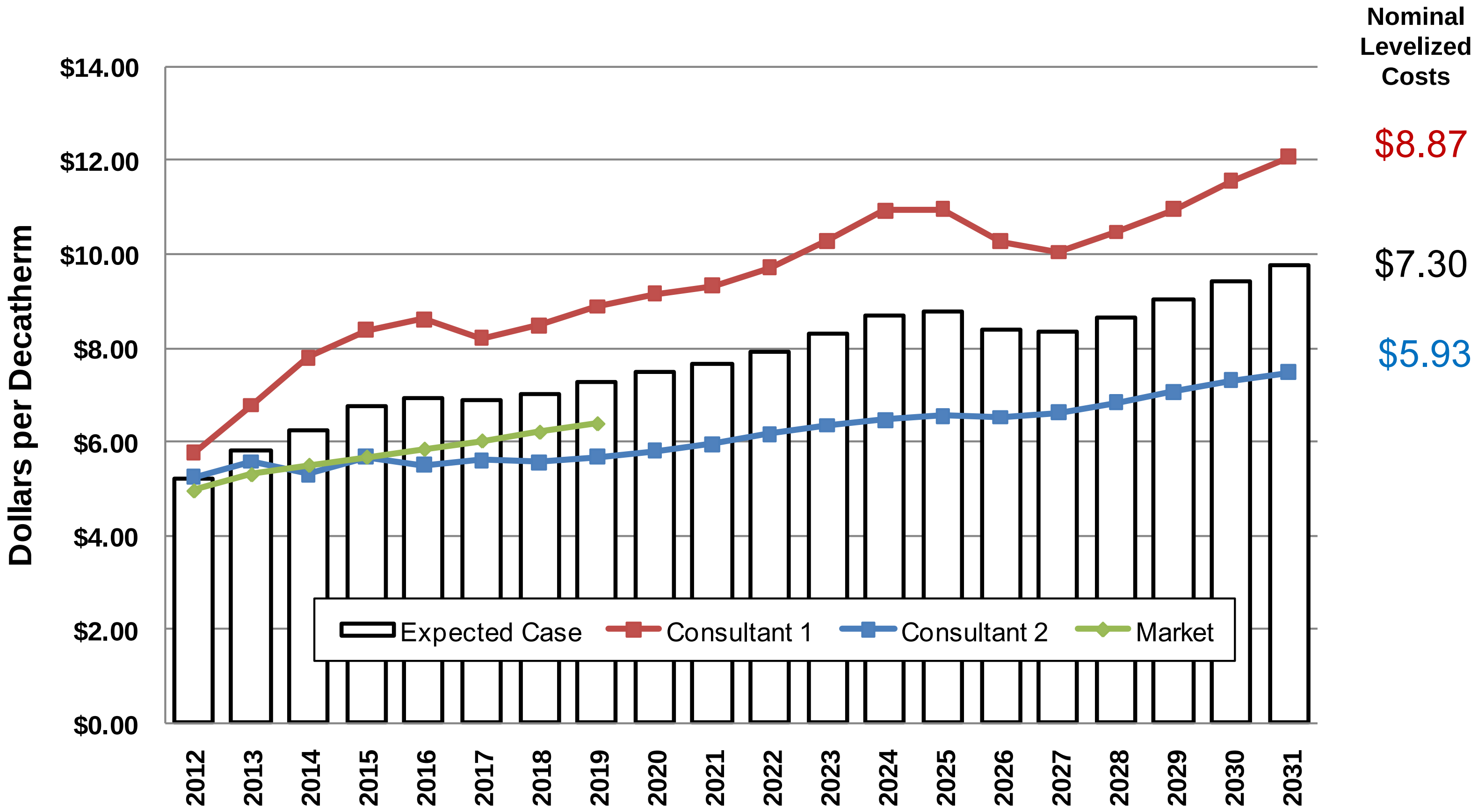
James Gall

Technical Advisory Committee Meeting #6

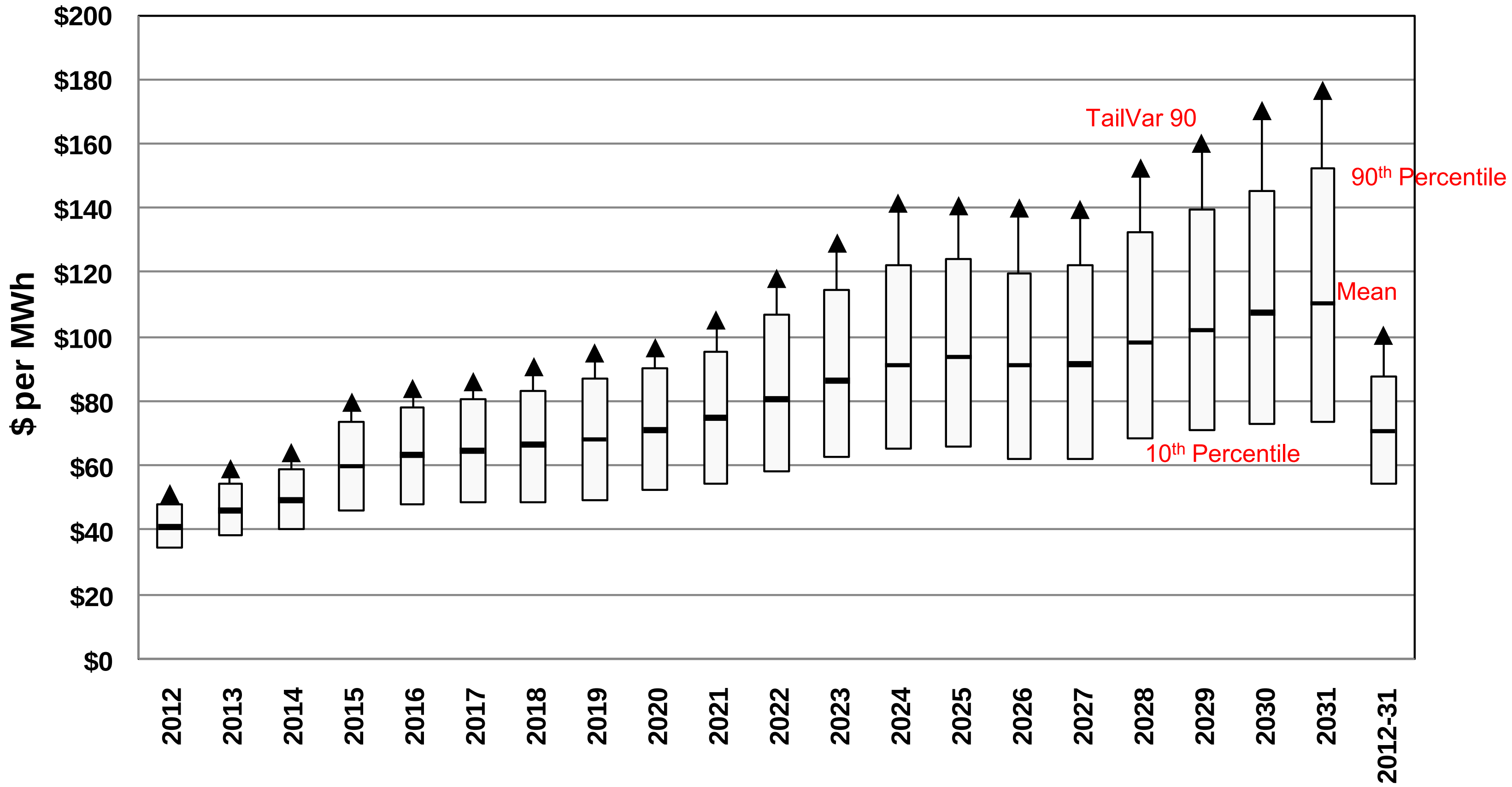
2011 Electric Integrated Resource Plan

June 23, 2011

Natural Gas Price Forecast (Henry Hub)

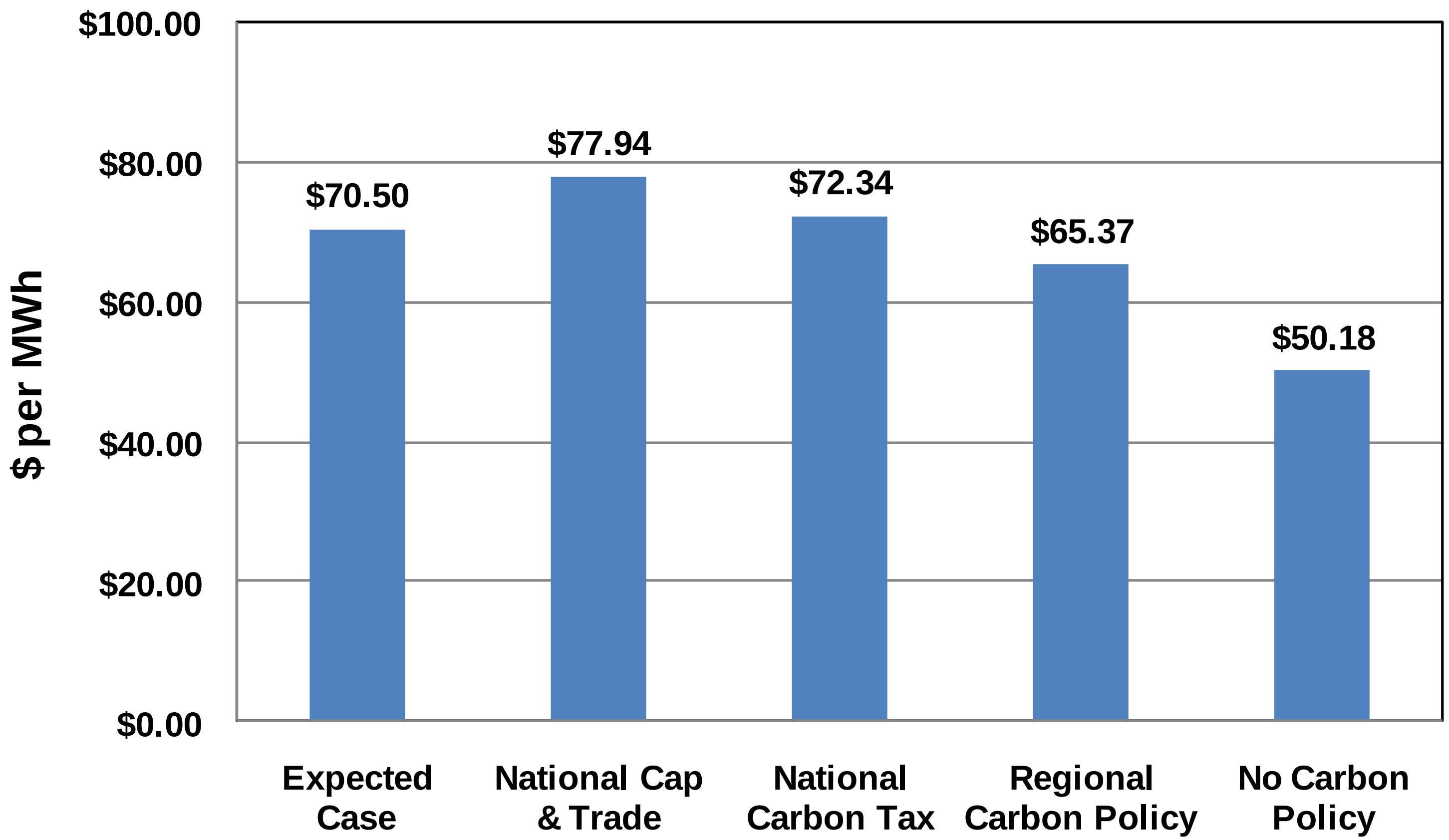


Expected Case: Mid-Columbia Electric Price Forecast



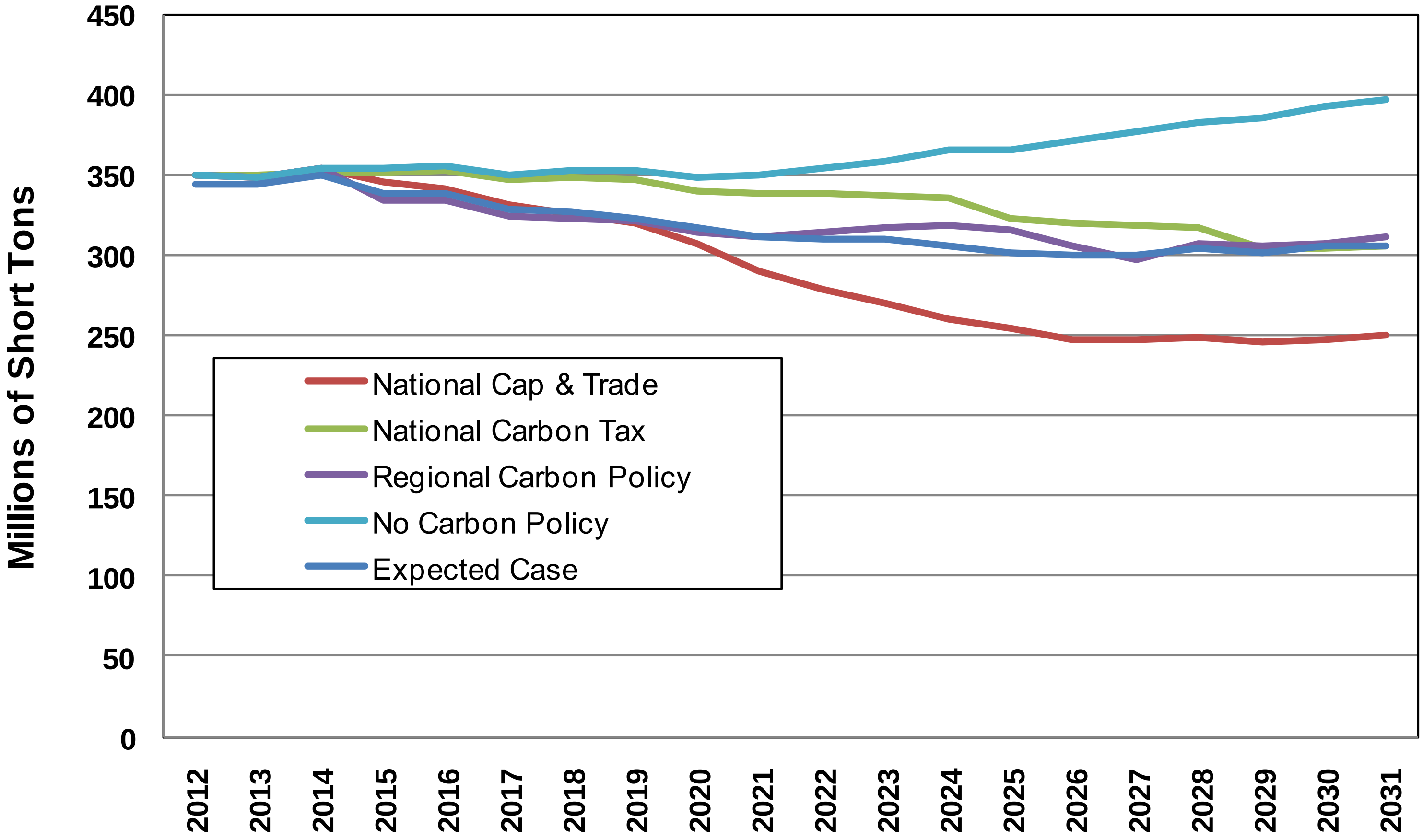
20 Year Levelized Price of $70.50 ($54 to $87) per MWh

Mid-Columbia Electric Price Forecast
Nominal 20 year Levelized Prices



Scenarios are deterministic study results

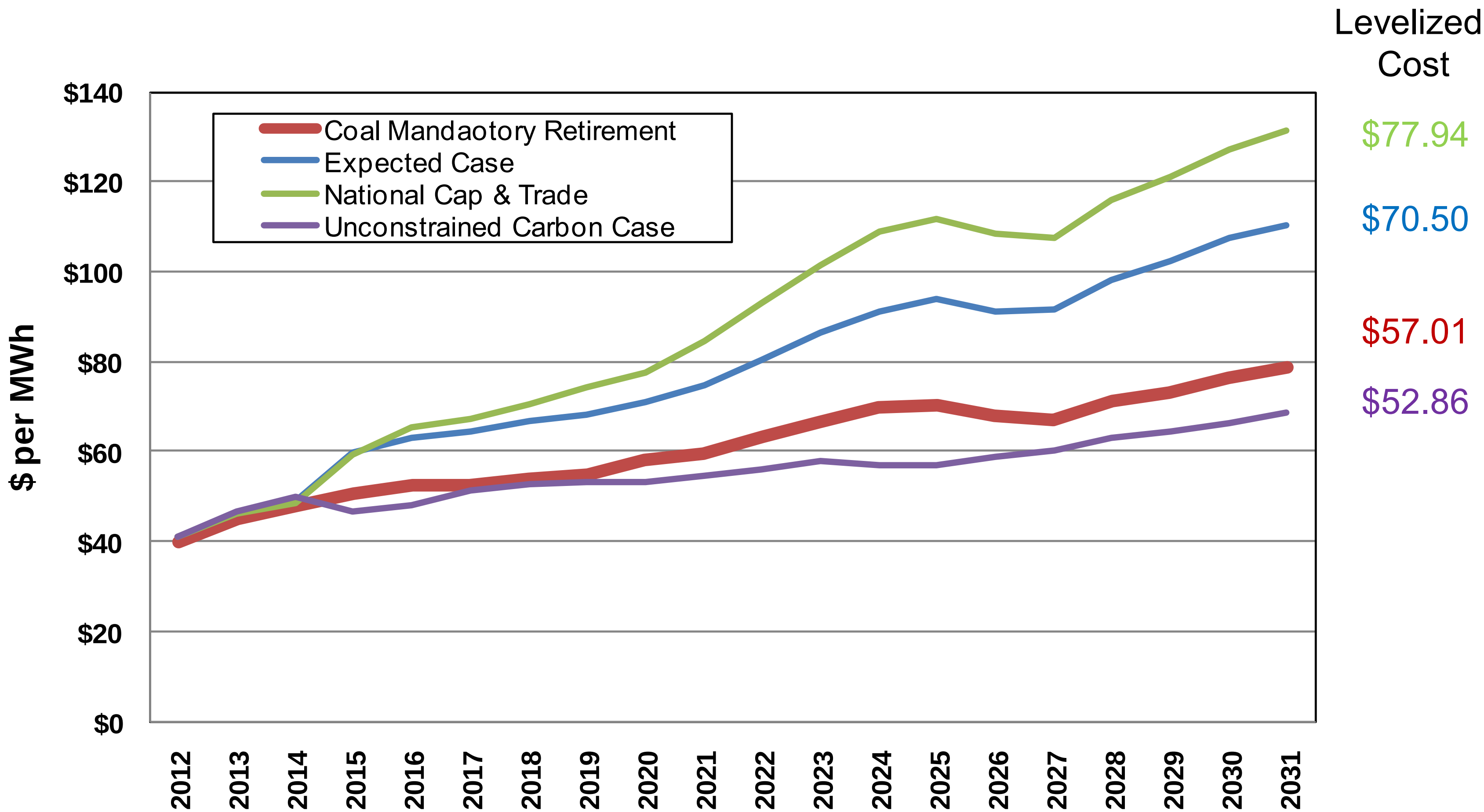
Western Interconnect Greenhouse Gas Forecast



Mandatory Coal Retirement Scenario

- Coal plants are to be phased out after 40 years of life.
- No greenhouse gas penalties
- Uses Expected Case’s natural gas forecast
- Modeled stochastically using 500 iterations

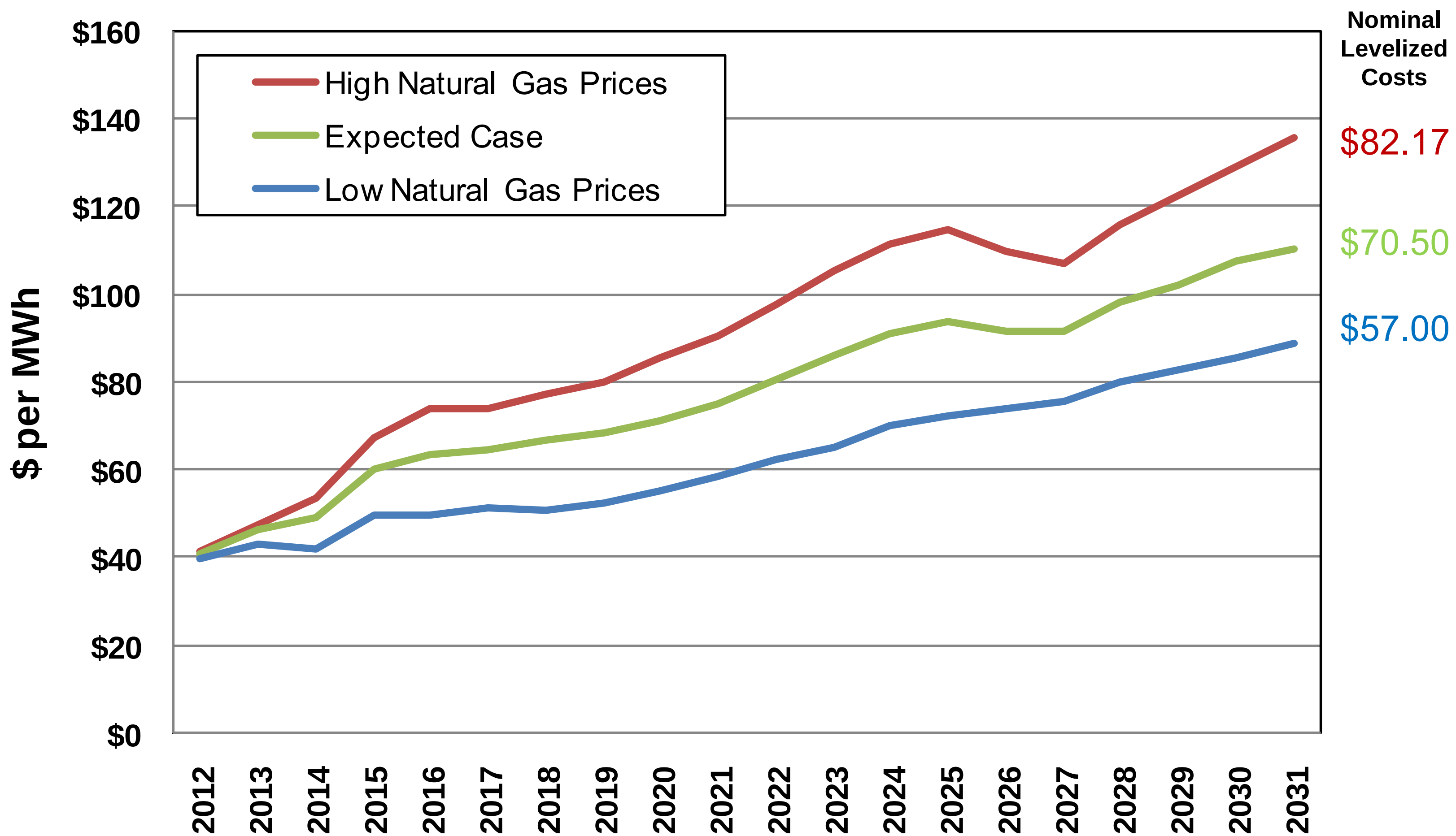
Mid-Columbia Electric Price Forecast



Greenhouse Gas and Costs of Carbon Mitigation Scenarios

Market Scenario	Change to GHG Emissions From 2012 by 2031	Added Levelized Cost per Year (Billions)
Unconstrained GHG Gas Case	14%	0.0
Expected Case	-18%	3.5
Coal Mandatory Retirement	-22%	8.1
National Cap & Trade	-29%	4.9

Mid-Columbia Price Forecast with Natural Gas Price Sensitivities

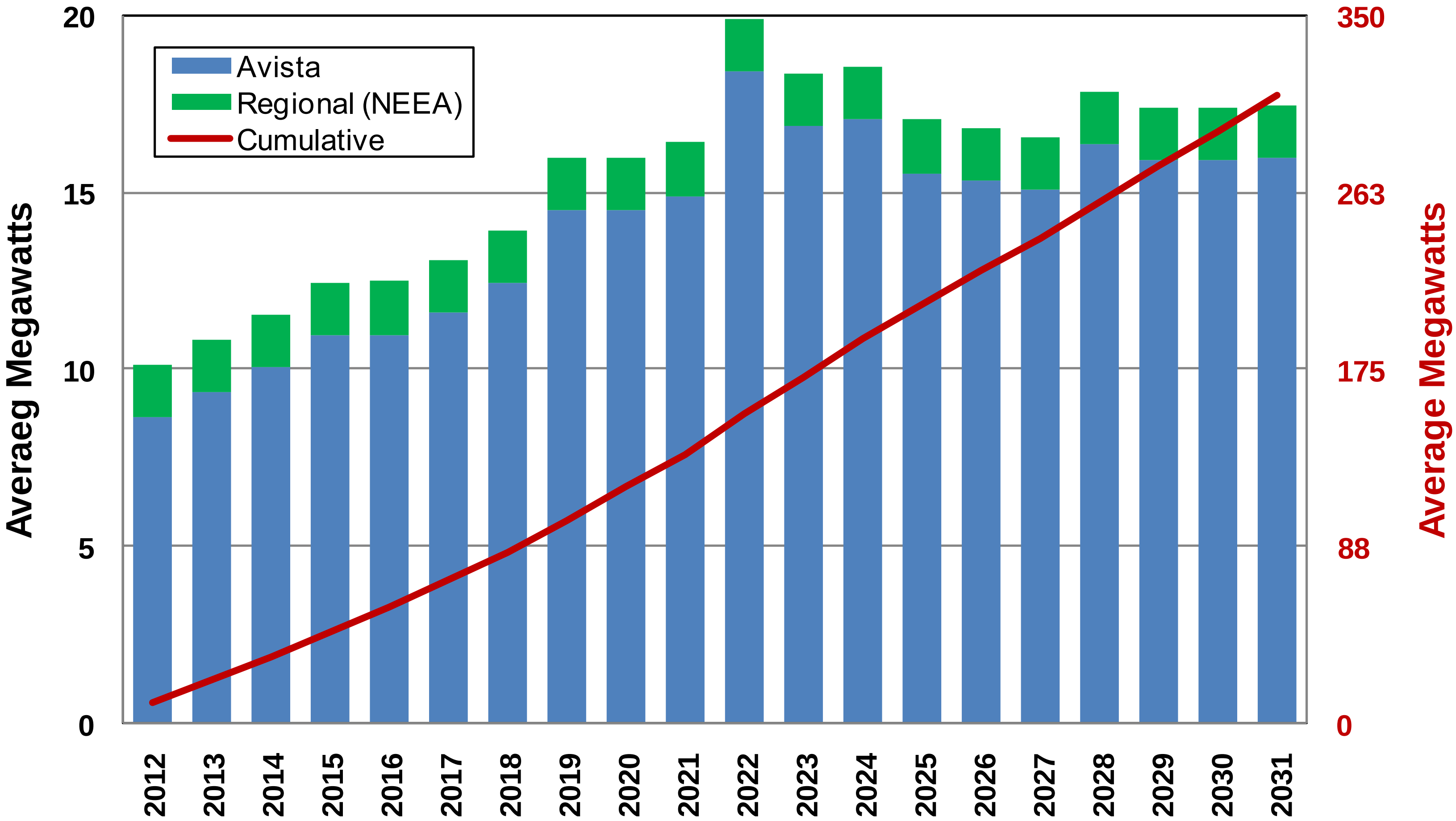


All cases have the same greenhouse reduction goal, but have different prices

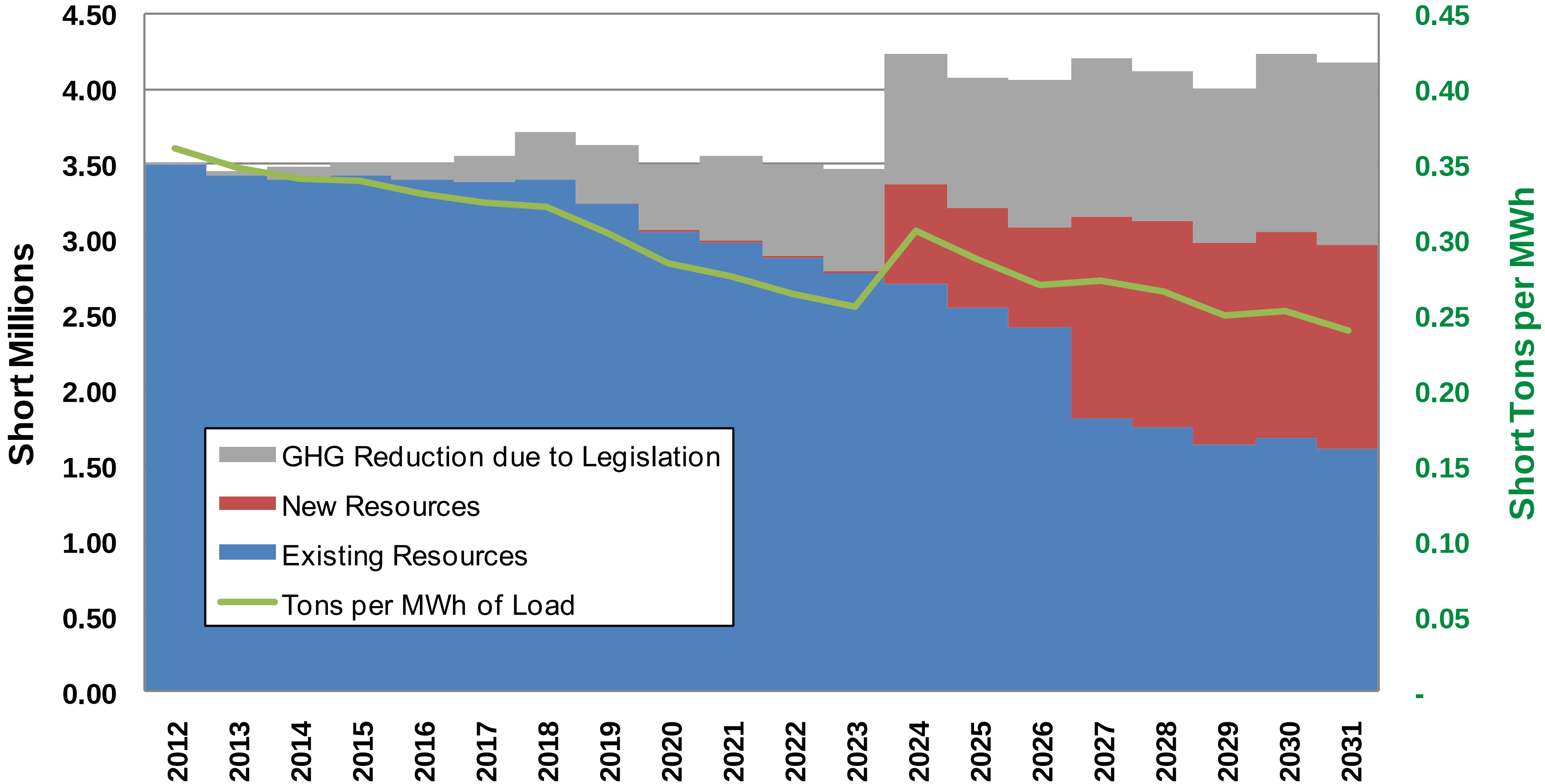
2011 Draft Preferred Resource Strategy

Year Ending	Resource
2012	Wind (~ 42 aMW REC)
2018	Simple Cycle CT(~ 83 MW)
2020	Simple Cycle CT (~ 83 MW)
2018-2019	Thermal Upgrades (~ 7 MW)
2018-2019	Wind (~ 43 aMW REC)
2023	Combined Cycle CT (~ 270 MW)
2026/27	Combined Cycle CT (~ 270 MW)
2029	Simple Cycle CT (~ 46 MW)
2012+	Distribution Feeder Upgrades (13 aMW by 2031)
2012+	Conservation (310 aMW by 2031)

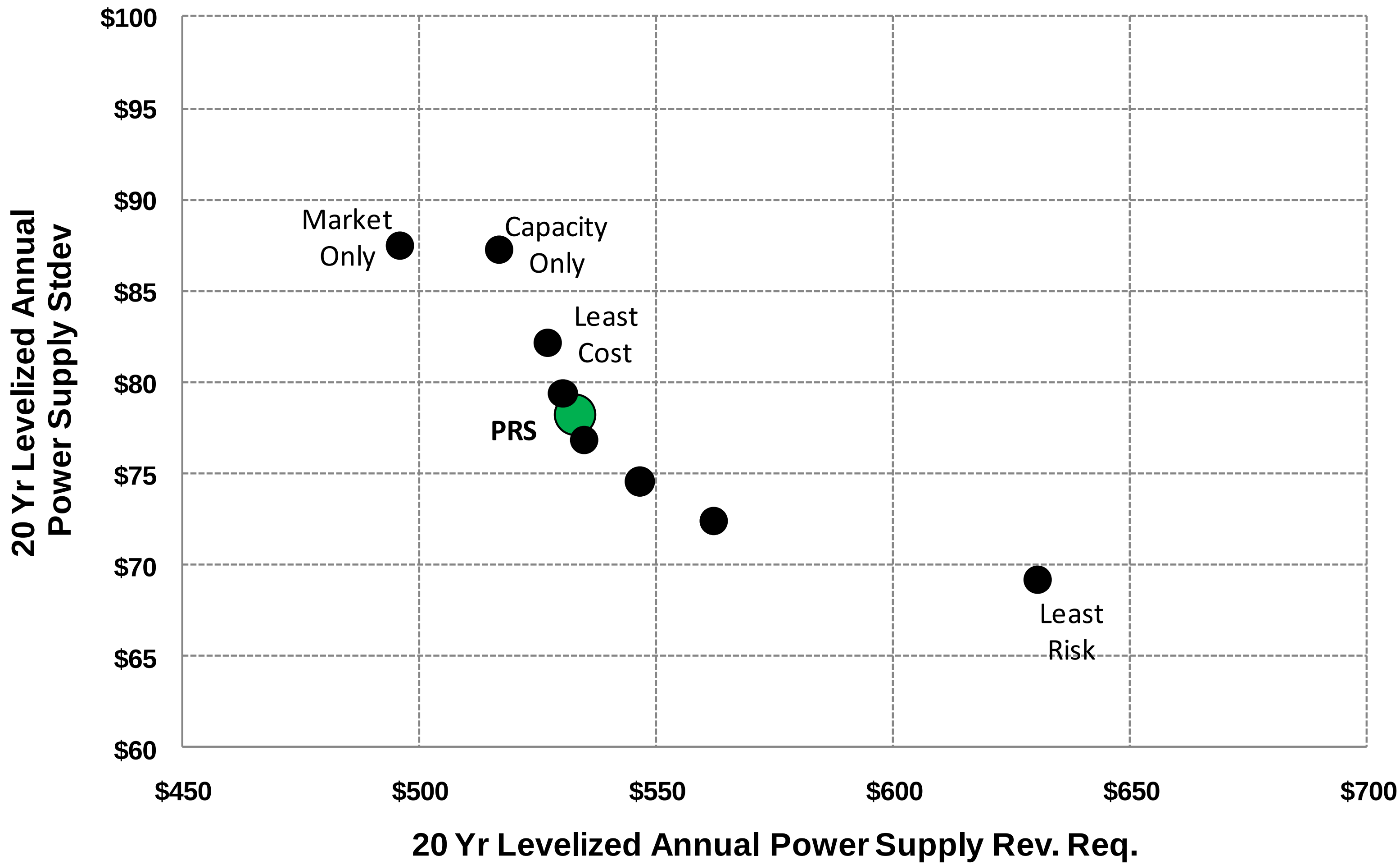
Conservation Projection



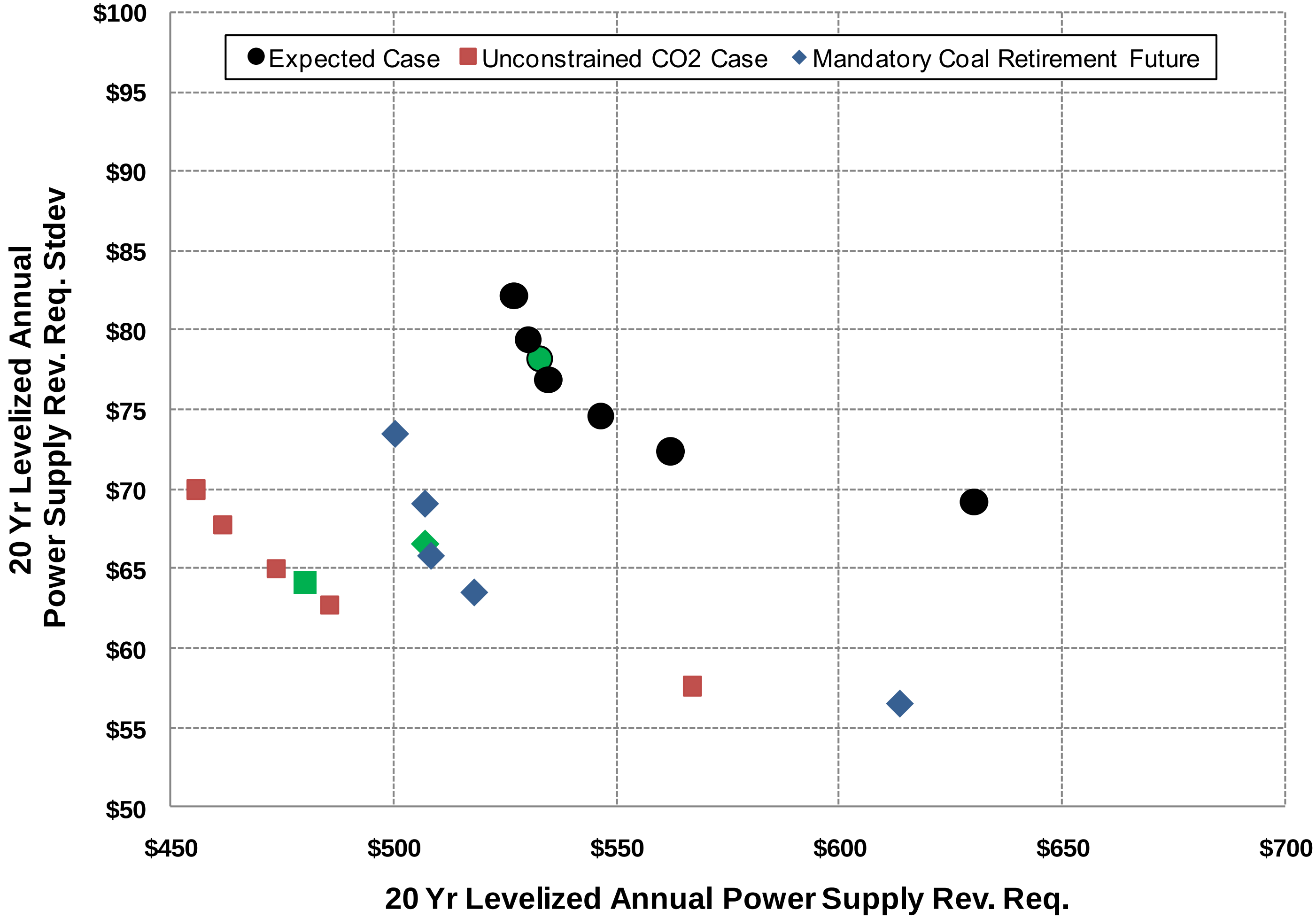
Avista Resource's Greenhouse Gas Emissions



Efficient Frontier



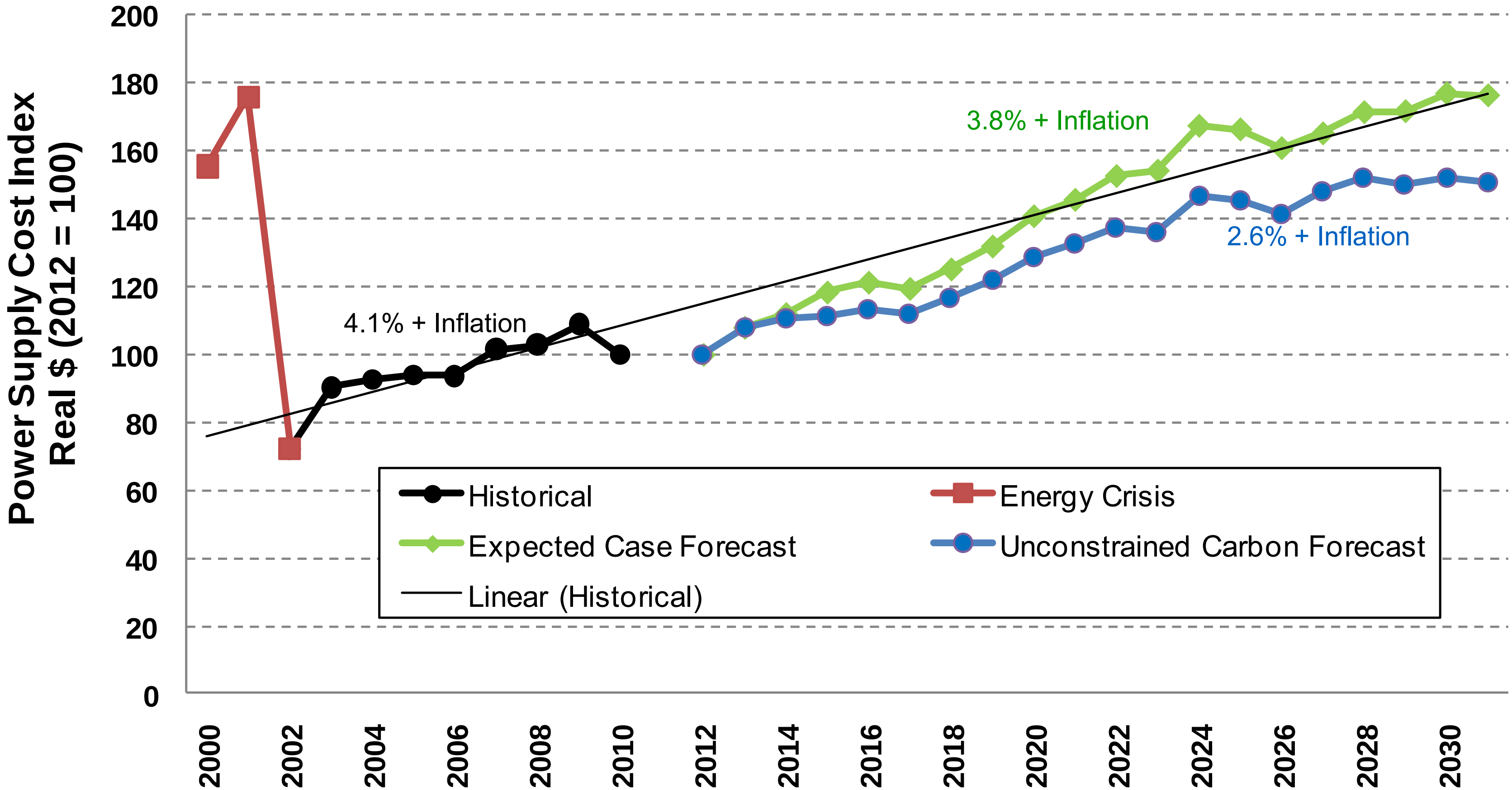
Efficient Frontier with Alternative Greenhouse Gas Methodologies



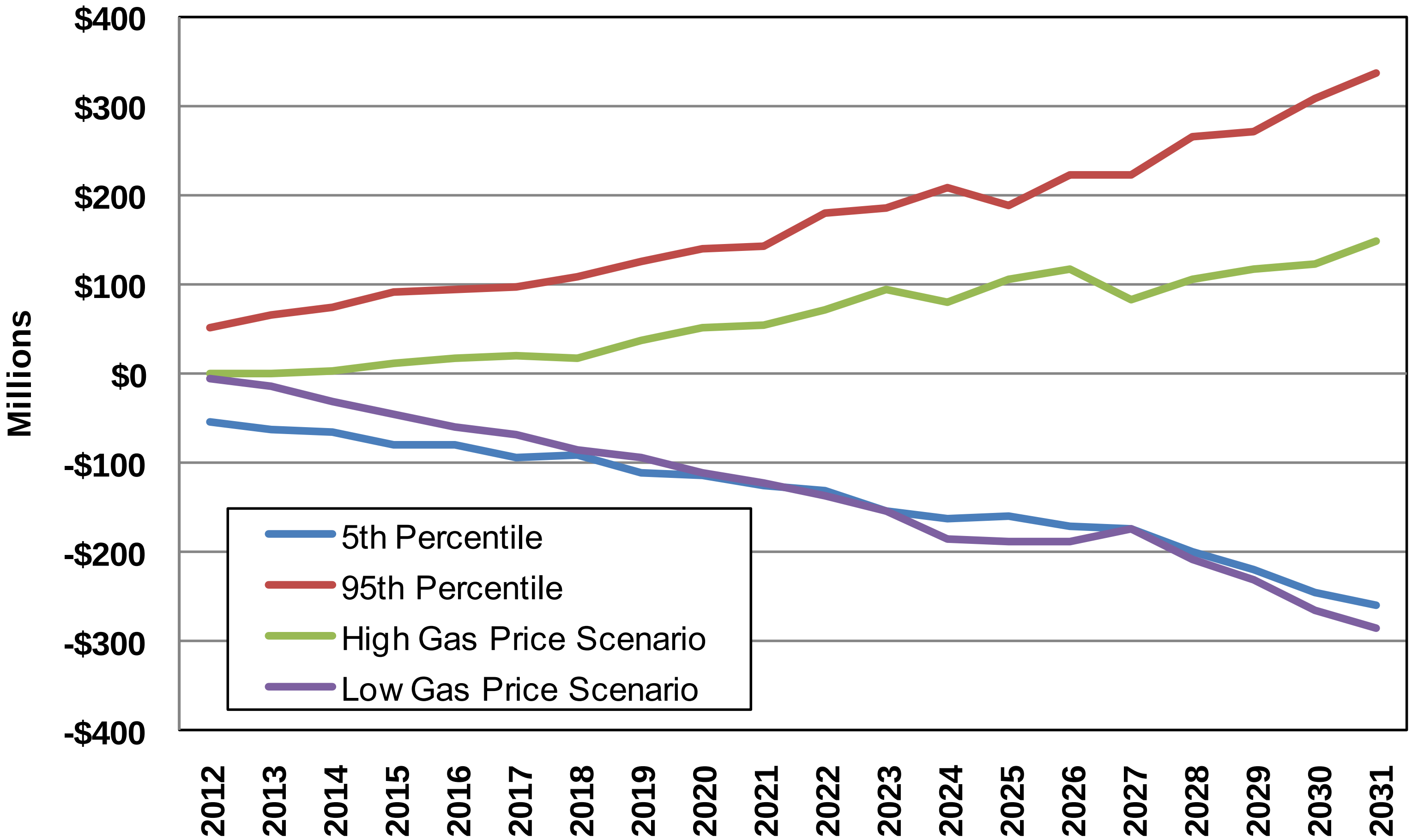
Greenhouse Gas Methodologies Summary

	Expected Case	Unconstrained Carbon	Coal Retirement
2012-2022 Cost NPV	3,094	2,886	2,937
2012-2031 Cost NPV	5,735	5,168	5,458
2022 Expected Cost	636	564	576
2022 Stdev	91	68	71
2022 Stdev/Cost	14%	12%	12%
2022 CO_2 Emissions (000's)	2,894	3,498	3,752
2031 CO_2 Emissions (000's)	2,972	4,177	3,560

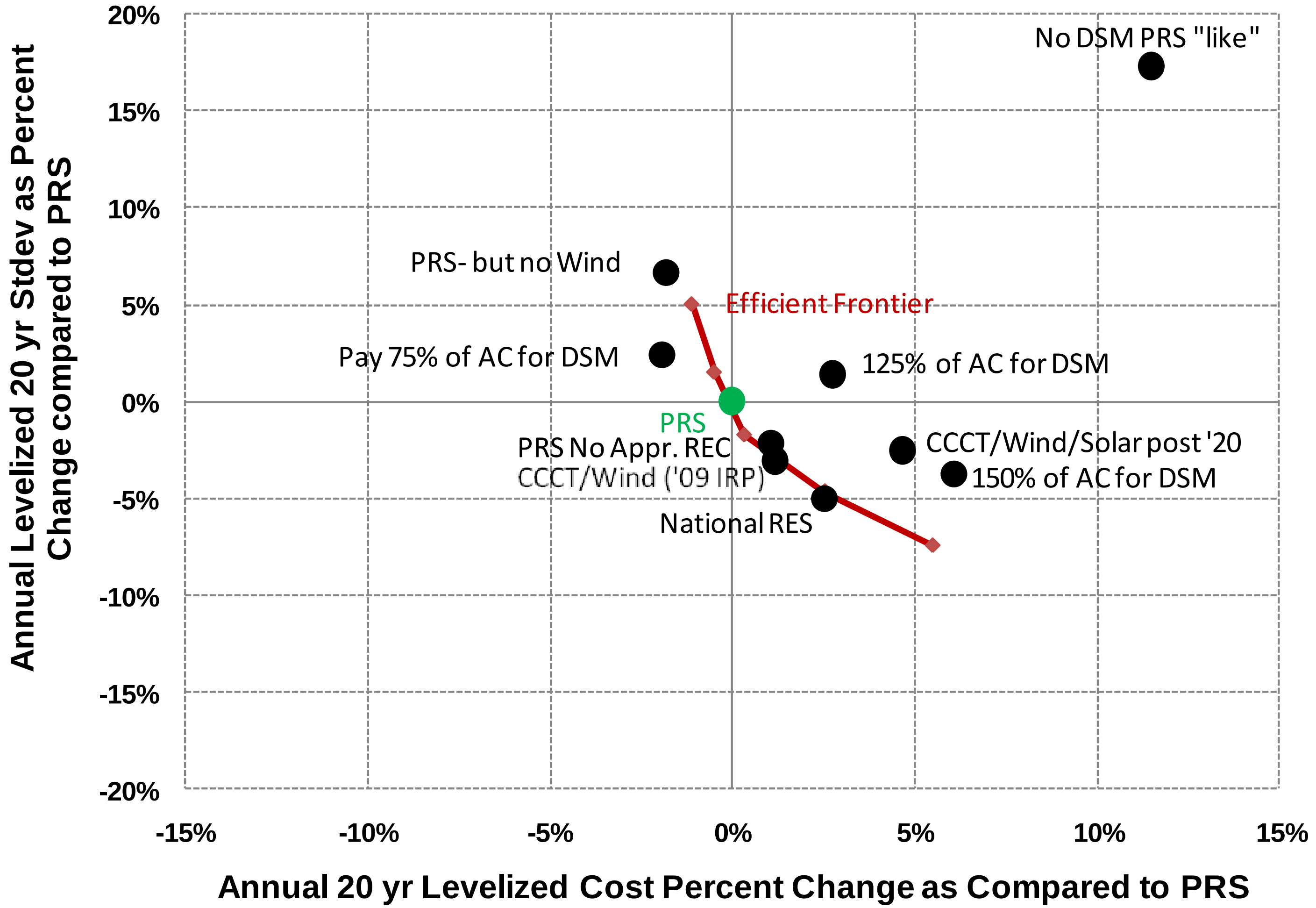
Power Supply Cost/MWh Index



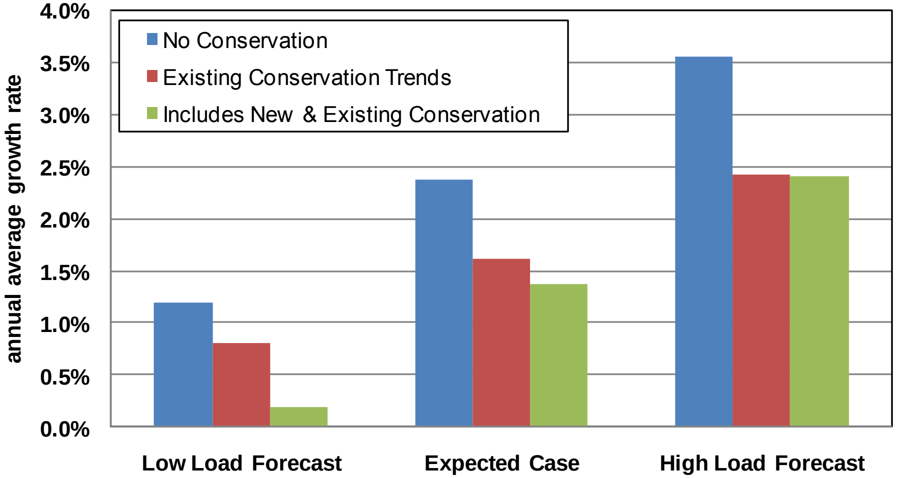
Power Supply Costs with Alternative Natural Gas Prices (Preferred Resource Strategy)

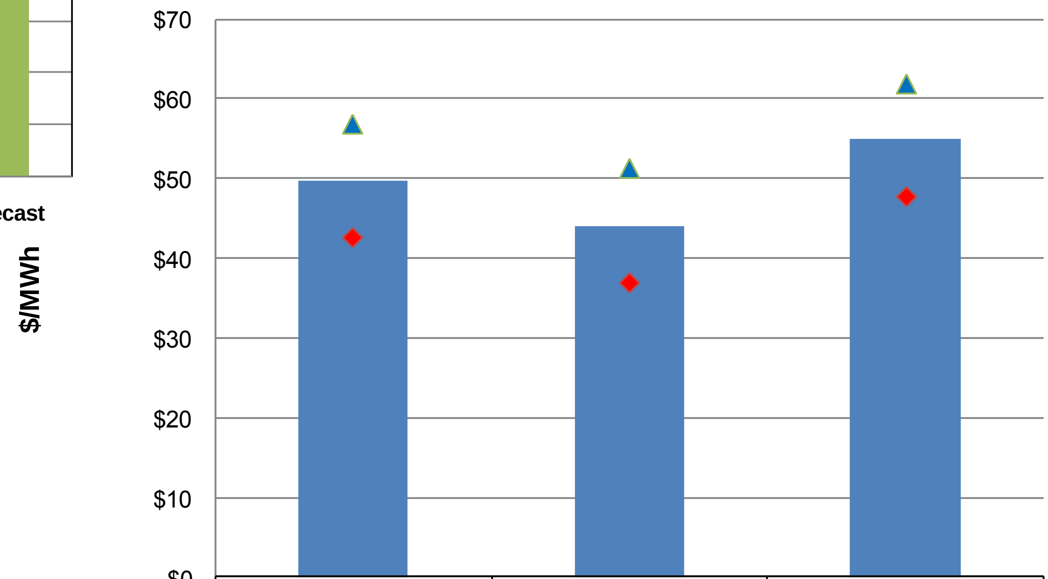


Efficient Frontier vs Alternative Portfolios



Load Growth Sensitivities





	Base Case	Low Load Growth	High Load Growth
Levelized Cost $/MWh	49.75	44.11	54.86
1 Sigma Lower	42.67	36.99	47.80
1 Sigma Higher	56.83	51.23	61.92

Portfolio Resources (MW)

Portfolio	SCCT (Nameplate)	CCCT (Nameplate)	Thermal Upgrades	Wind (Energy)	Solar (Energy)	Conservation (Energy)	Dist. Feeders (Energy)
Preferred Resource Strategy	212	540	4	71	0	310	13
Least Cost	747	0	0	71	0	310	13
Least Risk	187	540	17	98	64	310	13
50% Cost/50% Risk	177	540	4	93	9	310	13
75% Cost/ 25% Risk	332	540	0	82	0	310	13
25% Cost/ 75% Risk	83	810	4	95	5	310	13
PRS without Apprentice Credits	212	540	4	96	0	310	13
2009 IRP "Like"	0	810	0	102	0	310	13
PRS Without Wind	212	540	4	0	0	310	13
CCCT with Solar after 2015	0	810	10	36	33	310	13
PRS + Wind to meet National RES	212	540	4	177	1	310	13
PRS if no Conservation	475	815	10	94	0	0	13
PRS Conservation A/C 25% Lower	249	540	4	82	0	266	13
PRS Conservation A/C 25% Higher	415	270	7	70	0	334	13
PRS Conservation A/C 50% Higher	129	540	4	70	0	350	13
Low Load Growth	212	0	4	71	0	247	13
High Load Growth	510	810	10	93	1	443	13

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2011 IRP Action Items

John Lyons

Technical Advisory Committee Meeting #6

2011 Electric Integrated Resource Plan

June 23, 2011

2009 IRP Action Item Review

2009 IRP Action Items

- Resource Additions and Analysis
- Energy Efficiency
- Environmental Policy
- Modeling and Forecasting Enhancements
- Transmission Planning

2009 Action Items – Resource Additions & Analysis

- Continue to explore the potential for wind and non-wind renewable resources.
- Issue an RFP for turbines at Reardan and up to 100 MW of wind or other renewables in 2009.
- Finish studies on the costs and environmental benefits of hydro upgrades at Cabinet Gorge, Long Lake, Post Falls, and Monroe Street.
- Study potential locations for the natural gas-fired resource identified to be online between 2015 and 2020
- Continue participation in the regional IRP processes and where agreeable find resource opportunities to meet resource requirements on a collaborative basis.

2009 Action Items – Energy Efficiency

- Pursue American Reinvestment and Recovery Act of 2009 (ARRA) funding for low income weatherization.
- Analyze and report on the results of the July 2007 through December 2009 demand response pilot in Moscow and Sandpoint.
- Have an external party perform a study on technical, economic, and achievable potential for energy efficiency in Avista's entire service territory.
- Study and quantify transmission and distribution efficiency concepts as they apply to meeting Washington's RPS goals.
- Update processes and protocols for conservation measurement, evaluation and verification.
- Determine the potential impacts and costs of load management options.

2009 Action Items – Environmental Policy

- Continue to study the potential impact of state and federal climate change legislation.
- Continue and report on the work of Avista's Climate Change Council.

2009 Action Items – Modeling & Forecasting

- Refine stochastic model cost driver relationships.
- Continue PRiSM refinements by developing a resource retirement capability to solve for other risk measurements and by adding more resource options.
- Continue developing Loss of Load Probability and Sustained Peaking analysis for inclusion in the IRP process, and confirm appropriateness of the 15% capacity planning margin assumed for this IRP.
- Continue studying the impacts of climate change on the load forecast.
- Study load growth trends and their correlation to weather patterns.

2009 Action Items – Transmission Planning

- Work to maintain/retain existing transmission rights on the Company's transmission system, under applicable FERC policies, for transmission service to bundled retail native load.
- Continue to participate in BPA transmission practice processes and rate proceedings to minimize the costs of integrating existing resources outside of the Company's service area.
- Continue to participate in regional and sub-regional efforts to establish new regional transmission structures (ColumbiaGrid and other forums) to facilitate long-term expansion of the regional transmission system.
- Evaluate costs to integrate new resources across Avista's service territory and from regions outside of the Northwest.
- Study and implement distribution feeder rebuild projects to reduce system losses.
- Study transmission reconfigurations to economically reduce system losses.

2011 IRP Action Items

2011 Action Items Resource Additions & Analysis

- Continue to explore and follow potential new resources opportunities.
- Continue studies on the costs, energy, capacity and environmental benefits of hydro upgrades at Cabinet Gorge, Long Lake, Post Falls, and Monroe Street.
- Study potential locations for the natural gas-fired resource identified to be online in 2019.
- Continue participation in regional IRP processes and, where agreeable, find opportunities to meet resource requirements on a collaborative basis with other utilities.
- Provide an update on the Little Falls and Nine Mile hydroelectric project upgrades.

2011 Action Items – Energy Efficiency

- Study and quantify transmission and distribution efficiency projects as they apply to Washington RPS goals.
- Update processes and protocols for conservation measurement, evaluation and verification.
- Continue to determine the potential impacts and costs of load management options.

2011 Action Items – Environmental Policy

- Continue studies of state and federal climate change policies.
- Continue and report on the work of Avista's Climate Change Council.

2011 Action Items – Modeling & Forecasting

- Continue following regional reliability processes and develop Avista-centric modeling for possible inclusion in the 2013 IRP.
- Continue studying the impacts of climate change on retail loads.
- Refine the stochastic model for cost driver relationships, including further analyzing year-to-year hydro correlation and the correlation between wind, load, and hydro.

2011 Action Items – Transmission and Distribution Planning

- Work to maintain existing transmission rights, under applicable FERC policies, for transmission service to bundled retail native load.
- Continue to participate in BPA transmission processes and rate proceedings to minimize costs of integrating existing resources outside of Avista's service area.
- Continue to participate in efforts to establish new regional transmission structures to facilitate long-term expansion of the regional transmission system.
- Evaluate the costs to integrate new resources across Avista's service territory and from regions outside of the Northwest.
- Study and implement distribution feeder rebuild projects to reduce system losses.
- Study transmission reconfigurations to economically reduce system losses.

AVISTA

2011 IRP Section Highlights

John Lyons

Technical Advisory Committee Meeting #6

2011 Electric Integrated Resource Plan

June 23, 2011

Loads & Resources Highlights

- Historic conservation acquisitions are included in the load forecast; higher acquisition levels anticipated in the IRP reduce the load forecast further.
- Annual electricity sales growth from 2012 to 2031 averages 1.6%.
- Expected energy deficits begin in 2020, growing to 475 aMW by 2031.
- Expected capacity deficits begin in 2019, growing to 883 MW by 2031.
- Conservation pushes the need for resources out by one year for energy and six years for capacity.
- Renewable portfolio standard deficiencies drive near-term resource needs.

Energy Efficiency Highlights

- Conservation reduces load by 47 percent through the IRP timeframe.
- Avista began offering conservation programs in 1978.
- Company-sponsored conservation reduces retail loads by approximately 10 percent, or 120 aMW.
- More than 2,800 equipment options and over 1,500 measure options covering all major end-use equipment, as well as devices and actions to reduce energy consumption were evaluated for this IRP.
- This IRP includes a Conservation Potential Assessment of the Company's Idaho and Washington service territories.

Policy Considerations Highlights

- Avista supports national greenhouse gas legislation that is workable, cost effective and fair.
- Avista supports national greenhouse gas legislation that protects the economy, supports technological innovation, and addresses emissions from developing nations.
- The Company is a member of the Clean Energy Group
- Avista's Climate Change Council monitors greenhouse gas legislation and environmental regulation issues.

Transmission & Distribution Highlights

- Avista has received a total of 43 requests for non-Avista resource integration.
- Projected costs of transmission upgrades are included in the 2011 Preferred Resource Strategy.
- The Company has received matching federal grants and is investing in three Smart Grid programs projected to reduce load by 5.57 aMW by 2013.
- Sixty distribution feeders were found to be preliminarily economic during the IRP timeframe, reducing system losses by 6.1 aMW.
- The Company participates in various regional transmission planning forums.
- Various upgrades to our transmission system are planned over the next five years.

Generation Resource Options Highlights

- Only resources with well-defined costs and operating histories were considered in the PRS analysis.
- Wind and solar resources were evaluated as the renewable options available to the Company; other technologies will be considered in renewable RFP efforts.
- Renewable resource costs assume present state and federal incentive levels, but no extensions.
- For the first time, thermal generation upgrades were considered as resource options.

Market Analysis Highlights

- Gas and wind resources are expected to dominate new generation additions in the West for the foreseeable future.
- The massive growth in unconventional natural gas has lowered gas price forecasts and expected future electricity market prices.
- Expansion of the Northwest wind fleet is reducing the value of springtime hydroelectric generation and driving short-term market prices below zero.
- Federal greenhouse gas policy is uncertain; the IRP quantifies this uncertainty by modeling four different mitigation regimes.
- The Expected Case reduces greenhouse gas emissions by 18 percent and increases overall Western Interconnect costs by $3.5 billion per year. Absent mitigation, overall emissions are forecast to increase by 14 percent over the next 20 years.

Preferred Resource Strategy Highlights

- Avista's first load –driven acquisition is a natural gas-fired peaking plant in 2019; total gas-fired acquisition is 752 MW over the IRP timeframe.
- The 2011 plan splits natural gas-fired generation between simple- and combined-cycle plants in anticipation of a growing need for system flexibility to integrate variable resources.
- Efficiency improvements, both on the customer and utility sides of the meter, are at the highest expected level in our planning history.
- Total capital needs for generation resources in the PRS are $1.6 billion.
- Conservation and system efficiency spending will increase over time; a total of $1.5 billion will acquire 323 aMW.

Remaining 2011 IRP Schedule

- July 1, 2011 Management review of Internal Draft 2011 IRP complete
- July 8, 2011 distribution of Draft 2011 IRP to TAC participants
- August 1, 2011: External review by TAC complete
- August 8, 2011: Final 2011 IRP sent to print
- August 30, 2011: 2011 IRP documents sent to the Idaho and Washington Commissions
- August 31, 2011: 2011 IRP available to public, including publication on the Company's web site

2011 Electric Integrated Resource Plan

Appendix B – Work Plan

Work Plan for Avista's 2011 Electric Integrated Resource Plan

For the
Washington Utilities and Transportation Commission

August 31, 2010

2011 Integrated Resource Planning Work Plan

This Work Plan is submitted in compliance with the Washington Utilities and Transportation Commission's Integrated Resource Planning (IRP) rules (WAC 480-100-238). This work plan outlines the process Avista will follow to develop its 2011 Integrated Resource Plan to be filed with Washington and Idaho Commissions by August 31, 2011. Avista uses a public process to obtain technical expertise and guidance throughout the planning period through a series of public Technical Advisory Committee (TAC) meetings. The first of these meetings for the 2011 IRP was held on May 27, 2010.

The 2011 IRP process will be similar to those used to produce the previous three published plans. AURORA^{xmp} will be used for electric market forecasting, resource valuation, and for conducting Monte-Carlo style risk analyses. Results from AURORA^{xmp} will be used to select the Preferred Resource Strategy (PRS) using the proprietary PRiSM 3.0 model. This tool fills future capacity and energy (physical/renewable) deficits using an efficient frontier approach to evaluate quantitative portfolio risk versus portfolio cost while accounting for environmental legislation. Qualitative risk will be evaluated in a separate analysis. The process timeline is shown in Exhibit 1 and the process to identify the PRS is shown in Exhibit 2.

Avista intends to use both detailed site-specific and generic resource assumptions in this plan. These assumptions will be determined by using the 6th Power Plan for generic resources and site-specific assumptions developed by Avista will be used for existing resource upgrades. This plan will study renewable portfolio standards, environmental costs, sustained peaking requirements, and energy efficiency programs. This IRP will develop a strategy that meets or exceeds both the renewable portfolio standards and greenhouse gas emissions regulations.

Avista intends to test the PRS against several scenarios and stochastic futures. The TAC meetings will be an important factor to determine the underlying assumptions used in the scenarios and futures. The IRP process is very technical and data intensive; public comments are welcome and will require input in a timely manner for appropriate inclusion into the process so the plan can be submitted according to the tentative schedule.

Topics and meeting times may be changed depending on the availability of and requests for additional topics from the TAC members. The tentative timeline for public Technical Advisory Committee meetings:

- **May 27, 2010 –** Load & resource balance, climate change, loss of load probability analysis, work plan, and analytical process changes
- **September 8, 2010 –** Plant tours for TAC members
- **September 9, 2010 –** Generic resource assumptions, reliability planning, combined heat & power, sustainability, and energy efficiency
- **November 4, 2010 –** Load forecast, stochastic assumptions, resource upgrade costs, and transmission cost studies

- **January 20, 2011 –** Electric and gas price forecasts, load & resource forecast
- **March 10, 2011 –** Draft PRS, review of scenarios and futures, and portfolio analysis
- **April 28, 2011 –** Review of final PRS and action items
- **June 23, 2011 –** Review of the 2011 IRP

2011 Electric IRP Draft Outline

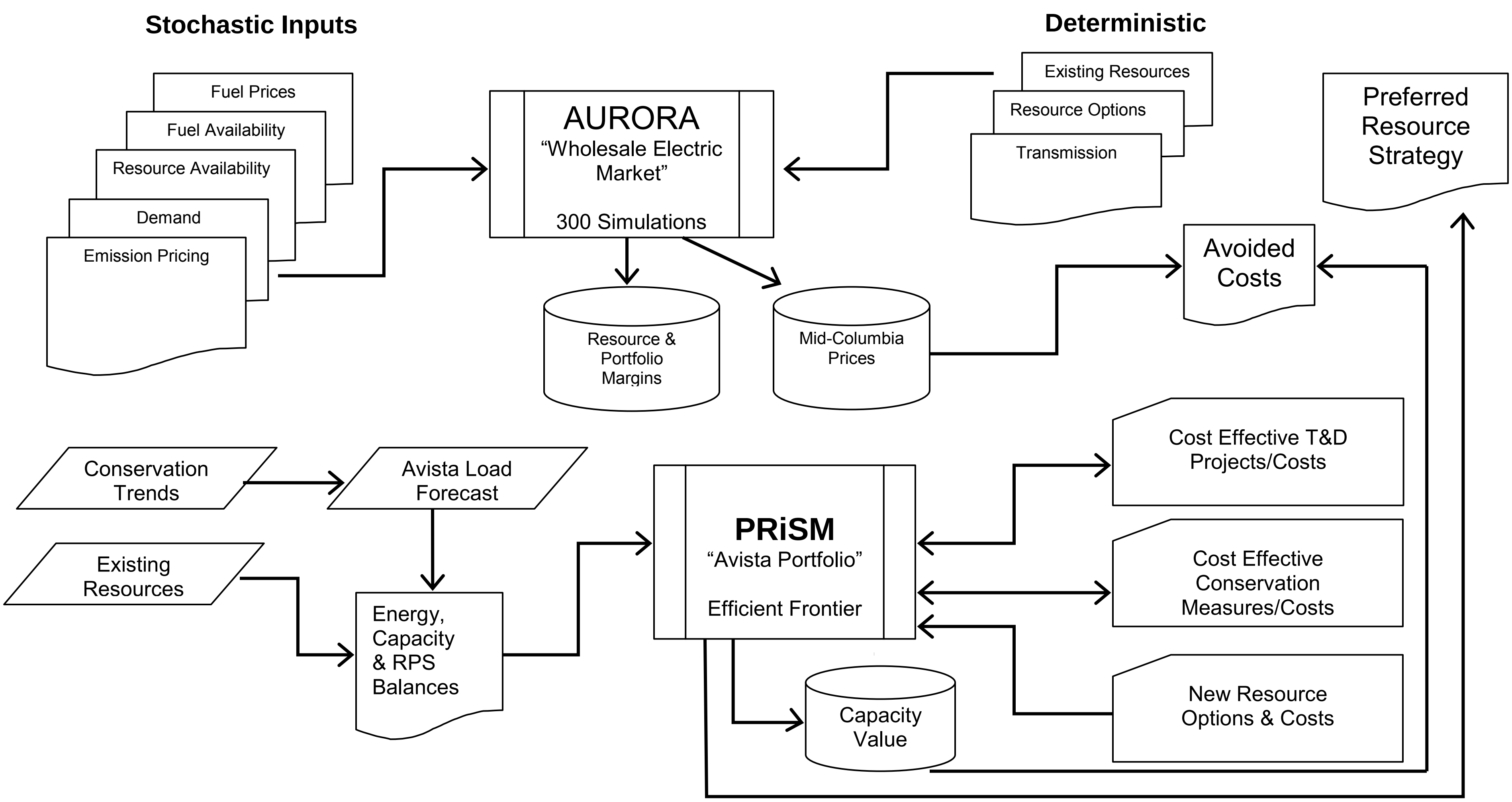
This section provides a draft outline of the major sections in the 2011 Electric IRP. This outline will be updated as IRP studies are completed and input from the Technical Advisory Committee has been received.

1. Executive Summary
2. Introduction and Stakeholder Involvement
3. Loads and Resources
    a. Economic Conditions
    b. Avista Load Forecast
    c. Load Forecast Scenarios
    d. Supply Side Resources
    e. Reserve Margins
    f. Resource Requirements
4. Energy Efficiency and Demand Response
5. Environmental Policy Issues
6. Transmission Planning
7. Modeling Approach
    a. Assumptions and Inputs
    b. Risk Modeling
    c. Resource Alternatives
    d. The PRiSM Model
8. Market Modeling Approach
    a. Futures
    b. Scenarios
    c. Avoided Costs
9. Preferred Resource Strategy & Stress Analysis
10. Action Items

Exhibit 1: 2011 Electric IRP Timeline

Task	Target Date
Preferred Resource Strategy (PRS)	
Finalize load forecast	July 2010
Identify regional resource options for electric market price forecast	September 2010
Identify Avista's supply & conservation resource options	September 2010
Update AURORA^{xmp} database for electric market price forecast	October 2010
Finalize datasets/statistics variables for risk studies	October 2010
Draft transmission study due	October 2010
Energy efficiency load shapes input into AURORA^{xmp}	October 2010
Final transmission study due	November 2010
Select natural gas price forecast	December 2010
Finalize deterministic base case	December 2010
Base case stochastic study complete	January 2011
Finalize PRiSM 3.0 model	January 2011
Develop efficient frontier and PRS	January 2011
Simulation of risk studies "futures" complete	February 2011
Simulate market scenarios in AURORA^{xmp}	February 2011
Evaluate resource strategies against market futures and scenarios	March 2011
Present preliminary study and PRS to TAC	March 2011
Writing Tasks	
File 2011 IRP work plan	August 2010
Prepare report and appendix outline	September 2010
Prepare text drafts	April 2011
Prepare charts and tables	April 2011
Internal draft released at Avista	May 2011
External draft released to the TAC	June 2011
Final editing and printing	August 2011
Final IRP submission to Commissions and distribution to TAC	August 31, 2011

Exhibit 2: 2011 Electric IRP Modeling Process



2011 Electric Integrated Resource Plan

Appendix C – Comprehensive Energy Efficiency Equipment List and Measure Options

APPENDIX | C

RESIDENTIAL ENERGY EFFICIENCY EQUIPMENT AND MEASURE DATA

This appendix presents detailed information for all residential energy efficiency equipment and measures that were evaluated in LoadMAP. Several sets of tables are provided.

Table C-1 provides brief descriptions for all equipment and measures that were assessed for potenital.

Tables C-2 through C-9 list the detailed unit-level data for the equipment measures for each of the housing type segments — single family, multi-family, mobile home, and limited income — and for existing and new construction, respectively. Savings are in kWh/yr/household, and incremental costs are in $/household, unless noted otherwise. The B/C ratio is zero if the measure represents the baseline technology or if the technology is not available in the first year of the forecast (2012). The B/C ratio is calculated within LoadMAP for each year of the forecast and is available once the technology or measure becomes available.

Tables C-10 through C-17 list the detailed unit-level data for the non-equipment energy efficiency measures for each of the housing type segments and for existing and new construction, respectively. Because these measures can produce energy-use savings for multiple end-use loads (e.g., insulation affects heating and cooling energy use) savings are expressed as a percentage of the end-use loads. Base saturation indicates the percentage of homes in which the measure is already installed. Applicability/Feasibility is the product of two factors that account for whether the measure is applicable to the building. Cost is expressed in $/household. The detailed measure-level tables present the results of the benefit/cost (B/C) analysis for the first year of the forecast. The B/C ratio is zero if the measure represents the baseline technology or if the measure is not available in the first year of the forecast (2012). The B/C ratio is calculated within LoadMAP for each year of the forecast and is available once the technology or measure becomes available.

Note that Tables C-2 through C-17 present information for Washington. For Idaho, savings and B/C ratios may be slightly different due to weather-related usage, differences in the states' market profiles, and different retail electricity prices. Although Idaho-specific values are not presented here, they are available within the LoadMAP files.

Table C–1 Residential Energy Efficiency Equipment/Measure Descriptions

End-Use	Equipment/ Measure	Description
Cooling	Air Conditioner — Central (CAC)	Central air conditioners consist of a refrigeration system using a direct expansion cycle. Equipment includes a compressor, an air-cooled condenser (located outdoors), an expansion valve, and an evaporator coil. A supply fan near the evaporator coil distributes supply air through air ducts to the building. Cooling efficiencies vary based on materials used, equipment size, condenser type, and system configuration. CACs may be unitary (all components housed in a factory-built assembly) or split system (an outdoor condenser section and an indoor evaporator section connected by refrigerant lines and with the compressor either indoors or outdoors). Energy efficiency is rated according to the size of the unit using the Seasonal Energy Efficiency Rating (SEER). Systems with Variable Refrigerant Flow further improve the operating efficiency. A high-efficiency option for a ductless mini-split system was also analyzed.
Cooling	Central Air Conditioner, Early Replacement	CAC systems currently on the market are significantly more efficient that older units, due to technology improvement and stricter appliance standards. This measure incents homeowners to replace an aging but still working unit with a new, higher-efficiency one.
Cooling	Central Air Conditioner Maintenance and Tune Up	An air conditioner's filters, coils, and fins require regular cleaning and maintenance for the unit to function effectively and efficiently throughout its life. Neglecting necessary maintenance leads to a steady decline in performance, requiring the AC unit to use more energy for the same cooling load.
Cooling	Air Conditioner - Room, ENERGY STAR or better	Room air conditioners are designed to cool a single room or space. They incorporate a complete air-cooled refrigeration and air-handling system in an individual package. Room air conditioners come in several forms, including window, split-type, and packaged terminal units. Energy efficiency is rated according to the size of the unit using the Energy Efficiency Rating (EER).
Cooling	Room AC — Removal of Second Unit	Homeowners may have a second room AC unit that is extremely inefficient. This measure incents homeowners to recycle the second unit and thus also eliminates associated electricity use.
Cooling	Attic Fan Attic Fan, Photovoltaic	Attic fans can reduce the need for AC by reducing heat transfer from the attic through the ceiling of the house. A well-ventilated attic can be several degrees cooler than a comparable, unventilated attic. An option for an attic fan equipped with a small solar photovoltaic generator was also modeled.
Cooling	Ceiling Fan	Ceiling fans can reduce the need for air conditioning. However, the house occupants must also select a ceiling fan with a high-efficiency motor and either shutoff the AC system or setup the thermostat temperature of the air conditioning system to realize the potential energy savings. Some ceiling fans also come with lamps. In this analysis, it is assumed that there are no lamps, and installing a ceiling fan will allow occupants to increase the thermostat cooling setpoint up by 2°F.
Cooling	Whole-House Fan	Whole-house fans can reduce the need for AC on moderate-weather days or on cool evenings. The fan facilitates a quick air change throughout the entire house. Several windows must be open to achieve the best results. The fan is mounted on the top floor of the house, usually in a hallway ceiling.

End-Use	Equipment/ Measure	Description
Space Heating	Convert to Gas	This fuel-switching measure is the replacement of an electric furnace with a gas-fired furnace. This measure will eliminate all electricity consumption and demand due to electric space heating. In this study, it is assumed that this measure can be implemented only in homes within 500 feet of a gas main.
Heat/Cool	Air Source Heat Pump	A central heat pump consists of components similar to a CAC system, but is usually designed to function both as a heat pump and an air conditioner. It consists of a refrigeration system using a direct expansion (DX) cycle. Equipment includes a compressor, an air-cooled condenser (located outdoors), an expansion valve, and an evaporator coil (located in the supply air duct near the supply fan) and a reversing valve to change the DX cycle from cooling to heating when required. The cooling and heating efficiencies vary based on the materials used, equipment size, condenser type, and system configuration. Heat pumps may be unitary (all components housed in a factory-built assembly) or a split system (an outdoor condenser section and an indoor evaporator section connected by refrigerant lines, with either outdoors or indoors. A high-efficiency option for a ductless mini-split system was also analyzed.
Heat / Cool	Geothermal Heat Pump	Geothermal heat pumps are similar to air-source heat pumps, but use the ground or groundwater instead of outside air to provide a heat source/sink. A geothermal heat pump system generally consists of three major subsystems or parts: a geothermal heat pump to move heat between the building and the fluid in the earth connection, an earth connection for transferring heat between the fluid and the earth, and a distribution subsystem for delivering heating or cooling to the building. The system may also have a desuperheater to supplement the building's water heater, or a full-demand water heater to meet all of the building's hot water needs.
Heat / Cool	Air Source Heat Pump Maintenance	A heat pump's filters, coils, and fins require regular cleaning and maintenance for the unit to function effectively and efficiently throughout its life. Neglecting necessary maintenance ensures a steady decline in performance while energy use steadily increases.
HVAC (all)	Insulation – Ducting	Air distribution ducts can be insulated to reduce heating or cooling losses. Best results can be achieved by covering the entire surface area with insulation. Several types of ducts and duct insulation are available, including flexible duct, pre-insulated duct, duct board, duct wrap, tacked, or glued rigid insulation, and waterproof hard shell materials for exterior ducts. This analysis assumes that installing duct insulation can reduce the temperature drop/gain in ducts by 50%.
HVAC (all)	Repair and Sealing – Ducting	An ideal duct system would be free of leaks. Leakage in unsealed ducts varies considerably because of differences in fabricating machinery used, methods for assembly, installation workmanship, and age of the ductwork. Air leaks from the system to the outdoors result in a direct loss proportional to the amount of leakage and the difference in enthalpy between the outdoor air and the conditioned air. This analysis assumes that over time air loss from ducts has doubled, and conducting repair and sealing of the ducts will restore leakage from ducts to the original baseline level.

End-Use	Equipment/ Measure	Description
HVAC (all)	Thermostat — Clock/Programmable	A programmable thermostat can be added to most heating/cooling systems. They are typically used during winter to lower temperatures at night and in summer to increase temperatures during the afternoon. The energy savings from this type of thermostat are identical to those of a "setback" strategy with standard thermostats, but the convenience of a programmable thermostat makes it a much more attractive option. In this analysis, the baseline is assumed to have no thermostat setback.
HVAC (all)	Doors — Storm and Thermal	Like other components of the shell, doors are subject to several types of heat loss: conduction, infiltration, and radiant losses. Similar to a storm window, a storm door creates an insulating air space between the storm and primary doors. A tight fitting storm door can also help reduce air leakage or infiltration. Thermal doors have exceptional thermal insulation properties and also are provided with weather-stripping on the doorframe to reduce air leakage.
HVAC (all)	Insulation — Infiltration Control	Lowering the air infiltration rate by caulking small leaks and weather-stripping around window frames, doorframes, power outlets, plumbing, and wall corners can provide significant energy savings. Weather-stripping doors and windows will create a tight seal and further reduce air infiltration.
HVAC (all)	Insulation —Ceiling	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation above ceilings can conserve energy by reducing the heat loss or gain into attics and/or through roofs. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose, loose-fill (blown) fiberglass, and rigid polystyrene.
HVAC (all)	Insulation — Radiant Barrier	Radiant barriers are materials installed to reduce the heat gain in buildings. Radiant barriers are made from materials that are highly reflective and have low emissivity like aluminum. The closer the emissivity is to 0 the better they will perform. Radiant barriers can be placed above the insulation or on the roof rafters.
HVAC (all)	Insulation — Foundation Insulation — Wall Cavity Insulation — Wall Sheathing	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing heat loss or gain from a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose, loose-fill (blown) fiberglass, and rigid polystyrene. Foundation, insulation, wall cavity insulation, and wall sheathing were modeled for new construction / major retrofits only.
Cooling	Roof — High Reflectivity	The color and material of a building structure surface determine the amount of solar radiation absorbed by that surface and subsequently transferred into a building. This is called solar absorptance. Using a roofing material with low solar absorptance or painting the roof a light color reduces the cooling load. This analysis assumes that implementing high reflectivity roofs will decrease the roof's absorptance of solar radiation by 45%.
Cooling	Windows — Reflective Film	Reflective films applied to the window interior help reduce solar gain into the space and thus lower cooling energy use.

End-Use	Equipment/ Measure	Description
HVAC (all)	Windows — High Efficiency / ENERGY STAR	High-efficiency windows, such as those labeled under the ENERGY STAR Program, are designed to reduce energy use and increase occupant comfort. High-efficiency windows reduce the amount of heat transfer through the glazing surface. For example, some windows have a low-E coating, a thin film of metallic oxide coating on the glass surface that allows passage of short-wave solar energy through glass and prevents long-wave energy from escaping. Another example is double-pane glass that reduces conductive and convective heat transfer. Some double-pane windows are gas-filled (usually argon) to further increase the insulating properties of the window.
Water Heating	Water Heater - Electric, High Efficiency	For electric hot water heating, the most common type is a storage heater, which incorporates an electric heating element, storage tank, outer jacket, insulation, and controls in a single unit. Efficient units are characterized by a high recovery or thermal efficiency and low standby losses (the ratio of heat lost per hour to the content of the stored water). Electric instantaneous water heaters are available, but are excluded from this study due to potentially high instantaneous demand concerns.
Water Heating	Water Heater, Heat Pump	An electric heat pump water heater (HPWH) uses a vapor-compression thermodynamic cycle similar to that found in an air-conditioner or refrigerator. Electrical work input allows a heat pump water heater to extract heat from an available source (e.g., air) and reject that heat to a higher temperature sink, in this case, the water in the water heater. Because a HPWH makes use of available ambient heat, the coefficient of performance is greater than one — typically in the range of 2 to 3. These devices are available as an alternative to conventional tank water heaters of 55 gallons or larger. By utilizing the earth as a thermal reservoir, ground source HPWH systems can reach even higher levels of efficiency. The heat pump can be integrated with a traditional water storage tank or installed remote to the storage tank.
Water Heating	Water Heating, Solar	Solar water heating systems can be used in residential buildings that have an appropriate near-south-facing roof or nearby unshaded grounds for installing a collector. Although system types vary, in general these systems use a solar absorber surface within a solar collector or an actual storage tank. Either a heat-transfer fluid or the actual potable water flows through tubes attached to the absorber and transfers heat from it. (Systems with a separate heat-transfer-fluid loop include a heat exchanger that then heats the potable water.) The heated water is stored in a separate preheat tank or a conventional water heater tank. If additional heat is needed, it is provided by a conventional water-heating system.
Water Heating	Convert to Gas	This fuel-switching measure is the replacement of an electric water heater with a gas-fired water heater. This measure will eliminate all electricity consumption and demand due to electric water heating. In this study, it is assumed that this measure can be implemented only in home within 500 feet of a gas main.
Water Heating	Faucet Aerators	Water faucet aerators are threaded screens that attach to existing faucets. They reduce the volume of water coming out of faucets while introducing air into the water stream. This measure provides energy saving by reducing hot water use, as well as water conservation for both hot and cold water.

End-Use	Equipment/ Measure	Description
Water Heating	Pipe Insulation	Insulating hot water pipes decreases energy losses from piping that distributes hot water throughout the building. I also results in quicker delivery of hot water and may allow lower the hot water set point, which saves energy. The most common insulation materials for this purpose are polyethylene and neoprene.
Water Heating	Low-Flow Showerheads	Similar to faucet aerators, low-flow showerheads reduce the consumption of hot water, which in turn decreases water heating energy use.
Water Heating	Tank Blanket	Insulating hot water tanks decreases standby energy losses from the tank. Pre-fitted insulating blankets are readily available.
Water Heating	Thermostat Setback / Timer	These measures use either a programmable thermostat or a timer to adjust the water heater setpoint at times of low usage, typically when a home is unoccupied.
Water Heating	Hot Water Saver	A hot water saver is a plumbing device that attaches to the showerhead and that pauses the flow of water until the water is hot enough for use. The water is re-started by the flip of a switch.
Interior Lighting / Exterior Lighting	Infrared Halogen Lamps	Infrared halogen lamps are designed to be a replacement for standards incandescent lamps. Also referred to as advanced incandescent lamps, these products meet the Energy Independence and Security Act (EISA) lighting standards and are phased in as the baseline technology screw-in lamp technology to reflect the timeline over which the EISA lighting standards take effect.
Interior Lighting / Exterior Lighting	Compact Fluorescent Lamps	Compact fluorescent lamps are designed to be a replacement for standard incandescent lamps and use about 25% of the energy used by standard incandescent lamps to produce the same lumen output. The can use either electronic or magnetic ballasts. Integral compact fluorescent lamps have the ballast integrated into the base of the lamp and have a standard screw-in base that permits installation into existing incandescent fixtures.
Interior Lighting / Exterior Lighting	Solid State Lighting, LEDs (Screw-in and linear)	Light-emitting diode (LED) lighting has seen recent penetration in specific applications such as traffic lights and exit signs. With the potential for extremely high efficiency, LEDs show promise to provide general-use lighting for interior spaces. Current models commercially available have efficacies comparable to CFLs. However, theoretical efficiencies are significantly higher. LED models under development are expected to provide improved efficacies.
Interior Lighting	Fluorescent, T8, Super T8, and T5 Lamps and Electronic Ballasts	T8 fluorescent lamps are smaller in diameter than standard T12 lamps, resulting in greater light output per watt. T8 lamps also operate at a lower current and wattage, which increases the efficiency of the ballast but requires the lamps to be compatible with the ballast. Fluorescent lamp fixtures can include a reflector that increases the light output from the fixture, and thus make it possible to use a fewer number of lamps in each fixture. T5 lamps further increase efficiency by reducing the lamp diameter to 5/8”.
Exterior Lighting	Metal Halide and High Pressure Sodium	These lamps technologies can provide slightly higher efficiencies than CFLs in exterior applications.
Interior Lighting	Occupancy Sensors	Occupancy sensors turn lights off when a space is unoccupied. They are appropriate for areas with intermittent use, such as bathrooms or storage areas.

End-Use	Equipment/ Measure	Description
Exterior Lighting	Photovoltaic Installation	Solar photovoltaic generation may be used to power exterior lighting and thus eliminate all or part of the electrical energy use.
Exterior Lighting	Photosensor Control	Photosensor controls turn exterior lighting on or off based on ambient lighting levels. Compared with manual operation, this can reduce the operation of exterior lighting during daylight hours.
Exterior Lighting	Timeclock Installation	Lighting timers turn exterior lighting on or off based on a preset schedule. Compared with manual operation, this can reduce the operation of exterior lighting during daylight hours.
Appliances	Refrigerator/Freezer, ENERGY STAR or better	Energy-efficient refrigerators/freezers incorporate features such as improved cabinet insulation, more efficient compressors and evaporator fans, defrost controls, mullion heaters, oversized condenser coils, and improved door seals. Further efficiency increases can be obtained by reducing the volume of refrigerated space, or adding multiple compartments to reduce losses from opening doors.
Appliances	Refrigerator/Freezer — Early Replacement	Refrigerators/freezers currently on the market are significantly more efficient that older units, due to technology improvement and stricter appliance standards. This measure incents homeowners to replace an aging but still working unit with a new, higher-efficiency one.
Appliances	Refrigerator/Freezer — Remove Second Unit	Homeowners may have a second refrigerator or freezer that is not used to full capacity and that, because of its age, is extremely inefficient. This measure incents homeowners to recycle the second unit and thus also eliminates associated electricity use.
Appliances	Dishwasher, ENERGY STAR or better	ENERGY STAR labeled dishwashers save by using both improved technology for the primary wash cycle, and by using less hot water. Construction includes more effective washing action, energy-efficient motors, and other advanced technology such as sensors that determine the length of the wash cycle and the temperature of the water necessary to clean the dishes.
Appliances	Clothes Washer, ENERGY STAR or better	ENERGY STAR labeled clothes washers use superior designs that require less water. Sensors match the hot water needs to the size and soil level of the load, preventing energy waste. Further energy and water savings can be achieved through advanced technologies such as inverter-drive or combination washer-dryer units.
Appliances	Clothes Dryer – Electric, High Efficiency	An energy-efficient clothes dryer has a moisture-sensing device to terminate the drying cycle rather than using a timer, and an energy-efficient motor is used for spinning the dryer tub. Application of a heat pump cycle for extracting the moisture from clothes leads to additional energy savings.
Appliances	Range and Oven – Electric, High Efficiency	These products have additional insulation in the oven compartment and tighter-fitting oven door gaskets and hinges to save energy. Conventional ovens must first heat up about 35 pounds of steel and a large amount of air before they heat up the food. Tests indicate that only 6% of the energy output of a typical oven is actually absorbed by the food.
Electronics	Color TVs and Home Electronics, ENERGY STAR or better	In the average home, electronic products consumed significant energy, even when they are turn off, to maintain features like clocks, remote control, and channel/station memory. ENERGY STAR labeled consumer electronics can drastically reduce consumption during standby mode, in addition to saving energy through advanced power management during normal use.

End-Use	Equipment/ Measure	Description
Electronics	Personal Computers, ENERGY STAR or better	Improved power management can significantly reduce the annual energy consumption of PCs and monitors in both standby and normal operation. ENERGY STAR and Climate Savers labeled products provide increasing level of energy efficiency.
Electronics	Reduce Standby Wattage	Representing a growing portion of home electricity consumption, plug-in electronics such as set-top boxes, DVD players, gaming systems, digital video recorders, and even battery chargers for mobile phones and laptop computers are often designed to supply a set voltage. When the units are not in use, this voltage could be dropped significantly (~1 W) and thereby generate a significant energy savings, assumed for this analysis to be between 4-5% on average. These savings are in excess of the measures already discussed for computers and televisions.
Misc.	Furnace Fans, Electronically Commutating Motor	In homes heated by a furnace, there is still substantial energy use by the fan responsible for moving the hot air throughout the ductwork. Application of an Electronically Commutating Motor (ECM) ensures that motor speed matches the heating requirements of the system and saves energy when compared to a continuously operating standard motor.
Miscellaneous	Pool Pump	High-efficiency motors and two-speed pumps provide improved energy efficiency for this load.
Miscellaneous	Pool Pump Timer	A pool pump timer allows the pump to turn off automatically, eliminating the wasted energy associated with unnecessary pumping.
Miscellaneous	Trees for Shading	Planting of shade trees, suitable to the local climate, can reduce the need for air conditioning and provide non-energy benefits as well.
Cooling / Space Heating / Interior Lighting	Home Energy Management System	A centralized home energy management system can be used to control and schedule cooling, space heating, lighting, and possibly appliances as well. Some designs also allow the homeowner to remotely control loads via the Internet.
Cooling / Space Heating	Solar Photovoltaic	Adding a solar photovoltaic (PV) system to the home can meet a portion of the home's electric load and in some cases nearly the entire load, depending on the PV system size, orientation, solar resource, and other factors. For this analysis, we assume a grid-connected system and apply the electricity savings to the home's cooling and space heating loads.
Cooling / Space Heating / Interior Lighting	Advanced New Construction Designs	Advanced new construction designs use an integrated approach to the design of new buildings to account for the interaction of building systems. Typically, designs specify the building orientation, building shell, building mechanical systems, and controls strategies with the goal of optimizing building energy efficiency and comfort. Options that may be evaluated and incorporated include passive solar strategies, increased thermal mass, natural ventilation, daylighting strategies, and shading strategies, This measure was modeled for new construction only.
Cooling / Space Heating / Interior Lighting	ENERGY STAR Homes	This measure was modeled for new construction only.
Cooling / Space Heating / Interior Lighting	Energy-Efficient Manufactured Homes	This measure was modeled for new construction only.

Table C-2 Energy Efficiency Equipment Data — Single Family, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	134	$278	15	0.41
Cooling	Central AC	SEER 15 (CEE Tier 2)	184	$556	15	0.28
Cooling	Central AC	SEER 16 (CEE Tier 3)	226	$834	15	0.23
Cooling	Central AC	Ductless Mini-Split System	405	$4,399	20	0.14
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	62	$104	10	0.33
Cooling	Room AC	EER 11	73	$282	10	0.15
Cooling	Room AC	EER 11.5	99	$626	10	0.09
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	492	$1,000	15	0.43
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	675	$2,318	15	0.26
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	829	$3,505	15	0.21
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	1,486	$5,655	20	0.45
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	516	$1,500	14	0.28
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	173	$41	15	5.79
Water Heating	Water Heater	Geothermal Heat Pump	2,269	$6,586	15	0.47
Water Heating	Water Heater	Solar	2,493	$5,653	15	0.60
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	14.44
Interior Lighting*	Screw-in	LED	40	$80	12	0.90
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	22.43
Exterior Lighting*	Screw-in	LED	37	$79	12	0.89
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	45	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	88	$487	10	0.16
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	98	$48	13	2.39
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	41	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	53	$1	9	31.05
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	108	$89	13	1.28
Appliances	Refrigerator	Baseline (2014)	144	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	230	$89	13	-

* Savings and costs are per unit, e.g., per lamp.

Table C-2 Energy Efficiency Equipment Data — Single Family, Existing Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	114	$32	11	3.03
Appliances	Freezer	Baseline (2014)	152	$0	11	-
Appliances	Freezer	Energy Star (2014)	243	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	111	$89	13	1.31
Appliances	Second Refrigerator	Baseline (2014)	148	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	237	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	9	$2	13	7.00
Appliances	Stove	Induction (High Efficiency)	46	$1,432	13	0.05
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	108	$1	5	35.63
Electronics	Personal Computers	Climate Savers	154	$175	5	0.35
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	87	$1	11	133.21
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	138	$85	15	1.96
Miscellaneous	Pool Pump	Two-Speed Pump	551	$579	15	1.15
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	127	$1	18	281.65
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-3 Energy Efficiency Equipment Data — Multi Family, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	67	$93	15	0.62
Cooling	Central AC	SEER 15 (CEE Tier 2)	133	$185	15	0.61
Cooling	Central AC	SEER 16 (CEE Tier 3)	187	$278	15	0.57
Cooling	Central AC	Ductless Mini-Split System	245	$2,012	20	0.19
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	32	$52	10	0.35
Cooling	Room AC	EER 11	38	$141	10	0.15
Cooling	Room AC	EER 11.5	52	$313	10	0.09
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	238	$1,246	15	0.17
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	467	$2,315	15	0.18
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	659	$3,277	15	0.18
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	862	$5,022	20	0.27
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	248	$1,500	14	0.14
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	107	$41	15	3.61
Water Heating	Water Heater	Solar	1,539	$5,653	15	0.38
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	10.47
Interior Lighting*	Screw-in	LED	40	$80	12	0.65
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	32.52
Exterior Lighting*	Screw-in	LED	37	$79	12	1.29
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	23	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	44	$487	10	0.08
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	93	$48	13	2.28
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	15	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	19	$1	9	11.14
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	92	$89	13	1.09
Appliances	Refrigerator	Baseline (2014)	123	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	196	$89	13	-

* Savings and costs are per unit, e.g., per lamp.

Table C-3 Energy Efficiency Equipment Data—Multi Family, Existing Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	108	$32	11	2.88
Appliances	Freezer	Baseline (2014)	145	$0	11	-
Appliances	Freezer	Energy Star (2014)	231	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	93	$89	13	1.11
Appliances	Second Refrigerator	Baseline (2014)	124	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	199	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	4	$2	13	2.99
Appliances	Stove	Induction (High Efficiency)	20	$1,432	13	0.02
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	86	$1	5	29.28
Electronics	Personal Computers	Climate Savers	123	$175	5	0.29
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	43	$1	11	67.65
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	-	$85	15	-
Miscellaneous	Pool Pump	Two-Speed Pump	-	$579	15	-
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	10	$1	18	21.87
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-4 Energy Efficiency Equipment Data — Mobile Home, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	80	$278	15	0.24
Cooling	Central AC	SEER 15 (CEE Tier 2)	110	$556	15	0.17
Cooling	Central AC	SEER 16 (CEE Tier 3)	134	$834	15	0.14
Cooling	Central AC	Ductless Mini-Split System	241	$4,399	20	0.08
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	37	$52	10	0.40
Cooling	Room AC	EER 11	44	$141	10	0.17
Cooling	Room AC	EER 11.5	59	$313	10	0.11
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	282	$1,246	15	0.20
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	387	$2,315	15	0.15
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	475	$3,277	15	0.13
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	852	$5,022	20	0.27
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	295	$1,500	14	0.16
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	88	$41	15	2.95
Water Heating	Water Heater	Solar	1,271	$5,653	15	0.31
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	13.00
Interior Lighting*	Screw-in	LED	40	$80	12	0.81
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.04
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.64
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.13
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.70
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	20.19
Exterior Lighting*	Screw-in	LED	37	$79	12	0.80
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	6.66
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	3.63
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	8.23
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.74
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	46	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	89	$487	10	0.16
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	99	$48	13	2.43
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	41	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	54	$1	9	31.57
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	110	$89	13	1.30
Appliances	Refrigerator	Baseline (2014)	146	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	234	$89	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-4 Energy Efficiency Equipment Data — Mobile Home, Existing Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	116	$32	11	3.08
Appliances	Freezer	Baseline (2014)	155	$0	11	-
Appliances	Freezer	Energy Star (2014)	248	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	113	$89	13	1.34
Appliances	Second Refrigerator	Baseline (2014)	150	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	241	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	8	$2	13	6.30
Appliances	Stove	Induction (High Efficiency)	41	$1,432	13	0.04
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	101	$1	5	33.39
Electronics	Personal Computers	Climate Savers	144	$175	5	0.33
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	87	$1	11	133.21
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	138	$85	15	1.96
Miscellaneous	Pool Pump	Two-Speed Pump	551	$579	15	1.15
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	127	$1	18	281.65
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-5 Energy Efficiency Equipment Data — Limited Income, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	76	$185	15	0.35
Cooling	Central AC	SEER 15 (CEE Tier 2)	104	$370	15	0.24
Cooling	Central AC	SEER 16 (CEE Tier 3)	127	$556	15	0.19
Cooling	Central AC	Ductless Mini-Split System	229	$2,394	20	0.15
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	65	$104	10	0.35
Cooling	Room AC	EER 11	77	$282	10	0.15
Cooling	Room AC	EER 11.5	104	$626	10	0.09
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	192	$1,246	15	0.13
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	263	$2,315	15	0.10
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	323	$3,277	15	0.09
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	579	$5,022	20	0.18
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	201	$1,500	14	0.11
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	116	$41	15	3.94
Water Heating	Water Heater	Solar	1,679	$5,653	15	0.41
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	13.85
Interior Lighting*	Screw-in	LED	40	$80	12	0.86
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	32.52
Exterior Lighting*	Screw-in	LED	37	$79	12	1.29
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	20	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	38	$487	10	0.07
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	104	$48	13	2.56
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	12	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	15	$1	9	9.07
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	92	$89	13	1.09
Appliances	Refrigerator	Baseline (2014)	123	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	196	$89	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-5 Energy Efficiency Equipment Data — Limited Income, Existing Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	108	$32	11	2.88
Appliances	Freezer	Baseline (2014)	145	$0	11	-
Appliances	Freezer	Energy Star (2014)	231	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	93	$89	13	1.11
Appliances	Second Refrigerator	Baseline (2014)	124	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	199	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	5	$2	13	3.59
Appliances	Stove	Induction (High Efficiency)	24	$1,432	13	0.02
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	89	$1	5	30.10
Electronics	Personal Computers	Climate Savers	127	$175	5	0.29
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	49	$1	11	77.80
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	57	$85	15	0.83
Miscellaneous	Pool Pump	Two-Speed Pump	226	$579	15	0.49
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	54	$1	18	123.18
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-6 Energy Efficiency Equipment Data —Single Family, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	180	$278	15	0.55
Cooling	Central AC	SEER 15 (CEE Tier 2)	240	$556	15	0.36
Cooling	Central AC	SEER 16 (CEE Tier 3)	290	$834	15	0.29
Cooling	Central AC	Ductless Mini-Split System	543	$4,399	20	0.19
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	76	$104	10	0.41
Cooling	Room AC	EER 11	90	$282	10	0.18
Cooling	Room AC	EER 11.5	122	$626	10	0.11
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	588	$1,000	15	0.51
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	783	$2,318	15	0.30
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	946	$3,505	15	0.24
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	1,775	$5,655	20	0.54
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	630	$1,500	14	0.35
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	219	$41	15	7.35
Water Heating	Water Heater	Geothermal Heat Pump	2,878	$6,586	15	0.60
Interior Lighting*	Water Heater	Solar	3,163	$5,653	15	0.77
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	14.05
Interior Lighting*	Screw-in	LED	40	$80	12	0.87
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Exterior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	21.82
Exterior Lighting*	Screw-in	LED	37	$79	12	0.87
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	58	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	112	$487	10	0.21
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	117	$48	13	2.86
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	47	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	62	$1	9	36.25
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	102	$89	13	1.20
Appliances	Refrigerator	Baseline (2014)	135	$0	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-6 Energy Efficiency Equipment Data —Single Family, New Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Refrigerator	Energy Star (2014)	217	$89	13	-
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	116	$32	11	3.08
Appliances	Freezer	Baseline (2014)	155	$0	11	-
Appliances	Freezer	Energy Star (2014)	248	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	116	$89	13	1.37
Appliances	Second Refrigerator	Baseline (2014)	154	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	247	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	11	$2	13	8.51
Appliances	Stove	Induction (High Efficiency)	56	$1,432	13	0.06
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	111	$1	5	36.63
Electronics	Personal Computers	Climate Savers	158	$175	5	0.36
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	96	$1	11	148.53
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	156	$85	15	2.22
Miscellaneous	Pool Pump	Two-Speed Pump	623	$579	15	1.30
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	155	$1	18	345.87
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-7 Energy Efficiency Equipment Data — Multi Family, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	85	$93	15	0.78
Cooling	Central AC	SEER 15 (CEE Tier 2)	166	$185	15	0.76
Cooling	Central AC	SEER 16 (CEE Tier 3)	234	$278	15	0.71
Cooling	Central AC	Ductless Mini-Split System	308	$2,012	20	0.24
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	37	$52	10	0.39
Cooling	Room AC	EER 11	43	$141	10	0.17
Cooling	Room AC	EER 11.5	59	$313	10	0.10
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	292	$1,246	15	0.21
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	571	$2,315	15	0.22
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	804	$3,277	15	0.21
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	1,058	$5,022	20	0.33
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	282	$1,500	14	0.15
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	124	$41	15	4.19
Water Heating	Water Heater	Solar	1,786	$5,653	15	0.44
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	10.18
Interior Lighting*	Screw-in	LED	40	$80	12	0.63
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	31.63
Exterior Lighting*	Screw-in	LED	37	$79	12	1.26
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	26	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	51	$487	10	0.09
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	105	$48	13	2.56
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	16	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	21	$1	9	12.38
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	108	$89	13	1.28
Appliances	Refrigerator	Baseline (2014)	144	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	230	$89	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-7 Energy Efficiency Equipment Data — Multi Family, New Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	115	$32	11	3.06
Appliances	Freezer	Baseline (2014)	154	$0	11	-
Appliances	Freezer	Energy Star (2014)	246	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	103	$89	13	1.21
Appliances	Second Refrigerator	Baseline (2014)	137	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	219	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	4	$2	13	3.31
Appliances	Stove	Induction (High Efficiency)	22	$1,432	13	0.02
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	88	$1	5	29.69
Electronics	Personal Computers	Climate Savers	125	$175	5	0.29
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	45	$1	11	71.54
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	-	$85	15	-
Miscellaneous	Pool Pump	Two-Speed Pump	-	$579	15	-
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	11	$1	18	24.36
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-8 Energy Efficiency Equipment Data — Mobile Home, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	100	$278	15	0.30
Cooling	Central AC	SEER 15 (CEE Tier 2)	133	$556	15	0.20
Cooling	Central AC	SEER 16 (CEE Tier 3)	161	$834	15	0.16
Cooling	Central AC	Ductless Mini-Split System	301	$4,399	20	0.11
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	42	$52	10	0.45
Cooling	Room AC	EER 11	50	$141	10	0.20
Cooling	Room AC	EER 11.5	67	$313	10	0.12
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	313	$1,246	15	0.22
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	417	$2,315	15	0.16
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	505	$3,277	15	0.13
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	946	$5,022	20	0.30
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	336	$1,500	14	0.18
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	102	$41	15	3.42
Water Heating	Water Heater	Solar	1,474	$5,653	15	0.36
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	12.64
Interior Lighting*	Screw-in	LED	40	$80	12	0.79
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.04
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.64
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.13
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.70
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	19.63
Exterior Lighting*	Screw-in	LED	37	$79	12	0.78
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	6.66
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	3.63
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	8.23
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.74
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	54	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	104	$487	10	0.19
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	111	$48	13	2.73
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	46	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	60	$1	9	35.11
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	129	$89	13	1.52
Appliances	Refrigerator	Baseline (2014)	172	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	275	$89	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-8 Energy Efficiency Equipment Data — Mobile Home, New Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	124	$32	11	3.28
Appliances	Freezer	Baseline (2014)	165	$0	11	-
Appliances	Freezer	Energy Star (2014)	263	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	124	$89	13	1.47
Appliances	Second Refrigerator	Baseline (2014)	165	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	264	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	9	$2	13	6.98
Appliances	Stove	Induction (High Efficiency)	46	$1,432	13	0.05
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	103	$1	5	33.86
Electronics	Personal Computers	Climate Savers	146	$175	5	0.33
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	91	$1	11	140.87
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	154	$85	15	2.20
Miscellaneous	Pool Pump	Two-Speed Pump	617	$579	15	1.29
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	141	$1	18	313.76
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-9 Energy Efficiency Equipment Data — Limited Income, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	95	$185	15	0.43
Cooling	Central AC	SEER 15 (CEE Tier 2)	126	$370	15	0.29
Cooling	Central AC	SEER 16 (CEE Tier 3)	152	$556	15	0.23
Cooling	Central AC	Ductless Mini-Split System	286	$2,394	20	0.18
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	74	$104	10	0.40
Cooling	Room AC	EER 11	87	$282	10	0.17
Cooling	Room AC	EER 11.5	118	$626	10	0.11
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	213	$1,246	15	0.15
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	284	$2,315	15	0.11
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	343	$3,277	15	0.09
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	643	$5,022	20	0.20
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	228	$1,500	14	0.13
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	135	$41	15	4.57
Water Heating	Water Heater	Solar	1,949	$5,653	15	0.48
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	13.47
Interior Lighting*	Screw-in	LED	40	$80	12	0.84
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	31.63
Exterior Lighting*	Screw-in	LED	37	$79	12	1.26
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	23	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	44	$487	10	0.08
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	117	$48	13	2.87
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	13	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	17	$1	9	10.08
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	108	$89	13	1.28
Appliances	Refrigerator	Baseline (2014)	144	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	230	$89	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-9 Energy Efficiency Equipment Data — Limited Income, New Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	115	$32	11	3.06
Appliances	Freezer	Baseline (2014)	154	$0	11	-
Appliances	Freezer	Energy Star (2014)	246	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	103	$89	13	1.21
Appliances	Second Refrigerator	Baseline (2014)	137	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	219	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	5	$2	13	3.98
Appliances	Stove	Induction (High Efficiency)	26	$1,432	13	0.03
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	90	$1	5	30.52
Electronics	Personal Computers	Climate Savers	129	$175	5	0.30
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	52	$1	11	82.28
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	63	$85	15	0.93
Miscellaneous	Pool Pump	Two-Speed Pump	254	$579	15	0.54
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	60	$1	18	137.23
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-10 Energy-Efficiency Measure Data—Single Family, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Early Replacement	Cooling	10%	0%	0%	8%	$2,895	15	0.05
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	41%	100%	$125	4	0.70
Room AC - Removal of Second Unit	Cooling	100%	0%	0%	25%	$75	5	2.45
Attic Fan - Installation	Cooling	1%	0%	12%	23%	$116	18	0.08
Attic Fan - Photovoltaic - Installation	Cooling	1%	0%	13%	45%	$350	19	0.06
Ceiling Fan - Installation	Cooling	11%	0%	51%	75%	$160	15	0.81
Whole-House Fan - Installation	Cooling	9%	0%	7%	19%	$200	18	0.62
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	1.49
Insulation - Ducting	Cooling	3%	0%	15%	75%	$500	18	0.78
Insulation - Ducting	Space Heating	4%	4%	15%	75%	$500	18	0.78
Repair and Sealing - Ducting	Cooling	10%	0%	12%	50%	$500	18	2.08
Repair and Sealing - Ducting	Space Heating	15%	15%	12%	50%	$500	18	2.08
Thermostat - Clock/Programmable	Cooling	8%	0%	55%	56%	$114	11	2.89
Thermostat - Clock/Programmable	Space Heating	9%	5%	55%	56%	$114	11	2.89
Doors - Storm and Thermal	Cooling	1%	0%	38%	75%	$320	12	0.25
Doors - Storm and Thermal	Space Heating	2%	2%	38%	75%	$320	12	0.25
Insulation - Infiltration Control	Cooling	3%	0%	46%	90%	$266	12	1.72
Insulation - Infiltration Control	Space Heating	10%	10%	46%	90%	$266	12	1.72
Insulation - Ceiling	Cooling	3%	0%	68%	72%	$594	20	1.11
Insulation - Ceiling	Space Heating	10%	5%	68%	72%	$594	20	1.11
Insulation - Radiant Barrier	Cooling	5%	0%	5%	90%	$923	12	0.41
Insulation - Radiant Barrier	Space Heating	2%	1%	5%	90%	$923	12	0.41
Roofs - High Reflectivity	Cooling	6%	0%	5%	10%	$1,550	15	0.05
Windows - Reflective Film	Cooling	7%	0%	5%	45%	$267	10	0.21
Windows - High Efficiency/Energy Star	Cooling	12%	0%	83%	90%	$7,500	25	0.38
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	83%	90%	$7,500	25	0.38
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	24%	25%	$750	15	0.10
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	0%	10%	80%	$2,975	15	0.03
Exterior Lighting - Photosensor Control	Exterior Lighting	15%	0%	24%	45%	$90	8	0.21
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	10%	45%	$72	8	0.35
Water Heater - Faucet Aerators	Water Heating	4%	2%	53%	90%	$24	25	8.78
Water Heater - Pipe Insulation	Water Heating	6%	3%	17%	38%	$180	13	1.05
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	75%	80%	$96	10	4.56
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	54%	75%	$15	10	15.53
Water Heater - Thermostat Setback	Water Heating	9%	5%	17%	75%	$40	5	2.99
Water Heater - Timer	Water Heating	8%	4%	17%	40%	$194	10	1.06
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	3.28
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	1.76
Refrigerator - Early Replacement	Appliances	15%	15%	0%	20%	$1,203	13	0.08
Refrigerator - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.99
Freezer - Early Replacement	Appliances	15%	15%	0%	20%	$484	11	0.18
Freezer - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.76
Home Energy Management System	Cooling	10%	0%	20%	38%	$300	20	2.46
Home Energy Management System	Space Heating	10%	5%	20%	38%	$300	20	2.46
Home Energy Management System	Interior Lighting	10%	5%	20%	38%	$300	20	2.46
Photovoltaics	Cooling	50%	0%	0%	48%	$17,000	15	0.10
Photovoltaics	Space Heating	25%	25%	0%	48%	$17,000	15	0.10
Pool - Pump Timer	Miscellaneous	60%	0%	59%	90%	$160	15	4.92
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.43
Water Heater - Heat Pump	Water Heating	30%	15%	0%	25%	$1,500	15	0.75
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$3,675	15	1.22
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$13,769	15	0.95

Note: Costs are per household.

Table C-11 Energy-Efficiency Measure Data — Multi Family, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Early Replacement	Cooling	10%	0%	0%	8%	$2,895	15	0.02
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	33%	100%	$100	4	0.59
Room AC - Removal of Second Unit	Cooling	100%	0%	0%	25%	$75	5	1.28
Ceiling Fan - Installation	Cooling	11%	0%	32%	75%	$80	15	0.49
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$100	4	1.05
Insulation - Ducting	Cooling	3%	0%	13%	75%	$375	18	1.16
Insulation - Ducting	Space Heating	4%	4%	13%	75%	$375	18	1.16
Repair and Sealing - Ducting	Cooling	4%	0%	12%	50%	$500	18	0.95
Repair and Sealing - Ducting	Space Heating	4%	4%	12%	50%	$500	18	0.95
Thermostat - Clock/Programmable	Cooling	8%	0%	27%	68%	$114	11	2.39
Thermostat - Clock/Programmable	Space Heating	6%	3%	27%	68%	$114	11	2.39
Doors - Storm and Thermal	Cooling	1%	0%	17%	75%	$320	12	0.35
Doors - Storm and Thermal	Space Heating	2%	2%	17%	75%	$320	12	0.35
Insulation - Infiltration Control	Cooling	1%	0%	19%	90%	$266	12	2.95
Insulation - Infiltration Control	Space Heating	13%	13%	19%	90%	$266	12	2.95
Insulation - Ceiling	Cooling	13%	0%	27%	30%	$215	20	5.67
Insulation - Ceiling	Space Heating	13%	13%	27%	30%	$215	20	5.67
Insulation - Radiant Barrier	Cooling	4%	0%	5%	90%	$923	12	0.52
Insulation - Radiant Barrier	Space Heating	4%	4%	5%	90%	$923	12	0.52
Roofs - High Reflectivity	Cooling	13%	0%	3%	10%	$1,550	15	0.03
Windows - Reflective Film	Cooling	7%	0%	5%	45%	$167	10	0.10
Windows - High Efficiency/Energy Star	Cooling	13%	0%	70%	90%	$2,500	25	0.56
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	70%	90%	$2,500	25	0.56
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	6%	10%	$256	15	0.14
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	0%	10%	50%	$2,975	15	0.00
Exterior Lighting - Photosensor Control	Exterior Lighting	20%	0%	7%	45%	$90	8	0.04
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	6%	45%	$72	8	0.05
Water Heater - Faucet Aerators	Water Heating	5%	2%	43%	90%	$24	25	6.63
Water Heater - Pipe Insulation	Water Heating	6%	3%	6%	38%	$180	13	0.65
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	71%	75%	$96	10	2.84
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	54%	75%	$15	10	9.66
Water Heater - Thermostat Setback	Water Heating	9%	5%	17%	75%	$40	5	1.86
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	0.66
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	2.04
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	0.58
Refrigerator - Early Replacement	Appliances	15%	15%	0%	20%	$1,203	13	0.07
Refrigerator - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.36
Freezer - Early Replacement	Appliances	15%	15%	0%	20%	$484	11	0.17
Freezer - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.57
Home Energy Management System	Cooling	10%	0%	5%	13%	$300	20	2.46
Home Energy Management System	Space Heating	10%	5%	5%	13%	$300	20	2.46
Home Energy Management System	Interior Lighting	10%	5%	5%	13%	$300	20	2.46
Photovoltaics	Cooling	50%	0%	0%	12%	$8,500	15	0.22
Photovoltaics	Space Heating	25%	25%	0%	12%	$8,500	15	0.22
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.13
Water Heater - Heat Pump	Water Heating	30%	15%	0%	10%	$1,500	15	0.47
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,845	15	0.99
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$10,946	15	0.72

Note: Costs are per household.

Table C-12 Energy-Efficiency Measure Data — Mobile Home, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Early Replacement	Cooling	10%	0%	0%	8%	$2,895	15	0.03
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	59%	100%	$100	4	0.63
Room AC - Removal of Second Unit	Cooling	100%	0%	0%	25%	$75	5	1.46
Ceiling Fan - Installation	Cooling	11%	0%	60%	75%	$80	15	0.79
Whole-House Fan - Installation	Cooling	9%	0%	5%	19%	$150	18	0.41
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	1.02
Insulation - Ducting	Cooling	3%	0%	15%	75%	$375	18	0.94
Insulation - Ducting	Space Heating	4%	4%	15%	75%	$375	18	0.94
Repair and Sealing - Ducting	Cooling	10%	0%	12%	50%	$500	18	2.08
Repair and Sealing - Ducting	Space Heating	15%	15%	12%	50%	$500	18	2.08
Thermostat - Clock/Programmable	Cooling	8%	0%	51%	56%	$114	11	2.78
Thermostat - Clock/Programmable	Space Heating	9%	5%	51%	56%	$114	11	2.78
Doors - Storm and Thermal	Cooling	1%	0%	38%	75%	$320	12	0.25
Doors - Storm and Thermal	Space Heating	2%	2%	38%	75%	$320	12	0.25
Insulation - Infiltration Control	Cooling	3%	0%	46%	90%	$266	12	1.80
Insulation - Infiltration Control	Space Heating	10%	10%	46%	90%	$266	12	1.80
Insulation - Ceiling	Cooling	3%	0%	79%	81%	$707	20	1.00
Insulation - Ceiling	Space Heating	10%	5%	79%	81%	$707	20	1.00
Insulation - Radiant Barrier	Cooling	2%	0%	5%	90%	$923	12	0.35
Insulation - Radiant Barrier	Space Heating	1%	1%	5%	90%	$923	12	0.35
Roofs - High Reflectivity	Cooling	6%	0%	5%	10%	$1,550	15	0.02
Windows - Reflective Film	Cooling	7%	0%	5%	45%	$167	10	0.16
Windows - High Efficiency/Energy Star	Cooling	12%	0%	47%	90%	$7,500	25	0.37
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	47%	90%	$7,500	25	0.37
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	67%	72%	$750	15	0.09
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	0%	10%	80%	$2,975	15	0.03
Exterior Lighting - Photosensor Control	Exterior Lighting	15%	0%	23%	45%	$90	8	0.19
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	10%	45%	$72	8	0.32
Water Heater - Faucet Aerators	Water Heating	4%	2%	79%	90%	$24	25	4.47
Water Heater - Pipe Insulation	Water Heating	6%	3%	17%	38%	$180	13	0.53
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	92%	95%	$96	10	2.32
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	54%	75%	$15	10	7.91
Water Heater - Thermostat Setback	Water Heating	9%	5%	17%	75%	$40	5	1.52
Water Heater - Timer	Water Heating	8%	4%	17%	40%	$194	10	0.54
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	1.67
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	1.65
Refrigerator - Early Replacement	Appliances	15%	15%	0%	20%	$1,203	13	0.08
Refrigerator - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	4.06
Freezer - Early Replacement	Appliances	15%	15%	0%	20%	$484	11	0.18
Freezer - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.82
Home Energy Management System	Cooling	10%	0%	20%	38%	$300	20	2.28
Home Energy Management System	Space Heating	10%	5%	20%	38%	$300	20	2.28
Home Energy Management System	Interior Lighting	10%	5%	20%	38%	$300	20	2.28
Photovoltaics	Cooling	50%	0%	0%	48%	$17,000	15	0.09
Photovoltaics	Space Heating	25%	25%	0%	48%	$17,000	15	0.09
Pool - Pump Timer	Miscellaneous	60%	0%	50%	90%	$160	15	4.92
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.21
Water Heater - Heat Pump	Water Heating	30%	15%	0%	10%	$1,500	15	0.38
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,616	15	0.88
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$11,135	15	0.62

Note: Costs are per household.

Table C-13 Energy-Efficiency Measure Data — Limited Income, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Early Replacement	Cooling	10%	0%	0%	8%	$2,895	15	0.03
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	25%	100%	$100	4	0.61
Room AC - Removal of Second Unit	Cooling	100%	0%	0%	25%	$75	5	2.56
Attic Fan - Installation	Cooling	1%	0%	3%	23%	$116	18	0.05
Attic Fan - Photovoltaic - Installation	Cooling	1%	0%	2%	11%	$350	19	0.03
Ceiling Fan - Installation	Cooling	11%	0%	41%	75%	$80	15	0.89
Whole-House Fan - Installation	Cooling	9%	0%	5%	19%	$150	18	0.46
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	0.82
Insulation - Ducting	Cooling	3%	0%	13%	75%	$395	18	0.90
Insulation - Ducting	Space Heating	4%	4%	13%	75%	$395	18	0.90
Repair and Sealing - Ducting	Cooling	10%	0%	12%	50%	$500	18	2.07
Repair and Sealing - Ducting	Space Heating	15%	15%	12%	50%	$500	18	2.07
Thermostat - Clock/Programmable	Cooling	8%	0%	27%	68%	$114	11	2.63
Thermostat - Clock/Programmable	Space Heating	9%	5%	27%	68%	$114	11	2.63
Doors - Storm and Thermal	Cooling	1%	0%	17%	75%	$320	12	0.25
Doors - Storm and Thermal	Space Heating	2%	2%	17%	75%	$320	12	0.25
Insulation - Infiltration Control	Cooling	3%	0%	19%	90%	$266	12	1.78
Insulation - Infiltration Control	Space Heating	10%	10%	19%	90%	$266	12	1.78
Insulation - Ceiling	Cooling	3%	0%	36%	41%	$215	20	2.44
Insulation - Ceiling	Space Heating	10%	5%	36%	41%	$215	20	2.44
Insulation - Radiant Barrier	Cooling	2%	0%	5%	90%	$923	12	0.35
Insulation - Radiant Barrier	Space Heating	1%	1%	5%	90%	$923	12	0.35
Roofs - High Reflectivity	Cooling	6%	0%	3%	10%	$1,550	15	0.03
Windows - Reflective Film	Cooling	7%	0%	5%	45%	$167	10	0.18
Windows - High Efficiency/Energy Star	Cooling	12%	0%	68%	90%	$2,500	25	0.51
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	68%	90%	$2,500	25	0.51
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	8%	10%	$256	15	0.16
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	50%	10%	50%	$2,975	15	0.01
Exterior Lighting - Photosensor Control	Exterior Lighting	15%	0%	8%	45%	$90	8	0.06
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	6%	45%	$72	8	0.10
Water Heater - Faucet Aerators	Water Heating	4%	2%	46%	90%	$24	25	5.95
Water Heater - Pipe Insulation	Water Heating	6%	3%	6%	38%	$180	13	0.71
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	73%	75%	$96	10	3.09
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	54%	75%	$15	10	10.53
Water Heater - Thermostat Setback	Water Heating	9%	5%	17%	75%	$40	5	2.03
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	0.72
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	2.23
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	0.77
Refrigerator - Early Replacement	Appliances	15%	15%	0%	20%	$1,203	13	0.07
Refrigerator - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.36
Freezer - Early Replacement	Appliances	15%	15%	0%	20%	$484	11	0.17
Freezer - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.57
Home Energy Management System	Cooling	10%	0%	5%	13%	$300	20	2.00
Home Energy Management System	Space Heating	10%	5%	5%	13%	$300	20	2.00
Home Energy Management System	Interior Lighting	10%	5%	5%	13%	$300	20	2.00
Photovoltaics	Cooling	50%	0%	0%	48%	$8,500	15	0.17
Photovoltaics	Space Heating	25%	25%	0%	48%	$8,500	15	0.17
Pool - Pump Timer	Miscellaneous	60%	0%	50%	90%	$160	15	2.02
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.24
Water Heater - Heat Pump	Water Heating	30%	15%	0%	20%	$1,500	15	0.51
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,970	15	1.03
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$10,798	15	0.69

Note: Costs are per household.

Table C-14 Energy-Efficiency Measure Data — Single Family, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	41%	100%	$125	4	0.78
Attic Fan - Installation	Cooling	1%	0%	13%	23%	$97	18	0.15
Attic Fan - Photovoltaic - Installation	Cooling	1%	0%	4%	11%	$200	19	0.15
Ceiling Fan - Installation	Cooling	10%	0%	53%	75%	$160	15	1.09
Whole-House Fan - Installation	Cooling	9%	0%	4%	19%	$200	18	0.92
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	1.69
Insulation - Ducting	Cooling	3%	0%	50%	75%	$250	18	1.31
Insulation - Ducting	Space Heating	4%	4%	50%	75%	$250	18	1.31
Thermostat - Clock/Programmable	Cooling	8%	0%	91%	95%	$114	11	2.91
Thermostat - Clock/Programmable	Space Heating	8%	4%	91%	95%	$114	11	2.91
Doors - Storm and Thermal	Cooling	1%	0%	13%	75%	$180	12	0.45
Doors - Storm and Thermal	Space Heating	2%	2%	13%	75%	$180	12	0.45
Insulation - Ceiling	Cooling	3%	0%	68%	71%	$634	20	0.99
Insulation - Ceiling	Space Heating	8%	6%	68%	71%	$634	20	0.99
Insulation - Radiant Barrier	Cooling	2%	0%	25%	90%	$923	12	0.37
Insulation - Radiant Barrier	Space Heating	1%	1%	25%	90%	$923	12	0.37
Insulation - Foundation	Cooling	3%	0%	20%	90%	$358	20	1.35
Insulation - Foundation	Space Heating	6%	6%	20%	90%	$358	20	1.35
Insulation - Wall Cavity	Cooling	2%	0%	20%	90%	$236	20	1.15
Insulation - Wall Cavity	Space Heating	3%	3%	20%	90%	$236	20	1.15
Insulation - Wall Sheathing	Cooling	1%	0%	64%	90%	$300	20	0.89
Insulation - Wall Sheathing	Space Heating	3%	3%	64%	90%	$300	20	0.89
Roofs - High Reflectivity	Cooling	5%	0%	5%	90%	$517	15	0.17
Windows - Reflective Film	Cooling	7%	0%	2%	45%	$267	10	0.31
Windows - High Efficiency/Energy Star	Cooling	12%	0%	100%	100%	$2,200	25	0.62
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	100%	100%	$2,200	25	0.62
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	24%	27%	$500	15	0.16
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	0%	10%	80%	$2,975	15	0.04
Exterior Lighting - Photosensor Control	Exterior Lighting	13%	0%	13%	45%	$90	8	0.19
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	16%	45%	$72	8	0.36
Water Heater - Faucet Aerators	Water Heating	4%	2%	38%	90%	$24	25	11.03
Water Heater - Pipe Insulation	Water Heating	6%	3%	8%	41%	$50	13	4.71
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	90%	95%	$48	10	11.33
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$15	10	19.30
Water Heater - Thermostat Setback	Water Heating	9%	5%	5%	75%	$40	5	3.70
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	1.31
Water Heater - Drainwater Heat Reocvery	Water Heating	9%	5%	1%	90%	$899	15	0.47
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	4.06
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	1.99
Home Energy Management System	Cooling	10%	0%	20%	68%	$250	20	3.16
Home Energy Management System	Space Heating	10%	5%	20%	68%	$250	20	3.16
Home Energy Management System	Interior Lighting	10%	5%	20%	68%	$250	20	3.16
Photovoltaics	Cooling	50%	0%	1%	48%	$15,800	15	0.12
Photovoltaics	Space Heating	25%	25%	1%	48%	$15,800	15	0.12
Pool - Pump Timer	Miscellaneous	60%	0%	55%	90%	$160	15	5.43
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.64
Advanced New Construction Designs	Cooling	40%	0%	2%	45%	$4,500	18	1.09
Advanced New Construction Designs	Space Heating	40%	40%	2%	45%	$4,500	18	1.09
Advanced New Construction Designs	Interior Lighting	20%	20%	2%	45%	$4,500	18	1.09
Energy Star Homes	Cooling	20%	0%	12%	75%	$5,000	18	0.75
Energy Star Homes	Space Heating	20%	20%	12%	75%	$5,000	18	0.75
Energy Star Homes	Interior Lighting	20%	20%	12%	75%	$5,000	18	0.75
Water Heater - Heat Pump	Water Heating	30%	15%	0%	25%	$1,500	15	0.94
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$3,675	15	1.53
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$13,769	15	1.14

Note: Costs are per household.

Table C-15 Energy-Efficiency Measure Data — Multi Family, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	33%	100%	$100	4	0.62
Ceiling Fan - Installation	Cooling	10%	0%	18%	75%	$80	15	0.77
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$100	4	1.12
Insulation - Ducting	Cooling	2%	0%	50%	75%	$200	18	1.18
Insulation - Ducting	Space Heating	2%	2%	50%	75%	$200	18	1.18
Thermostat - Clock/Programmable	Cooling	8%	0%	77%	80%	$114	11	2.29
Thermostat - Clock/Programmable	Space Heating	5%	3%	77%	80%	$114	11	2.29
Doors - Storm and Thermal	Cooling	1%	0%	19%	75%	$180	12	0.66
Doors - Storm and Thermal	Space Heating	2%	2%	19%	75%	$180	12	0.66
Insulation - Ceiling	Cooling	12%	0%	27%	48%	$152	20	10.12
Insulation - Ceiling	Space Heating	16%	16%	27%	48%	$152	20	10.12
Insulation - Radiant Barrier	Cooling	2%	0%	5%	90%	$923	12	0.50
Insulation - Radiant Barrier	Space Heating	3%	3%	5%	90%	$923	12	0.50
Insulation - Wall Cavity	Cooling	2%	0%	4%	90%	$63	20	6.14
Insulation - Wall Cavity	Space Heating	4%	4%	4%	90%	$63	20	6.14
Insulation - Wall Sheathing	Cooling	1%	0%	55%	90%	$210	20	1.59
Insulation - Wall Sheathing	Space Heating	3%	3%	55%	90%	$210	20	1.59
Roofs - High Reflectivity	Cooling	8%	0%	0%	90%	$517	15	0.10
Windows - Reflective Film	Cooling	7%	0%	2%	45%	$167	10	0.17
Windows - High Efficiency/Energy Star	Cooling	13%	0%	100%	100%	$2,200	25	0.63
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	100%	100%	$2,200	25	0.63
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	6%	9%	$256	15	0.14
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	0%	10%	50%	$2,975	15	0.01
Exterior Lighting - Photosensor Control	Exterior Lighting	20%	0%	1%	45%	$90	8	0.04
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	11%	45%	$72	8	0.05
Water Heater - Faucet Aerators	Water Heating	5%	2%	11%	90%	$24	25	7.63
Water Heater - Pipe Insulation	Water Heating	6%	3%	0%	41%	$50	13	2.68
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	66%	75%	$48	10	6.45
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$15	10	10.99
Water Heater - Thermostat Setback	Water Heating	9%	5%	5%	75%	$40	5	2.11
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	0.75
Water Heater - Drainwater Heat Reocvery	Water Heating	9%	5%	1%	90%	$899	15	0.27
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	2.31
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	0.63
Home Energy Management System	Cooling	10%	0%	5%	68%	$250	20	3.19
Home Energy Management System	Space Heating	10%	5%	5%	68%	$250	20	3.19
Home Energy Management System	Interior Lighting	10%	5%	5%	68%	$250	20	3.19
Photovoltaics	Cooling	50%	0%	0%	12%	$7,900	15	0.26
Photovoltaics	Space Heating	25%	25%	0%	12%	$7,900	15	0.26
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.23
Advanced New Construction Designs	Cooling	40%	0%	2%	45%	$2,500	18	1.47
Advanced New Construction Designs	Space Heating	40%	40%	2%	45%	$2,500	18	1.47
Advanced New Construction Designs	Interior Lighting	20%	20%	2%	45%	$2,500	18	1.47
Water Heater - Heat Pump	Water Heating	30%	15%	0%	10%	$1,500	15	0.53
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,845	15	1.13
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$10,946	15	0.84

Note: Costs are per household.

Table C-16 Energy-Efficiency Measure Data — Mobile Home, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	59%	100%	$100	4	0.66
Ceiling Fan - Installation	Cooling	10%	0%	57%	75%	$80	15	0.95
Whole-House Fan - Installation	Cooling	9%	0%	4%	19%	$150	18	0.53
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	1.09
Insulation - Ducting	Cooling	3%	0%	50%	75%	$200	18	1.59
Insulation - Ducting	Space Heating	4%	4%	50%	75%	$200	18	1.59
Thermostat - Clock/Programmable	Cooling	8%	0%	57%	75%	$114	11	2.77
Thermostat - Clock/Programmable	Space Heating	8%	4%	57%	75%	$114	11	2.77
Doors - Storm and Thermal	Cooling	1%	0%	13%	75%	$180	12	0.49
Doors - Storm and Thermal	Space Heating	2%	2%	13%	75%	$180	12	0.49
Insulation - Ceiling	Cooling	3%	0%	79%	81%	$176	20	3.02
Insulation - Ceiling	Space Heating	8%	6%	79%	81%	$176	20	3.02
Insulation - Radiant Barrier	Cooling	2%	0%	25%	90%	$923	12	0.36
Insulation - Radiant Barrier	Space Heating	1%	1%	25%	90%	$923	12	0.36
Insulation - Wall Cavity	Cooling	2%	0%	20%	90%	$197	20	1.35
Insulation - Wall Cavity	Space Heating	3%	3%	20%	90%	$197	20	1.35
Insulation - Wall Sheathing	Cooling	1%	0%	64%	90%	$300	20	0.96
Insulation - Wall Sheathing	Space Heating	3%	3%	64%	90%	$300	20	0.96
Roofs - High Reflectivity	Cooling	5%	0%	5%	90%	$517	15	0.07
Windows - Reflective Film	Cooling	7%	0%	2%	45%	$167	10	0.21
Windows - High Efficiency/Energy Star	Cooling	12%	0%	85%	90%	$2,200	25	0.57
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	85%	90%	$2,200	25	0.57
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	67%	72%	$500	15	0.14
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	50%	10%	80%	$2,975	15	0.03
Exterior Lighting - Photosensor Control	Exterior Lighting	13%	0%	13%	45%	$90	8	0.17
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	16%	45%	$72	8	0.32
Water Heater - Faucet Aerators	Water Heating	4%	2%	57%	90%	$24	25	5.14
Water Heater - Pipe Insulation	Water Heating	6%	3%	8%	41%	$50	13	2.20
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	92%	95%	$48	10	5.28
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$15	10	9.00
Water Heater - Thermostat Setback	Water Heating	9%	5%	5%	75%	$40	5	1.72
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	0.61
Water Heater - Drainwater Heat Reocvery	Water Heating	9%	5%	1%	90%	$899	15	0.22
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	1.89
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	1.79
Home Energy Management System	Cooling	10%	0%	20%	68%	$250	20	2.94
Home Energy Management System	Space Heating	10%	5%	20%	68%	$250	20	2.94
Home Energy Management System	Interior Lighting	10%	5%	20%	68%	$250	20	2.94
Photovoltaics	Cooling	50%	0%	1%	48%	$15,800	15	0.10
Photovoltaics	Space Heating	25%	25%	1%	48%	$15,800	15	0.10
Pool - Pump Timer	Miscellaneous	60%	0%	35%	90%	$160	15	5.38
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.28
Advanced New Construction Designs	Cooling	30%	0%	2%	45%	$4,500	18	0.52
Advanced New Construction Designs	Space Heating	30%	30%	2%	45%	$4,500	18	0.52
Advanced New Construction Designs	Interior Lighting	20%	20%	2%	45%	$4,500	18	0.52
Energy Efficient Manufactured Homes	Cooling	20%	0%	10%	75%	$3,500	18	0.88
Energy Efficient Manufactured Homes	Space Heating	20%	20%	10%	75%	$3,500	18	0.88
Energy Efficient Manufactured Homes	Interior Lighting	20%	20%	10%	75%	$3,500	18	0.88
Water Heater - Heat Pump	Water Heating	30%	15%	0%	10%	$1,500	15	0.44
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,616	15	1.00
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$11,738	15	0.69

Note: Costs are per household.

Table C-17 Energy-Efficiency Measure Data — Limited Income, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	25%	100%	$100	4	0.65
Attic Fan - Installation	Cooling	1%	0%	15%	23%	$97	18	0.07
Attic Fan - Photovoltaic - Installation	Cooling	1%	0%	5%	11%	$200	19	0.07
Ceiling Fan - Installation	Cooling	10%	0%	33%	75%	$80	15	1.03
Whole-House Fan - Installation	Cooling	9%	0%	4%	19%	$150	18	0.58
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	0.87
Insulation - Ducting	Cooling	3%	0%	50%	75%	$210	18	1.47
Insulation - Ducting	Space Heating	4%	4%	50%	75%	$210	18	1.47
Thermostat - Clock/Programmable	Cooling	8%	0%	29%	30%	$114	11	2.54
Thermostat - Clock/Programmable	Space Heating	8%	4%	29%	30%	$114	11	2.54
Doors - Storm and Thermal	Cooling	1%	0%	19%	75%	$180	12	0.46
Doors - Storm and Thermal	Space Heating	2%	2%	19%	75%	$180	12	0.46
Insulation - Ceiling	Cooling	3%	0%	36%	48%	$152	20	3.20
Insulation - Ceiling	Space Heating	8%	6%	36%	48%	$152	20	3.20
Insulation - Radiant Barrier	Cooling	2%	0%	5%	90%	$923	12	0.36
Insulation - Radiant Barrier	Space Heating	1%	1%	5%	90%	$923	12	0.36
Insulation - Foundation	Cooling	3%	0%	4%	90%	$358	20	1.37
Insulation - Foundation	Space Heating	6%	6%	4%	90%	$358	20	1.37
Insulation - Wall Cavity	Cooling	2%	0%	4%	90%	$63	20	3.46
Insulation - Wall Cavity	Space Heating	3%	3%	4%	90%	$63	20	3.46
Insulation - Wall Sheathing	Cooling	1%	0%	59%	90%	$210	20	1.19
Insulation - Wall Sheathing	Space Heating	3%	3%	59%	90%	$210	20	1.19
Roofs - High Reflectivity	Cooling	5%	0%	0%	90%	$517	15	0.08
Windows - Reflective Film	Cooling	7%	0%	2%	45%	$167	10	0.23
Windows - High Efficiency/Energy Star	Cooling	12%	0%	78%	90%	$2,200	25	0.55
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	78%	90%	$2,200	25	0.55
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	8%	9%	$256	15	0.17
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	50%	10%	50%	$2,975	15	0.01
Exterior Lighting - Photosensor Control	Exterior Lighting	13%	0%	0%	45%	$90	8	0.06
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	11%	45%	$72	8	0.10
Water Heater - Faucet Aerators	Water Heating	4%	2%	11%	90%	$24	25	6.84
Water Heater - Pipe Insulation	Water Heating	6%	3%	0%	41%	$50	13	2.92
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	21%	75%	$48	10	7.03
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$15	10	11.97
Water Heater - Thermostat Setback	Water Heating	9%	5%	5%	75%	$40	5	2.29
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	0.81
Water Heater - Drainwater Heat Reocvery	Water Heating	9%	5%	1%	90%	$899	15	0.29
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	2.52
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	0.83
Home Energy Management System	Cooling	10%	0%	5%	68%	$250	20	2.50
Home Energy Management System	Space Heating	10%	5%	5%	68%	$250	20	2.50
Home Energy Management System	Interior Lighting	10%	5%	5%	68%	$250	20	2.50
Photovoltaics	Cooling	50%	0%	0%	48%	$7,900	15	0.20
Photovoltaics	Space Heating	25%	25%	0%	48%	$7,900	15	0.20
Pool - Pump Timer	Miscellaneous	60%	0%	35%	90%	$160	15	2.21
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.30
Advanced New Construction Designs	Cooling	30%	0%	2%	45%	$2,500	18	1.25
Advanced New Construction Designs	Space Heating	30%	30%	2%	45%	$2,500	18	1.25
Advanced New Construction Designs	Interior Lighting	20%	20%	2%	45%	$2,500	18	1.25
Water Heater - Heat Pump	Water Heating	30%	15%	0%	20%	$1,500	15	0.58
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,970	15	1.18
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$10,798	15	0.81

Note: Costs are per household.

APPENDIX | **D**

COMMERCIAL ENERGY EFFICIENCY EQUIPMENT AND MEASURE DATA

This appendix presents detailed information for all commercial and industrial energy efficiency equipment and measures that were evaluated in LoadMAP. Several sets of tables are provided.

Table D-1 provides brief descriptions for all equipment and measures that were assessed for potenital.

Tables D-2 through D-9 list the detailed unit-level data for the equipment measures for each of the C&I segments — small/medium commercial, large commercial, extra-large commercial, and extra-large industial — and for existing and new construction, respectively. Savings are in kWh/yr/sq.ft., and incremental costs are in $/sq.ft. The B/C ratio is zero if the measure represents the baseline technology or if the technology is not available in the first year of the forecast (2012). The B/C ratio is calculated within LoadMAP for each year of the forecast and is available once the technology or measure becomes available.

Tables D-10 through D-17 list the detailed unit-level data for the non-equipment energy efficiency measures for each of the segments and for existing and new construction, respectively. Because these measures can produce energy-use savings for multiple end-use loads (e.g., insulation affects heating and cooling energy use) savings are expressed as a percentage of the end-use loads. Base saturation indicates the percentage of buildings in which the measure is already installed. Applicability/Feasibility is the product of two factors that account for whether the measure is applicable to the building. Cost is expressed in $/sq.ft. The detailed measure-level tables present the results of the benefit/cost (B/C) analysis for the first year of the forecast. The B/C ratio is zero if the measure represents the baseline technology or if the measure is not available in the first year of the forecast (2012). The B/C ratio is calculated within LoadMAP for each year of the forecast and is available once the technology or measure becomes available.

Note that Tables D-2 through D-17 present information for Washington. For Idaho, savings and B/C ratios may be slightly different due to weather-related usage, differences in the states' market profiles, and different retail electricity prices. Although Idaho-specific values are not presented here, they are available within the LoadMAP files.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Cooling	Central Cooling Systems	Commercial buildings are often cooled with a central chiller plant that creates chilled water for distribution throughout the facility. Chillers can be air source or water source, which include heat rejection via a condenser loop and cooling tower. Because of the wide variety of system types and sizes, savings and cost values for efficiency improvements in chiller systems represent an average over air- and water-cooled systems, as well as screw, reciprocating, and centrifugal technologies. Under this simplified approach, each central system is characterized by an aggregate efficiency value (inclusive of chiller, pumps, motors and condenser loop equipment), in kW/ton with a further efficiency upgrade through the application of variable refrigerant flow technology.
Cooling	Chilled Water Variable Flow System	The chilled water variable flow system is essentially a single chilled water loop with variable volume and speed. A single set of pumps operated by a VSD eliminates the need for separate distribution pumps and makes the chilled water flow throughout the entire system be variable. The use of adjustable flow limiting valves is designed to optimize water flow. Such valves provide flow limiting, shut-off and adjustment functions, automatically compensating for changes in system pressure to maximize energy efficiency.
Cooling	Packaged Cooling Systems / Rooftop Units (RTUs) and Heat Pumps	Packaged cooling systems are simple to install and maintain, and are commonly used in small and medium-sized commercial buildings. Applications range from a single supply system with air intake filters, supply fan, and cooling coil, or can become more complex with the addition of a return air duct, return air fan, and various controls to optimize performance. For packaged RTUs, varying Energy Efficiency Ratios (EER) were considered, as well as ductless or “mini-split” systems with variable refrigerant flow. For heat pumps, units with increasing EER and COP levels were evaluated, as well as a ductless mini-split system.
Cooling	Packaged Terminal Air Conditioners (PTAC)	Window (or wall) mounted room air conditioners (and heat pumps) are designed to cool (or heat) a single room or space. This type of unit incorporates a complete air-cooled refrigeration and air-handling system in an individual package. Conditioned air is discharged in response to thermostatic control to meet room requirements. Each unit has a self-contained, air-cooled direct expansion (DX) cooling system, a heat pump or other fuel-based heating system and associated controls. The energy savings increase with each incremental increase in efficiency, measured in terms of EER level.
Space Heating	Convert to Gas	This fuel-switching measure is the replacement of an electric furnace with a gas furnace. This measure eliminates all prior electricity consumption and demand due to electric space heating. In this study, it is assumed this measure can be implemented only in buildings within 500 feet of a gas main.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Cooling, Space Heating, Interior Lighting	Energy Management System	An energy management system (EMS) allows managers/owners to monitor and control the major energy-consuming systems within a commercial building. At the minimum, the EMS can be used to monitor and record energy consumption of the different end-uses in a building, and can control operation schedules of the HVAC and lighting systems. The monitoring function helps building managers/owners to identify systems that are operating inefficiently so that actions can be taken to correct the problem. The EMS can also provide preventive maintenance scheduling that will reduce the cost of operations and maintenance in the long run. The control functionality of the EMS allows the building manager/owner to operate building systems from one central location. The operation schedules set via the EMS help to prevent building systems from operating during unwanted or unoccupied periods. This analysis assumes that this measure is limited to buildings with a central HVAC system.
Cooling, Space Heating	Economizer	Economizers allow outside air (when it is cool and dry enough) to be brought into the building space to meet cooling loads instead of using mechanically cooled interior air. A dual enthalpy economizer consists of indoor and outdoor temperature and humidity sensors, dampers, motors, and motor controls. Economizers are most applicable to temperate climates and savings will be smaller in extremely hot or humid areas.
Cooling	VSD on Water Pumps	The part-load efficiency of chilled water loop pumps can be improved substantially by varying the speed of the motor drive according to the building demand for cooling. There is also a reduction in piping losses associated with this measure that has a major impact on the energy use for a building. However, pump speeds can generally only be reduced to a minimum specified rate, because chillers and the control valves may require a minimum flow rate to operate. There are two major types of variable speed drives: mechanical and electronic. An additional benefit of variable-speed drives is the ability to start and stop the motor gradually, thus extending the life of the motor and associated machinery. This analysis assumes that electronic variable speed drives are installed.
Cooling	Turbocor Compressor	Turbocor compressors use oil-free magnetic bearings to reduce friction losses and couples that with a two-stage centrifugal compressor to reduce central chiller energy consumption.
Cooling	High-Efficiency Cooling Tower Fans	High efficiency cooling tower fans utilize variable frequency drives in the cooling tower design. VFDs improve fan performance by adjusting fan speed and rotation as conditions change.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Cooling	Condenser Water Temperature Reset	Chilled water reset controls save energy by improving chiller performance through increasing the supply chilled water temperature, which allows increased suction pressure during low load periods. Raising the chilled water temperature also reduces chilled water piping losses. However, the primary savings from the chilled water reset measure results from chiller efficiency improvement. This is due partly to the smaller temperature difference between chilled water and ambient air, and partly due to the sensitivity of chiller performance to suction temperature.
Cooling	Maintenance	Filters, coils, and fins require regular cleaning and maintenance for the heat pump or roof top unit to function effectively and efficiently throughout its years of service. Neglecting necessary maintenance leads to a steady decline in performance while energy use increases. Maintenance can increase the efficiency of poorly performing equipment by as much as 10%.
Cooling	Evaporative Precooler	Evaporative precooling can improve the performance of air conditioning systems, most commonly RTUs. These systems typically use indirect evaporative cooling as a first stage to pre-cool outside air. If the evaporative system cannot meet the full cooling load, the air steam is further cooled with conventional refrigerative air conditioning technology.
Cooling	Roof- High Reflectivity (Cool Roof)	The color and material of a building structure surface will determine the amount of solar radiation absorbed by that surface and subsequently transferred into a building. This is called solar absorptance. By using a material or painting the roof with a light color (and a lower solar absorptance), the roof will absorb less solar radiation and consequently reduce the cooling load.
Cooling, Space Heating	Green Roofs	A green roof covers a section or the entire building roof with a waterproof membrane and vegetative material. Like cool roofs, green roofs can reduce solar absorptance and they can also provide insulation. They also provide non-energy benefits by absorbing rainwater and thus reducing storm water run-off, providing wildlife habitat, and reducing so-called urban heat island effects.
Cooling, Space Heating, Ventilation	HVAC Retrocommissioning	Over time, the performance of complex mechanical systems providing heating and cooling to existing commercial spaces degrades as a result of inappropriate changes to or overrides of controls, deteriorating equipment, clogged filters, changing demands and schedules, and pressure imbalances. Retrocommissioning is a comprehensive analysis of an entire system in which an engineer assesses shortcomings in system performance, and then optimizes through a process of tune-up, maintenance, and reprogramming of control or automation software. Energy efficiency programs throughout the country promote retrocommissioning as a means of greatly reducing energy consumption in existing buildings.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Cooling, Space Heating, Ventilation, Interior Lighting	Comprehensive Retrocommissioning	Comprehensive retrocommissioning covers not only HVAC and lighting, but other existing building systems as well. For example, it can improve efficiency of non-HVAC motors, vertical transport systems, and domestic hot water systems.
Cooling, Space Heating, Ventilation, Interior Lighting/Exterior Lighting	HVAC Commissioning Lighting Commissioning Comprehensive Commissioning	For new construction and major renovations, commissioning ensures that building systems are properly designed, specified, and installed to meet the design intent and provide high-efficiency performance. As the names suggests, HVAC Commissioning and Lighting Commissioning focus only on HVAC and lighting equipment and controls. Comprehensive commissioning addresses these systems but usually begins earlier in the design process, and may also address domestic hot water, non-HVAC fans, vertical transport, telecommunications, fire protection, and other building systems.
Cooling, Space Heating, Interior Lighting	Advanced New Construction Designs	Advanced new construction designs use an integrated approach to the design of new buildings to account for the interaction of building systems. Typically, architects and engineers work closely to specify the building orientation, building shell, building mechanical systems, and controls strategies with the goal of optimizing building energy efficiency and comfort. Options that may be evaluated and incorporated include passive solar strategies, increased thermal mass, daylighting strategies, and shading strategies, This measure was modeled for new construction only.
Cooling, Space Heating	Programmable Thermostat	A programmable thermostat can be added to most heating/cooling systems. They are typically used during winter to lower temperatures at night and in summer to increase temperatures during the afternoon. There are two-setting models, and well as models that allow separate programming for each day of the week. The energy savings from this type of thermostat are identical to those of a "setback" strategy with standard thermostats, but the convenience of a programmable thermostat makes it a much more attractive option. In this analysis, the baseline is assumed to have no thermostat setback.
Cooling, Space Heating	Duct Repair and Sealing	An ideal duct system would be free of leaks. Leakage in unsealed ducts varies considerably because of the differences in fabricating machinery used, the methods for assembly, installation workmanship, and age of the ductwork. Air leaks from the system to the outdoors result in a direct loss proportional to the amount of leakage and the difference in enthalpy between the outdoor air and the conditioned air. To seal ducts, a wide variety of sealing methods and products exist. Each has a relatively short shelf life, and no documented research has identified the aging characteristics of sealant applications. This analysis assumes that the baseline air loss from ducts has doubled, and conducting repair and sealing of the ducts will restore leakage from ducts to the original baseline level.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Cooling, Space Heating	Duct Insulation	Air distribution ducts can be insulated to reduce heating or cooling losses. Best results can be achieved by covering the entire surface area with insulation. Insulation material inhibits the transfer of heat through the air-supply duct. Several types of ducts and duct insulation are available, including flexible duct, pre-insulated duct, duct board, duct wrap, tacked, or glued rigid insulation, and waterproof hard shell materials for exterior ducts.
Cooling, Space Heating	Insulation – Radiant Barrier	Radiant barriers inhibit heat transfer by thermal radiation. When a radiant barrier is installed beneath the roofing material much of the heat radiated from a hot roof is reflected back to the roof limiting the amount of heat emitted downwards.
Cooling, Space Heating	High-Efficiency Windows	High-efficiency windows, such as those labeled under the ENERGY STAR Program, are designed to reduce a building's energy bill while increasing comfort for the occupants at the same time. High-efficiency windows have reducing properties that reduce the amount of heat transfer through the glazing surface. For example, some windows have a low-E coating, which is a thin film of metallic oxide coating on the glass surface that allows passage of short-wave solar energy through glass and prevents long-wave energy from escaping. Another example is double-pane glass that reduces conductive and convective heat transfer. There are also double-pane glasses that are gas-filled (usually argon) to further increase the insulating properties of the window.
Cooling, Space Heating	Ceiling and Wall Cavity Insulation	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing the heat loss or gain of a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose; loose-fill (blown) fiberglass; and rigid polystyrene.
Ventilation	Cooking – Exhaust Hoods with Sensor Controls	Improved exhaust hoods involve installing variable-speed controls on commercial kitchen hoods. These controls provide ventilation based on actual cooking loads. When grills, broilers, stoves, fryers or other kitchen appliances are not being used, the controls automatically sense the reduced load and decrease the fan speed accordingly. This results in lower energy consumption because the system is only running as needed rather than at 100% capacity at all times.
Ventilation	Variable Air Volume	A variable air volume ventilation system modulates the air flow rate as needed based on the interior conditions of the building to reduce fan load, improve dehumidification, and reduce energy usage.
Ventilation	Fans – Energy Efficient Motors	High-efficiency motors are essentially interchangeable with standard motors, but differences in construction make them more efficient. Energy-efficient motors achieve their improved efficiency by reducing the losses that occur in the conversion of electrical energy to mechanical energy. This analysis assumes that the efficiency of supply fans is increased by 5% due to installing energy-efficient motors.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Ventilation	Fans – Variable Speed Control (VSD)	The part-load efficiency of ventilation fans can be improved substantially by varying the speed of the motor drive. There are two major types of variable speed controls: mechanical and electronic. An additional benefit of variable-speed controls is the ability to start and stop the motor gradually, thus extending the life of the motor and associated machinery. This analysis assumes that electronic variable speed controls are installed.
Water Heating	High-Efficiency Water Heater Systems	Efficient electric water heaters are characterized by a high recovery or thermal efficiency (percentage of delivered electric energy which is transferred to the water) and low standby losses (the ratio of heat lost per hour to the content of the stored water). Included in the savings associated with high-efficiency electric water heaters are timers that allow temperature setpoints to change with hot water demand patterns. For example, the heating element could be shut off throughout the night, increasing the overall energy factor of the unit. In addition, tank and pipe insulation reduces standby losses and therefore reduces the demands on the water heater. This analysis considers conventional electric water heaters with efficiency greater than 96%, as well as geothermal heat pump water heaters for effective efficiency greater than one. Solar water heating was evaluated as well.
Water Heating	Convert to Gas	This fuel-switching measure is the replacement of an electric water heater with a gas-fired water heater. This measure will eliminate all prior electricity consumption and demand due to electric water heating. In this study, it is assumed that this measure can be implemented only in buildings within 500 feet of a gas main.
Water Heating	Heat Pump Water Heater	Heat pump water heaters use heat pump technology to extract heat from the ambient surroundings and transfer it to a hot water tank. These devices are available as an alternative to conventional tank water heaters of 55 gallons or larger.
Water Heating	Faucet Aerators/Low Flow Nozzles	A faucet aerator or low flow nozzle spreads the stream from a faucet helping to reduce water usage. The amount of water passing through the aerator is measured in gallons per minute (GPM) and the lower the GPM the more water the aerator conserves.
Water Heating	Pipe Insulation	Insulating hot water pipes decreases the amount of energy lost during distribution of hot water throughout the building. Insulating pipes will result in quicker delivery of hot water and allows lowering the water heating set point. There are several different types of insulation, the most common being polyethylene and neoprene.
Water Heating	High-Efficiency Circulation Pump	A high efficiency circulation pump uses an electronically commutated motor (ECM) to improve motor efficiency over a larger range of partial loads. In addition, an ECM allows for improved low RPM performance with greater torque and smaller pump dimensions.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Water Heating	Tank Blanket/Insulation	Insulation levels on domestic hot water heaters can be increased by installing a fiberglass blanket on the outside of the tank. This increase in insulation reduces standby losses and thus saves energy. Water heater insulation is available either by the blanket or by square foot of fiberglass insulation with R-values ranging from 5 to 14.
Water Heating	Thermostat Setback	Installing a setback thermostat on the water heater can lead to significant energy savings during periods when there is no one in the building.
Water Heating	Hot Water Saver	A hot water saver is a plumbing device that attaches to the showerhead and that pauses the flow of water until the water is hot enough for use. The water is re-started by the flip of a switch.
Interior Lighting, Exterior Lighting	Lamp Replacement (Interior Screw-in, HID, and Linear Fluorescent Exterior Screw-in, HID, and Linear Fluorescent)	Commercial lighting differs from the residential sector in that efficiency changes typically require more than the simple purchase and quick installation of a screw-in compact fluorescent lamp. Restrictions regarding ballasts, fixtures, and circuitry limit the potential for direct substitution of one lamp type for another. However, such replacements do exist. For example, screw-in incandescent lamps can readily be replaced with CFLs or LEDs. Also, during the buildout for a leased office space, the management could decide to replace all T12 lamps and magnetic ballasts with T8/electronic ballast configurations. This type of decision-making is modeled on a stock turnover basis because of the time between opportunities for upgrades.
Interior Lighting, Exterior Lighting	Lighting Retrocommissioning	Lighting retrocommissioning projects in existing commercial buildings do not require an event such as a tenant turnover, a major renovation, or an update to electrical circuits to drive its adoption. Rather, a decision-maker can decide at any time to perform a comprehensive audit of a facility's lighting systems, followed by an upgrade of equipment (lamps, ballasts, fixtures, reflectors), controls (occupancy sensors, daylighting controls, and central automation).
Interior Lighting	Delamping and Install Reflectors	While sometimes included in lighting retrofit projects, delamping is often performed as a separate energy efficiency measure in which a lighting engineer analyzes the lighting provided by current systems compared to the requirements of building occupants. This often leads to the removal of unnecessary lamps corresponding to an overall reduction in energy usage. .In addition, installing a reflector in each fixture can improve light distribution from the remaining lamps.
Interior Lighting, Exterior Lighting	Lighting Time Clocks and Timers	While outdoor lighting is typically required only at night, in many cases lighting remains on during daylight hours. A simple timer can set a diurnal schedule for outdoor lighting and thus reduce the operating hours by as much as 50%.
Interior Lighting	Central Lighting Controls	Central lighting control systems provide building-wide control of interior lighting to ensure that lights are properly scheduled based on expected building occupancy. Individual zones or circuits can be controlled.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Interior Lighting	Photocell Controlled T8 Dimming Ballasts	Photocells, in concert with dimming ballasts, can detect when adequate daylighting is available and dim or turn off lights to reduce electricity consumption. Usually one photocell is used to control a group of fixtures, a zone, or a circuit.
Interior Lighting	Bi-Level Fixture with Occupancy Sensor	Bi-level fixtures with occupancy sensors detect when a space is unoccupied and reduce light output to a lower level. These devices
Interior Lighting	High Bay Fixtures	Fluorescent fixtures designed for high-bay applications have several advantages over similar HID fixtures: lower energy consumption, lower lumen depreciation rates, better dimming options, faster start-up and restrike, better color rendition, more pupil lumens, and reduced glare.
Interior Lighting	Occupancy Sensor	The installation of occupancy sensors allows lights to be turned off during periods when a space is unoccupied, virtually eliminating the wasted energy due to lights being left on. There are several types of occupancy sensors in the market.
Interior Lighting	LED Exit Lighting	The lamps inside exit signs represent a significant energy end-use, since they usually operate 24 hours per day. Many old exit signs use incandescent lamps, which consume approximately 40 watts per sign. The incandescent lamps can be replaced with LED lamps that are specially designed for this specific purpose. In comparison, the LED lamps consume approximately 2-5 watts.
Interior Lighting	Task Lighting	In commercial facilities, individual work areas can use task lighting instead of brightly lighting the entire area. Significant energy savings can be realized by focusing light directly where it is needed and lowering the general lighting level. An example of task lighting is the common desk lamp. A 25W desk lamp can be installed in place of a typical lamp in a fixture.
Interior Lighting, Cooling	Hotel Guestroom Controls	Hotel guestrooms can be fitted with occupancy controls that turn off energy-using equipment when the guest is not using the room. The occupancy controls comes in several forms, but this analysis assumes the simplest kind, which is a simple switch near the room's entry where the guest can deposit their room key or card. If the key or card is present, then lights, TV, and air conditioning can receive power and operate. When the guest leaves and takes the key, all equipment shuts off.
Exterior Lighting	Daylighting Controls	Daylighting controls use a photosensor to detect ambient light and turn off exterior lights accordingly.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Exterior Lighting	Photovoltaic Lighting	Outdoor photovoltaic (PV) lighting systems use PV panels (or modules), which convert sunlight to electricity. The electricity is stored in batteries for use at night. They can be cost effective relative to installing power cables and/or step down transformers for relatively small lighting loads. The "nightly run time" listings on most "off-the-shelf" products are based on specific sunlight conditions. Systems located in places that receive less sunlight than the system is designed for will operate for fewer hours per night than expected. Nightly run times may also vary depending on how clear the sky is on any given day. Shading of the PV panel by landscape features (vegetation, buildings, etc.) will also have a large impact on battery charging and performance. Open areas with no shading, such as parking lots, are ideal places where PV lighting systems can be used.
Exterior Lighting	Cold Cathode Lighting	Cold cathode lighting does not use an external heat source to provide thermionic emission of electrons. Cold cathode lighting is typically used for exterior signage or where temperatures are likely to drop below freezing.
Exterior Lighting	Induction Lamps	Induction lamps use a contactless bulb and rely on electromagnetic fields to transfer power. This allows for the lamp to utilize more efficient materials that would otherwise react with metal electrodes. In addition, the lack of an electrode significantly extends lamp life while reducing lumen depreciation.
Office Equipment	Desktop and Laptop Computing Equipment	ENERGY STAR labeled office equipment saves energy by powering down and "going to sleep" when not in use. ENERGY STAR labeled computers automatically power down to 15 watts or less when not in use and may actually last longer than conventional products because they spend a large portion of time in a low-power sleep mode. ENERGY STAR labeled computers also generate less heat than conventional models. The ClimateSavers Initiative, made up of leading computer processor manufacturers, has stated a goal of reducing power consumption in active mode by 50% by integrating innovative power management into the chip design process.
Office Equipment	Monitors	ENERGY STAR labeled office equipment saves energy by powering down and "going to sleep" when not in use. ENERGY STAR labeled monitors automatically power down to 15 watts or less when not in use.
Office Equipment	Servers	In addition to the "sleep" mode a reductions and the efficient processors being designed by members of the ClimateSavers Initiative, servers have additional energy-saving opportunities through "virtualization" and other architecture solutions that involve optimal matching of computation tasks to hardware requirements

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Office Equipment	Printers/Copiers/ Fax/ POS Terminals	ENERGY STAR labeled office equipment saves energy by powering down and "going to sleep" when not in use. ENERGY STAR labeled copiers are equipped with a feature that allows them to automatically turn off after a period of inactivity, reducing a copier's annual electricity costs by over 60%. High-speed copiers that include a duplexing unit that is set to automatically make double-sided copies can reduce paper costs and help to save trees.
Office Equipment	ENERGY STAR Power Supply	Power supplies with an efficient ac-dc or ac-ac conversion process can obtain the ENERGY STAR label. These devices can be used to power computers, phones, and other office equipment.
Refrigeration	Walk-in Refrigeration Systems	Standard compressors typically operate at approximately 65% efficiency. High-efficiency models are available that can improve compressor efficiency by 15%.
Refrigeration	Glass Door and Solid Door Refrigeration Units (Reach-in /Open Display Case/Vending Machine) Door Gasket Replacement High Efficiency Case Lighting	In addition to walk-in, "cold-storage" refrigeration, a significant amount of energy in the commercial sector can be attributed to "reach-in" units. These stand-alone appliances can range from a residential-style refrigerator/freezer unit in an office kitchen or the breakroom of a retail store to the refrigerated display cases in some grocery or convenience stores. As in the case of residential units, these refrigerators can be designed to perform at higher efficiency through a combination of compressor equipment upgrades, default temperature settings, and defrost patterns. Other measures for these units are replacing aging door gaskets that no longer adequately seal the case, and replacing inefficient display lights with CFL or LED systems to reduce internal heat gains in the cases.
Refrigeration	Open Display Case	Glass doors can be used to enclose multi-deck display cases for refrigerated items in supermarkets. In addition, more efficient units are designed to perform at higher efficiency through a combination of compressor equipment upgrades, default temperature settings, and defrost patterns.
Refrigeration	Anti-Sweat Heater/ Auto Door Closer Controls	Anti-sweat heaters are used in virtually all low-temperature display cases and many medium-temperature cases to control humidity and prevent the condensation of water vapor on the sides and doors and on the products contained in the cases. Typically, these heaters stay on all the time, even though they only need to be on about half the time. Anti-sweat heater controls can come in the form of humidity sensors or time clocks.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Refrigeration	Floating Head Pressure Controls	Floating head pressure control allows the pressure in the condenser to "float" with ambient temperatures. This method reduces refrigeration compression ratios, improves system efficiency and extends the compressor life. The greatest savings with a floating head pressure approach occurs when the ambient temperatures are low, such as in the winter season. Floating head pressure control is most practical for new installations. However, retrofits installation can be completed with some existing refrigeration systems. Installing floating head pressure control increases the capacity of the compressor when temperatures are low, which may lead to short cycling.
Refrigeration	Bare Suction Lines	Insulating bare suction lines reduces heat
Refrigeration	Night Covers	Night covers can be used on open refrigeration cases when a facility is closed or few customers are in the store.
Refrigeration	Strip Curtain	Strip curtains at the entrances to large walk-in coolers or freezers, such as those used in supermarkets, reduce air transfer between the refrigerated space and the surrounding space.
Refrigeration	Icemakers	In certain building types (restaurant, hotel), the production of ice is a significant usage of electricity. By optimizing the timing of ice production and the type of output to the specific application, icemakers are assumed to deliver electricity savings.
Refrigeration	Vending Machine - Controller	Cold beverage vending machines usually operate 24 hours a day regardless of whether the surrounding area is occupied or not. The result is that the vending machine consumes energy unnecessarily, because it will operate all night to keep the beverage cold even when there would be no customer until the next morning. A vending machine controller can reduce energy consumption without compromising the temperature of the vended product. The controller uses an infrared sensor to monitor the surrounding area's occupancy and will power down the vending machine when the area is unoccupied. It will also monitor the room's temperature and will re -power the machine at one to three hour intervals independent of occupancy to ensure that the product stays cold.
Food Service	Kitchen Equipment	Commercial cooking and food preparation equipment represent a significant contribution to energy consumption in restaurants and other food service applications. By replacing old units with efficient ones, this energy consumption can be greatly reduced. These measures include fryers, commercial ovens, dishwashers, hot food containers and miscellaneous other food preparation equipment. Savings range between 15 and 65%, depending on the specific unit being replaced.
Cooling, Space Heating, Interior Lighting, Food Preparation, Refrigeration	Custom Measures	Custom measures were included in the CPA analysis to serve as a "catch all" for measures for which costs and savings are not easily quantified and that could be part of a program such as Avista's existing Site-Specific incentive program. Costs and energy savings were assumed such that the measures passed the economic screen.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Miscellaneous	Non-HVAC motor	Because the Small/Medium Commercial and Large Commercial segments include some industrial customers, the CPA analysis included equipment upgrades for non-HVAC motors. This equipment measure also incorporates improvements for vertical transport. Premium efficiency motors reduce the amount of lost energy going into heat rather than power. Since less heat is generated, less energy is needed to cool the motor with a fan. Therefore, the initial cost of energy efficient motors is generally higher than for standard motors. However their life-cycle costs can make them far more economical because of savings they generate in operating expense. Premium efficiency motors can provide savings of 0.5% to 3% over standard motors. The savings results from the fact that energy efficient motors run cooler than their standard counterparts, resulting in an increase in the life of the motor insulation and bearing. In general, an efficient motor is a more reliable motor because there are fewer winding failures, longer periods between needed maintenance, and fewer forced outages. For example, using copper instead of aluminum in the windings, and increasing conductor cross-sectional area, lowers a motor's I2R losses.
Miscellaneous	Pumps – Variable Speed Control	The part-load efficiency of chilled and hot water loop pumps can be improved substantially by varying the speed of the motor drive according to the building demand for heating or cooling. There is also a reduction in piping losses associated with this measure that has a major impact on the heating loads and energy use for a building. However, pump speeds can generally only be reduced to a minimum specified rate, because chillers, boilers, and the control valves may require a minimum flow rate to operate. There are two major types of variable speed controls: mechanical and electronic. An additional benefit of variable-speed drives is the ability to start and stop the motor gradually, thus extending the life of the motor and associated machinery. This analysis assumes that electronic variable speed controls are installed.
Miscellaneous	Laundry – High Efficiency Clothes Washer	High efficiency clothes washers use designs that require less water. These machines use sensors to match the hot water needs to the load, preventing energy waste. There are two designs: top-loading and front-loading. Further energy and water savings can be achieved through advanced technologies such as inverter-drive or combination washer-dryer units.
Miscellaneous	ENERGY STAR Water Cooler	An ENERGY STAR water cooler has more insulation and improved chilling mechanisms, resulting in about half the energy use of a standard cooler.
Miscellaneous	Industrial Process Improvements	Because the Avista C&I sector segmentation was based on Avista's rate classes, the commercial building segments include a small percentage or industrial business types. This measure was included to account for energy efficiency potential that could be achieved through various process improvements at these customers.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Machine Drive.	Motors, Premium Efficiency	Premium efficiency motors reduce the amount of lost energy going into heat rather than power. Since less heat is generated, less energy is needed to cool the motor with a fan. Therefore, the initial cost of energy efficient motors is generally higher than for standard motors. However their life-cycle costs can make them far more economical because of savings they generate in operating expense. Premium efficiency motors can provide savings of 0.5% to 3% over standard motors. The savings results from the fact that energy efficient motors run cooler than their standard counterparts, resulting in an increase in the life of the motor insulation and bearing. In general, an efficient motor is a more reliable motor because there are fewer winding failures, longer periods between needed maintenance, and fewer forced outages. For example, using copper instead of aluminum in the windings, and increasing conductor cross-sectional area, lowers a motor's I2R losses. This analysis assumes 75% loading factor (for peak efficiency) for 1800 rpm motor. Hours of operation vary depending on horsepower size. In addition, improved drives and controls are assumed to be implemented along with the motors, resulting in savings as high as 10% of annual energy consumption
Machine Drive	Motors – Variable Frequency Drive	In addition to energy savings, VFDs increase motor and system life and provide a greater degree of control over the motor system. Especially for motor systems handling fluids, VFDs can efficiently respond to changing operating conditions.
Machine Drive	Magnetic Adjustable Speed Drive	To allow for adjustable speed operation, this technology uses magnetic induction to couple a drive to its load. Varying the magnetic slip within the coupling controls the speed of the output shaft. Magnetic drives perform best at the upper end of the speed range due to the energy consumed by the slip. Unlike traditional ASDs, magnetically coupled ASDs create no power distortion on the electrical system. However, magnetically coupled ASD efficiency is best when power needs are greatest. VFDs may show greater efficiency when the average load speed is below 90% of the motor speed, however this occurs when power demands are reduced.
Machine Drive	Compressed Air – System Controls, Optimization and Improvements, Maintenance	Controls for compressed air systems can shift load from two partially loaded compressors to one compressor in order to maximize compression efficiency and may also involve the addition of VFDs. Improvements include installing high-efficiency motors. Maintenance includes fixing air leaks and replacing air filters.
Machine Drive	Fan Systems – Controls, Optimization and Maintenance	Certain practices require a consistent flow rate, such as indoor air quality and clean room ventilation. To achieve this, fan flow controls can be used to maintain precise volume flow control ensuring a constant air delivery even on fluctuating pressure conditions. This is done through programmable circuitry to electronically control fan motor speed. Motors can be configured to accept a signal from a controller that would vary the flow rate in direct proportion to the signal.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Machine Drive	Pumping Systems – Controls, Optimization and Maintenance	Pumping systems optimization includes installing VFDs, correctly resizing the motors, and installing timers and automated on-off controls. Maintenance includes repairing diaphragms and fixing piping leaks.
Process	Process Cooling/Refrigeration	Because of the customized nature of industrial cooling and refrigeration applications, a variety of opportunities are summarized as a general improvement in cooling and cold storage equipment. Costs and savings were developed using average values for this group of measures from the Sixth Plan industrial supply curve workbooks.
Process	Process Heating	Because of the customized nature of industrial heating applications, a variety of opportunities are summarized as a general improvement in process heating equipment, such as arc furnaces. Costs and savings were developed using average values for this group of measures from the Sixth Plan industrial supply curve workbooks.
Process	Electrochemical Process	Because of the customized nature of industrial electrochemical applications, a variety of opportunities are summarized as a general improvement in equipment and processes. Costs and savings were developed using average values for this group of measures from the Sixth Plan industrial supply curve workbooks.
Process	Refrigeration – System Controls, Maintenance, and Optimization	Because refrigeration equipment performance degrades over time and control settings are frequently overridden, these measures account for savings that can be achieved through system maintenance and controls optimization.

Table D-2 Energy Efficiency Equipment Data — Small/Medium Comm., Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.29	$0.39	20	-
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.35	$0.50	20	0.51
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.73	$0.62	20	1.90
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.77	$0.74	20	1.39
Cooling	Central Chiller	Variable Refrigerant Flow	1.01	$11.57	20	0.07
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.22	$0.18	16	-
Cooling	RTU	EER 11.2	0.43	$0.35	16	-
Cooling	RTU	EER 12.0	0.57	$0.58	16	0.49
Cooling	RTU	Ductless VRF	0.69	$5.12	16	0.05
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.09	$0.08	14	0.86
Cooling	PTAC	EER 10.8	0.21	$0.16	14	1.00
Cooling	PTAC	EER 11	0.25	$0.43	14	0.43
Cooling	PTAC	EER 11.5	0.33	$0.96	14	0.27
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.57	$0.39	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.90	$1.18	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	1.20	$1.57	15	0.98
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.31	$1.96	15	0.68
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.46	$11.50	20	0.10
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.30	$1.22	15	1.07
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.23	$0.09	4	-
Interior Lighting	Interior Screw-in	CFL	0.94	$0.03	7	16.50
Interior Lighting	Interior Screw-in	LED	1.04	$1.18	12	0.84
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.30	($0.07)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.30	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.91	$0.25	6	1.73
Interior Lighting	Linear Fluorescent	T5	0.95	$0.43	6	1.06
Interior Lighting	Linear Fluorescent	LED	0.99	$3.74	15	0.33
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.14	$0.05	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.60	$0.02	7	17.60
Exterior Lighting	Exterior Screw-in	Metal Halides	0.60	$0.05	4	3.16
Exterior Lighting	Exterior Screw-in	LED	0.66	$0.64	12	0.90
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.22	($0.13)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.24	$0.55	9	0.37
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.01	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.04	$0.02	6	1.12
Exterior Lighting	Linear Fluorescent	T5	0.04	$0.03	6	0.69
Exterior Lighting	Linear Fluorescent	LED	0.05	$0.24	15	0.22
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.10	$0.02	15	5.23
Water Heating	Water Heater	Geothermal Heat Pump	1.33	$3.53	15	0.43
Water Heating	Water Heater	Solar	1.46	$3.03	15	0.55
Food Preparation	Fryer	Standard	-	$0.00	12	-
Food Preparation	Fryer	Efficient	0.03	$0.04	12	0.80
Food Preparation	Oven	Standard	-	$0.00	12	-

Note: Costs and savings are per sq. ft.

Table D-2 Energy Efficiency Equipment Data — Small/Med. Comm., Existing Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Oven	Efficient	0.39	$0.36	12	1.02
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.02	$0.05	12	0.36
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.40	$0.16	12	2.29
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.07
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	-	$0.09	18	-
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.16	$0.00	18	56.08
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.19	$0.02	18	9.87
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.00	$0.00	18	0.24
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.11	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.20	$0.00	10	46.48
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.05	$0.00	12	12.76
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.19	$0.00	4	23.04
Office Equipment	Desktop Computer	Climate Savers	0.27	$0.36	4	0.23
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	7.34
Office Equipment	Laptop Computer	Climate Savers	0.03	$0.12	4	0.08
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.12	$0.01	3	2.14
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.22	$0.00	4	19.68
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.09	$0.04	6	0.98
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.03	$0.00	4	2.96
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.05	$0.06	15	0.95
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.06	$0.06	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.07	$0.11	15	0.72
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.08	$0.11	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-3 Energy Efficiency Equipment Data — Large Commercial, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.30	$0.26	20	-
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.36	$0.33	20	0.83
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.75	$0.41	20	3.11
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.79	$0.49	20	2.28
Cooling	Central Chiller	Variable Refrigerant Flow	1.04	$7.63	20	0.11
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.22	$0.13	16	-
Cooling	RTU	EER 11.2	0.45	$0.25	16	-
Cooling	RTU	EER 12.0	0.59	$0.41	16	0.75
Cooling	RTU	Ductless VRF	0.72	$3.67	16	0.07
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.09	$0.09	14	0.86
Cooling	PTAC	EER 10.8	0.21	$0.17	14	1.00
Cooling	PTAC	EER 11	0.25	$0.46	14	0.43
Cooling	PTAC	EER 11.5	0.34	$1.03	14	0.27
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.46	$0.18	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.73	$0.55	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	0.97	$0.73	15	1.85
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.07	$0.91	15	1.28
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.19	$5.35	20	0.19
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.03	$1.22	15	0.86
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.19	$0.08	4	-
Interior Lighting	Interior Screw-in	CFL	0.78	$0.03	7	14.13
Interior Lighting	Interior Screw-in	LED	0.87	$1.11	12	0.72
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.31	($0.08)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.30	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.89	$0.25	6	1.66
Interior Lighting	Linear Fluorescent	T5	0.92	$0.42	6	1.02
Interior Lighting	Linear Fluorescent	LED	0.97	$3.67	15	0.32
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.08	$0.01	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.34	$0.01	7	34.02
Exterior Lighting	Exterior Screw-in	Metal Halides	0.34	$0.02	4	6.10
Exterior Lighting	Exterior Screw-in	LED	0.38	$0.19	12	1.73
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.19	($0.11)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.20	$0.45	9	0.37
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.01	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.04	$0.02	6	1.18
Exterior Lighting	Linear Fluorescent	T5	0.04	$0.03	6	0.72
Exterior Lighting	Linear Fluorescent	LED	0.05	$0.24	15	0.23
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.12	$0.02	15	5.71
Water Heating	Water Heater	Geothermal Heat Pump	1.54	$3.53	15	0.46
Water Heating	Water Heater	Solar	1.69	$3.03	15	0.60
Food Preparation	Fryer	Standard	-	$0.00	12	-
Food Preparation	Fryer	Efficient	0.07	$0.02	12	3.52
Food Preparation	Oven	Standard	-	$0.00	12	-

Note: Costs and savings are per sq. ft.

Table D-3 Energy Efficiency Equipment Data — Large Commercial, Existing Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Oven	Efficient	0.75	$0.46	12	1.43
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.07	$0.10	12	0.58
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.35	$0.30	12	0.99
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.01	$0.03	12	0.24
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	0.15	$1.26	18	0.13
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.13	$0.01	18	24.96
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.30	$0.08	18	4.39
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.00	$0.04	18	0.16
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.15	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.23	$0.00	10	20.70
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.11	$0.02	12	5.62
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.35	$0.00	4	47.46
Office Equipment	Desktop Computer	Climate Savers	0.50	$0.32	4	0.46
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	15.12
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.06	4	0.17
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.13	$0.01	3	4.41
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.19	$0.01	4	9.14
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.08	$0.02	6	2.02
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.01	$0.00	4	2.94
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.06	$0.06	15	0.92
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.06	$0.06	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.08	$0.13	15	0.69
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.09	$0.13	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-4 Energy Efficiency Equipment Data — Extra Large Commercial, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	-
Cooling	Central Chiller	0.60 kw/ton, COP 5.9	0.43	$0.09	20	-
Cooling	Central Chiller	0.58 kw/ton, COP 6.1	0.49	$0.18	20	0.66
Cooling	Central Chiller	0.55 kw/Ton, COP 6.4	0.57	$0.25	20	0.91
Cooling	Central Chiller	0.51 kw/ton, COP 6.9	0.69	$0.44	20	0.78
Cooling	Central Chiller	0.50 kw/Ton, COP 7.0	0.72	$0.53	20	0.69
Cooling	Central Chiller	0.48 kw/ton, COP 7.3	0.77	$0.62	20	0.68
Cooling	Central Chiller	Variable Refrigerant Flow	1.00	$10.92	20	0.05
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.20	$0.24	16	-
Cooling	RTU	EER 11.2	0.41	$0.45	16	-
Cooling	RTU	EER 12.0	0.53	$0.75	16	0.37
Cooling	RTU	Ductless VRF	0.65	$6.64	16	0.03
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.08	$0.06	14	1.09
Cooling	PTAC	EER 10.8	0.19	$0.12	14	1.28
Cooling	PTAC	EER 11	0.22	$0.32	14	0.55
Cooling	PTAC	EER 11.5	0.30	$0.71	14	0.34
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.50	$0.24	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.79	$0.73	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	1.06	$0.97	15	1.34
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.16	$1.21	15	0.93
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.29	$7.10	20	0.14
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.21	$1.22	15	1.01
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.30	$0.14	4	-
Interior Lighting	Interior Screw-in	CFL	1.25	$0.06	7	13.22
Interior Lighting	Interior Screw-in	LED	1.38	$1.90	12	0.67
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.13	($0.05)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.20	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.59	$0.21	6	1.31
Interior Lighting	Linear Fluorescent	T5	0.61	$0.35	6	0.80
Interior Lighting	Linear Fluorescent	LED	0.64	$3.08	15	0.25
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.02	$0.00	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.10	$0.00	7	37.00
Exterior Lighting	Exterior Screw-in	Metal Halides	0.10	$0.00	4	6.64
Exterior Lighting	Exterior Screw-in	LED	0.11	$0.05	12	1.89
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.26	($0.16)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.28	$0.64	9	0.37
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.00	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.01	$0.00	6	1.12
Exterior Lighting	Linear Fluorescent	T5	0.01	$0.01	6	0.69
Exterior Lighting	Linear Fluorescent	LED	0.01	$0.06	15	0.22
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.19	$0.02	15	9.79
Water Heating	Water Heater	Geothermal Heat Pump	2.47	$3.53	15	0.80
Water Heating	Water Heater	Solar	2.72	$3.03	15	1.02
Food Preparation	Fryer	Standard	-	$0.00	12	-

Note: Costs and savings are per sq. ft.

Table D-4 Energy Efficiency Equipment Data — Extra Large Commercial, Existing Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Fryer	Efficient	0.03	$0.00	12	6.02
Food Preparation	Oven	Standard	-	$0.00	12	-
Food Preparation	Oven	Efficient	0.85	$0.38	12	2.11
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.03	$0.04	12	0.57
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.17	$0.22	12	0.73
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.15
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	0.06	$0.05	18	1.42
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.04	$0.00	18	78.11
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.27	$0.02	18	12.81
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.01	$0.03	18	0.34
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.16	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.24	$0.00	10	68.21
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.05	$0.00	12	17.60
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.25	$0.00	4	32.37
Office Equipment	Desktop Computer	Climate Savers	0.35	$0.33	4	0.32
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	10.31
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.10	4	0.12
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.06	$0.00	3	3.01
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.11	$0.01	4	6.80
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.02	$0.01	6	1.38
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.00	$0.00	4	2.01
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.03	$0.03	15	1.02
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.04	$0.03	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.05	$0.07	15	0.76
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.05	$0.07	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-5 Energy Efficiency Equipment Data — Extra Large Industrial, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	-
Cooling	Central Chiller	0.60 kw/ton, COP 5.9	1.61	$0.33	20	-
Cooling	Central Chiller	0.58 kw/ton, COP 6.1	1.82	$0.66	20	0.68
Cooling	Central Chiller	0.55 kw/Ton, COP 6.4	2.15	$0.93	20	0.94
Cooling	Central Chiller	0.51 kw/ton, COP 6.9	2.58	$1.59	20	0.80
Cooling	Central Chiller	0.50 kw/Ton, COP 7.0	2.68	$1.92	20	0.71
Cooling	Central Chiller	0.48 kw/ton, COP 7.3	2.90	$2.25	20	0.70
Cooling	Central Chiller	Variable Refrigerant Flow	3.74	$39.62	20	0.06
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.56	$0.39	16	-
Cooling	RTU	EER 11.2	1.12	$0.73	16	-
Cooling	RTU	EER 12.0	1.47	$1.22	16	0.62
Cooling	RTU	Ductless VRF	1.79	$10.83	16	0.06
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.20	$0.06	14	2.79
Cooling	PTAC	EER 10.8	0.47	$0.11	14	3.27
Cooling	PTAC	EER 11	0.55	$0.31	14	1.41
Cooling	PTAC	EER 11.5	0.75	$0.69	14	0.87
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	1.07	$0.92	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	1.69	$2.75	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	2.25	$3.66	15	0.75
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	2.47	$4.58	15	0.52
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	2.74	$26.86	20	0.08
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	7.66	$1.22	15	6.38
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.09	$0.04	4	-
Interior Lighting	Interior Screw-in	CFL	0.38	$0.02	7	14.80
Interior Lighting	Interior Screw-in	LED	0.42	$0.52	12	0.75
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.46	($0.14)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.10	($0.01)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.31	$0.08	6	1.73
Interior Lighting	Linear Fluorescent	T5	0.32	$0.14	6	1.06
Interior Lighting	Linear Fluorescent	LED	0.33	$1.21	15	0.33
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.01	$0.00	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.02	$0.00	7	15.02
Exterior Lighting	Exterior Screw-in	Metal Halides	0.02	$0.00	4	2.69
Exterior Lighting	Exterior Screw-in	LED	0.03	$0.03	12	0.77
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.07	($0.04)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.08	$0.18	9	0.37
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.00	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.00	$0.00	6	1.16
Exterior Lighting	Linear Fluorescent	T5	0.00	$0.00	6	0.71
Exterior Lighting	Linear Fluorescent	LED	0.00	$0.01	15	0.22
Process	Process Cooling/Refrigera	Standard	-	$0.00	10	-
Process	Process Cooling/Refrigera	Efficient	18.88	$5.59	10	2.49
Process	Process Heating	Standard	-	$0.00	10	-
Process	Process Heating	Efficient	6.18	$0.57	10	7.97
Process	Electrochemical Process	Standard	-	$0.00	10	-

Note: Costs and savings are per sq. ft.

Table D-5 Energy Efficiency Equipment Data — Extra Large Industrial, Existing Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Process	Electrochemical Process	Efficient	13.16	$2.64	10	3.67
Machine Drive	Less than 5 HP	Standard	-	$0.00	10	-
Machine Drive	Less than 5 HP	High Efficiency	0.05	$0.02	10	2.08
Machine Drive	Less than 5 HP	Standard (2015)	0.07	$0.00	10	-
Machine Drive	Less than 5 HP	Premium	0.07	$0.03	10	1.66
Machine Drive	Less than 5 HP	High Efficiency (2015)	0.11	$0.02	10	-
Machine Drive	Less than 5 HP	Premium (2015)	0.14	$0.03	10	-
Machine Drive	5-24 HP	Standard	-	$0.00	10	-
Machine Drive	5-24 HP	High	0.11	$0.02	10	5.09
Machine Drive	5-24 HP	Premium	0.18	$0.03	10	4.07
Machine Drive	25-99 HP	Standard	-	$0.00	10	-
Machine Drive	25-99 HP	High	0.31	$0.02	10	13.72
Machine Drive	25-99 HP	Premium	0.49	$0.03	10	10.97
Machine Drive	100-249 HP	Standard	-	$0.00	10	-
Machine Drive	100-249 HP	High	0.12	$0.02	10	5.17
Machine Drive	100-249 HP	Premium	0.15	$0.03	10	3.44
Machine Drive	250-499 HP	Standard	-	$0.00	10	-
Machine Drive	250-499 HP	High	0.35	$0.02	10	15.66
Machine Drive	250-499 HP	Premium	0.47	$0.03	10	10.44
Machine Drive	500 and more HP	Standard	-	$0.00	10	-
Machine Drive	500 and more HP	High	0.59	$0.02	10	26.28
Machine Drive	500 and more HP	Premium	0.78	$0.03	10	17.52
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-6 Energy Efficiency Equipment Data — Small/Medium Commercial, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.29	$0.39	20	-
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.35	$0.50	20	0.51
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.73	$0.62	20	1.90
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.77	$0.74	20	1.39
Cooling	Central Chiller	Variable Refrigerant Flow	1.01	$11.57	20	0.07
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.22	$0.18	16	-
Cooling	RTU	EER 11.2	0.43	$0.35	16	-
Cooling	RTU	EER 12.0	0.57	$0.58	16	0.49
Cooling	RTU	Ductless VRF	0.69	$5.12	16	0.05
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.09	$0.08	14	0.86
Cooling	PTAC	EER 10.8	0.21	$0.16	14	1.00
Cooling	PTAC	EER 11	0.25	$0.43	14	0.43
Cooling	PTAC	EER 11.5	0.33	$0.96	14	0.27
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.57	$0.39	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.90	$1.18	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	1.20	$1.57	15	0.98
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.31	$1.96	15	0.68
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.46	$11.50	20	0.10
Combined Heating/Cooling	Heat Pump	Geothermal Heat Pump	1.75	$20.69	20	-
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.64	$1.22	15	1.35
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.20	$0.09	4	-
Interior Lighting	Interior Screw-in	CFL	0.85	$0.03	7	14.85
Interior Lighting	Interior Screw-in	LED	0.93	$1.18	12	0.76
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.27	($0.07)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.27	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.82	$0.25	6	1.56
Interior Lighting	Linear Fluorescent	T5	0.85	$0.43	6	0.95
Interior Lighting	Linear Fluorescent	LED	0.89	$3.74	15	0.30
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.13	$0.05	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.54	$0.02	7	15.84
Exterior Lighting	Exterior Screw-in	Metal Halides	0.54	$0.05	4	2.84
Exterior Lighting	Exterior Screw-in	LED	0.60	$0.64	12	0.81
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.20	($0.13)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.22	$0.55	9	0.33
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.01	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.04	$0.02	6	1.01
Exterior Lighting	Linear Fluorescent	T5	0.04	$0.03	6	0.62
Exterior Lighting	Linear Fluorescent	LED	0.04	$0.24	15	0.20
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.10	$0.02	15	5.23
Water Heating	Water Heater	Geothermal Heat Pump	1.33	$3.53	15	0.43
Water Heating	Water Heater	Solar	1.46	$3.03	15	0.55
Food Preparation	Fryer	Standard	-	$0.00	12	-
Food Preparation	Fryer	Efficient	0.03	$0.04	12	0.80

Note: Costs and savings are per sq. ft.

Table D-6 Energy Efficiency Equipment Data — Small/Medium Commercial, New Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Oven	Standard	-	$0.00	12	-
Food Preparation	Oven	Efficient	0.39	$0.36	12	1.02
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.02	$0.05	12	0.36
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.40	$0.16	12	2.29
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.07
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	-	$0.09	18	-
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.16	$0.00	18	56.08
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.19	$0.02	18	9.87
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.00	$0.00	18	0.24
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.11	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.20	$0.00	10	46.48
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.05	$0.00	12	12.76
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.19	$0.00	4	23.04
Office Equipment	Desktop Computer	Climate Savers	0.27	$0.36	4	0.23
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	7.34
Office Equipment	Laptop Computer	Climate Savers	0.03	$0.12	4	0.08
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.12	$0.01	3	2.14
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.22	$0.00	4	19.68
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.09	$0.04	6	0.98
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.03	$0.00	4	2.96
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.05	$0.06	15	0.95
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.06	$0.06	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.07	$0.11	15	0.72
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.08	$0.11	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-7 Energy Efficiency Equipment Data — Large Commercial, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.32	$0.24	20	-
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.39	$0.31	20	0.97
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.80	$0.38	20	3.62
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.85	$0.45	20	2.66
Cooling	Central Chiller	Variable Refrigerant Flow	1.12	$7.06	20	0.12
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.22	$0.13	16	-
Cooling	RTU	EER 11.2	0.45	$0.25	16	-
Cooling	RTU	EER 12.0	0.59	$0.41	16	0.75
Cooling	RTU	Ductless VRF	0.72	$3.67	16	0.07
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.09	$0.09	14	0.86
Cooling	PTAC	EER 10.8	0.21	$0.17	14	1.00
Cooling	PTAC	EER 11	0.25	$0.46	14	0.43
Cooling	PTAC	EER 11.5	0.34	$1.03	14	0.27
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.46	$0.18	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.73	$0.55	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	0.97	$0.73	15	1.85
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.07	$0.91	15	1.28
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.19	$5.35	20	0.19
Combined Heating/Cooling	Heat Pump	Geothermal Heat Pump	1.42	$9.62	20	-
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.30	$1.22	15	1.09
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.17	$0.08	4	-
Interior Lighting	Interior Screw-in	CFL	0.71	$0.03	7	12.72
Interior Lighting	Interior Screw-in	LED	0.78	$1.11	12	0.65
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.28	($0.08)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.27	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.80	$0.25	6	1.49
Interior Lighting	Linear Fluorescent	T5	0.83	$0.42	6	0.92
Interior Lighting	Linear Fluorescent	LED	0.87	$3.67	15	0.29
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.07	$0.01	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.31	$0.01	7	30.62
Exterior Lighting	Exterior Screw-in	Metal Halides	0.31	$0.02	4	5.49
Exterior Lighting	Exterior Screw-in	LED	0.34	$0.19	12	1.56
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.17	($0.11)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.18	$0.45	9	0.34
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.01	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.04	$0.02	6	1.06
Exterior Lighting	Linear Fluorescent	T5	0.04	$0.03	6	0.65
Exterior Lighting	Linear Fluorescent	LED	0.04	$0.24	15	0.20
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.12	$0.02	15	5.71
Water Heating	Water Heater	Geothermal Heat Pump	1.54	$3.53	15	0.46
Water Heating	Water Heater	Solar	1.69	$3.03	15	0.60
Food Preparation	Fryer	Standard	-	$0.00	12	-
Food Preparation	Fryer	Efficient	0.07	$0.02	12	3.52

Note: Costs and savings are per sq. ft.

Table D-7 Energy Efficiency Equipment Data — Large Commercial, New Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Oven	Standard	-	$0.00	12	-
Food Preparation	Oven	Efficient	0.75	$0.46	12	1.43
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.07	$0.10	12	0.58
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.35	$0.30	12	0.99
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.01	$0.03	12	0.24
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	0.15	$1.26	18	0.13
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.13	$0.01	18	24.96
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.30	$0.08	18	4.39
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.00	$0.04	18	0.16
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.15	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.23	$0.00	10	20.70
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.11	$0.02	12	5.62
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.35	$0.00	4	47.46
Office Equipment	Desktop Computer	Climate Savers	0.50	$0.32	4	0.46
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	15.12
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.06	4	0.17
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.13	$0.01	3	4.41
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.19	$0.01	4	9.14
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.08	$0.02	6	2.02
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.01	$0.00	4	2.94
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.06	$0.06	15	0.92
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.06	$0.06	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.08	$0.13	15	0.69
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.09	$0.13	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-8 Energy Efficiency Equipment Data — Extra Large Commercial, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	-
Cooling	Central Chiller	0.60 kw/ton, COP 5.9	0.43	$0.09	20	-
Cooling	Central Chiller	0.58 kw/ton, COP 6.1	0.49	$0.18	20	0.66
Cooling	Central Chiller	0.55 kw/Ton, COP 6.4	0.57	$0.25	20	0.91
Cooling	Central Chiller	0.51 kw/ton, COP 6.9	0.69	$0.44	20	0.78
Cooling	Central Chiller	0.50 kw/Ton, COP 7.0	0.72	$0.53	20	0.69
Cooling	Central Chiller	0.48 kw/ton, COP 7.3	0.77	$0.62	20	0.68
Cooling	Central Chiller	Variable Refrigerant Flow	1.00	$10.92	20	0.05
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.20	$0.24	16	-
Cooling	RTU	EER 11.2	0.41	$0.44	16	-
Cooling	RTU	EER 12.0	0.53	$0.73	16	0.37
Cooling	RTU	Ductless VRF	0.65	$6.51	16	0.04
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.08	$0.06	14	1.09
Cooling	PTAC	EER 10.8	0.19	$0.12	14	1.28
Cooling	PTAC	EER 11	0.22	$0.32	14	0.55
Cooling	PTAC	EER 11.5	0.30	$0.71	14	0.34
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.50	$0.24	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.79	$0.73	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	1.06	$0.97	15	1.34
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.16	$1.21	15	0.93
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.29	$7.10	20	0.14
Combined Heating/Cooling	Heat Pump	Geothermal Heat Pump	1.55	$12.77	20	-
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.52	$1.22	15	1.27
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.27	$0.14	4	-
Interior Lighting	Interior Screw-in	CFL	1.13	$0.06	7	11.90
Interior Lighting	Interior Screw-in	LED	1.24	$1.90	12	0.61
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.11	($0.05)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.18	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.53	$0.21	6	1.18
Interior Lighting	Linear Fluorescent	T5	0.55	$0.35	6	0.72
Interior Lighting	Linear Fluorescent	LED	0.58	$3.08	15	0.23
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.02	$0.00	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.09	$0.00	7	33.30
Exterior Lighting	Exterior Screw-in	Metal Halides	0.09	$0.00	4	5.97
Exterior Lighting	Exterior Screw-in	LED	0.10	$0.05	12	1.70
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.24	($0.16)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.25	$0.64	9	0.33
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.00	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.01	$0.00	6	1.01
Exterior Lighting	Linear Fluorescent	T5	0.01	$0.01	6	0.62
Exterior Lighting	Linear Fluorescent	LED	0.01	$0.06	15	0.19
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.19	$0.02	15	9.79
Water Heating	Water Heater	Geothermal Heat Pump	2.47	$3.53	15	0.80
Water Heating	Water Heater	Solar	2.72	$3.03	15	1.02

Note: Costs and savings are per sq. ft.

Table D-9 Energy Efficiency Equipment Data — Extra Large Commercial, New Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Fryer	Standard	-	$0.00	12	-
Food Preparation	Fryer	Efficient	0.03	$0.00	12	6.02
Food Preparation	Oven	Standard	-	$0.00	12	-
Food Preparation	Oven	Efficient	0.85	$0.38	12	2.11
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.03	$0.04	12	0.57
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.17	$0.22	12	0.73
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.15
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	0.06	$0.05	18	1.42
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.04	$0.00	18	78.11
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.27	$0.02	18	13.75
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.01	$0.03	18	0.34
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.16	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.24	$0.00	10	68.21
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.05	$0.00	12	17.60
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.25	$0.00	4	32.37
Office Equipment	Desktop Computer	Climate Savers	0.35	$0.33	4	0.32
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	10.31
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.10	4	0.12
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.06	$0.00	3	3.01
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.11	$0.01	4	6.80
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.02	$0.01	6	1.38
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.00	$0.00	4	2.01
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.03	$0.03	15	1.02
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.04	$0.03	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.05	$0.07	15	0.76
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.05	$0.07	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-9 Energy Efficiency Equipment Data — Extra Large Industrial, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	-
Cooling	Central Chiller	0.60 kw/ton, COP 5.9	1.61	$0.33	20	-
Cooling	Central Chiller	0.58 kw/ton, COP 6.1	1.82	$0.66	20	0.68
Cooling	Central Chiller	0.55 kw/Ton, COP 6.4	2.15	$0.93	20	0.94
Cooling	Central Chiller	0.51 kw/ton, COP 6.9	2.58	$1.59	20	0.80
Cooling	Central Chiller	0.50 kw/Ton, COP 7.0	2.68	$1.92	20	0.71
Cooling	Central Chiller	0.48 kw/ton, COP 7.3	2.90	$2.25	20	0.70
Cooling	Central Chiller	Variable Refrigerant Flow	3.74	$39.62	20	0.06
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.56	$0.39	16	-
Cooling	RTU	EER 11.2	1.12	$0.74	16	-
Cooling	RTU	EER 12.0	1.47	$1.23	16	0.62
Cooling	RTU	Ductless VRF	1.79	$10.88	16	0.06
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.20	$0.06	14	2.79
Cooling	PTAC	EER 10.8	0.47	$0.11	14	3.27
Cooling	PTAC	EER 11	0.55	$0.31	14	1.41
Cooling	PTAC	EER 11.5	0.75	$0.69	14	0.87
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	1.07	$0.92	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	1.69	$2.75	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	2.25	$3.66	15	0.75
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	2.47	$4.58	15	0.52
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	2.74	$26.86	20	0.08
Combined Heating/Cooling	Heat Pump	Geothermal Heat Pump	3.29	$48.32	20	-
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	9.66	$1.22	15	8.05
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.08	$0.04	4	-
Interior Lighting	Interior Screw-in	CFL	0.34	$0.02	7	13.32
Interior Lighting	Interior Screw-in	LED	0.38	$0.52	12	0.68
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.41	($0.14)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.09	($0.01)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.28	$0.08	6	1.56
Interior Lighting	Linear Fluorescent	T5	0.29	$0.14	6	0.96
Interior Lighting	Linear Fluorescent	LED	0.30	$1.21	15	0.30
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.01	$0.00	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.02	$0.00	7	13.52
Exterior Lighting	Exterior Screw-in	Metal Halides	0.02	$0.00	4	2.42
Exterior Lighting	Exterior Screw-in	LED	0.02	$0.03	12	0.69
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.07	($0.04)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.07	$0.18	9	0.33
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.00	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.00	$0.00	6	1.05
Exterior Lighting	Linear Fluorescent	T5	0.00	$0.00	6	0.64
Exterior Lighting	Linear Fluorescent	LED	0.00	$0.01	15	0.20
Process	Process Cooling/Refrigera	Standard	-	$0.00	10	-
Process	Process Cooling/Refrigera	Efficient	18.88	$5.59	10	2.49
Process	Process Heating	Standard	-	$0.00	10	-
Process	Process Heating	Efficient	6.18	$0.57	10	7.97

Note: Costs and savings are per sq. ft.

Table D-9 Energy Efficiency Equipment Data — Extra Large Industrial, New Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Process	Electrochemical Process	Standard	-	$0.00	10	-
Process	Electrochemical Process	Efficient	13.16	$2.64	10	3.67
Machine Drive	Less than 5 HP	Standard	-	$0.00	10	-
Machine Drive	Less than 5 HP	High Efficiency	0.05	$0.02	10	2.08
Machine Drive	Less than 5 HP	Standard (2015)	0.07	$0.00	10	-
Machine Drive	Less than 5 HP	Premium	0.07	$0.03	10	1.66
Machine Drive	Less than 5 HP	High Efficiency (2015)	0.11	$0.02	10	-
Machine Drive	Less than 5 HP	Premium (2015)	0.14	$0.03	10	-
Machine Drive	5-24 HP	Standard	-	$0.00	10	-
Machine Drive	5-24 HP	High	0.11	$0.02	10	5.09
Machine Drive	5-24 HP	Premium	0.18	$0.03	10	4.07
Machine Drive	25-99 HP	Standard	-	$0.00	10	-
Machine Drive	25-99 HP	High	0.31	$0.02	10	13.72
Machine Drive	25-99 HP	Premium	0.49	$0.03	10	10.97
Machine Drive	100-249 HP	Standard	-	$0.00	10	-
Machine Drive	100-249 HP	High	0.12	$0.02	10	5.17
Machine Drive	100-249 HP	Premium	0.15	$0.03	10	3.44
Machine Drive	250-499 HP	Standard	-	$0.00	10	-
Machine Drive	250-499 HP	High	0.35	$0.02	10	15.66
Machine Drive	250-499 HP	Premium	0.47	$0.03	10	10.44
Machine Drive	500 and more HP	Standard	-	$0.00	10	-
Machine Drive	500 and more HP	High	0.59	$0.02	10	26.28
Machine Drive	500 and more HP	Premium	0.78	$0.03	10	17.52
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-10 Energy Efficiency Measure Data — Small/Med. Comm., Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	14%	90%	$0.08	4	0.75
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.20
Chiller - Chilled Water Reset	Cooling	14%	0%	0%	0%	$0.86	4	0.08
Chiller - Chilled Water Variable-Flow System	Cooling	5%	0%	0%	0%	$0.86	10	0.07
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	0%	$0.90	20	0.70
Chiller - VSD	Cooling	27%	0%	0%	0%	$1.17	20	0.48
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	0%	0%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	10%	0%	0%	0%	$0.87	14	0.18
Cooling - Economizer Installation	Cooling	6%	0%	45%	49%	$0.15	15	0.71
Heat Pump - Maintenance	Combined Heating/Cooling	7%	7%	10%	95%	$0.03	4	5.00
Insulation - Ducting	Cooling	6%	0%	9%	50%	$0.41	20	0.71
Insulation - Ducting	Space Heating	3%	1%	9%	50%	$0.41	20	0.71
Repair and Sealing - Ducting	Cooling	2%	0%	5%	25%	$0.38	15	0.45
Repair and Sealing - Ducting	Space Heating	2%	1%	5%	25%	$0.38	15	0.45
Energy Management System	Cooling	6%	0%	24%	75%	$0.35	14	0.72
Energy Management System	Space Heating	5%	3%	24%	75%	$0.35	14	0.72
Energy Management System	Interior Lighting	2%	1%	24%	75%	$0.35	14	0.72
Cooking - Exhaust Hoods with Sensor Control	Ventilation	25%	13%	1%	15%	$0.04	10	7.36
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.38
Fans - Variable Speed Control	Ventilation	15%	5%	8%	90%	$0.20	10	0.89
Retrocommissioning - HVAC	Cooling	9%	0%	15%	90%	$0.60	4	0.50
Retrocommissioning - HVAC	Space Heating	9%	6%	15%	90%	$0.60	4	0.50
Retrocommissioning - HVAC	Ventilation	9%	6%	15%	90%	$0.60	4	0.50
Pumps - Variable Speed Control	Miscellaneous	1%	0%	0%	34%	$0.44	10	1.01
Thermostat - Clock/Programmable	Cooling	5%	0%	34%	50%	$0.13	11	1.12
Thermostat - Clock/Programmable	Space Heating	5%	1%	34%	50%	$0.13	11	1.12
Insulation - Ceiling	Cooling	2%	0%	10%	18%	$0.64	20	0.70
Insulation - Ceiling	Space Heating	17%	4%	10%	18%	$0.64	20	0.70
Insulation - Radiant Barrier	Cooling	3%	0%	7%	13%	$0.26	20	0.81
Insulation - Radiant Barrier	Space Heating	5%	2%	7%	13%	$0.26	20	0.81
Roofs - High Reflectivity	Cooling	15%	0%	2%	95%	$0.18	15	1.47
Windows - High Efficiency	Cooling	5%	0%	61%	75%	$0.44	20	0.63
Windows - High Efficiency	Space Heating	3%	2%	61%	75%	$0.44	20	0.63
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	81%	90%	$0.65	8	0.34
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	1%	45%	$0.50	8	0.90
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	2%	50%	$0.11	8	1.36
Interior Fluorescent - Delamp and Install Reflectors	Interior Lighting	20%	10%	18%	25%	$0.50	11	0.97
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.50	8	0.36
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.70	11	1.73
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	7%	45%	$0.20	8	1.11
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.26
Interior Screw-in - Task Lighting	Interior Lighting	7%	4%	25%	75%	$0.24	5	0.09
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	9%	56%	$0.20	8	0.56
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	8%	90%	$0.01	9	4.28
Water Heater - Pipe Insulation	Water Heating	6%	3%	46%	50%	$0.28	15	0.37
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	0%	$0.11	10	0.64
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	40%	50%	$0.02	10	5.87
Water Heater - Thermostat Setback	Water Heating	4%	2%	5%	75%	$0.11	10	0.47
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	0%	$0.02	5	1.56
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	0%	75%	$0.20	16	1.10
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	18%	38%	$0.35	16	1.25
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.10
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.21
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	1.02
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.00
Retrocommissioning - Comprehensive	Cooling	12%	0%	40%	90%	$0.70	4	0.71
Retrocommissioning - Comprehensive	Space Heating	12%	9%	40%	90%	$0.70	4	0.71
Retrocommissioning - Comprehensive	Interior Lighting	12%	9%	40%	90%	$0.70	4	0.71
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	61.20
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.09
LED Exit Lighting	Interior Lighting	2%	2%	9%	86%	$0.00	10	12.75
Retrocommissioning - Lighting	Interior Lighting	9%	6%	5%	90%	$0.10	5	1.59
Retrocommissioning - Lighting	Exterior Lighting	9%	6%	5%	90%	$0.10	5	1.59
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.00
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.37
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	8.10
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	36.95
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	0%	0%	$0.14	8	0.33
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.95
Industrial Process Improvements	Miscellaneous	10%	8%	0%	23%	$0.52	10	1.16
Custom Measures	Cooling	10%	0%	10%	45%	$1.50	15	0.59
Custom Measures	Space Heating	10%	8%	10%	45%	$1.50	15	0.59
Custom Measures	Interior Lighting	10%	6%	10%	45%	$1.50	15	0.59
Custom Measures	Food Preparation	10%	7%	10%	45%	$1.50	15	0.59
Custom Measures	Refrigeration	10%	5%	10%	45%	$1.50	15	0.59
Water Heater - Heat Pump	Water Heating	30%	15%	0%	19%	$0.80	15	0.69
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$4.00	15	0.54
Furnace - Convert to Gas	Space Heating	100%	100%	0%	47%	$8.04	15	1.08

Note: Costs are per sq. ft.

Table D-11 Energy Efficiency Measure Data — Large Commercial, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	27%	90%	$0.06	4	1.30
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.21
Chiller - Chilled Water Reset	Cooling	19%	0%	15%	75%	$0.18	4	0.50
Chiller - Chilled Water Variable-Flow System	Cooling	5%	0%	30%	34%	$0.18	10	0.31
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	66%	$0.90	20	0.64
Chiller - VSD	Cooling	32%	0%	15%	66%	$1.17	20	0.52
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	15%	41%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	9%	0%	5%	75%	$0.18	14	0.76
Cooling - Economizer Installation	Cooling	11%	0%	44%	49%	$0.15	15	1.29
Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	10%	95%	$0.06	4	3.04
Insulation - Ducting	Cooling	3%	0%	8%	50%	$0.41	20	0.52
Insulation - Ducting	Space Heating	3%	1%	8%	50%	$0.41	20	0.52
Repair and Sealing - Ducting	Cooling	2%	0%	5%	25%	$0.38	15	0.43
Repair and Sealing - Ducting	Space Heating	2%	1%	5%	25%	$0.38	15	0.43
Energy Management System	Cooling	23%	0%	37%	90%	$0.35	14	2.63
Energy Management System	Space Heating	18%	12%	37%	90%	$0.35	14	2.63
Energy Management System	Interior Lighting	9%	6%	37%	90%	$0.35	14	2.63
Cooking - Exhaust Hoods with Sensor Control	Ventilation	13%	7%	1%	11%	$0.04	10	2.97
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.11
Fans - Variable Speed Control	Ventilation	15%	5%	2%	90%	$0.20	10	0.71
Retrocommissioning - HVAC	Cooling	12%	0%	15%	90%	$0.30	4	0.72
Retrocommissioning - HVAC	Space Heating	12%	9%	15%	90%	$0.30	4	0.72
Retrocommissioning - HVAC	Ventilation	9%	6%	15%	90%	$0.30	4	0.72
Pumps - Variable Speed Control	Miscellaneous	1%	0%	0%	34%	$0.13	10	1.05
Thermostat - Clock/Programmable	Cooling	5%	0%	33%	50%	$0.13	11	1.02
Thermostat - Clock/Programmable	Space Heating	5%	1%	33%	50%	$0.13	11	1.02
Insulation - Ceiling	Cooling	1%	0%	9%	30%	$0.85	20	0.45
Insulation - Ceiling	Space Heating	12%	3%	9%	30%	$0.85	20	0.45
Insulation - Radiant Barrier	Cooling	2%	0%	7%	13%	$0.26	20	0.64
Insulation - Radiant Barrier	Space Heating	5%	2%	7%	13%	$0.26	20	0.64
Roofs - High Reflectivity	Cooling	5%	0%	2%	75%	$0.08	15	1.08
Windows - High Efficiency	Cooling	12%	0%	72%	75%	$0.88	20	0.74
Windows - High Efficiency	Space Heating	11%	8%	72%	75%	$0.88	20	0.74
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	86%	90%	$0.65	8	0.34
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	1%	45%	$0.45	8	0.96
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	2%	13%	$0.29	8	0.42
Interior Fluorescent - Delamp and Install Reflectors	Interior Lighting	30%	15%	17%	38%	$0.50	11	1.40
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.40	8	0.43
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.63	11	1.85
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	13%	45%	$0.20	8	1.10
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.21
Interior Screw-in - Task Lighting	Interior Lighting	10%	5%	10%	75%	$0.24	5	0.13
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	9%	56%	$0.20	8	0.55
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	3%	90%	$0.03	9	1.62
Water Heater - Pipe Insulation	Water Heating	6%	3%	0%	0%	$0.28	15	0.42
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	23%	$0.11	10	0.70
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$0.04	10	3.28
Water Heater - Thermostat Setback	Water Heating	4%	2%	0%	0%	$0.11	10	0.52
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	3%	$0.04	5	0.88
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	0%	75%	$0.20	16	0.58
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	38%	45%	$0.35	16	0.95
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.65
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.37
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	0.65
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.96
Retrocommissioning - Comprehensive	Cooling	12%	0%	40%	90%	$0.35	4	1.06
Retrocommissioning - Comprehensive	Space Heating	12%	9%	40%	90%	$0.35	4	1.06
Retrocommissioning - Comprehensive	Interior Lighting	12%	9%	40%	90%	$0.35	4	1.06
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	68.11
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.11
LED Exit Lighting	Interior Lighting	2%	2%	9%	86%	$0.00	10	12.29
Retrocommissioning - Lighting	Interior Lighting	9%	6%	5%	90%	$0.05	5	3.07
Retrocommissioning - Lighting	Exterior Lighting	9%	6%	5%	90%	$0.05	5	3.07
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.52
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.14
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	6.50
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	33.94
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	1%	2%	$0.14	8	0.32
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.78
Industrial Process Improvements	Miscellaneous	10%	8%	0%	5%	$0.52	10	1.18
Custom Measures	Cooling	10%	0%	10%	45%	$0.90	15	0.99
Custom Measures	Space Heating	10%	8%	10%	45%	$0.90	15	0.99
Custom Measures	Interior Lighting	10%	8%	10%	45%	$0.90	15	0.99
Custom Measures	Food Preparation	10%	8%	10%	45%	$0.90	15	0.99
Custom Measures	Refrigeration	10%	8%	10%	45%	$0.90	15	0.99
Water Heater - Heat Pump	Water Heating	30%	15%	0%	28%	$0.80	15	0.77
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	0%	$4.00	15	0.59
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$6.00	15	1.04

Note: Costs are per sq. ft.

Table D-12 Energy Efficiency Measure Data — Extra Large Comm., Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	47%	90%	$0.06	4	1.15
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.19
Chiller - Chilled Water Reset	Cooling	15%	0%	30%	75%	$0.09	4	0.79
Chiller - Chilled Water Variable-Flow System	Cooling	8%	0%	30%	34%	$0.09	10	1.00
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	75%	$0.90	20	0.66
Chiller - VSD	Cooling	28%	0%	3%	75%	$1.17	20	0.47
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	25%	37%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	9%	0%	0%	75%	$0.09	14	1.49
Cooling - Economizer Installation	Cooling	11%	0%	73%	81%	$0.15	15	1.20
Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	5%	95%	$0.06	4	2.91
Insulation - Ducting	Cooling	8%	0%	2%	50%	$0.41	20	0.77
Insulation - Ducting	Space Heating	3%	1%	2%	50%	$0.41	20	0.77
Repair and Sealing - Ducting	Cooling	5%	0%	5%	25%	$0.38	15	0.65
Repair and Sealing - Ducting	Space Heating	5%	3%	5%	25%	$0.38	15	0.65
Energy Management System	Cooling	12%	0%	80%	90%	$0.35	14	1.21
Energy Management System	Space Heating	9%	6%	80%	90%	$0.35	14	1.21
Energy Management System	Interior Lighting	5%	3%	80%	90%	$0.35	14	1.21
Cooking - Exhaust Hoods with Sensor Control	Ventilation	13%	7%	1%	8%	$0.04	10	3.46
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.30
Fans - Variable Speed Control	Ventilation	15%	5%	2%	90%	$0.20	10	0.83
Retrocommissioning - HVAC	Cooling	12%	0%	15%	90%	$0.20	4	1.00
Retrocommissioning - HVAC	Space Heating	12%	9%	15%	90%	$0.20	4	1.00
Retrocommissioning - HVAC	Ventilation	9%	6%	15%	90%	$0.20	4	1.00
Pumps - Variable Speed Control	Miscellaneous	1%	0%	1%	34%	$0.44	10	1.01
Thermostat - Clock/Programmable	Cooling	3%	0%	25%	50%	$0.13	11	0.69
Thermostat - Clock/Programmable	Space Heating	3%	1%	25%	50%	$0.13	11	0.69
Insulation - Ceiling	Cooling	1%	0%	2%	9%	$0.85	20	0.48
Insulation - Ceiling	Space Heating	12%	3%	2%	9%	$0.85	20	0.48
Insulation - Radiant Barrier	Cooling	1%	0%	2%	13%	$0.26	20	0.57
Insulation - Radiant Barrier	Space Heating	4%	2%	2%	13%	$0.26	20	0.57
Roofs - High Reflectivity	Cooling	10%	0%	0%	95%	$0.18	15	0.90
Windows - High Efficiency	Cooling	6%	0%	95%	100%	$2.10	20	0.37
Windows - High Efficiency	Space Heating	2%	2%	95%	100%	$2.10	20	0.37
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	78%	90%	$0.65	8	0.26
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	3%	45%	$0.40	8	0.72
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	2%	10%	$0.29	8	0.45
Interior Fluorescent - Delamp and Install Reflectors	Interior Lighting	30%	15%	3%	25%	$0.50	11	0.93
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.20	8	0.57
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.56	11	1.38
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	42%	45%	$0.20	8	0.84
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.23
Interior Screw-in - Task Lighting	Interior Lighting	10%	5%	5%	75%	$0.24	5	0.18
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	12%	56%	$0.20	8	0.42
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	2%	90%	$0.03	9	2.66
Water Heater - Pipe Insulation	Water Heating	6%	3%	0%	0%	$0.28	15	0.70
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	23%	$0.11	10	1.19
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$0.04	10	5.48
Water Heater - Thermostat Setback	Water Heating	4%	0%	0%	0%	$0.11	10	0.72
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	0%	$0.04	5	1.45
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	10%	75%	$0.20	16	0.02
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	10%	38%	$0.35	16	0.34
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.13
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.28
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	0.29
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.18
Retrocommissioning - Comprehensive	Cooling	12%	0%	40%	90%	$0.25	4	1.21
Retrocommissioning - Comprehensive	Space Heating	12%	9%	40%	90%	$0.25	4	1.21
Retrocommissioning - Comprehensive	Interior Lighting	12%	9%	40%	90%	$0.25	4	1.21
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	39.11
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.12
LED Exit Lighting	Interior Lighting	2%	2%	9%	86%	$0.00	10	18.34
Retrocommissioning - Lighting	Interior Lighting	9%	6%	5%	90%	$0.05	5	2.54
Retrocommissioning - Lighting	Exterior Lighting	9%	6%	5%	90%	$0.05	5	2.54
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.04
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.61
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	6.95
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	20.31
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	0%	0%	$0.14	8	0.47
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.07
Industrial Process Improvements	Miscellaneous	10%	8%	0%	0%	$0.52	10	1.11
Custom Measures	Cooling	10%	0%	10%	45%	$0.67	15	1.09
Custom Measures	Space Heating	10%	8%	10%	45%	$0.67	15	1.09
Custom Measures	Interior Lighting	10%	8%	10%	45%	$0.67	15	1.09
Custom Measures	Food Preparation	10%	8%	10%	45%	$0.67	15	1.09
Custom Measures	Refrigeration	10%	8%	10%	45%	$0.67	15	1.09
Water Heater - Heat Pump	Water Heating	30%	15%	0%	41%	$0.80	15	1.28
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	0%	$4.00	15	1.00
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$4.00	15	1.66

Note: Costs are per sq. ft.

Table D-13 Energy Efficiency Measure Data — Extra Large Industrial, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Refrigeration - System Controls	Process	11%	8%	5%	34%	$0.40	10	18.09
Refrigeration - System Maintenance	Process	3%	2%	5%	34%	$0.00	10	2,067.93
Refrigeration - System Optimization	Process	15%	11%	5%	34%	$0.80	10	12.92
Motors - Variable Frequency Drive	Machine Drive	13%	9%	25%	38%	$0.10	10	3.38
Motors - Magnetic Adjustable Speed Drives	Machine Drive	13%	9%	25%	38%	$0.10	10	3.38
Compressed Air - System Controls	Machine Drive	9%	7%	5%	34%	$0.40	10	0.59
Compressed Air - System Optimization and Improvements	Machine Drive	13%	9%	5%	34%	$0.80	10	0.42
Compressed Air - System Maintenance	Machine Drive	3%	2%	5%	34%	$0.20	10	0.34
Compressed Air - Compressor Replacement	Machine Drive	5%	4%	5%	34%	$0.20	10	0.68
Fan System - Controls	Machine Drive	4%	3%	10%	38%	$0.35	10	0.11
Fan System - Controls	Machine Drive	4%	3%	10%	38%	$0.35	10	0.11
Fan System - Optimization	Machine Drive	6%	5%	10%	38%	$0.70	10	0.08
Fan System - Optimization	Machine Drive	6%	5%	10%	38%	$0.70	10	0.08
Fan System - Maintenance	Machine Drive	1%	1%	10%	38%	$0.15	10	0.07
Fan System - Maintenance	Machine Drive	1%	1%	10%	38%	$0.15	10	0.07
Pumping System - Controls	Machine Drive	5%	4%	5%	34%	$0.38	12	0.43
Pumping System - Optimization	Machine Drive	13%	9%	5%	34%	$0.75	12	0.54
Pumping System - Maintenance	Machine Drive	2%	1%	5%	34%	$0.19	10	0.27
RTU - Maintenance	Cooling	14%	0%	22%	90%	$0.06	4	3.18
Chiller - Chilled Water Reset	Cooling	14%	0%	30%	75%	$0.09	4	2.69
Chiller - Chilled Water Variable-Flow System	Cooling	5%	0%	30%	34%	$0.20	10	1.05
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	67%	$0.90	20	2.48
Chiller - VSD	Cooling	26%	0%	15%	67%	$1.17	20	1.68
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	25%	50%	$0.04	10	0.03
Chiller - Condenser Water Temprature Reset	Cooling	10%	0%	0%	75%	$0.20	14	2.72
Cooling - Economizer Installation	Cooling	6%	0%	29%	34%	$0.15	15	2.02
Heat Pump - Maintenance	Combined Heating/Cooling	7%	7%	2%	95%	$0.03	4	8.67
Insulation - Ducting	Space Heating	6%	6%	12%	50%	$0.41	20	1.01
Insulation - Ducting	Cooling	3%	0%	12%	50%	$0.41	20	1.01
Repair and Sealing - Ducting	Cooling	2%	0%	5%	25%	$0.38	15	0.63
Repair and Sealing - Ducting	Space Heating	2%	1%	5%	25%	$0.38	15	0.63
Energy Management System	Cooling	6%	0%	11%	90%	$0.35	14	1.09
Energy Management System	Space Heating	5%	3%	11%	90%	$0.35	14	1.09
Energy Management System	Interior Lighting	2%	1%	11%	90%	$0.35	14	1.09
Fans - Energy Efficient Motors	Ventilation	5%	5%	2%	90%	$0.14	10	2.94
Fans - Variable Speed Control	Ventilation	15%	5%	3%	90%	$0.20	10	5.29
Retrocommissioning - HVAC	Cooling	12%	0%	1%	70%	$0.25	4	1.54
Retrocommissioning - HVAC	Space Heating	12%	9%	1%	70%	$0.25	4	1.54
Retrocommissioning - HVAC	Ventilation	9%	6%	1%	70%	$0.25	4	1.54
Pumps - Variable Speed Control	Machine Drive	5%	4%	0%	34%	$0.44	10	0.31
Thermostat - Clock/Programmable	Cooling	5%	0%	59%	70%	$0.13	11	2.11
Thermostat - Clock/Programmable	Space Heating	5%	1%	59%	70%	$0.13	11	2.11
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	84%	90%	$0.65	8	0.17
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	2%	27%	$0.08	8	0.46
Interior Fluorescent - Delamp and Install Reflectors	Interior Lighting	20%	10%	17%	38%	$0.50	11	0.31
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	38%	$0.20	11	1.95
LED Exit Lighting	Interior Lighting	2%	2%	9%	86%	$0.00	10	4.00
Retrocommissioning - Lighting	Interior Lighting	9%	6%	9%	70%	$0.05	5	1.44
Retrocommissioning - Lighting	Exterior Lighting	9%	6%	9%	70%	$0.05	5	1.44
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	15%	45%	$0.20	8	0.55
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.07
Interior Screw-in - Task Lighting	Interior Lighting	7%	4%	10%	75%	$0.24	5	0.03
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	2%	56%	$0.20	8	0.27
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	0.46
Custom Measures	Cooling	10%	0%	10%	45%	$1.60	15	1.63
Custom Measures	Space Heating	10%	8%	10%	45%	$1.60	15	1.63
Custom Measures	Interior Lighting	10%	8%	10%	45%	$1.60	15	1.63
Custom Measures	Machine Drive	10%	8%	10%	45%	$1.60	15	1.63
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$4.00	15	2.67

Note: Costs are per sq. ft.

Table D-14 Energy Efficiency Measure Data — Small/Medium Comm., New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	14%	90%	$0.08	4	0.82
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.18
Chiller - Chilled Water Reset	Cooling	11%	0%	0%	0%	$0.86	4	0.06
Chiller - Chilled Water Variable-Flow System	Cooling	4%	0%	0%	0%	$0.86	10	0.05
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	0%	$0.90	20	0.63
Chiller - VSD	Cooling	26%	0%	0%	0%	$1.17	20	0.42
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	0%	0%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	8%	0%	0%	0%	$0.87	14	0.13
Cooling - Economizer Installation	Cooling	6%	0%	45%	49%	$0.15	15	0.65
Heat Pump - Maintenance	Combined Heating/Cooling	7%	7%	10%	95%	$0.03	4	4.32
Insulation - Ducting	Cooling	5%	0%	9%	50%	$0.41	20	0.64
Insulation - Ducting	Space Heating	3%	1%	9%	50%	$0.41	20	0.64
Energy Management System	Cooling	5%	0%	24%	75%	$0.35	14	0.55
Energy Management System	Space Heating	2%	1%	24%	75%	$0.35	14	0.55
Energy Management System	Interior Lighting	2%	1%	24%	75%	$0.35	14	0.55
Cooking - Exhaust Hoods with Sensor Control	Ventilation	25%	13%	1%	15%	$0.04	10	7.04
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.32
Fans - Variable Speed Control	Ventilation	15%	5%	8%	90%	$0.20	10	0.85
Commissioning - HVAC	Cooling	5%	0%	40%	75%	$0.90	25	0.33
Commissioning - HVAC	Space Heating	5%	4%	40%	75%	$0.90	25	0.33
Commissioning - HVAC	Ventilation	5%	4%	40%	75%	$0.90	25	0.33
Pumps - Variable Speed Control	Miscellaneous	1%	0%	5%	34%	$0.44	10	1.01
Thermostat - Clock/Programmable	Cooling	5%	0%	34%	50%	$0.13	11	1.06
Thermostat - Clock/Programmable	Space Heating	5%	1%	34%	50%	$0.13	11	1.06
Insulation - Ceiling	Cooling	1%	0%	10%	81%	$0.16	20	1.60
Insulation - Ceiling	Space Heating	15%	4%	10%	81%	$0.16	20	1.60
Insulation - Radiant Barrier	Cooling	2%	0%	7%	13%	$0.26	20	0.76
Insulation - Radiant Barrier	Space Heating	6%	2%	7%	13%	$0.26	20	0.76
Roofs - High Reflectivity	Cooling	7%	0%	5%	95%	$0.09	15	1.25
Windows - High Efficiency	Cooling	5%	0%	61%	75%	$0.35	20	0.69
Windows - High Efficiency	Space Heating	3%	2%	61%	75%	$0.35	20	0.69
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	81%	90%	$0.65	8	0.31
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	1%	45%	$0.38	8	1.07
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	10%	75%	$0.09	8	1.50
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.50	8	0.32
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.70	11	1.56
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	7%	45%	$0.20	8	1.00
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.24
Interior Screw-in - Task Lighting	Interior Lighting	7%	4%	25%	75%	$0.24	5	0.08
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	9%	56%	$0.20	8	0.50
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	8%	90%	$0.01	9	4.22
Water Heater - Pipe Insulation	Water Heating	4%	2%	46%	50%	$0.28	15	0.24
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	0%	$0.11	10	0.63
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	40%	50%	$0.02	10	5.80
Water Heater - Thermostat Setback	Water Heating	4%	0%	10%	75%	$0.11	10	0.38
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	0%	$0.02	5	1.53
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	0%	75%	$0.20	16	1.09
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	18%	38%	$0.35	16	1.24
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.09
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.20
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	1.02
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.00
Commissioning - Comprehensive	Cooling	10%	0%	40%	75%	$1.25	25	0.83
Commissioning - Comprehensive	Space Heating	10%	7%	40%	75%	$1.25	25	0.83
Commissioning - Comprehensive	Interior Lighting	10%	7%	40%	75%	$1.25	25	0.83
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	61.07
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.08
LED Exit Lighting	Interior Lighting	2%	2%	85%	86%	$0.00	10	11.83
Commissioning - Lighting	Interior Lighting	5%	4%	30%	75%	$0.20	25	1.54
Commissioning - Lighting	Exterior Lighting	5%	4%	30%	75%	$0.20	25	1.54
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.00
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.23
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	7.30
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	36.95
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	0%	0%	$0.14	8	0.30
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.95
Advanced New Construction Designs	Cooling	40%	0%	5%	75%	$2.00	35	2.01
Advanced New Construction Designs	Space Heating	40%	30%	5%	75%	$2.00	35	2.01
Advanced New Construction Designs	Interior Lighting	25%	19%	5%	75%	$2.00	35	2.01
Insulation - Wall Cavity	Cooling	1%	0%	10%	68%	$0.34	20	0.72
Insulation - Wall Cavity	Space Heating	10%	2%	10%	68%	$0.34	20	0.72
Roofs - Green	Cooling	7%	0%	2%	11%	$1.00	30	0.26
Roofs - Green	Space Heating	4%	3%	2%	11%	$1.00	30	0.26
Industrial Process Improvements	Miscellaneous	10%	8%	0%	23%	$0.52	10	1.16
Custom Measures	Cooling	8%	0%	10%	45%	$1.50	15	0.45
Custom Measures	Space Heating	8%	6%	10%	45%	$1.50	15	0.45
Custom Measures	Interior Lighting	8%	6%	10%	45%	$1.50	15	0.45
Custom Measures	Food Preparation	8%	6%	10%	45%	$1.50	15	0.45
Custom Measures	Refrigeration	8%	6%	10%	45%	$1.50	15	0.45
Water Heater - Heat Pump	Water Heating	30%	15%	0%	19%	$0.80	15	0.68
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$4.00	15	0.53
Furnace - Convert to Gas	Space Heating	100%	100%	0%	47%	$8.04	15	1.01

Note: Costs are per sq. ft.

Table D-15 Energy Efficiency Measure Data — Large Commercial, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	27%	90%	$0.06	4	1.13
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.19
Chiller - Chilled Water Reset	Cooling	18%	0%	30%	75%	$0.18	4	0.42
Chiller - Chilled Water Variable-Flow System	Cooling	5%	0%	30%	34%	$0.18	10	0.28
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	66%	$0.90	20	0.61
Chiller - VSD	Cooling	32%	0%	15%	66%	$1.17	20	0.50
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	15%	41%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	8%	0%	25%	75%	$0.18	14	0.63
Cooling - Economizer Installation	Cooling	11%	0%	44%	49%	$0.15	15	1.19
Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	10%	95%	$0.06	4	2.72
Insulation - Ducting	Cooling	4%	0%	8%	50%	$0.41	20	0.56
Insulation - Ducting	Space Heating	3%	1%	8%	50%	$0.41	20	0.56
Energy Management System	Cooling	21%	0%	48%	90%	$0.35	14	2.10
Energy Management System	Space Heating	8%	5%	48%	90%	$0.35	14	2.10
Energy Management System	Interior Lighting	9%	6%	48%	90%	$0.35	14	2.10
Cooking - Exhaust Hoods with Sensor Control	Ventilation	13%	7%	1%	11%	$0.04	10	2.84
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.07
Fans - Variable Speed Control	Ventilation	15%	5%	2%	90%	$0.20	10	0.68
Commissioning - HVAC	Cooling	5%	0%	50%	75%	$0.85	25	0.30
Commissioning - HVAC	Space Heating	5%	4%	50%	75%	$0.85	25	0.30
Commissioning - HVAC	Ventilation	5%	4%	50%	75%	$0.85	25	0.30
Pumps - Variable Speed Control	Miscellaneous	1%	0%	5%	34%	$0.13	10	1.05
Thermostat - Clock/Programmable	Cooling	5%	0%	33%	50%	$0.13	11	0.97
Thermostat - Clock/Programmable	Space Heating	5%	1%	33%	50%	$0.13	11	0.97
Insulation - Ceiling	Cooling	1%	0%	75%	81%	$0.35	20	0.60
Insulation - Ceiling	Space Heating	10%	3%	75%	81%	$0.35	20	0.60
Insulation - Radiant Barrier	Cooling	1%	0%	7%	13%	$0.26	20	0.56
Insulation - Radiant Barrier	Space Heating	5%	2%	7%	13%	$0.26	20	0.56
Roofs - High Reflectivity	Cooling	4%	0%	5%	95%	$0.05	15	1.28
Windows - High Efficiency	Cooling	12%	0%	72%	75%	$0.88	20	0.72
Windows - High Efficiency	Space Heating	11%	8%	72%	75%	$0.88	20	0.72
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	86%	90%	$0.65	8	0.30
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	1%	45%	$0.34	8	1.14
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	10%	19%	$0.19	8	0.57
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.40	8	0.39
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.63	11	1.66
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	13%	45%	$0.20	8	0.99
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.19
Interior Screw-in - Task Lighting	Interior Lighting	10%	5%	10%	75%	$0.24	5	0.11
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	9%	56%	$0.20	8	0.49
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	3%	90%	$0.03	9	1.60
Water Heater - Pipe Insulation	Water Heating	4%	2%	0%	0%	$0.28	15	0.27
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	23%	$0.11	10	0.69
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$0.04	10	3.23
Water Heater - Thermostat Setback	Water Heating	4%	0%	0%	0%	$0.11	10	0.44
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	3%	$0.04	5	0.87
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	0%	75%	$0.20	16	0.58
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	38%	45%	$0.35	16	0.94
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.63
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.35
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	0.65
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.94
Commissioning - Comprehensive	Cooling	10%	0%	40%	75%	$1.00	25	0.96
Commissioning - Comprehensive	Space Heating	10%	7%	40%	75%	$1.00	25	0.96
Commissioning - Comprehensive	Interior Lighting	10%	7%	40%	75%	$1.00	25	0.96
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	67.83
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.09
LED Exit Lighting	Interior Lighting	2%	2%	85%	86%	$0.00	10	11.13
Commissioning - Lighting	Interior Lighting	5%	4%	60%	75%	$0.15	25	1.99
Commissioning - Lighting	Exterior Lighting	5%	4%	60%	75%	$0.15	25	1.99
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.52
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.03
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	5.86
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	33.94
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	1%	2%	$0.14	8	0.29
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.78
Advanced New Construction Designs	Cooling	40%	0%	5%	75%	$2.00	35	1.84
Advanced New Construction Designs	Space Heating	40%	30%	5%	75%	$2.00	35	1.84
Advanced New Construction Designs	Interior Lighting	25%	19%	5%	75%	$2.00	35	1.84
Insulation - Wall Cavity	Cooling	1%	0%	9%	68%	$0.78	20	0.43
Insulation - Wall Cavity	Space Heating	10%	2%	9%	68%	$0.78	20	0.43
Roofs - Green	Cooling	4%	0%	2%	13%	$1.00	15	0.08
Roofs - Green	Space Heating	2%	2%	2%	13%	$1.00	15	0.08
Industrial Process Improvements	Miscellaneous	10%	8%	0%	5%	$0.52	10	1.18
Custom Measures	Cooling	8%	0%	10%	45%	$0.90	15	0.73
Custom Measures	Space Heating	8%	6%	10%	45%	$0.90	15	0.73
Custom Measures	Interior Lighting	8%	6%	10%	45%	$0.90	15	0.73
Custom Measures	Food Preparation	8%	6%	10%	45%	$0.90	15	0.73
Custom Measures	Refrigeration	8%	6%	10%	45%	$0.90	15	0.73
Water Heater - Heat Pump	Water Heating	30%	15%	0%	28%	$0.80	15	0.76
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	0%	$4.00	15	0.58
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$6.00	15	0.98

Note: Costs are per sq. ft.

Table D-16 Energy Efficiency Measure Data — Extra Large Commercial, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	47%	90%	$0.06	4	1.02
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.17
Chiller - Chilled Water Reset	Cooling	12%	0%	60%	75%	$0.09	4	0.61
Chiller - Chilled Water Variable-Flow System	Cooling	8%	0%	30%	34%	$0.09	10	0.95
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	75%	$0.90	20	0.64
Chiller - VSD	Cooling	28%	0%	3%	75%	$1.17	20	0.45
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	25%	37%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	8%	0%	25%	75%	$0.09	14	1.28
Cooling - Economizer Installation	Cooling	11%	0%	73%	81%	$0.15	15	1.14
Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	5%	95%	$0.06	4	2.61
Insulation - Ducting	Cooling	7%	0%	2%	50%	$0.41	20	0.71
Insulation - Ducting	Space Heating	3%	1%	2%	50%	$0.41	20	0.71
Energy Management System	Cooling	11%	0%	80%	90%	$0.35	14	0.94
Energy Management System	Space Heating	4%	2%	80%	90%	$0.35	14	0.94
Energy Management System	Interior Lighting	5%	3%	80%	90%	$0.35	14	0.94
Cooking - Exhaust Hoods with Sensor Control	Ventilation	13%	7%	1%	8%	$0.04	10	3.31
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.24
Fans - Variable Speed Control	Ventilation	15%	5%	2%	90%	$0.20	10	0.80
Commissioning - HVAC	Cooling	5%	0%	50%	75%	$0.70	25	0.42
Commissioning - HVAC	Space Heating	5%	4%	50%	75%	$0.70	25	0.42
Commissioning - HVAC	Ventilation	5%	4%	50%	75%	$0.70	25	0.42
Pumps - Variable Speed Control	Miscellaneous	1%	0%	1%	34%	$0.44	10	1.01
Thermostat - Clock/Programmable	Cooling	3%	0%	25%	50%	$0.13	11	0.67
Thermostat - Clock/Programmable	Space Heating	3%	1%	25%	50%	$0.13	11	0.67
Insulation - Ceiling	Cooling	1%	0%	2%	81%	$0.35	20	0.68
Insulation - Ceiling	Space Heating	10%	3%	2%	81%	$0.35	20	0.68
Insulation - Radiant Barrier	Cooling	1%	0%	2%	13%	$0.26	20	0.47
Insulation - Radiant Barrier	Space Heating	2%	1%	2%	13%	$0.26	20	0.47
Roofs - High Reflectivity	Cooling	10%	0%	5%	95%	$0.18	15	0.85
Windows - High Efficiency	Cooling	6%	0%	95%	100%	$1.69	20	0.38
Windows - High Efficiency	Space Heating	2%	2%	95%	100%	$1.69	20	0.38
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	78%	90%	$0.65	8	0.23
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	3%	45%	$0.30	8	0.86
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	10%	15%	$0.19	8	0.61
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.20	8	0.52
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.56	11	1.24
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	42%	45%	$0.20	8	0.76
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.20
Interior Screw-in - Task Lighting	Interior Lighting	10%	5%	25%	75%	$0.24	5	0.16
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	12%	56%	$0.20	8	0.38
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	2%	90%	$0.03	9	2.63
Water Heater - Pipe Insulation	Water Heating	6%	3%	0%	0%	$0.28	15	0.69
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	23%	$0.11	10	1.18
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$0.04	10	5.43
Water Heater - Thermostat Setback	Water Heating	4%	0%	0%	0%	$0.11	10	0.71
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	0%	$0.04	5	1.43
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	10%	75%	$0.20	16	0.02
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	10%	38%	$0.35	16	0.32
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.12
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.26
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	0.27
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.17
Commissioning - Comprehensive	Cooling	10%	0%	40%	75%	$0.80	25	1.05
Commissioning - Comprehensive	Space Heating	10%	7%	40%	75%	$0.80	25	1.05
Commissioning - Comprehensive	Interior Lighting	10%	7%	40%	75%	$0.80	25	1.05
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	38.86
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.10
LED Exit Lighting	Interior Lighting	2%	2%	85%	86%	$0.00	10	16.52
Commissioning - Lighting	Interior Lighting	5%	4%	60%	75%	$0.10	25	2.47
Commissioning - Lighting	Exterior Lighting	5%	4%	60%	75%	$0.10	25	2.47
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.04
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.45
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	6.26
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	20.31
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	0%	0%	$0.14	8	0.42
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.07
Advanced New Construction Designs	Cooling	40%	0%	5%	75%	$2.00	35	1.67
Advanced New Construction Designs	Space Heating	40%	30%	5%	75%	$2.00	35	1.67
Advanced New Construction Designs	Interior Lighting	25%	19%	5%	75%	$2.00	35	1.67
Insulation - Wall Cavity	Cooling	1%	0%	2%	68%	$0.09	20	1.73
Insulation - Wall Cavity	Space Heating	10%	2%	2%	68%	$0.09	20	1.73
Roofs - Green	Cooling	10%	0%	2%	13%	$1.00	15	0.20
Roofs - Green	Space Heating	5%	3%	2%	13%	$1.00	15	0.20
Industrial Process Improvements	Miscellaneous	10%	8%	0%	0%	$0.52	10	1.11
Custom Measures	Cooling	8%	0%	10%	45%	$0.67	15	0.81
Custom Measures	Space Heating	8%	6%	10%	45%	$0.67	15	0.81
Custom Measures	Interior Lighting	8%	6%	10%	45%	$0.67	15	0.81
Custom Measures	Food Preparation	8%	6%	10%	45%	$0.67	15	0.81
Custom Measures	Refrigeration	8%	6%	10%	45%	$0.67	15	0.81
Water Heater - Heat Pump	Water Heating	30%	15%	0%	41%	$0.80	15	1.27
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	0%	$4.00	15	1.00
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$4.00	15	1.57

Note: Costs are per sq. ft.

Table D-17 Energy Efficiency Measure Data — Extra Large Industrial, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Refrigeration - System Controls	Process	11%	8%	5%	34%	$0.40	10	18.09
Refrigeration - System Maintenance	Process	3%	2%	5%	34%	$0.00	10	2,067.93
Refrigeration - System Optimization	Process	15%	11%	5%	34%	$0.80	10	12.92
Motors - Variable Frequency Drive	Machine Drive	13%	9%	25%	38%	$0.10	10	3.38
Motors - Magnetic Adjustable Speed Drives	Machine Drive	13%	9%	25%	38%	$0.10	10	3.38
Compressed Air - System Controls	Machine Drive	9%	7%	5%	34%	$0.40	10	0.59
Compressed Air - System Optimization and Improvements	Machine Drive	13%	9%	5%	34%	$0.80	10	0.42
Compressed Air - System Maintenance	Machine Drive	3%	2%	5%	34%	$0.20	10	0.34
Compressed Air - Compressor Replacement	Machine Drive	5%	4%	5%	34%	$0.20	10	0.68
Fan System - Controls	Machine Drive	4%	3%	10%	38%	$0.35	10	0.11
Fan System - Controls	Machine Drive	4%	3%	10%	38%	$0.35	10	0.11
Fan System - Optimization	Machine Drive	6%	5%	10%	38%	$0.70	10	0.08
Fan System - Optimization	Machine Drive	6%	5%	10%	38%	$0.70	10	0.08
Fan System - Maintenance	Machine Drive	1%	1%	10%	38%	$0.15	10	0.07
Fan System - Maintenance	Machine Drive	1%	1%	10%	38%	$0.15	10	0.07
Pumping System - Controls	Machine Drive	5%	4%	5%	34%	$0.38	12	0.42
Pumping System - Optimization	Machine Drive	13%	9%	5%	34%	$0.75	12	0.54
Pumping System - Maintenance	Machine Drive	2%	1%	5%	34%	$0.19	10	0.27
RTU - Maintenance	Cooling	14%	0%	22%	90%	$0.06	4	2.82
Chiller - Chilled Water Reset	Cooling	14%	0%	60%	75%	$0.09	4	2.53
Chiller - Chilled Water Variable-Flow System	Cooling	4%	0%	30%	34%	$0.20	10	0.80
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	67%	$0.90	20	2.40
Chiller - VSD	Cooling	27%	0%	25%	67%	$1.17	20	1.63
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	25%	50%	$0.04	10	0.04
Chiller - Condenser Water Temprature Reset	Cooling	10%	0%	5%	75%	$0.20	14	2.60
Cooling - Economizer Installation	Cooling	6%	0%	29%	34%	$0.15	15	1.92
Heat Pump - Maintenance	Combined Heating/Cooling	7%	7%	2%	95%	$0.03	4	7.76
Insulation - Ducting	Space Heating	5%	5%	12%	50%	$0.41	20	0.95
Insulation - Ducting	Cooling	3%	0%	12%	50%	$0.41	20	0.95
Energy Management System	Cooling	5%	0%	11%	90%	$0.35	14	0.88
Energy Management System	Space Heating	2%	1%	11%	90%	$0.35	14	0.88
Energy Management System	Interior Lighting	2%	1%	11%	90%	$0.35	14	0.88
Fans - Energy Efficient Motors	Ventilation	5%	5%	2%	90%	$0.14	10	2.81
Fans - Variable Speed Control	Ventilation	15%	5%	3%	90%	$0.34	10	2.97
Commissioning - HVAC	Cooling	5%	0%	60%	75%	$0.70	25	0.92
Commissioning - HVAC	Space Heating	5%	4%	60%	75%	$0.70	25	0.92
Commissioning - HVAC	Ventilation	5%	4%	60%	75%	$0.70	25	0.92
Pumps - Variable Speed Control	Machine Drive	5%	4%	0%	34%	$0.44	10	0.31
Thermostat - Clock/Programmable	Cooling	5%	0%	59%	70%	$0.13	11	2.02
Thermostat - Clock/Programmable	Space Heating	5%	1%	59%	70%	$0.13	11	2.02
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	84%	90%	$0.65	8	0.15
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	10%	40%	$0.08	8	0.42
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	38%	$0.20	11	1.76
LED Exit Lighting	Interior Lighting	2%	2%	85%	86%	$0.00	10	3.72
Commissioning - Lighting	Interior Lighting	5%	4%	60%	75%	$0.10	25	1.41
Commissioning - Lighting	Exterior Lighting	5%	4%	60%	75%	$0.10	25	1.41
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	15%	45%	$0.20	8	0.50
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.06
Interior Screw-in - Task Lighting	Interior Lighting	7%	4%	10%	75%	$0.24	5	0.03
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	2%	56%	$0.20	8	0.25
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	0.41
Advanced New Construction Designs	Cooling	40%	0%	5%	75%	$2.00	35	2.67
Advanced New Construction Designs	Space Heating	40%	30%	5%	75%	$2.00	35	2.67
Advanced New Construction Designs	Interior Lighting	25%	19%	5%	75%	$2.00	35	2.67
Custom Measures	Cooling	8%	0%	10%	45%	$1.60	15	1.28
Custom Measures	Space Heating	8%	6%	10%	45%	$1.60	15	1.28
Custom Measures	Interior Lighting	8%	6%	10%	45%	$1.60	15	1.28
Custom Measures	Machine Drive	8%	6%	10%	45%	$1.60	15	1.28
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$4.00	15	2.51

Note: Costs are per sq. ft.

2011 Electric Integrated Resource Plan

Appendix D – Avista Electric Conservation Potential Assessment Study

AVISTA ELECTRIC CONSERVATION POTENTIAL ASSESSMENT STUDY

Final Report — Electricity Potentials

August 19, 2011

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EXECUTIVE SUMMARY

Avista Corporation (Avista) engaged Global Energy Partners (Global) to conduct a Conservation Potential Assessment (CPA) Study. The CPA is a 20-year potentials study for energy efficiency (EE) and demand response (DR) to provide data on demand-side resources for developing Avista's 2011 Integrated Resource Plan (IRP), and in accordance with Washington I-937. The study used 2009, the first year for which complete billing data was available, as the baseline year and then developed potential estimates for the period 2012–2032. This report provides results of the electricity energy efficiency potential study only, and subsequent documents will address natural gas and DR potential.

Study Objectives

The study objectives included:

- Conduct a conservation potential study for electricity for Washington and Idaho, and natural gas for Washington, Idaho, and Oregon. The study will account for:
  - Impacts of existing Avista conservation programs
  - Avista's load forecasts and load shapes
  - Impacts of codes and standards
  - Technology developments and innovation
  - The economy and energy prices
  - Naturally occurring energy savings
- Assess and analyze cost-effective EE and DR potentials in accordance with the Northwest Power and Conservation Council's (NWPPC) 6th Power Plan and Washington I-937 requirements.
- Obtain supply curves showing the incremental costs associated with achieving higher levels of EE and stacking EE resources by cost of conserved energy.
- Analyze various market penetration rates associated with technical, economic, achievable, and naturally occurring potential estimates.

Study Approach

To execute this project, Global took the following steps, which are also shown in Figure ES-1.

1. Performed a market assessment to describe base year energy consumption for the residential and C&I sectors. This included using utility data and secondary data to understand customers in Avista's service territory and how these customers currently use electricity. Based on the market assessment, we developed energy market profiles for the study's base year, 2009.

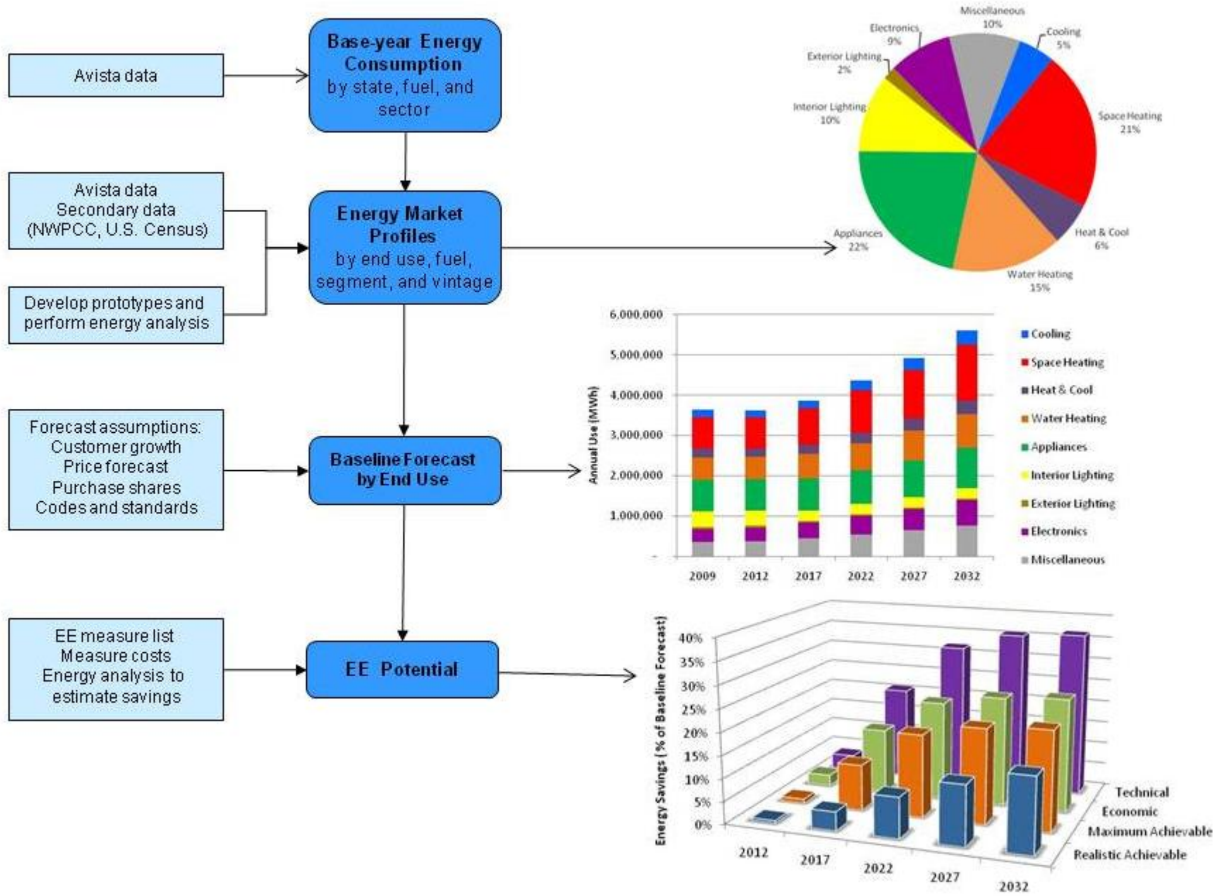
2. Developed a baseline energy forecast by sector and end use for the twenty-year study period.

3. Identified and analyzed energy-efficiency measures appropriate for the Avista service area.

4. Estimated four levels of energy-efficiency potential, *technical, economic, maximum achievable,* and *realistic achievable*.

The steps are described in further detail in Chapter 2.

Figure ES-1 Analysis Approach Overview



The study segmented Avista customers by state and rate class (Residential, Commercial & Industrial (C&I) General Service, C&I Large General Service, Extra Large Commercial, and Extra Large Industrial). In addition, the residential class was segmented by housing type and income (single family, multi-family, mobile home, and low income). The low-income threshold for purposes of this study was defined as 200% of the Federal poverty level. For the pumping rate classes, representing 2% of load, the Northwest Power and Conservation Council (NWPCC) Sixth Plan calculator was used to determine future EE potential. Within each segment, energy use was characterized by end-use (e.g., space heating, cooling, lighting, water heat, motors, etc.) and by technology (e.g., heat pump, resistance heating, furnace for space heating). This market characterization is detailed in Chapter 3.

The baseline forecast is the "business as usual" metric, without new utility conservation programs, against which energy savings from energy efficiency measures are compared. The baseline forecast includes the projected impacts of known codes and standards, as of 2010 when the study was conducted. These include the Energy Independence and Security Act (EISA), which mandates higher efficacies for lighting technologies starting in 2012, and a series of recent appliance standards agreed upon in 2010. These recent codes and standards have direct bearing on the amount of utility program potential over and above the effects of codes and standards and naturally occurring conservation. This process incorporates the changes in market conditions such as customer and market growth, income growth, Avista's retail rates forecast, trends in end-use and technology saturations, equipment purchase decisions, consumer price elasticity, and income and persons per household. The baseline forecast enables understanding customer potential estimates in the context of total energy use in the future.

For each customer sector, a robust list of electrical energy efficiency measures was compiled, drawing upon the Sixth Power Plan database, the Regional Technical Forum (RTF), and other measures considered applicable to Avista. This list of energy efficiency equipment and measures included 2,808 equipment options and 1,524 measure options and represented a wide variety of major types of end-use equipment, as well as devices and actions to reduce energy consumption. Considered against current avoided costs, many of these measures do not pass the economic screens, but may ultimately be part of Avista's energy efficiency program portfolio during this 20-year planning horizon. Measure cost, savings, estimated useful life, and other performance factors were characterized for the list of measures. Cost-effectiveness screening was performed, using the total resource cost (TRC) test, for each measure and each year of the study to develop economic potential. The measure analysis is discussed in Chapter 5.

Market Characterization and Baseline Forecast

During 2009, Avista served 354,615 residential, commercial, industrial, and pumping customers with a combined electricity use of approximately 8,862 GWh.

Residential Sector

The total number of 2009 residential customers was 200,134 in Washington and 99,579 in Idaho. Table ES-1 shows their distribution by housing type and income level. The limited income category, which is composed of single-family, multi-family, and mobile homes, represents households with income below $35,000 annually.

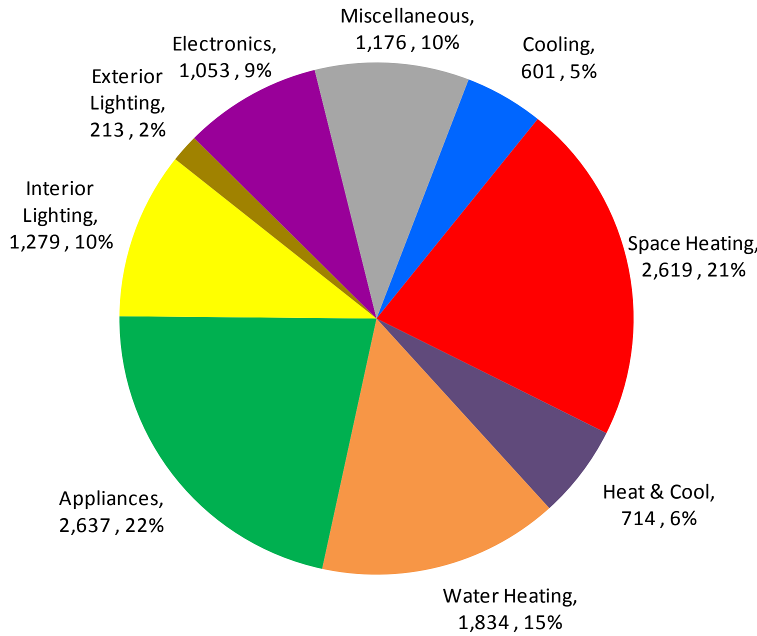
Table ES-1 Residential Electricity Usage and Intensity by Segment and State, 2009

Washington Segment	Intensity (kWh/Household)	Number of Customers	% of Customers	2009 Electricity Sales (MWh)	% of Sales
Single Family	14,547	109,134	54%	1,587,572	65%
Multi-Family	8,728	18,219	9%	159,019	6%
Mobile Home	13,092	5,248	3%	68,708	3%
Limited Income	9,424	67,533	34%	636,407	26%
Total	**12,250**	**200,134**	**100%**	**2,451,707**	**100%**

Idaho Segment	Intensity (kWh/Household)	Number of Customers	% of Customers	2009 Electricity Sales (MWh)	% of Sales
Single Family	13,703	59,205	59%	811,302	69%
Multi-Family	8,213	5,237	5%	43,013	4%
Mobile Home	12,320	4,774	5%	58,815	5%
Limited Income	8,868	30,363	31%	269,249	23%
Total	**11,874**	**99,580**	**100%**	**1,182,379**	**100%**

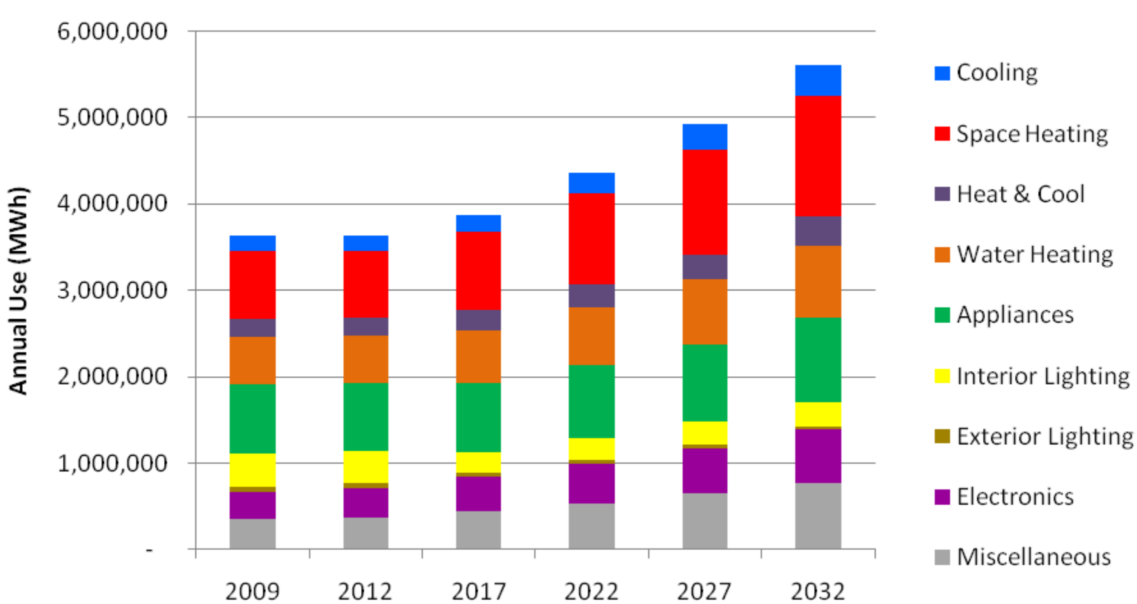
For each residential segment, a snapshot of electricity use by end use and technology was developed. Figure ES-2 presents the end-use breakout by household for the residential sector as a whole. The appliance end use accounts for the largest share of the usage, closely followed by space heating, with water heating the third largest end use. The miscellaneous end use includes such devices as furnace fans, pool pumps, and other "plug" loads (hair dryers, power tools, coffee makers, etc.). Interior and exterior lighting combined account for 12% of electricity use in 2009. The electronics end use, which includes personal computers, televisions, home audio, video game consoles, etc., also contributes significantly to household electricity usage. Cooling and combined heating and cooling through heat pumps make up the remainder.

Figure ES-2 Residential Electricity Use by End Use per Household, 2009 (kWh and %)



The residential baseline forecast incorporates the effects of future customer growth, trends in appliance ownership, building codes, federal appliance standards and customer usage response to changes in electricity prices and household income. As such, it includes naturally-occurring energy efficiency. Overall, residential use in both states and for all segments increases from 3,634,054 MWh in 2009 to 5,600,870 MWh in 2032, an average annual growth rate of 1.9%. This reflects projected growth in the number of households, home size, and income levels, as well as relatively low electricity prices. Figure ES-3 shows the residential baseline forecast by end use.

Figure ES-3 Residential Baseline Forecast by End Use



Commercial & Industrial Sector

Table ES-2 and Table ES-3 present the segmentation of C&I customers in Washington and Idaho respectively. Although the General Service 011 and Large General Service 021 rate classes include a small percentage of industrial customers, we treated them as primarily commercial building types. For the General Service segment, we assumed facilities were small to medium buildings, dominated by retail facilities. For the Large General Service segment, we assumed the typical facility was an office building.

Table ES-2 Commercial Sector Market Characterization Results, Washington 2009

Avista Rate Schedule		LoadMAP Segment and Typical Building	Electricity sales (MWh)	Intensity (kWh/sq.ft.)
General Service	011, 012	Small and Medium Commercial — Retail	415,935	17.5
Large General Service	021, 022	Large Commercial — Office	1,556,929	16.7
Extra Large General Service Commercial	025C	Extra Large Commercial — University	265,686	13.9
Extra Large General Service Industrial	025I	Extra Large Industrial	613,615	40.0
Total			**2,852,165**	

Table ES-3 Commercial Sector Market Characterization Results, Idaho 2009

Avista Rate Schedule		LoadMAP Segment and Typical Building	Electricity sales (MWh)	Intensity (kWh/sq.ft.)
General Service	011, 012	Small and Medium Commercial — Retail	322,570	17.5
Large General Service	021, 022	Large Commercial — Office	699,953	16.7
Extra Large General Service Commercial	025C	Extra Large Commercial — University	70,361	13.9
Extra Large General Service Industrial	025I, 025P	Extra Large Industrial	1,087,974	40.0
Total			**2,180,858**	

Figure ES-4 shows the breakdown of annual electricity usage by end use for the C&I sector as a whole. Lighting is the largest single end use in the sector, accounting for one fifth of total usage.

Figure ES-4 Commercial and Industrial Electricity Consumption by End Use, 2009

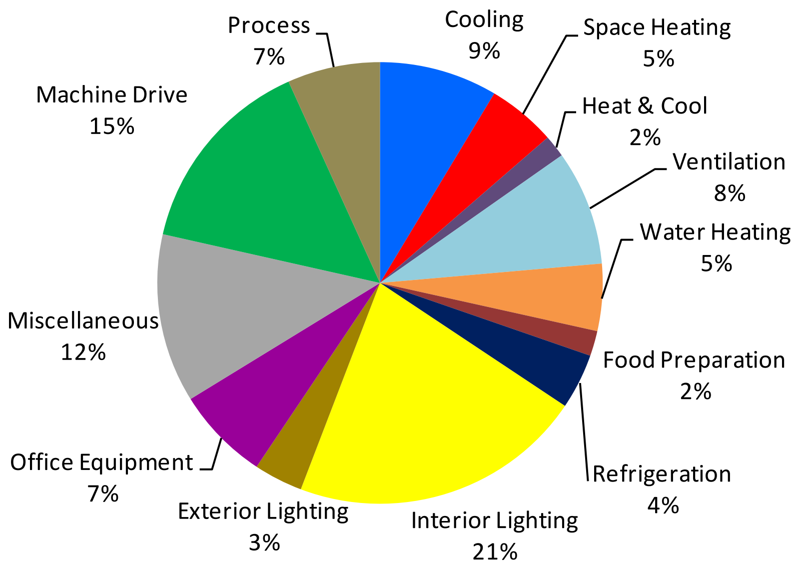
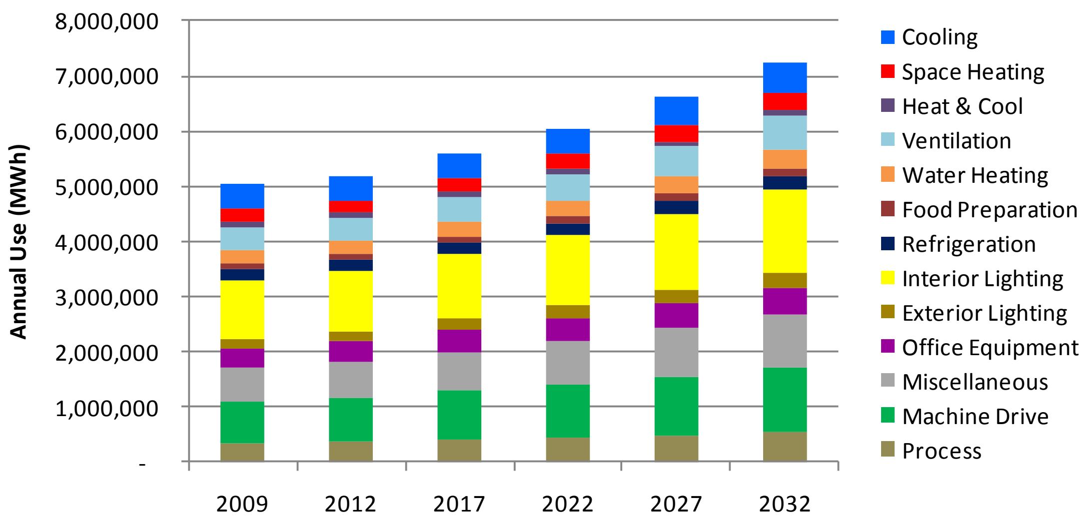


Figure ES-5 presents the baseline forecast at the end-use level for the C&I sector as a whole. Overall, C&I annual energy use increases from 5,033,023 MWh in 2009 to 7,239,694 MWh in 2032, a 43.8% increase. This reflects growth in floor space across all sectors. Interior screw-in lighting increases over the forecast period, but at a slower rate than other technologies as a result of the EISA lighting standard.

Figure ES-5 C&I Baseline Electricity Forecast by End Use



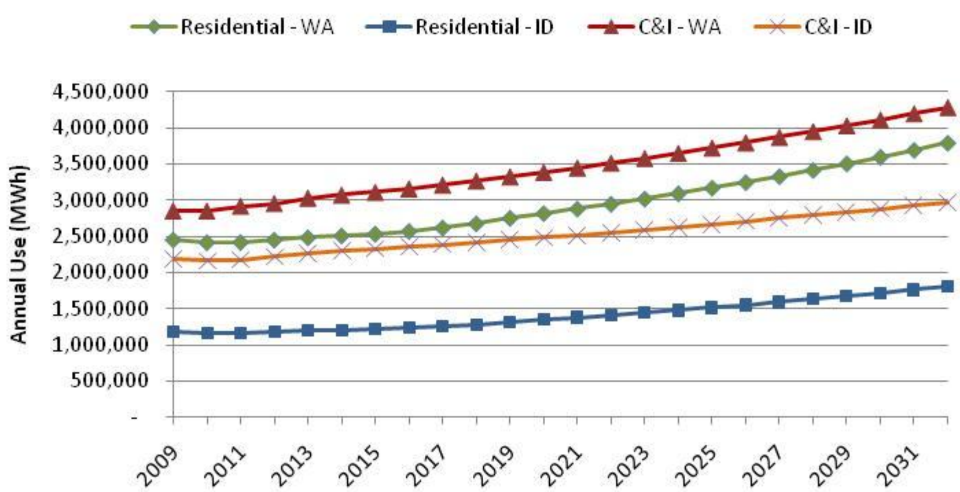
System-wide Baseline Forecast Summary

Table ES-4 and Figure ES-6 provide an overall summary of the baseline forecast by sector and for the Avista system as a whole. Overall, the forecast for the next 20 years shows substantial growth, reflecting projected increases in customers and income. This forecast is the metric against which the energy-efficiency savings potential is compared.

Table ES-4 Baseline Forecast Summary by Sector and State

End Use	2009	2012	2022	2032	% Change ('09–'32)	Avg. Growth Rate ('09–'32)
Res. WA	2,451,707	2,448,104	2,947,427	3,792,486	54.7%	1.9%
Res. ID	1,182,379	1,178,591	1,408,812	1,808,300	52.9%	1.8%
C&I WA	2,852,165	2,955,156	3,509,816	4,280,649	50.1%	1.8%
C&I ID	2,180,858	2,217,188	2,551,291	2,970,324	36.2%	1.3%
Total	**8,667,109**	**8,799,039**	**10,417,347**	**12,851,760**	**48.3%**	**1.7%**

Figure ES-6 Baseline Forecast Summary by Sector and State



The baseline forecast, prior to the consideration of potentials, projects overall growth of 48% in electric consumption. This compounded average annual growth rate of 1.7% during this 20 year period is consistent with Avista's current and previous Integrated Resource Plans. Chapter 4 provides details of the baseline forecast.

Definitions of Potential

In this study, we estimated four types of potential: *technical; economic;* and achievable potential, which is further divided into *maximum achievable,* and *realistic achievable*. Technical and economic potential are both theoretical limits to efficiency savings. Achievable potential embodies a set of assumptions about the decisions consumers make regarding the efficiency of the equipment they purchase, the maintenance activities they undertake, the controls they use for energy-consuming equipment, and the elements of building construction.

Technical potential is defined as the theoretical upper limit of energy efficiency potential. It assumes that customers adopt all feasible measures regardless of their cost. At the time of equipment failure, customers replace their equipment with the most efficient option available. In new construction, customers and developers also choose the most efficient equipment option. Examples of measures that make up technical potential in the residential sector include:

- Ductless mini-split air conditioners with variable refrigerant flow
- Ground source (or geothermal) heat pumps
- LED lighting for general service and linear applications

Technical potential also assumes the adoption of every available other measure, where applicable. For example, it includes installation of high-efficiency windows in all new construction opportunities and air conditioner maintenance in all existing buildings with central and room air conditioning.

Economic potential represents the adoption of all ***cost-effective*** energy efficiency measures. As described earlier, LoadMAP performs an economic screen to determine which measures are economically viable. LoadMAP incorporates the result of the screen into the purchase shares to reflect the most efficient measure that passes the screen. For our analysis, we apply the total resource cost (TRC) test, which compares lifetime energy and capacity benefits to the incremental cost, including the administrative costs associated with any energy-efficiency program. The benefits include non-energy benefits.

Achievable potential refines the economic potential by taking into account penetration rates of efficient technologies, expected program participation, and customer preferences and likely behavior. Two types of achievable potential were evaluated for this study:

- ***Maximum achievable potential (MAP)*** establishes an upper boundary of potential savings a utility could achieve through its energy efficiency programs. MAP presumes incentives that are sufficient to ensure customer adoption. It also considers a maximum participation rate by customers for the various energy efficiency programs that are designed to deliver the various measures. For this study, we developed market acceptance rate (MAR) factors, based on the ramp rate curves used in the Sixth Power Plan.1 These MAR factors were then applied to this study's estimates of economic potential to estimate MAP.
- ***Realistic achievable potential (RAP)*** represents a lower boundary forecast of potentials resulting from likely customer behavior and penetration rates of efficient technologies. It uses a set of program implementation factors (PIFs) to take into account existing barriers that are likely to limit the amount of savings that might be achieved through energy efficiency programs. The RAP also takes into account recent utility experience and reported savings from past and present programs.

[1] The Sixth Power Plan Conservation Supply Curve workbooks are available at http://www.nwcouncil.org/energy/powerplan/6/supplycurves/default.htm, with separate workbooks for specific sectors and end uses.

Potential Savings from Electric Energy Efficiency

Maximum achievable potential across all sectors is 88,760 MWh (10.1 aMW) in 2012 and increases to a cumulative value of 2,905,702 MWh (331.7 aMW) by 2032. These savings represents 1.0% of the baseline forecast in 2012 and 22.6% in 2032. Realistic achievable potential in 2012 is 50,261 MWh (5.7 aMW) and reaches a cumulative value of 2,155,133 MWh (246.0 aMW) by 2032, for savings that are 0.6% and 16.8% of the baseline in 2012 and 2032 respectively. Between 2012 and 2032, the baseline forecast shows overall electricity consumption growth of 46%, but the realistic achievable potential forecast reduces growth by half to 23%. Technical potential by 2032 is 37.8% of the baseline and economic potential savings are 26.4% of the baseline, or roughly 70% of technical potential savings. MAP and RAP savings in 2012 are 86% and 64% respectively of the economic potential savings.

Figure ES-7 displays the energy use forecast for the four potential levels versus the baseline forecast. Figure ES-8 summarizes the energy-efficiency savings for the four potential levels relative to the baseline forecast for selected years. Table ES-5 presents the energy consumption and peak demand for the potential levels across sectors.

Figure ES-7 Energy Efficiency Potential Forecasts, All Sectors

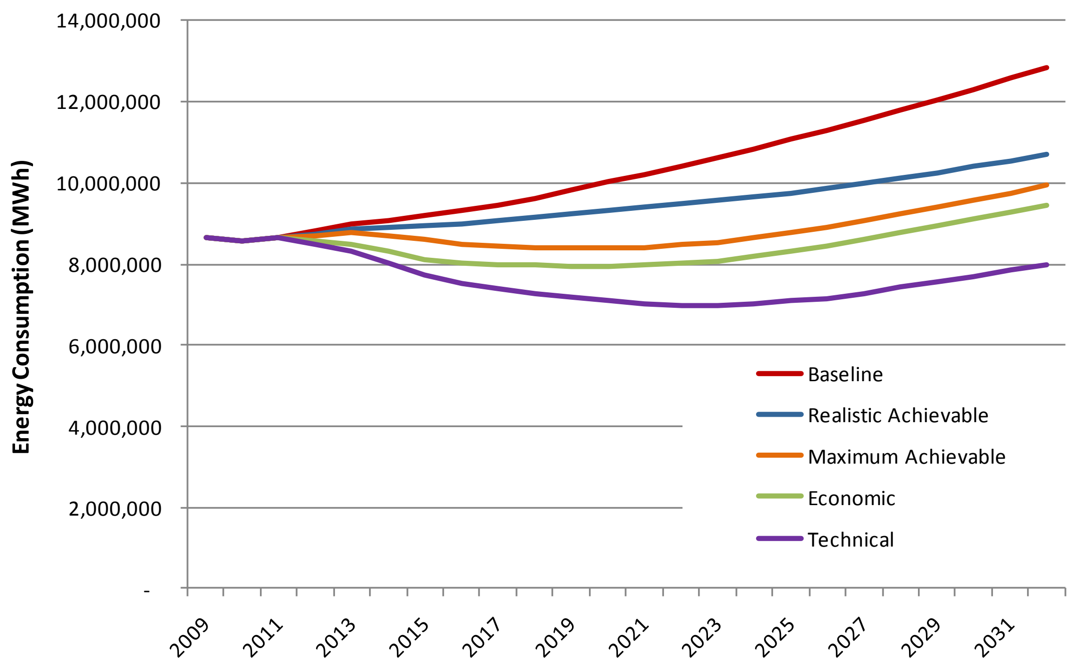


Figure ES-8 Summary of Energy Efficiency Potential Savings, All Sectors

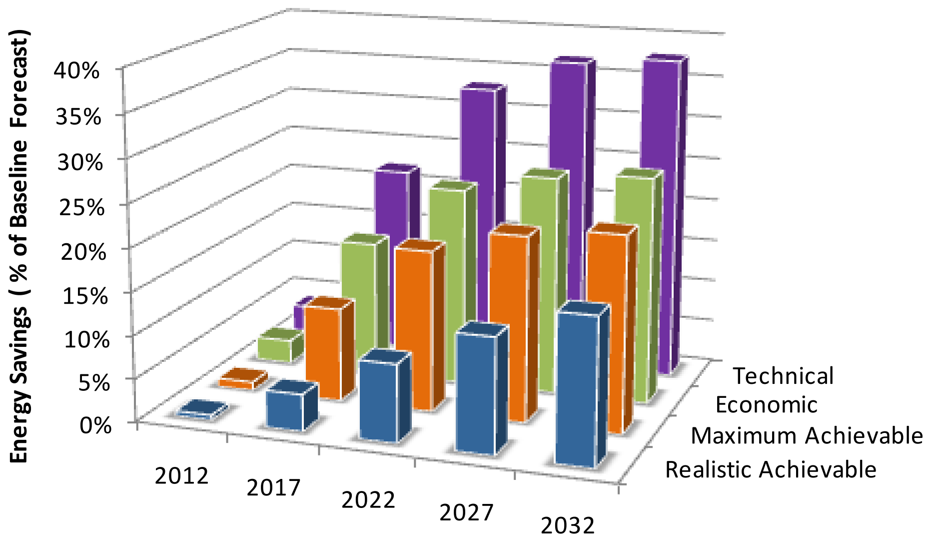


Table ES-5 Summary of Energy Efficiency Potential, All Sectors

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	8,799,039	9,463,880	10,417,347	11,536,869	12,851,760
Baseline Peak Demand (MW)	1,780	1,880	2,080	2,306	2,566
Cumulative Energy Savings (MWh)					
Realistic Achievable	50,261	405,985	945,183	1,536,357	2,155,133
Maximum Achievable	88,760	1,035,470	1,952,473	2,476,694	2,905,702
Economic	244,292	1,493,608	2,411,399	2,937,775	3,387,203
Technical	329,513	2,087,061	3,435,475	4,250,217	4,852,362
Cumulative Energy Savings (% of Baseline)					
Realistic Achievable	0.6%	4.3%	9.1%	13.3%	16.8%
Maximum Achievable	1.0%	10.9%	18.7%	21.5%	22.6%
Economic	2.8%	15.8%	23.1%	25.5%	26.4%
Technical	3.7%	22.1%	33.0%	36.8%	37.8%
Peak Savings (MW)					
Realistic Achievable	14	84	183	306	431
Maximum Achievable	22	207	386	492	566
Economic	60	302	479	580	659
Technical	78	422	669	826	943
Peak Savings (% of Baseline)					
Realistic Achievable	0.8%	4.5%	8.8%	13.3%	16.8%
Maximum Achievable	1.2%	11.0%	18.6%	21.3%	22.1%
Economic	3.4%	16.0%	23.0%	25.2%	25.7%
Technical	4.4%	22.4%	32.2%	35.8%	36.8%

Table ES-6 and Figure ES-9 summarize cumulative realistic achievable potential by sector. Initially, the residential sector accounts for about 52% of the savings, but by the end of the study, the C&I sector becomes the source of 58% of the savings.

Table ES-6 Realistic Achievable Cumulative Energy-efficiency Potential by Sector, MWh

Segment	2012	2017	2022	2027	2032
Residential, WA	17,413	94,529	238,739	431,973	637,029
Residential, ID	8,692	43,922	97,705	172,179	260,003
C&I, WA	15,733	173,433	378,252	575,328	774,619
C&I, ID	8,423	94,102	230,487	356,878	483,482
Total	**50,261**	**405,985**	**945,183**	**1,536,357**	**2,155,133**

Figure ES-9 Realistic Achievable Cumulative Potential by Sector

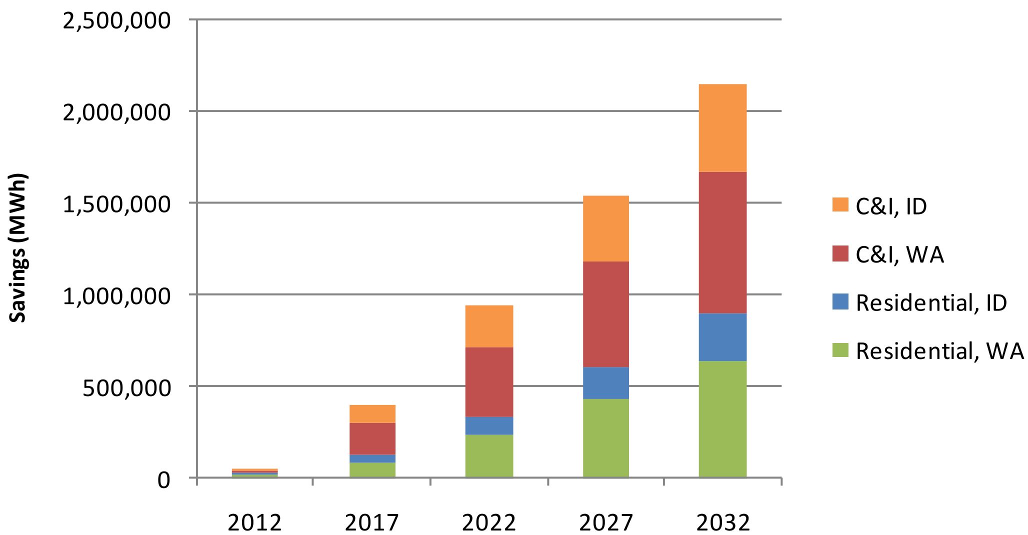


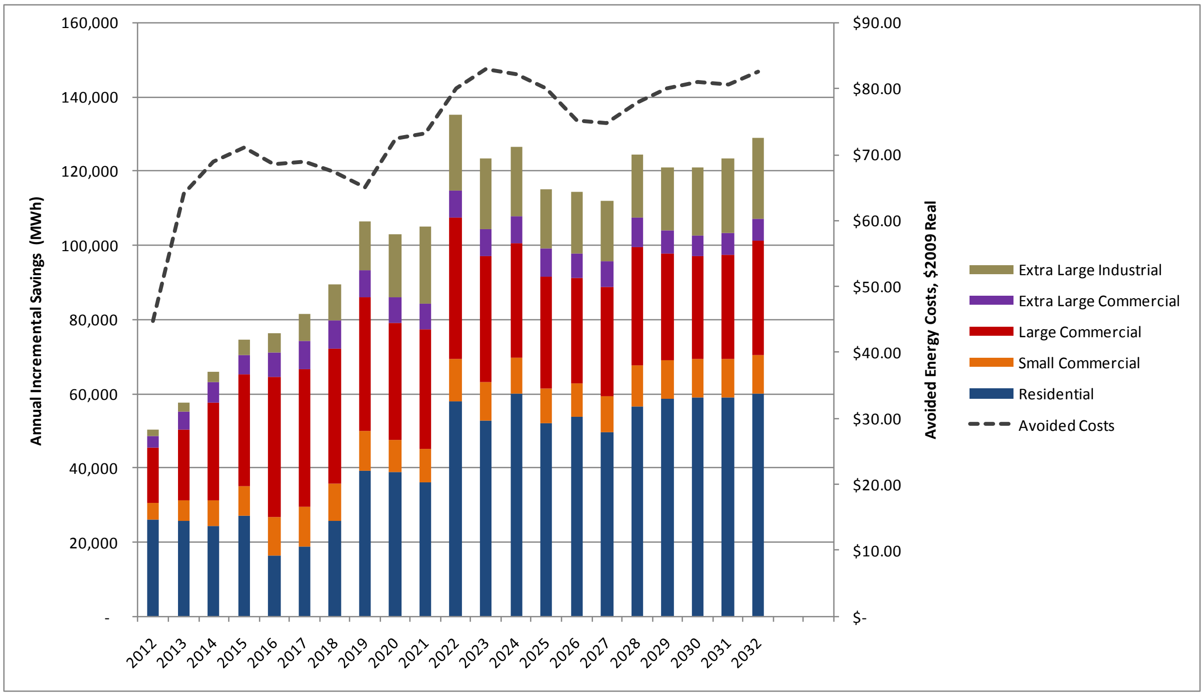
Table ES-7 shows the incremental annual realistic achievable potential by sector for 2012 through 2015. During this period, lighting and appliance standards slow the rate of growth in the residential baseline energy consumption, thus reducing the amount of incremental annual potential savings from residential conservation programs. On the other hand, C&I potential continues to grow. Complete annual incremental savings for Washington and Idaho appear in Appendices A and B respectively.

Table ES-7 Incremental Annual Realistic Achievable Energy-efficiency Potential by Sector, MWh

Segment	2012	2013	2014	2015
Residential, WA	17,413	17,161	16,488	18,514
Residential, ID	8,692	8,451	7,943	8,569
C&I, WA	15,733	21,165	26,869	30,393
C&I, ID	8,423	10,734	14,543	16,956
Total	**50,261**	**57,511**	**65,843**	**74,432**

Figure ES-10 illustrates how the annual incremental realistic achievable potential throughout the study tracks the avoided energy costs, with annual potential generally increasing or decreasing along with avoided costs. Note however that other factors also influence potential, particularly the rates at which programs can ramp up over time, which is particularly relevant to how potential changes from year to year in the early years of the study.

Figure ES-10 Incremental Annual Realistic Achievable Energy-efficiency (MWh) vs. Avoided Energy Cost



Note: Avoided costs are 2009 real dollars and include energy costs, risk, and the 10% Power Act premium.

Residential Sector Potential

Realistic achievable potential savings for the residential sector in both states is 26,105 MWh in 2012, or 0.7% of the sector's baseline forecast. It reaches 897,032 MWh, or 16.0% of the baseline forecast by 2032. Technical and economic potential savings are 37.7% and 24.5% respectively. Table ES-8 presents estimates for energy and peak demand under the four types of potential.

Table ES-8 Energy Efficiency Potential, Residential Sector

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	3,626,696	3,871,294	4,356,240	4,918,847	5,600,787
Baseline Peak Demand (MW)	991	1,026	1,150	1,288	1,449
Cumulative Energy Savings (MWh)					
Realistic Achievable	26,105	138,450	336,444	604,152	897,032
Maximum Achievable	36,300	429,065	798,829	1,024,671	1,192,794
Economic	104,111	583,427	967,788	1,188,497	1,373,869
Technical	153,100	918,965	1,468,041	1,825,587	2,112,855
Cumulative Energy Savings (% of Baseline)					
Realistic Achievable	0.7%	3.6%	7.7%	12.3%	16.0%
Maximum Achievable	1.0%	11.1%	18.3%	20.8%	21.3%
Economic	2.9%	15.1%	22.2%	24.2%	24.5%
Technical	4.2%	23.7%	33.7%	37.1%	37.7%
Peak Savings (MW)					
Realistic Achievable	10	44	100	179	262
Maximum Achievable	14	120	232	301	343
Economic	38	171	286	349	396
Technical	51	256	407	503	579
Peak Savings (% of Baseline)					
Realistic Achievable	1.1%	4.3%	8.7%	13.9%	18.1%
Maximum Achievable	1.4%	11.7%	20.2%	23.3%	23.7%
Economic	3.8%	16.7%	24.9%	27.1%	27.3%
Technical	5.1%	24.9%	35.4%	39.0%	40.0%

In terms of how residential potential is divided among the various end uses, we note the following:

- ***Water Heating*** offers the highest cumulative technical potential over the 20-year period, which reflects the high potential for conversion to natural gas in homes where gas is available (see discussion below) and use of heat pump water heaters where gas is not available, as well as a wide range of other water heating measures. Conversion to natural gas passes the TRC test throughout the study period for most Washington housing types and for single family homes in Idaho. In contrast, based on the study's assumptions of equipment cost and avoided cost, heat pump water heaters are cost-effective in new single family homes by 2014, but do not become cost-effective for existing homes until 2024 in Idaho and 2028 in Washington. Water heating also has the highest cumulative realistic achievable potential.

- ***Space Heating*** offers the second-highest cumulative technical potential over the study and its economic potential is slightly higher than water heating, again due to the potential for conversion to natural gas (see discussion below), but also due to shell measures, controls, and advanced new construction designs. Based on realistic achievable savings, space heating also ranks second.
- ***Interior lighting*** offers the fourth-largest technical potential savings, but the third-largest economic and realistic achievable potential. The lighting standard begins its phase-in starting in 2012, which coincides with the availability in the market place of advanced incandescent lamps that meet the minimum efficacy standard. The baseline forecast assumes that people will install both advanced incandescent and CFLs in screw-in lighting applications. For technical potential, LED lamps are the most efficient option, starting in 2012. However, LED lamps do not pass the economic screen until 2022, when they begin to become cost-effective for pin-based fixtures. Nonetheless, there is significant economic and realistic achievable lighting potential due to conversion from advanced incandescents to CFLs.
- ***Appliances*** rank sixth based on technical potential, but fourth in terms of realistic achievable potential. This reflects the cost-effectiveness of the highest-efficiency white-goods appliances for both new construction and for replacing failed units, as well as the market acceptance of high-efficiency appliances. Removal of second refrigerators and freezers also contributes to economic and realistic achievable potential within this end use.
- ***Cooling*** offers the third-highest technical potential, but is sixth based on realistic achievable potential. Initially technical potential is low but ramps up due to the assumption of increased saturation of air conditioning over time. Economic potential for cooling in 2031 is about 40% of technical potential because the higher SEER units do not pass the economic screen based on based on the study's assumptions of equipment cost and avoided cost.
- ***Home electronics*** also offer substantial savings opportunities. Technical potential reflects the purchase of ENERGY STAR units for all technologies, except PCs and laptops for which a super-efficient "climate saver" option is available in the marketplace. However, the climate saver options are not cost-effective during the forecast horizon, so economic potential reflects the purchase of ENERGY STAR units across all technologies in this end use.

Commercial and Industrial Sector Potential

Realistic achievable potential savings for the C&I sector in both states is 24,155 MWh in 2012, or 0.5% of the sector's baseline forecast. It reaches 1,258,101 MWh, or 17.4% of the baseline forecast by 2032. Technical and economic potential savings are 37.8% and 27.8% of the baseline forecast respectively. Table ES-9 presents estimates for the sector's energy and peak demand under the four types of potential.

In terms of how potential is divided among the various end uses, we note the following:

- ***Interior lighting*** offers the largest technical, economic, and achievable potential. The high technical potential of 892,840 MWh in 2032 is a result of LED lighting that is now commercially available in screw-in and linear lighting applications, as well as numerous fixture improvement and control options. However, LED lighting is not cost effective given the study's avoided cost assumptions, so economic potential reflects installation of CFL, T5, and Super T8 lamps throughout most of the commercial sector. Still, this results in realistic achievable potential of 598,564 MWh by 2032.
- ***Cooling*** has the third highest savings for technical potential at 302,301 MWh in 2032, and many of the cooling measures are cost effective, including installation of high-efficiency equipment, thermal shell measures, HVAC control strategies, and retrocommissioning. Because the market for cooling technologies is mature, these savings are relatively easy to capture, as reflected in the ramp rates for these measures. Thus realistic achievable potential for cooling, at 119,700 MWh, is the second highest among C&I end uses.

- ***Ventilation*** is second in terms of technical and economic potential due to conversion to variable air volume systems, high-efficiency and variable speed control fans, and retrocommissioning. Realistic achievable potential in 2032 of 117,020 MWh ranks this end use third, just behind cooling.
- ***Machine drive*** ranks fourth in realistic achievable potential at 101,018 MWh in 2032. Even though the National Electrical Manufacturer's Association (NEMA) standards make premium efficiency motors the baseline efficiency level, savings remain available from upgrading to still more efficient levels.
- ***Office equipment, exterior lighting, and industrial process improvements*** offer smaller but still significant realistic achievable potential by 2032 at 73,152 MWh, 68,467 MWh, and 60,759 MWh respectively.
- Savings from ***commercial refrigeration, food preparation, and water heating*** are relatively small across the C&I sector as a whole, though these end uses can offer significant savings in supermarkets, restaurants, hospitals, and other buildings where these end use constitute a larger portion of overall energy use.

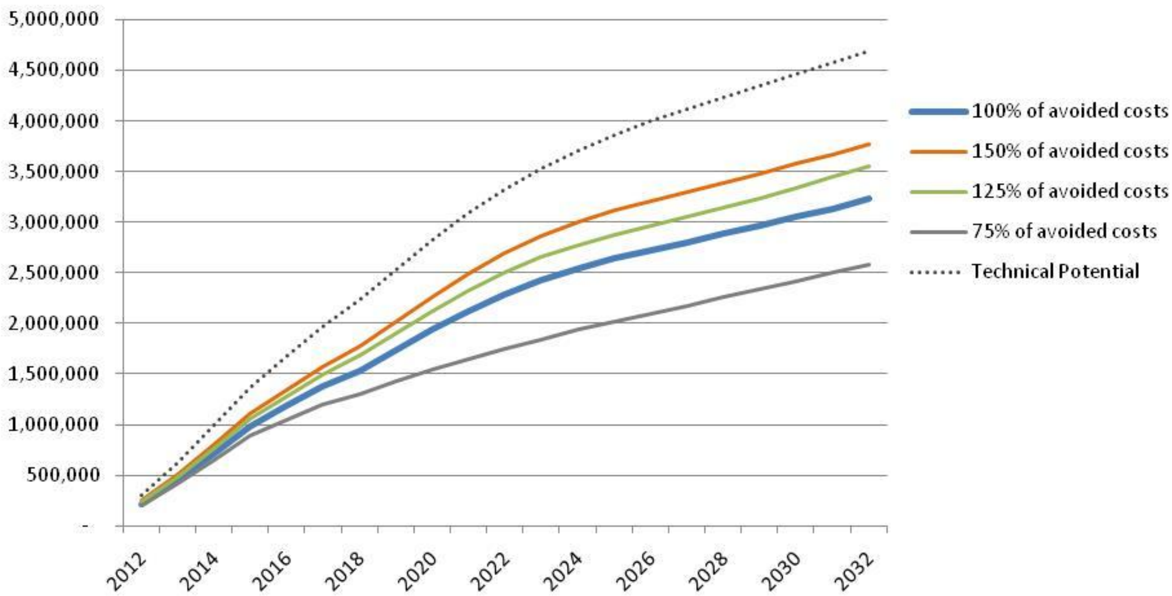
Table ES-9 Energy Efficiency Potential, Commercial and Industrial Sector

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	5,172,344	5,592,586	6,061,107	6,618,022	7,250,973
Cumulative Energy Savings (MWh)					
Realistic Achievable	24,155	267,535	608,739	932,205	1,258,101
Maximum Achievable	52,460	606,406	1,153,644	1,452,022	1,712,907
Economic	140,180	910,181	1,443,612	1,749,278	2,013,333
Technical	176,414	1,168,096	1,967,434	2,424,630	2,739,507
Cumulative Energy Savings (% of Baseline)					
Realistic Achievable	0.5%	4.8%	10.0%	14.1%	17.4%
Maximum Achievable	1.0%	10.8%	19.0%	21.9%	23.6%
Economic	2.7%	16.3%	23.8%	26.4%	27.8%
Technical	3.4%	20.9%	32.5%	36.6%	37.8%
Peak Savings (MW)					
Realistic Achievable	4	40	84	127	169
Maximum Achievable	8	88	154	191	223
Economic	22	130	193	231	263
Technical	27	166	262	324	364
Peak Savings (% of Baseline)					
Realistic Achievable	0.5%	4.7%	9.0%	12.4%	15.1%
Maximum Achievable	1.0%	10.3%	16.6%	18.8%	20.0%
Economic	2.7%	15.3%	20.8%	22.7%	23.6%
Technical	3.4%	19.4%	28.2%	31.8%	32.6%

Sensitivity of Potential to Avoided Costs

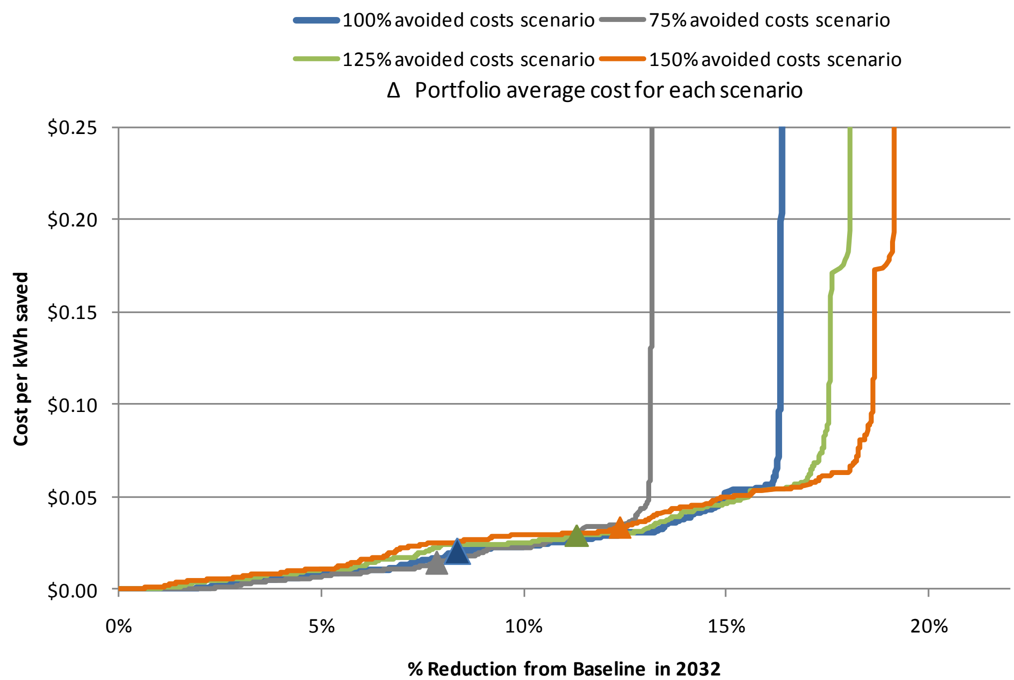
Global modeled several scenarios with varying levels of avoided costs in addition to the base case. The other scenarios included 150%, 125%, and 75% of the avoided costs used in the base case. Figure ES -11 shows how realistic achievable potential varies under the four scenarios. The base case realistic achievable potential is approximately 16.4% of the baseline forecast by 2032. With the 150% avoided cost case, realistic achievable potential increased to 19.2% of the baseline forecast, while the 125% avoided cost case and the 75% avoided cost case yielded realistic achievable potential equal to 18.1% and 13.2% of the baseline forecast respectively. While the changes are significant, the relationship between avoided cost and realistic achievable potential is not linear and increases in avoided costs do not provide equivalent percentage increases in realistic achievable potential. Technical potential imposes a limit on the amount of additional conservation and each incremental unit of conservation becomes increasingly expensive.

Figure ES -11 Energy Savings, Economic Potential Case by Avoided Costs Scenario (MWh)



The project developed a series of supply curves based on the four avoided cost scenarios, shown in Figure ES -12. Each supply curve is created by stacking measures and equipment over the 20-year planning horizon in ascending order of cost. As expected, this stacking of conservation resources produces a traditional upward-sloping supply curve. The 75% of avoided cost scenario provides roughly a 13% reduction in energy use compared with the baseline forecast in 2032, at a cost of $0.05/kWh or less. The other three scenarios track one another closely, providing just over 15% savings in 2032 at costs below $0.05/kWh.

Figure ES -12 Supply Curves for Evaluated EE Measures and Avoided Cost Scenarios



Sensitivity of Potential to Customer and Economic Growth

This conservation potential assessment shows that conservation offsets roughly 50% of growth in electrical energy use for the Avista system, whereas the Sixth Plan projects that conservation can offset 80% of growth. Of course, Avista's service territory differs from the region overall in many ways, including its climate. Another significant factor may be the CPA study's assumptions regarding customer and economic growth. To better understand how growth affects the study's results, the project team evaluated scenarios with lower customer and economic growth, as indicated in Table ES-10.

Table ES-10 Varying Growth Scenario Descriptions

	Reference Scenario	Low Growth Scenario 1	Low Growth Scenario 2
Home size	~ 1% per year growth	Capped at 110% of existing home size	Capped at 110% of existing home size
Per capita income growth	1.6% 2011–2015; 2.2% 2016–2020; 2.1% thereafter	1.6% after 2016	1.6% after 2016
Residential sector market growth	1.30% after 2015 (WA) 1.25% after 2015 (ID)	no change	1.0% after 2015 (WA & ID)
Commercial sector market growth, WA & ID	~ 2.0% (varies by segment)	no change	1.0% all segments

Table ES -11 shows that as economic and customer growth decreases, the ability of conservation to offset growth increases. In the reference scenario, energy efficiency offsets 52% of growth in consumption, while in the lower growth scenarios, EE offsets 54% and 76% of growth respectively. This is the case because with reduced new construction, load growth and achievable potential drop, but savings due to the retrofit of existing buildings constitute a greater proportion of load growth.

Table ES -11 Varying Growth Scenario Results

	Reference Scenario	Low Growth Scenario 1	Low Growth Scenario 2
Baseline forecast 2012 (MWh)	8,799,039	8,799,039	8,799,033
Baseline forecast 2032 (MWh)	12,851,760	12,523,843	11,178,008
Load growth 2012-2032 (MWh)	4,052,720	3,724,803	2,378,975
Realistic achievable potential forecast 2032 (MWh)	10,745,176	10,500,088	9,366,471
Realistic achievable potential savings 2032 (MWh)	2,106,584	2,023,754	1,811,538
Percentage of growth offset	52%	54%	76%

Note: Value of 2,106,548 MWh for 2032 realistic achievable potential was based on interim results and thus is different from the value shown elsewhere in this report.

Pumping Potential

As displayed in Table ES -12, pumping accounts represent 2.2% of Avista's total electricity sales and 0.8% of peak demand. Because pumping represents a relatively small percentage of Avista's total sales, the project team decided to use the NWPCC Sixth Plan calculator to estimate pumping energy efficiency potential.

Table ES -12 Pumping Rate Classes, Electricity Sales and Peak Demand 2009

Sector	Rate Schedule(s)	Number of meters (customers)	2009 Electricity sales (MWh)	Peak demand (MW)
Pumping, Washington	031, 032	2,361	135,999	10
Pumping, Idaho	031, 032	1,312	58,885	4
Pumping, Total		3,673	194,884	14
Percentage of System Total			**2.2%**	**0.8%**

The Sixth Plan Calculator estimates agricultural conservation targets through 2019, based on 2007 sales. We trended the data through 2022 to provide annual savings estimates for the ten-year period 2012–2022, with the results provided in Table ES -13 and Table ES -14.

Table ES -13 Sixth Plan Calculator Agriculture Incremental Annual Potential, Selected Years (MWh)

Segment	2012	2013	2014	2015
Pumping, Washington	1,567	1,484	1,402	1,835
Pumping, Idaho	690	654	618	809
Pumping, Total	**2,257**	**2,138**	**2,020**	**2,643**

Table ES -14 Sixth Plan Calculator Agriculture Cumulative Potential, Selected Years (MWh)

Measure	2012	2017	2022
Pumping, Washington	1,567	9,979	18,892
Pumping, Idaho	690	4,397	8,324
Pumping, Total	**2,257**	**14,375**	**27,217**

Report Organization

The body of the report is organized as follows:

- Chapter 1, Introduction
- Chapter 2, Study Approach for Energy Efficiency Analysis
- Chapter 3, Market Assessment and Market Profiles
- Chapter 4, Baseline Forecast
- Chapter 5, Energy Efficiency Measure Analysis
- Chapter 6, Energy Efficiency Potential Results
- Appendix A, Washington Results
- Appendix B, Idaho Results
- Appendix C, Residential Energy Efficiency Equipment and Measure Data
- Appendix D, Commercial Energy Efficiency Equipment and Measure Data
- Appendix E, Study References

Results of the demand response analysis and the natural gas potential assessment will be presented in separate forthcoming documents.

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CHAPTER | 1

INTRODUCTION

1.1 BACKGROUND

Avista Corporation (Avista) engaged Global Energy Partners (Global) to conduct a Conservation Potential Assessment (CPA) Study. The CPA is a 20-year potentials study for energy efficiency (EE) and demand response (DR) to provide data on demand-side resources for developing Avista's 2011 Integrated Resource Plan (IRP), and in accordance with Washington I-937. The study used 2009, the first year for which complete billing data was available, as the baseline year and then developed potential estimates for the period 2012-2032. Although the final report will address electricity and natural gas, this interim report provides results of the electricity potential study only.

1.2 OBJECTIVES

Key objectives for the study include:

- Conduct a conservation potential study for electricity for Washington and Idaho, and natural gas for Washington, Idaho, and Oregon. The study will account for:
  - Impacts of existing Avista conservation programs
  - Avista's load forecasts and load shapes
  - Impacts of codes and standards
  - Technology developments and innovation
  - The economy and energy prices
  - Naturally occurring energy savings
- Assess and analyze cost-effective EE and DR potentials in accordance with the Northwest Power and Conservation Council's (NWPPC) 6th Power Plan and Washington I-937 requirements.
- Obtain supply curves showing the incremental costs associated with achieving higher levels of EE and DR and stacking EE and DR resources by cost of conserved energy.
- Analyze various market penetration rates associated with technical, economic, achievable, and naturally occurring potential estimates.

1.3 REPORT ORGANIZATION

The remainder of this report presents the results of the electricity conservation potential assessment for Avista's Washington and Oregon service territory. In most cases, results for Avista's overall electric system are presented in the body of the report, and Washington- and Oregon-specific results are presented in Appendices A and B respectively. The report is organized as follows:

- Chapter 2, Study Approach for Energy Efficiency Analysis
- Chapter 3, Market Assessment and Market Profiles
- Chapter 4, Baseline Forecast
- Chapter 5, Energy Efficiency Measure Analysis
- Chapter 6, Energy Efficiency Potential Results
- Appendix A, Washington Results
- Appendix B, Idaho Results
- Appendix C, Residential Energy Efficiency Equipment and Measure Data
- Appendix D, Commercial Energy Efficiency Equipment and Measure Data
- Appendix E, Study References

Results of the demand response analysis and the natural gas potential assessment will be presented in separate forthcoming documents.

CHAPTER | 2

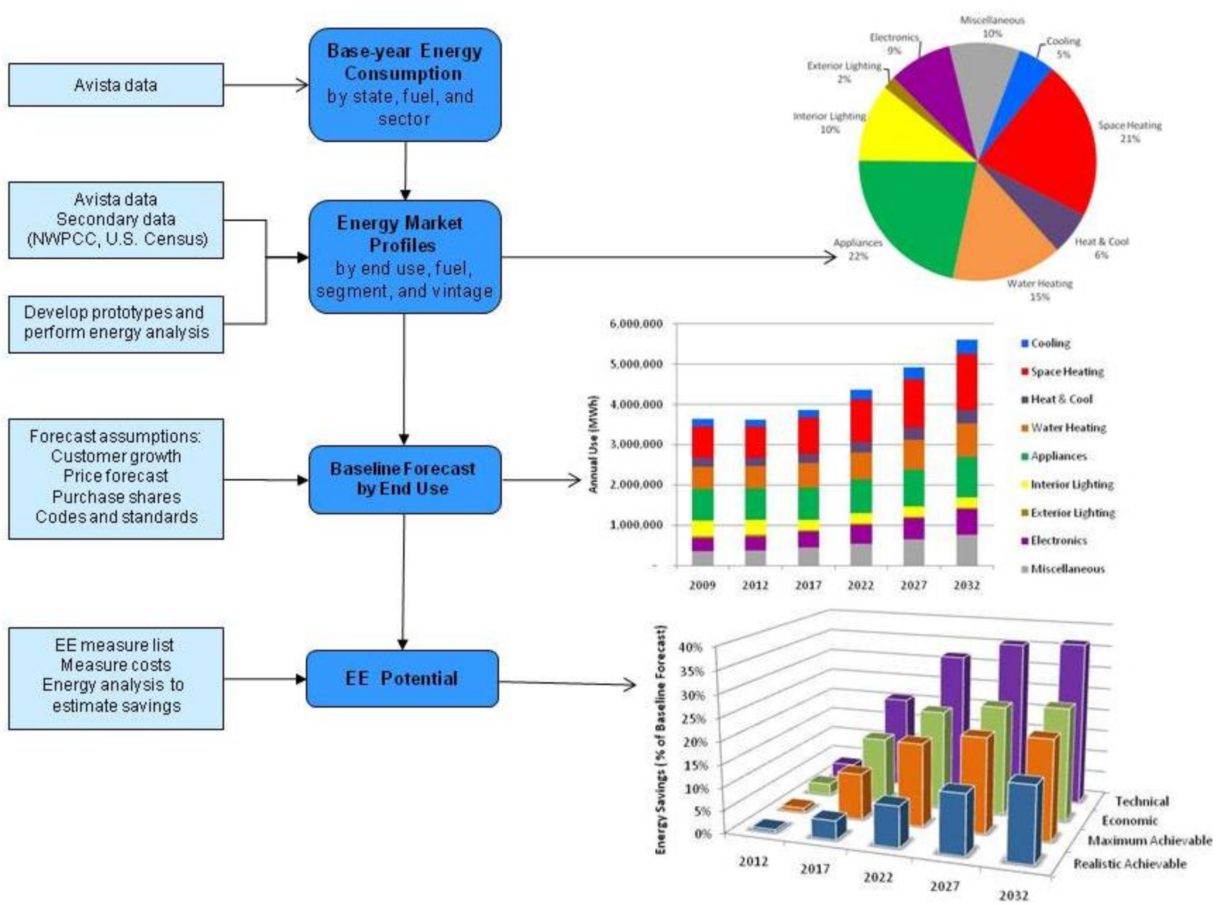
STUDY APPROACH FOR ENERGY EFFICIENCY ANALYSIS

To execute this project, Global took the following steps, which are also shown in Figure 2-1.

1. Performed a market assessment to describe base year energy consumption for the residential and C&I sectors. This included using utility data and secondary data to understand customers in Avista's service territory and how these customers currently use electricity. Based on the market assessment, we developed energy market profiles for the study's base year, 2009.
2. Developed a baseline energy forecast by sector and end use for the twenty-year study period.
3. Identified and analyzed energy-efficiency measures appropriate for the Avista service area.
4. Estimated four levels of energy-efficiency potential, *Technical, Economic, Maximum Achievable,* and *Realistic Achievable*.

The steps are described in further detail throughout the remainder of this section.

Figure 2-1 Analysis Approach Overview



2.1 MARKET ASSESSMENT AND MARKET PROFILES

It is absolutely critical to develop a good understanding of where Avista is today in terms of energy use and customer behavior before developing projections of potential EE savings. The purpose of the market assessment is to develop market profiles that describe current electricity use in terms of sector, customer segment, and end use. The base year for this study is 2009, the most recent year for which complete billing data was available at the start of the study.

We began the market assessment by defining the market segments (building types, end uses and other dimensions) that are relevant in the Avista service territory. The segmentation scheme employed for this project, as presented in Table 2-1, is based on Avista rate schedules. For the pumping rate classes, we determined to use the Northwest Power and Conservation Council (NWPCC) Sixth Plan calculator to determine future EE potential.

Table 2-1 Segmentation Framework for Electricity

Market Dimension	Segmentation Design	Dimension Examples
Dimension 1	Geographic Region	Washington, Idaho
Dimension 2	Sector / Rate Class	Residential — Rate Class 001 C&I General Service — Rate Class 011, 012 C&I Large General Service — Rate Classes 021, 022 Comm. Extra Large General Service — Rate Class 025 Ind. Extra Large General Service — Rate Classes 025, 025P Pumping — Rate Classes 030, 031, 032
Dimension 3	Building Type	Residential: single-family, multi-family, mobile home, limited income No further segmentation of C&I and pumping, except for XLarge General Service, which was divided into commercial and industrial segments
Dimension 4	Vintage	Existing and new construction (as appropriate for residential and commercial sectors)
Dimension 5	End Uses	Cooling, lighting, water heat, motors, etc. (as appropriate by sector)
Dimension 6	Appliances/End Uses and Technologies	Cooling, lighting, water heat, motors, etc. (as appropriate by sector); Technologies such as types of lamps, chillers, color TVs, etc.
Dimension 7	Equipment Efficiency Levels	Old, Standard (minimum standard), Maximum Efficiency

With the segmentation scheme defined, we set out to populate the market profiles. The first step was to identify the electricity sales in the base year for each segment using Avista's 2009 historical customer billing data by rate class. In order to further divide the residential sector, we relied upon regional demographic and economic data from secondary sources (see below).

Then, we developed the data for the remaining market profile elements, which include market size, annual electricity use, electric appliance and equipment saturations, technology shares, and end-use consumption estimates (unit energy consumption or UEC for residential customers and energy use index or EUI for C&I customers). We calibrated the elements of the market profile for each segment to match the segment and sector-level sales we developed in the previous step. We developed market profiles for the entire existing market, as well as new construction in each segment.

While this study did not involve any primary market research, a wealth of primary data is available for the Pacific Northwest region from NEEA and a recent customer saturation survey from Inland Power and Light, a neighboring utility. In addition, data were available from a residential survey conducted as part of Inland Power's December 2009 CPA. We used these sources together with other secondary data, including the Energy Information Agency's Residential Energy Consumption Survey (RECS), the Annual Energy Outlook (AEO), the California's Residential Appliance Saturation Survey (RASS), and the California Commercial End Use Survey (CEUS), to develop the market profiles.

In addition to information about annual electricity use, we also needed estimates of peak demand by segment and end use in order to calculate peak-demand savings from EE measures. We developed a set of peak factors, factors that represent the fraction of annual energy use that occurs during the peak hour, and apply them to annual electricity use to calculate peak demand by end use. Peak factors for this study were developed for each sector, customer segment and end use using Global's EnergyShape™ database and information from Avista regarding its load shapes and peak demand.[2]

Table 2-2 summarizes the data required for the market profiles. This information is required for each segment within each sector, as well as for new construction and existing dwellings/buildings. Additional details regarding sources appear in Appendix E.

Table 2-2 Data Needs for the Market Profiles

Model Inputs	Description	Key Sources
Base-year data		
Market size	Base-year residential dwellings and C&I floor space	Avista billing data, NEEA Reports
Appliance/equipment saturations	Fraction of dwellings with an appliance/technology; Percentage of C&I floor space with equipment/technology	NEAA reports, Inland Power & Light residential saturation survey, RECS, and other secondary data
UEC/EUI for each end-use technology	UEC: Annual electricity use for a technology in dwelling that have the technology; EUI: Annual electricity use per square foot for a technology in floor space that has the technology	NEAA reports, RASS, CEUS, engineering analysis, prototype simulations, engineering analysis
Appliance/equipment vintage distribution	Age distribution for each technology	NEEA reports, RASS, CEUS, secondary data (DEEM, EIA, EPRI, DEER, etc.)
Efficiency options for each technology	List of available efficiency options and annual energy use for each technology	Prototype simulations, engineering analysis, appliance/equipment standards, secondary data (DEEM, EIA, EPRI, DEER, etc.)
Peak factors	Share of technology energy use that occurs during the peak hour	Avista data; Global's EnergyShape database

The quality of data inputs is critical. To ensure the best results, we pursued the following course during the data-development process.

[2] The peak factors were used to compute peak demand savings only and they were not used to develop a stand-alone peak-demand forecast.

1. Used NEEA reports, the Inland Power & Light survey of its residential customers, and RECS to provide information about market size for customer segments, appliance and equipment saturations, appliance and equipment characteristics, UECs, building characteristics, customer behavior, operating characteristics, and energy-efficiency actions already taken.
2. Incorporated secondary data sources to supplement and corroborate the research in items 1 and 2 above.
3. Compared and cross-checked with data obtained as part of other northwest utility studies, the EPRI National Potential Study, and other regional sources.
4. Ensured calibration to control totals such as total usage values by segment, available through the billing data.
5. Worked with the Avista staff and the extended project team to vet the data against their knowledge and experience.

The market assessment, market segmentation, and resulting market profiles are presented in Chapter 3.

2.2 BASELINE FORECAST

The next step of the energy efficiency potential study was to develop the baseline forecast which is the metric against which savings from energy-efficiency measures are compared. The baseline case forecasts annual electricity use and peak demand by customer segment and end use under a "business as usual" (without new utility programs) scenario for the 20-year planning horizon starting in 2012. This process is crucial as it allows for projections to be determined in the absence of future conservation programs. This puts the changes in market conditions and customer potentials estimates in context of total energy use in the future and also allows us to project where the energy-efficiency savings will come from. The end-use forecast also includes the expected impacts of codes and standards, which affect what is possible through utility programs. Given the recent extensive attention to energy efficiency at the national level through Smart Grid and American Reinvestment and Recovery Act (ARRA) stimulus efforts and promulgated through the implementation of more stringent codes and standards both nationally and in local jurisdictions, we have taken steps in our modeling framework to capture the effects of market influences in our baseline forecast assessments. This is an important issue for this study, as the adoption of future codes and standards will have a direct bearing on how much utility program EE potential there can be over and above the effects of those efforts. This study includes standards in effect as of late 2010, which were not taken into account during the development of the Sixth Plan.

Inputs to the baseline forecast include:

- Current economic growth forecasts
- New construction forecasts
- Appliance and equipment standards
- Existing and approved changes to building codes and standards
- Forecasted changes in fuel share and equipment saturation
- The (future) effects of utility programs offered prior to 2010
- Avista's electricity price and sales forecasts

2.2.1 Modeling Approach

We used the Load Management Analysis and Planning tool (LoadMAP^{TM}) to develop the baseline forecast, as well as forecasts of energy-efficiency potential. Global developed LoadMAP in 2007 and has used it for the EPRI National Potential Study and numerous utility-specific forecasting and potential studies. Built in Excel, the LoadMAP framework is both accessible and transparent and has the following key features.

- Embodies the basic principles of rigorous end-use models (such as EPRI's REEPS and COMMEND) but in a more simplified, accessible form.
- Includes stock-accounting algorithms that treat older, less efficient appliance/equipment stock separately from newer, more efficient equipment. Equipment is replaced according to the measure life defined by the user.
- Balances the competing needs of simplicity and robustness by incorporating important modeling details related to equipment saturations, efficiencies, vintage, and the like, where market data are available, and treats end uses separately to account for varying importance and availability of data resources.
- Isolates new construction from existing equipment and buildings and treats purchase decisions for new construction, replacement upon failure, early replacement, and non-owner acquisition separately.
- Uses a simple logic for appliance and equipment decisions. Other models available for this purpose embody complex decision choice algorithms or diffusion assumptions, and the model parameters tend to be difficult to estimate or observe and sometimes produce anomalous results that require calibration or even overriding. The LoadMAP approach allows the user to drive the appliance and equipment choices year by year directly in the model. This flexible approach allows users to import the results from diffusion models or to input individual assumptions. The framework also facilitates sensitivity analysis.
- Includes appliance and equipment models customized by end use. For example, the logic for lighting equipment is distinct from refrigerators and freezers.
- Can accommodate various levels of segmentation. Analysis can be performed at the sector level (e.g., total residential) or for customized segments within sectors (e.g., housing type or income level).

Consistent with the segmentation scheme and the market profiles we describe above, the LoadMAP model provides forecasts of baseline energy use by sector, segment, end use and technology for existing and new buildings. It provides forecasts of total energy use and energy-efficiency savings associated with the four types of potential. It also provides forecasts of peak-demand savings for each type of potential.[3]

Table 2-3 summarizes the LoadMAP model inputs required for the baseline forecast. These inputs are required for each segment within each sector, as well as for new construction and existing dwellings/buildings.

[3] The model computes a peak-demand forecast for each type of potential for each end use as an intermediate calculation. Peak-demand savings are calculated as the difference between the peak-demand value in the potential forecast (e.g., technical potential) and the peak-demand value in the baseline forecast.

Table 2-3 Data Needs for the Baseline Forecast and Potentials Estimation in LoadMAP

Model Inputs	Description	Key Sources
Customer growth forecasts	Forecasts of new construction in residential and C&I sectors	Avista 2009 IRP, Sixth Power Plan, Regional census data
Equipment purchase shares for baseline forecast	For each equipment/technology, purchase shares for each efficiency level; specified separately for equipment replacement (replace-on-burnout), non-owner acquisition, and new construction	Shipments data, AEO forecast assumptions, appliance/efficiency standards analysis
Electricity prices	Forecast of average electricity prices	Avista price forecast data
Utilization model parameters	Price elasticities, elasticities for other variables (income, weather)	EPRI's REEPS and COMMEND models; Avista forecasting data

We present the results of the baseline forecast development in Chapter 4. As with the development of the market profiles, we reviewed the baseline forecast results with the Avista staff.

2.3 ENERGY EFFICIENCY MEASURES ANALYSIS

The framework for assessing savings, costs, and other attributes of energy-efficiency measures involves identifying the list of measures to include in the analysis, determining their applicability to each market sector and segment, fully characterizing each measure, and performing cost-effectiveness screening. Potential measures include the replacement of a unit that has failed or is at the end of its useful life with an efficient unit, retrofit/early replacement of equipment, improvements to the building envelope and other actions resulting in improved energy efficiency, and the application of controls to optimize energy use.

We compiled a robust listing of energy efficiency measures for each customer sector, drawing upon a variety of secondary sources:

- The Sixth Power Plan database of EE measure costs and savings
- NEEA's Regional Technical Forum
- Database for Energy Efficient Resources (DEER). The California Energy Commission and California Public Utilities Commission (CPUC) sponsor this database, which is designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life (EUL) all with one data source for the state of California.
- Global's Database of Energy Efficiency Measures (DEEM). In 2004, Global prepared a database of energy efficiency measures for residential and commercial segments across the U.S. This is analogous to the DEER database developed for California. Global updates the database on a regular basis as it conducts new energy efficiency potential studies.
- EPRI National Potential Study (2009). In 2009, Global conducted an assessment of the national potential for energy efficiency, with estimates derived for the four DOE regions (including the Pacific region that includes California).

Based on this compilation of information, Global assembled a broad and inclusive universal list of EE measures, covering all major types of end-use equipment, as well as devices and actions to reduce energy consumption. If considered today, many of these measures would not pass the economic screens, but may ultimately be part of Avista's EE program portfolios.

Once we assembled the list of EE measures, the project team assessed their energy-saving characteristics. For energy-saving measures not already specified in the databases above, we used Global's Building Energy Simulation Tool (BEST), a derivative of the DOE 2.2 building simulation model, to estimate measure savings. We used building prototypes for the Northwest region to estimate energy savings.

For each measure we also characterized incremental cost, service life, and other performance factors. Following the measure characterization, we performed an economic screening of each measure, which serves as the basis for developing the economic potential.

We provide further descriptions of EE measures analysis and the economic screening process in Chapter 5.

2.4 ASSESSMENT OF ENERGY-EFFICIENCY POTENTIAL

A key objective of this study is to estimate the potential for energy savings through energy efficiency activities in the Avista electric service territory. The potential impact of EE activities is the cumulative total of all energy-related projects.

The approach we used for this study adheres to the approaches and conventions outlined in the National Action Plan for Energy-Efficiency (NAPEE) Guide for Conducting Potential Studies (November 2007).[4] The NAPEE Guide represents the most credible and comprehensive industry practice for specifying energy-efficiency potential. Specifically, four types of potentials were developed as part of this study.

Technical potential is calculated by applying the most efficient option commercially available to each purchase decision, regardless of cost. It is a theoretical case that provides the broadest and highest definition of savings potential since it quantifies the savings that would result if all current equipment, processes, and practices in all sectors of the market were replaced by the most efficient feasible type. Technical potential does not take into account the cost-effectiveness of the measures. Further, technical potential is specifically defined as "phase-in technical potential," which assumes that only the portion of the current stock of equipment that has reached the end of its useful life and is due for turnover is changed out by the most efficient measures available (i.e., replacement). Non-equipment measures, such as controls and other devices (e.g., programmable thermostats) are not adopted all at once but are phased-in over time, just like the equipment measures. Lighting retrofits, which are in effect early replacements of existing lighting systems, are considered a non-equipment measure.

Economic potential results from the purchase of the most efficient *cost-effective* option available for a given equipment or non-equipment measure. Cost effectiveness is determined by applying an economic test. In this report, the total resource cost (TRC) test[5] was used to assess the cost-effectiveness of individual measures. Measures that passed the economic screen were then represented in the aggregate for economic potential. As with technical potential, economic potential is a phased-in approach. Economic potential is still a hypothetical upper-boundary of savings potential as it represents only measures that are economic but does not yet consider customer acceptance and other factors.

Achievable potential refines the economic potential by taking into account penetration rates of efficient technologies, expected program participation, and customer preferences and likely behavior. Two types of achievable potential were evaluated for this study:

- ***Maximum achievable potential (MAP)*** establishes an upper boundary of potential savings a utility could achieve through its energy efficiency programs. MAP presumes incentives that are sufficient to ensure customer adoption. It also considers a maximum

[4] National Action Plan for Energy Efficiency (2007). *National Action Plan for Energy Efficiency Vision for 2025:* Developing a Framework for Change. www.epa.gov/eeactionplan.

[5] While there are other tests that can be used to represent the economic potential (e.g., Participant or Utility Cost), the TRC is generally seen as the most appropriate representation of economic potential since it tends to be most representative of the net benefits of energy efficiency to society as a whole. The TRC is used in the economic screen as a proxy for moving forward and representing achievable energy efficiency savings potential for those measures that are most widely cost-effective.

participation rate by customers for the various energy efficiency programs that are designed to deliver the various measures. For this study, we developed market acceptance rate (MAR) factors, based on the ramp rate curves used in the Sixth Power Plan. These MAR factors were then applied to this study's estimates of economic potential to estimate MAP.

- ***Realistic achievable potential (RAP)*** represents a lower boundary forecast of potentials resulting from likely customer behavior and penetration rates of efficient technologies. It uses a set of program implementation factors (PIFs) to take into account existing barriers that are likely to limit the amount of savings that might be achieved through energy efficiency programs. The RAP also takes into account recent utility experience and reported savings from past and present programs.

2.4.1 Modeling Approach

We used LoadMAP to develop the estimates of technical, economic, and achievable potential. LoadMAP calculates results in terms of annual energy saved (kWh) and peak demand reduction (MW) for each level of potential by market segment, end use, and measure type. Figure 2-2 illustrates the LoadMAP process for developing both the baseline forecast the potentials forecasts.

For the ***technical potential***, LoadMAP "chooses" the most efficient option for each purchase decision involving major end-use equipment (refrigerators, air conditioners) during the forecast period. It also phases in all non-equipment measures during the forecast period.

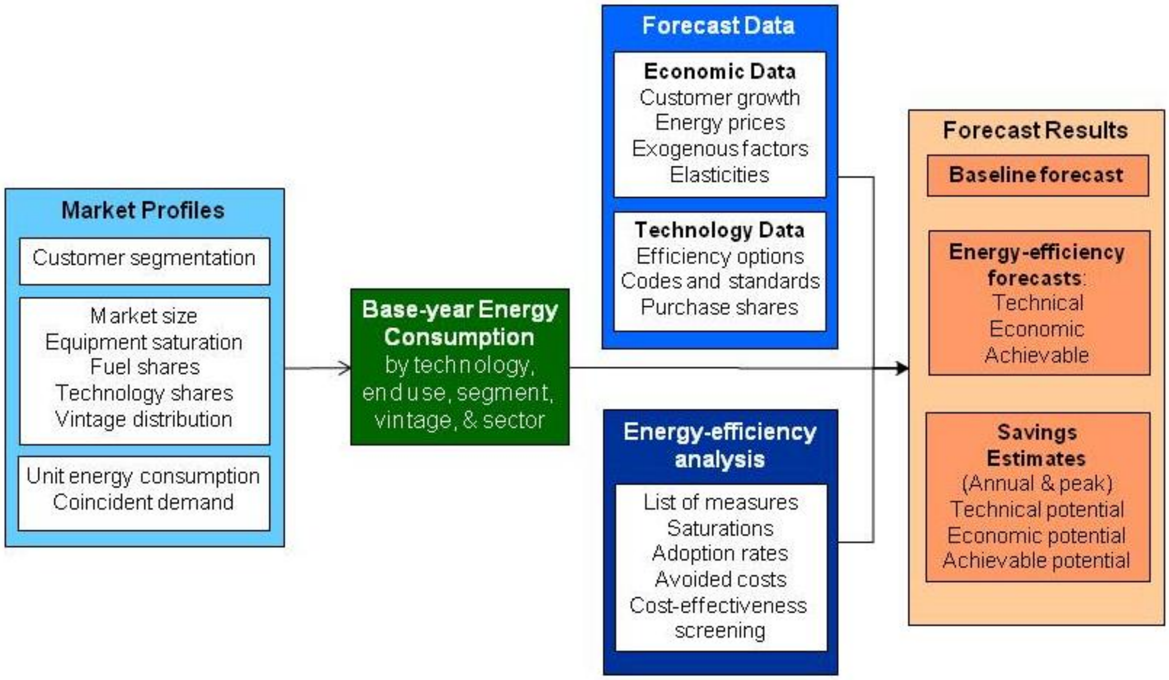
For the ***economic potential***, LoadMAP applies the TRC, which tests each measure in terms of its lifetime benefits (i.e., energy savings multiplied by the avoided cost) relative to the initial capital cost required to install the measure. If the benefit/cost ratio is greater than or equal to 1.0, then the measure passes the screen and it is included in the calculation of economic potential. If the B/C ratio is less than 1.0, the measure is screened out of economic potential. To allow for the changing characteristics of individual, new measures, we perform the economic screen during each year of the forecast period. Therefore, a measure than may not pass the screen in 2010 may pass in some future year. If more than one efficiency option passes the economic screen, for example if SEER 15 and SEER 16 both pass, then the most efficient option, SEER 16, is included in the calculation of economic potential.

Economic potential still does not take into account the acceptance of those measures by customers, so it is still a hypothetical upper-boundary of EE potential. But again, this exercise is important as it provides useful insights as to how much potential is economic and oftentimes can be compared with other studies of economic potential.

To develop estimates for ***maximum and realistic achievable potential***, we specify market adoption rates and program implementation factors for each measure as described above. For this study, we based these factors on the Sixth Power Plan's conservation curve ramp rates, and the past experience at Avista and at other utility EE programs. We also tapped into our recently completed market research for two EE potential studies in which we assessed customer acceptance rates taking into account some degree of financial intervention on the part of the utility to bring down customer paybacks to a level that motivates their participation in various EE programs. While there is a significant degree of uncertainty associated with these adoption rates, we believe that the approach is reasonable and is bounded by the experience gained from other utility EE efforts. Because the adoption rates are model inputs, they can be modified as new information becomes available.

The LoadMAP model provides a forecast of annual electricity use and peak demand under the four types of potential. The energy and peak-demand savings from energy efficiency measures are calculated as the difference between the values for the baseline forecast and the potential forecast.

Figure 2-2 LoadMAP Baseline and Potential Modeling



Results of the potentials assessment are presented in Chapter 6.

CHAPTER 3

MARKET ASSESSMENT AND MARKET PROFILES

Avista Utilities, headquartered in Spokane, Washington is an investor-owned utility with annual revenues of more than $1.3 billion. Avista provides electric and natural gas service to about 481,000 customers in a service territory of more than 30,000 square miles. Avista uses a mix of hydro, natural gas, coal and biomass generation delivered over 2,100 miles of transmission line, 17,000 miles of distribution line, and 6,100 miles of natural gas distribution mains. Avista currently operates a portfolio of electric and natural gas conservation programs in Washington, Idaho, and Oregon for residential, low-income, and non-residential customers that is funded by a non-bypassable systems benefits charge.

The base year for this study is 2009, the most recent year for which complete billing data were available at the beginning of the study. Table 3-1 and Table 3-2 show the breakdown, for Washington and Idaho respectively, of 2009 electricity sales among the major sectors and rate classes, drawn from billing data provided by Avista. Peak demand data was taken from the 2009 *System Load Research Project* report.[6] Figure 3-1and Figure 3-2 show similar data, but with the Extra Large General Service customers (rate class 025) further divided into commercial and industrial. In Figure 3-2 for Idaho, Extra Large General Service also includes Potlatch, rate class 25P.

Table 3-1 Electricity Sales and Peak Demand by Rate Class, Washington 2009

Sector	Rate Schedule(s)	Number of meters (customers)	2009 Electricity sales (MWh)	Peak demand (MW)
Residential	001	200,134	2,451,687	710
General Service	011, 012	27,142	415,935	64
Large General Service	021, 022	3,352	1,556,929	232
Extra Large General Service	025	22	879,233	134
Pumping	031, 032	2,361	135,999	10
Total		**233,011**	**5,439,850**	**1,150**

Table 3-2 Electricity Use and Peak Demand by Rate Class, Idaho 2009

Sector	Rate Schedule(s)	Number of meters (customers)	2009 Electricity sales (MWh)	Peak demand (MW)
Residential	001	99,580	1,182,368	283
General Service	011, 012	19,245	322,570	61
Large General Service	021, 022	1,456	699,953	115
Extra Large General Service	025, 025P	10	266,044	40
Extra Large GS Potlatch	025P	1	892	101
Pumping	031, 032	1,312	58,885	4
Total		**121,604**	**3,422,111**	**603**

[6] Avista Corp. *System Load Research Project* report, March 2010, prepared by KEMA.

Figure 3-1 Electricity Sales by Rate Class, Washington 2009

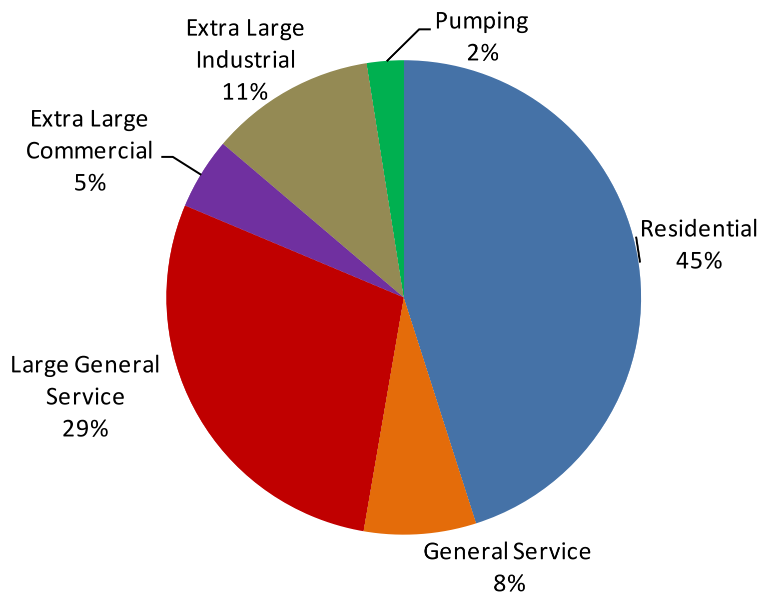
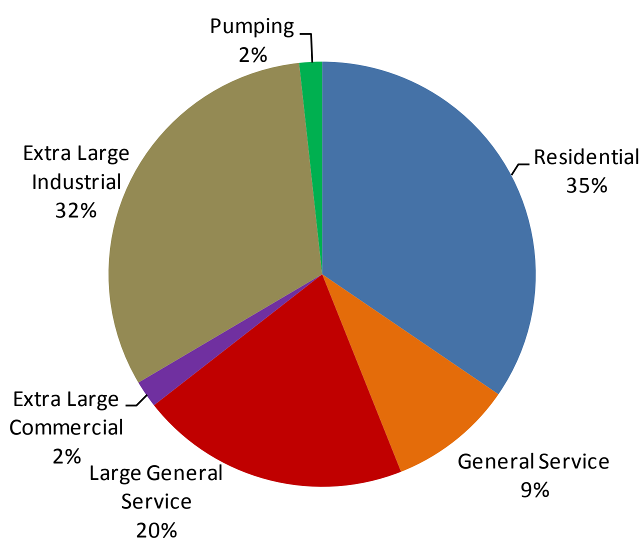


Figure 3-2 Electricity Sales by Rate Class, Idaho 2009



For this study, the project team decided not to explicitly model the EE potential for pumping customers but instead to use the Northwest Power and Conservation Council (NPCC) standard calculator to estimate EE potential. Results of that calculation appear in Chapter 6.

Below we discuss the market characterization and development of market profiles for the Residential and C&I sectors.

3.1 RESIDENTIAL SECTOR

This section characterizes the residential market at a high level, and then provides a profile of how customers in each residential segment use electricity by end use.

3.1.1 Market Characterization

The total number of residential customers was 200,134 in Washington and 99,579 in Idaho, based on the average number of rate class 001 monthly customers for 2009 provided by Avista.[7] We segmented these customers into four groups based on housing type and level of income: single family, multi family, mobile home, and limited income. The single family segment includes single-family detached homes, townhouses, and duplexes or row houses. The multi family segment includes apartments or condos in buildings with more than two units. The limited income segment is composed of all three housing types: single-family homes, multi-family homes, and mobile homes.

Because Avista does not maintain information on housing type or income level, we relied on a variety of survey and demographic sources for segmenting the residential market, including the U.S. Census American Community Survey 2006-2008, a 2009 Inland Power customer survey, and other sources (see Appendix E). Avista defines the limited-income category as those customers with annual income less than or equal to two times the poverty level. For an average household size of 2.5 persons, two times the poverty level is $32,880. For the purpose of our analysis, we used a slightly higher income level cutoff of $35,000 to define this segment, which allowed us to take advantage of the data sources listed above.

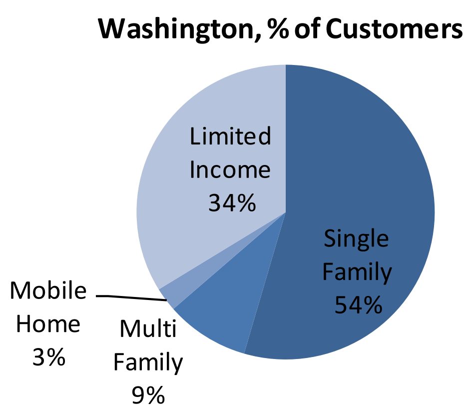
The resulting residential customer allocation by segment appears in Table 3-3 and in Figure 3-3.

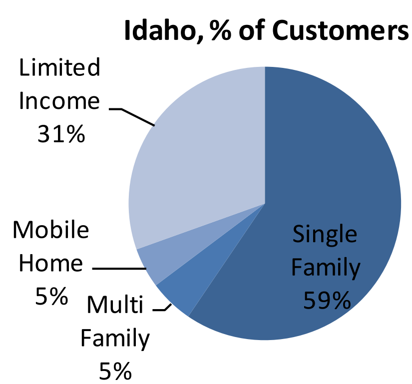
Table 3-3 Residential Sector Allocation by Segments

	Washington		Idaho	
Segment	**Allocation of Customers**	**% of Total**	**Allocation of Customers**	**% of Total**
Single Family	109,134	54%	59,205	59%
Multi Family	18,219	9%	5,237	5%
Mobile Home	5,248	3%	4,774	5%
Limited Income	67,533	34%	30,363	31%
Total	**200,134**	100%	**99,579**	**100%**

Note: Minor difference with Idaho residential customer total 99,580 Table 3-2 due to calibration.

Figure 3-3 Residential Sector Allocation by Segments, Percentage of Customers





[7] Rate classes 12 and 22, although they include homes, are included with rates classes 11 and 21 respectively, which corresponds with how customer classes were combined for Avista's *System Load Research Project* report.

Next, to determine the residential whole building energy intensity (kWh/household) by segment, we drew upon data from the Energy Information Agency, a NEEA residential billing analysis report, and the Inland Power & Light 2009 Conservation Potential Assessment. Based on these sources, we developed the segment level energy intensities shown in Table 3-4. The selected energy intensity values multiplied by the number of households equal the annual sales for each segment. These values sum to the total annual energy use for the residential sector in each state. Figure 3-4 presents the resulting energy sales by segment. The single-family segment used just over half the total residential sector electricity in 2009.

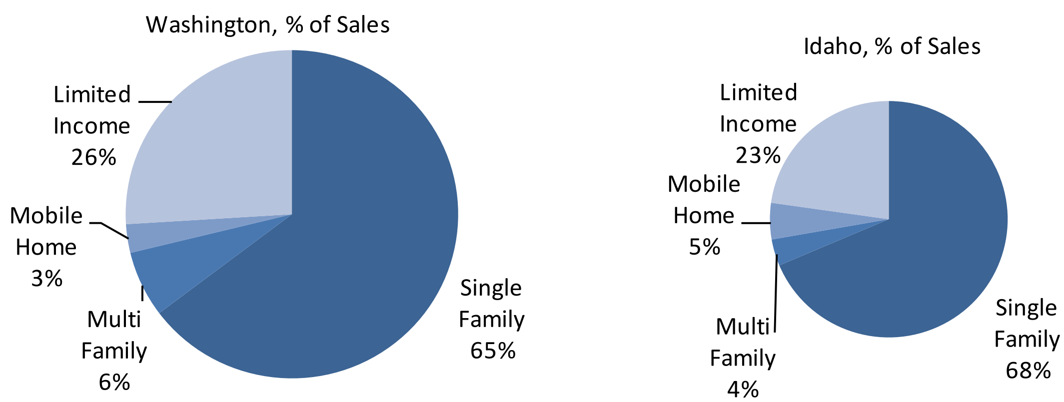
Table 3-4 Residential Electricity Usage and Intensity by Segment and State, 2009

Washington Segment	Intensity (kWh/Household)	Number of Customers	% of Customers	2009 Electricity Sales (MWh)	% of Sales
Single Family	14,547	109,134	54%	1,587,572	65%
Multi-Family	8,728	18,219	9%	159,019	6%
Mobile Home	13,092	5,248	3%	68,708	3%
Limited Income	9,424	67,533	34%	636,407	26%
Total	**12,250**	**200,134**	**100%**	**2,451,707**	**100%**

Idaho Segment	Intensity (kWh/Household)	Number of Customers	% of Customers	2009 Electricity Sales (MWh)	% of Sales
Single Family	13,703	59,205	59%	811,302	69%
Multi-Family	8,213	5,237	5%	43,013	4%
Mobile Home	12,320	4,774	5%	58,815	5%
Limited Income	8,868	30,363	31%	269,249	23%
Total	**11,874**	**99,580**	**100%**	**1,182,379**	**100%**

Note: Minor differences with totals in Table 3-1 and Table 3-2 due to calibration.

Figure 3-4 Residential Electricity Use by Customer Segment, Percentage of Sales 2009



3.1.2 Residential Market Profiles

As we describe in the previous chapter, the market profiles provide the foundation upon which we develop the baseline forecast. For each segment, we created a market profile, which includes the following elements:

- ***Market size*** represents the number of customers in the segment
- ***Saturations*** embody the fraction of homes with the electric technologies. (e.g., homes with electric space heating). We developed these using a combination of survey data from sources including Inland Power & Light, NEEA, and Puget Sound Energy (PSE). The results were cross-checked and validated against various other secondary sources.
- ***UEC (unit energy consumption)*** describes the amount of electricity consumed in 2009 by a specific technology in homes that have the technology (in kWh/household). As above, we used data from Inland Power & Light, NEEA, and PSE. We also used data from various utility potential studies that Global has recently completed. As needed, some minor adjustments were made to calibrate to whole-building intensities.
- ***Intensity*** represents the average use for the technology across all homes in 2009. It is computed as the product of the saturation and the UEC and is defined as kWh/household.
- ***Usage*** is the annual electricity use by a technology/end use in the segment. It is the product of the number of households and intensity and is quantified in GWh.

Table 3-5 presents the average existing home market profile for the entire Avista residential sector. The table shows data captured directly from LoadMAP. Values in red are inputs to LoadMAP. The existing-home profile represents all the housing stock in the Avista service area in 2009. Market profiles for each of the residential segments in Washington and Idaho respectively appear in Appendix A and B.

Figure 3-5 presents the end-use breakout for the residential sector as a whole. The appliance end use accounts for the largest share of the usage, closely followed by space heating, with water heating the third largest end use. The miscellaneous end use includes such devices as furnace fans, pool pumps, and other "plug" loads (hair dryers, power tools, coffee makers, etc.). Interior and exterior lighting combined account for 12% of electricity use in 2009. The electronics end use, which includes personal computers, televisions, home audio, video game consoles, etc., also contributes significantly to household electricity usage. Cooling and combined heating and cooling through heat pumps make up the remainder.

Figure 3-5 Residential Electricity Use by End Use per Household, 2009 (kWh and %)

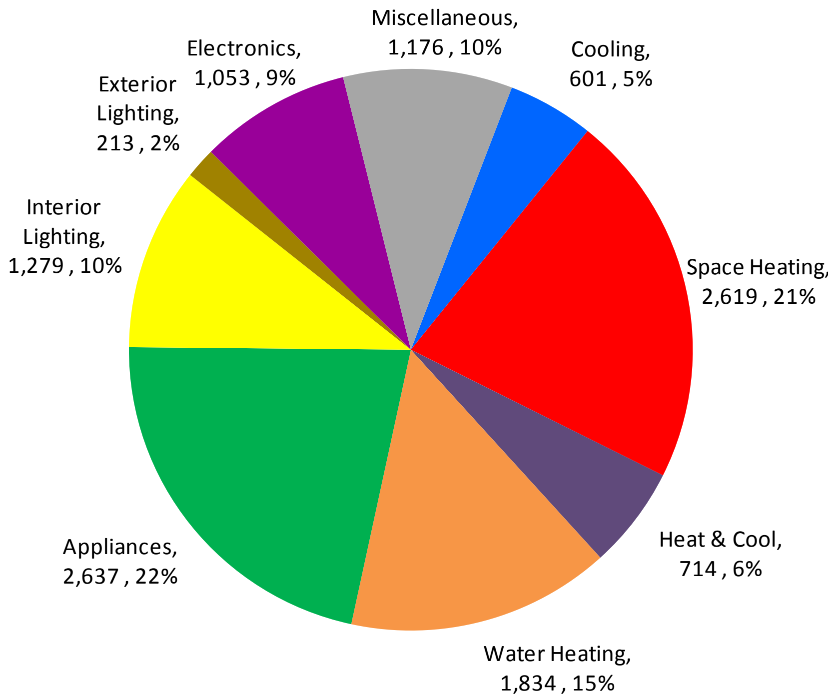
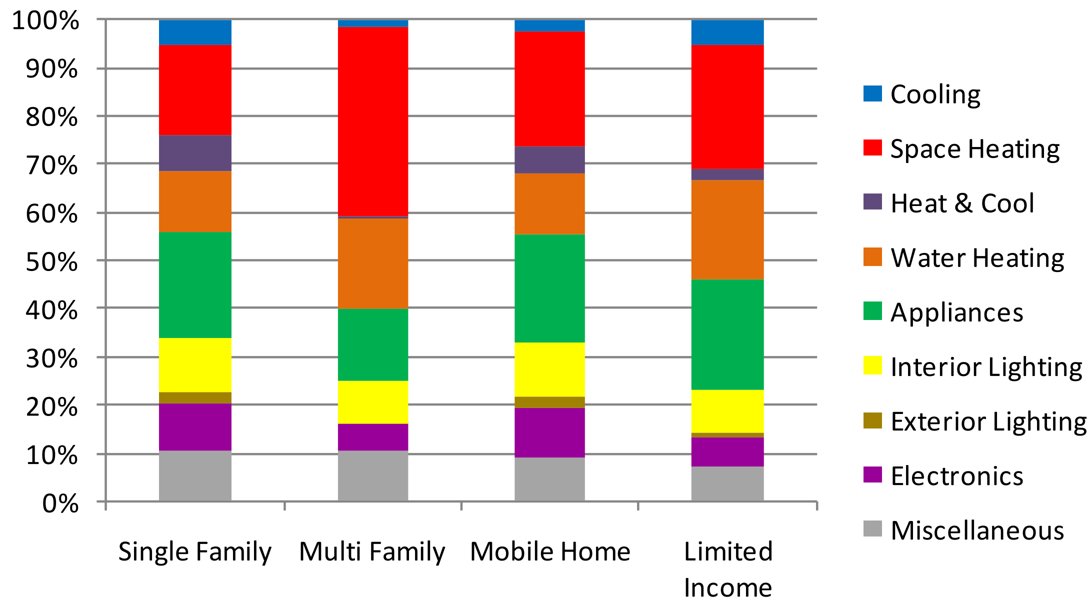


Table 3-5 Average Residential Sector Market Profile

Average Market Profile - Residential Sector					
End Use	**Technology**	**Saturation**	**UEC (kWh)**	**Intensity (kWh/HH)**	**Usage (GWh)**
Cooling	Central AC	29%	1,613	470	141
Cooling	Room AC	20%	643	131	39
Combined Heating/Cooling	Air Source Heat Pump	14%	5,051	699	209
Combined Heating/Cooling	Geothermal Heat Pump	0%	3,715	15	4
Space Heating	Electric Resistance	18%	6,114	1,119	335
Space Heating	Electric Furnace	22%	6,779	1,492	447
Space Heating	Supplemental	9%	83	8	2
Water Heating	Water Heater	66%	2,796	1,834	550
Interior Lighting	Screw-in	100%	1,144	1,144	343
Interior Lighting	Linear Fluorescent	66%	121	80	24
Interior Lighting	Pin-based	92%	59	55	16
Exterior Lighting	Screw-in	70%	301	211	63
Exterior Lighting	High Intensity/Flood	2%	116	2	1
Appliances	Clothes Washer	84%	105	88	26
Appliances	Clothes Dryer	80%	621	498	149
Appliances	Dishwasher	86%	185	160	48
Appliances	Refrigerator	100%	746	746	224
Appliances	Freezer	62%	760	474	142
Appliances	Second Refrigerator	35%	787	277	83
Appliances	Stove	86%	299	257	77
Appliances	Microwave	95%	144	137	41
Electronics	Personal Computers	121%	263	317	95
Electronics	TVs	222%	311	688	206
Electronics	Devices and Gadgets	100%	48	48	14
Miscellaneous	Pool Pump	10%	1,328	130	39
Miscellaneous	Furnace Fan	26%	404	107	32
Miscellaneous	Miscellaneous	100%	940	940	282
Total				**12,125**	**3,634**

Figure 3-6 presents the end-use shares of total electricity use for each housing type. Space heating is the largest single use in all housing types except single family homes where it is lower relative to other uses. Appliances are the largest energy consumer in the single family segment and are a significant energy use in the other segments as well.

Figure 3-6 End-Use Shares of Total Electricity Use by Housing Type, 2009



3.2 COMMERCIAL AND INDUSTRIAL SECTORS

The approach we used for the C&I sectors is analogous to the residential sector. It begins with segmentation, then defines market size and annual electricity use, and concludes with market profiles.

3.2.1 C&I Market Characterization

We developed the non-residential energy use by segment using Avista 2009 billing data by rate class. Table 3-6 and Table 3-7 present the results for the market characterization for Washington and Idaho respectively. Although the General Service 011 and Large General Service 021 rate classes include a small percentage of industrial customers, we chose to model these as primarily commercial building types. For the General Service segment, we assumed facilities were small to medium buildings, dominated by retail facilities. For the Large General Service segment, we assumed the typical facility was an office building. When developing the market profiles, as further described below, we began with these assumed prototypical building types, but adjusted them to account for the diversity in each segment. For the Extra Large General Service rate class 025, we divided customers into separate commercial and industrial segments and included the Potlatch facility, Idaho rate class 025P, with the other Idaho Extra Large industrial customers. This grouping enabled better modeling of the industrial customers.

We then used data from NEEA, the California Commercial End Use Study (CEUS), and other recently completed studies to develop estimates of floor space and annual intensities (in kWh/square foot) for each segment. Because of the heterogeneous nature of the C&I sectors and the wide variation in customer size (compared to residential homes), floor space is used as the unit of measure to quantify energy use and equipment inventories on a per-square-foot basis. Note that we are not concerned with absolute square footage, as the purpose of this study is not to estimate C&I floor space, but with the relative size of each segment and its growth over time.

Table 3-6 Commercial Sector Market Characterization Results, Washington 2009

Avista Rate Schedule		LoadMAP Segment and Typical Building	Electricity sales (MWh)	Intensity (kWh/sq.ft.)
General Service	011, 012	Small and Medium Commercial — Retail	415,935	17.5
Large General Service	021, 022	Large Commercial — Office	1,556,929	16.7
Extra Large General Service Commercial	025C	Extra Large Commercial — University	265,686	13.9
Extra Large General Service Industrial	025I	Extra Large Industrial	613,615	40.0
Total			**2,852,165**	

Table 3-7 Commercial Sector Market Characterization Results, Idaho 2009

Avista Rate Schedule		LoadMAP Segment and Typical Building	Electricity sales (MWh)	Intensity (kWh/sq.ft.)
General Service	011, 012	Small and Medium Commercial — Retail	322,570	17.5
Large General Service	021, 022	Large Commercial — Office	699,953	16.7
Extra Large General Service Commercial	025C	Extra Large Commercial — University	70,361	13.9
Extra Large General Service Industrial	025I, 025P	Extra Large Industrial	1,087,974	40.0
Total			**2,180,858**	

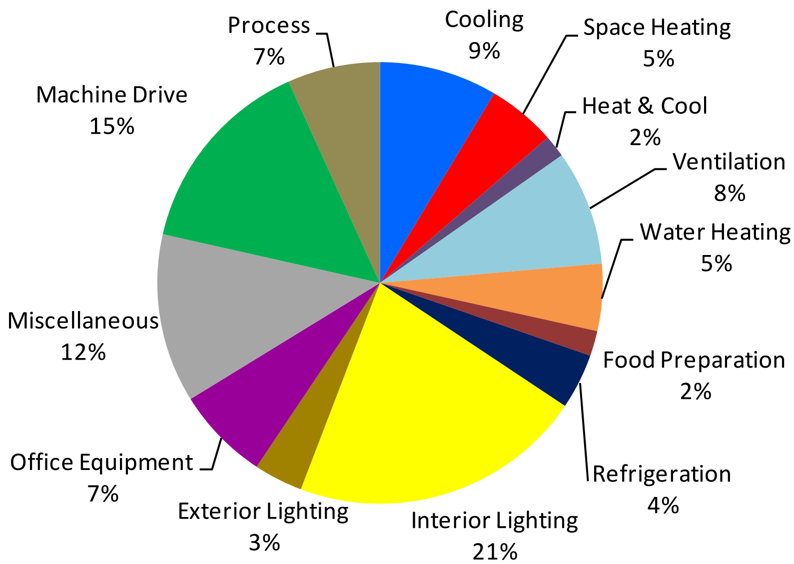
3.2.2 C&I Market Profiles

For the C&I sector, the approach we used to develop market profiles is similar to what we described above for residential.

- ***Saturations*** are the percentage of floor space with each electric end use. For space heating, cooling and water heating, this embodies the electric fuel share. For space heating and cooling, it also embodies the fraction of conditioned space. The saturation values for each end use are from NEEA reports, supplemented with other secondary sources to develop the technology-level saturations. For the industrial segments, we drew upon U.S. Industrial Electric Motor Systems Market Opportunities Assessment from the US Department of Energy (US DOE) and the EIA Annual Energy Outlook.
- ***EUIs (end-use indices)*** represent the amount of electricity used per square foot of floor space in buildings where the equipment is present. Data from NEEA. US DOE, EIA, and other secondary sources provided EUIs by end use. We developed the technology-level EUIs using our engineering model BEST and other secondary sources. Finally, we adjusted the EUIs to calibrate to Avista's overall building type intensity.
- ***Intensity*** is the average use across all floor space (computed as the product of saturation and EUI). For the industrial sector, we calibrate
- ***Annual use*** is the total consumption in 2009 for each end use (computed as the product of the intensity and the floor space for the segment.

Figure 3-7 shows the breakdown of annual electricity usage by end use for the C&I sector as a whole. Lighting is the largest single end use in the sector, accounting for one fifth of total usage.

Figure 3-7 Commercial and Industrial Electricity Consumption by End Use, 2009



This information is further detailed in Figure 3-8, which shows the end-use breakdown for the composite of the three commercial segments — Small/Medium, Large, and Extra Large — and Figure 3-9, which shows similar information for the Extra Large Industrial segment.

Observations include the following:

- Commercial buildings
  - Lighting is the largest single energy use across all of the commercial buildings, accounting for 29% of energy use.
  - Space conditioning, including heating, cooling, and ventilation, is close behind with 27% of energy use.
  - Miscellaneous and office equipment are the next largest energy uses.
  - Water heating, refrigeration, and food preparation are only a small portion of energy use in the commercial sector overall, though they are more significant in specific building types (supermarkets, restaurants, hospitals, lodging).
- Extra Large Industrial facilities
  - Machine drive and process loads dominate in this segment, together accounting for 65% of energy use.
  - HVAC and interior lighting consume 17% and 6% of energy respectively.

Figure 3-8 Commercial End Use Consumption, 2009

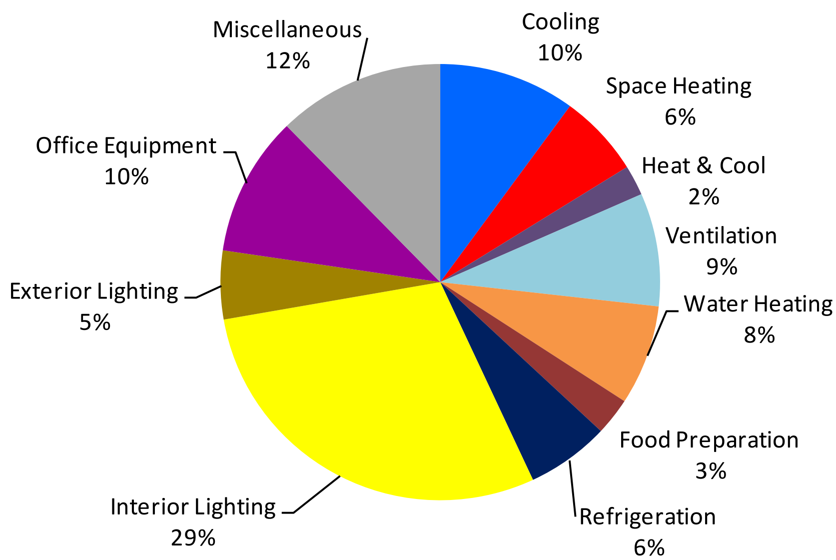


Figure 3-9 Extra Large Industrial End Use Consumption, 2009

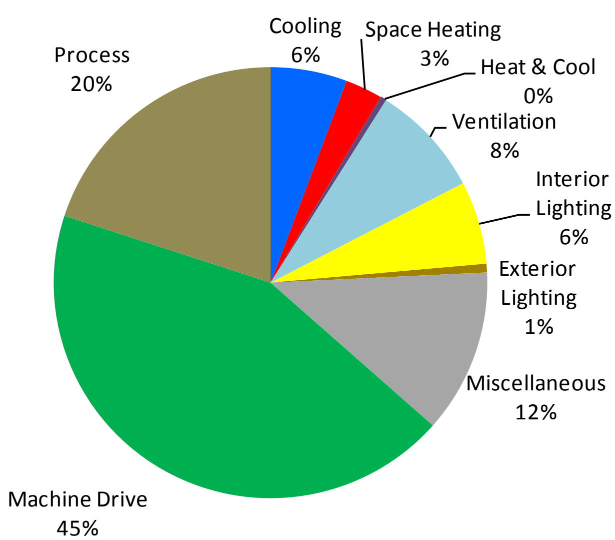


Table 3-8 shows an example commercial average base year market profile, in this case for the Washington Small/Medium Commercial Segment. The table show data captured from LoadMAP, where values shown in red are inputs to the model. The market profiles for each of the Washington and Idaho C&I segments are shown in Appendices A and B respectively.

Table 3-8 Small/Medium Commercial Segment Market Profile, Washington, 2009

Average Market Profiles

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)
Cooling	Central Chiller	13.8%	2.39	0.33	8
Cooling	RTU	63.1%	2.46	1.55	37
Cooling	PTAC	3.3%	2.44	0.08	2
Combined Heating/Cooling	Heat Pump	3.6%	6.19	0.22	5
Space Heating	Electric Resistance	5.9%	6.72	0.39	9
Space Heating	Furnace	17.7%	7.05	1.25	30
Ventilation	Ventilation	76.9%	2.09	1.61	38
Interior Lighting	Interior Screw-in	100.0%	1.00	1.00	24
Interior Lighting	HID	100.0%	0.68	0.68	16
Interior Lighting	Linear Fluorescent	100.0%	3.37	3.37	80
Exterior Lighting	Exterior Screw-in	82.6%	0.20	0.16	4
Exterior Lighting	HID	82.6%	0.76	0.63	15
Exterior Lighting	Linear Fluorescent	82.6%	0.16	0.13	3
Water Heating	Water Heater	63.0%	2.00	1.26	30
Food Preparation	Fryer	25.8%	0.16	0.04	1
Food Preparation	Oven	25.8%	0.98	0.25	6
Food Preparation	Dishwasher	25.8%	0.06	0.01	0
Food Preparation	Hot Food Container	25.8%	0.31	0.08	2
Food Preparation	Food Prep	25.8%	0.01	0.00	0
Refrigeration	Walk in Refrigeration	0.0%	-	-	-
Refrigeration	Glass Door Display	52.4%	0.45	0.23	6
Refrigeration	Solid Door Refrigerator	52.4%	0.50	0.26	6
Refrigeration	Open Display Case	52.4%	0.04	0.02	1
Refrigeration	Vending Machine	52.4%	0.30	0.16	4
Refrigeration	Icemaker	52.4%	0.34	0.18	4
Office Equipment	Desktop Computer	99.9%	0.48	0.48	11
Office Equipment	Laptop Computer	99.9%	0.06	0.06	1
Office Equipment	Server	99.9%	0.36	0.36	9
Office Equipment	Monitor	99.9%	0.25	0.25	6
Office Equipment	Printer/copier/fax	99.9%	0.24	0.24	6
Office Equipment	POS Terminal	99.9%	0.27	0.27	7
Miscellaneous	Non-HVAC Motor	40.2%	1.22	0.49	12
Miscellaneous	Other Miscellaneous	100.0%	1.43	1.43	34
Total				**17.50**	**416**

CHAPTER | 4

BASELINE FORECAST

Prior to developing estimates of energy-efficiency potential, a baseline end-use forecast was prepared to quantify how electricity is used by end use in the base year and what electricity is likely to be in the future in absence of new utility programs. The baseline forecast serves as the metric against which energy-efficiency potentials — technical, economic, and achievable — are compared.

4.1 RESIDENTIAL SECTOR

4.1.1 Residential Baseline Forecast Drivers

In general, the baseline forecast incorporates assumptions about economic growth, electricity prices, appliance/equipment standards and building codes already mandated, and naturally occurring conservation. The key inputs we used to develop the forecast for Avista include:

- Customer growth: provided by Avista through 2015, and rate of growth assumed constant thereafter
- Forecasts of electricity prices: provided by Avista through 2015, with rate of increases thereafter based on the Annual Energy Outlook (AEO)
- Forecasts of household size: from Census data and the 6th Plan
- Forecast of income: from Washington state data
- Trends in end-use/technology saturations: developed from the AEO
- Equipment purchase decisions: developed from AEO

Table 4-1 presents the assumptions used in the forecast regarding market size growth, household size, median household income, and electricity prices. The market size growth rate was applied equally to each of the four segments.

Table 4-1 Residential Market Size Forecast (number of households)

Driver	2009	2012	2017	2022	2027	2032	Average Growth (%/yr)
Market Size WA (number of households)	200,134	204,530	217,921	232,414	247,871	264,356	1.21%
Market Size ID (number of households)	99,579	102,077	108,592	115,553	122,960	130,842	1.19%
Persons per household	2.50	2.50	2.50	2.50	2.50	2.50	–
Electricity price WA (cents per kWh)	$0.0721	$0.0796	$0.0804	$0.0825	$0.0845	$0.0867	0.80%
Electricity price ID (cents per kWh)	$0.0742	$0.0855	$0.0876	$0.0898	$0.0921	$0.0944	1.05%
Per capita income ($ real, 2000)	$34,506	$35,787	$39,202	$43,623	$48,400	$53,700	1.92%

In addition to forecasts for household size, electricity price, and median household income, the model also requires elasticities for these variables. The elasticities for prices and persons per household are based on the REEPS model developed by the Electric Power Research Institute (EPRI). The income elasticity was provided by Avista. The values are as follows:

- –0.151 for electricity prices
- 0.75 for income for all end uses except for appliances, where we use 0.375
- 0.20 for persons per household

In addition, we implemented the following assumptions for the residential sector[8]:

- In 2006, a Federal standard for central air conditioners and heat pumps went into effect, requiring all newly manufactured air conditioners and heat pumps to meet SEER 13 or better. This standard applies to replace-upon-burnout in existing construction and new construction. In 2016, the standard becomes SEER 14[9].
- In April 2010, DOE released updated water heater standards that go into effect April 16, 2015. The new standard for water heaters with volume at or below 55 gallons requires an energy factor (EF) equal to 0.96 minus 0.0003 times the rated storage volume in gallons.
- DOE is scheduled to make a final ruling on refrigerator and freezer standards on December 31, 2010. We incorporated this anticipated ruling into the forecast and assumed that refrigeration and freezer consumption will decrease by 20% in 2014[10]. This forecast does not include anticipated standards for room air conditioners, clothes washers, clothes dryers and dishwashers because DOE rulings on the standards have not yet been set.
- Residential lighting is affected by the passage of the Energy Independence and Security Act (EISA) in 2007, which mandates higher efficacies for lighting technologies starting in 2012. Several lighting technologies are anticipated to meet this standard when it goes into effect, including compact fluorescent lamps (CFL) and white light-emitting diodes (LED). As a result, the share of incandescent lamps decreases while CFL and LED purchases increase. CFLs dominate over the forecast period, but LEDs account for about 20% of purchases by 2020.
- In November 2008, ENERGY STAR 3.0 for color televisions went into effect. This standard sets the rules for becoming ENERGY STAR qualified. One such criterion is that TVs must not exceed 1 watt of power in standby mode.

4.1.2 Residential Baseline Forecast Results

Overall, residential use in both states and for all segments increases from 3,634,054 MWh in 2009 to 5,600,870 MWh in 2032, an average annual growth rate of 1.9%. This is slightly higher than the 1.5% annual growth rate in Avista's 2009 IRP for the period 2009 through 2030. Because the IRP forecast includes future conservation activities and LoadMAP's baseline forecast does not, we would generally expect LoadMAP's baseline forecast to be somewhat higher. This increase is also more than double the AEO forecast of 0.8% average growth.

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[8] These assumptions reflect standards in effect as of late 2010 or scheduled to take effect over the course of the 20-year study period. Because some of these standards were not yet announced when the NWPCC Sixth Plan was developed, this study's baseline incorporates reduced baseline energy usage compared with the Sixth Plan.

[9] This assumption was included in the 2010 Annual Energy Outlook (AEO) forecast. The SEER 14 standard level used in the AEO forecast was established in a 2009 consensus agreement made between equipment manufacturers and energy efficiency advocacy organizations. DOE is required to publish the final rule on central air conditioners and heat pump standards in 2011.

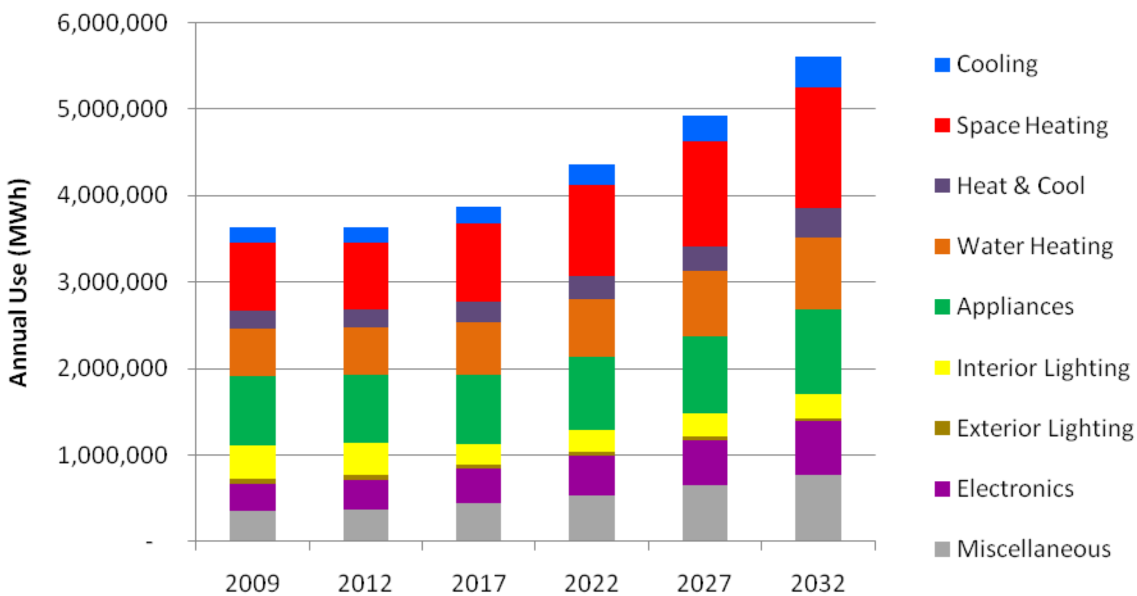
[10] This level is consistent with the standard recently agreed upon in a joint proposal by home appliance manufacturers and energy efficiency advocates which states that refrigeration and freezer consumption must decrease by 20-30% effective in 2014.

General observations about this forecast include the following:

- Overall, household growth is robust, with a nearly 32% increase between 2009 and 2032. The AEO forecast is somewhat lower, with a 26% increase in the number of households.
- The factors that impact usage — relatively low electricity prices and strong income growth — result in strong residential consumption growth over the forecast period.
- New homes are larger than existing homes, based on data from the AEO and other studies. However, equipment and appliances are more efficient, so the combined effect is slightly positive.

Figure 4-1 presents the baseline forecast at the end-use level for the residential sector as a whole, in both Washington and Idaho.

Figure 4-1 Residential Baseline Forecast by End Use



End-use specific observations include:

- The drop in all space conditioning loads from 2009 to 2012 is due to the transition from actual weather in 2009 (589 cooling degree days and 6,976 heating degree days) to the normal weather forecast (434 cooling degree days and 6,657 heating degree days) thereafter.
- Cooling grows due to increasing saturation of central air conditioning in new homes and larger home sizes, as well as the addition of central air conditioning to existing homes.
- Space heating, combined heating and cooling, and water heating grow, but at a slightly moderate rate compared to cooling, again due to the growth in households and to larger home sizes.
- Beginning in 2012, the federal lighting standards cause a decline in electricity for interior lighting use of 29% and exterior lighting use by 41% over the forecast period. The AEO 2010 forecast projects a 26% decline in lighting energy use over the same period. The AEO reduction is less than that shown here, again due to increasing home size.
- Appliances decrease, reflecting efficiency gains, particularly in the refrigeration appliances due to standards that offset the small increases in saturations of dishwashers, clothes washers, and clothes dryers.

- Growth in electricity use in electronics is strong and reflects an increase in the saturation of electronics and the trend toward higher-powered computers and larger televisions.
- Growth in miscellaneous use is also substantial. This has been a long-term trend and we incorporate growth assumptions that are consistent with the AEO.

Figure 4-2 presents the forecast of use per household. Most noticeable is that lighting use decreases significantly after 2010, as the lighting standard from EISA comes into effect and as LED lamps begin to gain traction in the later years of the forecast. Appliance use also decreases over the forecast period due to appliance standards. Use in electronics and miscellaneous increase over the forecast period, reflecting the trend that households continue to add various electronics to the home.

Figure 4-2 Residential Baseline Electricity Use per Household by End Use

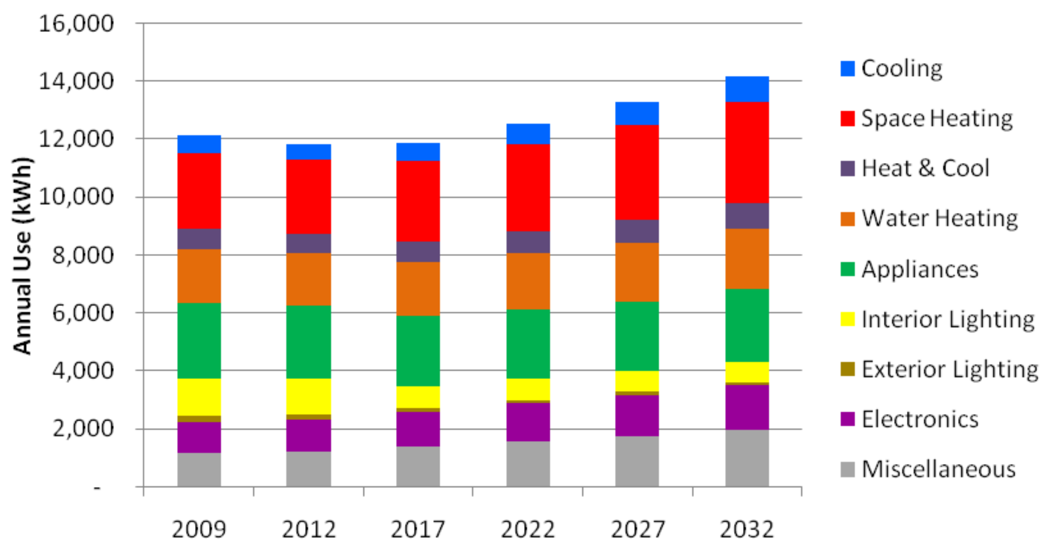


Table 4-2 shows the forecast by end use, while Table 4-3 provides additional detail by technology within each end use. Central AC increases during the forecast as more households add air conditioning. Screw-in lighting decreases as a result of the EISA lighting standard. Over the forecast period there is strong growth in usage from electronics due to the increase in saturation.

Table 4-2 Residential Baseline Forecast Electricity Consumption by End Use (MWh)

End Use	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. growth rate
Cooling	180,022	164,865	197,394	239,439	292,044	355,171	97%	3.0%
Space Heating	784,854	783,258	906,261	1,051,822	1,210,093	1,383,665	76%	2.5%
Heat & Cool	213,860	201,410	229,160	258,676	295,177	341,644	60%	2.0%
Water Heating	549,606	557,022	611,950	675,037	748,494	830,988	51%	1.8%
Interior Lighting	790,377	776,482	795,594	835,023	894,245	989,025	25%	1.0%
Exterior Lighting	383,305	371,610	246,575	256,864	262,823	271,374	-29%	-1.5%
Appliances	63,864	61,321	41,763	39,795	38,430	37,735	-41%	-2.3%
Electronics	315,599	336,152	394,727	459,538	529,485	616,688	95%	2.9%
Miscellaneous	352,599	374,575	447,870	540,047	648,055	774,496	120%	3.4%
Total	**180,022**	**164,865**	**197,394**	**239,439**	**292,044**	**355,171**	**54%**	**1.9%**

Table 4-3 Residential Baseline Electricity Forecast by End Use and Technology (MWh)

End Use	Technology	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. Growth Rate
Cooling	Central AC	140,731	130,669	161,085	199,996	249,120	308,429	119%	3.4%
	Room AC	39,291	34,196	36,310	39,443	42,924	46,742	19%	0.8%
Space Heating	Electric Furnace	447,317	447,255	520,409	606,695	700,178	801,899	79%	2.5%
	Electric Resistance	335,280	333,732	383,172	441,947	506,164	577,358	72%	2.4%
	Supplemental	2,257	2,272	2,680	3,180	3,750	4,409	95%	2.9%
Heat & Cool	Air Source Heat Pump	209,371	197,111	224,050	252,476	287,663	332,619	59%	2.0%
	Geothermal Heat Pump	4,489	4,299	5,109	6,200	7,514	9,025	101%	3.0%
Water Heating	Water Heater	549,606	557,022	611,950	675,037	748,494	830,988	51%	1.8%
Appliances	Refrigerator	223,654	213,517	204,566	204,184	209,933	231,329	3%	0.1%
	Freezer	141,950	137,910	137,084	136,274	143,528	158,560	12%	0.5%
	Second Refrigerator	83,117	77,296	72,374	70,707	69,137	73,789	-11%	-0.5%
	Clothes Washer	26,332	26,102	27,746	30,875	34,868	39,019	48%	1.7%
	Clothes Dryer	149,267	150,677	163,829	180,582	199,465	221,428	48%	1.7%
	Dishwasher	47,886	48,894	54,242	60,691	68,105	76,321	59%	2.0%
	Stove	77,079	79,792	89,107	99,966	111,884	125,081	62%	2.1%
	Microwave	41,092	42,294	46,647	51,744	57,325	63,498	55%	1.9%
Interior Lighting	Screw-in	342,923	329,329	198,253	200,264	196,856	194,811	-43%	-2.5%
	Linear Fluorescent	24,025	25,171	29,266	34,273	39,944	46,451	93%	2.9%
	Pin-based	16,358	17,110	19,056	22,326	26,023	30,112	84%	2.7%
Exterior Lighting	Screw-in	63,165	60,629	41,255	39,254	37,834	37,069	-41%	-2.3%
	High Intensity/Flood	698	692	508	540	596	666	-5%	-0.2%
Electronics	Personal Computers	94,922	101,516	120,451	143,627	170,677	202,632	113%	3.3%
	TVs	206,326	219,527	256,515	294,816	333,825	384,485	86%	2.7%
	Devices and Gadgets	14,351	15,110	17,761	21,095	24,983	29,572	106%	3.1%
Miscellaneous	Furnace Fan	32,029	33,795	39,817	47,004	54,841	63,046	97%	2.9%
	Pool Pump	38,852	39,438	44,334	51,331	59,964	69,728	79%	2.5%
	Miscellaneous	281,718	301,342	363,719	441,712	533,250	641,722	128%	3.6%
Grand Total		**3,634,086**	**3,626,696**	**3,871,294**	**4,356,240**	**4,918,847**	**5,600,787**	**54%**	**1.9%**

4.2 COMMERCIAL AND INDUSTRIAL SECTOR

4.2.1 C&I Baseline Forecast Drivers

As is the case with the residential sector, the C&I baseline forecast incorporates assumptions about economic growth, electricity prices, equipment standards and building codes already mandated, and naturally occurring conservation. The key inputs we used to develop the forecast for Avista include:

- Floor space growth for Commercial segments derived from Avista customer and load growth projections through 2015 and from Avista IRP projections regarding expansion of existing Extra Large Customer facilities; after 2015 assumed constant growth rate of 2% based on Avista IRP[11]
- Floor space growth for Extra Large Industrial segment derived from Avista customer and load growth projections through 2015; thereafter based on based on employment growth of 2.8% in Washington and 1.4% in Idaho[12]
- Forecasts of electricity prices provided by Avista through 2015, with rate of increases thereafter based on the Annual Energy Outlook (AEO)
- Trends in end-use/technology saturations developed from the AEO
- Equipment purchase decisions developed from AEO[13]

Table 4-4 presents the growth and electricity price assumptions used in the C&I forecast. Market size growth is shown as an indexed value where 2009 equals 1.0

Table 4-4 Commercial Market Size Growth and Electricity Price Forecast

Indexed Market Size 2009 = 1.0	2009	2012	2017	2022	2027	2032	Avg. Growth (%/yr)
Small/Med. Comm., WA	1.00	1.04	1.14	1.26	1.39	1.53	1.85%
Large Comm., WA	1.00	1.01	1.10	1.22	1.34	1.48	1.72%
Extra Large Comm., WA	1.00	1.05	1.34	1.48	1.63	1.80	2.57%
Extra Large Industrial, WA	1.00	1.16	1.31	1.51	1.73	1.99	2.99%
Small/Med. Comm., ID	1.00	1.03	1.13	1.25	1.38	1.53	1.84%
Large Comm., ID	1.00	1.03	1.15	1.27	1.40	1.54	1.88%
Extra Large Comm., ID	1.00	1.04	1.25	1.38	1.52	1.68	2.26%
Extra Large Industrial, ID	1.00	1.04	1.13	1.21	1.30	1.39	1.44%

Electricity Price	2009	2012	2017	2022	2027	2032	Avg. Growth (%/yr)
Electricity price, WA (cents per kWh)	$0.0700	$0.0698	$0.0703	$0.0727	$0.0752	$0.0778	0.46%
Electricity price, ID (cents per kWh)	$0.0566	$0.0586	$0.0600	$0.0621	$0.0642	$0.0664	0.69%

[11] Avista 2009 IRP, p. 2-10: Commercial usage per customer is forecast to increase for several years due to additional buildings either built or anticipated to be built by existing very large customers, such as Washington State University and Sacred Heart Hospital. Expected additions for very large customers are included in the forecast through 2015, and no additions are included in the forecast after 2015.

[12] Avista 2009 IRP p. 2-6.

[13] We developed baseline purchase decisions using the Energy Information Agency's *Annual Energy Outlook* report (2010), which utilizes the National Energy Modeling System (NEMS) to produce a self-consistent supply and demand economic model. We calibrated equipment purchase options to match manufacturer shipment data for recent years and trended forward.

4.2.2 C&I Baseline Forecast Results

Figure 4-3 and Table 4-5 present the baseline forecast at the end-use level for the C&I sector as a whole. Overall, C&I annual energy use increases from 5,033,023 MWh in 2009 to 7,239,694 MWh in 2032, a 43.8% increase. This reflects growth in floor space across all sectors. Table 4-6 presents the C&I forecast by technology. Interior screw-in lighting increases over the forecast period, but at a slower rate than other technologies as a result of the lighting standard.

Figure 4-3 C&I Baseline Electricity Forecast by End Use

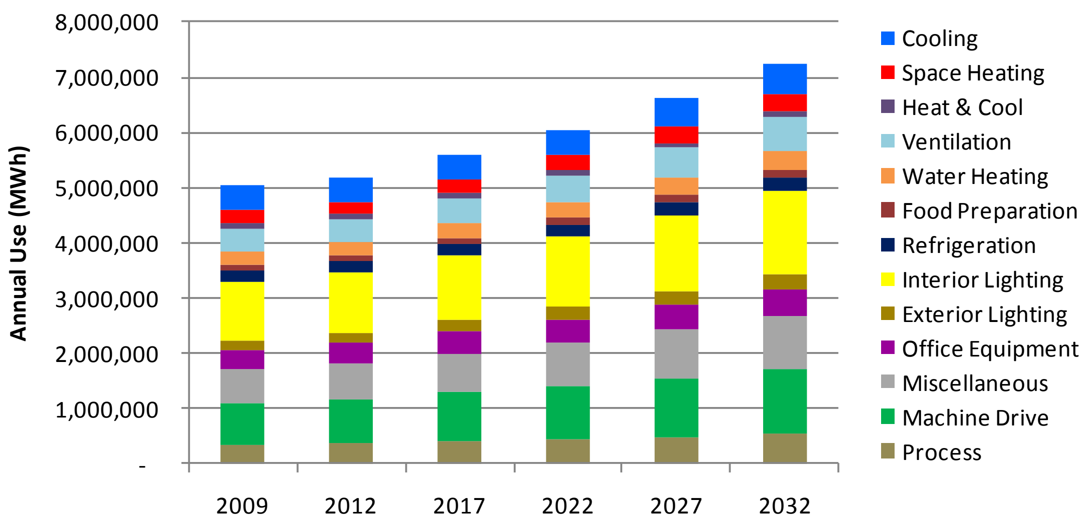


Table 4-5 C&I Electricity Consumption by End Use (MWh)

End Use	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. growth rate
Cooling	433,257	429,715	453,330	473,311	504,446	550,621	27.1%	1.04%
Space Heating	250,919	224,970	249,918	273,638	300,093	330,065	31.5%	1.19%
Heat & Cool	81,984	80,104	82,263	86,559	94,007	103,167	25.8%	1.00%
Ventilation	421,805	426,987	457,118	487,582	534,845	588,427	39.5%	1.45%
Water Heating	246,022	244,232	266,435	289,253	315,002	344,844	40.2%	1.47%
Food Preparation	92,263	94,294	104,419	114,396	125,186	136,992	48.5%	1.72%
Refrigeration	203,660	204,139	213,050	224,372	242,222	264,431	29.8%	1.14%
Interior Lighting	1,079,050	1,106,035	1,175,567	1,274,090	1,388,871	1,513,165	40.2%	1.47%
Exterior Lighting	179,595	183,933	202,023	219,529	239,546	261,703	45.7%	1.64%
Office Equipment	344,351	363,758	387,164	421,052	458,189	498,560	44.8%	1.61%
Miscellaneous	619,607	645,918	714,601	785,490	863,772	950,463	53.4%	1.86%
Machine Drive	740,191	800,303	881,202	966,387	1,061,952	1,169,146	58.0%	1.99%
Process	340,318	367,955	405,497	445,447	489,890	539,389	58.5%	2.00%
Total	**433,257**	**429,715**	**453,330**	**473,311**	**504,446**	**550,621**	**27.1%**	**1.04%**

Table 4-6 C&I Baseline Electricity Forecast by End Use and Technology (MWh)

End Use	Technology	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. Growth Rate
Cooling	Central Chiller	161,468	161,651	175,544	184,829	194,228	210,874	30.6%	1.16%
	PTAC	18,631	18,428	18,862	19,691	21,069	23,036	23.6%	0.92%
	RTU	253,158	249,637	258,925	268,791	289,149	316,711	25.1%	0.97%
Space Heating	Electric Resistance	102,223	191,387	212,950	234,235	257,713	283,617	177.5%	4.44%
	Furnace	148,697	33,583	36,969	39,403	42,380	46,447	-68.8%	-5.06%
Heat & Cool	Heat Pump	81,984	80,104	82,263	86,559	94,007	103,167	25.8%	1.00%
Ventilation	Ventilation	421,805	426,987	457,118	487,582	534,845	588,427	39.5%	1.45%
Water Heating	Water Heater	246,022	244,232	266,435	289,253	315,002	344,844	40.2%	1.47%
Food Preparation	Dishwasher	5,561	5,675	6,260	6,889	7,580	8,341	50.0%	1.76%
	Fryer	10,938	11,160	12,267	13,442	14,715	16,107	47.3%	1.68%
	Oven	64,439	65,882	73,158	80,123	87,640	95,864	48.8%	1.73%
	Hot Food Container	10,600	10,838	11,915	13,043	14,260	15,590	47.1%	1.68%
	Food Prep	724	739	818	900	991	1,090	50.5%	1.78%
Refrigeration	Walk in Refrigeration	26,545	26,356	27,877	29,977	32,721	35,993	35.6%	1.32%
	Glass Door Display	29,998	29,887	31,549	33,927	37,032	40,736	35.8%	1.33%
	Solid Door Refrigerator	56,389	55,997	58,578	61,819	66,199	71,682	27.1%	1.04%
	Open Display Case	18,136	18,080	19,502	20,983	22,909	25,201	39.0%	1.43%
	Vending Machine	28,068	28,373	25,594	23,005	23,392	24,849	-11.5%	-0.53%
	Icemaker	44,524	45,447	49,951	54,661	59,969	65,969	48.2%	1.71%
Interior Lighting	HID	175,721	181,398	198,158	215,929	235,578	257,305	46.4%	1.66%
	Linear Fluorescent	686,924	702,882	771,014	840,371	916,893	1,001,311	45.8%	1.64%
	Interior Screw-in	216,406	221,755	206,395	217,790	236,400	254,549	17.6%	0.71%

Table 4-6 C&I Baseline Electricity Forecast by End Use and Technology (MWh) (continued)

End Use	Technology	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. Growth Rate
Exterior Lighting	HID	132,407	135,795	150,576	164,140	179,105	195,616	47.7%	1.70%
	Linear Fluorescent	25,393	25,871	28,196	30,732	33,529	36,611	44.2%	1.59%
	Exterior Screw-in	21,795	22,266	23,250	24,657	26,912	29,475	35.2%	1.31%
Office Equipment	Monitor	41,029	53,265	46,532	50,891	55,743	61,060	48.8%	1.73%
	Server	74,853	76,495	84,537	93,022	102,358	112,632	50.5%	1.78%
	Desktop Computer	154,994	158,861	173,772	187,271	201,951	217,747	40.5%	1.48%
	Laptop Computer	13,081	13,425	14,794	15,996	17,306	18,722	43.1%	1.56%
	Printer/copier/fax	39,520	40,314	44,034	48,018	52,383	57,096	44.5%	1.60%
	POS Terminal	20,873	21,398	23,495	25,853	28,448	31,304	50.0%	1.76%
Miscellaneous	Other Miscellaneous	263,934	269,935	298,454	328,409	361,370	397,639	50.7%	1.78%
	Miscellaneous	208,493	225,425	248,425	272,900	300,128	330,453	58.5%	2.00%
	Non-HVAC Motor	147,180	150,558	167,722	184,182	202,275	222,371	51.1%	1.79%
Machine Drive	Less than 5 HP	35,529	38,415	41,579	44,045	47,585	52,286	47.2%	1.68%
	5-24 HP	76,980	83,231	91,723	100,760	110,813	122,010	58.5%	2.00%
	25-99 HP	188,009	203,277	224,017	246,087	270,640	297,986	58.5%	2.00%
	100-249 HP	106,588	115,244	127,002	139,514	153,434	168,937	58.5%	2.00%
	250-499 HP	116,950	126,448	139,349	153,078	168,351	185,361	58.5%	2.00%
	500 and more HP	216,136	233,688	257,531	282,903	311,129	342,566	58.5%	2.00%
Process	Process Cooling/Refrigeration	102,095	110,387	121,649	133,634	146,967	161,817	58.5%	2.00%
	Process Heating	153,143	165,580	182,474	200,451	220,451	242,725	58.5%	2.00%
	Electrochemical Process	85,079	91,989	101,374	111,362	122,473	134,847	58.5%	2.00%
Grand Total		**5,033,023**	**5,172,344**	**5,592,586**	**6,061,107**	**6,618,022**	**7,250,973**	**44.1%**	**1.59%**

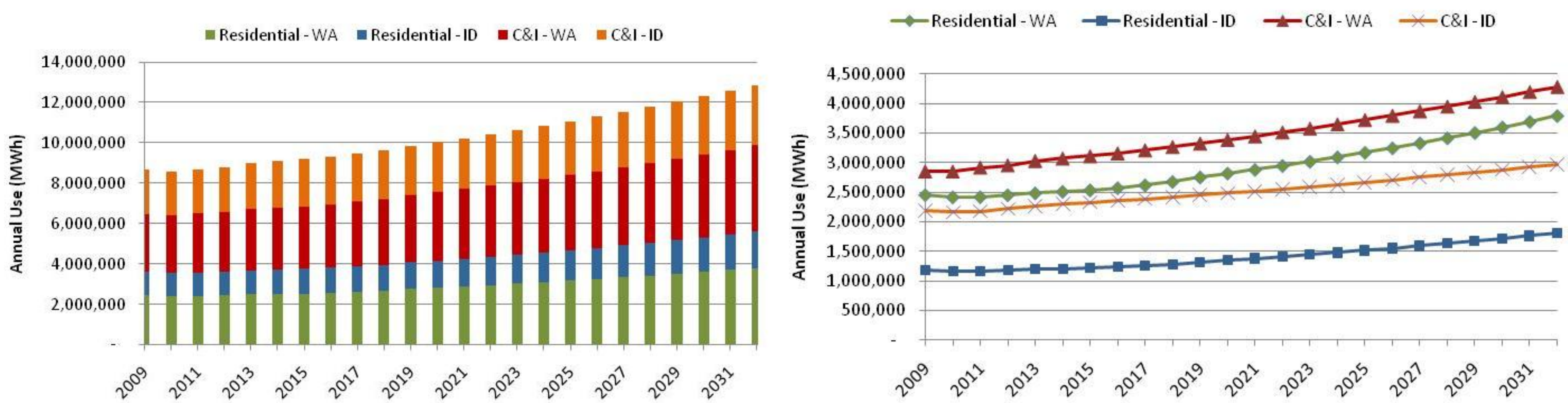
4.3 BASELINE FORECAST SUMMARY

Table 4-7 and Figure 4-4 provide an overall summary of the baseline forecast by sector and for the Avista system as a whole. Overall, the forecast for the next 20 years shows substantial growth, reflecting projected increases in customers and income. This forecast is the metric against which the energy-efficiency savings potential is compared.

Table 4-7 Baseline Forecast Summary by Sector and State

End Use	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. Growth Rate ('09–'32)
Res. WA	2,451,707	2,448,104	2,617,630	2,947,427	3,329,882	3,792,486	54.7%	1.9%
Res. ID	1,182,379	1,178,591	1,253,664	1,408,812	1,588,965	1,808,300	52.9%	1.8%
C&I WA	2,852,165	2,955,156	3,209,083	3,509,816	3,869,176	4,280,649	50.1%	1.8%
C&I ID	2,180,858	2,217,188	2,383,504	2,551,291	2,748,846	2,970,324	36.2%	1.3%
Total	8,667,109	8,799,039	9,463,880	10,417,347	11,536,869	12,851,760	48.3%	1.7%

Figure 4-4 Baseline Forecast Summary by Sector and State



4.3.1 Comparison of Baseline Forecast with Avista 2009 IRP

Table 4-8 compares the Avista 2009 IRP forecast, the LoadMAP baseline forecast for Washington and Idaho combined, and the regional forecast from the Sixth Plan. For the LoadMAP baseline and Avista forecast, the table shows data for the period 2009 through 2030, the last year of the IRP forecast. The Sixth Plan forecast is the medium case scenario for 2010 through 2030.

Table 4-8 Comparison of LoadMAP Baseline, Avista IRP, and Sixth Plan Energy Forecasts (MWh)

	LoadMAP Baseline			Avista IRP[14]			Sixth Plan[15]
Sector	2009	2030	Avg. Growth ('09-'30)	2009	2030	Avg. Growth ('09-'30)	Avg. Growth ('10-'30)
Residential	3,634,086	5,314,970	1.8%	3,700,000	5,048,000	1.5%	1.4%
Commercial	3,331,433	4,457,968	1.4%	3,400,000	4,773,000	1.6%	1.6%
Industrial	1,701,589	2,530,353	1.9%	1,900,000	3,029,000	2.2%	0.8%
Total	**8,667,109**	**12,303,291**	**1.7%**	**9,002,009**	**12,852,030**	**1.7%**	**1.4%**

The LoadMAP and IRP forecasts do not match exactly for the base year, likely due to the slightly different ways in which the study team selected rate classes to include and how we grouped them. Also, the IRP was prepared in September 2009, before final results for 2009 were available.

Overall growth in energy usage agrees well between LoadMAP and the IRP, at approximately 1.7% annual average growth. However, Global's forecast for the Residential sector produces greater growth than the IRP's projections, while the opposite is true for Commercial and Industrial sectors. Because the LoadMAP baseline excludes future additional conservation activities, we would generally expect it to be somewhat higher than the IRP forecast, as is the case with the Residential sector. In general, the Sixth Plan forecast, which also excludes additional conservation, is lower than both the LoadMAP and Avista IRP forecasts, with the exception of the Commercial sector, where the Sixth Plan and the Avista IRP agree.

Retail Electricity Prices

Table 4-9 compares retail electricity prices used in the LoadMAP model and those projected in the IRP.

Table 4-9 Comparison of Retail Electricity Prices

Sector	LoadMAP						Avista IRP[16]	
	2009 ($/kWh)	2018 ($/kWh)	Avg. Growth ('09-'18)	2019 ($/kWh)	2032 ($/kWh)	Avg. Growth ('19-'32)	Avg. Growth ('19-'32)	Avg. Growth ('19-'30)
Res. WA	$0.072	$0.080	1.2%	$0.0818	$0.087	0.5%	10.0%	Inflation
Res. ID	$0.074	$0.088	1.8%	$0.089	$0.094	0.5%	10.0%	Inflation
C&I WA	$0.0700	$0.0703	0.1%	$0.0713	$0.0778	0.7%	10.0%	Inflation
C&I ID	$0.0566	$0.0600	0.6%	$0.0608	$0.0664	0.7%	10.0%	inflation

[14] Avista forecast from 2009 IRP, Figure 2.10 and p. 2-12.
[15] NPCC Sixth Northwest Conservation and Electric Power Plan, p. C-6, table C-3.
[16] Avista 2009 IRP, p. 2-9.

Avista's IRP forecast "is based on retail prices increasing an average of 10 percent annually from 2010 to 2018, followed by increases at the rate of inflation thereafter." However, Avista's most recent load forecast for 2011–2015 shows lower annual rate increases. For this study, Global used the rates from the 2011–2015 load forecast and thereafter, based on data from the AEO, increased rates by 0.50% and 0.68% respectively for residential and C/I customers.

Residential Energy Use per Household

As mentioned above, the LoadMAP residential baseline energy use forecast is higher than the IRP residential forecast. Furthermore, the baseline forecast of energy use per household is notably different, with average growth of 0.6% compared with Avista IRP showing that energy use per household decreases over time.[17]

Long-Term Weather

This study used the 30-year normal weather data. In contrast, the IRP mentions warming trends in recent weather. Although the model does not directly account for climate changes, the residential market profiles show an increase in air conditioning saturation over time, which indirectly reflects weather trends.

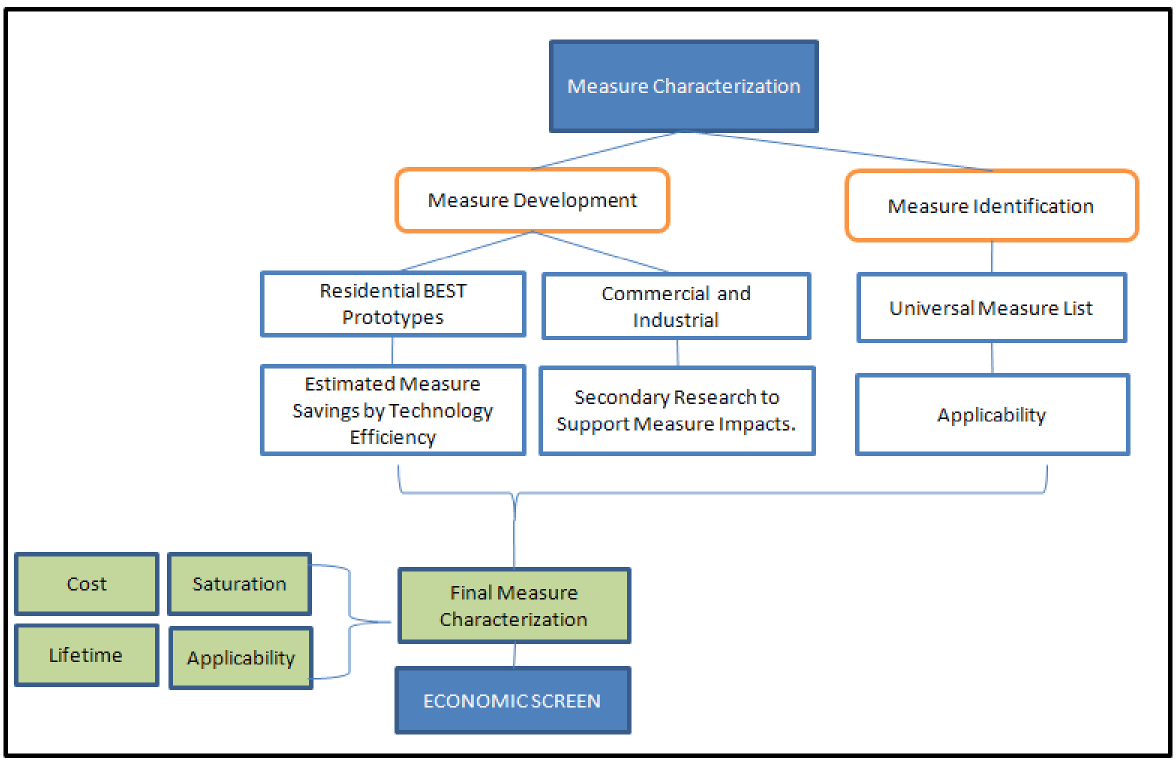
[17] Avista 2009 IRP Figure 2.9, p. 2-11.

CHAPTER 5

ENERGY-EFFICIENCY MEASURE ANALYSIS

This section describes the framework used to assess the savings, costs, and other attributes of energy-efficiency measures. These characteristics form the basis for measure-level cost-effectiveness analyses as well as for determining measure-level savings. For all measures, Global assembled information to reflect equipment performance, incremental costs, and equipment lifetimes. We used this information, along with the avoided costs, in the economic screen to determine economically feasible measures. Figure 5-1 outlines the framework for measure analysis.

Figure 5-1 Approach for Measure Assessment



5.1 SELECTION OF ENERGY EFFICIENCY MEASURES

The first step of the energy efficiency measure analysis was to identify the list of all relevant energy efficiency measures that should be considered for the Avista CPA. Sources consulted to develop the list for this study included:

- Avista's existing conservation programs
- The Sixth Power Plan database of EE measure costs and savings
- NEEA's Regional Technical Forum
- Database for Energy Efficient Resources (DEER): The California Energy Commission and California Public Utilities Commission (CPUC) sponsor this database, which is designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life (EUL) all with one data source for the state of California.

- Global's Database of Energy Efficiency Measures (DEEM). In 2004, Global prepared a database of energy efficiency measures for residential and commercial segments across the U.S., analogous to the DEER database developed for California. Global updates the database on a regular basis as it conducts new energy efficiency potential studies.
- EPRI National Potential Study (2009). Global's assessment of the national potential for energy efficiency derived for the four DOE regions (including the Pacific region.
- Other recent Global potential studies

Measures can be categorized into one of two types, equipment measures and non-equipment measures, according to the LoadMAP taxonomy:

Equipment measures, or efficient energy-consuming equipment, save energy by providing the same service with a lower energy requirement. An example is the replacement of a standard efficiency refrigerator with an ENERGY STAR model. For equipment measures, many efficiency levels are available for a specific technology that range from the baseline unit (often determined by code or standard) up to the most efficient product commercially available. For instance, in the case of central air conditioners, this list begins with the federal standard SEER 13 unit and spans a broad spectrum of efficiency, with the highest efficiency level represented by a ductless mini-split system with variable refrigerant flow (at SEER levels of 18 or greater).

Non-equipment measures save energy by reducing the need for delivered energy but do not involve replacement or purchase of major end-use equipment (such as a refrigerator or air conditioner). An example would be a programmable thermostat that is pre-set, for example, to run the air conditioner only when people are home. Non-equipment measures fall into one of the following categories:

- Building shell (windows, insulation, roofing material)
- Equipment controls (thermostat, occupancy sensors)
- Equipment maintenance (cleaning filters, changing setpoints)
- Whole-building design (natural ventilation, passive solar lighting)
- Lighting retrofits (included as a non-equipment measure because retrofits are performed prior to the equipment's normal end of life)
- Displacement measures (ceiling fan instead of central air conditioner)

Non-equipment measures can apply to more than one end use. For example, insulation levels will affect both cooling and space heating energy consumption.

Global prepared a preliminary list of measures for Avista's review and revised the list based on Avista's input.

5.1.1 Residential Measures

Table 5-1 and Table 5-2 show the residential equipment and non-equipment measure options respectively and the segments for which they were modeled. Residential measures are described in Appendix C.

5.1.2 Commercial and Industrial Measures

Table 5-3and Table 5-4 list the C&I equipment and non-equipment measures, respectively. Measures were modeled for nearly all C&I building types, both new and existing, with only a few exceptions as shown. For all C&I segments, a custom measure category was included to serve as a "catch all" for measures for which costs and savings are not easily quantified and that could be part of a program such as Avista's existing Site-Specific incentive program. In addition, because the Small/Medium Commercial and Large Commercial segments also include some industrial customers, we included a non-equipment measure called Industrial Process Improvements to capture potential savings from these customers. C&I Measures are described in Appendix D.

Table 5-1 Summary of Residential Equipment Measures

End Use	Technology	Efficiency Option	Efficiency	Lifetime	On Market	Off Market	Single Family (existing & new)	Mulfi Family (existing & new)	Mobile Home (existing & new)	Low Income (existing & new)
Cooling	Central AC	SEER 13	100%	15	2009	2014	●	●	●	●
	Central AC	SEER 14 (ENERGY STAR)	92%	15	2009	2032	●	●	●	●
	Central AC	SEER 15 (CEE Tier 2)	89%	15	2009	2032	●	●	●	●
	Central AC	SEER 16 (CEE Tier 3)	86%	15	2009	2032	●	●	●	●
	Central AC	Ductless Mini-Split System	75%	20	2009	2032	●	●	●	●
	Room AC	EER 9.8	100%	10	2009	2032	●	●	●	●
	Room AC	EER 10.8 (ENERGY STAR)	91%	10	2009	2032	●	●	●	●
	Room AC	EER 11	89%	10	2009	2032	●	●	●	●
	Room AC	EER 11.5	85%	10	2009	2032	●	●	●	●
Heat & Cool	Air Source Heat Pump	SEER 13	100%	15	2009	2014	●	●	●	●
	Air Source Heat Pump	SEER 14 (ENERGY STAR)	92%	15	2009	2032	●	●	●	●
	Air Source Heat Pump	SEER 15 (CEE Tier 2)	89%	15	2009	2032	●	●	●	●
	Air Source Heat Pump	SEER 16 (CEE Tier 3)	86%	15	2009	2032	●	●	●	●
	Air Source Heat Pump	Ductless Mini-Split System	75%	20	2009	2032	●	●	●	●
	Geothermal Heat Pump	Standard	100%	14	2009	2032	●	●	●	●
	Geothermal Heat Pump	High Efficiency	86%	14	2009	2032	●	●	●	●
Space Heating	Electric Resistance	Electric Resistance	100%	20	2009	2032	●	●	●	●
	Electric Furnace	3400 BTU/KW	100%	15	2009	2032	●	●	●	●
	Supplemental	Supplemental	100%	5	2009	2032	●	●	●	●
Water Heating	Water Heater	Baseline (EF=0.90)	100%	15	2009	2015	●	●	●	●
	Water Heater	High Efficiency (EF=0.95)	95%	15	2009	2032	●	●	●	●
	Water Heater	Geothermal Heat Pump	32%	15	2009	2032	●			
	Water Heater	Solar	25%	15	2009	2032	●	●	●	●
Interior Lighting	Screw-in	Incandescent	100%	4	2009	2014	●	●	●	●
	Screw-in	Infrared Halogen	81%	5	2015	2020	●	●	●	●
	Screw-in	CFL	22%	6	2009	2032	●	●	●	●
	Screw-in	LED	14%	12	2009	2032	●	●	●	●
	Linear Fluorescent	T12	100%	6	2009	2032	●	●	●	●
	Linear Fluorescent	T8	91%	6	2009	2032	●	●	●	●
	Linear Fluorescent	Super T8	74%	6	2009	2032	●	●	●	●
	Linear Fluorescent	T5	73%	6	2009	2032	●	●	●	●
	Linear Fluorescent	LED	72%	10	2009	2032	●	●	●	●
	Pin-based	Halogen	100%	4	2009	2032	●	●	●	●
	Pin-based	CFL	23%	6	2009	2032	●	●	●	●
	Pin-based	LED	16%	10	2009	2032	●	●	●	●
Exterior Lighting	Screw-in	Incandescent	100%	4	2009	2014	●	●	●	●
	Screw-in	Infrared Halogen	79%	5	2015	2020	●	●	●	●
	Screw-in	CFL	20%	6	2009	2032	●	●	●	●
	Screw-in	LED	14%	12	2009	2032	●	●	●	●
	High Intensity/Flood	Incandescent	100%	4	2009	2014	●	●	●	●
	High Intensity/Flood	Infrared Halogen	88%	4	2015	2020	●	●	●	●
	High Intensity/Flood	CFL	29%	5	2009	2032	●	●	●	●
	High Intensity/Flood	Metal Halide	27%	5	2009	2032	●	●	●	●
	High Intensity/Flood	High Pressure Sodium	19%	5	2009	2032	●	●	●	●
	High Intensity/Flood	LED	18%	10	2009	2032	●	●	●	●

Table 5-1 Summary of Residential Equipment Measures (continued)

End Use	Technology	Efficiency Option	Efficiency	Lifetime	On Market	Off Market	Single Family (existing & new)	Mulfi Family (existing & new)	Mobile Home (existing & new)	Low Income (existing & new)
Appliances	Clothes Washer	Baseline	100%	10	2009	2032	●	●	●	●
	Clothes Washer	ENERGY STAR (MEF > 1.8)	70%	10	2009	2032	●	●	●	●
	Clothes Washer	Horizontal Axis	42%	10	2009	2032	●	●	●	●
	Clothes Dryer	Baseline	100%	13	2009	2032	●	●	●	●
	Clothes Dryer	Moisture Detection	85%	13	2009	2032	●	●	●	●
	Dishwasher	Baseline	100%	9	2009	2032	●	●	●	●
	Dishwasher	ENERGY STAR	85%	9	2009	2010	●	●	●	●
	Dishwasher	ENERGY STAR (2011)	81%	9	2011	2032	●	●	●	●
	Refrigerator	Baseline	100%	13	2009	2013	●	●	●	●
	Refrigerator	ENERGY STAR	85%	13	2009	2013	●	●	●	●
	Refrigerator	Baseline (2014)	80%	13	2014	2032	●	●	●	●
	Refrigerator	ENERGY STAR (2014)	68%	13	2014	2032	●	●	●	●
	Freezer	Baseline	100%	11	2009	2013	●	●	●	●
	Freezer	ENERGY STAR	85%	11	2009	2013	●	●	●	●
	Freezer	Baseline (2014)	80%	11	2014	2032	●	●	●	●
	Freezer	ENERGY STAR (2014)	68%	11	2014	2032	●	●	●	●
	Second Refrigerator	Baseline	100%	13	2009	2013	●	●	●	●
	Second Refrigerator	ENERGY STAR	85%	13	2009	2013	●	●	●	●
	Second Refrigerator	Baseline (2014)	80%	13	2014	2032	●	●	●	●
	Second Refrigerator	ENERGY STAR (2014)	68%	13	2014	2032	●	●	●	●
	Stove	Baseline	100%	13	2009	2032	●	●	●	●
	Stove	Convection Oven	98%	13	2009	2032	●	●	●	●
	Stove	Induction (High Efficiency)	88%	13	2009	2032	●	●	●	●
	Microwave	Microwave	100%	9	2009	2032	●	●	●	●
Electronics	Personal Computers	Baseline	100%	5	2009	2032	●	●	●	●
	Personal Computers	ENERGY STAR	65%	5	2009	2032	●	●	●	●
	Personal Computers	Climate Savers	50%	5	2009	2032	●	●	●	●
	TVs	Baseline	100%	11	2009	2032	●	●	●	●
	TVs	ENERGY STAR	80%	11	2009	2032	●	●	●	●
	Devices and Gadgets	Devices and Gadgets	100%	5	2009	2032	●	●	●	●
Miscellaneous	Pool Pump	Baseline Pump	100%	15	2009	2032	●		●	●
	Pool Pump	High Efficiency Pump	90%	15	2009	2032	●		●	●
	Pool Pump	Two-Speed Pump	60%	15	2009	2032	●		●	●
	Furnace Fan	Baseline	100%	18	2009	2032	●	●	●	●
	Furnace Fan	Furnace Fan with ECM	75%	18	2009	2032	●	●	●	●
	Miscellaneous	Miscellaneous	100%	5	2009	2032	●	●	●	●

Table 5-2 Summary of Residential Non-equipment Measures

End Use	Measure	Single Family Existing	Single Family New Construction	Multi Family Existing	Multi Family New Construction	Mobile Home Existing	Mobile Home New Construction	Low Income Existing	Low Income New Construction
HVAC	Central AC - Early Replacement	●		●		●	●	●	
	Central AC - Maintenance and Tune-Up	●	●	●	●	●	●	●	●
	Room AC - Removal of Second Unit	●		●		●	●	●	
	Air Source Heat Pump - Maintenance	●	●	●	●	●	●	●	●
	Furnace - Convert to Gas	●	●	●	●	●	●	●	●
	Attic Fan - Installation	●	●					●	●
	Attic Fan - Photovoltaic - Installation	●	●					●	●
	Ceiling Fan - Installation	●	●	●	●	●	●	●	●
	Whole-House Fan - Installation	●	●			●	●	●	●
	Thermostat - Clock/Programmable	●	●	●	●	●	●	●	●
	Insulation - Ceiling / Attic	●	●	●	●	●	●	●	●
	Insulation - Radiant Barrier	●	●	●	●	●	●	●	●
	Insulation - Infiltration Control	●		●		●		●	●
	Insulation - Ducting	●	●	●	●	●	●	●	●
	Repair and Sealing - Ducting	●		●		●		●	
	Insulation - Foundation		●						●
	Insulation - Wall Cavity		●		●		●		●
	Insulation - Wall Sheathing		●		●		●		●
	Doors - Storm and Thermal	●	●	●	●	●	●	●	●
	Windows - Reflective Film	●	●	●	●	●	●	●	●
	Windows - High Efficiency/ENERGY STAR	●	●	●	●	●	●	●	●
	Roofs - High Reflectivity	●	●	●	●	●	●	●	●
	Trees for Shading	●	●	●	●	●	●	●	●
Int. Lighting	Interior Lighting - Occupancy Sensors	●	●	●	●	●	●	●	●
Exterior Lighting	Exterior Lighting - Photovoltaic Installation	●	●	●	●	●	●	●	●
	Exterior Lighting - Photosensor Control	●	●	●	●	●	●	●	●
	Exterior Lighting - Timeclock Installation	●	●	●	●	●	●	●	●
Water Heating	Water Heater - Faucet Aerators	●	●	●	●	●	●	●	●
	Water Heater - Pipe Insulation	●	●	●	●	●	●	●	●
	Water Heater - Low Flow Showerheads	●	●	●	●	●	●	●	●
	Water Heater - Tank Blanket/Insulation	●	●	●	●	●	●	●	●
	Water Heater - Thermostat Setback	●	●	●	●	●	●	●	●
	Water Heater - Timer	●	●	●	●	●	●	●	●
	Water Heater - Hot Water Saver	●	●	●	●	●	●	●	●
	Water Heater - Drainwater Heat Recovery		●		●		●		●
	Water Heater - Convert to Gas	●	●	●	●	●	●	●	●
	Water Heater - Heat Pump Water Heater	●	●	●	●	●	●	●	●
Appliances	Refrigerator - Early Replacement	●		●		●		●	
	Refrigerator - Remove Second Unit	●		●		●		●	
	Freezer - Early Replacement	●		●		●		●	
	Freezer - Remove Second Unit	●		●		●		●	
Electronics	Electronics - Reduce Standby Wattage	●	●	●	●	●	●	●	●
Misc.	Pool - Pump Timer	●	●			●	●	●	●
Multiple End Uses	Home Energy Management System	●	●	●	●	●	●	●	●
	Advanced New Construction Designs		●		●		●		●
	Energy Efficient Manufactured Homes						●		
	ENERGY STAR Homes		●						
	Photovoltaic System	●	●	●	●	●	●	●	●

Table 5-3 Summary of Commercial and Industrial Equipment Measures

End Use	Technology	Efficiency Option	Small/Med. Comm. (existing & new)	Large Comm. (existing & new)	Extra Large Comm. (existing & new)	Extra Large Ind. (existing & new)
Cooling	Central Chiller	1.5 kW/ton, COP 2.3	●	●		
	Central Chiller	1.3 kW/ton, COP 2.7	●	●		
	Central Chiller	1.26 kW/ton, COP 2.8	●	●		
	Central Chiller	1.0 kW/ton, COP 3.5	●	●		
	Central Chiller	0.97 kW/ton, COP 3.6	●	●		
	Central Chiller	0.75 kw/ton, COP 4.7			●	●
	Central Chiller	0.60 kw/ton, COP 5.9			●	●
	Central Chiller	0.58 kw/ton, COP 6.1			●	●
	Central Chiller	0.55 kw/Ton, COP 6.4			●	●
	Central Chiller	0.51 kw/ton, COP 6.9			●	●
	Central Chiller	0.50 kw/Ton, COP 7.0			●	●
	Central Chiller	0.48 kw/ton, COP 7.3			●	●
	Central Chiller	Variable Refrigerant Flow	●	●	●	●
	RTU	EER 9.2	●	●	●	●
	RTU	EER 10.1	●	●	●	●
	RTU	EER 11.2	●	●	●	●
	RTU	EER 12.0	●	●	●	●
	RTU	Ductless VRF	●	●	●	●
Heat & Cool	PTAC	EER 9.8	●	●	●	●
	PTAC	EER 10.2	●	●	●	●
	PTAC	EER 10.8	●	●	●	●
	PTAC	EER 11	●	●	●	●
	PTAC	EER 11.5	●	●	●	●
	Heat Pump	EER 9.3, COP 3.1	●	●	●	●
	Heat Pump	EER 10.3, COP 3.2	●	●	●	●
	Heat Pump	EER 11.0, COP 3.3	●	●	●	●
	Heat Pump	EER 11.7, COP 3.4	●	●	●	●
	Heat Pump	EER 12, COP 3.4	●	●	●	●
	Heat Pump	Ductless Mini-Split System	●	●	●	●
	Heat Pump	Geothermal*	●	●	●	●
Space Heating	Electric Resistance	Standard	●	●	●	●
	Furnace	Standard	●	●	●	●
Ventilation	Ventilation	Constant Volume	●	●	●	●
	Ventilation	Variable Air Volume	●	●	●	●

*** New construction only**

Table 5-3 Summary of Commercial and Industrial Equipment Measures (continued)

End Use	Technology	Efficiency Option	Small/Med. Comm. (existing & new)	Large Comm. (existing & new)	Extra Large Comm. (existing & new)	Extra Large Ind. (existing & new)
Interior Lighting	Interior Screw-in	Incandescents	•	•	•	•
	Interior Screw-in	Infrared Halogen	•	•	•	•
	Interior Screw-in	CFL	•	•	•	•
	Interior Screw-in	LED	•	•	•	•
	HID	Metal Halides	•	•	•	•
	HID	High Pressure Sodium	•	•	•	•
	Linear Fluorescent	T12	•	•	•	•
	Linear Fluorescent	T8	•	•	•	•
	Linear Fluorescent	Super T8	•	•	•	•
	Linear Fluorescent	T5	•	•	•	•
	Linear Fluorescent	LED	•	•	•	•
Exterior Lighting	Exterior Screw-in	Incandescents	•	•	•	•
	Exterior Screw-in	Infrared Halogen	•	•	•	•
	Exterior Screw-in	CFL	•	•	•	•
	Exterior Screw-in	Metal Halides	•	•	•	•
	Exterior Screw-in	LED	•	•	•	•
	HID	Metal Halides	•	•	•	•
	HID	High Pressure Sodium	•	•	•	•
	HID	Low Pressure Sodium	•	•	•	•
	Linear Fluorescent	T12	•	•	•	•
	Linear Fluorescent	T8	•	•	•	•
	Linear Fluorescent	Super T8	•	•	•	•
	Linear Fluorescent	T5	•	•	•	•
	Linear Fluorescent	LED	•	•	•	•
Water Heating	Water Heater	Baseline (EF=0.90)	•	•	•	
	Water Heater	High Efficiency (EF=0.95)	•	•	•	
	Water Heater	Geothermal Heat Pump	•	•	•	
	Water Heater	Solar	•	•	•	
Food Preparation	Fryer	Standard	•	•	•	
	Fryer	Efficient	•	•	•	
	Oven	Standard	•	•	•	
	Oven	Efficient	•	•	•	
	Dishwasher	Standard	•	•	•	
	Dishwasher	Efficient	•	•	•	
	Hot Food Container	Standard	•	•	•	
	Hot Food Container	Efficient	•	•	•	
	Food Prep Misc.	Standard	•	•	•	
	Food Prep Misc.	Efficient	•	•	•	

Table 5-3 Summary of Commercial and Industrial Equipment Measures (continued)

End Use	Technology	Efficiency Option	Small/Med. Comm. (existing & new)	Large Comm. (existing & new)	Extra Large Comm. (existing & new)	Extra Large Ind. (existing & new)
Refrigeration	Walk in Refrigeration	Standard	●	●	●	
	Walk in Refrigeration	Efficient	●	●	●	
	Glass Door Display	Standard	●	●	●	
	Glass Door Display	Efficient	●	●	●	
	Solid Door Refrigerator	Standard	●	●	●	
	Solid Door Refrigerator	Efficient	●	●	●	
	Open Display Case	Standard	●	●	●	
	Open Display Case	Efficient	●	●	●	
	Vending Machine	Base	●	●	●	
	Vending Machine	Base (2012)	●	●	●	
	Vending Machine	High Efficiency	●	●	●	
	Vending Machine	High Efficiency (2012)	●	●	●	
	Icemaker	Standard	●	●	●	
	Icemaker	Efficient	●	●	●	
Office Equipment	Desktop Computer	Baseline	●	●	●	
	Desktop Computer	ENERGY STAR	●	●	●	
	Desktop Computer	Climate Savers	●	●	●	
	Laptop Computer	Baseline	●	●	●	
	Laptop Computer	ENERGY STAR	●	●	●	
	Laptop Computer	Climate Savers	●	●	●	
	Server	Standard	●	●	●	
	Server	ENERGY STAR	●	●	●	
	Monitor	Standard	●	●	●	
	Monitor	ENERGY STAR	●	●	●	
	Printer/copier/fax	Standard	●	●	●	
	Printer/copier/fax	ENERGY STAR	●	●	●	
	POS Terminal	Standard	●	●	●	
	POS Terminal	ENERGY STAR	●	●	●	
Miscellaneous	Non-HVAC Motor	Standard	●	●	●	
	Non-HVAC Motor	Standard (2015)	●	●	●	
	Non-HVAC Motor	High Efficiency	●	●	●	
	Non-HVAC Motor	High Efficiency (2015)	●	●	●	
	Non-HVAC Motor	Premium	●	●	●	
	Non-HVAC Motor	Premium (2015)	●	●	●	
	Other Miscellaneous	Miscellaneous	●	●	●	●
	Other Miscellaneous	Miscellaneous (2013)	●	●	●	

Table 5-3 Summary of Commercial and Industrial Equipment Measures (continued)

End Use	Technology	Efficiency Option	Small/Med. Comm. (existing & new)	Large Comm. (existing & new)	Extra Large Comm. (existing & new)	Extra Large Ind. (existing & new)
Machine Drive	Less than 5 HP	Standard				●
	Less than 5 HP	High Efficiency				●
	Less than 5 HP	Standard (2015)				●
	Less than 5 HP	Premium				●
	Less than 5 HP	High Efficiency (2015)				●
	Less than 5 HP	Premium (2015)				●
	5-24 HP	Standard				●
	5-24 HP	High				●
	5-24 HP	Premium				●
	25-99 HP	Standard				●
	25-99 HP	High				●
	25-99 HP	Premium				●
	100-249 HP	Standard				●
	100-249 HP	High				●
	100-249 HP	Premium				●
	250-499 HP	Standard				●
	250-499 HP	High				●
	250-499 HP	Premium				●
	500 and more HP	Standard				●
	500 and more HP	High				●
	500 and more HP	Premium				●
Process	Process Cooling/Refrig.	Standard				●
	Process Cooling/Refrig.	Efficient				●
	Process Heating	Standard				●
	Process Heating	Efficient				●
	Electrochemical Process	Standard				●
	Electrochemical Process	Efficient				●

Table 5-4 Summary of Commercial and Industrial Non-equipment Measures

End Use	Measure	Commercial Existing Buildings	Commercial New Construction	Industrial Existing Buildings	Industrial New Construction
HVAC	RTU - Maintenance	●	●	●	●
	RTU - Evaporative Precooler	●	●		
	Chiller - Chilled Water Reset	●	●	●	●
	Chiller - Chilled Water Variable-Flow System	●	●	●	●
	Chiller - Condenser Water Temprature Reset	●	●	●	●
	Chiller - High Efficiency Cooling Tower Fans	●	●	●	●
	Chiller - Turbocor Compressor	●	●	●	●
	Chiller - VSD	●	●	●	●
	Cooling - Economizer Installation	●	●	●	●
	Heat Pump - Maintenance	●	●	●	●
	Insulation - Ducting	●	●	●	●
	Repair and Sealing - Ducting	●		●	
	Insulation - Ceiling	●	●		
	Insulation - Radiant Barrier	●	●		
	Insulation - Wall Cavity		●		
	Cooking - Exhaust Hoods with Sensor Control	●	●		
	Fans - Energy Efficient Motors	●	●	●	●
	Fans - Variable Speed Control	●	●	●	●
	Pumps - Variable Speed Control	●	●		
	Thermostat - Clock/Programmable	●	●	●	●
	Roofs - High Reflectivity	●	●		
	Roofs - Green		●		
	Windows - High Efficiency	●	●		
	Retrocommissioning - HVAC	●		●	
	Commissioning - HVAC		●		●
	Furnace - Convert to Gas	●	●	●	●
Interior Lighting	Interior Fluorescent - Photocell Controlled T8 Dimming	●	●		
	Interior Fluorescent - Delamp and Install Reflectors	●		●	
	Interior Fluorescent - Bi-Level Fixture w/Occupancy Sen	●	●		
	Interior Fluorescent - High Bay Fixtures	●	●	●	●
	Interior Screw-in - Task Lighting	●	●	●	●
	Central Lighting Controls	●	●	●	●
	Occupancy Sensors	●	●	●	●
	Time Clocks and Timers	●	●	●	●
	LED Exit Lighting	●	●	●	●
	Hotel Guestroom Controls	●	●		
	Retrocommissioning - Lighting	●		●	
	Commissioning - Lighting		●		●
Exterior Lighting	Daylighting Controls	●	●	●	●
	Photovoltaic Installation	●	●	●	●
	Cold Cathode Lighting	●	●	●	●
	Induction Lamps	●	●		

Note: Conversion of electric furnaces to gas was only modeled for Small/Medium Commercial segment.

Table 5-4 Summary of Commercial and Industrial Non-equipment Measures (continued)

End Use	Measure	Commercial Existing Buildings	Commercial New Construction	Industrial Existing Buildings	Industrial New Construction
Water Heating	Faucet Aerators/Low Flow Nozzles	●	●		
	Hot Water Saver	●	●		
	Pipe Insulation	●	●		
	Tank Blanket/Insulation	●	●		
	Thermostat Setback	●	●		
	Convert to Gas	●	●		
	Heat Pump Water Heater	●	●		
Refrigeration	Floating Head Pressure	●	●		
	Insulation - Bare Suction Lines	●	●		
	Demand Defrost	●	●		
	High Efficiency Case Lighting	●	●		
	Evaporator Fan Controls	●	●		
	Anti-Sweat Heater/Auto Door Closer	●	●		
	Door Gasket Replacement	●	●		
	Night Covers	●	●		
	Strip Curtain	●	●		
	Vending Machine - Controller	●	●		
Office Equipment	ENERGY STAR Power Supply	●	●		
Miscellaneous	Laundry - High Efficiency Clothes Washer	●	●		
	Miscellaneous - Energy Star Water Cooler	●	●		
Machine Drive	Motors - Variable Frequency Drive			●	●
	Motors - Magnetic Adjustable Speed Drives			●	●
	Compressed Air - System Controls			●	●
	Compressed Air - System Optimization & Improvements			●	●
	Compressed Air - System Maintenance			●	●
	Compressed Air - Compressor Replacement			●	●
	Fan System - Controls			●	●
	Fan System - Optimization			●	●
	Fan System - Maintenance			●	●
	Pumping System - Controls			●	●
	Pumping System - Optimization			●	●
	Pumping System - Maintenance			●	●
	Pumps - Variable Speed Control	●	●	●	●
Industrial Process	Industrial Process Improvements	●	●		
	Refrigeration - System Controls			●	●
	Refrigeration - System Maintenance			●	●
	Refrigeration - System Optimization			●	●
Multiple End Uses	Energy Management System	●	●	●	●
	Retrocommissioning - Comprehensive	●			
	Advanced New Construction Designs		●		●
	Commissioning - Comprehensive		●		
	Pumps - Variable Speed Control	●	●	●	●
	Custom Measures	●	●	●	●

Note: Conversion of electric water heaters to gas only modeled for Small/Medium Commercial segment.

5.2 MEASURE CHARACTERISTICS

For each measure considered, the Global team developed the following data for input to the LoadMAP model:

- ***Energy Impacts:*** The energy-savings impacts represent the annual reduction in consumption attributable to each specific measure. Savings were developed as a percentage of the energy end use that the measure affects. This approach takes into account the efficiency of the equipment that is providing that end use. For example, savings due to increased insulation will be greater if heating is provided by electric resistance, and lower if heating is provided by a heat pump. For the residential and commercial sectors, the BEST simulation model was used to determine the savings impacts. The key advantage of utilizing BEST is that interactive effects between HVAC measures and other measures such as lighting and building construction are captured and quantified. In addition, the prototype modeling combines the primary market data with Spokane-specific Typical Meteorological Year (TMY) weather data to derive savings. For the industrial sector, secondary data resources such as the EPRI National Potential Study and DEEM were used to develop assessments of savings at the end-use level.
- ***Peak Demand Impacts:*** Savings during the peak demand periods are specified for each measure. These impacts relate to the energy savings and depend on each measure's "coincidence" with the system peak. To accurately express the peak impacts of the energy efficiency measures considered, the project used a combined approach of prototype simulation (BEST model) and Global's proprietary end-use load shape database, EnergyShape.
- ***Costs:*** For equipment measures, the measure characterization includes the full cost of purchasing and installing the equipment on a per-unit or per-square-foot basis for the residential and C&I sectors, respectively. For non-equipment measures in existing buildings, the cost likewise represents the full installed cost. For non-equipment measures in new construction, the approach is slightly different; the costs may be either the full cost of the measure, for example a programmable thermostat, or as appropriate, it may be the incremental cost of upgrading from a standard level to a higher efficiency level, such as upgrading from R13 to R26 insulation. These costs were developed specifically for the Spokane area and drew upon sources including the Sixth Plan databases.
- ***Measure Lifetimes:*** These estimates were derived from the technical data and secondary data sources that support the measure demand and energy savings analysis. Values were obtained from the Sixth Plan database, DEER database, DEEM, and other secondary sources.
- ***Applicability:*** This factor is an estimate of the percentage of either dwellings in the residential sector or square feet in the C&I sectors where it is technically feasible for the specific measure to be implemented. These figures are based on secondary data sources such as NEEA reports, California's DEER database, DEEM, and others.
- ***On Market and Off Market Availability:*** To account for the fact that some equipment will no longer be available for sale due to changes in appliance standards, or that some high-efficiency equipment is expected to enter the market during the study period, the project also developed on market and off market inputs, expressed as years, for the equipment measures.

5.2.1 Measure Cost Data Development

Costs for equipment and non-equipment measures include both material and labor costs associated with the measure's installation. These costs draw upon national construction cost averages.

The following references were used to develop the equipment and measure costs:

- Sixth Northwest Conservation and Electric Power Plan Conservation Supply Curves workbooks
- DEER – California Database for Energy Efficient Resources
- RS Means Facilities Maintenance and Repair Cost Data
- RS Means Mechanical Construction Costs
- RS Means Building Construction Cost Data
- USGBC — LEED New Construction & Major Renovation (2008)
- RS Means Green Buildings Project Planning & Cost Estimating Second Edition (2008)
- Grainger Catalog Volume 398, (2007-2008)

5.2.2 Representative Measure Data Inputs

To provide an example of the measure data, Table 5-5 and Table 5-6 present samples of the detailed data inputs behind equipment and non-equipment measures, respectively, for the case of residential central air conditioning in single-family homes. Table 5-5 displays the various efficiency levels available as equipment measures, as well as the corresponding useful life, usage, and cost estimates. These values all contribute to the outcome of the stock accounting model, in which the purchase of an above-standard unit is first analyzed for cost-effectiveness (comparing incremental cost to lifetime benefits) and then, for the levels that pass the screen, incorporated into the new units purchased.

Table 5-5 Sample Equipment Measures for Central Air Conditioning — Single Family Home Segment

Efficiency Level	Useful Life	Equipment Cost	Energy Usage(kWh/yr)	On Market	Off Market
SEER 13	15	$3,794	1,619	2009	2014
SEER 14 (ENERGY STAR)	15	$4,072	1,485	2009	2032
SEER 15 (CEE Tier 2)	15	$4,350	1,435	2009	2032
SEER 16 (CEE Tier 3)	15	$4,628	1,393	2009	2032
Ductless Mini-split System	20	$8,193	1,214	2009	2032

Table 5-6 lists the non-equipment measures affecting an existing single-family home's central air conditioning electricity use. These measures are also evaluated for cost-effectiveness based on the lifetime benefits relative to the cost of the measure. The total savings are calculated for each year of the model and depend on the base year saturation of the measure, the overall applicability of the measure, and the savings as a percentage of the relevant energy end uses. Residential central air conditioning provides energy savings, but no demand savings due to Avista's existing heating season peak. In addition to the Applicability factor, a Feasibility factor is applied to account for the feasibility of installing the measure.

Table 5-6 Sample Non-Equipment Measures – Single Family Homes, Existing

End Use	Measure	Saturation in 2009[18]	Applicability	Feasibility	Lifetime (years)	Measure Installed Cost	Energy Savings (%)	Demand Savings (%)
Cooling	Central AC — Early Replacement	0%	80%	10%	15	$2,895	10.0%	0%
Cooling	Central AC — Maintenance and Tune-Up	41%	100%	100%	4	$125	10.0%	0%
Cooling	Attic Fan — Installation	11%	50%	45%	18	$116	0.7%	0%
Cooling	Attic Fan — Photovoltaic	13%	100%	45%	19	$350	1.4%	0%
Cooling	Ceiling Fan	52%	100%	75%	15	$160	11.0%	0%
Cooling	Whole-House Fan	7%	25%	75%	18	$200	9.0%	0%
Cooling	Insulation — Ducting	15%	100%	75%	18	$500	3.0%	0%
Cooling	Repair and Sealing — Ducting	12%	100%	50%	18	$500	10.0%	0%
Cooling	Doors — Storm and Thermal	38%	100%	75%	11	$320	1.0%	0%
Cooling	Insulation — Infiltration Control	46%	100%	90%	12	$266	3.0%	0%
Cooling	Insulation — Ceiling	68%	90%	80%	20	$594	3.0%	0%
Cooling	Insulation — Radiant Barrier	5%	100%	90%	12	$923	5.0%	0%
Cooling	Roofs — High Reflectivity	5%	100%	10%	15	$1,550	6.1%	0%
Cooling	Windows — Reflective Film	5%	50%	90%	10	$267	7.0%	0%
Cooling	Windows — High Efficiency/ENERGY STAR	83%	100%	90%	25	$7,500	12.0%	0%
Cooling	Thermostat — Clock/Programmable	55%	75%	75%	11	$114	8.0%	0%
Cooling	Home Energy Management System	20%	50%	75%	20	$300	10.0%	0%
Cooling	Photovoltaics	0%	80%	60%	15	$17,000	50.0%	0%
Cooling	Trees for Shading	10%	90%	75%	20	$40	1.1%	0%

5.2.3 Conversion to Natural Gas

Conversion to natural gas (fuel switching) for both space heating and water heating was evaluated as a special case. These options were evaluated as non-equipment measures, though of course, they are in fact equipment changes. Modeling conversion to gas as a non-equipment measure allowed using the applicability and feasibility factors to better account for customers' real ability to implement these technologies.

For conversion of water heaters to natural gas, an applicability factor was developed based on Avista GIS data combined with the market profiles to indicate that approximately 63% of Washington homes and 57% of Idaho homes with electric water heating are within 500 feet of a gas main. The feasibility factor of 80% assumes that other factors, such as inability to accommodate venting, would prevent 20% of customers from making the switch to gas water heating. For heat pump water heaters, we assumed the technology is applicable to the remaining customers (100% – (63% * 80%) = 50% in Washington and 54% using a similar calculation for

[18] Note that saturation levels reflected for 2009 change over time as more measures are adopted.

Idaho). However, the feasibility factor is 50% for single family homes because only about half of these customers have water heating systems with tanks larger than 55 gallons that are suitable for heat pump water heaters. For the other housing types, the feasibility factors were lower due to the still lower saturation of larger than 55 gallon water heating systems. Conversion of electric furnaces to gas was modeled using similar assumptions.

Table 5-7 shows assumptions for water heating non-equipment measures in Washington single-family homes, including the conversion to gas and heat pump measures discussed above.

Table 5-7 Sample Non-Equipment Water Heating Measures – Single Family Homes, Existing, Washington

End Use	Measure	Satura-tion in 2009[19]	Applica-bility	Feasi-bility	Lifetime (years)	Measure Installed Cost	Energy Savings (%)	Demand Savings (%)
Water Heating	Faucet Aerators	53%	100%	90%	25	$24	3.7%	1.9%
Water Heating	Pipe Insulation	17%	100%	38%	13	$180	5.7%	2.9%
Water Heating	Low Flow Showerheads	75%	100%	80%	10	$96	17.1%	8.6%
Water Heating	Tank Blanket/Insulation	17%	100%	75%	10	$15	9.1%	4.6%
Water Heating	Thermostat Setback	17%	100%	75%	5	$40	9.1%	4.6%
Water Heating	Timer	17%	100%	40%	10	$194	8.0%	4.0%
Water Heating	Hot Water Saver	5%	100%	50%	5	$35	8.8%	4.4%
Water Heating	Convert to Gas	0%	63%	80%	15	$3,675	100.0%	100.0%
Water Heating	Heat Pump	0%	50%	50%	15	$1,500	30.0%	15.0%

The equipment measure data tables for all energy efficiency measures assessed in this study are presented in Appendix C for the residential sector and Appendix C for the C&I sectors.

5.3 APPLICATION OF MEASURES FOR TECHNICAL POTENTIAL

Technical potential, as we defined it in Chapter 2, is a theoretical construct that assumes the highest efficiency measures that are technically feasible to install are adopted by customers, regardless of cost or customer preferences. Thus, determining the technical potential is relatively straightforward; LoadMAP uses the energy use associated with the most efficient equipment options for each end use and technology, as well as the energy savings for all defined non-equipment measures that apply to that end use and technology, to calculate energy use at the technical potential level. For example, for residential central air conditioning, as shown in Table 5-5, the most efficient option is a ductless mini-split system. The multiple non-equipment measures shown in Table 5-7 are then applied to the energy used by the ductless mini-split system to further reduce CAC energy use. LoadMAP applies the savings due to the non-equipment measures one-by-one to avoid double counting of savings. The measures are evaluated in order of their B/C ratio, with the measure with the highest B/C ratio applied first. Each time a measure is applied, the baseline energy use for the end use is reduced and the percentage savings for the next measure is applied to the revised (lower) usage.

5.4 APPLICATION OF MEASURES FOR ECONOMIC POTENTIAL

Next, to determine the economic level of efficiency potential, it is necessary to perform an economic screen on each individual measure. The economic screen applied in this study for non-

[19] Note that saturation levels reflected for 2009 change over time as more measures are adopted.

equipment measures is a total resource cost (TRC) test that compares the lifetime benefits (both energy and peak demand) of each applicable measure with installed cost (including material, labor, and administration of a delivery mechanism, such as an energy efficiency program).[20] The lifetime benefits are obtained by multiplying the annual energy and demand savings for each measure by all appropriate avoided costs for each year, and discounting the dollar savings to the present value equivalent. Global assigns each measure values for savings, costs, and lifetimes as part of our measure characterization process. For economic screening of measures, incentives are not included because they represent a simple transfer from one party to another but have no effect on the overall measure cost.

The lifetime benefits of each energy efficiency measure depend on the forecast of Avista avoided costs. Avista provided projected avoided costs for energy and capacity over the study period. Figure 5-2 shows the avoided energy costs for the residential and C&I segments, which are 2009 real $/MWh and include Avista's adjustments for risk and the 10% Power Act premium. The avoided energy costs differ by segment due to the segments' differing load shapes. Figure 5-2 also shows the avoided capacity costs for Avista's overall system in 2009 real $/kW.

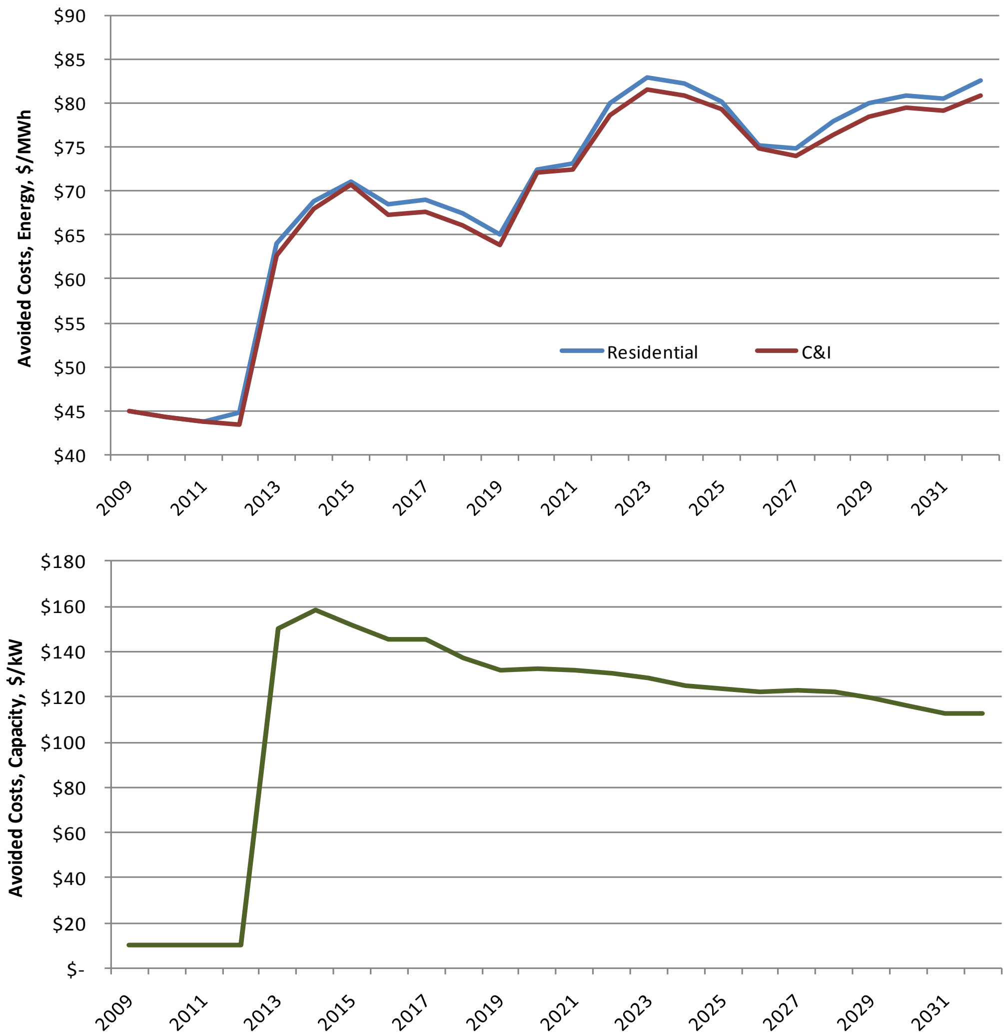
The LoadMAP model performs the economic screening dynamically, taking into account changing savings and cost data over time. Thus, some measures pass the economic screen for some — but not all — of the years in the forecast.

It is important to note the following about the economic screen:

- The economic evaluation of every measure in the screen is conducted relative to a baseline condition. For instance, in order to determine the kilowatt-hour (kWh) savings potential of a measure, kWh consumption with the measure applied must be compared to the kWh consumption of a baseline condition.
- The economic screening was conducted only for measures that are applicable to each building type and vintage; thus if a measure is deemed to be irrelevant to a particular building type and vintage, it is excluded from the respective economic screen table.

[20] Note that the TRC test is typically the industry standard for evaluating measure-level cost-effectiveness. There are other test perspectives that are often considered in energy efficiency potential studies. The Participant test measures the benefits and costs from the perspective of program participants as a whole. The Ratepayer Impact Measure (RIM) test measures the difference between the change in total revenues paid to a utility and the change in total costs to a utility resulting from the energy efficiency and demand response programs. The Utility Cost (UC) test measures the costs and benefits from the perspective of the utility administering the program. Neither the RIM nor UC tests are typically applied in the context of measure-level economic screens, but rather in the broader context of energy efficiency programs and initiatives put into place to deliver the energy efficiency measures.

Figure 5-2 Avoided Costs for Energy and Capacity



5.4.1 Equipment Measures Economic Screening

For equipment measures, LoadMAP evaluates the cost-effectiveness of each measure option, compared to the efficiency option that immediately precedes it. Continuing with the example of residential central air conditioning, as shown in Table 5-5, the standard efficiency option in 2010 is SEER 13. LoadMAP calculates the lifetime benefits and costs associated with each of the higher efficiency options to select the option with the highest net present value.

Table 5-8 shows the results of the economic screen for CAC for selected years, as well as results for two interior lighting technologies. In 2010, the most cost-effective option is SEER 14, while in 2012, due to rising energy costs, it changes to SEER 15. However, in 2015, due to federal energy efficiency standards, the SEER 13 unit goes off the market and SEER 14 becomes the standard efficiency unit. In 2015 and beyond, the economic screen selects the SEER 14 option because the marginal savings between the standard efficiency SEER 14 unit and the higher-efficiency options are not sufficient to make the higher-efficiency units economical. The table also shows how the economic choice for two of the lighting technology options varies over the study period.

Table 5-8 Economic Screen Results for Selected Residential Equipment Measures

Technology	2012	2017	2022	2027	2032
Central AC	SEER 13	SEER 14	SEER 14	SEER 14	SEER 14
Interior Lighting Screw-in	CFL	CFL	CFL	LED	LED
Interior Lighting Linear Fluorescent	T8	T8	T8	Super T8	Super T8

5.4.2 Non-equipment Measures Economic Screening

For non-equipment measures, LoadMAP evaluates the cost-effectiveness of each measure. The kWh savings are computed as the percent savings from the measure applied to the relevant end-use energy. If the measure passes the screen (has a B/C ratio greater than or equal to 1.0), the measure is included in economic potential. Otherwise, it is screened out for that year.

5.5 TOTAL MEASURES EVALUATED

Table 5-9 summarizes the number of equipment and non-equipment measures evaluated for each sector. In total, the project evaluated 4,332 energy efficiency measures.

Table 5-9 Number of Measures Evaluated

	Residential	C&I	Total Number of Measures
Equipment Measures Evaluated	1,284	608	1,892
Non-Equipment Measures Evaluated	1,524	916	2,440
Total Measures Evaluated	**2,808**	**1,524**	**4,332**

Appendix C shows the results of the economic screening process by segment, vintage, end use and measure for the residential sector. Appendix D shows the equivalent information for the commercial and industrial sectors.

CHAPTER | 6

ENERGY EFFICIENCY POTENTIAL RESULTS

This chapter presents the results of the energy-efficiency analysis. Before we provide the overall and sector-level results, we review the four levels of potential developed for this study.

6.1 DEFINITIONS OF POTENTIAL

In this study, we estimated four types of potential: *technical; economic;* and achievable potential, which is further divided into *maximum achievable,* and *realistic achievable*. Technical and economic potential are both theoretical limits to efficiency savings. Achievable potential embodies a set of assumptions about the decisions consumers make regarding the efficiency of the equipment they purchase, the maintenance activities they undertake, the controls they use for energy-consuming equipment, and the elements of building construction. Two types of achievable potential were developed for this study, maximum achievable and realistic achievable, to bound the range of achievable potential. For details on the types of potentials, see Chapter 2.

As with the baseline forecast, we developed the estimates of energy-efficiency potential using the LoadMAP model. We present high-level results in the rest of this chapter for the overall Avista electricity system. Separate results for Washington and Idaho are presented in Appendices A and B.

6.2 OVERALL ENERGY EFFICIENCY POTENTIAL

Maximum achievable potential across all sectors is 88,760 MWh (10.1 aMW) in 2012 and increases to a cumulative value of 2,905,702 MWh (331.7 aMW) by 2032. These savings represents 1.0% of the baseline forecast in 2012 and 22.6% in 2032. Realistic achievable potential in 2012 is 50,261 MWh (5.7 aMW) and reaches a cumulative value of 2,155,133 MWh (246.0 aMW) by 2032, for savings that are 0.6% and 16.8% of the baseline in 2012 and 2032 respectively. Between 2012 and 2032, the baseline forecast shows overall electricity consumption growth of 46%, but the realistic achievable potential forecast reduces growth by half to 23%. Technical potential by 2032 is 37.8% of the baseline and economic potential savings are 26.4% of the baseline, or roughly 70% of technical potential savings. MAP and RAP savings in 2012 are 86% and 64% respectively of the economic potential savings.

Figure 6-1 summarizes the energy-efficiency savings for the four potential levels relative to the baseline forecast for selected years. Figure 6-2 displays the energy use forecast for the four potential levels versus the baseline forecast. Table 6-1 presents the energy consumption and peak demand for the potential levels across sectors.

Figure 6-1 Summary of Energy Efficiency Potential Savings, All Sectors

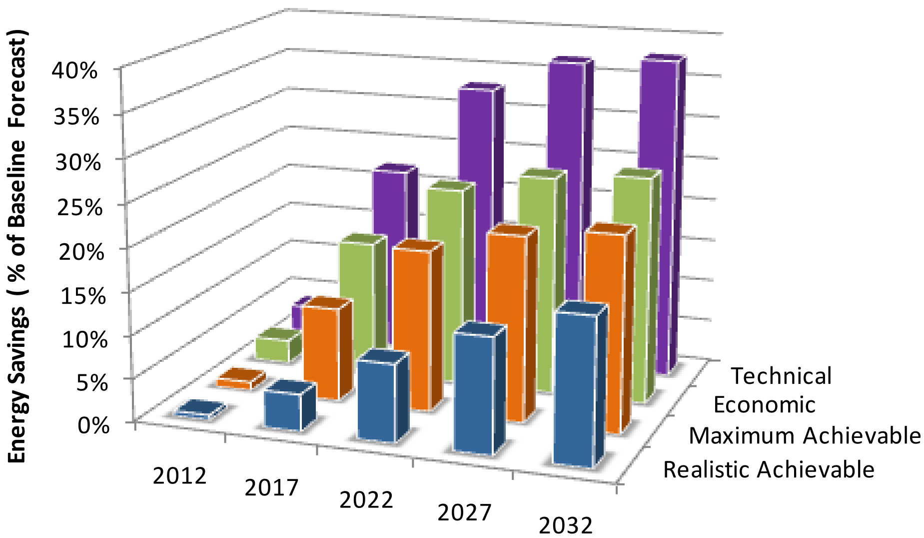


Figure 6-2 Energy Efficiency Potential Forecasts, All Sectors

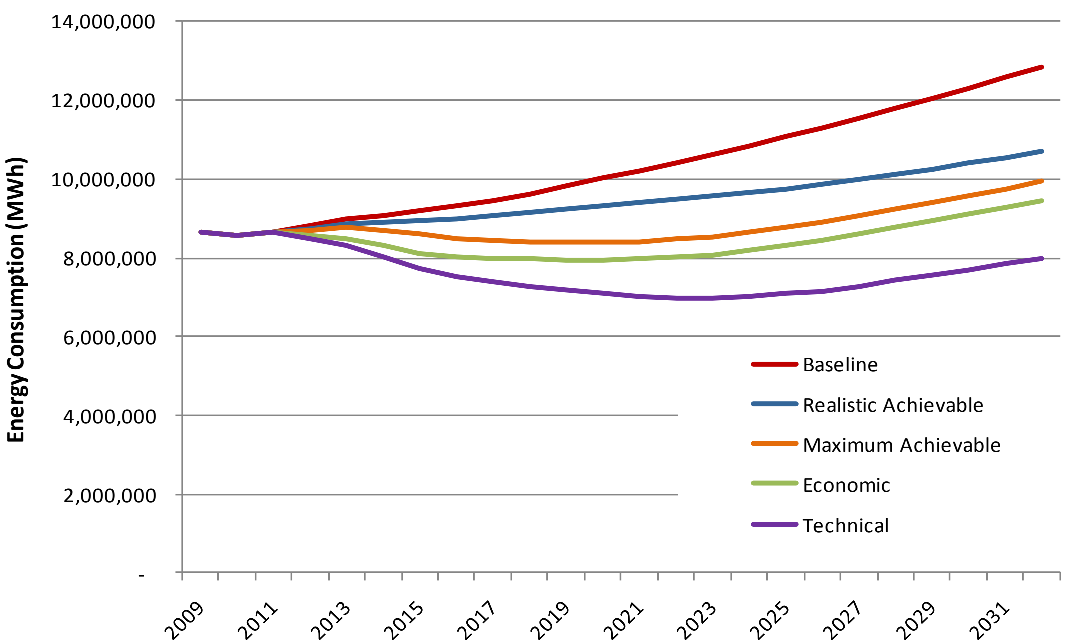


Table 6-1 Summary of Energy Efficiency Potential, All Sectors

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	8,799,039	9,463,880	10,417,347	11,536,869	12,851,760
Baseline Peak Demand (MW)	1,780	1,880	2,080	2,306	2,566
Cumulative Energy Savings (MWh)					
Realistic Achievable	50,261	405,985	945,183	1,536,357	2,155,133
Maximum Achievable	88,760	1,035,470	1,952,473	2,476,694	2,905,702
Economic	244,292	1,493,608	2,411,399	2,937,775	3,387,203
Technical	329,513	2,087,061	3,435,475	4,250,217	4,852,362
Cumulative Energy Savings (% of Baseline)					
Realistic Achievable	0.6%	4.3%	9.1%	13.3%	16.8%
Maximum Achievable	1.0%	10.9%	18.7%	21.5%	22.6%
Economic	2.8%	15.8%	23.1%	25.5%	26.4%
Technical	3.7%	22.1%	33.0%	36.8%	37.8%
Peak Savings (MW)					
Realistic Achievable	14	84	183	306	431
Maximum Achievable	22	207	386	492	566
Economic	60	302	479	580	659
Technical	78	422	669	826	943
Peak Savings (% of Baseline)					
Realistic Achievable	0.8%	4.5%	8.8%	13.3%	16.8%
Maximum Achievable	1.2%	11.0%	18.6%	21.3%	22.1%
Economic	3.4%	16.0%	23.0%	25.2%	25.7%
Technical	4.4%	22.4%	32.2%	35.8%	36.8%

Table 6-2 and Figure 6-3 summarize cumulative realistic achievable potential by sector. Initially, the residential sector accounts for about 52% of the savings, but by the end of the study, the C&I sector becomes the source of 58% of the savings.

Table 6-2 Realistic Achievable Cumulative Energy-efficiency Potential by Sector, MWh

Segment	2012	2017	2022	2027	2032
Residential, WA	17,413	94,529	238,739	431,973	637,029
Residential, ID	8,692	43,922	97,705	172,179	260,003
C&I, WA	15,733	173,433	378,252	575,328	774,619
C&I, ID	8,423	94,102	230,487	356,878	483,482
Total	50,261	405,985	945,183	1,536,357	2,155,133

Figure 6-3 Realistic Achievable Cumulative Potential by Sector

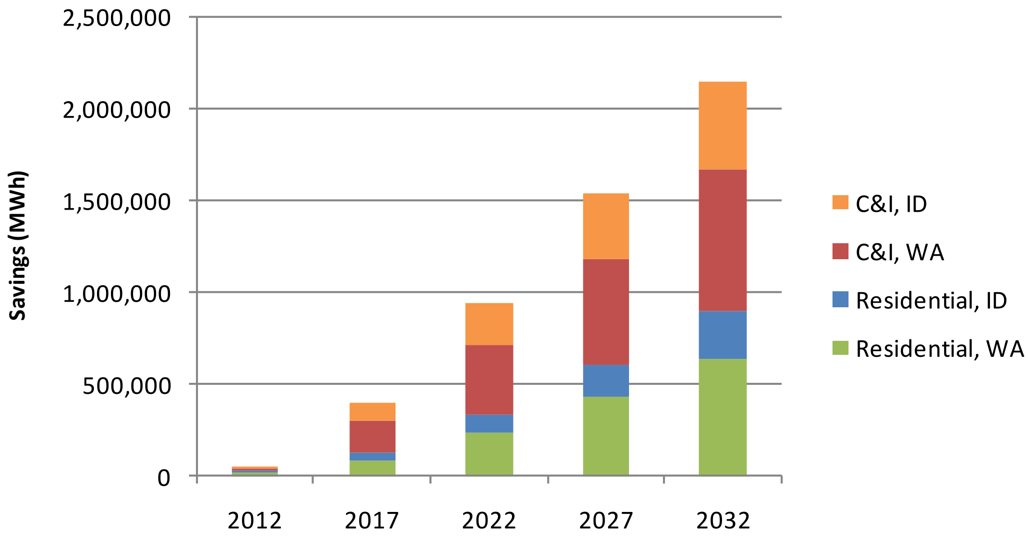


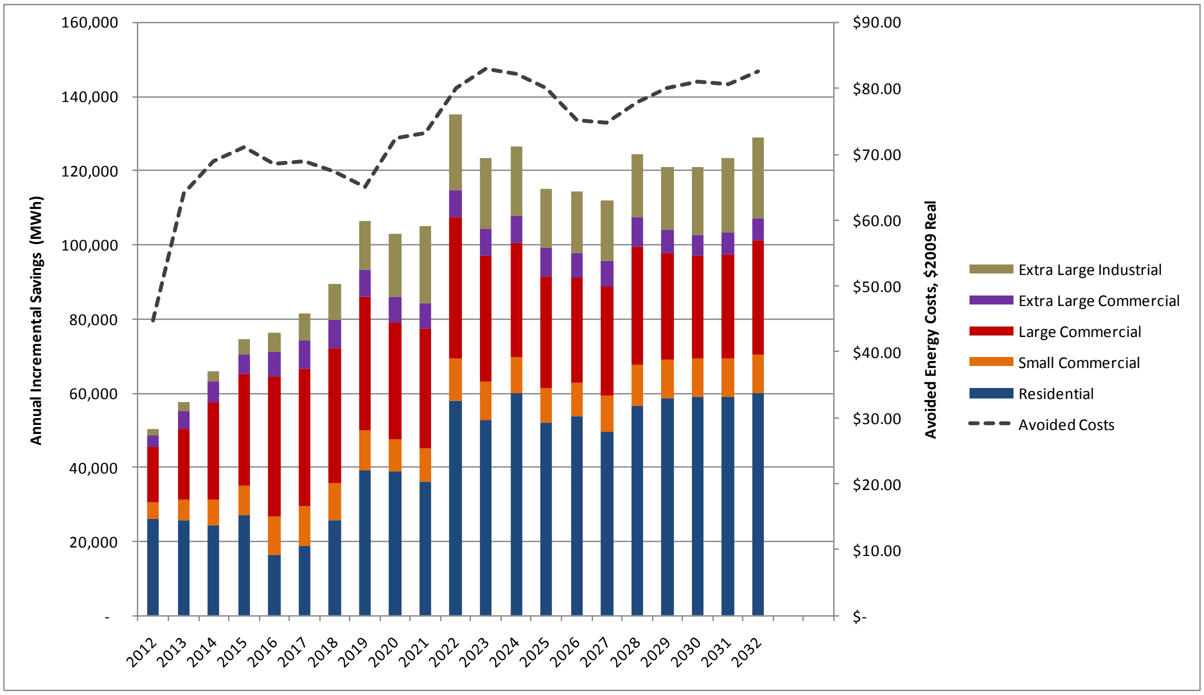
Table 6-3 shows the incremental annual realistic achievable potential by sector for 2012 through 2015. During this period, lighting and appliance standards slow the rate of growth in the residential baseline energy consumption, thus reducing the amount of incremental annual potential savings from residential conservation programs. On the other hand, C&I potential continues to grow. Complete annual incremental savings for Washington and Idaho appear in Appendices A and B respectively.

Table 6-3 Incremental Annual Realistic Achievable Energy-efficiency Potential by Sector, MWh

Segment	2012	2013	2014	2015
Residential, WA	17,413	17,161	16,488	18,514
Residential, ID	8,692	8,451	7,943	8,569
C&I, WA	15,733	21,165	26,869	30,393
C&I, ID	8,423	10,734	14,543	16,956
Total	**50,261**	**57,511**	**65,843**	**74,432**

In Figure 6-4, we can see how the annual incremental realistic achievable potential throughout the study tracks the avoided energy costs, with annual potential generally increasing or decreasing along with avoided costs. Note however that other factors also influence potential, particularly the rates at which programs can ramp up over time, which is particularly relevant to how potential changes from year to year in the early years of the study.

Figure 6-4 Incremental Annual Realistic Achievable Energy-efficiency (MWh) vs. Avoided Energy Cost



Note: Avoided costs are 2009 real dollars and include energy costs, risk, and the 10% Power Act premium.

6.3 RESIDENTIAL SECTOR

Realistic achievable potential savings for the residential sector in both states is 26,105 MWh in 2012, or 0.7% of the sector's baseline forecast. It reaches 897,032 MWh, or 16.0% of the baseline forecast by 2032. Technical and economic potential savings are 37.7% and 24.5% respectively. Figure 6-5 depicts the potential savings estimates graphically. Figure 6-6 shows the energy use forecasts under the four types of potential versus the baseline forecast. Table 6-3 presents estimates for energy and peak demand under the four types of potential.

Figure 6-5 Energy Efficiency Potential Savings, Residential Sector

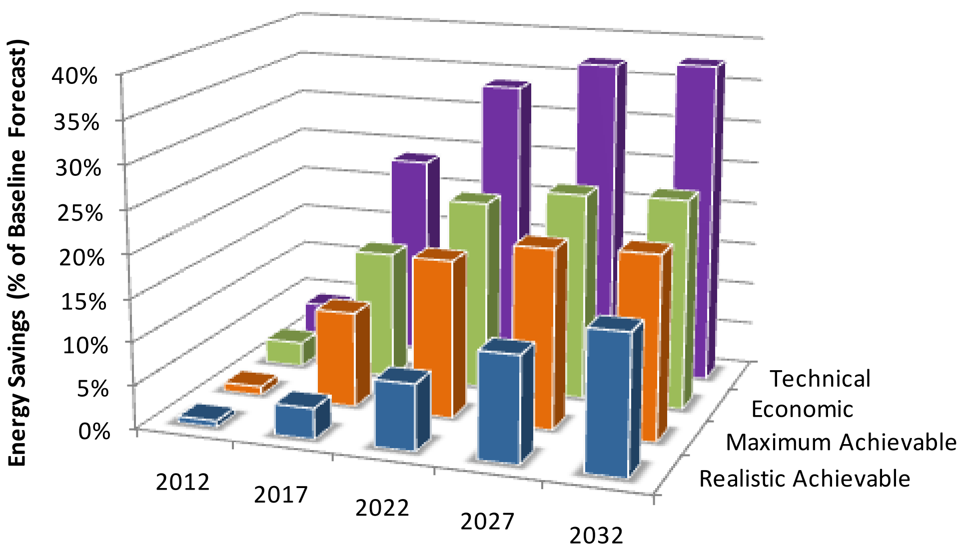


Figure 6-6 Energy Efficiency Potential Forecast, Residential Sector

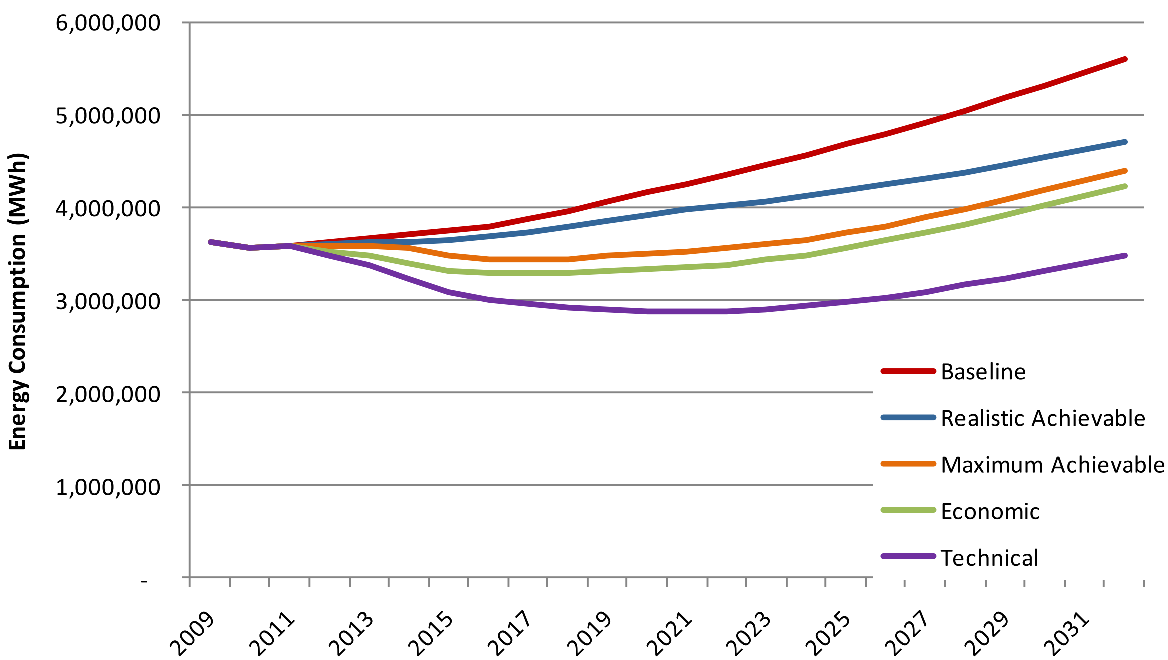


Table 6-4 Energy Efficiency Potential, Residential Sector

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	3,626,696	3,871,294	4,356,240	4,918,847	5,600,787
Baseline Peak Demand (MW)	991	1,026	1,150	1,288	1,449
Cumulative Energy Savings (MWh)					
Realistic Achievable	26,105	138,450	336,444	604,152	897,032
Maximum Achievable	36,300	429,065	798,829	1,024,671	1,192,794
Economic	104,111	583,427	967,788	1,188,497	1,373,869
Technical	153,100	918,965	1,468,041	1,825,587	2,112,855
Cumulative Energy Savings (% of Baseline)					
Realistic Achievable	0.7%	3.6%	7.7%	12.3%	16.0%
Maximum Achievable	1.0%	11.1%	18.3%	20.8%	21.3%
Economic	2.9%	15.1%	22.2%	24.2%	24.5%
Technical	4.2%	23.7%	33.7%	37.1%	37.7%
Peak Savings (MW)					
Realistic Achievable	10	44	100	179	262
Maximum Achievable	14	120	232	301	343
Economic	38	171	286	349	396
Technical	51	256	407	503	579
Peak Savings (% of Baseline)					
Realistic Achievable	1.1%	4.3%	8.7%	13.9%	18.1%
Maximum Achievable	1.4%	11.7%	20.2%	23.3%	23.7%
Economic	3.8%	16.7%	24.9%	27.1%	27.3%
Technical	5.1%	24.9%	35.4%	39.0%	40.0%

6.3.1 Residential Potential by Market Segment

Table 6-5 shows the baseline forecast and realistic achievable potential energy savings for the four residential segments in selected years. Single-family homes in Washington and Idaho account for 65% and 68% of each state's residential sector total sales during the base year and throughout the forecast. Thus, as one would expect, single-family homes account for the largest share of potential savings. Table 6-6 takes a closer look at savings by segment and potential level in 2022, the mid-point of the 20-year period.

Table 6-5 Residential Sector, Baseline and Realistic Achievable Potential by Segment

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)					
Single Family	2,394,930	2,551,956	2,876,301	3,252,564	3,709,958
Multi Family	203,544	222,114	253,265	288,585	330,209
Mobile Home	126,939	133,923	149,975	168,639	191,313
Limited Income	901,283	963,301	1,076,699	1,209,059	1,369,306
Total	3,626,696	3,871,294	4,356,240	4,918,847	5,600,787
Cumulative Energy Savings, Realistic Achievable Potential (MWh)					
Single Family	18,783	96,418	240,911	426,483	630,128
Multi Family	1,066	5,833	14,343	28,236	42,801
Mobile Home	985	4,280	7,677	13,381	20,040
Limited Income	5,272	31,920	73,512	136,051	204,063
Total	26,105	138,450	336,444	604,152	897,032
% of Total Residential Cumulative Energy Savings					
Single Family	72.0%	69.6%	71.6%	70.6%	70.2%
Multi Family	4.1%	4.2%	4.3%	4.7%	4.8%
Mobile Home	3.8%	3.1%	2.3%	2.2%	2.2%
Limited Income	20.2%	23.1%	21.8%	22.5%	22.7%

Table 6-6 Residential Realistic Achievable Potential by Housing Type, 2022

Forecast	Single Family	Multi Family	Mobile Home	Limited Income	Total
Baseline Forecast (MWh)	2,876,301	253,265	149,975	1,076,699	4,356,240
Cumulative Energy Savings (MWh)					
Realistic Achievable	240,911	14,343	7,677	73,512	336,444
Economic Potential	679,288	46,859	21,400	220,241	967,788
Technical Potential	950,449	77,463	52,154	387,975	1,468,041
Cumulative Energy Savings % of Baseline					
Realistic Achievable	8.4%	5.7%	5.1%	6.8%	7.7%
Economic Potential	23.6%	18.5%	14.3%	20.5%	22.2%
Technical Potential	33.0%	30.6%	34.8%	36.0%	33.7%

6.3.2 Residential Potential by End Use, Technology, and Measure Type

Table 6-7 provides estimates of savings for each end use and type of potential.

- ***Water Heating*** offers the highest cumulative technical potential over the 20-year period, which reflects the high potential for conversion to natural gas in homes where gas is available (see discussion below) and use of heat pump water heaters where gas is not available, as well as a wide range of other water heating measures. Conversion to natural gas passes the TRC test throughout the study period for most Washington housing types and for single family homes in Idaho. In contrast, based on the study's assumptions of equipment cost and avoided cost, heat pump water heaters are cost-effective in new single family homes by 2014, but do not become cost-effective for existing homes until 2024 in Idaho and 2028 in Washington. Water heating also has the highest cumulative realistic achievable potential.
- ***Space Heating*** offers the second-highest cumulative technical potential over the study and its economic potential is slightly higher than water heating, again due to the potential for conversion to natural gas (see discussion below), but also due to shell measures, controls, and advanced new construction designs. Based on realistic achievable savings, space heating also ranks second.
- ***Interior lighting*** offers the fourth-largest technical potential savings, but the third-largest economic and realistic achievable potential. The lighting standard begins its phase-in starting in 2012, which coincides with the availability in the market place of advanced incandescent lamps that meet the minimum efficacy standard. The baseline forecast assumes that people will install both advanced incandescent and CFLs in screw-in lighting applications. For technical potential, LED lamps are the most efficient option, starting in 2012. However, LED lamps do not pass the economic screen until 2022, when they begin to become cost-effective for pin-based fixtures. Nonetheless, there is significant economic and realistic achievable lighting potential due to conversion from advanced incandescents to CFLs.
- ***Appliances*** rank sixth based on technical potential, but fourth in terms of realistic achievable potential. This reflects the cost-effectiveness of the highest-efficiency white-goods appliances for both new construction and for replacing failed units, as well as the market acceptance of high-efficiency appliances. Removal of second refrigerators and freezers also contributes to economic and realistic achievable potential within this end use.
- ***Cooling*** offers the third-highest technical potential, but is sixth based on realistic achievable potential. Initially technical potential is low but ramps up due to the assumption of increased saturation of air conditioning over time. Economic potential for cooling in 2031 is about 40% of technical potential because the higher SEER units do not pass the economic screen based on based on the study's assumptions of equipment cost and avoided cost.
- ***Home electronics*** also offer substantial savings opportunities. Technical potential reflects the purchase of ENERGY STAR units for all technologies, except PCs and laptops for which a super-efficient "climate saver" option is available in the marketplace. However, the climate saver options are not cost-effective during the forecast horizon, so economic potential reflects the purchase of ENERGY STAR units across all technologies in this end use.

Table 6-7 Residential Cumulative Savings by End Use and Potential Type (MWh)

End Use	Case	2012	2017	2022	2027	2032
Cooling	Realistic Achievable	14	2,443	8,588	23,412	44,892
	Economic	364	22,925	41,690	60,482	82,185
	Technical	4,155	63,885	102,963	147,309	200,588
Space Heating	Realistic Achievable	306	17,366	81,141	187,511	304,466
	Economic	9,645	157,044	303,749	401,120	480,554
	Technical	13,047	206,921	390,626	523,886	650,322
Heat/Cool	Realistic Achievable	12	872	2,353	6,048	15,539
	Economic	447	12,872	15,291	18,697	27,916
	Technical	3,334	27,773	47,801	66,829	76,389
Water Heating	Realistic Achievable	636	25,578	102,451	201,179	317,521
	Economic	12,121	135,781	297,102	388,156	462,418
	Technical	35,027	281,264	527,056	667,224	745,280
Appliances	Realistic Achievable	1,282	12,411	26,859	42,554	59,056
	Economic	5,548	61,277	80,081	85,195	91,618
	Technical	7,229	78,554	105,335	113,831	120,932
Interior Lighting	Realistic Achievable	18,569	52,269	64,439	74,958	71,445
	Economic	55,377	107,842	116,225	106,057	86,182
	Technical	64,748	148,015	146,127	136,520	126,690
Exterior Lighting	Realistic Achievable	3,281	10,532	10,777	10,042	8,058
	Economic	9,770	21,965	17,611	13,313	9,494
	Technical	11,200	28,680	24,906	22,638	22,320
Electronics	Realistic Achievable	1,780	13,544	32,080	45,568	57,382
	Economic	8,967	45,853	67,702	76,036	87,323
	Technical	12,390	65,526	93,981	106,595	122,734
Miscellaneous	Realistic Achievable	225	3,435	7,756	12,880	18,673
	Economic	1,871	17,869	28,336	39,442	46,180
	Technical	1,970	18,348	29,247	40,754	47,600
Total	Realistic Achievable	26,105	138,450	336,444	604,152	897,032
	Economic	104,111	583,427	967,788	1,188,497	1,373,869
	Technical	153,100	918,965	1,468,041	1,825,587	2,112,855

Figure 6-7 focuses on realistic achievable potential by end use in selected years. As discussed above, by the end of the study period, water heating and space heating are the largest contributors to realistic achievable potential. In the early years of the study period, lighting maintains its historic role as the largest contributor to residential sector savings, due to remaining opportunities for conversion from incandescent lighting (both today's standard lamps and the new advanced incandescents) to CFLs. By 2022, however, the percentage of savings due to lighting is projected to drop off as advanced incandescents become the new baseline.

Figure 6-7 Residential Realistic Achievable Potential by End Use, Selected Years

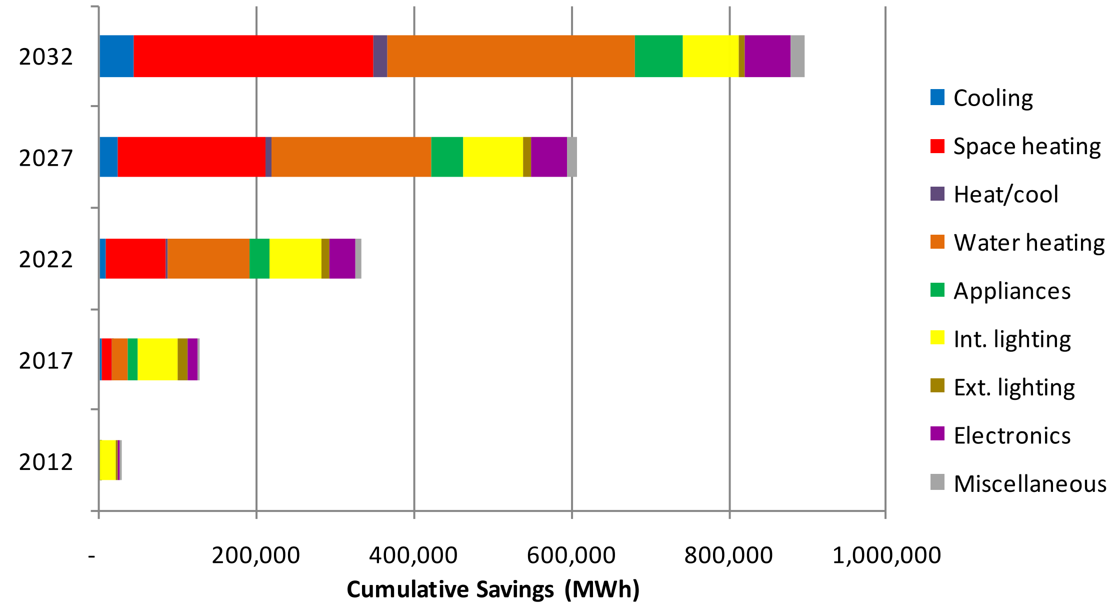


Table 6-8 shows the savings by end use and market segment in 2022. The segments are similar in terms of the savings opportunities by end use, but there are a few notable differences. Single-family homes have more exterior lighting and so have more savings potential for this end use. Similarly, single-family homes have swimming pools and therefore have more potential for savings in pool pumps, which are included in miscellaneous loads. Water heating is a higher proportion of potential savings in multi-family homes, mobile homes, and limited income homes, reflecting the smaller home sizes and thus diminished savings potential for space conditioning and appliances, compared to single family homes.

Table 6-8 Residential Potential by End Use and Market Segment, 2022 (MWh)

	Single Family	Multi Family	Mobile Home	Limited Income	Total
Cooling	4,975	258	129	3,226	8,588
Space heating	63,291	3,985	908	12,957	81,141
Heat/cool	2,138	12	88	114	2,353
Water heating	65,162	6,257	1,293	29,739	102,451
Appliances	19,090	529	950	6,290	26,859
Interior lighting	45,467	2,415	2,203	14,354	64,439
Exterior lighting	8,875	127	480	1,295	10,777
Electronics	25,054	754	1,302	4,970	32,080
Miscellaneous	6,860	6	324	566	7,756
Total	**240,911**	**14,343**	**7,677**	**73,512**	**336,444**

As described in Chapter 5, using our LoadMAP model, we develop separate estimates of potential for equipment and non-equipment measures. Table 6-9 presents results for equipment at the technology level, for which realistic chievable potential is greater than zero.

Table 6-9 Residential Cumulative Realistic Achievable Potential by End Use and Equipment Measures, Selected Years (MWh)

End Use	Technology	2012	2017	2022
Cooling	Central AC	-	152	167
Heat/Cool	Air Source Ht. Pump	-	-	-
Water Heating	Water Heater	140	1,047	1,096
Appliances	Clothes Washer	83	1,014	2,552
	Clothes Dryer	103	708	1,299
	Dishwasher	115	1,074	2,621
	Refrigerator	438	1,999	4,064
	Freezer	333	1,651	3,592
	Second Refrigerator	154	747	1,424
	Stove	22	165	371
Interior Lighting	Screw-in	17,292	42,771	48,939
	Linear Fluorescent	173	1,906	3,576
	Pin-based	1,102	7,398	11,079
Exterior Lighting	Screw-in	3,256	10,404	10,606
	High Intensity/Flood	25	128	171
Electronics	Personal Computers	1,148	9,279	15,975
	TVs	620	3,260	6,039
Miscellaneous	Pool Pump	171	1,581	3,896
	Furnace Fan	45	560	1,668
Total		**25,220**	**85,845**	**119,135**

Conversion of electric water heaters and electric furnaces to natural gas was modeled as a special case within the measure analysis to allow consideration of feasibility (e.g., homes too far from a natural gas line), as well as to allow the option of a heat pump water heater for homes where conversion to gas is not feasible. Table 6-10 shows the residential sector achievable savings from converting electric furnaces and water heaters to natural gas. Conversion ramps up slowly, but because it completely removes use of electricity from two of the largest ends uses, it accounts for a substantial portion of savings by 2032: For water heating, about one-fourth of the savings from conversion to gas occurs in new construction. For furnaces, the fraction due to new construction is roughly one-third.

Table 6-10 Residential Realistic Achievable Savings from Conversion to Natural Gas (MWh)

	2012	2017	2022	2027	2032
Water heater —convert to gas Realistic achievable potential (MWh)	267	10,214	69,745	145,049	216,351
Water heater –convert to gas (% of Res. Achievable potential)	0.5%	2.5%	7.4%	9.4%	10.0%
Furnace — convert to gas Realistic achievable potential (MWh)	244	7,803	49,719	106,607	171,095
Furnace — convert to gas (% of Res. Achievable potential)	0.5%	1.9%	5.3%	6.9%	7.9%

Table 6-11 presents savings results for non-equipment measures for which realistic achievable potential is greater than zero, sorted by cumulative potential in 2032. Note that because a measure such as insulation provides both space cooling and space heating savings, Table 6-11 does not break down savings by end use.

Table 6-11 Residential Realistic Achievable Savings for Non-equipment Measures (MWh), Selected Years

Measure	2012	2017	2022
Water Heater - Convert to Gas	267	10,214	69,745
Furnace - Convert to Gas	244	7,803	49,719
Advanced New Construction Designs	1	180	4,206
Repair and Sealing - Ducting	20	2,713	7,763
Insulation - Infiltration Control	20	2,731	7,696
Water Heater - Thermostat Setback	142	8,150	13,721
Home Energy Management System	7	1,175	4,146
Water Heater - Hot Water Saver	6	426	5,447
Freezer - Remove Second Unit	22	3,246	6,959
Electronics - Reduce Standby Wattage	13	1,004	10,066
Thermostat - Clock/Programmable	21	2,859	7,907
Insulation - Foundation	1	438	1,979
Air Source Heat Pump - Maintenance	12	872	2,353
Refrigerator - Remove Second Unit	13	1,807	3,977
Water Heater - Faucet Aerators	12	978	2,341
Insulation - Ducting	1	195	1,024
Insulation - Wall Cavity	1	275	1,234
Water Heater - Tank Blanket/Insulation	49	2,596	4,051
Ceiling Fan - Installation	0	87	743
Room AC - Removal of Second Unit	6	919	2,280
Water Heater - Heat Pump	-	23	793
Water Heater - Timer	8	1,152	2,477
Insulation - Ceiling	2	400	1,201
Water Heater - Low Flow Showerheads	9	887	1,762
Central AC - Maintenance and Tune-Up	-	-	-
Pool - Pump Timer	8	1,294	2,192
Insulation - Wall Sheathing	0	50	230
Water Heater - Pipe Insulation	2	105	1,018
Whole-House Fan - Installation	0	27	278
Total	**885**	**52,605**	**217,309**

Looking at both the equipment (Table 6-9) and non-equipment measure results (Table 6-11), we see that initially nearly all of the savings come from the equipment measures, particularly lighting, but over time an increasing proportion of the savings come from conversion of water heating and space heating to natural gas. At the study mid-point in 2022, the four measures with the greatest realistic achievable poential are:

- Water heater conversion to gas (69,745 MWh)
- Furnace conversion to gas (49,719 MWh)
- Replacement of interior screw in lamps (48,939 MWh)
- Replacement of personal computers with ENERGY STAR units (15,975 MWh)

These four measures provide realistic achievable potential of 184,378 MWh in 2022, which is approximately 55% of the total 2022 potential for the residential sector.

6.4 COMMERCIAL AND INDUSTRIAL SECTOR POTENTIAL

Realistic achievable potential savings for the C&I sector in both states is 24,155 MWh in 2012, or 0.5% of the sector's baseline forecast. It reaches 1,258,101 MWh, or 17.4% of the baseline forecast by 2032. Technical and economic potential savings are 37.8% and 27.8% of the baseline forecast respectively. Figure 6-8 depicts the potential savings estimates graphically. Figure 6-9 shows the energy use forecasts under the four types of potential versus the baseline forecast. Table 6-12 presents estimates for the sector's energy and peak demand under the four types of potential.

Figure 6-8 Energy Efficiency Potential Savings, Commercial and Industrial Sector

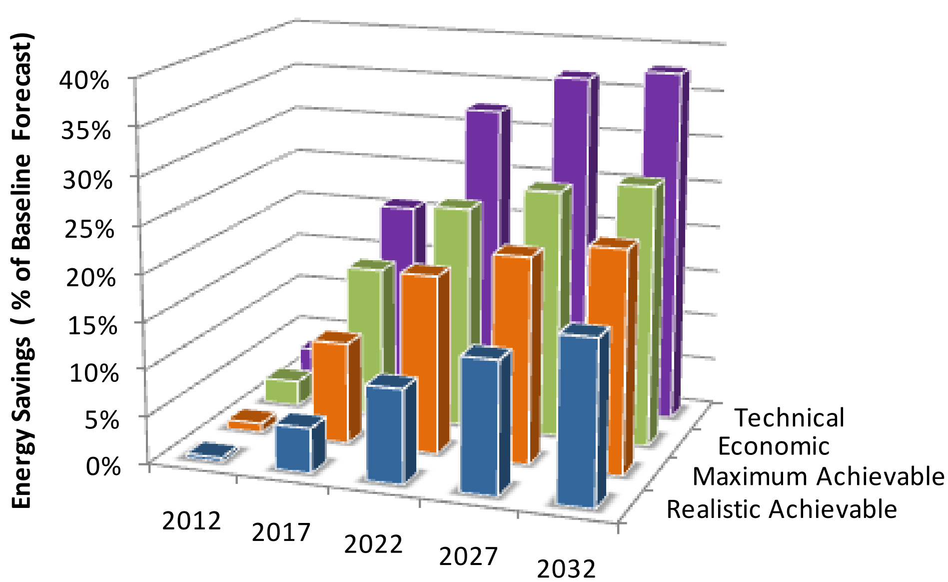


Figure 6-9 Energy Efficiency Potential Forecast, Commercial and Industrial Sector

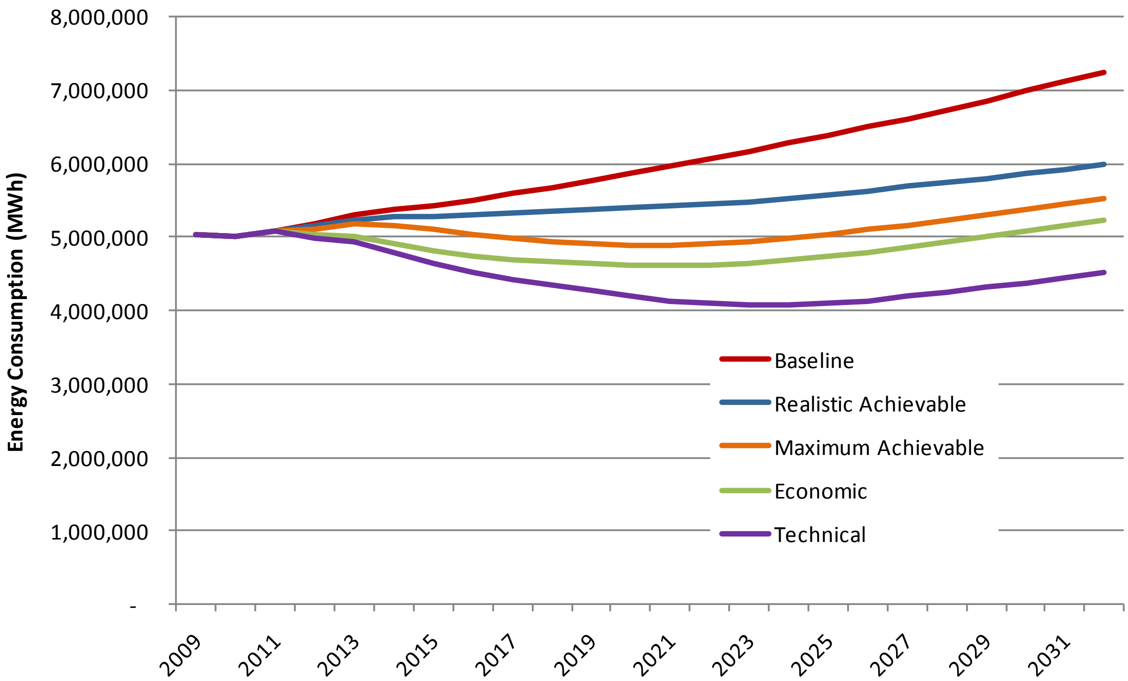


Table 6-12 Energy Efficiency Potential, Commercial and Industrial Sector

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	5,172,344	5,592,586	6,061,107	6,618,022	7,250,973
Cumulative Energy Savings (MWh)					
Realistic Achievable	24,155	267,535	608,739	932,205	1,258,101
Maximum Achievable	52,460	606,406	1,153,644	1,452,022	1,712,907
Economic	140,180	910,181	1,443,612	1,749,278	2,013,333
Technical	176,414	1,168,096	1,967,434	2,424,630	2,739,507
Cumulative Energy Savings (% of Baseline)					
Realistic Achievable	0.5%	4.8%	10.0%	14.1%	17.4%
Maximum Achievable	1.0%	10.8%	19.0%	21.9%	23.6%
Economic	2.7%	16.3%	23.8%	26.4%	27.8%
Technical	3.4%	20.9%	32.5%	36.6%	37.8%
Peak Savings (MW)					
Realistic Achievable	4	40	84	127	169
Maximum Achievable	8	88	154	191	223
Economic	22	130	193	231	263
Technical	27	166	262	324	364
Peak Savings (% of Baseline)					
Realistic Achievable	0.5%	4.7%	9.0%	12.4%	15.1%
Maximum Achievable	1.0%	10.3%	16.6%	18.8%	20.0%
Economic	2.7%	15.3%	20.8%	22.7%	23.6%
Technical	3.4%	19.4%	28.2%	31.8%	32.6%

6.4.1 Commercial Potential by Market Segment and State

Table 6-13 shows the baseline forecast and realistic achievable potential energy savings for the four C&I segments. Large Commercial customers account for the largest portion of the baseline forecast and thus also have the largest realistic achievable potential. In 2012 the Large Commercial segment's realistic achievable potential is 14,754 MWh or 61.1% of C&I total realistic achievable potential. By 2032 its share of C&I potential has dropped slightly to 50.8%. In contrast, the Extra Large Industrial customers increase their role in savings over the study period, beginning with only 1,673 MWh of realistic achievable potential or 6.9% of total C&I potential in 2012, but growing by 2032 to cumulative realistic achievable savings of 285,178 MWh or 22.7% of the C&I sector savings. Table 6-14 takes a closer look at savings by segment and potential level in 2022, the mid-point of the 20-year period.

Table 6-13 C&I Sector, Baseline and Realistic Achievable Potential by Segment

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)					
Small/Med. Commercial	730,499	772,442	832,324	906,807	992,374
Large Commercial	2,266,380	2,403,446	2,592,110	2,822,788	3,088,354
Extra Large Commercial	347,860	421,489	457,725	497,943	541,389
Extra Large Industrial	1,827,605	1,995,209	2,178,948	2,390,485	2,628,857
Total	5,172,344	5,592,586	6,061,107	6,618,022	7,250,973
Cumulative Energy Savings, Realistic Achievable Potential (MWh)					
Small/Med. Commercial	4,513	46,375	96,231	144,812	197,619
Large Commercial	14,754	164,668	338,450	491,020	638,562
Extra Large Commercial	3,216	33,198	69,605	105,163	136,743
Extra Large Industrial	1,673	23,294	104,453	191,210	285,178
Total	24,155	267,535	608,739	932,205	1,258,101
% of Total C&I Cumulative Energy Savings					
Small/Med. Commercial	18.7%	17.3%	15.8%	15.5%	15.7%
Large Commercial	61.1%	61.6%	55.6%	52.7%	50.8%
Extra Large Commercial	13.3%	12.4%	11.4%	11.3%	10.9%
Extra Large Industrial	6.9%	8.7%	17.2%	20.5%	22.7%

Table 6-14 C&I Realistic Achievable Potential by Segment, 2022

Forecast	Small/Med. Commercial	Large Commercial	Extra Large Commercial	Extra Large Industrial	Total
Baseline Forecast (MWh)	832,324	2,592,110	457,725	2,178,948	6,061,107
Cumulative Energy Savings (MWh)					
Realistic achievable	96,231	338,450	69,605	104,453	608,739
Economic Potential	193,950	646,644	144,275	458,743	1,443,612
Technical Potential	308,119	951,283	184,560	523,472	1,967,434
Cumulative Energy Savings % of Baseline					
Realistic achievable	12%	13%	15%	5%	10%
Economic Potential	23%	25%	32%	21%	24%
Technical Potential	37%	37%	40%	24%	32%

6.4.2 C&I Potential by End Use, Technology, and Measure Type

Table 6-15 presents the C&I sector savings by end use and potential type. Recall that the Small/Medium Commercial and Large Commercial Segments include a small percentage of industrial-type customers. Hence, we included a non-equipment measure called Industrial Process Improvements to capture potential savings from these customers. In addition, the miscellaneous category includes non-HVAC motors to capture motor use within small industrial facilities. For all C&I customers, a custom measure category was included to serve as a “catch all” for measures for which costs and savings are not easily quantified and that could be part of a program such as Avista’s existing Site-Specific incentive program. In terms of how potential is divided among the various end uses, we note the following:

- ***Interior lighting*** offers the largest technical, economic, and achievable potential. The high technical potential of 892,840 MWh in 2032 is a result of LED lighting that is now commercially available in screw-in and linear lighting applications, as well as numerous fixture improvement and control options. However, LED lighting is not cost effective given the study’s avoided cost assumptions, so economic potential reflects installation of CFL, T5, and Super T8 lamps throughout most of the commercial sector. Still, this results in realistic achievable potential of 598,564 MWh by 2032.
- ***Cooling*** has the third highest savings for technical potential at 302,301 MWh in 2032, and many of the cooling measures are cost effective, including installation of high-efficiency equipment, thermal shell measures, HVAC control strategies, and retrocommissioning. Because the market for cooling technologies is mature, these savings are relatively easy to capture, as reflected in the ramp rates for these measures. Thus realistic achievable potential for cooling, at 119,700 MWh, is the second highest among C&I end uses.
- ***Ventilation*** is second in terms of technical and economic potential due to conversion to variable air volume systems, high-efficiency and variable speed control fans, and retrocommissioning. Realistic achievable potential in 2032 of 117,020 MWh ranks this end use third, just behind cooling.
- ***Machine drive*** ranks fourth in realistic achievable potential at 101,018 MWh in 2032. Even though the National Electrical Manufacturer’s Association (NEMA) standards make premium efficiency motors the baseline efficiency level, savings remain available from upgrading to still more efficient levels.
- ***Office equipment, exterior lighting, and industrial process improvements*** offer smaller but still significant realistic achievable potential by 2032 at 73,152 MWh, 68,467 MWh, and 60,759 MWh respectively.
- ***Commercial refrigeration, food preparation, and water heating*** savings are relatively small across the C&I sector as a whole, though these end uses can offer significant savings in supermarkets, restaurants, hospitals, and other buildings where these end use constitute a larger portion of overall energy use.

Table 6-15 C&I Cumulative Savings by End Use and Potential Type, Selected Years, (MWh)

End Use	Case	2012	2017	2022	2027	2032
Cooling	RAP	205	14,595	50,416	82,103	119,700
	Economic	2,848	51,234	108,395	146,209	191,484
	Technical	7,425	96,886	200,488	252,951	302,301
Space Heating	RAP	17	2,185	11,476	22,223	36,932
	Economic	346	11,546	31,407	45,917	66,710
	Technical	571	18,000	51,975	71,620	94,893
Heat/Cool	RAP	47	3,765	6,874	8,352	10,413
	Economic	541	8,928	11,319	13,415	15,092
	Technical	743	10,317	13,864	16,814	18,949
Ventilation	RAP	457	7,102	35,467	69,845	117,020
	Economic	7,544	56,221	144,530	201,459	237,313
	Technical	10,719	82,071	220,464	294,789	323,008
Water Heating	RAP	205	6,315	13,969	20,663	27,581
	Economic	1,907	19,044	27,780	34,762	36,791
	Technical	13,251	96,031	174,865	249,540	274,478
Food Preparation	RAP	213	2,665	7,608	14,695	22,009
	Economic	2,824	17,789	32,528	39,188	42,755
	Technical	3,215	19,520	35,976	43,195	47,322
Refrigeration	RAP	185	1,877	6,192	11,901	17,567
	Economic	2,768	13,518	25,844	33,360	37,422
	Technical	3,273	17,982	40,008	51,933	58,855
Interior Lighting	RAP	17,619	166,503	328,877	477,040	598,564
	Economic	78,200	461,679	609,517	700,595	803,195
	Technical	85,734	504,965	681,379	784,870	892,840
Exterior Lighting	Achievable	1,634	23,519	46,019	57,477	68,467
	Economic	7,096	67,172	78,193	81,864	86,650
	Technical	7,893	73,413	87,263	98,652	110,984
Office Equipment	RAP	2,642	27,112	44,602	58,637	73,152
	Economic	19,053	86,895	91,341	95,389	99,348
	Technical	25,452	119,267	126,773	134,377	142,248
Machine Drive	RAP	581	9,104	42,030	72,656	101,018
	Economic	6,560	57,477	158,387	196,285	214,864
	Technical	6,994	67,404	204,459	258,683	286,647
Process	RAP	345	2,590	14,014	33,699	60,759
	Economic	10,390	57,275	120,473	154,151	172,559
	Technical	10,390	57,275	120,473	154,151	172,559
Miscellaneous	RAP	7	204	1,194	2,914	4,921
	Economic	103	1,403	3,897	6,684	9,150
	Technical	753	4,964	9,446	13,056	14,423
Total	RAP	24,154	267,494	608,739	932,221	1,258,104
	Economic	140,121	909,897	1,443,612	1,749,309	2,013,338
	Technical	175,565	1,165,177	1,967,434	2,424,763	2,739,528

Figure 6-10 focuses on achievable potential by end use in selected years. Interior lighting remains the largest source of potential in the C&I sector throughout the study. Cooling, ventilation, and machine drive are the next largest contributors as discussed above.

Figure 6-10 C&I Realistic Achievable Potential by End Use, Selected Years

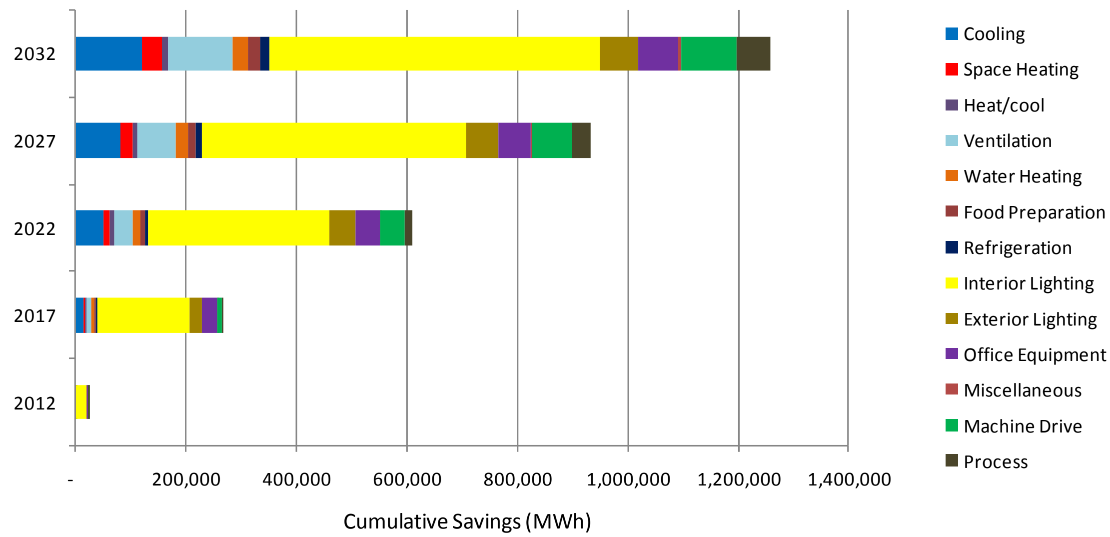


Table 6-16 shows the savings by end use and C&I market segment in 2022. As one would expect, the Extra Large Industrial segment differs significantly from the other segments. Machine drive and process improvements constitute 40% and 13% of realistic achievable potential for this segment. Note that the three commercial building segments, which are based on Avista's rate structure, do include a small percentage of industrial businesses. For these customers, the miscellaneous savings end-use includes non-HVAC motors.

Table 6-16 C&I Realistic Achievable Potential by End Use and Market Segment, 2022 (MWh)

	Small/Med. Commercial	Large Commercial	Extra Large Commercial	Extra Large Industrial	Total
Cooling	3,823	26,225	5,151	15,217	50,416
Space Heating	778	6,727	1,521	2,450	11,476
Combined Heating/Cooling	572	5,264	583	455	6,874
Ventilation	8,757	5,663	5,627	15,420	35,467
Water Heating	2,190	5,825	5,954	-	13,969
Food Preparation	1,238	5,563	807	-	7,608
Refrigeration	1,313	4,383	496	-	6,192
Interior Lighting	58,481	218,078	38,555	13,764	328,877
Exterior Lighting	10,719	27,639	6,557	1,103	46,019
Office Equipment	8,011	32,404	4,187	-	44,602
Machine Drive	-	-	-	42,030	42,030
Process	-	-	-	14,014	14,014
Miscellaneous	349	678	168	-	1,194
Total	**96,231**	**338,450**	**69,605**	**104,453**	**608,739**

Table 6-17 presents realistic achievable potential savings for equipment measures for which realistic achievable potential is greater than zero. These results provide additional detail at the technology level. For example, within interior lighting, screw-in lamps initial provide the greatest share of savings, but the EISA standards move the baseline in that category to a higher efficiency level. Consequently, in the long run, fluorescent lamps offer the greatest savings potential.

Table 6-17 C&I Cumulative Realistic Achievable Potential by End Use and Equipment Measures, Selected Years (MWh)

End Use	Technology	2012	2017	2022
Cooling	Central Chiller	81	855	3,288
	PTAC	6	6	6
Heat/Cool	Heat Pump	21	391	1,172
Ventilation	Ventilation	140	1,047	1,096
Water Heater	Water Heater	174	2,019	4,463
Food Preparation	Fryer	13	147	392
	Hot Food Container	13	275	763
	Oven	187	2,203	5,881
Refrigeration	Glass Door Display	32	434	1,248
	Icemaker	25	324	961
	Solid Door Refrigerator	43	497	1,331
	Vending Machine	83	455	1,111
	Walk in Refrigeration	2	26	63
Interior Lighting	Interior Screw-in	10,283	66,690	101,556
	HID	2,837	25,587	50,762
	Linear Fluorescent	4,319	53,111	104,450
Exterior Lighting	Screw-in	230	3,155	5,265
	HID	1,267	16,135	31,807
	Linear Fluorescent	124	2,230	3,784
Office Equipment	Desktop Computer	1,546	14,363	22,986
	Laptop Computer	111	1,031	1,649
	Monitor	317	1,139	1,970
	POS Terminal	37	514	939
	Printer/copier/fax	110	1,626	2,988
	Server	511	7,235	11,670
Machine Drive	Less than 5 HP	34	236	663
	5-24 HP	73	532	1,536
	25-99 HP	183	1,325	3,825
	100-249 HP	51	373	1,077
	250-499 HP	55	397	1,145
	500 and more HP	103	748	2,160
Process	Electrochem. Process	49	358	1,869
	Process Cooling/Refrig.	65	479	2,500
	Process Heating	231	1,707	8,907
Miscellaneous	Non-HVAC Motor	6	95	520
Total		**23,654**	**212,346**	**405,630**

Table 6-18 presents savings results for non-equipment measures for which realistic achievable potential is greater than zero, sorted by cumulative potential in 2032. Note that, because a measure such as insulation provides both space cooling and space heating savings, Table 6-18 does not break down savings by end use.

Table 6-18 C&I Cumulative Realistic Achievable Savings for Non-equipment Measures, Selected Years (MWh)

Measure	2012	2017	2022
Energy Management System	39	2,372	25,108
Advanced New Construction Designs	1	106	1,626
Retrocommissioning - Lighting	57	11,775	21,760
Interior Fluorescent - High Bay Fixtures	21	1,262	13,307
Custom Measures	4	829	11,321
Retrocommissioning - Comprehensive	41	8,649	15,523
Fans - Variable Speed Control	12	553	5,368
RTU - Maintenance	63	7,964	14,458
Fans - Energy Efficient Motors	10	651	6,782
Photocell Controlled T8 Dimming Ballasts	0	61	535
Retrocommissioning - HVAC	5	580	5,758
Pumping System - Optimization	11	507	4,907
Compressed Air - System Optimization and Improvements	11	506	4,837
Interior Lighting - Occupancy Sensors	19	726	5,616
Motors - Variable Frequency Drive	18	2,220	4,618
Motors - Magnetic Adjustable Speed Drives	8	367	3,707
Water Heater - Faucet Aerators/Low Flow Nozzles	27	3,964	8,101
Interior Fluorescent - Delamp and Install Reflectors	18	728	5,429
Commissioning - Comprehensive	0	368	2,614
Compressed Air - System Controls	7	355	3,457
Chiller - Turbocor Compressor	4	276	3,008
Heat Pump - Maintenance	26	3,374	5,702
Roofs - High Reflectivity	2	54	426
Pumps - Variable Speed Control	5	250	2,395
Chiller - Condenser Water Temperature Reset	7	419	3,987
Chiller - VSD	3	208	2,116
Compressed Air - Compressor Replacement	4	203	1,982
Pumping System - Controls	4	202	1,942
Thermostat - Clock/Programmable	5	762	1,499
Exterior Lighting - Daylighting Controls	4	161	1,309
Commissioning - Lighting	0	248	842
Office Equipment - Energy Star Power Supply	9	1,205	2,400
Compressed Air - System Maintenance	13	717	1,198
Insulation - Ducting	1	145	1,221
Chiller - Chilled Water Reset	4	645	1,142

Measure	2012	2017	2022
Water Heater - Heat Pump	1	69	870
Cooking - Exhaust Hoods with Sensor Control	1	14	127
Pumping System - Maintenance	-	43	606
Furnace - Convert to Gas	2	80	527
Cooling - Economizer Installation	3	125	1,138
Exterior Lighting - Induction Lamps	0	29	430
Refrigeration - System Optimization	0	24	388
Insulation - Ceiling	0	2	29
Refrigeration - System Controls	0	17	272
Industrial Process Improvements	0	28	332
LED Exit Lighting	25	932	1,028
Insulation - Wall Cavity	0	12	177
Commissioning - HVAC	-	-	20
Water Heater - Tank Blanket/Insulation	4	255	449
Miscellaneous - Energy Star Water Cooler	0	59	173
Refrigeration - Floating Head Pressure	0	10	105
Refrigeration - Strip Curtain	-	1	34
Refrigeration - System Maintenance	0	5	78
Refrigeration - Anti-Sweat Heater/Auto Door Closer	0	8	81
Water Heater - Hot Water Saver	-	-	4
Water Heater - High Efficiency Circulation Pump	0	8	83
Vending Machine - Controller	0	39	66
Chiller - Chilled Water Variable-Flow System	0	6	51
Exterior Lighting - Cold Cathode Lighting	0	2	24
Laundry - High Efficiency Clothes Washer	0	9	16
Refrigeration - Night Covers	0	1	9
Total	501	55,189	203,109

By the mid-point of the study period, 2022, the greatest savings come from:

- Replacement of interior lamps (linear fluorescent, screw in, and HID systems: 42,202 MWh)
- Replacement of office equipment with more efficient units (101,556 MWh)
- Replacement of exterior lamps (40,855 GWh)
- Installation of Energy Management Systems (25,108 MWh)
- Retrocommissioning of lighting systems (21,760 MWh)

Together, these five measures account for 285,137 MWh or 47% of the realistic achievable potential savings in the commercial sector in 2022.

6.5 SENSITIVITY ANALYSIS

Global conducted two sets of sensitivity analyses to better understand the effects of changing assumptions on conservation potential. The first looked at changes in avoided costs, and the second considered lower rates of customer and economic growth in Avista's service territory. Because these sensitivity analyses were conducted using an interim, earlier set of potential results, the potential levels in the discussion below are slightly lower than the potential levels presented elsewhere in this chapter. For example, the 2032 realistic achievable cumulative potential in 2032 shown above is 2,155,133 MWh, but the value in the sensitivity analyses is 2,106,548 MWh or 2% less. However, the project team agreed that the general results of the sensitivity analyses would be essentially unchanged, and therefore the sensitivity analyses based on interim results are presented here.

6.5.1 Sensitivity of Potential to Avoided Cost

Global modeled several scenarios with varying levels of avoided costs in addition to the base case. The other scenarios included 150%, 125%, and 75% of the avoided costs used in the base case. Figure 6-11 illustrates how realistic achievable potential varies under the four scenarios. The dotted line in Figure 6-11 indicates the technical potential, which is not affected by avoided costs. The four other lines illustrate how economic potential changes over time with avoided costs. While the changes are significant, the relationship between avoided cost and achievable potential is not linear and increases in avoided costs do not provide equivalent percentage increases in economic potential, and therefore in achievable potential also. Technical potential imposes a limit on the amount of additional conservation and each incremental unit of conservation becomes increasingly expensive.

Figure 6-11 Energy Savings, Economic Potential Case by Avoided Costs Scenario (MWh)

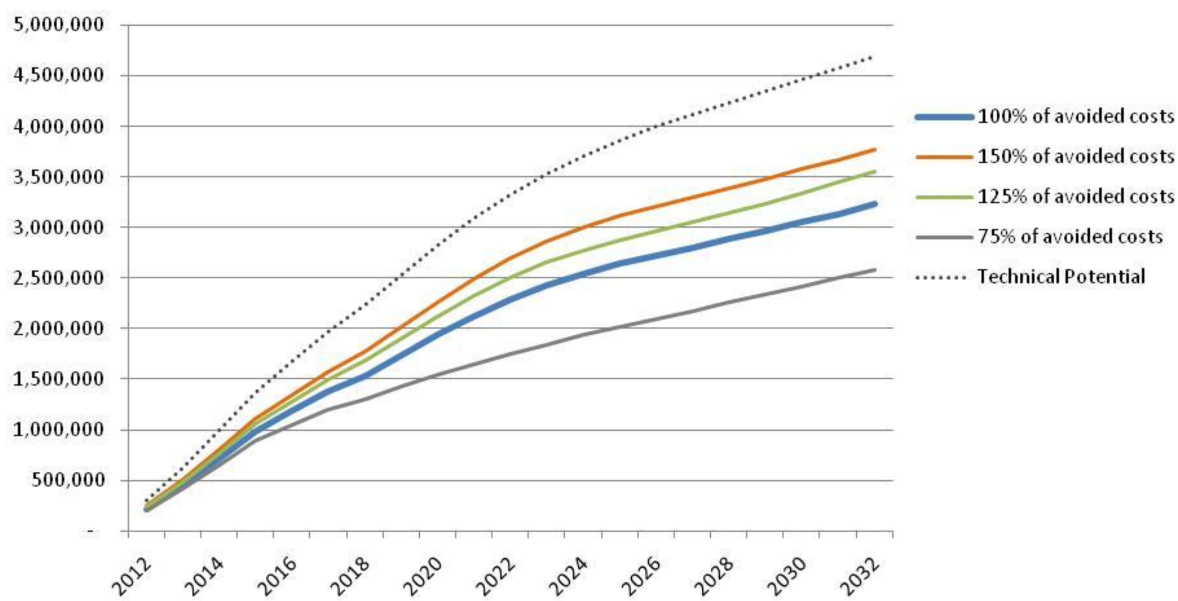


Table 6-19 provides additional information on how avoided cost changes affect realistic achievable potential. In the reference case, realistic achievable potential is approximately 16.4% of the baseline forecast by 2032. With the 150% avoided cost case, realistic achievable potential increased to 19.2% of the baseline forecast, while the 125% avoided cost case and the 75% avoided cost case yielded realistic achievable potential equal to 18.1% and 13.2% of the baseline forecast respectively.

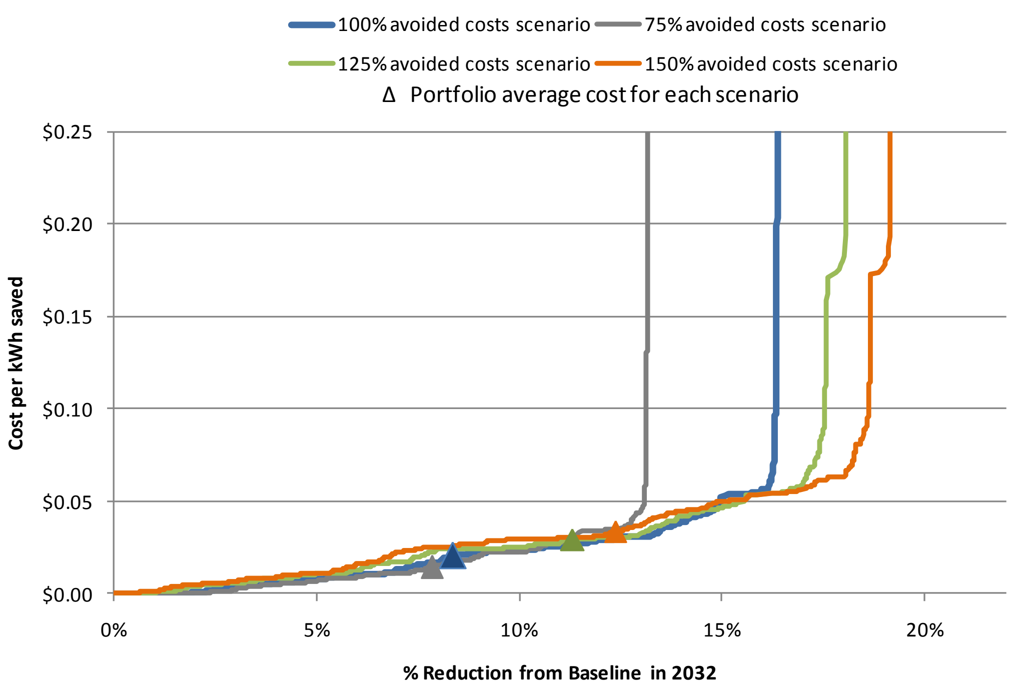
Table 6-19 Realistic Achievable Potential with Varying Avoided Costs

	Reference Scenario	75% of avoided costs	125% of avoided costs	150% of avoided costs
Realistic achievable potential savings 2032 (MWh)	2,106,584	1,690,671	2,320,926	2,464,465
Realistic achievable potential, percentage of baseline forecast, 2032	16.4%	13.2%	18.1%	19.2%
Percentage change in savings vs. 100% avoided cost scenario		-20%	10%	17%

Note: Value of 2,106,548 MWh for 2032 realistic achievable potential was based on interim results and thus is different from the value shown elsewhere in this report.

The project developed a series of supply curves based on the four avoided cost scenarios, shown in Figure 6-12. Each supply curve is created by stacking measures and equipment over the 20-year planning horizon in ascending order of cost. As expected, this stacking of conservation resources produces a traditional upward-sloping supply curve. Because there is a gap in the cost of the energy efficiency measures as you move up the supply curve, the measures with a very high cost cause a rapid sloping of the supply curve. The 75% of avoided cost scenario provides roughly a 13% reduction in energy use compared with the baseline forecast in 2032, at a cost of $0.05/kWh or less. The other three scenarios track one another closely, providing just over 15% savings in 2032 at costs below $0.05/kWh. Results do not differ greatly until the curves begin to reach the increasingly high-cost measures.

Figure 6-12 Supply Curves for Evaluated EE Measures and Avoided Cost Scenarios



6.5.2 Sensitivity of Potential to Customer and Economic Growth

This conservation potential assessment shows that conservation offsets roughly half of growth in electrical energy use for the Avista system, whereas the Sixth Plan projects that conservation can offset 80% of growth. Of course, Avista's service territory differs from the region overall in many ways, including its climate. Another significant factor may be the CPA study's assumptions regarding customer and economic growth. To better understand how growth affects the study's results, we used the LoadMAP model to evaluate several scenarios with lower customer and economic growth, as indicated in Table 6-20. Low Growth Scenario 1 assumes that home size (in square footage) grows 1% per year but is then capped at 110% of home size in the base year. This scenario also assumes lower rates of income growth, as shown in Table 6-20. The Low Growth Scenario 2 uses the same assumptions but in addition assumes lower customer growth in terms of total households for the residential sector and total square footage for the C&I sector.

Table 6-20 Varying Growth Scenario Descriptions

	Reference Scenario	Low Growth Scenario 1	Low Growth Scenario 2
Home size	~ 1% per year growth	Capped at 110% of existing home size	Capped at 110% of existing home size
Per capita income growth	1.6% 2011–2015; 2.2% 2016–2020; 2.1% thereafter	1.6% after 2016	1.6% after 2016
Residential sector market growth	1.30% after 2015 (WA) 1.25% after 2015 (ID)	no change	1.0% after 2015 (WA & ID)
Commercial sector market growth, WA & ID	~ 2.0% (varies by segment)	no change	1.0% all segments

Table 6-21 shows that as economic and customer growth decreases, the ability of conservation to offset growth increases. In the reference scenario, energy efficiency offsets 52% of growth in consumption, while in the lower growth scenarios, EE offsets 54% and 76% of growth respectively. This is the case because with reduced new construction, load growth and realistic achievable potential drop, but savings due to the retrofit of existing buildings constitute a greater proportion of load growth.

Table 6-21 Varying Growth Scenario Results

	Reference Scenario	Low Growth Scenario 1	Low Growth Scenario 2
Baseline forecast 2012 (MWh)	8,799,039	8,799,039	8,799,033
Baseline forecast 2032 (MWh)	12,851,760	12,523,843	11,178,008
Load growth 2012-2032 (MWh)	4,052,720	3,724,803	2,378,975
Realistic achievable potential forecast 2032 (MWh)	10,745,176	10,500,088	9,366,471
Realistic achievable potential savings 2032 (MWh)	2,106,584	2,023,754	1,811,538
Percentage of growth offset	52%	54%	76%

Note: Value of 2,106,548 MWh for 2032 realistic achievable potential was based on an interim results reference case and thus is different from the value shown elsewhere in this report. The general effects would be the same with the revised reference case.

6.6 PUMPING POTENTIAL

Table 6-22 displays the 2009 electricity sales and peak demand of Avista's pumping customers. These customers include mostly municipal water systems and some irrigation customers. The pumping accounts represent 2.2% of total electricity sales and 0.8% of peak demand. (Total in this case refers to the rate classes listed in Table 3-1 and Table 3-2: residential, commercial, industrial, and pumping). Because pumping represents a relatively small percentage of Avista's total sales, the project team decided to use the NWPCC Sixth Plan calculator to estimate pumping energy efficiency potential.

Table 6-22 Pumping Rate Classes, Electricity Sales and Peak Demand 2009

Sector	Rate Schedule(s)	Number of meters (customers)	2009 Electricity sales (MWh)	Peak demand (MW)
Pumping, Washington	031, 032	2,361	135,999	10
Pumping, Idaho	031, 032	1,312	58,885	4
Pumping, Total		3,673	194,884	14
Percentage of System Total			**2.2%**	**0.8%**

The Sixth Plan Calculator estimates agricultural conservation targets based on 2007 sales. It provides annual conservation targets through 2019. Therefore, we trended the data through 2022 to provide annual savings estimates for the ten-year period 2012–2022, with the results shown in Figure 6-13. Table 6-23 displays incremental annual savings potential for 2012–2015, while Table 6-24 provides cumulative potential for selected years.

Figure 6-13 Sixth Plan Calculator Agriculture Incremental Annual Potential

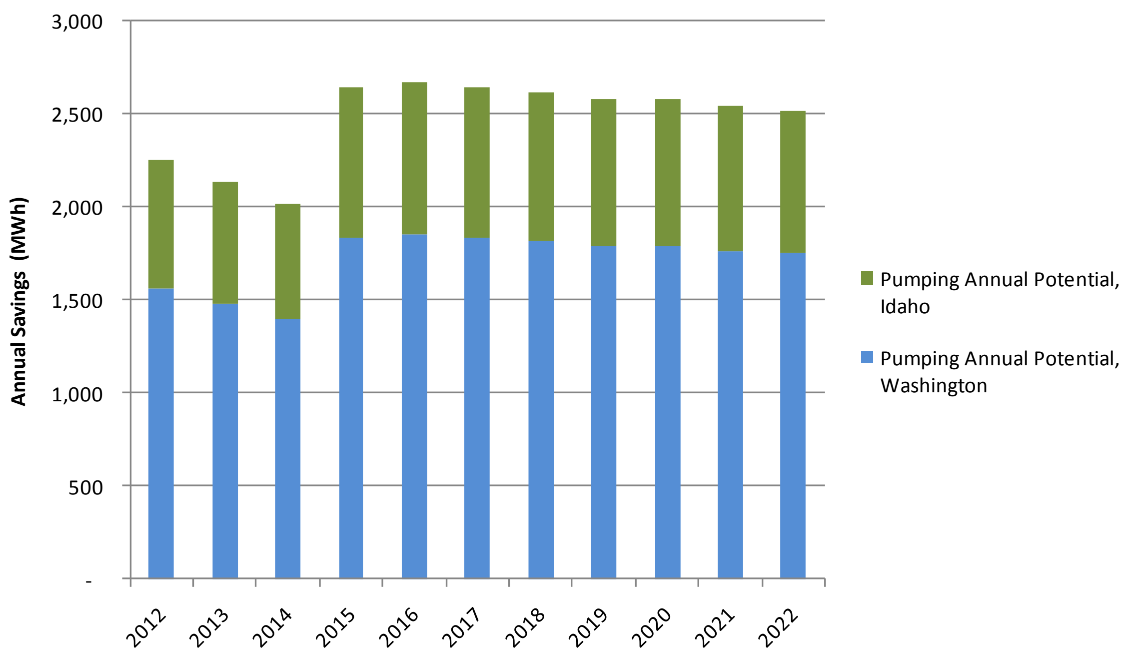


Table 6-23 Sixth Plan Calculator Agriculture Incremental Annual Potential, Selected Years (MWh)

Segment	2012	2013	2014	2015
Pumping, Washington	1,567	1,484	1,402	1,835
Pumping, Idaho	690	654	618	809
Pumping, Total	**2,257**	**2,138**	**2,020**	**2,643**

Table 6-24 Sixth Plan Calculator Agriculture Cumulative Potential, Selected Years (MWh)

Measure	2012	2017	2022
Pumping, Washington	1,567	9,979	18,892
Pumping, Idaho	690	4,397	8,324
Pumping, Total	2,257	14,375	27,217

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AVISTA CONSERVATION POTENTIAL ASSESSMENT APPENDICES

Final Report — Electricity Potentials

August 19, 2011

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WASHINGTON MARKET PROFILES, BASELINE FORECAST, AND POTENTIAL RESULTS

This appendix contains Washington-specific tables that summarize the study assumptions, inputs, and results for Avista's Washington service territory only. These tables either repeat Washington-specific information provided previously within the body of the report, or provide Washington-specific information that corresponds to Avista system-level information in the report.

Table A–1 Electricity Sales and Peak Demand by Rate Class, Washington 2009

Sector	Rate Schedule(s)	Number of meters (customers)	2009 Electricity sales (MWh)	Peak demand (MW)
Residential	001	200,134	2,451,687	710
General Service	011, 012	27,142	415,935	64
Large General Service	021, 022	3,352	1,556,929	232
Extra Large General Service	025	22	879,233	134
Pumping	031, 032	2,361	135,999	10
Total		**233,011**	**5,439,850**	**1,150**

Table A-2 Residential Electricity Usage and Intensity by Segment, Washington 2009

Washington Segment	Intensity (kWh/Household)	Number of Customers	% of Customers	2009 Electricity Sales (MWh)	% of Sales
Single Family	14,547	109,134	54%	1,587,572	65%
Multi-Family	8,728	18,219	9%	159,019	6%
Mobile Home	13,092	5,248	3%	68,708	3%
Limited Income	9,424	67,533	34%	636,407	26%
Total	**12,250**	**200,134**	**100%**	**2,451,707**	**100%**

Note: Minor differences with totals in Table A-1 due to calibration.

Table A-3 Single Family Market Profile, 2009, Washington

		Average Market Profiles				New Units			
End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)	Saturation	UEC (kWh)	Intensity (kWh/HH)	Compared to Average
Cooling	Central AC	36.8%	1,857	684	75	73.4%	2,154	1,581	16%
Cooling	Room AC	10.8%	683	74	8	1.4%	793	11	16%
Combined Heating/Cooling	Air Source Heat Pump	18.4%	6,091	1,122	122	15.0%	7,066	1,063	16%
Combined Heating/Cooling	Geothermal Heat Pump	0.7%	3,655	26	3	0.8%	4,239	32	16%
Space Heating	Electric Resistance	6.2%	10,449	647	71	3.0%	12,539	373	20%
Space Heating	Electric Furnace	25.0%	8,360	2,088	228	25.0%	10,031	2,505	20%
Space Heating	Supplemental	6.1%	117	7	1	6.1%	140	9	20%
Water Heating	Water Heater	55.3%	3,466	1,918	209	43.7%	4,177	1,827	21%
Interior Lighting	Screw-in	100.0%	1,452	1,452	158	100.0%	1,452	1,452	0%
Interior Lighting	Linear Fluorescent	69.2%	152	105	11	69.2%	152	105	0%
Interior Lighting	Pin-based	100.0%	60	60	7	100.0%	60	60	0%
Exterior Lighting	Screw-in	86.7%	381	330	36	86.7%	381	330	0%
Exterior Lighting	High Intensity/Flood	1.9%	146	3	0	1.9%	146	3	0%
Appliances	Clothes Washer	98.0%	126	124	13	99.8%	154	154	22%
Appliances	Clothes Dryer	92.8%	609	565	62	89.0%	692	616	14%
Appliances	Dishwasher	93.9%	246	231	25	99.9%	271	271	11%
Appliances	Refrigerator	100.0%	793	793	87	100.0%	625	625	-21%
Appliances	Freezer	69.4%	773	536	58	69.4%	708	491	-8%
Appliances	Second Refrigerator	47.3%	816	386	42	20.5%	711	146	-13%
Appliances	Stove	82.1%	383	314	34	82.1%	465	382	22%
Appliances	Microwave	98.5%	168	166	18	98.5%	173	171	3%
Electronics	Personal Computers	140.0%	279	391	43	147.0%	287	422	3%
Electronics	TVs	260.0%	359	933	102	260.0%	400	1,041	12%
Electronics	Devices and Gadgets	100.0%	60	60	7	100.0%	67	67	10%
Miscellaneous	Pool Pump	13.3%	1,500	200	22	14.0%	1,526	214	2%
Miscellaneous	Furnace Fan	30.1%	500	151	16	30.1%	614	185	23%
Miscellaneous	Miscellaneous	100.0%	1,180	1,180	129	100.0%	1,416	1,416	20%
Total				**14,547**	**1,588**			**15,549**	

Table A-4 Multi-family Market Profile, 2009, Washington

		Average Market Profiles				New Units			
End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)	Saturation	UEC (kWh)	Intensity (kWh/HH)	Compared to Average
Cooling	Central AC	5.0%	928	46	1	24.1%	1,003	241	8%
Cooling	Room AC	25.0%	355	89	2	18.9%	384	73	8%
Combined Heating/Cooling	Air Source Heat Pump	1.0%	2,928	29	1	3.4%	3,163	108	8%
Combined Heating/Cooling	Geothermal Heat Pump	0.0%	1,757	-	-	0.5%	1,898	9	8%
Space Heating	Electric Resistance	59.0%	5,476	3,231	59	59.0%	6,023	3,554	10%
Space Heating	Electric Furnace	5.0%	4,381	219	4	5.0%	4,819	241	10%
Space Heating	Supplemental	18.0%	61	11	0	18.9%	67	13	10%
Water Heating	Water Heater	77.0%	2,142	1,650	30	71.3%	2,362	1,684	10%
Interior Lighting	Screw-in	100.0%	750	750	14	100.0%	750	750	0%
Interior Lighting	Linear Fluorescent	32.0%	76	24	0	32.0%	76	24	0%
Interior Lighting	Pin-based	3.0%	75	2	0	3.0%	75	2	0%
Exterior Lighting	Screw-in	38.5%	55	21	0	38.5%	55	21	0%
Exterior Lighting	High Intensity/Flood	0.2%	73	0	0	0.2%	73	0	0%
Appliances	Clothes Washer	32.0%	63	20	0	32.0%	70	22	11%
Appliances	Clothes Dryer	30.7%	582	179	3	30.7%	621	191	7%
Appliances	Dishwasher	64.0%	88	56	1	64.0%	93	59	5%
Appliances	Refrigerator	100.0%	677	677	12	100.0%	665	665	-2%
Appliances	Freezer	8.4%	734	62	1	8.4%	703	59	-4%
Appliances	Second Refrigerator	5.0%	687	34	1	5.0%	631	32	-8%
Appliances	Stove	96.4%	163	158	3	96.4%	181	175	11%
Appliances	Microwave	90.0%	99	89	2	90.0%	101	91	1%
Electronics	Personal Computers	63.0%	223	141	3	66.2%	226	150	1%
Electronics	TVs	165.0%	178	293	5	165.0%	188	310	6%
Electronics	Devices and Gadgets	100.0%	25	25	0	100.0%	26	26	5%
Miscellaneous	Pool Pump	0.0%	-	-	-	0.0%	-	-	0%
Miscellaneous	Furnace Fan	13.0%	38	5	0	13.0%	42	5	11%
Miscellaneous	Miscellaneous	100.0%	917	917	17	100.0%	963	963	5%
Total				**8,728**	**159**			**9,468**	

Table A-5 Mobile Home Market Profile, 2009, Washington

End Use	Technology	Average Market Profiles: Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)	New Units: Saturation	UEC (kWh)	Intensity (kWh/HH)	Compared to Average
Cooling	Central AC	23.2%	1,106	256	1	35.9%	1,194	428	8%
Cooling	Room AC	23.2%	407	94	0	22.0%	439	97	8%
Combined Heating/Cooling	Air Source Heat Pump	21.7%	3,488	759	4	22.8%	3,767	860	8%
Combined Heating/Cooling	Geothermal Heat Pump	0.0%	2,093	-	-	0.0%	2,260	-	8%
Space Heating	Electric Resistance	0.0%	5,888	-	-	0.0%	6,476	-	10%
Space Heating	Electric Furnace	68.1%	4,710	3,209	17	68.1%	5,181	3,530	10%
Space Heating	Supplemental	1.4%	34	0	0	1.5%	37	1	10%
Water Heating	Water Heater	96.3%	1,766	1,702	9	91.0%	1,947	1,771	10%
Interior Lighting	Screw-in	100.0%	1,307	1,307	7	100.0%	1,307	1,307	0%
Interior Lighting	Linear Fluorescent	69.2%	137	95	0	69.2%	137	95	0%
Interior Lighting	Pin-based	100.0%	54	54	0	100.0%	54	54	0%
Exterior Lighting	Screw-in	86.7%	343	297	2	86.7%	343	297	0%
Exterior Lighting	High Intensity/Flood	1.9%	131	2	0	1.9%	131	2	0%
Appliances	Clothes Washer	96.3%	128	124	1	96.3%	142	137	11%
Appliances	Clothes Dryer	98.8%	620	612	3	98.8%	662	653	7%
Appliances	Dishwasher	89.0%	250	222	1	89.0%	263	234	5%
Appliances	Refrigerator	100.0%	806	806	4	100.0%	792	792	-2%
Appliances	Freezer	59.3%	786	466	2	59.3%	753	446	-4%
Appliances	Second Refrigerator	19.5%	830	162	1	19.5%	762	149	-8%
Appliances	Stove	93.9%	344	323	2	93.9%	381	358	11%
Appliances	Microwave	82.0%	151	124	1	82.0%	154	126	2%
Electronics	Personal Computers	116.5%	262	305	2	122.3%	265	324	1%
Electronics	TVs	260.0%	359	933	5	260.0%	380	987	6%
Electronics	Devices and Gadgets	100.0%	60	60	0	100.0%	64	64	5%
Miscellaneous	Pool Pump	11.1%	1,500	167	1	11.7%	1,513	177	1%
Miscellaneous	Furnace Fan	8.3%	500	42	0	8.3%	557	47	11%
Miscellaneous	Miscellaneous	100.0%	971	971	5	100.0%	1,020	1,020	5%
Total				**13,092**	**69**			**13,955**	

Table A-6 Limited Income Market Profile, 2009, Washington

		Average Market Profiles				New Units			
End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)	Saturation	UEC (kWh)	Intensity (kWh/HH)	Compared to Average
Cooling	Central AC	22.2%	1,049	233	16	28.7%	1,133	325	8%
Cooling	Room AC	35.4%	712	252	17	18.0%	769	138	8%
Combined Heating/Cooling	Air Source Heat Pump	10.4%	2,372	247	17	10.4%	2,561	267	8%
Combined Heating/Cooling	Geothermal Heat Pump	0.0%	1,423	-	-	0.5%	1,537	8	8%
Space Heating	Electric Resistance	32.0%	5,164	1,651	112	28.8%	5,680	1,635	10%
Space Heating	Electric Furnace	19.3%	4,123	796	54	21.2%	4,536	963	10%
Space Heating	Supplemental	12.7%	63	8	1	13.4%	69	9	10%
Water Heating	Water Heater	83.9%	2,334	1,958	132	67.0%	2,574	1,725	10%
Interior Lighting	Screw-in	100.0%	728	728	49	100.0%	728	728	0%
Interior Lighting	Linear Fluorescent	69.2%	75	52	3	69.2%	75	52	0%
Interior Lighting	Pin-based	100.0%	59	59	4	100.0%	59	59	0%
Exterior Lighting	Screw-in	47.1%	106	50	3	47.1%	106	50	0%
Exterior Lighting	High Intensity/Flood	2.7%	84	2	0	2.7%	84	2	0%
Appliances	Clothes Washer	71.3%	55	39	3	71.3%	61	43	11%
Appliances	Clothes Dryer	68.6%	652	447	30	68.6%	696	477	7%
Appliances	Dishwasher	78.5%	72	56	4	78.5%	75	59	5%
Appliances	Refrigerator	100.0%	677	677	46	100.0%	665	665	-2%
Appliances	Freezer	63.4%	734	466	31	63.4%	703	446	-4%
Appliances	Second Refrigerator	23.4%	687	161	11	23.4%	631	148	-8%
Appliances	Stove	89.7%	196	176	12	89.7%	217	195	11%
Appliances	Microwave	92.6%	109	101	7	92.6%	111	102	1%
Electronics	Personal Computers	101.4%	230	233	16	106.5%	233	248	1%
Electronics	TVs	165.0%	204	337	23	165.0%	216	356	6%
Electronics	Devices and Gadgets	100.0%	30	30	2	105.0%	32	33	5%
Miscellaneous	Pool Pump	5.8%	617	36	2	5.8%	622	36	1%
Miscellaneous	Furnace Fan	25.2%	213	54	4	25.2%	238	60	11%
Miscellaneous	Miscellaneous	100.0%	575	575	39	100.0%	604	604	5%
Total				**9,424**	**636**			**9,434**	

Table A-7 Commercial Sector Market Characterization Results, Washington 2009

Avista Rate Schedule		LoadMAP Segment and Typical Building	Electricity sales (MWh)	Intensity (kWh/sq.ft.)
General Service	011, 012	Small and Medium Commercial — Retail	415,935	17.5
Large General Service	021, 022	Large Commercial — Office	1,556,929	16.7
Extra Large General Service Commercial	025C	Extra Large Commercial — University	265,686	13.9
Extra Large General Service Industrial	025I	Extra Large Industrial	613,615	40.0
Total			**2,852,165**	

Table A-8 Small/Medium Commercial Segment Market Profile, Washington, 2009

		Average Market Profiles				New Units			
End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Central Chiller	13.8%	2.39	0.33	8	13.8%	2.15	0.30	-10%
Cooling	RTU	63.1%	2.46	1.55	37	63.1%	2.22	1.40	-10%
Cooling	PTAC	3.3%	2.44	0.08	2	3.3%	2.20	0.07	-10%
Combined Heating/Cooling	Heat Pump	3.6%	6.19	0.22	5	3.6%	5.57	0.20	-10%
Space Heating	Electric Resistance	5.9%	6.72	0.39	9	5.9%	6.72	0.39	0%
Space Heating	Furnace	17.7%	7.05	1.25	30	17.7%	6.34	1.13	-10%
Ventilation	Ventilation	76.9%	2.09	1.61	38	76.9%	1.88	1.45	-10%
Interior Lighting	Interior Screw-in	100.0%	1.00	1.00	24	100.0%	0.90	0.90	-10%
Interior Lighting	HID	100.0%	0.68	0.68	16	100.0%	0.61	0.61	-10%
Interior Lighting	Linear Fluorescent	100.0%	3.37	3.37	80	100.0%	3.03	3.03	-10%
Exterior Lighting	Exterior Screw-in	82.6%	0.20	0.16	4	82.6%	0.18	0.15	-10%
Exterior Lighting	HID	82.6%	0.76	0.63	15	82.6%	0.68	0.56	-10%
Exterior Lighting	Linear Fluorescent	82.6%	0.16	0.13	3	82.6%	0.14	0.12	-10%
Water Heating	Water Heater	63.0%	2.00	1.26	30	63.0%	1.90	1.19	-5%
Food Preparation	Fryer	25.8%	0.16	0.04	1	25.8%	0.16	0.04	0%
Food Preparation	Oven	25.8%	0.98	0.25	6	25.8%	0.98	0.25	0%
Food Preparation	Dishwasher	25.8%	0.06	0.01	0	25.8%	0.06	0.01	0%
Food Preparation	Hot Food Container	25.8%	0.31	0.08	2	25.8%	0.31	0.08	0%
Food Preparation	Food Prep	25.8%	0.01	0.00	0	25.8%	0.01	0.00	0%
Refrigeration	Walk in Refrigeration	0.0%	-	-	-	0.0%	-	-	
Refrigeration	Glass Door Display	52.4%	0.45	0.23	6	52.4%	0.40	0.21	-10%
Refrigeration	Solid Door Refrigerator	52.4%	0.50	0.26	6	52.4%	0.45	0.24	-10%
Refrigeration	Open Display Case	52.4%	0.04	0.02	1	52.4%	0.04	0.02	-10%
Refrigeration	Vending Machine	52.4%	0.30	0.16	4	52.4%	0.30	0.16	0%
Refrigeration	Icemaker	52.4%	0.34	0.18	4	52.4%	0.34	0.18	0%
Office Equipment	Desktop Computer	99.9%	0.48	0.48	11	99.9%	0.48	0.48	0%
Office Equipment	Laptop Computer	99.9%	0.06	0.06	1	99.9%	0.06	0.06	0%
Office Equipment	Server	99.9%	0.36	0.36	9	99.9%	0.36	0.36	0%
Office Equipment	Monitor	99.9%	0.25	0.25	6	99.9%	0.25	0.25	0%
Office Equipment	Printer/copier/fax	99.9%	0.24	0.24	6	99.9%	0.24	0.24	0%
Office Equipment	POS Terminal	99.9%	0.27	0.27	7	99.9%	0.27	0.27	0%
Miscellaneous	Non-HVAC Motor	40.2%	1.22	0.49	12	40.2%	1.22	0.49	0%
Miscellaneous	Other Miscellaneous	100.0%	1.43	1.43	34	100.0%	1.43	1.43	0%
Total				**17.50**	**416**			**16.3**	

Table A-9 Large Commercial Segment Market Profile, Washington, 2009

		Average Market Profiles				New Units			
End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Central Chiller	24.7%	2.15	0.53	49	24.7%	1.93	0.48	-10%
Cooling	RTU	37.8%	2.52	0.95	89	37.8%	2.26	0.86	-10%
Cooling	PTAC	3.8%	2.49	0.09	9	3.8%	2.24	0.08	-10%
Combined Heating/Cooling	Heat Pump	9.1%	4.81	0.44	41	9.1%	4.33	0.40	-10%
Space Heating	Electric Resistance	5.9%	3.62	0.21	20	5.9%	3.62	0.21	0%
Space Heating	Furnace	12.7%	4.68	0.60	55	12.7%	4.21	0.54	-10%
Ventilation	Ventilation	75.1%	1.66	1.24	116	75.1%	1.49	1.12	-10%
Interior Lighting	Interior Screw-in	100.0%	0.94	0.94	88	100.0%	0.85	0.85	-10%
Interior Lighting	HID	100.0%	0.71	0.71	66	100.0%	0.64	0.64	-10%
Interior Lighting	Linear Fluorescent	100.0%	3.29	3.29	307	100.0%	2.96	2.96	-10%
Exterior Lighting	Exterior Screw-in	89.6%	0.11	0.10	9	89.6%	0.10	0.09	-10%
Exterior Lighting	HID	89.6%	0.62	0.56	52	89.6%	0.56	0.50	-10%
Exterior Lighting	Linear Fluorescent	89.6%	0.16	0.14	13	89.6%	0.14	0.13	-10%
Water Heating	Water Heater	54.2%	2.31	1.25	117	54.2%	2.20	1.19	-5%
Food Preparation	Fryer	18.4%	0.35	0.06	6	18.4%	0.35	0.06	0%
Food Preparation	Oven	18.4%	1.88	0.35	32	18.4%	1.88	0.35	0%
Food Preparation	Dishwasher	18.4%	0.19	0.03	3	18.4%	0.19	0.03	0%
Food Preparation	Hot Food Container	18.4%	0.27	0.05	5	18.4%	0.27	0.05	0%
Food Preparation	Food Prep	18.4%	0.02	0.00	0	18.4%	0.02	0.00	0%
Refrigeration	Walk in Refrigeration	39.1%	0.48	0.19	17	39.1%	0.43	0.17	-10%
Refrigeration	Glass Door Display	39.1%	0.37	0.14	13	39.1%	0.33	0.13	-10%
Refrigeration	Solid Door Refrigerator	39.1%	0.77	0.30	28	39.1%	0.69	0.27	-10%
Refrigeration	Open Display Case	39.1%	0.27	0.10	10	39.1%	0.24	0.09	-10%
Refrigeration	Vending Machine	39.1%	0.36	0.14	13	39.1%	0.36	0.14	0%
Refrigeration	Icemaker	39.1%	0.66	0.26	24	39.1%	0.66	0.26	0%
Office Equipment	Desktop Computer	98.4%	0.90	0.88	82	98.4%	0.90	0.88	0%
Office Equipment	Laptop Computer	98.4%	0.07	0.07	6	98.4%	0.07	0.07	0%
Office Equipment	Server	98.4%	0.42	0.41	38	98.4%	0.42	0.41	0%
Office Equipment	Monitor	98.4%	0.21	0.20	19	98.4%	0.21	0.20	0%
Office Equipment	Printer/copier/fax	98.4%	0.21	0.21	19	98.4%	0.21	0.21	0%
Office Equipment	POS Terminal	98.4%	0.07	0.07	6	98.4%	0.07	0.07	0%
Miscellaneous	Non-HVAC Motor	57.7%	1.40	0.81	75	57.7%	1.40	0.81	0%
Miscellaneous	Other Miscellaneous	100.0%	1.36	1.36	127	100.0%	1.36	1.36	0%
Total				**16.70**	**1,557**			**15.6**	

Table A-10 Extra Large Commercial Segment Market Profile, Washington, 2009

		Average Market Profiles				New Units			
End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Central Chiller	52.2%	2.13	1.11	21	52.2%	1.92	1.00	-10%
Cooling	RTU	24.7%	2.22	0.55	10	24.7%	2.00	0.49	-10%
Cooling	PTAC	0.0%	2.22	-	-	0.0%	2.00	-	-10%
Combined Heating/Cooling	Heat Pump	4.4%	5.23	0.23	4	4.4%	4.70	0.21	-10%
Space Heating	Electric Resistance	15.8%	4.39	0.69	13	15.8%	4.39	0.69	0%
Space Heating	Furnace	5.6%	5.67	0.32	6	5.6%	5.11	0.29	-10%
Ventilation	Ventilation	90.2%	1.94	1.75	33	90.2%	1.74	1.57	-10%
Interior Lighting	Interior Screw-in	100.0%	1.37	1.37	26	100.0%	1.23	1.23	-10%
Interior Lighting	HID	100.0%	0.29	0.29	6	100.0%	0.26	0.26	-10%
Interior Lighting	Linear Fluorescent	100.0%	2.19	2.19	42	100.0%	1.97	1.97	-10%
Exterior Lighting	Exterior Screw-in	96.3%	0.03	0.03	1	96.3%	0.03	0.03	-10%
Exterior Lighting	HID	96.3%	0.88	0.85	16	96.3%	0.79	0.76	-10%
Exterior Lighting	Linear Fluorescent	96.3%	0.04	0.03	1	96.3%	0.03	0.03	-10%
Water Heating	Water Heater	26.3%	3.72	0.98	19	26.3%	3.53	0.93	-5%
Food Preparation	Fryer	13.8%	0.13	0.02	0	13.8%	0.13	0.02	0%
Food Preparation	Oven	13.8%	2.12	0.29	6	13.8%	2.12	0.29	0%
Food Preparation	Dishwasher	13.8%	0.08	0.01	0	13.8%	0.08	0.01	0%
Food Preparation	Hot Food Container	13.8%	0.13	0.02	0	13.8%	0.13	0.02	0%
Food Preparation	Food Prep	13.8%	0.01	0.00	0	13.8%	0.01	0.00	0%
Refrigeration	Walk in Refrigeration	26.6%	0.19	0.05	1	26.6%	0.17	0.04	-10%
Refrigeration	Glass Door Display	26.6%	0.11	0.03	1	26.6%	0.10	0.03	-10%
Refrigeration	Solid Door Refrigerator	26.6%	0.71	0.19	4	26.6%	0.64	0.17	-10%
Refrigeration	Open Display Case	26.6%	0.50	0.13	3	26.6%	0.45	0.12	-10%
Refrigeration	Vending Machine	26.6%	0.38	0.10	2	26.6%	0.38	0.10	0%
Refrigeration	Icemaker	26.6%	0.31	0.08	2	26.6%	0.31	0.08	0%
Office Equipment	Desktop Computer	100.0%	0.64	0.64	12	100.0%	0.64	0.64	0%
Office Equipment	Laptop Computer	100.0%	0.07	0.07	1	100.0%	0.07	0.07	0%
Office Equipment	Server	100.0%	0.17	0.17	3	100.0%	0.17	0.17	0%
Office Equipment	Monitor	100.0%	0.13	0.13	2	100.0%	0.13	0.13	0%
Office Equipment	Printer/copier/fax	100.0%	0.05	0.05	1	100.0%	0.05	0.05	0%
Office Equipment	POS Terminal	100.0%	0.01	0.01	0	100.0%	0.01	0.01	0%
Miscellaneous	Non-HVAC Motor	88.8%	0.82	0.73	14	88.8%	0.82	0.73	0%
Miscellaneous	Other Miscellaneous	100.0%	0.80	0.80	15	100.0%	0.80	0.80	0%
Total				**13.90**	**266**			**12.9**	

Table A-11 Extra Large Industrial Segment Market Profile, Washington, 2009

End Use	Technology	Average Market Profiles: Saturation	Average Market Profiles: EUI (kWh)	Average Market Profiles: Intensity (kWh/Sqft.)	Average Market Profiles: Usage (GWh)	New Units: Saturation	New Units: EUI (kWh)	New Units: Intensity (kWh/Sqft.)	New Units: Compared to Average
Cooling	Central Chiller	14.4%	7.98	1.15	18	14.4%	7.18	1.04	-10%
Cooling	RTU	17.1%	6.32	1.08	17	17.1%	5.68	0.97	-10%
Cooling	PTAC	1.1%	5.50	0.06	1	1.1%	4.95	0.05	-10%
Combined Heating/Cooling	Heat Pump	1.6%	11.13	0.18	3	1.6%	10.01	0.16	-10%
Space Heating	Electric Resistance	10.8%	8.67	0.93	14	10.8%	8.67	0.93	0%
Space Heating	Furnace	2.0%	9.10	0.18	3	2.0%	8.19	0.17	-10%
Ventilation	Ventilation	27.4%	12.31	3.37	52	27.4%	11.08	3.04	-10%
Interior Lighting	Interior Screw-in	100.0%	0.33	0.33	5	100.0%	0.30	0.30	-10%
Interior Lighting	HID	100.0%	1.05	1.05	16	100.0%	0.94	0.94	-10%
Interior Lighting	Linear Fluorescent	100.0%	1.10	1.10	17	100.0%	0.99	0.99	-10%
Exterior Lighting	Exterior Screw-in	92.5%	0.02	0.02	0	92.5%	0.02	0.02	-10%
Exterior Lighting	HID	92.5%	0.25	0.23	4	92.5%	0.23	0.21	-10%
Exterior Lighting	Linear Fluorescent	92.5%	0.01	0.01	0	92.5%	0.01	0.01	-10%
Process	Process Cooling/Refrigeration	2.4%	99.67	2.40	37	2.4%	99.67	2.40	0%
Process	Process Heating	26.2%	13.74	3.60	55	26.2%	13.74	3.60	0%
Process	Electrochemical Process	2.6%	77.43	2.00	31	2.6%	77.43	2.00	0%
Machine Drive	Less than 5 HP	90.5%	0.92	0.84	13	90.5%	0.92	0.84	0%
Machine Drive	5-24 HP	80.1%	2.26	1.81	28	80.1%	2.26	1.81	0%
Machine Drive	25-99 HP	72.4%	6.10	4.42	68	72.4%	6.10	4.42	0%
Machine Drive	100-249 HP	65.3%	3.84	2.51	38	65.3%	3.84	2.51	0%
Machine Drive	250-499 HP	23.7%	11.61	2.75	42	23.7%	11.61	2.75	0%
Machine Drive	500 and more HP	26.1%	19.50	5.08	78	26.1%	19.50	5.08	0%
Miscellaneous	Miscellaneous	100.0%	4.90	4.90	75	100.0%	4.90	4.90	0%
	Total			**40.00**	**614**			**39.1**	

Figure A–1 Residential Baseline Forecast by End Use, Washington

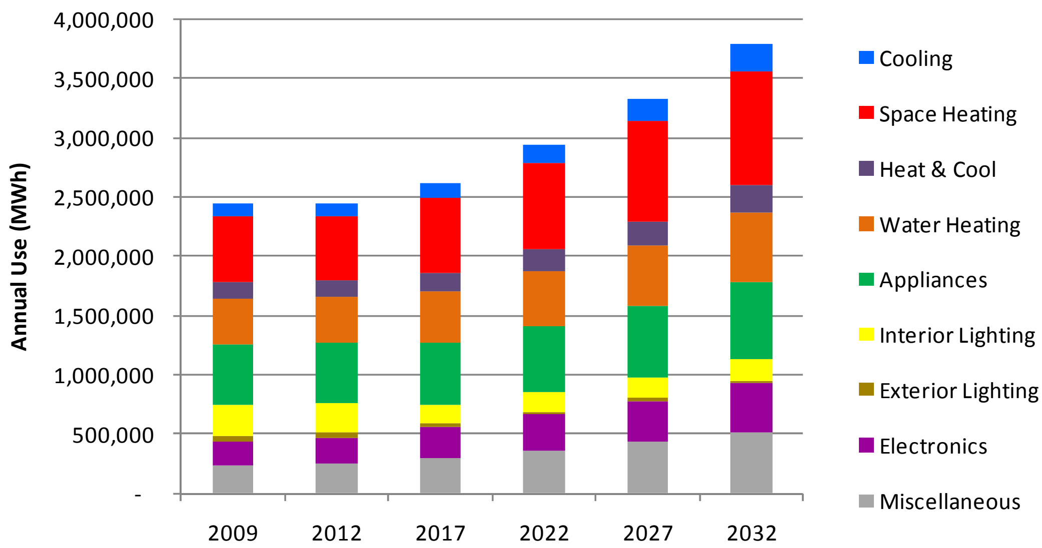

Figure A-2 C&I Baseline Electricity Forecast by End Use, Washington

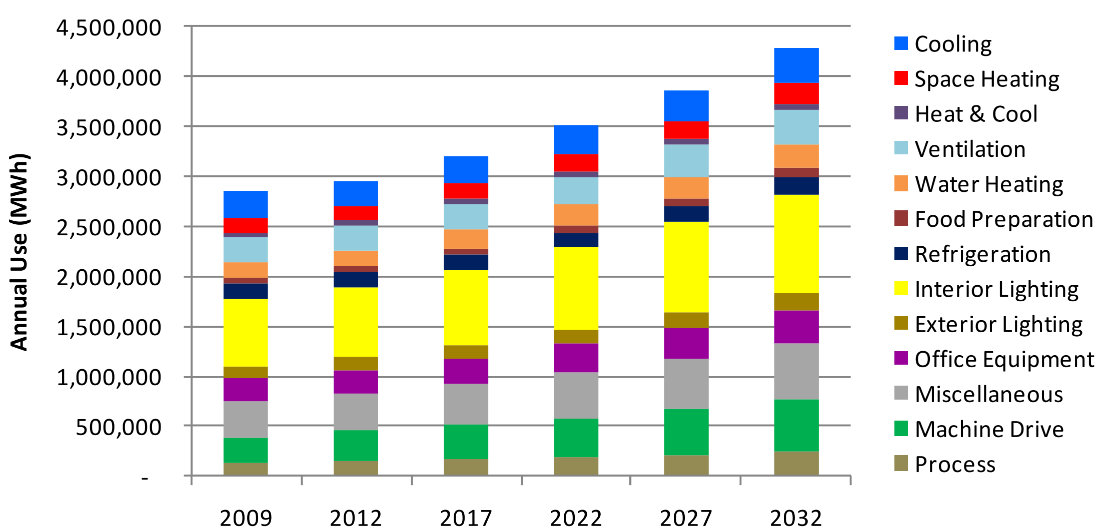

Table A-12 Baseline Forecast Summary by Sector, Washington

End Use	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. Growth Rate ('09–'32)
Res. WA	2,451,707	2,448,104	2,617,630	2,947,427	3,329,882	3,792,486	54.7%	1.9%
C&I WA	2,852,165	2,955,156	3,209,083	3,509,816	3,869,176	4,280,649	50.1%	1.8%
Total	5,303,872	5,403,260	5,826,712	6,457,243	7,199,059	8,073,136	52.2%	1.8%

Figure A-3 Baseline Forecast Summary by Sector, Washington

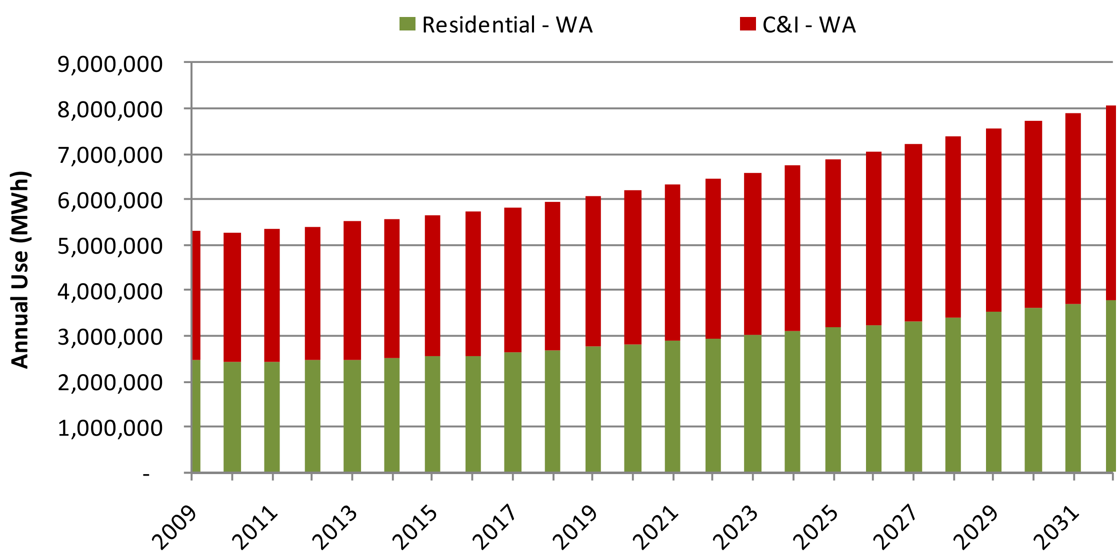

Figure A-4 Summary of Energy Efficiency Potential Savings, Washington, All Sectors

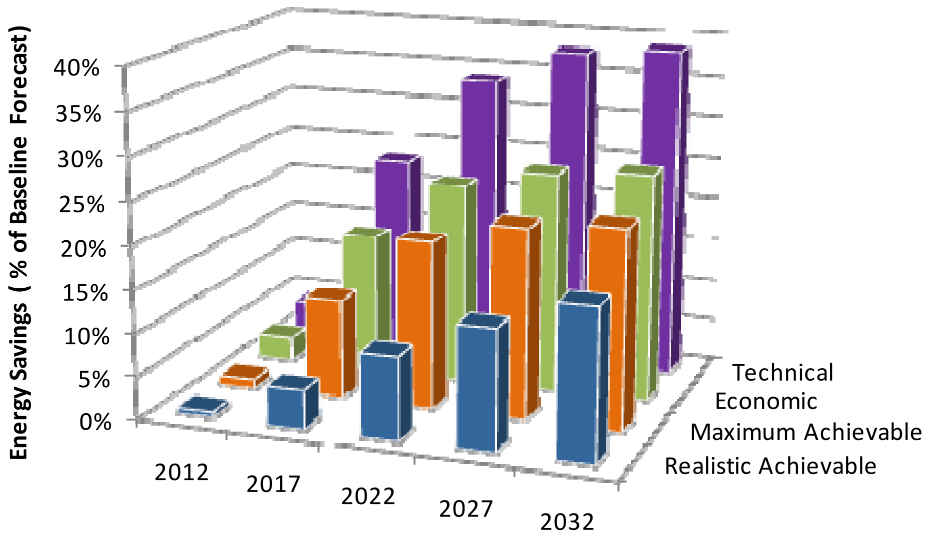

Figure A-5 Energy Efficiency Potential Forecasts, Washington, All Sectors

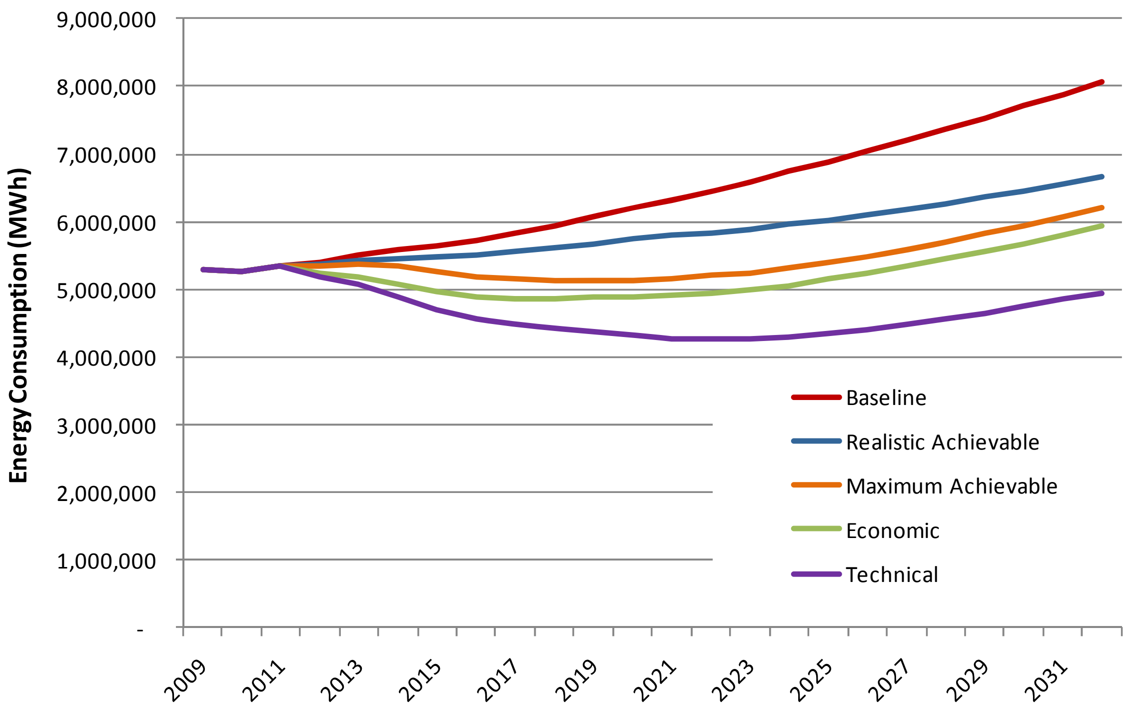

Table A-13 Summary of Energy Efficiency Potential, Washington, All Sectors

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	5,403,260	5,826,712	6,457,243	7,199,059	8,073,136
Baseline Peak Demand(MW)	1,170	1,236	1,374	1,531	1,713
Cumulative Energy Savings (MWh)					
Realistic Achievable	33,146	267,962	616,991	1,007,301	1,411,648
Maximum Achievable	57,434	679,603	1,258,467	1,598,673	1,869,605
Economic	156,759	956,924	1,517,670	1,853,199	2,143,779
Technical	212,980	1,349,814	2,191,746	2,718,118	3,118,733
Cumulative Energy Savings (% of Baseline)					
Realistic Achievable	0.6%	4.6%	9.6%	14.0%	17.5%
Maximum Achievable	1.1%	11.7%	19.5%	22.2%	23.2%
Economic	2.9%	16.4%	23.5%	25.7%	26.6%
Technical	3.9%	23.2%	33.9%	37.8%	38.6%
Peak Savings (MW)					
Realistic Achievable	10	57	126	212	298
Maximum Achievable	15	142	266	339	388
Economic	41	204	325	394	447
Technical	53	289	457	565	645
Peak Savings (% of Baseline)					
Realistic Achievable	0.8%	4.6%	9.2%	13.8%	17.4%
Maximum Achievable	1.3%	11.5%	19.3%	22.1%	22.6%
Economic	3.5%	16.5%	23.7%	25.8%	26.1%
Technical	4.6%	23.4%	33.3%	36.9%	37.6%

Table A-14 Achievable Cumulative EE Potential by Sector, Washington (MWh)

Segment	2012	2017	2022	2027	2032
Residential, WA	17,413	94,529	238,739	431,973	637,029
C&I, WA	15,733	173,433	378,252	575,328	774,619
Total	**33,146**	**267,962**	**616,991**	**1,007,301**	**1,411,648**

Figure A-6 Achievable Cumulative Potential by Sector, Washington

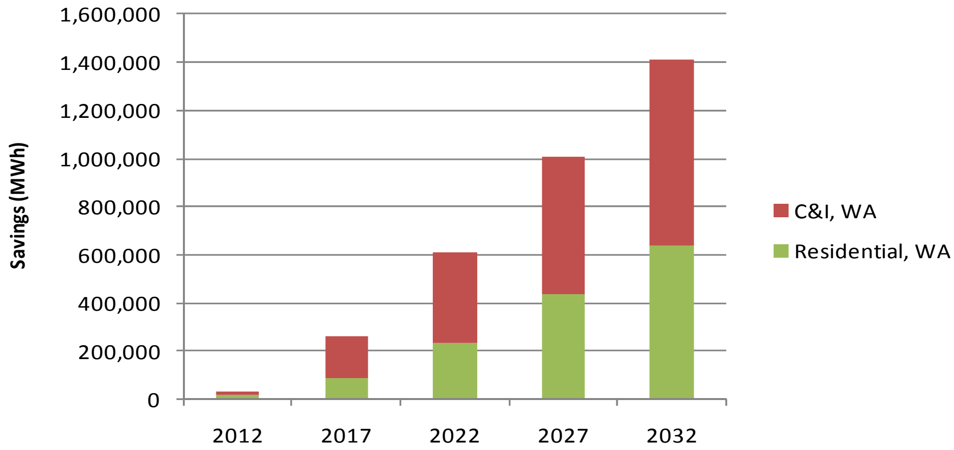

Figure A-7 Residential Energy Efficiency Potential Savings, Washington

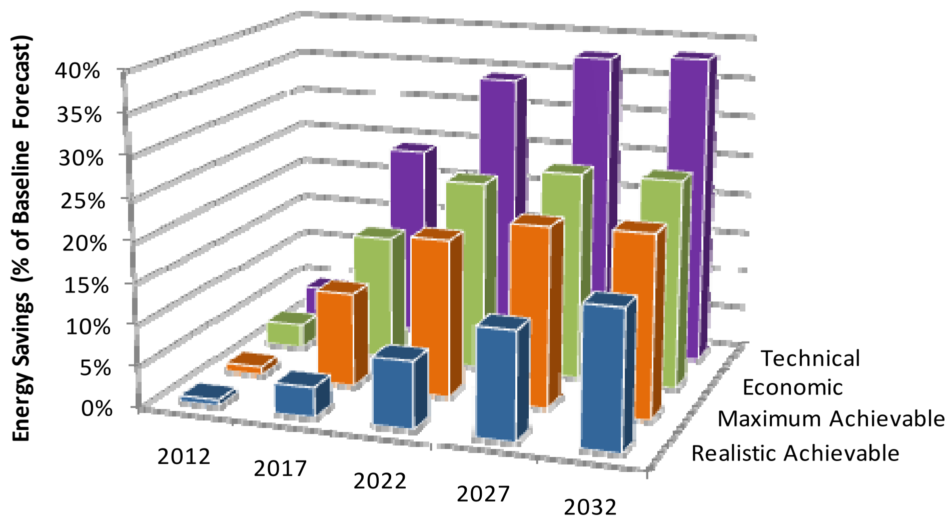

Figure A-8 Residential Energy Efficiency Potential Forecast, Washington

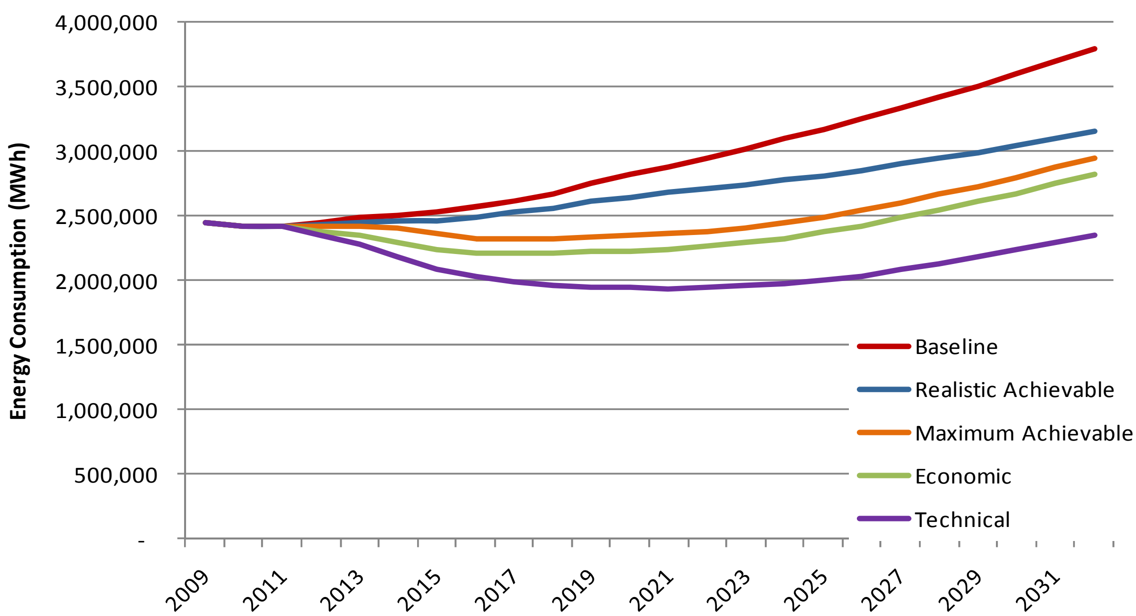

Table A-15 Energy Efficiency Potential for the Residential Sector, Washington

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	2,448,104	2,617,630	2,947,427	3,329,882	3,792,486
Baseline Peak Demand (MW)	710	736	825	925	1,041
Cumulative Energy Savings (MWh)					
Realistic achievable	17,413	94,529	238,739	431,973	637,029
Maximum achievable	24,459	298,135	567,960	730,774	843,186
Economic	70,743	404,323	687,451	847,003	970,769
Technical	103,446	626,769	1,005,455	1,250,538	1,446,982
Cumulative Energy Savings (% of Baseline)					
Realistic Achievable	0.7%	3.6%	8.1%	13.0%	16.8%
Maximum achievable	1.0%	11.4%	19.3%	21.9%	22.2%
Economic	2.9%	15.4%	23.3%	25.4%	25.6%
Technical	4.2%	23.9%	34.1%	37.6%	38.2%
Peak Savings (MW)					
Realistic Achievable	7	32	74	133	193
Maximum achievable	10	87	171	222	251
Economic	27	124	211	258	290
Technical	37	187	298	368	422
Peak Savings (% of Baseline)					
Realistic Achievable	1.0%	4.3%	9.0%	14.4%	18.5%
Maximum achievable	1.4%	11.9%	20.7%	24.0%	24.1%
Economic	3.9%	16.8%	25.5%	27.9%	27.8%
Technical	5.2%	25.4%	36.1%	39.8%	40.5%

Table A-16 Residential Baseline & Realistic Achievable Potential by Segment, WA

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)					
Single Family	1,585,536	1,691,161	1,906,692	2,156,609	2,459,834
Multi Family	160,305	175,186	199,898	227,929	260,943
Mobile Home	68,448	72,476	81,311	91,591	104,051
Limited Income	633,816	678,807	759,527	853,753	967,658
Total	2,448,104	2,617,630	2,947,427	3,329,882	3,792,486
Energy Savings, Realistic Achievable Potential (MWh)					
Single Family	12,388	64,350	164,414	291,057	426,412
Multi Family	830	4,691	12,243	24,346	36,864
Mobile Home	520	2,283	4,274	7,827	11,714
Limited Income	3,674	23,204	57,808	108,744	162,039
Total	17,413	94,529	238,739	431,973	637,029
% of Total Residential Energy Savings					
Single Family	71.1%	68.1%	68.9%	67.4%	66.9%
Multi Family	4.8%	5.0%	5.1%	5.6%	5.8%
Mobile Home	3.0%	2.4%	1.8%	1.8%	1.8%
Limited Income	21.1%	24.5%	24.2%	25.2%	25.4%

Table A-17 Residential Potential by Housing Type, 2022, Washington

Forecast	Single Family	Multi Family	Mobile Home	Limited Income	Total
Baseline Forecast (MWh)	1,906,692	199,898	81,311	759,527	2,947,427
Cumulative Energy Savings (MWh)					
Realistic Achievable	164,414	12,243	4,274	57,808	238,739
Maximum Achievable	386,645	31,832	9,576	139,906	567,960
Economic Potential	463,459	39,746	11,955	172,291	687,451
Technical Potential	639,003	61,512	28,913	276,028	1,005,455
Energy Savings % of Baseline					
Realistic Achievable	8.6%	6.1%	5.3%	7.6%	8.1%
Maximum Achievable	20.3%	15.9%	11.8%	18.4%	19.3%
Economic Potential	24.3%	19.9%	14.7%	22.7%	23.3%
Technical Potential	33.5%	30.8%	35.6%	36.3%	34.1%

Table A-18 Residential Cumulative Savings by End Use and Potential Type, Washington (MWh)

End Use	Case	2012	2017	2022	2027	2032
Cooling	Realistic Achievable	9	1,659	5,876	15,615	29,687
	Economic	246	15,452	28,210	40,243	54,276
	Technical	2,766	42,662	68,576	97,845	132,886
Space Heating	Realistic Achievable	216	12,242	57,209	132,448	215,198
	Economic	6,791	110,158	213,315	282,271	338,227
	Technical	9,175	144,853	273,139	365,838	453,464
Heat/Cool	Realistic Achievable	9	595	1,581	4,130	10,179
	Economic	311	8,778	10,272	12,770	18,457
	Technical	2,278	18,977	32,657	45,591	52,056
Water Heating	Realistic Achievable	469	18,949	78,476	154,418	239,950
	Economic	9,253	101,513	227,153	297,020	348,485
	Technical	24,475	195,999	366,992	463,545	517,698
Appliances	Realistic Achievable	848	8,195	17,794	28,160	39,054
	Economic	3,663	40,418	53,006	56,444	60,723
	Technical	4,768	51,790	69,442	75,057	79,777
Interior Lighting	Realistic Achievable	12,389	34,835	44,682	52,336	47,795
	Economic	36,945	71,839	81,146	74,030	56,992
	Technical	43,188	98,598	97,421	91,087	84,570
Exterior Lighting	Realistic Achievable	2,156	6,922	7,102	6,615	5,305
	Economic	6,420	14,434	11,588	8,760	6,252
	Technical	7,353	18,822	16,360	14,884	14,685
Electronics	Realistic Achievable	1,173	8,913	21,007	29,939	37,810
	Economic	5,909	30,195	44,462	50,005	57,525
	Technical	8,171	43,205	61,954	70,337	81,054
Miscellaneous	Realistic Achievable	145	2,218	5,012	8,312	12,051
	Economic	1,205	11,535	18,300	25,461	29,833
	Technical	1,273	11,864	18,916	26,354	30,793
Total	Realistic Achievable	17,413	94,529	238,739	431,973	637,029
	Economic	70,743	404,323	687,451	847,003	970,769
	Technical	103,446	626,769	1,005,455	1,250,538	1,446,982

Figure A–9 Residential Achievable Potential by End Use, Selected Years, Washington

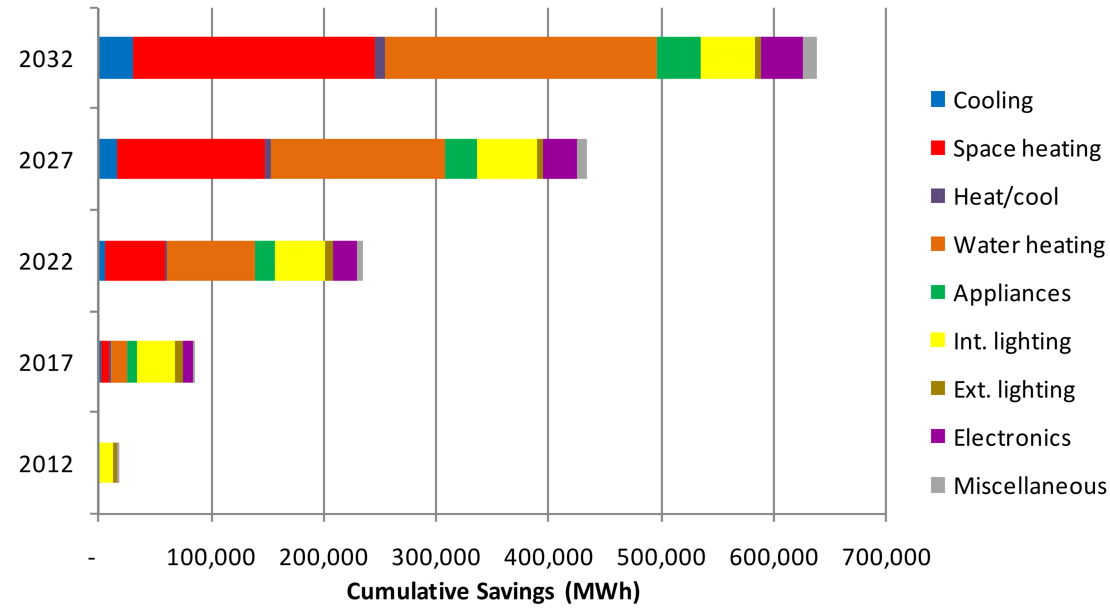

Table A-19 Residential Realistic Achievable Potential by End Use and Market Segment, 2022, WA (MWh)

	Single Family	Multi Family	Mobile Home	Limited Income	Total
Cooling	3,239	206	70	2,360	5,876
Space heating	44,225	3,196	506	9,282	57,209
Heat/cool	1,464	10	49	58	1,581
Water heating	44,891	5,834	886	26,864	78,476
Appliances	12,433	426	499	4,436	17,794
Interior lighting	31,573	1,880	1,155	10,074	44,682
Exterior lighting	5,854	99	252	896	7,102
Electronics	16,296	587	685	3,438	21,007
Miscellaneous	4,438	5	171	399	5,012
Total	**164,414**	**12,243**	**4,274**	**57,808**	**238,739**

Table A-20 Residential Cumulative Realistic Achievable Potential by End Use and Equipment Measures, Washington, Selected Years (MWh)

End Use	Technology	2012	2017	2022
Cooling	Central AC	-	100	112
Heat/Cool	Air Source Ht. Pump	-	-	-
Water Heating	Water Heater	97	726	760
Appliances	Clothes Washer	54	661	1,664
	Clothes Dryer	68	468	858
	Dishwasher	75	701	1,709
	Refrigerator	293	1,347	2,798
	Freezer	220	1,091	2,371
	Second Refrigerator	101	490	949
	Stove	14	109	245
Interior Lighting	Screw-in	11,536	28,508	34,316
	Linear Fluorescent	117	1,267	2,373
	Pin-based	735	4,932	7,438
Exterior Lighting	Screw-in	2,139	6,837	6,987
	High Intensity/Flood	17	85	115
Electronics	Personal Computers	758	6,128	10,557
	TVs	407	2,139	3,960
Miscellaneous	Pool Pump	110	1,022	2,525
	Furnace Fan	29	358	1,066
Total		16,770	56,971	80,803

Table A-21 Residential Realistic Achievable Savings for Non-equipment Measures, Washington (MWh)

Measure	2012	2017	2022
Water Heater - Convert to Gas	211	8,173	55,933
Furnace - Convert to Gas	172	5,504	35,051
Advanced New Construction Designs	1	119	2,781
Repair and Sealing - Ducting	13	1,860	5,347
Insulation - Infiltration Control	14	1,927	5,432
Water Heater - Thermostat Setback	98	5,644	9,489
Home Energy Management System	5	798	2,822
Water Heater - Hot Water Saver	4	296	3,785
Freezer - Remove Second Unit	15	2,142	4,592
Thermostat - Clock/Programmable	15	2,060	5,686
Electronics - Reduce Standby Wattage	8	646	6,490
Insulation - Foundation	1	298	1,351
Air Source Heat Pump - Maintenance	9	595	1,581
Refrigerator - Remove Second Unit	8	1,185	2,608
Water Heater - Faucet Aerators	9	685	1,639
Insulation - Ducting	1	146	836
Insulation - Wall Cavity	0	190	865
Water Heater - Tank Blanket/Insulation	34	1,803	2,812
Room AC - Removal of Second Unit	4	638	1,582
Ceiling Fan - Installation	0	63	576
Water Heater - Timer	8	934	1,676
Insulation - Ceiling	2	285	862
Water Heater - Low Flow Showerheads	6	617	1,233
Water Heater - Heat Pump	-	11	458
Central AC - Maintenance and Tune-Up	-	-	-
Insulation - Wall Sheathing	0	36	172
Pool - Pump Timer	5	838	1,421
Water Heater - Pipe Insulation	1	72	692
Whole-House Fan - Installation	-	6	166
Total	643	37,558	157,936

Figure A-10 Energy Efficiency Potential Savings, C&I Sector, Washington

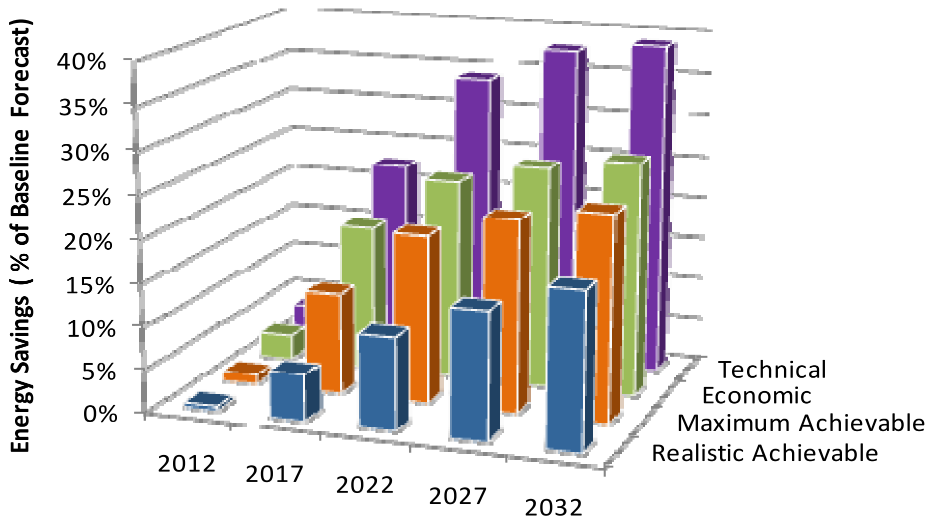

Figure A-11 Energy Efficiency Potential Forecast, C&I Sector, Washington

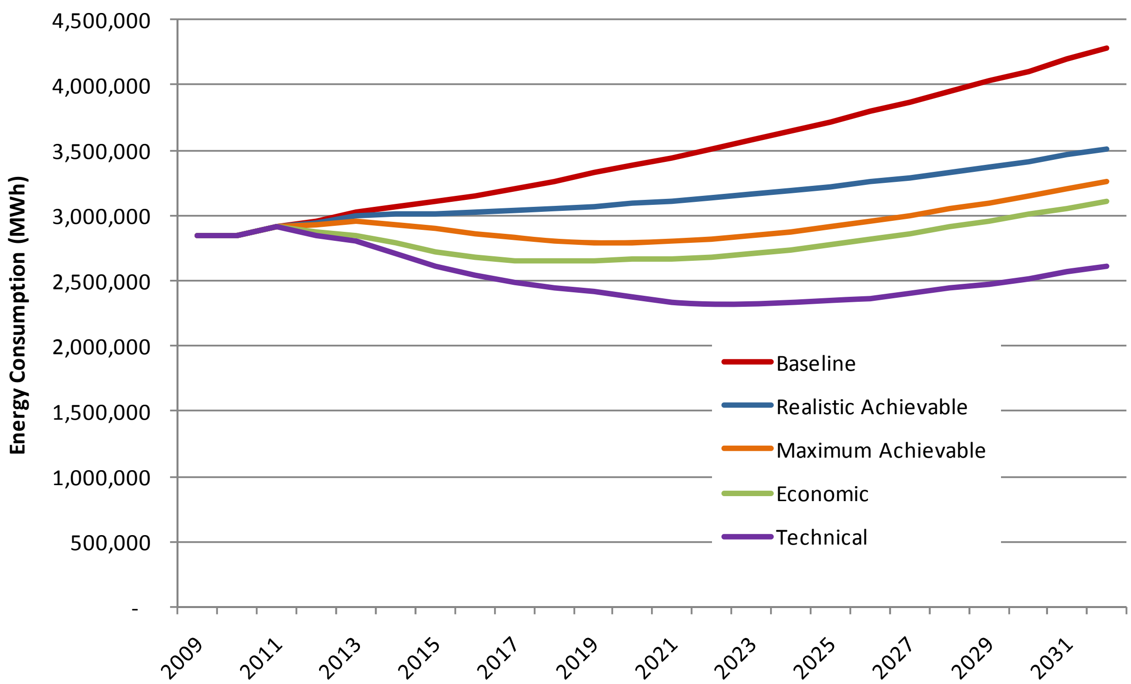

Table A-22 Energy Efficiency Potential, C&I Sector, Washington

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	2,955,156	3,209,083	3,509,816	3,869,176	4,280,649
Baseline Peak Demand(MW)	460	500	549	607	671
Cumulative Energy Savings (MWh)					
Realistic Achievable	15,733	173,433	378,252	575,328	774,619
Maximum Achievable	32,975	381,468	690,507	867,899	1,026,419
Economic	86,016	552,602	830,218	1,006,195	1,173,010
Technical	109,533	723,045	1,186,290	1,467,580	1,671,750
Cumulative Energy Savings (% of Baseline)					
Realistic Achievable	0.5%	5.4%	10.8%	14.9%	18.1%
Maximum Achievable	1.1%	11.9%	19.7%	22.4%	24.0%
Economic	2.9%	17.2%	23.7%	26.0%	27.4%
Technical	3.7%	22.5%	33.8%	37.9%	39.1%
Peak Savings (MW)					
Realistic Achievable	2	25	52	79	105
Maximum Achievable	5	55	95	117	137
Economic	13	80	114	137	157
Technical	17	102	159	197	223
Peak Savings (% of Baseline)					
Realistic Achievable	0.5%	5.1%	9.5%	13.0%	15.7%
Maximum Achievable	1.1%	11.0%	17.2%	19.4%	20.4%
Economic	2.9%	15.9%	20.8%	22.6%	23.4%
Technical	3.6%	20.4%	28.9%	32.5%	33.2%

Table A-23 C&I Sector, Baseline and Realistic Achievable Potential by Segment, Washington

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)					
Small/Med. Commercial	413,131	436,628	470,488	512,594	560,964
Large Commercial	1,558,848	1,641,938	1,770,523	1,927,937	2,109,236
Extra Large Commercial	275,848	338,184	367,338	399,653	434,542
Extra Large Industrial	707,328	792,332	901,468	1,028,993	1,175,907
Total	2,955,156	3,209,083	3,509,816	3,869,176	4,280,649
Cumulative Energy Savings, Achievable Potential (MWh)					
Small/Med. Commercial	2,551	25,567	52,366	79,356	108,891
Large Commercial	10,092	112,528	231,487	335,497	435,628
Extra Large Commercial	2,607	27,021	56,555	85,997	112,469
Extra Large Industrial	483	8,317	37,844	74,477	117,630
Total	15,733	173,433	378,252	575,328	774,619
% of Total C&I Cumulative Energy Savings					
Small/Med. Commercial	16.2%	14.7%	13.8%	13.8%	14.1%
Large Commercial	64.1%	64.9%	61.2%	58.3%	56.2%
Extra Large Commercial	16.6%	15.6%	15.0%	14.9%	14.5%
Extra Large Industrial	3.1%	4.8%	10.0%	12.9%	15.2%

Table A-24 C&I Potential by Segment, Washington, 2022

Forecast	Small/Med. Commercial	Large Commercial	Extra Large Commercial	Extra Large Industrial	Total
Baseline Forecast (MWh)	470,488	1,770,523	367,338	901,468	3,509,816
Cumulative Energy Savings (MWh)					
Realistic Achievable	52,366	231,487	56,555	37,844	378,252
Economic Potential	106,676	441,853	118,311	163,378	830,218
Technical Potential	172,714	650,066	148,095	215,416	1,186,290
Cumulative Energy Savings % of Baseline					
Realistic Achievable	11%	13%	15%	4%	11%
Economic Potential	23%	25%	32%	18%	24%
Technical Potential	37%	37%	40%	24%	34%

Table A-25 C&I Cumulative Savings by End Use and Potential Type, Washington (MWh)

End Use	Case	2012	2017	2022	2027	2032
Cooling	Realistic Achievable	127	8,672	29,166	48,498	72,425
	Economic	1,709	30,259	62,983	86,699	116,136
	Technical	4,457	60,126	124,114	157,093	189,090
Space Heating	Realistic Achievable	10	1,427	7,180	14,045	23,624
	Economic	212	7,563	19,650	28,833	42,274
	Technical	356	11,555	32,534	45,033	60,186
Heat/Cool	Realistic Achievable	31	2,494	4,572	5,575	6,982
	Economic	357	5,927	7,558	8,984	10,138
	Technical	483	6,778	9,118	11,073	12,505
Ventilation	Realistic Achievable	246	4,256	20,112	40,397	69,089
	Economic	4,017	29,775	75,187	107,501	130,189
	Technical	6,107	47,417	127,261	172,058	190,303
Water Heating	Realistic Achievable	181	4,769	10,742	16,921	23,513
	Economic	1,709	15,526	22,956	29,467	31,482
	Technical	8,806	63,741	116,091	166,541	183,186
Food Preparation	Realistic Achievable	140	1,796	5,159	9,950	14,898
	Economic	1,863	11,976	21,990	26,511	28,922
	Technical	2,173	13,179	24,316	29,162	31,947
Refrigeration	Realistic Achievable	123	1,246	4,138	7,959	11,717
	Economic	1,843	8,978	17,215	22,233	24,920
	Technical	2,183	11,986	26,785	34,794	39,418
Interior Lighting	Realistic Achievable	11,768	111,221	218,748	316,260	394,891
	Economic	50,511	299,598	396,845	456,682	523,557
	Technical	55,416	327,215	442,057	510,066	581,362
Exterior Lighting	Realistic Achievable	1,108	15,661	30,450	38,068	45,433
	Economic	4,693	44,035	50,942	53,236	56,711
	Technical	5,191	48,166	57,089	64,537	72,708
Office Equipment	Realistic Achievable	1,779	18,258	30,020	39,448	49,199
	Economic	12,800	58,446	61,458	64,159	66,791
	Technical	17,214	80,539	85,590	90,712	96,009
Machine Drive	Realistic Achievable	199	2,492	8,718	15,739	23,806
	Economic	2,252	17,069	40,392	50,946	58,527
	Technical	2,653	26,498	84,466	111,180	128,005
Process	Realistic Achievable	17	999	8,473	20,545	35,763
	Economic	3,980	22,472	50,483	66,505	77,283
	Technical	3,980	22,472	50,483	66,505	77,283
Miscellaneous	Realistic Achievable	5	142	775	1,924	3,280
	Economic	70	977	2,561	4,439	6,080
	Technical	514	3,373	6,388	8,826	9,749
Total	Realistic Achievable	15,733	173,433	378,252	575,328	774,619
	Economic	86,016	552,602	830,218	1,006,195	1,173,010
	Technical	109,533	723,045	1,186,290	1,467,580	1,671,750

Figure A-12 C&I Achievable Potential by End Use, Selected Years, Washington

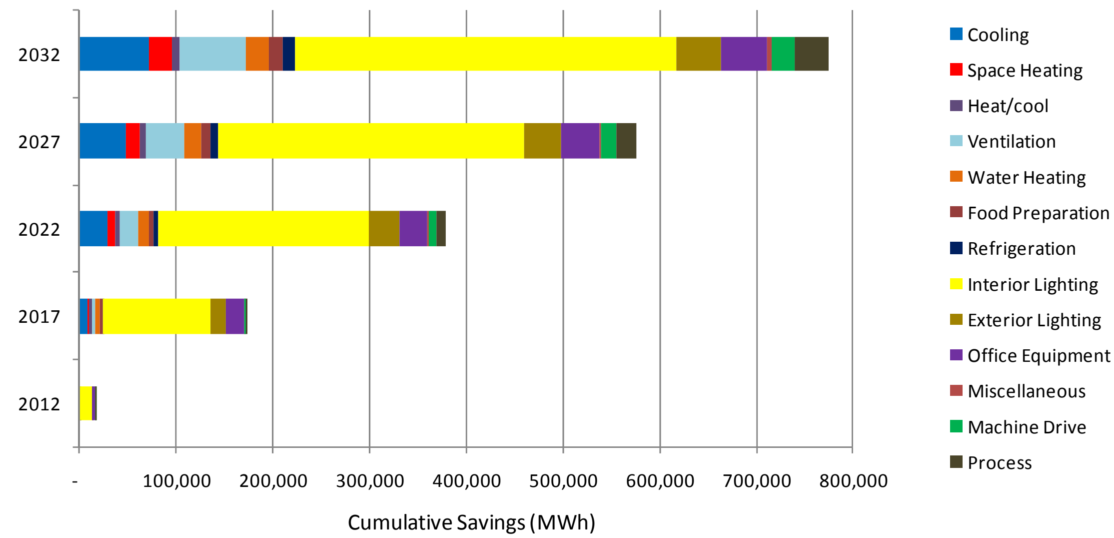

Table A-26 C&I Realistic Achievable Potential by End Use and Market Segment, 2022, Washington (MWh)

	Small/Med. Commercial	Large Commercial	Extra Large Commercial	Extra Large Industrial	Total
Cooling	1,017	17,942	4,119	6,087	29,166
Space Heating	440	4,617	1,216	906	7,180
Combined Heating/Cooling	323	3,597	464	188	4,572
Ventilation	4,268	3,818	4,496	7,530	20,112
Water Heating	1,238	3,974	5,530	-	10,742
Food Preparation	700	3,815	644	-	5,159
Refrigeration	741	3,001	396	-	4,138
Interior Lighting	33,054	149,244	30,943	5,507	218,748
Exterior Lighting	5,854	18,916	5,246	434	30,450
Office Equipment	4,529	22,130	3,362	-	30,020
Machine Drive	-	-	-	8,718	8,718
Process	-	-	-	8,473	8,473
Miscellaneous	202	432	141	-	775
Total	**52,366**	**231,487**	**56,555**	**37,844**	**378,252**

Table A-27 C&I Cumulative Achievable Potential by End Use and Equipment Measures, Washington (MWh)

End Use	Technology	2012	2017	2022
Cooling	Central Chiller	53	551	2,062
	PTAC	4	4	4
Heat/Cool	Heat Pump	14	263	795
Ventilation	Ventilation	235	3,625	13,529
Water Heater	Water Heater	160	1,908	4,354
Food Preparation	Fryer	9	101	271
	Hot Food Container	5	172	488
	Oven	127	1,495	3,996
Refrigeration	Glass Door Display	21	279	808
	Icemaker	16	216	644
	Solid Door Refrigerator	29	332	893
	Vending Machine	55	303	740
	Walk in Refrigeration	21	279	808
Interior Lighting	Interior Screw-in	6,957	45,558	69,399
	HID	1,823	16,436	32,323
	Linear Fluorescent	2,869	35,193	69,229
Exterior Lighting	Screw-in	154	2,018	3,288
	HID	864	10,866	21,367
	Linear Fluorescent	82	1,472	2,497
Office Equipment	Desktop Computer	1,056	9,794	15,665
	Laptop Computer	75	700	1,119
	Monitor	211	757	1,307
	POS Terminal	23	318	580
	Printer/copier/fax	66	1,061	1,963
	Server	342	4,823	7,781
Machine Drive	Less than 5 HP	13	92	280
	5-24 HP	28	208	649
	25-99 HP	69	518	1,616
	100-249 HP	19	146	455
	250-499 HP	21	155	484
	500 and more HP	39	292	913
Process	Electrochem. Process	2	138	1,150
	Process Cooling/Refrig.	3	185	1,538
	Process Heating	11	658	5,482
Miscellaneous	Non-HVAC Motor	4	70	339
Total		**15,460**	**140,725**	**268,060**

Table A-28 C&I Cumulative Achievable Savings for Non-equipment Measures, Washington (MWh)

Measure	2012	2017	2022
Energy Management System	25	1,553	16,501
Advanced New Construction Designs	1	70	1,070
Retrocommissioning - Lighting	37	7,653	14,120
Interior Fluorescent - High Bay Fixtures	13	787	8,430
Retrocommissioning - Comprehensive	29	6,096	10,951
Custom Measures	2	533	7,173
RTU - Maintenance	39	4,686	8,093
Fans - Variable Speed Control	5	218	2,179
Fans - Energy Efficient Motors	5	304	3,318
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	0	39	342
Interior Lighting - Occupancy Sensors	13	477	3,666
Interior Fluorescent - Delamp and Install Reflectors	12	506	3,807
Water Heater - Faucet Aerators/Low Flow Nozzles	18	2,657	5,409
Commissioning - Comprehensive	0	245	1,809
Retrocommissioning - HVAC	2	258	2,720
Heat Pump - Maintenance	17	2,231	3,777
Motors - Variable Frequency Drive	7	883	1,911
Motors - Magnetic Adjustable Speed Drives	3	146	1,535
Roofs - High Reflectivity	1	33	262
Chiller - Turbocor Compressor	2	109	1,244
Chiller - Condenser Water Temperature Reset	4	222	2,148
Chiller - VSD	1	81	859
Commissioning - Lighting	0	155	528
Thermostat - Clock/Programmable	3	458	904
Office Equipment - ENERGY STAR Power Supply	6	806	1,605
Exterior Lighting - Daylighting Controls	2	92	747
Water Heater - Heat Pump	0	54	659
Cooking - Exhaust Hoods with Sensor Control	0	8	71
Cooling - Economizer Installation	2	83	760
Insulation - Ducting	1	53	443
Exterior Lighting - Induction Lamps	0	20	290
Furnace - Convert to Gas	1	45	297
Chiller - Chilled Water Reset	1	242	437
Insulation - Wall Cavity	0	10	146
Insulation - Ceiling	0	1	17
Refrigeration - System Optimization	0	10	159
LED Exit Lighting	17	613	670
Industrial Process Improvements	0	17	205

Measure	2012	2017	2022
Refrigeration - System Controls	0	7	112
Commissioning - HVAC	-	-	16
Water Heater - Tank Blanket/Insulation	2	144	254
Pumps - Variable Speed Control	0	9	106
Miscellaneous - ENERGY STAR Water Cooler	0	40	115
Refrigeration - Strip Curtain	-	1	20
Refrigeration - Floating Head Pressure	0	6	59
Water Heater - Hot Water Saver	-	-	2
Refrigeration - Anti-Sweat Heater/Auto Door Closer	0	4	46
Refrigeration - System Maintenance	0	2	32
Water Heater - High Efficiency Circulation Pump	0	6	64
Vending Machine - Controller	0	26	44
Chiller - Chilled Water Variable-Flow System	0	4	32
Exterior Lighting - Cold Cathode Lighting	0	1	16
Laundry - High Efficiency Clothes Washer	0	6	10
Refrigeration - Night Covers	0	0	5
Total	**273**	**32,708**	**110,192**

APPENDIX | B

IDAHO MARKET PROFILES, BASELINE FORECAST, AND POTENTIAL RESULTS

This appendix contains Idaho-specific tables that summarize the study assumptions, inputs, and results for Avista's Idaho service territory only. These tables either repeat Idaho-specific information provided previously within the body of the report, or provide Idaho-specific information that corresponds to Avista system-level information in the report.

Table B–1 Electricity Use and Peak Demand by Rate Class, Idaho 2009

Sector	Rate Schedule(s)	Number of meters (customers)	2009 Electricity sales (MWh)	Peak demand (MW)
Residential	001	99,580	1,182,368	283
General Service	011, 012	19,245	322,570	61
Large General Service	021, 022	1,456	699,953	115
Extra Large General Service	025, 025P	10	266,044	40
Extra Large GS Potlatch	025P	1	892	101
Pumping	031, 032	1,312	58,885	4
Total		**121,604**	**3,422,111**	**603**

Table B–2 Residential Electricity Usage and Intensity by Segment, Idaho 2009

Idaho Segment	Intensity (kWh/Household)	Number of Customers	% of Customers	2009 Electricity Sales (MWh)	% of Sales
Single Family	13,703	59,205	59%	811,302	69%
Multi-Family	8,213	5,237	5%	43,013	4%
Mobile Home	12,320	4,774	5%	58,815	5%
Limited Income	8,868	30,363	31%	269,249	23%
Total	**11,874**	**99,580**	**100%**	**1,182,379**	**100%**

Note: Minor differences with totals in Table B–1 due to calibration.

Table B–3 Single Family Market Profile, 2009, Idaho

		Average Market Profiles				New Units			
End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)	Saturation	UEC (kWh)	Intensity (kWh/HH)	Compared to Average
Cooling	Central AC	36.8%	1,857	684	41	73.4%	2,154	1,581	16%
Cooling	Room AC	10.8%	683	74	4	1.4%	793	11	16%
Combined Heating/Cooling	Air Source Heat Pump	14.7%	6,377	940	56	13.6%	7,398	1,004	16%
Combined Heating/Cooling	Geothermal Heat Pump	0.7%	3,826	27	2	0.8%	4,439	33	16%
Space Heating	Electric Resistance	5.0%	11,494	570	34	2.5%	13,793	342	20%
Space Heating	Electric Furnace	20.0%	9,195	1,837	109	21.0%	11,035	2,315	20%
Space Heating	Supplemental	6.1%	128	8	0	6.1%	154	9	20%
Water Heating	Water Heater	44.4%	3,813	1,694	100	37.8%	4,595	1,736	21%
Interior Lighting	Screw-in	100.0%	1,394	1,394	83	100.0%	1,394	1,394	0%
Interior Lighting	Linear Fluorescent	69.2%	146	101	6	69.2%	146	101	0%
Interior Lighting	Pin-based	100.0%	58	58	3	100.0%	58	58	0%
Exterior Lighting	Screw-in	86.7%	366	317	19	86.7%	366	317	0%
Exterior Lighting	High Intensity/Flood	1.9%	140	3	0	1.9%	140	3	0%
Appliances	Clothes Washer	98.0%	126	124	7	99.8%	154	154	22%
Appliances	Clothes Dryer	92.8%	609	565	33	89.0%	692	616	14%
Appliances	Dishwasher	93.9%	246	231	14	99.9%	271	271	11%
Appliances	Refrigerator	100.0%	793	793	47	100.0%	625	625	-21%
Appliances	Freezer	69.4%	773	536	32	69.4%	708	491	-8%
Appliances	Second Refrigerator	47.3%	816	386	23	20.5%	711	146	-13%
Appliances	Stove	82.1%	383	314	19	82.1%	465	382	22%
Appliances	Microwave	98.5%	168	166	10	98.5%	173	171	3%
Electronics	Personal Computers	140.0%	279	391	23	147.0%	287	422	3%
Electronics	TVs	260.0%	359	933	55	260.0%	400	1,041	12%
Electronics	Devices and Gadgets	100.0%	60	60	4	100.0%	67	67	10%
Miscellaneous	Pool Pump	13.3%	1,500	200	12	14.0%	1,526	214	2%
Miscellaneous	Furnace Fan	30.1%	550	166	10	30.1%	675	203	23%
Miscellaneous	Miscellaneous	100.0%	1,132	1,132	67	100.0%	1,359	1,359	20%
Total				**13,703**	**811**			**15,063**	

Table B–4 Multi-family Market Profile, 2009, Idaho

		Average Market Profiles				New Units			
End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)	Saturation	UEC (kWh)	Intensity (kWh/HH)	Compared to Average
Cooling	Central AC	5.0%	845	42	0	24.1%	912	220	8%
Cooling	Room AC	25.0%	324	81	0	18.9%	350	66	8%
Combined Heating/Cooling	Air Source Heat Pump	1.0%	2,665	27	0	3.4%	2,878	98	8%
Combined Heating/Cooling	Geothermal Heat Pump	0.0%	1,599	-	-	0.5%	1,727	9	8%
Space Heating	Electric Resistance	59.0%	4,983	2,940	15	59.0%	5,481	3,234	10%
Space Heating	Electric Furnace	5.0%	3,986	199	1	5.0%	4,385	219	10%
Space Heating	Supplemental	18.0%	56	10	0	18.9%	61	12	10%
Water Heating	Water Heater	77.0%	1,936	1,491	8	71.3%	2,134	1,522	10%
Interior Lighting	Screw-in	100.0%	750	750	4	100.0%	750	750	0%
Interior Lighting	Linear Fluorescent	32.0%	76	24	0	32.0%	76	24	0%
Interior Lighting	Pin-based	3.0%	75	2	0	3.0%	75	2	0%
Exterior Lighting	Screw-in	38.5%	55	21	0	38.5%	55	21	0%
Exterior Lighting	High Intensity/Flood	0.2%	73	0	0	0.2%	73	0	0%
Appliances	Clothes Washer	32.0%	63	20	0	32.0%	70	22	11%
Appliances	Clothes Dryer	30.7%	582	179	1	30.7%	621	191	7%
Appliances	Dishwasher	64.0%	88	56	0	64.0%	93	59	5%
Appliances	Refrigerator	100.0%	677	677	4	100.0%	665	665	-2%
Appliances	Freezer	8.4%	734	62	0	8.4%	703	59	-4%
Appliances	Second Refrigerator	5.0%	687	34	0	5.0%	631	32	-8%
Appliances	Stove	96.4%	163	158	1	96.4%	181	175	11%
Appliances	Microwave	90.0%	99	89	0	90.0%	101	91	1%
Electronics	Personal Computers	63.0%	223	141	1	66.2%	226	150	1%
Electronics	TVs	165.0%	178	293	2	165.0%	188	310	6%
Electronics	Devices and Gadgets	100.0%	25	25	0	100.0%	26	26	5%
Miscellaneous	Pool Pump	0.0%	-	-	-	0.0%	-	-	0%
Miscellaneous	Furnace Fan	13.0%	38	5	0	13.0%	42	5	11%
Miscellaneous	Miscellaneous	100.0%	888	888	5	100.0%	932	932	5%
	Total			**8,213**	**43**			**8,893**	

Table B–5 Mobile Home Market Profile, 2009, Idaho

		Average Market Profiles				New Units			
End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)	Saturation	UEC (kWh)	Intensity (kWh/HH)	Compared to Average
Cooling	Central AC	23.2%	962	223	1	35.9%	1,039	373	8%
Cooling	Room AC	23.2%	354	82	0	22.0%	382	84	8%
Combined Heating/Cooling	Air Source Heat Pump	21.7%	3,035	660	3	22.8%	3,277	748	8%
Combined Heating/Cooling	Geothermal Heat Pump	0.0%	1,821	-	-	0.0%	1,966	-	8%
Space Heating	Electric Resistance	0.0%	5,122	-	-	0.0%	5,634	-	10%
Space Heating	Electric Furnace	68.1%	4,098	2,792	13	68.1%	4,508	3,071	10%
Space Heating	Supplemental	1.4%	30	0	0	1.5%	33	0	10%
Water Heating	Water Heater	96.3%	1,607	1,549	7	91.0%	1,772	1,612	10%
Interior Lighting	Screw-in	100.0%	1,307	1,307	6	100.0%	1,307	1,307	0%
Interior Lighting	Linear Fluorescent	69.2%	137	95	0	69.2%	137	95	0%
Interior Lighting	Pin-based	100.0%	54	54	0	100.0%	54	54	0%
Exterior Lighting	Screw-in	86.7%	343	297	1	86.7%	343	297	0%
Exterior Lighting	High Intensity/Flood	1.9%	131	2	0	1.9%	131	2	0%
Appliances	Clothes Washer	96.3%	128	124	1	96.3%	142	137	11%
Appliances	Clothes Dryer	98.8%	620	612	3	98.8%	662	653	7%
Appliances	Dishwasher	89.0%	250	222	1	89.0%	263	234	5%
Appliances	Refrigerator	100.0%	806	806	4	100.0%	792	792	-2%
Appliances	Freezer	59.3%	786	466	2	59.3%	753	446	-4%
Appliances	Second Refrigerator	19.5%	830	162	1	19.5%	762	149	-8%
Appliances	Stove	93.9%	344	323	2	93.9%	381	358	11%
Appliances	Microwave	82.0%	151	124	1	82.0%	154	126	2%
Electronics	Personal Computers	116.5%	262	305	1	122.3%	265	324	1%
Electronics	TVs	260.0%	359	933	4	260.0%	380	987	6%
Electronics	Devices and Gadgets	100.0%	60	60	0	100.0%	64	64	5%
Miscellaneous	Pool Pump	11.1%	1,500	167	1	11.7%	1,513	177	1%
Miscellaneous	Furnace Fan	8.3%	500	42	0	8.3%	557	47	11%
Miscellaneous	Miscellaneous	100.0%	913	913	4	100.0%	959	959	5%
Total				**12,320**	**59**			**13,096**	

Table B–6 Limited Income Market Profile, 2009, Idaho

		Average Market Profiles				New Units			
End Use	Technology	Saturation	UEC (kWh)	Intensity (kWh/HH)	Usage (GWh)	Saturation	UEC (kWh)	Intensity (kWh/HH)	Compared to Average
Cooling	Central AC	22.2%	944	210	6	28.7%	1,019	293	8%
Cooling	Room AC	35.4%	641	227	7	18.0%	692	124	8%
Combined Heating/Cooling	Air Source Heat Pump	10.4%	2,134	222	7	10.4%	2,305	240	8%
Combined Heating/Cooling	Geothermal Heat Pump	0.0%	1,281	-	-	0.5%	1,383	7	8%
Space Heating	Electric Resistance	32.0%	4,647	1,486	45	28.8%	5,112	1,471	10%
Space Heating	Electric Furnace	19.3%	3,711	716	22	21.2%	4,082	867	10%
Space Heating	Supplemental	12.7%	57	7	0	13.4%	62	8	10%
Water Heating	Water Heater	83.9%	2,101	1,762	54	67.0%	2,316	1,552	10%
Interior Lighting	Screw-in	100.0%	728	728	22	100.0%	728	728	0%
Interior Lighting	Linear Fluorescent	69.2%	75	52	2	69.2%	75	52	0%
Interior Lighting	Pin-based	100.0%	59	59	2	100.0%	59	59	0%
Exterior Lighting	Screw-in	47.1%	106	50	2	47.1%	106	50	0%
Exterior Lighting	High Intensity/Flood	2.7%	84	2	0	2.7%	84	2	0%
Appliances	Clothes Washer	71.3%	55	39	1	71.3%	61	43	11%
Appliances	Clothes Dryer	68.6%	652	447	14	68.6%	696	477	7%
Appliances	Dishwasher	78.5%	72	56	2	78.5%	75	59	5%
Appliances	Refrigerator	100.0%	677	677	21	100.0%	665	665	-2%
Appliances	Freezer	63.4%	734	466	14	63.4%	703	446	-4%
Appliances	Second Refrigerator	23.4%	687	161	5	23.4%	631	148	-8%
Appliances	Stove	89.7%	196	176	5	89.7%	217	195	11%
Appliances	Microwave	92.6%	109	101	3	92.6%	111	102	1%
Electronics	Personal Computers	101.4%	230	233	7	106.5%	233	248	1%
Electronics	TVs	165.0%	204	337	10	165.0%	216	356	6%
Electronics	Devices and Gadgets	100.0%	30	30	1	105.0%	32	33	5%
Miscellaneous	Pool Pump	5.8%	617	36	1	5.8%	622	36	1%
Miscellaneous	Furnace Fan	25.2%	213	54	2	25.2%	238	60	11%
Miscellaneous	Miscellaneous	100.0%	534	534	16	100.0%	561	561	5%
Total				**8,868**	**269**			**8,884**	

Table B–7 Commercial Sector Market Characterization Results, Idaho 2009

Avista Rate Schedule		LoadMAP Segment and Typical Building	Electricity sales (MWh)	Intensity (kWh/sq.ft.)
General Service	011, 012	Small and Medium Commercial — Retail	322,570	17.5
Large General Service	021, 022	Large Commercial — Office	699,953	16.7
Extra Large General Service Commercial	025C	Extra Large Commercial — University	70,361	13.9
Extra Large General Service Industrial	025I, 025P	Extra Large Industrial	1,087,974	40.0
Total			**2,180,858**	

Table B–8 Small/Medium Commercial Segment Market Profile, Idaho, 2009

Average Market Profiles

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)
Cooling	Central Chiller	13.8%	2.39	0.33	6
Cooling	RTU	63.1%	2.46	1.55	29
Cooling	PTAC	3.3%	2.44	0.08	1
Combined Heating/Cooling	Heat Pump	3.6%	6.19	0.22	4
Space Heating	Electric Resistance	5.9%	6.72	0.39	7
Space Heating	Furnace	17.7%	7.05	1.25	23
Ventilation	Ventilation	76.9%	2.09	1.61	30
Interior Lighting	Interior Screw-in	100.0%	1.00	1.00	18
Interior Lighting	HID	100.0%	0.68	0.68	13
Interior Lighting	Linear Fluorescent	100.0%	3.37	3.37	62
Exterior Lighting	Exterior Screw-in	82.6%	0.20	0.16	3
Exterior Lighting	HID	82.6%	0.76	0.63	12
Exterior Lighting	Linear Fluorescent	82.6%	0.16	0.13	2
Water Heating	Water Heater	63.0%	2.00	1.26	23
Food Preparation	Fryer	25.8%	0.16	0.04	1
Food Preparation	Oven	25.8%	0.98	0.25	5
Food Preparation	Dishwasher	25.8%	0.06	0.01	0
Food Preparation	Hot Food Container	25.8%	0.31	0.08	1
Food Preparation	Food Prep	25.8%	0.01	0.00	0
Refrigeration	Walk in Refrigeration	52.4%	-	-	-
Refrigeration	Glass Door Display	52.4%	0.45	0.23	4
Refrigeration	Solid Door Refrigerator	52.4%	0.50	0.26	5
Refrigeration	Open Display Case	52.4%	0.04	0.02	0
Refrigeration	Vending Machine	52.4%	0.30	0.16	3
Refrigeration	Icemaker	52.4%	0.34	0.18	3
Office Equipment	Desktop Computer	99.9%	0.48	0.48	9
Office Equipment	Laptop Computer	99.9%	0.06	0.06	1
Office Equipment	Server	99.9%	0.36	0.36	7
Office Equipment	Monitor	99.9%	0.25	0.25	5
Office Equipment	Printer/copier/fax	99.9%	0.24	0.24	4
Office Equipment	POS Terminal	99.9%	0.27	0.27	5
Miscellaneous	Non-HVAC Motor	40.2%	1.22	0.49	9
Miscellaneous	Other Miscellaneous	100.0%	1.43	1.43	26
Total				**17.50**	**323**

New Units

End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Central Chiller	13.8%	2.15	0.30	-10%
Cooling	RTU	63.1%	2.22	1.40	-10%
Cooling	PTAC	3.3%	2.20	0.07	-10%
Combined Heating/Cooling	Heat Pump	3.6%	5.57	0.20	-10%
Space Heating	Electric Resistance	5.9%	6.72	0.39	0%
Space Heating	Furnace	17.7%	6.34	1.13	-10%
Ventilation	Ventilation	76.9%	1.88	1.45	-10%
Interior Lighting	Interior Screw-in	100.0%	0.90	0.90	-10%
Interior Lighting	HID	100.0%	0.61	0.61	-10%
Interior Lighting	Linear Fluorescent	100.0%	3.03	3.03	-10%
Exterior Lighting	Exterior Screw-in	82.6%	0.18	0.15	-10%
Exterior Lighting	HID	82.6%	0.68	0.56	-10%
Exterior Lighting	Linear Fluorescent	82.6%	0.14	0.12	-10%
Water Heating	Water Heater	63.0%	1.90	1.19	-5%
Food Preparation	Fryer	25.8%	0.16	0.04	0%
Food Preparation	Oven	25.8%	0.98	0.25	0%
Food Preparation	Dishwasher	25.8%	0.06	0.01	0%
Food Preparation	Hot Food Container	25.8%	0.31	0.08	0%
Food Preparation	Food Prep	25.8%	0.01	0.00	0%
Refrigeration	Walk in Refrigeration	52.4%	-	-	0%
Refrigeration	Glass Door Display	52.4%	0.40	0.21	-10%
Refrigeration	Solid Door Refrigerator	52.4%	0.45	0.24	-10%
Refrigeration	Open Display Case	52.4%	0.04	0.02	-10%
Refrigeration	Vending Machine	52.4%	0.30	0.16	0%
Refrigeration	Icemaker	52.4%	0.34	0.18	0%
Office Equipment	Desktop Computer	99.9%	0.48	0.48	0%
Office Equipment	Laptop Computer	99.9%	0.06	0.06	0%
Office Equipment	Server	99.9%	0.36	0.36	0%
Office Equipment	Monitor	99.9%	0.25	0.25	0%
Office Equipment	Printer/copier/fax	99.9%	0.24	0.24	0%
Office Equipment	POS Terminal	99.9%	0.27	0.27	0%
Miscellaneous	Non-HVAC Motor	40.2%	1.22	0.49	0%
Miscellaneous	Other Miscellaneous	100.0%	1.43	1.43	0%
Total				**16.3**	

Table B–9 Large Commercial Segment Market Profile, Idaho, 2009

		Average Market Profiles				New Units			
End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Central Chiller	24.7%	2.15	0.53	22	24.7%	1.93	0.48	-10%
Cooling	RTU	37.8%	2.52	0.95	40	37.8%	2.26	0.86	-10%
Cooling	PTAC	3.8%	2.49	0.09	4	3.8%	2.24	0.08	-10%
Combined Heating/Cooling	Heat Pump	9.1%	4.81	0.44	18	9.1%	4.33	0.40	-10%
Space Heating	Electric Resistance	5.9%	3.62	0.21	9	5.9%	3.62	0.21	0%
Space Heating	Furnace	12.7%	4.68	0.60	25	12.7%	4.21	0.54	-10%
Ventilation	Ventilation	75.1%	1.66	1.24	52	75.1%	1.49	1.12	-10%
Interior Lighting	Interior Screw-in	100.0%	0.94	0.94	39	100.0%	0.85	0.85	-10%
Interior Lighting	HID	100.0%	0.71	0.71	30	100.0%	0.64	0.64	-10%
Interior Lighting	Linear Fluorescent	100.0%	3.29	3.29	138	100.0%	2.96	2.96	-10%
Exterior Lighting	Exterior Screw-in	89.6%	0.11	0.10	4	89.6%	0.10	0.09	-10%
Exterior Lighting	HID	89.6%	0.62	0.56	23	89.6%	0.56	0.50	-10%
Exterior Lighting	Linear Fluorescent	89.6%	0.16	0.14	6	89.6%	0.14	0.13	-10%
Water Heating	Water Heater	54.2%	2.31	1.25	53	54.2%	2.20	1.19	-5%
Food Preparation	Fryer	18.4%	0.35	0.06	3	18.4%	0.35	0.06	0%
Food Preparation	Oven	18.4%	1.88	0.35	14	18.4%	1.88	0.35	0%
Food Preparation	Dishwasher	18.4%	0.19	0.03	1	18.4%	0.19	0.03	0%
Food Preparation	Hot Food Container	18.4%	0.27	0.05	2	18.4%	0.27	0.05	0%
Food Preparation	Food Prep	18.4%	0.02	0.00	0	18.4%	0.02	0.00	0%
Refrigeration	Walk in Refrigeration	39.1%	0.48	0.19	8	39.1%	0.43	0.17	-10%
Refrigeration	Glass Door Display	39.1%	0.37	0.14	6	39.1%	0.33	0.13	-10%
Refrigeration	Solid Door Refrigerator	39.1%	0.77	0.30	13	39.1%	0.69	0.27	-10%
Refrigeration	Open Display Case	39.1%	0.27	0.10	4	39.1%	0.24	0.09	-10%
Refrigeration	Vending Machine	39.1%	0.36	0.14	6	39.1%	0.36	0.14	0%
Refrigeration	Icemaker	39.1%	0.66	0.26	11	39.1%	0.66	0.26	0%
Office Equipment	Desktop Computer	98.4%	0.90	0.88	37	98.4%	0.90	0.88	0%
Office Equipment	Laptop Computer	98.4%	0.07	0.07	3	98.4%	0.07	0.07	0%
Office Equipment	Server	98.4%	0.42	0.41	17	98.4%	0.42	0.41	0%
Office Equipment	Monitor	98.4%	0.21	0.20	9	98.4%	0.21	0.20	0%
Office Equipment	Printer/copier/fax	98.4%	0.21	0.21	9	98.4%	0.21	0.21	0%
Office Equipment	POS Terminal	98.4%	0.07	0.07	3	98.4%	0.07	0.07	0%
Miscellaneous	Non-HVAC Motor	57.7%	1.40	0.81	34	57.7%	1.40	0.81	0%
Miscellaneous	Other Miscellaneous	100.0%	1.36	1.36	57	100.0%	1.36	1.36	0%
Total				**16.70**	**700**			**15.6**	

Table B–10 Extra Large Commercial Segment Market Profile, Idaho, 2009

		Average Market Profiles				New Units			
End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Central Chiller	52.2%	2.13	1.11	6	52.2%	1.92	1.00	-10%
Cooling	RTU	24.7%	2.22	0.55	3	24.7%	2.00	0.49	-10%
Cooling	PTAC	0.0%	2.22	-	-	0.0%	2.00	-	-10%
Combined Heating/Cooling	Heat Pump	4.4%	5.23	0.23	1	4.4%	4.70	0.21	-10%
Space Heating	Electric Resistance	15.8%	4.39	0.69	4	15.8%	4.39	0.69	0%
Space Heating	Furnace	5.6%	5.67	0.32	2	5.6%	5.11	0.29	-10%
Ventilation	Ventilation	90.2%	1.94	1.75	9	90.2%	1.74	1.57	-10%
Interior Lighting	Interior Screw-in	100.0%	1.37	1.37	7	100.0%	1.23	1.23	-10%
Interior Lighting	HID	100.0%	0.29	0.29	1	100.0%	0.26	0.26	-10%
Interior Lighting	Linear Fluorescent	100.0%	2.19	2.19	11	100.0%	1.97	1.97	-10%
Exterior Lighting	Exterior Screw-in	96.3%	0.03	0.03	0	96.3%	0.03	0.03	-10%
Exterior Lighting	HID	96.3%	0.88	0.85	4	96.3%	0.79	0.76	-10%
Exterior Lighting	Linear Fluorescent	96.3%	0.04	0.03	0	96.3%	0.03	0.03	-10%
Water Heating	Water Heater	26.3%	3.72	0.98	5	26.3%	3.53	0.93	-5%
Food Preparation	Fryer	13.8%	0.13	0.02	0	13.8%	0.13	0.02	0%
Food Preparation	Oven	13.8%	2.12	0.29	1	13.8%	2.12	0.29	0%
Food Preparation	Dishwasher	13.8%	0.08	0.01	0	13.8%	0.08	0.01	0%
Food Preparation	Hot Food Container	13.8%	0.13	0.02	0	13.8%	0.13	0.02	0%
Food Preparation	Food Prep	13.8%	0.01	0.00	0	13.8%	0.01	0.00	0%
Refrigeration	Walk in Refrigeration	26.6%	0.19	0.05	0	26.6%	0.17	0.04	-10%
Refrigeration	Glass Door Display	26.6%	0.11	0.03	0	26.6%	0.10	0.03	-10%
Refrigeration	Solid Door Refrigerator	26.6%	0.71	0.19	1	26.6%	0.64	0.17	-10%
Refrigeration	Open Display Case	26.6%	0.50	0.13	1	26.6%	0.45	0.12	-10%
Refrigeration	Vending Machine	26.6%	0.38	0.10	1	26.6%	0.38	0.10	0%
Refrigeration	Icemaker	26.6%	0.31	0.08	0	26.6%	0.31	0.08	0%
Office Equipment	Desktop Computer	100.0%	0.64	0.64	3	100.0%	0.64	0.64	0%
Office Equipment	Laptop Computer	100.0%	0.07	0.07	0	100.0%	0.07	0.07	0%
Office Equipment	Server	100.0%	0.17	0.17	1	100.0%	0.17	0.17	0%
Office Equipment	Monitor	100.0%	0.13	0.13	1	100.0%	0.13	0.13	0%
Office Equipment	Printer/copier/fax	100.0%	0.05	0.05	0	100.0%	0.05	0.05	0%
Office Equipment	POS Terminal	100.0%	0.01	0.01	0	100.0%	0.01	0.01	0%
Miscellaneous	Non-HVAC Motor	88.8%	0.82	0.73	4	88.8%	0.82	0.73	0%
Miscellaneous	Other Miscellaneous	100.0%	0.80	0.80	4	100.0%	0.80	0.80	0%
Total				**13.90**	**70**			**12.9**	

Table B–11 Extra Large Industrial Segment Market Profile, Idaho, 2009

		Average Market Profiles				New Units			
End Use	Technology	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Usage (GWh)	Saturation	EUI (kWh)	Intensity (kWh/Sqft.)	Compared to Average
Cooling	Central Chiller	14.4%	7.98	1.15	31	14.4%	7.18	1.04	-10%
Cooling	RTU	17.1%	6.32	1.08	29	17.1%	5.68	0.97	-10%
Cooling	PTAC	1.1%	5.50	0.06	2	1.1%	4.95	0.05	-10%
Combined Heating/Cooling	Heat Pump	1.6%	11.13	0.18	5	1.6%	10.01	0.16	-10%
Space Heating	Electric Resistance	10.8%	8.67	0.93	25	10.8%	8.67	0.93	0%
Space Heating	Furnace	2.0%	9.10	0.18	5	2.0%	8.19	0.17	-10%
Ventilation	Ventilation	27.4%	12.31	3.37	92	27.4%	11.08	3.04	-10%
Interior Lighting	Interior Screw-in	100.0%	0.33	0.33	9	100.0%	0.30	0.30	-10%
Interior Lighting	HID	100.0%	1.05	1.05	28	100.0%	0.94	0.94	-10%
Interior Lighting	Linear Fluorescent	100.0%	1.10	1.10	30	100.0%	0.99	0.99	-10%
Exterior Lighting	Exterior Screw-in	92.5%	0.02	0.02	1	92.5%	0.02	0.02	-10%
Exterior Lighting	HID	92.5%	0.25	0.23	6	92.5%	0.23	0.21	-10%
Exterior Lighting	Linear Fluorescent	92.5%	0.01	0.01	0	92.5%	0.01	0.01	-10%
Process	Process Cooling/Refrigeration	2.4%	99.67	2.40	65	2.4%	99.67	2.40	0%
Process	Process Heating	26.2%	13.74	3.60	98	26.2%	13.74	3.60	0%
Process	Electrochemical Process	2.6%	77.43	2.00	54	2.6%	77.43	2.00	0%
Machine Drive	Less than 5 HP	90.5%	0.92	0.84	23	90.5%	0.92	0.84	0%
Machine Drive	5-24 HP	80.1%	2.26	1.81	49	80.1%	2.26	1.81	0%
Machine Drive	25-99 HP	72.4%	6.10	4.42	120	72.4%	6.10	4.42	0%
Machine Drive	100-249 HP	65.3%	3.84	2.51	68	65.3%	3.84	2.51	0%
Machine Drive	250-499 HP	23.7%	11.61	2.75	75	23.7%	11.61	2.75	0%
Machine Drive	500 and more HP	26.1%	19.50	5.08	138	26.1%	19.50	5.08	0%
Miscellaneous	Miscellaneous	100.0%	4.90	4.90	133	100.0%	4.90	4.90	0%
	Total			**40.00**	**1,088**			**39.1**	

Figure B–1 Residential Baseline Forecast by End Use, Idaho

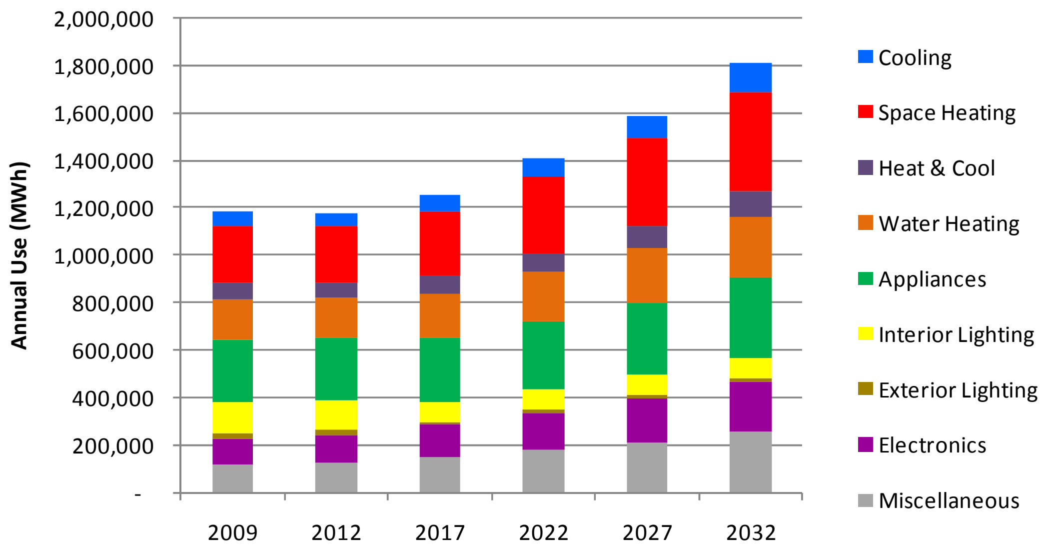

Figure B–2 C&I Baseline Electricity Forecast by End Use, Idaho

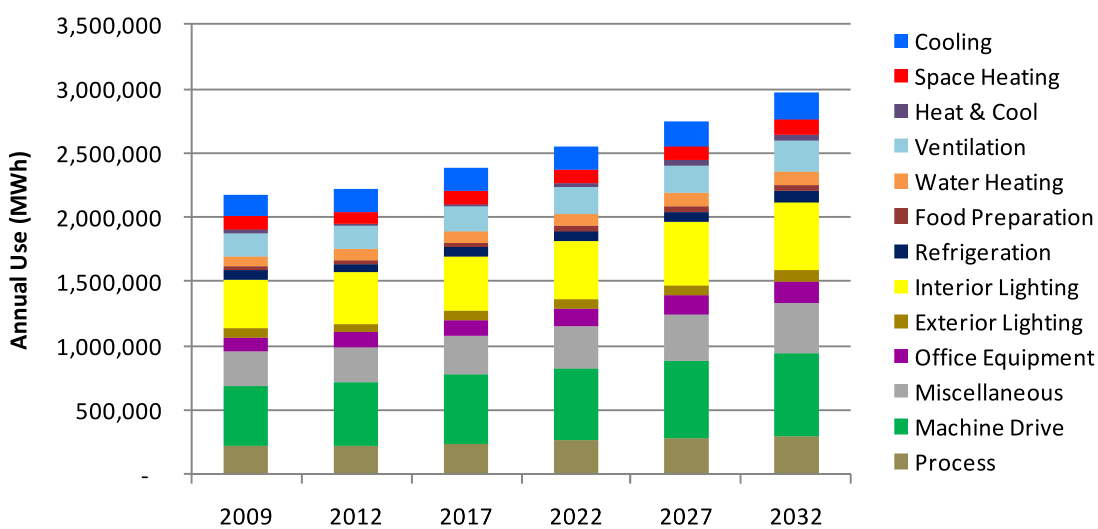

Table B-12 Baseline Forecast Summary by Sector, Idaho

End Use	2009	2012	2017	2022	2027	2032	% Change ('09–'32)	Avg. Growth Rate ('09–'32)
Res. ID	1,182,379	1,178,591	1,253,664	1,408,812	1,588,965	1,808,300	52.9%	1.8%
C&I ID	2,180,858	2,217,188	2,383,504	2,551,291	2,748,846	2,970,324	36.2%	1.3%
Total	3,363,237	3,395,780	3,637,168	3,960,104	4,337,811	4,778,624	42.1%	1.5%

Figure B–3 Baseline Forecast Summary by Sector, Idaho

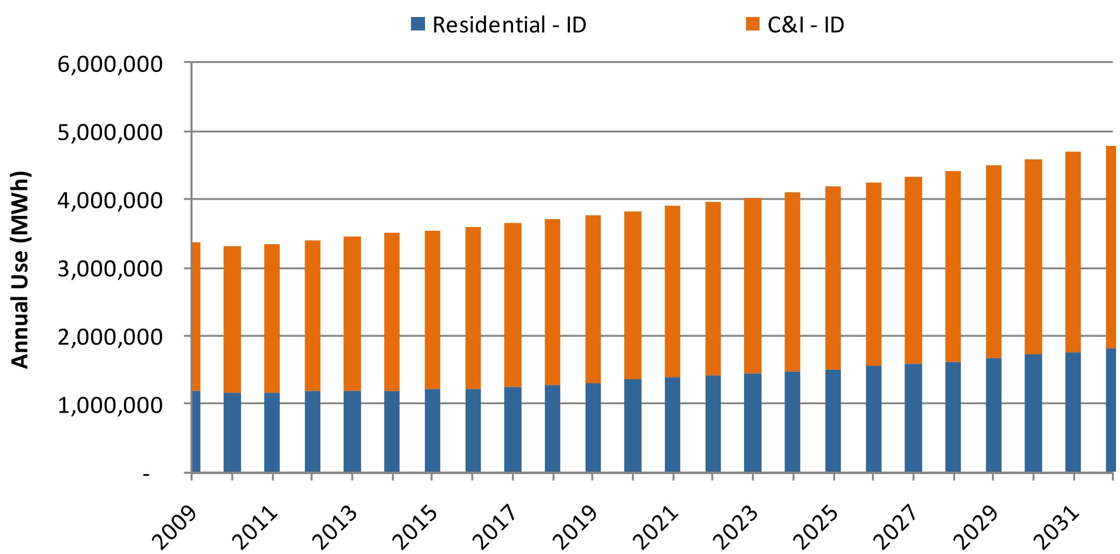

Figure B–4 Summary of Energy Efficiency Potential Savings, Idaho, All Sectors

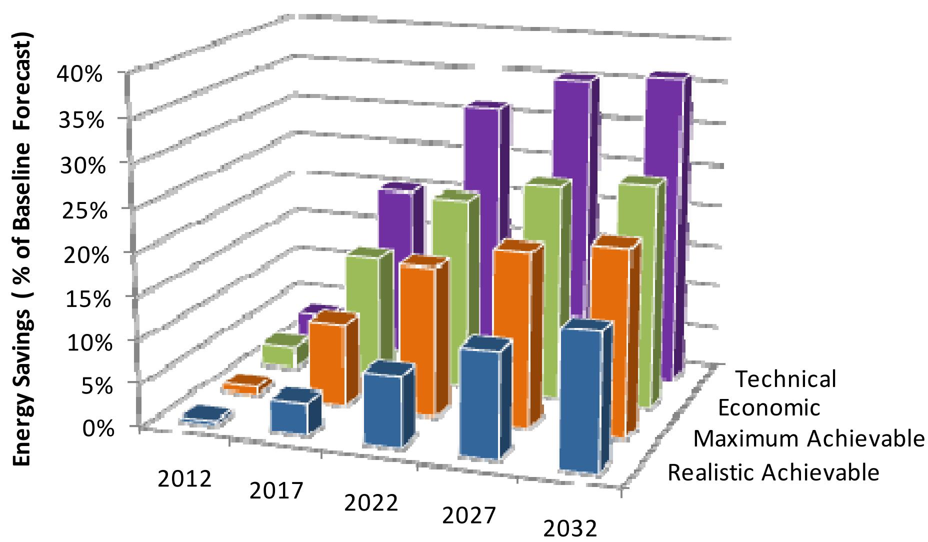

Figure B–5 Energy Efficiency Potential Forecasts, Idaho, All Sectors

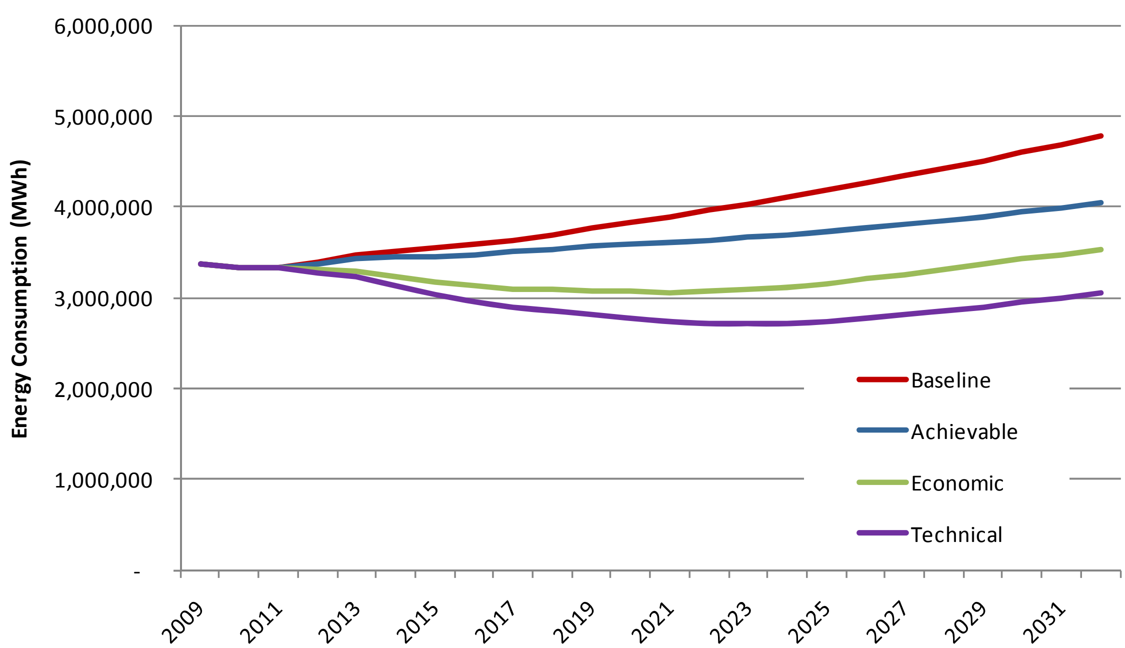

Table B–13 Summary of Energy Efficiency Potential, Idaho, All Sectors

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	3,395,780	3,637,168	3,960,104	4,337,811	4,778,624
Baseline Peak Demand(MW)	610	644	705	775	854
Cumulative Energy Savings (MWh)					
Realistic Achievable	17,115	138,024	328,192	529,056	743,485
Maximum Achievable	31,326	355,867	694,006	878,021	1,036,097
Economic	87,533	536,684	893,730	1,084,577	1,243,423
Technical	116,533	737,247	1,243,729	1,532,099	1,733,629
Cumulative Energy Savings (% of Baseline)					
Realistic Achievable	0.5%	3.8%	8.3%	12.2%	15.6%
Maximum Achievable	0.9%	9.8%	17.5%	20.2%	21.7%
Economic	2.6%	14.8%	22.6%	25.0%	26.0%
Technical	3.4%	20.3%	31.4%	35.3%	36.3%
Peak Savings (MW)					
Realistic Achievable	4	27	57	94	133
Maximum Achievable	7	65	120	153	178
Economic	19	98	154	186	213
Technical	24	133	212	262	299
Peak Savings (% of Baseline)					
Realistic Achievable	0.7%	4.1%	8.1%	12.1%	15.6%
Maximum Achievable	1.1%	10.1%	17.1%	19.7%	20.9%
Economic	3.1%	15.2%	21.9%	24.0%	24.9%
Technical	4.0%	20.6%	30.1%	33.8%	35.0%

Table B–14 Achievable Cumulative EE Potential by Sector, Idaho (MWh)

Segment	2012	2017	2022	2027	2032
Residential, Idaho	8,692	43,922	97,705	172,179	260,003
C&I, Idaho	8,423	94,102	230,487	356,878	483,482
Total	17,115	138,024	328,192	529,056	743,485

Figure B-6 Achievable Cumulative Potential by Sector, Idaho

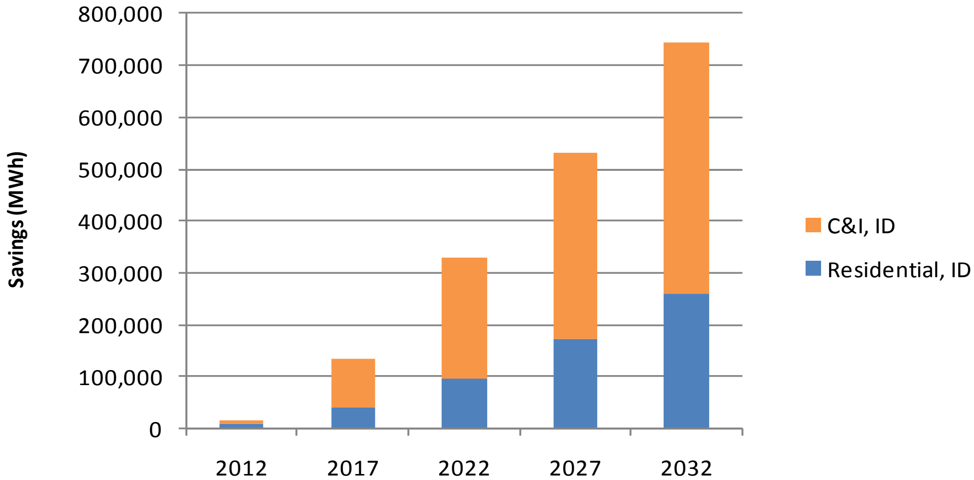

Figure B-7 Residential Energy Efficiency Potential Savings, Idaho

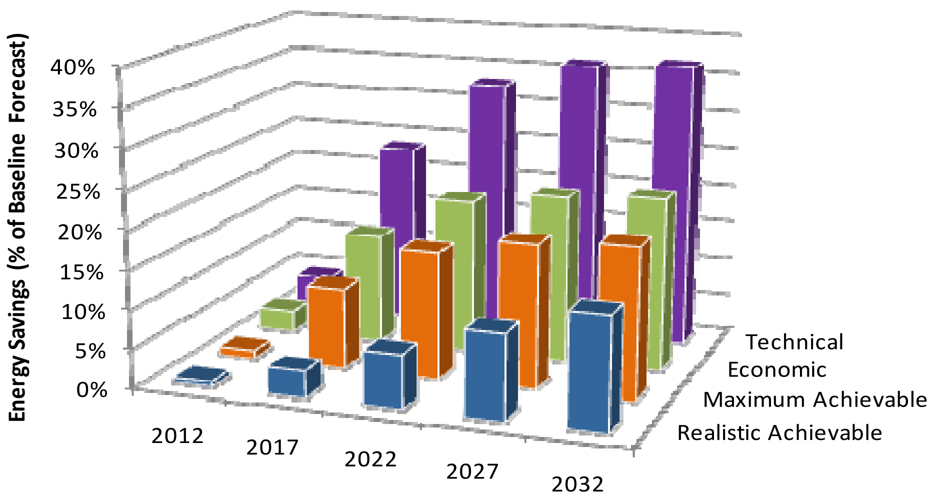

Figure B-8 Residential Energy Efficiency Potential Forecast, Idaho

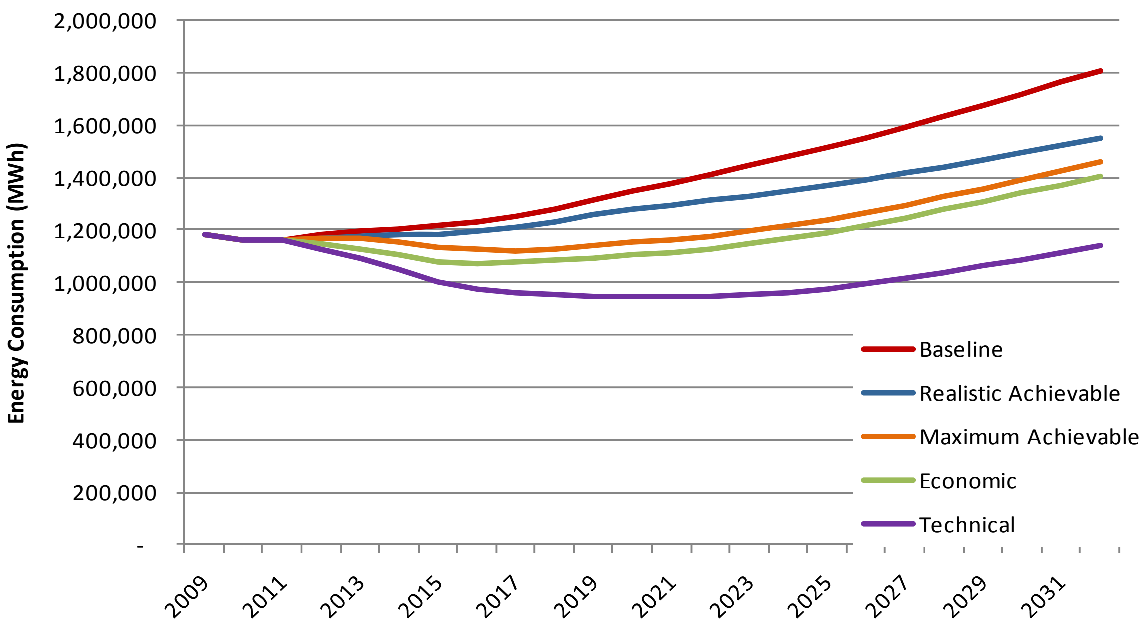

Table B–15 Energy Efficiency Potential for the Residential Sector, Idaho

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	1,178,591	1,253,664	1,408,812	1,588,965	1,808,300
Baseline Peak Demand(MW)	281	290	325	363	408
Cumulative Energy Savings (MWh)					
Realistic achievable	8,692	43,922	97,705	172,179	260,003
Maximum achievable	11,841	130,930	230,870	293,897	349,609
Economic	33,369	179,104	280,336	341,494	403,100
Technical	49,653	292,196	462,586	575,049	665,872
Cumulative Energy Savings (% of Baseline)					
Realistic achievable	0.7%	3.5%	6.9%	10.8%	14.4%
Maximum achievable	1.0%	10.4%	16.4%	18.5%	19.3%
Economic	2.8%	14.3%	19.9%	21.5%	22.3%
Technical	4.2%	23.3%	32.8%	36.2%	36.8%
Peak Savings (MW)					
Realistic achievable	3	12	26	47	70
Maximum achievable	4	32	61	79	92
Economic	11	47	75	92	106
Technical	14	69	109	135	157
Peak Savings (% of Baseline)					
Realistic achievable	1.1%	4.2%	7.9%	12.8%	17.0%
Maximum achievable	1.4%	11.2%	18.7%	21.7%	22.5%
Economic	3.8%	16.3%	23.2%	25.3%	26.1%
Technical	4.9%	23.8%	33.5%	37.2%	38.6%

Table B-16 Residential Baseline & Realistic Achievable Potential by Segment, Idaho

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)					
Single Family	809,394	860,796	969,610	1,095,955	1,250,124
Multi Family	43,239	46,927	53,367	60,656	69,266
Mobile Home	58,491	61,447	68,664	77,048	87,262
Limited Income	267,467	284,494	317,172	355,306	401,648
Total	1,178,591	1,253,664	1,408,812	1,588,965	1,808,300
Energy Savings, Realistic Achievable Potential (MWh)					
Single Family	6,394	32,068	76,498	135,426	203,716
Multi Family	236	1,141	2,100	3,891	5,937
Mobile Home	465	1,997	3,403	5,554	8,326
Limited Income	1,597	8,715	15,705	27,307	42,024
Total	8,692	43,922	97,705	172,179	260,003
% of Total Residential Energy Savings					
Single Family	73.6%	73.0%	78.3%	78.7%	78.4%
Multi Family	2.7%	2.6%	2.1%	2.3%	2.3%
Mobile Home	5.3%	4.5%	3.5%	3.2%	3.2%
Limited Income	18.4%	19.8%	16.1%	15.9%	16.2%

Table B-17 Residential Potential by Housing Type, 2022, Idaho

Forecast	Single Family	Multi Family	Mobile Home	Limited Income	Total
Baseline Forecast (MWh)	969,610	53,367	68,664	317,172	1,408,812
Cumulative Energy Savings (MWh)					
Realistic Achievable	76,498	2,100	3,403	15,705	97,705
Maximum Achievable	180,146	5,514	7,612	37,597	230,870
Economic Potential	215,829	7,112	9,445	47,950	280,336
Technical Potential	311,446	15,951	23,241	111,948	462,586
Energy Savings % of Baseline					
Realistic Achievable	7.9%	3.9%	5.0%	5.0%	6.9%
Maximum Achievable	18.6%	10.3%	11.1%	11.9%	16.4%
Economic Potential	22.3%	13.3%	13.8%	15.1%	19.9%
Technical Potential	32.1%	29.9%	33.8%	35.3%	32.8%

Table A-18 Residential Cumulative Savings by End Use and Potential Type, Oregon (MWh)

End Use	Case	2012	2017	2022	2027	2032
Cooling	Realistic Achievable	4	784	2,713	7,797	15,205
	Economic	118	7,473	13,481	20,239	27,909
	Technical	1,389	21,223	34,387	49,464	67,702
Space Heating	Realistic Achievable	90	5,124	23,932	55,063	89,268
	Economic	2,854	46,886	90,434	118,849	142,327
	Technical	3,872	62,068	117,487	158,049	196,858
Heat/Cool	Realistic Achievable	4	277	772	1,917	5,360
	Economic	136	4,094	5,019	5,928	9,460
	Technical	1,056	8,796	15,144	21,238	24,333
Water Heating	Realistic Achievable	167	6,629	23,974	46,762	77,570
	Economic	2,868	34,268	69,949	91,136	113,933
	Technical	10,553	85,265	160,064	203,679	227,582
Appliances	Realistic Achievable	434	4,216	9,065	14,393	20,002
	Economic	1,885	20,859	27,076	28,751	30,895
	Technical	2,461	26,764	35,893	38,774	41,155
Interior Lighting	Realistic Achievable	6,180	17,434	19,757	22,622	23,650
	Economic	18,432	36,002	35,080	32,028	29,190
	Technical	21,560	49,417	48,706	45,433	42,120
Exterior Lighting	Realistic Achievable	1,125	3,610	3,675	3,426	2,753
	Economic	3,350	7,531	6,023	4,553	3,242
	Technical	3,846	9,858	8,546	7,753	7,635
Electronics	Realistic Achievable	607	4,630	11,073	15,629	19,572
	Economic	3,058	15,658	23,240	26,031	29,797
	Technical	4,219	22,321	32,027	36,258	41,681
Miscellaneous	Realistic Achievable	80	1,217	2,744	4,568	6,622
	Economic	667	6,334	10,036	13,980	16,348
	Technical	697	6,484	10,331	14,400	16,807
Total	Realistic Achievable	8,692	43,922	97,705	172,179	260,003
	Economic	33,369	179,104	280,336	341,494	403,100
	Technical	49,653	292,196	462,586	575,049	665,872

Figure B–9 Residential Realistic Achievable Potential by End Use, Selected Years, Idaho

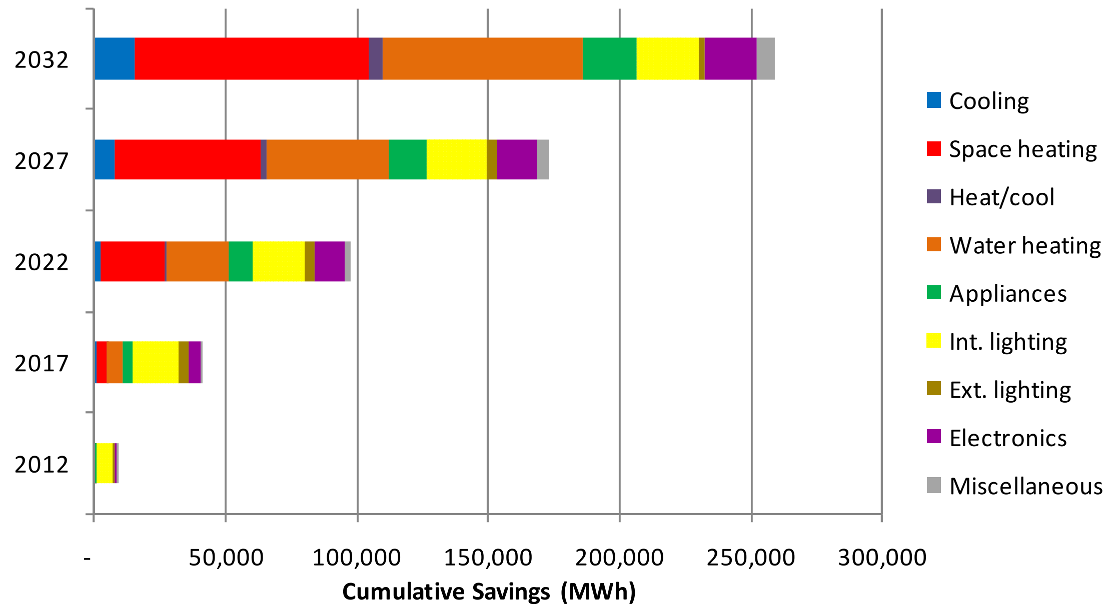

Table B-19 Residential Realistic Achievable Potential by End Use and Market Segment, 2022, Idaho (MWh)

	Single Family	Multi Family	Mobile Home	Limited Income	Total
Cooling	1,736	51	59	866	2,713
Space heating	19,066	789	402	3,676	23,932
Heat/cool	675	3	39	56	772
Water heating	20,270	422	407	2,875	23,974
Appliances	6,657	103	451	1,854	9,065
Interior lighting	13,894	535	1,047	4,281	19,757
Exterior lighting	3,020	28	227	399	3,675
Electronics	8,757	167	617	1,531	11,073
Miscellaneous	2,422	1	153	168	2,744
Total	**76,498**	**2,100**	**3,403**	**15,705**	**97,705**

Table B–20 Residential Cumulative Realistic Achievable Potential by End Use and Equipment Measures, Idaho, Selected Years (MWh)

End Use	Technology	2012	2017	2022
Cooling	Central AC	-	51	55
Heat/Cool	Air Source Ht. Pump	-	-	-
Water Heating	Water Heater	43	321	336
Appliances	Clothes Washer	29	352	888
	Clothes Dryer	35	240	440
	Dishwasher	40	373	912
	Refrigerator	146	652	1,266
	Freezer	113	560	1,221
	Second Refrigerator	53	257	475
	Stove	7	56	126
Interior Lighting	Screw-in	5,757	14,262	14,623
	Linear Fluorescent	56	639	1,202
	Pin-based	367	2,466	3,641
Exterior Lighting	Screw-in	1,117	3,567	3,619
	High Intensity/Flood	8	43	56
Electronics	Personal Computers	389	3,151	5,418
	TVs	213	1,121	2,079
Miscellaneous	Pool Pump	61	559	1,372
	Furnace Fan	16	202	602
Total		**8,450**	**28,875**	**38,332**

Table B–21 Residential Realistic Achievable Savings for Non-equipment Measures, Idaho (MWh)

Measure	2012	2017	2022
Furnace - Convert to Gas	72	2,299	14,668
Water Heater - Convert to Gas	56	2,041	13,812
Advanced New Construction Designs	0	62	1,426
Repair and Sealing - Ducting	6	853	2,417
Insulation - Infiltration Control	6	804	2,265
Water Heater - Thermostat Setback	44	2,506	4,232
Home Energy Management System	2	377	1,323
Freezer - Remove Second Unit	8	1,104	2,367
Water Heater - Hot Water Saver	2	130	1,663
Electronics - Reduce Standby Wattage	4	358	3,576
Thermostat - Clock/Programmable	6	799	2,222
Insulation - Foundation	0	141	628
Air Source Heat Pump - Maintenance	4	277	772
Refrigerator - Remove Second Unit	4	622	1,369
Water Heater - Heat Pump	-	12	334
Water Heater - Faucet Aerators	4	293	702
Insulation - Ducting	0	49	188
Water Heater - Tank Blanket/Insulation	15	794	1,238
Insulation - Wall Cavity	0	85	369
Ceiling Fan - Installation	0	24	167
Room AC - Removal of Second Unit	2	281	698
Insulation - Ceiling	1	115	339
Water Heater - Timer	0	231	801
Water Heater - Low Flow Showerheads	3	270	529
Central AC - Maintenance and Tune-Up	-	-	-
Whole-House Fan - Installation	0	21	112
Pool - Pump Timer	3	456	771
Water Heater - Pipe Insulation	0	34	326
Insulation - Wall Sheathing	0	13	58
Total	242	15,047	59,373

Figure B–10 Energy Efficiency Potential Savings, C&I Sector, Idaho

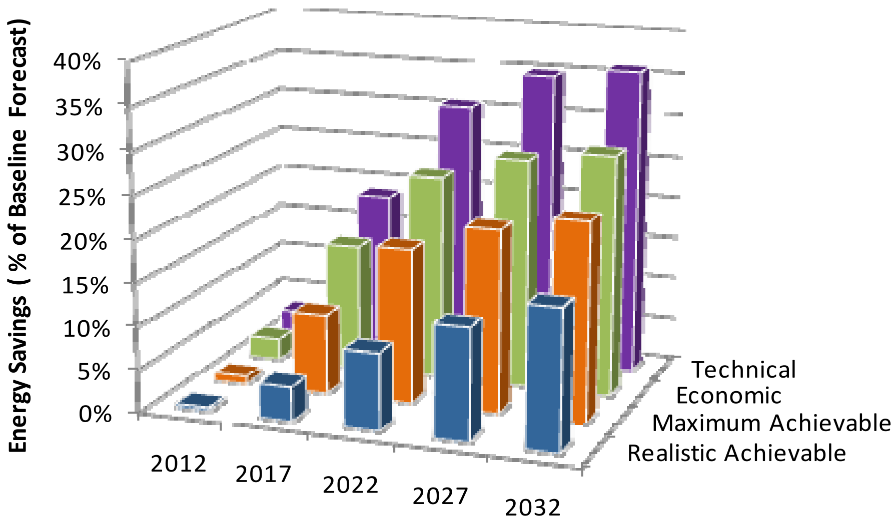

Figure B–11 Energy Efficiency Potential Forecast, C&I Sector, Idaho

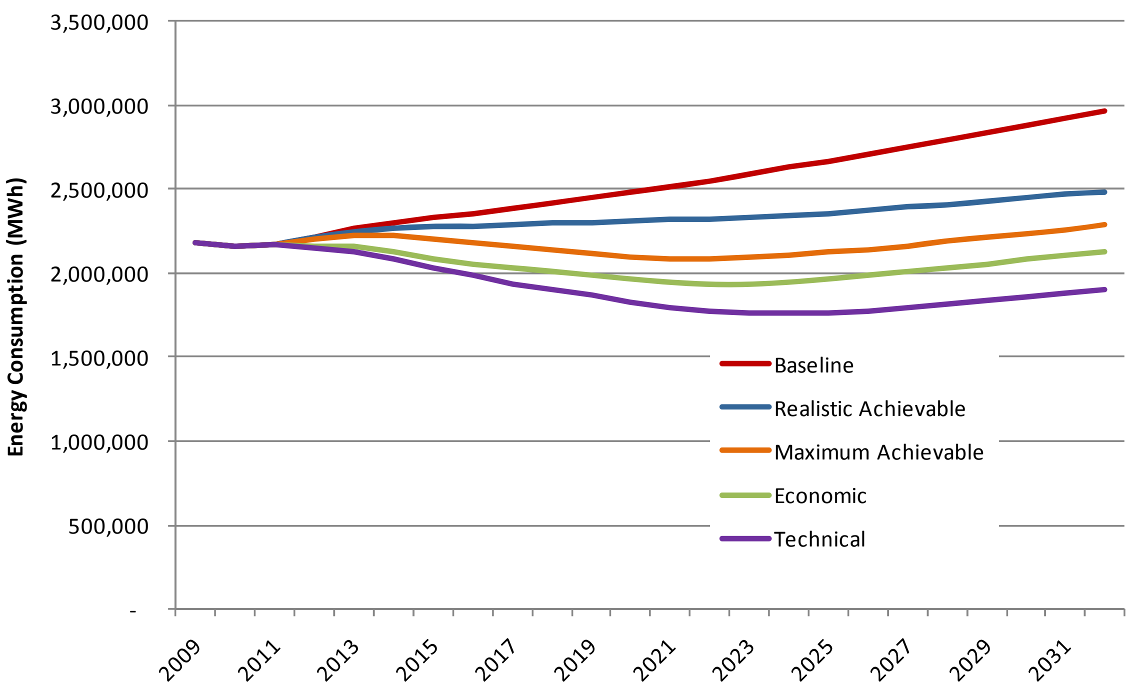

Table B–22 Energy Efficiency Potential, C&I Sector, Idaho

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)	2,217,188	2,383,504	2,551,291	2,748,846	2,970,324
Baseline Peak Demand(MW)	329	354	380	411	446
Cumulative Energy Savings (MWh)					
Realistic Achievable	8,423	94,102	230,487	356,878	483,482
Maximum Achievable	19,485	224,938	463,136	584,124	686,488
Economic	54,164	357,579	613,394	743,082	840,323
Technical	66,880	445,051	781,143	957,050	1,067,757
Cumulative Energy Savings (% of Baseline)					
Realistic Achievable	0.4%	3.9%	9.0%	13.0%	16.3%
Maximum Achievable	0.9%	9.4%	18.2%	21.2%	23.1%
Economic	2.4%	15.0%	24.0%	27.0%	28.3%
Technical	3.0%	18.7%	30.6%	34.8%	35.9%
Peak Savings (MW)					
Realistic Achievable	1	14	31	48	64
Maximum Achievable	3	33	60	74	86
Economic	8	51	79	94	106
Technical	10	64	103	127	141
Peak Savings (% of Baseline)					
Realistic Achievable	0.4%	4.1%	8.3%	11.6%	14.3%
Maximum Achievable	0.9%	9.2%	15.7%	17.9%	19.4%
Economic	2.5%	14.3%	20.7%	22.9%	23.8%
Technical	3.1%	18.1%	27.2%	30.8%	31.7%

Table B–23 C&I Sector, Baseline and Realistic Achievable Potential by Segment, Idaho

	2012	2017	2022	2027	2032
Baseline Forecast (MWh)					
Small/Med. Commercial	317,367	335,813	361,837	394,213	431,409
Large Commercial	707,532	761,508	821,587	894,850	979,118
Extra Large Commercial	72,013	83,305	90,387	98,291	106,847
Extra Large Industrial	1,120,277	1,202,878	1,277,480	1,361,492	1,452,949
Total	2,217,188	2,383,504	2,551,291	2,748,846	2,970,324
Cumulative Energy Savings, Achievable Potential (MWh)					
Small/Med. Commercial	1,962	20,807	43,865	65,456	88,728
Large Commercial	4,662	52,140	106,963	155,523	202,933
Extra Large Commercial	609	6,178	13,050	19,166	24,274
Extra Large Industrial	1,190	14,977	66,609	116,733	167,548
Total	8,423	94,102	230,487	356,878	483,482
% of Total C&I Cumulative Energy Savings					
Small/Med. Commercial	23.3%	22.1%	19.0%	18.3%	18.4%
Large Commercial	55.4%	55.4%	46.4%	43.6%	42.0%
Extra Large Commercial	7.2%	6.6%	5.7%	5.4%	5.0%
Extra Large Industrial	14.1%	15.9%	28.9%	32.7%	34.7%

Table B–24 C&I Potential by Segment, Idaho, 2022

Forecast	Small/Med. Commercial	Large Commercial	Extra Large Commercial	Extra Large Industrial	Total
Baseline Forecast (MWh)	361,837	821,587	90,387	1,277,480	2,551,291
Cumulative Energy Savings (MWh)					
Realistic Achievable	43,865	106,963	13,050	66,609	230,487
Economic Potential	87,274	204,790	25,964	295,365	613,394
Technical Potential	135,405	301,217	36,465	308,056	781,143
Cumulative Energy Savings % of Baseline					
Realistic Achievable	12%	13%	14%	5%	9%
Economic Potential	24%	25%	29%	23%	24%
Technical Potential	37%	37%	40%	24%	31%

Table B-25 C&I Cumulative Savings by End Use and Potential Type, Idaho (MWh)

End Use	Case	2012	2017	2022	2027	2032
Cooling	Realistic Achievable	78	5,923	21,250	33,605	47,275
	Economic	1,138	20,975	45,413	59,510	75,348
	Technical	2,968	36,760	76,374	95,858	113,212
Space Heating	Realistic Achievable	6	758	4,296	8,178	13,308
	Economic	133	3,983	11,757	17,084	24,436
	Technical	215	6,445	19,442	26,587	34,707
Heat/Cool	Realistic Achievable	16	1,271	2,302	2,778	3,432
	Economic	185	3,001	3,761	4,432	4,954
	Technical	260	3,540	4,747	5,741	6,445
Ventilation	Realistic Achievable	211	2,846	15,356	29,448	47,931
	Economic	3,528	26,446	69,343	93,958	107,124
	Technical	4,612	34,655	93,204	122,731	132,705
Water Heating	Realistic Achievable	25	1,545	3,227	3,742	4,068
	Economic	198	3,518	4,823	5,295	5,309
	Technical	4,444	32,290	58,774	82,998	91,291
Food Preparation	Realistic Achievable	72	868	2,449	4,745	7,111
	Economic	962	5,813	10,539	12,677	13,834
	Technical	1,043	6,341	11,660	14,033	15,375
Refrigeration	Realistic Achievable	62	631	2,054	3,943	5,850
	Economic	925	4,540	8,629	11,127	12,502
	Technical	1,091	5,996	13,223	17,139	19,437
Interior Lighting	Realistic Achievable	5,851	55,282	110,129	160,780	203,673
	Economic	27,689	162,081	212,672	243,913	279,638
	Technical	30,318	177,750	239,322	274,804	311,478
Exterior Lighting	Realistic Achievable	526	7,858	15,569	19,409	23,034
	Economic	2,403	23,137	27,251	28,628	29,938
	Technical	2,701	25,247	30,174	34,115	38,276
Office Equipment	Realistic Achievable	862	8,854	14,582	19,189	23,952
	Economic	6,253	28,449	29,883	31,230	32,556
	Technical	8,238	38,728	41,183	43,665	46,239
Machine Drive	Realistic Achievable	382	6,612	33,312	56,917	77,212
	Economic	4,308	40,409	117,995	145,338	156,337
	Technical	4,341	40,906	119,993	147,502	158,642
Process	Realistic Achievable	328	1,590	5,541	13,154	24,996
	Economic	6,410	34,803	69,990	87,646	95,276
	Technical	6,410	34,803	69,990	87,646	95,276
Miscellaneous	Realistic Achievable	2	62	419	989	1,641
	Economic	33	426	1,336	2,245	3,070
	Technical	239	1,591	3,058	4,230	4,673
Total	Realistic Achievable	8,423	94,102	230,487	356,878	483,482
	Economic	54,164	357,579	613,394	743,082	840,323
	Technical	66,880	445,051	781,143	957,050	1,067,757

Figure B-12 C&I Achievable Potential by End Use, Selected Years, Idaho

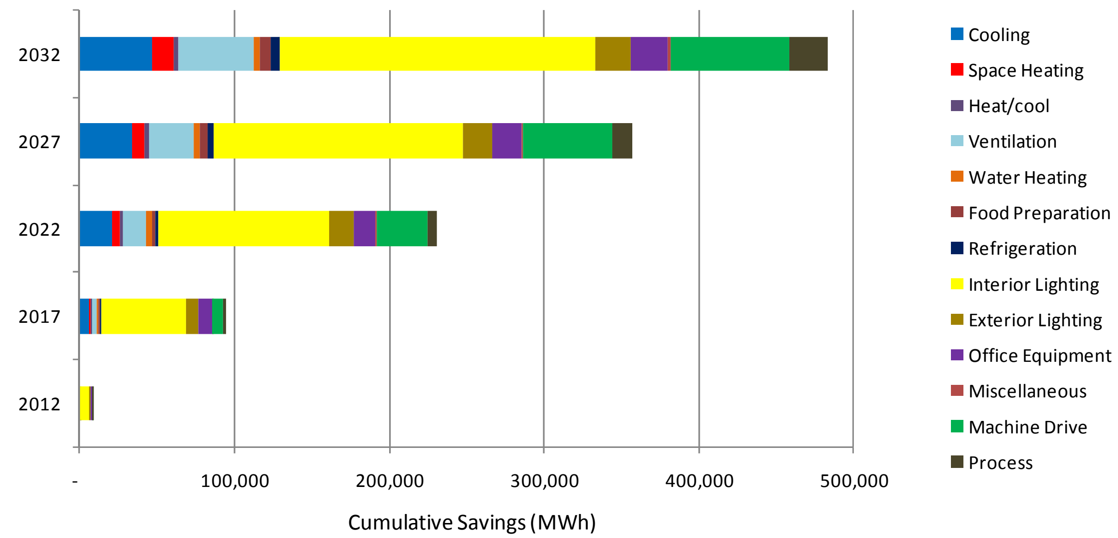

Table B-26 C&I Realistic Achievable Potential by End Use Market Segment, 2022, Idaho (MWh)

	Small/Med. Commercial	Large Commercial	Extra Large Commercial	Extra Large Industrial	Total
Cooling	2,805	8,283	1,032	9,129	21,250
Space Heating	338	2,110	305	1,544	4,296
Combined Heating/Cooling	249	1,666	119	267	2,302
Ventilation	4,489	1,846	1,131	7,890	15,356
Water Heating	952	1,851	424	-	3,227
Food Preparation	538	1,748	163	-	2,449
Refrigeration	572	1,382	100	-	2,054
Interior Lighting	25,426	68,834	7,612	8,256	110,129
Exterior Lighting	4,866	8,723	1,312	669	15,569
Office Equipment	3,482	10,274	825	-	14,582
Machine Drive	-	-	-	33,312	33,312
Process	-	-	-	5,541	5,541
Miscellaneous	146	246	26	-	419
Total	**43,865**	**106,963**	**13,050**	**66,609**	**230,487**

Table B-27 C&I Cumulative Achievable Potential by End Use and Equipment Measures, Washington (MWh)

End Use	Technology	2012	2017	2022
Cooling	Central Chiller	29	304	1,225
	PTAC	2	2	2
Heat/Cool	Heat Pump	7	128	376
Ventilation	Ventilation	196	2,023	7,393
Water Heater	Water Heater	14	111	109
Food Preparation	Fryer	4	46	121
	Hot Food Container	9	102	274
	Oven	60	708	1,884
Refrigeration	Glass Door Display	11	155	440
	Icemaker	8	108	317
	Solid Door Refrigerator	14	165	438
	Vending Machine	27	152	371
	Walk in Refriger'n	0	5	13
Interior Lighting	Interior Screw-in	3,326	21,132	32,157
	HID	1,014	9,151	18,439
	Linear Fluorescent	1,450	17,918	35,222
Exterior Lighting	Screw-in	76	1,138	1,977
	HID	403	5,269	10,440
	Linear Fluorescent	42	758	1,287
Office Equipment	Desktop Computer	490	4,569	7,322
	Laptop Computer	35	331	530
	Monitor	106	383	662
	POS Terminal	14	196	359
	Printer/copier/fax	44	564	1,025
	Server	169	2,412	3,889
Machine Drive	Less than 5 HP	21	144	383
	5-24 HP	46	324	887
	25-99 HP	114	808	2,209
	100-249 HP	32	227	622
	250-499 HP	34	242	661
	500 and more HP	64	456	1,247
Process	Electrochem. Process	46	220	719
	Process Cooling/Refrig.	62	294	961
	Process Heating	220	1,048	3,426
Miscellaneous	Non-HVAC Motor	2	25	181
Total		8,194	71,620	137,570

Table B-28 C&I Cumulative Achievable Savings for Non-equipment Measures, Idaho (MWh)

Measure	2012	2017	2022
Energy Management System	13	819	8,607
Advanced New Construction Designs	0	36	557
Retrocommissioning - Lighting	20	4,122	7,640
Interior Fluorescent - High Bay Fixtures	8	475	4,877
Pumping System - Optimization	11	507	4,907
Compressed Air - System Optimization and Improvements	11	506	4,837
Custom Measures	2	296	4,148
Fans - Variable Speed Control	7	335	3,189
Compressed Air - System Controls	7	355	3,457
RTU - Maintenance	24	3,277	6,364
Fans - Energy Efficient Motors	6	346	3,463
Retrocommissioning - Comprehensive	12	2,552	4,572
Retrocommissioning - HVAC	3	323	3,038
Motors - Variable Frequency Drive	11	1,338	2,707
Pumps - Variable Speed Control	5	241	2,289
Motors - Magnetic Adjustable Speed Drives	5	221	2,171
Compressed Air - Compressor Replacement	4	203	1,982
Pumping System - Controls	4	202	1,942
Chiller - Turbocor Compressor	3	167	1,764
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	0	22	193
Interior Lighting - Occupancy Sensors	7	249	1,949
Water Heater - Faucet Aerators/Low Flow Nozzles	9	1,306	2,692
Chiller - VSD	2	127	1,257
Interior Fluorescent - Delamp and Install Reflectors	6	222	1,622
Roofs - High Reflectivity	1	21	165
Commissioning - Comprehensive	0	123	805
Chiller - Condenser Water Temperature Reset	3	196	1,839
Heat Pump - Maintenance	9	1,143	1,925
Compressed Air - System Maintenance	13	717	1,198
Pumping System - Maintenance	-	43	606
Exterior Lighting - Daylighting Controls	2	70	562
Insulation - Ducting	1	93	778
Chiller - Chilled Water Reset	2	403	705
Thermostat - Clock/Programmable	2	304	595
Commissioning - Lighting	0	94	314
Office Equipment - ENERGY STAR Power Supply	3	399	795
Cooking - Exhaust Hoods with Sensor Control	0	6	56
Refrigeration - System Optimization	0	15	229

Measure	2012	2017	2022
Furnace - Convert to Gas	1	35	229
Water Heater - Heat Pump	0	16	211
Refrigeration - System Controls	0	10	160
Cooling - Economizer Installation	1	42	378
Exterior Lighting - Induction Lamps	0	10	140
Insulation - Ceiling	0	1	13
Industrial Process Improvements	0	11	127
LED Exit Lighting	9	319	358
Commissioning - HVAC	-	-	4
Water Heater - Tank Blanket/Insulation	2	111	195
Miscellaneous - ENERGY STAR Water Cooler	0	20	58
Refrigeration - System Maintenance	0	3	46
Refrigeration - Floating Head Pressure	0	4	46
Insulation - Wall Cavity	0	2	31
Refrigeration - Strip Curtain	-	0	14
Refrigeration - Anti-Sweat Heater/Auto Door Closer	0	3	35
Water Heater - Hot Water Saver	-	-	1
Water Heater - High Efficiency Circulation Pump	0	2	19
Vending Machine - Controller	0	13	22
Chiller - Chilled Water Variable-Flow System	0	2	19
Exterior Lighting - Cold Cathode Lighting	0	1	8
Refrigeration - Night Covers	0	0	4
Laundry - High Efficiency Clothes Washer	0	3	5
Total	**228**	**22,482**	**92,917**

APPENDIX | C

RESIDENTIAL ENERGY EFFICIENCY EQUIPMENT AND MEASURE DATA

This appendix presents detailed information for all residential energy efficiency equipment and measures that were evaluated in LoadMAP. Several sets of tables are provided.

Table C-1 provides brief descriptions for all equipment and measures that were assessed for potenital.

Tables C-2 through C-9 list the detailed unit-level data for the equipment measures for each of the housing type segments — single family, multi-family, mobile home, and limited income — and for existing and new construction, respectively. Savings are in kWh/yr/household, and incremental costs are in $/household, unless noted otherwise. The B/C ratio is zero if the measure represents the baseline technology or if the technology is not available in the first year of the forecast (2012). The B/C ratio is calculated within LoadMAP for each year of the forecast and is available once the technology or measure becomes available.

Tables C-10 through C-17 list the detailed unit-level data for the non-equipment energy efficiency measures for each of the housing type segments and for existing and new construction, respectively. Because these measures can produce energy-use savings for multiple end-use loads (e.g., insulation affects heating and cooling energy use) savings are expressed as a percentage of the end-use loads. Base saturation indicates the percentage of homes in which the measure is already installed. Applicability/Feasibility is the product of two factors that account for whether the measure is applicable to the building. Cost is expressed in $/household. The detailed measure-level tables present the results of the benefit/cost (B/C) analysis for the first year of the forecast. The B/C ratio is zero if the measure represents the baseline technology or if the measure is not available in the first year of the forecast (2012). The B/C ratio is calculated within LoadMAP for each year of the forecast and is available once the technology or measure becomes available.

Note that Tables C-2 through C-17 present information for Washington. For Idaho, savings and B/C ratios may be slightly different due to weather-related usage, differences in the states' market profiles, and different retail electricity prices. Although Idaho-specific values are not presented here, they are available within the LoadMAP files.

Table C–1 Residential Energy Efficiency Equipment/Measure Descriptions

End-Use	Equipment/ Measure	Description
Cooling	Air Conditioner — Central (CAC)	Central air conditioners consist of a refrigeration system using a direct expansion cycle. Equipment includes a compressor, an air-cooled condenser (located outdoors), an expansion valve, and an evaporator coil. A supply fan near the evaporator coil distributes supply air through air ducts to the building. Cooling efficiencies vary based on materials used, equipment size, condenser type, and system configuration. CACs may be unitary (all components housed in a factory-built assembly) or split system (an outdoor condenser section and an indoor evaporator section connected by refrigerant lines and with the compressor either indoors or outdoors). Energy efficiency is rated according to the size of the unit using the Seasonal Energy Efficiency Rating (SEER). Systems with Variable Refrigerant Flow further improve the operating efficiency. A high-efficiency option for a ductless mini-split system was also analyzed.
Cooling	Central Air Conditioner, Early Replacement	CAC systems currently on the market are significantly more efficient that older units, due to technology improvement and stricter appliance standards. This measure incents homeowners to replace an aging but still working unit with a new, higher-efficiency one.
Cooling	Central Air Conditioner Maintenance and Tune Up	An air conditioner's filters, coils, and fins require regular cleaning and maintenance for the unit to function effectively and efficiently throughout its life. Neglecting necessary maintenance leads to a steady decline in performance, requiring the AC unit to use more energy for the same cooling load.
Cooling	Air Conditioner - Room, ENERGY STAR or better	Room air conditioners are designed to cool a single room or space. They incorporate a complete air-cooled refrigeration and air-handling system in an individual package. Room air conditioners come in several forms, including window, split-type, and packaged terminal units. Energy efficiency is rated according to the size of the unit using the Energy Efficiency Rating (EER).
Cooling	Room AC — Removal of Second Unit	Homeowners may have a second room AC unit that is extremely inefficient. This measure incents homeowners to recycle the second unit and thus also eliminates associated electricity use.
Cooling	Attic Fan Attic Fan, Photovoltaic	Attic fans can reduce the need for AC by reducing heat transfer from the attic through the ceiling of the house. A well-ventilated attic can be several degrees cooler than a comparable, unventilated attic. An option for an attic fan equipped with a small solar photovoltaic generator was also modeled.
Cooling	Ceiling Fan	Ceiling fans can reduce the need for air conditioning. However, the house occupants must also select a ceiling fan with a high-efficiency motor and either shutoff the AC system or setup the thermostat temperature of the air conditioning system to realize the potential energy savings. Some ceiling fans also come with lamps. In this analysis, it is assumed that there are no lamps, and installing a ceiling fan will allow occupants to increase the thermostat cooling setpoint up by 2°F.
Cooling	Whole-House Fan	Whole-house fans can reduce the need for AC on moderate-weather days or on cool evenings. The fan facilitates a quick air change throughout the entire house. Several windows must be open to achieve the best results. The fan is mounted on the top floor of the house, usually in a hallway ceiling.

End-Use	Equipment/ Measure	Description
Space Heating	Convert to Gas	This fuel-switching measure is the replacement of an electric furnace with a gas-fired furnace. This measure will eliminate all electricity consumption and demand due to electric space heating. In this study, it is assumed that this measure can be implemented only in homes within 500 feet of a gas main.
Heat/Cool	Air Source Heat Pump	A central heat pump consists of components similar to a CAC system, but is usually designed to function both as a heat pump and an air conditioner. It consists of a refrigeration system using a direct expansion (DX) cycle. Equipment includes a compressor, an air-cooled condenser (located outdoors), an expansion valve, and an evaporator coil (located in the supply air duct near the supply fan) and a reversing valve to change the DX cycle from cooling to heating when required. The cooling and heating efficiencies vary based on the materials used, equipment size, condenser type, and system configuration. Heat pumps may be unitary (all components housed in a factory-built assembly) or a split system (an outdoor condenser section and an indoor evaporator section connected by refrigerant lines, with either outdoors or indoors. A high-efficiency option for a ductless mini-split system was also analyzed.
Heat / Cool	Geothermal Heat Pump	Geothermal heat pumps are similar to air-source heat pumps, but use the ground or groundwater instead of outside air to provide a heat source/sink. A geothermal heat pump system generally consists of three major subsystems or parts: a geothermal heat pump to move heat between the building and the fluid in the earth connection, an earth connection for transferring heat between the fluid and the earth, and a distribution subsystem for delivering heating or cooling to the building. The system may also have a desuperheater to supplement the building's water heater, or a full-demand water heater to meet all of the building's hot water needs.
Heat / Cool	Air Source Heat Pump Maintenance	A heat pump's filters, coils, and fins require regular cleaning and maintenance for the unit to function effectively and efficiently throughout its life. Neglecting necessary maintenance ensures a steady decline in performance while energy use steadily increases.
HVAC (all)	Insulation – Ducting	Air distribution ducts can be insulated to reduce heating or cooling losses. Best results can be achieved by covering the entire surface area with insulation. Several types of ducts and duct insulation are available, including flexible duct, pre-insulated duct, duct board, duct wrap, tacked, or glued rigid insulation, and waterproof hard shell materials for exterior ducts. This analysis assumes that installing duct insulation can reduce the temperature drop/gain in ducts by 50%.
HVAC (all)	Repair and Sealing – Ducting	An ideal duct system would be free of leaks. Leakage in unsealed ducts varies considerably because of differences in fabricating machinery used, methods for assembly, installation workmanship, and age of the ductwork. Air leaks from the system to the outdoors result in a direct loss proportional to the amount of leakage and the difference in enthalpy between the outdoor air and the conditioned air. This analysis assumes that over time air loss from ducts has doubled, and conducting repair and sealing of the ducts will restore leakage from ducts to the original baseline level.

End-Use	Equipment/ Measure	Description
HVAC (all)	Thermostat — Clock/Programmable	A programmable thermostat can be added to most heating/cooling systems. They are typically used during winter to lower temperatures at night and in summer to increase temperatures during the afternoon. The energy savings from this type of thermostat are identical to those of a "setback" strategy with standard thermostats, but the convenience of a programmable thermostat makes it a much more attractive option. In this analysis, the baseline is assumed to have no thermostat setback.
HVAC (all)	Doors — Storm and Thermal	Like other components of the shell, doors are subject to several types of heat loss: conduction, infiltration, and radiant losses. Similar to a storm window, a storm door creates an insulating air space between the storm and primary doors. A tight fitting storm door can also help reduce air leakage or infiltration. Thermal doors have exceptional thermal insulation properties and also are provided with weather-stripping on the doorframe to reduce air leakage.
HVAC (all)	Insulation — Infiltration Control	Lowering the air infiltration rate by caulking small leaks and weather-stripping around window frames, doorframes, power outlets, plumbing, and wall corners can provide significant energy savings. Weather-stripping doors and windows will create a tight seal and further reduce air infiltration.
HVAC (all)	Insulation —Ceiling	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation above ceilings can conserve energy by reducing the heat loss or gain into attics and/or through roofs. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose, loose-fill (blown) fiberglass, and rigid polystyrene.
HVAC (all)	Insulation — Radiant Barrier	Radiant barriers are materials installed to reduce the heat gain in buildings. Radiant barriers are made from materials that are highly reflective and have low emissivity like aluminum. The closer the emissivity is to 0 the better they will perform. Radiant barriers can be placed above the insulation or on the roof rafters.
HVAC (all)	Insulation — Foundation Insulation — Wall Cavity Insulation — Wall Sheathing	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing heat loss or gain from a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose, loose-fill (blown) fiberglass, and rigid polystyrene. Foundation, insulation, wall cavity insulation, and wall sheathing were modeled for new construction / major retrofits only.
Cooling	Roof — High Reflectivity	The color and material of a building structure surface determine the amount of solar radiation absorbed by that surface and subsequently transferred into a building. This is called solar absorptance. Using a roofing material with low solar absorptance or painting the roof a light color reduces the cooling load. This analysis assumes that implementing high reflectivity roofs will decrease the roof's absorptance of solar radiation by 45%.
Cooling	Windows — Reflective Film	Reflective films applied to the window interior help reduce solar gain into the space and thus lower cooling energy use.

End-Use	Equipment/ Measure	Description
HVAC (all)	Windows — High Efficiency / ENERGY STAR	High-efficiency windows, such as those labeled under the ENERGY STAR Program, are designed to reduce energy use and increase occupant comfort. High-efficiency windows reduce the amount of heat transfer through the glazing surface. For example, some windows have a low-E coating, a thin film of metallic oxide coating on the glass surface that allows passage of short-wave solar energy through glass and prevents long-wave energy from escaping. Another example is double-pane glass that reduces conductive and convective heat transfer. Some double-pane windows are gas-filled (usually argon) to further increase the insulating properties of the window.
Water Heating	Water Heater - Electric, High Efficiency	For electric hot water heating, the most common type is a storage heater, which incorporates an electric heating element, storage tank, outer jacket, insulation, and controls in a single unit. Efficient units are characterized by a high recovery or thermal efficiency and low standby losses (the ratio of heat lost per hour to the content of the stored water). Electric instantaneous water heaters are available, but are excluded from this study due to potentially high instantaneous demand concerns.
Water Heating	Water Heater, Heat Pump	An electric heat pump water heater (HPWH) uses a vapor-compression thermodynamic cycle similar to that found in an air-conditioner or refrigerator. Electrical work input allows a heat pump water heater to extract heat from an available source (e.g., air) and reject that heat to a higher temperature sink, in this case, the water in the water heater. Because a HPWH makes use of available ambient heat, the coefficient of performance is greater than one — typically in the range of 2 to 3. These devices are available as an alternative to conventional tank water heaters of 55 gallons or larger. By utilizing the earth as a thermal reservoir, ground source HPWH systems can reach even higher levels of efficiency. The heat pump can be integrated with a traditional water storage tank or installed remote to the storage tank.
Water Heating	Water Heating, Solar	Solar water heating systems can be used in residential buildings that have an appropriate near-south-facing roof or nearby unshaded grounds for installing a collector. Although system types vary, in general these systems use a solar absorber surface within a solar collector or an actual storage tank. Either a heat-transfer fluid or the actual potable water flows through tubes attached to the absorber and transfers heat from it. (Systems with a separate heat-transfer-fluid loop include a heat exchanger that then heats the potable water.) The heated water is stored in a separate preheat tank or a conventional water heater tank. If additional heat is needed, it is provided by a conventional water-heating system.
Water Heating	Convert to Gas	This fuel-switching measure is the replacement of an electric water heater with a gas-fired water heater. This measure will eliminate all electricity consumption and demand due to electric water heating. In this study, it is assumed that this measure can be implemented only in home within 500 feet of a gas main.
Water Heating	Faucet Aerators	Water faucet aerators are threaded screens that attach to existing faucets. They reduce the volume of water coming out of faucets while introducing air into the water stream. This measure provides energy saving by reducing hot water use, as well as water conservation for both hot and cold water.

End-Use	Equipment/ Measure	Description
Water Heating	Pipe Insulation	Insulating hot water pipes decreases energy losses from piping that distributes hot water throughout the building. I also results in quicker delivery of hot water and may allow lower the hot water set point, which saves energy. The most common insulation materials for this purpose are polyethylene and neoprene.
Water Heating	Low-Flow Showerheads	Similar to faucet aerators, low-flow showerheads reduce the consumption of hot water, which in turn decreases water heating energy use.
Water Heating	Tank Blanket	Insulating hot water tanks decreases standby energy losses from the tank. Pre-fitted insulating blankets are readily available.
Water Heating	Thermostat Setback / Timer	These measures use either a programmable thermostat or a timer to adjust the water heater setpoint at times of low usage, typically when a home is unoccupied.
Water Heating	Hot Water Saver	A hot water saver is a plumbing device that attaches to the showerhead and that pauses the flow of water until the water is hot enough for use. The water is re-started by the flip of a switch.
Interior Lighting / Exterior Lighting	Infrared Halogen Lamps	Infrared halogen lamps are designed to be a replacement for standards incandescent lamps. Also referred to as advanced incandescent lamps, these products meet the Energy Independence and Security Act (EISA) lighting standards and are phased in as the baseline technology screw-in lamp technology to reflect the timeline over which the EISA lighting standards take effect.
Interior Lighting / Exterior Lighting	Compact Fluorescent Lamps	Compact fluorescent lamps are designed to be a replacement for standard incandescent lamps and use about 25% of the energy used by standard incandescent lamps to produce the same lumen output. The can use either electronic or magnetic ballasts. Integral compact fluorescent lamps have the ballast integrated into the base of the lamp and have a standard screw-in base that permits installation into existing incandescent fixtures.
Interior Lighting / Exterior Lighting	Solid State Lighting, LEDs (Screw-in and linear)	Light-emitting diode (LED) lighting has seen recent penetration in specific applications such as traffic lights and exit signs. With the potential for extremely high efficiency, LEDs show promise to provide general-use lighting for interior spaces. Current models commercially available have efficacies comparable to CFLs. However, theoretical efficiencies are significantly higher. LED models under development are expected to provide improved efficacies.
Interior Lighting	Fluorescent, T8, Super T8, and T5 Lamps and Electronic Ballasts	T8 fluorescent lamps are smaller in diameter than standard T12 lamps, resulting in greater light output per watt. T8 lamps also operate at a lower current and wattage, which increases the efficiency of the ballast but requires the lamps to be compatible with the ballast. Fluorescent lamp fixtures can include a reflector that increases the light output from the fixture, and thus make it possible to use a fewer number of lamps in each fixture. T5 lamps further increase efficiency by reducing the lamp diameter to 5/8”.
Exterior Lighting	Metal Halide and High Pressure Sodium	These lamps technologies can provide slightly higher efficiencies than CFLs in exterior applications.
Interior Lighting	Occupancy Sensors	Occupancy sensors turn lights off when a space is unoccupied. They are appropriate for areas with intermittent use, such as bathrooms or storage areas.

End-Use	Equipment/ Measure	Description
Exterior Lighting	Photovoltaic Installation	Solar photovoltaic generation may be used to power exterior lighting and thus eliminate all or part of the electrical energy use.
Exterior Lighting	Photosensor Control	Photosensor controls turn exterior lighting on or off based on ambient lighting levels. Compared with manual operation, this can reduce the operation of exterior lighting during daylight hours.
Exterior Lighting	Timeclock Installation	Lighting timers turn exterior lighting on or off based on a preset schedule. Compared with manual operation, this can reduce the operation of exterior lighting during daylight hours.
Appliances	Refrigerator/Freezer, ENERGY STAR or better	Energy-efficient refrigerators/freezers incorporate features such as improved cabinet insulation, more efficient compressors and evaporator fans, defrost controls, mullion heaters, oversized condenser coils, and improved door seals. Further efficiency increases can be obtained by reducing the volume of refrigerated space, or adding multiple compartments to reduce losses from opening doors.
Appliances	Refrigerator/Freezer — Early Replacement	Refrigerators/freezers currently on the market are significantly more efficient that older units, due to technology improvement and stricter appliance standards. This measure incents homeowners to replace an aging but still working unit with a new, higher-efficiency one.
Appliances	Refrigerator/Freezer — Remove Second Unit	Homeowners may have a second refrigerator or freezer that is not used to full capacity and that, because of its age, is extremely inefficient. This measure incents homeowners to recycle the second unit and thus also eliminates associated electricity use.
Appliances	Dishwasher, ENERGY STAR or better	ENERGY STAR labeled dishwashers save by using both improved technology for the primary wash cycle, and by using less hot water. Construction includes more effective washing action, energy-efficient motors, and other advanced technology such as sensors that determine the length of the wash cycle and the temperature of the water necessary to clean the dishes.
Appliances	Clothes Washer, ENERGY STAR or better	ENERGY STAR labeled clothes washers use superior designs that require less water. Sensors match the hot water needs to the size and soil level of the load, preventing energy waste. Further energy and water savings can be achieved through advanced technologies such as inverter-drive or combination washer-dryer units.
Appliances	Clothes Dryer – Electric, High Efficiency	An energy-efficient clothes dryer has a moisture-sensing device to terminate the drying cycle rather than using a timer, and an energy-efficient motor is used for spinning the dryer tub. Application of a heat pump cycle for extracting the moisture from clothes leads to additional energy savings.
Appliances	Range and Oven – Electric, High Efficiency	These products have additional insulation in the oven compartment and tighter-fitting oven door gaskets and hinges to save energy. Conventional ovens must first heat up about 35 pounds of steel and a large amount of air before they heat up the food. Tests indicate that only 6% of the energy output of a typical oven is actually absorbed by the food.
Electronics	Color TVs and Home Electronics, ENERGY STAR or better	In the average home, electronic products consumed significant energy, even when they are turn off, to maintain features like clocks, remote control, and channel/station memory. ENERGY STAR labeled consumer electronics can drastically reduce consumption during standby mode, in addition to saving energy through advanced power management during normal use.

End-Use	Equipment/ Measure	Description
Electronics	Personal Computers, ENERGY STAR or better	Improved power management can significantly reduce the annual energy consumption of PCs and monitors in both standby and normal operation. ENERGY STAR and Climate Savers labeled products provide increasing level of energy efficiency.
Electronics	Reduce Standby Wattage	Representing a growing portion of home electricity consumption, plug-in electronics such as set-top boxes, DVD players, gaming systems, digital video recorders, and even battery chargers for mobile phones and laptop computers are often designed to supply a set voltage. When the units are not in use, this voltage could be dropped significantly (~1 W) and thereby generate a significant energy savings, assumed for this analysis to be between 4-5% on average. These savings are in excess of the measures already discussed for computers and televisions.
Misc.	Furnace Fans, Electronically Commutating Motor	In homes heated by a furnace, there is still substantial energy use by the fan responsible for moving the hot air throughout the ductwork. Application of an Electronically Commutating Motor (ECM) ensures that motor speed matches the heating requirements of the system and saves energy when compared to a continuously operating standard motor.
Miscellaneous	Pool Pump	High-efficiency motors and two-speed pumps provide improved energy efficiency for this load.
Miscellaneous	Pool Pump Timer	A pool pump timer allows the pump to turn off automatically, eliminating the wasted energy associated with unnecessary pumping.
Miscellaneous	Trees for Shading	Planting of shade trees, suitable to the local climate, can reduce the need for air conditioning and provide non-energy benefits as well.
Cooling / Space Heating / Interior Lighting	Home Energy Management System	A centralized home energy management system can be used to control and schedule cooling, space heating, lighting, and possibly appliances as well. Some designs also allow the homeowner to remotely control loads via the Internet.
Cooling / Space Heating	Solar Photovoltaic	Adding a solar photovoltaic (PV) system to the home can meet a portion of the home's electric load and in some cases nearly the entire load, depending on the PV system size, orientation, solar resource, and other factors. For this analysis, we assume a grid-connected system and apply the electricity savings to the home's cooling and space heating loads.
Cooling / Space Heating / Interior Lighting	Advanced New Construction Designs	Advanced new construction designs use an integrated approach to the design of new buildings to account for the interaction of building systems. Typically, designs specify the building orientation, building shell, building mechanical systems, and controls strategies with the goal of optimizing building energy efficiency and comfort. Options that may be evaluated and incorporated include passive solar strategies, increased thermal mass, natural ventilation, daylighting strategies, and shading strategies, This measure was modeled for new construction only.
Cooling / Space Heating / Interior Lighting	ENERGY STAR Homes	This measure was modeled for new construction only.
Cooling / Space Heating / Interior Lighting	Energy-Efficient Manufactured Homes	This measure was modeled for new construction only.

Table C-2 Energy Efficiency Equipment Data — Single Family, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	134	$278	15	0.41
Cooling	Central AC	SEER 15 (CEE Tier 2)	184	$556	15	0.28
Cooling	Central AC	SEER 16 (CEE Tier 3)	226	$834	15	0.23
Cooling	Central AC	Ductless Mini-Split System	405	$4,399	20	0.14
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	62	$104	10	0.33
Cooling	Room AC	EER 11	73	$282	10	0.15
Cooling	Room AC	EER 11.5	99	$626	10	0.09
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	492	$1,000	15	0.43
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	675	$2,318	15	0.26
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	829	$3,505	15	0.21
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	1,486	$5,655	20	0.45
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	516	$1,500	14	0.28
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	173	$41	15	5.79
Water Heating	Water Heater	Geothermal Heat Pump	2,269	$6,586	15	0.47
Water Heating	Water Heater	Solar	2,493	$5,653	15	0.60
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	14.44
Interior Lighting*	Screw-in	LED	40	$80	12	0.90
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	22.43
Exterior Lighting*	Screw-in	LED	37	$79	12	0.89
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	45	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	88	$487	10	0.16
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	98	$48	13	2.39
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	41	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	53	$1	9	31.05
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	108	$89	13	1.28
Appliances	Refrigerator	Baseline (2014)	144	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	230	$89	13	-

* Savings and costs are per unit, e.g., per lamp.

Table C-2 Energy Efficiency Equipment Data — Single Family, Existing Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	114	$32	11	3.03
Appliances	Freezer	Baseline (2014)	152	$0	11	-
Appliances	Freezer	Energy Star (2014)	243	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	111	$89	13	1.31
Appliances	Second Refrigerator	Baseline (2014)	148	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	237	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	9	$2	13	7.00
Appliances	Stove	Induction (High Efficiency)	46	$1,432	13	0.05
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	108	$1	5	35.63
Electronics	Personal Computers	Climate Savers	154	$175	5	0.35
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	87	$1	11	133.21
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	138	$85	15	1.96
Miscellaneous	Pool Pump	Two-Speed Pump	551	$579	15	1.15
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	127	$1	18	281.65
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-3 Energy Efficiency Equipment Data — Multi Family, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	67	$93	15	0.62
Cooling	Central AC	SEER 15 (CEE Tier 2)	133	$185	15	0.61
Cooling	Central AC	SEER 16 (CEE Tier 3)	187	$278	15	0.57
Cooling	Central AC	Ductless Mini-Split System	245	$2,012	20	0.19
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	32	$52	10	0.35
Cooling	Room AC	EER 11	38	$141	10	0.15
Cooling	Room AC	EER 11.5	52	$313	10	0.09
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	238	$1,246	15	0.17
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	467	$2,315	15	0.18
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	659	$3,277	15	0.18
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	862	$5,022	20	0.27
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	248	$1,500	14	0.14
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	107	$41	15	3.61
Water Heating	Water Heater	Solar	1,539	$5,653	15	0.38
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	10.47
Interior Lighting*	Screw-in	LED	40	$80	12	0.65
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	32.52
Exterior Lighting*	Screw-in	LED	37	$79	12	1.29
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	23	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	44	$487	10	0.08
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	93	$48	13	2.28
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	15	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	19	$1	9	11.14
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	92	$89	13	1.09
Appliances	Refrigerator	Baseline (2014)	123	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	196	$89	13	-

* Savings and costs are per unit, e.g., per lamp.

Table C-3 Energy Efficiency Equipment Data—Multi Family, Existing Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	108	$32	11	2.88
Appliances	Freezer	Baseline (2014)	145	$0	11	-
Appliances	Freezer	Energy Star (2014)	231	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	93	$89	13	1.11
Appliances	Second Refrigerator	Baseline (2014)	124	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	199	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	4	$2	13	2.99
Appliances	Stove	Induction (High Efficiency)	20	$1,432	13	0.02
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	86	$1	5	29.28
Electronics	Personal Computers	Climate Savers	123	$175	5	0.29
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	43	$1	11	67.65
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	-	$85	15	-
Miscellaneous	Pool Pump	Two-Speed Pump	-	$579	15	-
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	10	$1	18	21.87
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-4 Energy Efficiency Equipment Data — Mobile Home, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	80	$278	15	0.24
Cooling	Central AC	SEER 15 (CEE Tier 2)	110	$556	15	0.17
Cooling	Central AC	SEER 16 (CEE Tier 3)	134	$834	15	0.14
Cooling	Central AC	Ductless Mini-Split System	241	$4,399	20	0.08
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	37	$52	10	0.40
Cooling	Room AC	EER 11	44	$141	10	0.17
Cooling	Room AC	EER 11.5	59	$313	10	0.11
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	282	$1,246	15	0.20
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	387	$2,315	15	0.15
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	475	$3,277	15	0.13
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	852	$5,022	20	0.27
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	295	$1,500	14	0.16
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	88	$41	15	2.95
Water Heating	Water Heater	Solar	1,271	$5,653	15	0.31
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	13.00
Interior Lighting*	Screw-in	LED	40	$80	12	0.81
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.04
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.64
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.13
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.70
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	20.19
Exterior Lighting*	Screw-in	LED	37	$79	12	0.80
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	6.66
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	3.63
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	8.23
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.74
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	46	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	89	$487	10	0.16
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	99	$48	13	2.43
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	41	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	54	$1	9	31.57
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	110	$89	13	1.30
Appliances	Refrigerator	Baseline (2014)	146	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	234	$89	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-4 Energy Efficiency Equipment Data — Mobile Home, Existing Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	116	$32	11	3.08
Appliances	Freezer	Baseline (2014)	155	$0	11	-
Appliances	Freezer	Energy Star (2014)	248	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	113	$89	13	1.34
Appliances	Second Refrigerator	Baseline (2014)	150	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	241	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	8	$2	13	6.30
Appliances	Stove	Induction (High Efficiency)	41	$1,432	13	0.04
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	101	$1	5	33.39
Electronics	Personal Computers	Climate Savers	144	$175	5	0.33
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	87	$1	11	133.21
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	138	$85	15	1.96
Miscellaneous	Pool Pump	Two-Speed Pump	551	$579	15	1.15
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	127	$1	18	281.65
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-5 Energy Efficiency Equipment Data — Limited Income, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	76	$185	15	0.35
Cooling	Central AC	SEER 15 (CEE Tier 2)	104	$370	15	0.24
Cooling	Central AC	SEER 16 (CEE Tier 3)	127	$556	15	0.19
Cooling	Central AC	Ductless Mini-Split System	229	$2,394	20	0.15
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	65	$104	10	0.35
Cooling	Room AC	EER 11	77	$282	10	0.15
Cooling	Room AC	EER 11.5	104	$626	10	0.09
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	192	$1,246	15	0.13
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	263	$2,315	15	0.10
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	323	$3,277	15	0.09
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	579	$5,022	20	0.18
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	201	$1,500	14	0.11
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	116	$41	15	3.94
Water Heating	Water Heater	Solar	1,679	$5,653	15	0.41
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	13.85
Interior Lighting*	Screw-in	LED	40	$80	12	0.86
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	32.52
Exterior Lighting*	Screw-in	LED	37	$79	12	1.29
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	20	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	38	$487	10	0.07
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	104	$48	13	2.56
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	12	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	15	$1	9	9.07
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	92	$89	13	1.09
Appliances	Refrigerator	Baseline (2014)	123	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	196	$89	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-5 Energy Efficiency Equipment Data — Limited Income, Existing Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	108	$32	11	2.88
Appliances	Freezer	Baseline (2014)	145	$0	11	-
Appliances	Freezer	Energy Star (2014)	231	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	93	$89	13	1.11
Appliances	Second Refrigerator	Baseline (2014)	124	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	199	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	5	$2	13	3.59
Appliances	Stove	Induction (High Efficiency)	24	$1,432	13	0.02
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	89	$1	5	30.10
Electronics	Personal Computers	Climate Savers	127	$175	5	0.29
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	49	$1	11	77.80
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	57	$85	15	0.83
Miscellaneous	Pool Pump	Two-Speed Pump	226	$579	15	0.49
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	54	$1	18	123.18
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-6 Energy Efficiency Equipment Data —Single Family, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	180	$278	15	0.55
Cooling	Central AC	SEER 15 (CEE Tier 2)	240	$556	15	0.36
Cooling	Central AC	SEER 16 (CEE Tier 3)	290	$834	15	0.29
Cooling	Central AC	Ductless Mini-Split System	543	$4,399	20	0.19
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	76	$104	10	0.41
Cooling	Room AC	EER 11	90	$282	10	0.18
Cooling	Room AC	EER 11.5	122	$626	10	0.11
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	588	$1,000	15	0.51
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	783	$2,318	15	0.30
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	946	$3,505	15	0.24
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	1,775	$5,655	20	0.54
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	630	$1,500	14	0.35
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	219	$41	15	7.35
Water Heating	Water Heater	Geothermal Heat Pump	2,878	$6,586	15	0.60
Interior Lighting*	Water Heater	Solar	3,163	$5,653	15	0.77
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	14.05
Interior Lighting*	Screw-in	LED	40	$80	12	0.87
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Exterior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	21.82
Exterior Lighting*	Screw-in	LED	37	$79	12	0.87
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	58	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	112	$487	10	0.21
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	117	$48	13	2.86
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	47	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	62	$1	9	36.25
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	102	$89	13	1.20
Appliances	Refrigerator	Baseline (2014)	135	$0	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-6 Energy Efficiency Equipment Data —Single Family, New Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Refrigerator	Energy Star (2014)	217	$89	13	-
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	116	$32	11	3.08
Appliances	Freezer	Baseline (2014)	155	$0	11	-
Appliances	Freezer	Energy Star (2014)	248	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	116	$89	13	1.37
Appliances	Second Refrigerator	Baseline (2014)	154	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	247	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	11	$2	13	8.51
Appliances	Stove	Induction (High Efficiency)	56	$1,432	13	0.06
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	111	$1	5	36.63
Electronics	Personal Computers	Climate Savers	158	$175	5	0.36
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	96	$1	11	148.53
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	156	$85	15	2.22
Miscellaneous	Pool Pump	Two-Speed Pump	623	$579	15	1.30
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	155	$1	18	345.87
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-7 Energy Efficiency Equipment Data — Multi Family, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	85	$93	15	0.78
Cooling	Central AC	SEER 15 (CEE Tier 2)	166	$185	15	0.76
Cooling	Central AC	SEER 16 (CEE Tier 3)	234	$278	15	0.71
Cooling	Central AC	Ductless Mini-Split System	308	$2,012	20	0.24
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	37	$52	10	0.39
Cooling	Room AC	EER 11	43	$141	10	0.17
Cooling	Room AC	EER 11.5	59	$313	10	0.10
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	292	$1,246	15	0.21
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	571	$2,315	15	0.22
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	804	$3,277	15	0.21
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	1,058	$5,022	20	0.33
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	282	$1,500	14	0.15
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	124	$41	15	4.19
Water Heating	Water Heater	Solar	1,786	$5,653	15	0.44
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	10.18
Interior Lighting*	Screw-in	LED	40	$80	12	0.63
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	31.63
Exterior Lighting*	Screw-in	LED	37	$79	12	1.26
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	26	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	51	$487	10	0.09
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	105	$48	13	2.56
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	16	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	21	$1	9	12.38
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	108	$89	13	1.28
Appliances	Refrigerator	Baseline (2014)	144	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	230	$89	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-7 Energy Efficiency Equipment Data — Multi Family, New Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	115	$32	11	3.06
Appliances	Freezer	Baseline (2014)	154	$0	11	-
Appliances	Freezer	Energy Star (2014)	246	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	103	$89	13	1.21
Appliances	Second Refrigerator	Baseline (2014)	137	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	219	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	4	$2	13	3.31
Appliances	Stove	Induction (High Efficiency)	22	$1,432	13	0.02
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	88	$1	5	29.69
Electronics	Personal Computers	Climate Savers	125	$175	5	0.29
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	45	$1	11	71.54
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	-	$85	15	-
Miscellaneous	Pool Pump	Two-Speed Pump	-	$579	15	-
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	11	$1	18	24.36
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-8 Energy Efficiency Equipment Data — Mobile Home, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	100	$278	15	0.30
Cooling	Central AC	SEER 15 (CEE Tier 2)	133	$556	15	0.20
Cooling	Central AC	SEER 16 (CEE Tier 3)	161	$834	15	0.16
Cooling	Central AC	Ductless Mini-Split System	301	$4,399	20	0.11
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	42	$52	10	0.45
Cooling	Room AC	EER 11	50	$141	10	0.20
Cooling	Room AC	EER 11.5	67	$313	10	0.12
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	313	$1,246	15	0.22
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	417	$2,315	15	0.16
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	505	$3,277	15	0.13
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	946	$5,022	20	0.30
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	336	$1,500	14	0.18
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	102	$41	15	3.42
Water Heating	Water Heater	Solar	1,474	$5,653	15	0.36
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	12.64
Interior Lighting*	Screw-in	LED	40	$80	12	0.79
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.04
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.64
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.13
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.70
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	19.63
Exterior Lighting*	Screw-in	LED	37	$79	12	0.78
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	6.66
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	3.63
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	8.23
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.74
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	54	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	104	$487	10	0.19
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	111	$48	13	2.73
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	46	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	60	$1	9	35.11
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	129	$89	13	1.52
Appliances	Refrigerator	Baseline (2014)	172	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	275	$89	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-8 Energy Efficiency Equipment Data — Mobile Home, New Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	124	$32	11	3.28
Appliances	Freezer	Baseline (2014)	165	$0	11	-
Appliances	Freezer	Energy Star (2014)	263	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	124	$89	13	1.47
Appliances	Second Refrigerator	Baseline (2014)	165	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	264	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	9	$2	13	6.98
Appliances	Stove	Induction (High Efficiency)	46	$1,432	13	0.05
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	103	$1	5	33.86
Electronics	Personal Computers	Climate Savers	146	$175	5	0.33
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	91	$1	11	140.87
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	154	$85	15	2.20
Miscellaneous	Pool Pump	Two-Speed Pump	617	$579	15	1.29
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	141	$1	18	313.76
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-9 Energy Efficiency Equipment Data — Limited Income, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost (/HH)	Lifetime (yrs)	BC Ratio
Cooling	Central AC	SEER 13	-	$0	15	-
Cooling	Central AC	SEER 14 (Energy Star)	95	$185	15	0.43
Cooling	Central AC	SEER 15 (CEE Tier 2)	126	$370	15	0.29
Cooling	Central AC	SEER 16 (CEE Tier 3)	152	$556	15	0.23
Cooling	Central AC	Ductless Mini-Split System	286	$2,394	20	0.18
Cooling	Room AC	EER 9.8	-	$0	10	-
Cooling	Room AC	EER 10.8 (Energy Star)	74	$104	10	0.40
Cooling	Room AC	EER 11	87	$282	10	0.17
Cooling	Room AC	EER 11.5	118	$626	10	0.11
Combined Heating/Cooling	Air Source Heat Pump	SEER 13	-	$0	15	-
Combined Heating/Cooling	Air Source Heat Pump	SEER 14 (Energy Star)	213	$1,246	15	0.15
Combined Heating/Cooling	Air Source Heat Pump	SEER 15 (CEE Tier 2)	284	$2,315	15	0.11
Combined Heating/Cooling	Air Source Heat Pump	SEER 16 (CEE Tier 3)	343	$3,277	15	0.09
Combined Heating/Cooling	Air Source Heat Pump	Ductless Mini-Split System	643	$5,022	20	0.20
Combined Heating/Cooling	Geothermal Heat Pump	Standard	-	$0	14	-
Combined Heating/Cooling	Geothermal Heat Pump	High Efficiency	228	$1,500	14	0.13
Space Heating	Electric Resistance	Electric Resistance	-	$0	20	-
Space Heating	Electric Furnace	3400 BTU/KW	-	$0	15	-
Space Heating	Supplemental	Supplemental	-	$0	5	-
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	135	$41	15	4.57
Water Heating	Water Heater	Solar	1,949	$5,653	15	0.48
Interior Lighting*	Screw-in	Incandescent	-	$0	4	-
Interior Lighting*	Screw-in	Infrared Halogen	14	$4	5	-
Interior Lighting*	Screw-in	CFL	38	$2	6	13.47
Interior Lighting*	Screw-in	LED	40	$80	12	0.84
Interior Lighting*	Linear Fluorescent	T12	-	$0	6	-
Interior Lighting*	Linear Fluorescent	T8	6	($1)	6	1.00
Interior Lighting*	Linear Fluorescent	Super T8	6	$7	6	1.16
Interior Lighting*	Linear Fluorescent	T5	10	$10	6	0.71
Interior Lighting*	Linear Fluorescent	LED	18	$55	10	0.14
Interior Lighting*	Pin-based	Halogen	-	$0	4	-
Interior Lighting*	Pin-based	CFL	13	$4	6	1.00
Interior Lighting*	Pin-based	LED	14	$17	10	0.77
Exterior Lighting*	Screw-in	Incandescent	-	$0	4	-
Exterior Lighting*	Screw-in	Infrared Halogen	12	$4	5	-
Exterior Lighting*	Screw-in	CFL	27	$3	6	31.63
Exterior Lighting*	Screw-in	LED	37	$79	12	1.26
Exterior Lighting*	High Intensity/Flood	Incandescent	-	$0	4	-
Exterior Lighting*	High Intensity/Flood	Infrared Halogen	34	$4	4	-
Exterior Lighting*	High Intensity/Flood	CFL	60	$4	5	7.40
Exterior Lighting*	High Intensity/Flood	Metal Halide	22	$31	5	4.03
Exterior Lighting*	High Intensity/Flood	High Pressure Sodium	22	$23	5	9.14
Exterior Lighting*	High Intensity/Flood	LED	66	$79	10	0.82
Appliances	Clothes Washer	Baseline	-	$0	10	-
Appliances	Clothes Washer	Energy Star (MEF > 1.8)	23	$0	10	1.00
Appliances	Clothes Washer	Horizontal Axis	44	$487	10	0.08
Appliances	Clothes Dryer	Baseline	-	$0	13	-
Appliances	Clothes Dryer	Moisture Detection	117	$48	13	2.87
Appliances	Dishwasher	Baseline	-	$0	9	-
Appliances	Dishwasher	Energy Star	13	$1	9	-
Appliances	Dishwasher	Energy Star (2011)	17	$1	9	10.08
Appliances	Refrigerator	Baseline	-	$0	13	-
Appliances	Refrigerator	Energy Star	108	$89	13	1.28
Appliances	Refrigerator	Baseline (2014)	144	$0	13	-
Appliances	Refrigerator	Energy Star (2014)	230	$89	13	-

* Savings and costs are per unit, e.g., per lamp

Table C-9 Energy Efficiency Equipment Data — Limited Income, New Vintage (cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr/HH)	Incremental Cost ($/HH)	Lifetime (yrs)	BC Ratio
Appliances	Freezer	Baseline	-	$0	11	-
Appliances	Freezer	Energy Star	115	$32	11	3.06
Appliances	Freezer	Baseline (2014)	154	$0	11	-
Appliances	Freezer	Energy Star (2014)	246	$32	11	-
Appliances	Second Refrigerator	Baseline	-	$0	13	-
Appliances	Second Refrigerator	Energy Star	103	$89	13	1.21
Appliances	Second Refrigerator	Baseline (2014)	137	$0	13	-
Appliances	Second Refrigerator	Energy Star (2014)	219	$89	13	-
Appliances	Stove	Baseline	-	$0	13	-
Appliances	Stove	Convection Oven	5	$2	13	3.98
Appliances	Stove	Induction (High Efficiency)	26	$1,432	13	0.03
Appliances	Microwave	Baseline	-	$0	9	-
Electronics	Personal Computers	Baseline	-	$0	5	-
Electronics	Personal Computers	Energy Star	90	$1	5	30.52
Electronics	Personal Computers	Climate Savers	129	$175	5	0.30
Electronics	TVs	Baseline	-	$0	11	-
Electronics	TVs	Energy Star	52	$1	11	82.28
Electronics	Devices and Gadgets	Devices and Gadgets	-	$0	5	-
Miscellaneous	Pool Pump	Baseline Pump	-	$0	15	-
Miscellaneous	Pool Pump	High Efficiency Pump	63	$85	15	0.93
Miscellaneous	Pool Pump	Two-Speed Pump	254	$579	15	0.54
Miscellaneous	Furnace Fan	Baseline	-	$0	18	-
Miscellaneous	Furnace Fan	Furnace Fan with ECM	60	$1	18	137.23
Miscellaneous	Miscellaneous	Miscellaneous	-	$0	5	-

Table C-10 Energy-Efficiency Measure Data—Single Family, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Early Replacement	Cooling	10%	0%	0%	8%	$2,895	15	0.05
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	41%	100%	$125	4	0.70
Room AC - Removal of Second Unit	Cooling	100%	0%	0%	25%	$75	5	2.45
Attic Fan - Installation	Cooling	1%	0%	12%	23%	$116	18	0.08
Attic Fan - Photovoltaic - Installation	Cooling	1%	0%	13%	45%	$350	19	0.06
Ceiling Fan - Installation	Cooling	11%	0%	51%	75%	$160	15	0.81
Whole-House Fan - Installation	Cooling	9%	0%	7%	19%	$200	18	0.62
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	1.49
Insulation - Ducting	Cooling	3%	0%	15%	75%	$500	18	0.78
Insulation - Ducting	Space Heating	4%	4%	15%	75%	$500	18	0.78
Repair and Sealing - Ducting	Cooling	10%	0%	12%	50%	$500	18	2.08
Repair and Sealing - Ducting	Space Heating	15%	15%	12%	50%	$500	18	2.08
Thermostat - Clock/Programmable	Cooling	8%	0%	55%	56%	$114	11	2.89
Thermostat - Clock/Programmable	Space Heating	9%	5%	55%	56%	$114	11	2.89
Doors - Storm and Thermal	Cooling	1%	0%	38%	75%	$320	12	0.25
Doors - Storm and Thermal	Space Heating	2%	2%	38%	75%	$320	12	0.25
Insulation - Infiltration Control	Cooling	3%	0%	46%	90%	$266	12	1.72
Insulation - Infiltration Control	Space Heating	10%	10%	46%	90%	$266	12	1.72
Insulation - Ceiling	Cooling	3%	0%	68%	72%	$594	20	1.11
Insulation - Ceiling	Space Heating	10%	5%	68%	72%	$594	20	1.11
Insulation - Radiant Barrier	Cooling	5%	0%	5%	90%	$923	12	0.41
Insulation - Radiant Barrier	Space Heating	2%	1%	5%	90%	$923	12	0.41
Roofs - High Reflectivity	Cooling	6%	0%	5%	10%	$1,550	15	0.05
Windows - Reflective Film	Cooling	7%	0%	5%	45%	$267	10	0.21
Windows - High Efficiency/Energy Star	Cooling	12%	0%	83%	90%	$7,500	25	0.38
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	83%	90%	$7,500	25	0.38
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	24%	25%	$750	15	0.10
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	0%	10%	80%	$2,975	15	0.03
Exterior Lighting - Photosensor Control	Exterior Lighting	15%	0%	24%	45%	$90	8	0.21
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	10%	45%	$72	8	0.35
Water Heater - Faucet Aerators	Water Heating	4%	2%	53%	90%	$24	25	8.78
Water Heater - Pipe Insulation	Water Heating	6%	3%	17%	38%	$180	13	1.05
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	75%	80%	$96	10	4.56
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	54%	75%	$15	10	15.53
Water Heater - Thermostat Setback	Water Heating	9%	5%	17%	75%	$40	5	2.99
Water Heater - Timer	Water Heating	8%	4%	17%	40%	$194	10	1.06
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	3.28
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	1.76
Refrigerator - Early Replacement	Appliances	15%	15%	0%	20%	$1,203	13	0.08
Refrigerator - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.99
Freezer - Early Replacement	Appliances	15%	15%	0%	20%	$484	11	0.18
Freezer - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.76
Home Energy Management System	Cooling	10%	0%	20%	38%	$300	20	2.46
Home Energy Management System	Space Heating	10%	5%	20%	38%	$300	20	2.46
Home Energy Management System	Interior Lighting	10%	5%	20%	38%	$300	20	2.46
Photovoltaics	Cooling	50%	0%	0%	48%	$17,000	15	0.10
Photovoltaics	Space Heating	25%	25%	0%	48%	$17,000	15	0.10
Pool - Pump Timer	Miscellaneous	60%	0%	59%	90%	$160	15	4.92
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.43
Water Heater - Heat Pump	Water Heating	30%	15%	0%	25%	$1,500	15	0.75
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$3,675	15	1.22
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$13,769	15	0.95

Note: Costs are per household.

Table C-11 Energy-Efficiency Measure Data — Multi Family, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Early Replacement	Cooling	10%	0%	0%	8%	$2,895	15	0.02
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	33%	100%	$100	4	0.59
Room AC - Removal of Second Unit	Cooling	100%	0%	0%	25%	$75	5	1.28
Ceiling Fan - Installation	Cooling	11%	0%	32%	75%	$80	15	0.49
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$100	4	1.05
Insulation - Ducting	Cooling	3%	0%	13%	75%	$375	18	1.16
Insulation - Ducting	Space Heating	4%	4%	13%	75%	$375	18	1.16
Repair and Sealing - Ducting	Cooling	4%	0%	12%	50%	$500	18	0.95
Repair and Sealing - Ducting	Space Heating	4%	4%	12%	50%	$500	18	0.95
Thermostat - Clock/Programmable	Cooling	8%	0%	27%	68%	$114	11	2.39
Thermostat - Clock/Programmable	Space Heating	6%	3%	27%	68%	$114	11	2.39
Doors - Storm and Thermal	Cooling	1%	0%	17%	75%	$320	12	0.35
Doors - Storm and Thermal	Space Heating	2%	2%	17%	75%	$320	12	0.35
Insulation - Infiltration Control	Cooling	1%	0%	19%	90%	$266	12	2.95
Insulation - Infiltration Control	Space Heating	13%	13%	19%	90%	$266	12	2.95
Insulation - Ceiling	Cooling	13%	0%	27%	30%	$215	20	5.67
Insulation - Ceiling	Space Heating	13%	13%	27%	30%	$215	20	5.67
Insulation - Radiant Barrier	Cooling	4%	0%	5%	90%	$923	12	0.52
Insulation - Radiant Barrier	Space Heating	4%	4%	5%	90%	$923	12	0.52
Roofs - High Reflectivity	Cooling	13%	0%	3%	10%	$1,550	15	0.03
Windows - Reflective Film	Cooling	7%	0%	5%	45%	$167	10	0.10
Windows - High Efficiency/Energy Star	Cooling	13%	0%	70%	90%	$2,500	25	0.56
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	70%	90%	$2,500	25	0.56
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	6%	10%	$256	15	0.14
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	0%	10%	50%	$2,975	15	0.00
Exterior Lighting - Photosensor Control	Exterior Lighting	20%	0%	7%	45%	$90	8	0.04
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	6%	45%	$72	8	0.05
Water Heater - Faucet Aerators	Water Heating	5%	2%	43%	90%	$24	25	6.63
Water Heater - Pipe Insulation	Water Heating	6%	3%	6%	38%	$180	13	0.65
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	71%	75%	$96	10	2.84
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	54%	75%	$15	10	9.66
Water Heater - Thermostat Setback	Water Heating	9%	5%	17%	75%	$40	5	1.86
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	0.66
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	2.04
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	0.58
Refrigerator - Early Replacement	Appliances	15%	15%	0%	20%	$1,203	13	0.07
Refrigerator - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.36
Freezer - Early Replacement	Appliances	15%	15%	0%	20%	$484	11	0.17
Freezer - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.57
Home Energy Management System	Cooling	10%	0%	5%	13%	$300	20	2.46
Home Energy Management System	Space Heating	10%	5%	5%	13%	$300	20	2.46
Home Energy Management System	Interior Lighting	10%	5%	5%	13%	$300	20	2.46
Photovoltaics	Cooling	50%	0%	0%	12%	$8,500	15	0.22
Photovoltaics	Space Heating	25%	25%	0%	12%	$8,500	15	0.22
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.13
Water Heater - Heat Pump	Water Heating	30%	15%	0%	10%	$1,500	15	0.47
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,845	15	0.99
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$10,946	15	0.72

Note: Costs are per household.

Table C-12 Energy-Efficiency Measure Data — Mobile Home, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Early Replacement	Cooling	10%	0%	0%	8%	$2,895	15	0.03
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	59%	100%	$100	4	0.63
Room AC - Removal of Second Unit	Cooling	100%	0%	0%	25%	$75	5	1.46
Ceiling Fan - Installation	Cooling	11%	0%	60%	75%	$80	15	0.79
Whole-House Fan - Installation	Cooling	9%	0%	5%	19%	$150	18	0.41
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	1.02
Insulation - Ducting	Cooling	3%	0%	15%	75%	$375	18	0.94
Insulation - Ducting	Space Heating	4%	4%	15%	75%	$375	18	0.94
Repair and Sealing - Ducting	Cooling	10%	0%	12%	50%	$500	18	2.08
Repair and Sealing - Ducting	Space Heating	15%	15%	12%	50%	$500	18	2.08
Thermostat - Clock/Programmable	Cooling	8%	0%	51%	56%	$114	11	2.78
Thermostat - Clock/Programmable	Space Heating	9%	5%	51%	56%	$114	11	2.78
Doors - Storm and Thermal	Cooling	1%	0%	38%	75%	$320	12	0.25
Doors - Storm and Thermal	Space Heating	2%	2%	38%	75%	$320	12	0.25
Insulation - Infiltration Control	Cooling	3%	0%	46%	90%	$266	12	1.80
Insulation - Infiltration Control	Space Heating	10%	10%	46%	90%	$266	12	1.80
Insulation - Ceiling	Cooling	3%	0%	79%	81%	$707	20	1.00
Insulation - Ceiling	Space Heating	10%	5%	79%	81%	$707	20	1.00
Insulation - Radiant Barrier	Cooling	2%	0%	5%	90%	$923	12	0.35
Insulation - Radiant Barrier	Space Heating	1%	1%	5%	90%	$923	12	0.35
Roofs - High Reflectivity	Cooling	6%	0%	5%	10%	$1,550	15	0.02
Windows - Reflective Film	Cooling	7%	0%	5%	45%	$167	10	0.16
Windows - High Efficiency/Energy Star	Cooling	12%	0%	47%	90%	$7,500	25	0.37
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	47%	90%	$7,500	25	0.37
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	67%	72%	$750	15	0.09
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	0%	10%	80%	$2,975	15	0.03
Exterior Lighting - Photosensor Control	Exterior Lighting	15%	0%	23%	45%	$90	8	0.19
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	10%	45%	$72	8	0.32
Water Heater - Faucet Aerators	Water Heating	4%	2%	79%	90%	$24	25	4.47
Water Heater - Pipe Insulation	Water Heating	6%	3%	17%	38%	$180	13	0.53
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	92%	95%	$96	10	2.32
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	54%	75%	$15	10	7.91
Water Heater - Thermostat Setback	Water Heating	9%	5%	17%	75%	$40	5	1.52
Water Heater - Timer	Water Heating	8%	4%	17%	40%	$194	10	0.54
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	1.67
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	1.65
Refrigerator - Early Replacement	Appliances	15%	15%	0%	20%	$1,203	13	0.08
Refrigerator - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	4.06
Freezer - Early Replacement	Appliances	15%	15%	0%	20%	$484	11	0.18
Freezer - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.82
Home Energy Management System	Cooling	10%	0%	20%	38%	$300	20	2.28
Home Energy Management System	Space Heating	10%	5%	20%	38%	$300	20	2.28
Home Energy Management System	Interior Lighting	10%	5%	20%	38%	$300	20	2.28
Photovoltaics	Cooling	50%	0%	0%	48%	$17,000	15	0.09
Photovoltaics	Space Heating	25%	25%	0%	48%	$17,000	15	0.09
Pool - Pump Timer	Miscellaneous	60%	0%	50%	90%	$160	15	4.92
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.21
Water Heater - Heat Pump	Water Heating	30%	15%	0%	10%	$1,500	15	0.38
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,616	15	0.88
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$11,135	15	0.62

Note: Costs are per household.

Table C-13 Energy-Efficiency Measure Data — Limited Income, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Early Replacement	Cooling	10%	0%	0%	8%	$2,895	15	0.03
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	25%	100%	$100	4	0.61
Room AC - Removal of Second Unit	Cooling	100%	0%	0%	25%	$75	5	2.56
Attic Fan - Installation	Cooling	1%	0%	3%	23%	$116	18	0.05
Attic Fan - Photovoltaic - Installation	Cooling	1%	0%	2%	11%	$350	19	0.03
Ceiling Fan - Installation	Cooling	11%	0%	41%	75%	$80	15	0.89
Whole-House Fan - Installation	Cooling	9%	0%	5%	19%	$150	18	0.46
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	0.82
Insulation - Ducting	Cooling	3%	0%	13%	75%	$395	18	0.90
Insulation - Ducting	Space Heating	4%	4%	13%	75%	$395	18	0.90
Repair and Sealing - Ducting	Cooling	10%	0%	12%	50%	$500	18	2.07
Repair and Sealing - Ducting	Space Heating	15%	15%	12%	50%	$500	18	2.07
Thermostat - Clock/Programmable	Cooling	8%	0%	27%	68%	$114	11	2.63
Thermostat - Clock/Programmable	Space Heating	9%	5%	27%	68%	$114	11	2.63
Doors - Storm and Thermal	Cooling	1%	0%	17%	75%	$320	12	0.25
Doors - Storm and Thermal	Space Heating	2%	2%	17%	75%	$320	12	0.25
Insulation - Infiltration Control	Cooling	3%	0%	19%	90%	$266	12	1.78
Insulation - Infiltration Control	Space Heating	10%	10%	19%	90%	$266	12	1.78
Insulation - Ceiling	Cooling	3%	0%	36%	41%	$215	20	2.44
Insulation - Ceiling	Space Heating	10%	5%	36%	41%	$215	20	2.44
Insulation - Radiant Barrier	Cooling	2%	0%	5%	90%	$923	12	0.35
Insulation - Radiant Barrier	Space Heating	1%	1%	5%	90%	$923	12	0.35
Roofs - High Reflectivity	Cooling	6%	0%	3%	10%	$1,550	15	0.03
Windows - Reflective Film	Cooling	7%	0%	5%	45%	$167	10	0.18
Windows - High Efficiency/Energy Star	Cooling	12%	0%	68%	90%	$2,500	25	0.51
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	68%	90%	$2,500	25	0.51
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	8%	10%	$256	15	0.16
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	50%	10%	50%	$2,975	15	0.01
Exterior Lighting - Photosensor Control	Exterior Lighting	15%	0%	8%	45%	$90	8	0.06
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	6%	45%	$72	8	0.10
Water Heater - Faucet Aerators	Water Heating	4%	2%	46%	90%	$24	25	5.95
Water Heater - Pipe Insulation	Water Heating	6%	3%	6%	38%	$180	13	0.71
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	73%	75%	$96	10	3.09
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	54%	75%	$15	10	10.53
Water Heater - Thermostat Setback	Water Heating	9%	5%	17%	75%	$40	5	2.03
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	0.72
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	2.23
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	0.77
Refrigerator - Early Replacement	Appliances	15%	15%	0%	20%	$1,203	13	0.07
Refrigerator - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.36
Freezer - Early Replacement	Appliances	15%	15%	0%	20%	$484	11	0.17
Freezer - Remove Second Unit	Appliances	100%	100%	0%	25%	$75	5	3.57
Home Energy Management System	Cooling	10%	0%	5%	13%	$300	20	2.00
Home Energy Management System	Space Heating	10%	5%	5%	13%	$300	20	2.00
Home Energy Management System	Interior Lighting	10%	5%	5%	13%	$300	20	2.00
Photovoltaics	Cooling	50%	0%	0%	48%	$8,500	15	0.17
Photovoltaics	Space Heating	25%	25%	0%	48%	$8,500	15	0.17
Pool - Pump Timer	Miscellaneous	60%	0%	50%	90%	$160	15	2.02
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.24
Water Heater - Heat Pump	Water Heating	30%	15%	0%	20%	$1,500	15	0.51
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,970	15	1.03
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$10,798	15	0.69

Note: Costs are per household.

Table C-14 Energy-Efficiency Measure Data — Single Family, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	41%	100%	$125	4	0.78
Attic Fan - Installation	Cooling	1%	0%	13%	23%	$97	18	0.15
Attic Fan - Photovoltaic - Installation	Cooling	1%	0%	4%	11%	$200	19	0.15
Ceiling Fan - Installation	Cooling	10%	0%	53%	75%	$160	15	1.09
Whole-House Fan - Installation	Cooling	9%	0%	4%	19%	$200	18	0.92
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	1.69
Insulation - Ducting	Cooling	3%	0%	50%	75%	$250	18	1.31
Insulation - Ducting	Space Heating	4%	4%	50%	75%	$250	18	1.31
Thermostat - Clock/Programmable	Cooling	8%	0%	91%	95%	$114	11	2.91
Thermostat - Clock/Programmable	Space Heating	8%	4%	91%	95%	$114	11	2.91
Doors - Storm and Thermal	Cooling	1%	0%	13%	75%	$180	12	0.45
Doors - Storm and Thermal	Space Heating	2%	2%	13%	75%	$180	12	0.45
Insulation - Ceiling	Cooling	3%	0%	68%	71%	$634	20	0.99
Insulation - Ceiling	Space Heating	8%	6%	68%	71%	$634	20	0.99
Insulation - Radiant Barrier	Cooling	2%	0%	25%	90%	$923	12	0.37
Insulation - Radiant Barrier	Space Heating	1%	1%	25%	90%	$923	12	0.37
Insulation - Foundation	Cooling	3%	0%	20%	90%	$358	20	1.35
Insulation - Foundation	Space Heating	6%	6%	20%	90%	$358	20	1.35
Insulation - Wall Cavity	Cooling	2%	0%	20%	90%	$236	20	1.15
Insulation - Wall Cavity	Space Heating	3%	3%	20%	90%	$236	20	1.15
Insulation - Wall Sheathing	Cooling	1%	0%	64%	90%	$300	20	0.89
Insulation - Wall Sheathing	Space Heating	3%	3%	64%	90%	$300	20	0.89
Roofs - High Reflectivity	Cooling	5%	0%	5%	90%	$517	15	0.17
Windows - Reflective Film	Cooling	7%	0%	2%	45%	$267	10	0.31
Windows - High Efficiency/Energy Star	Cooling	12%	0%	100%	100%	$2,200	25	0.62
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	100%	100%	$2,200	25	0.62
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	24%	27%	$500	15	0.16
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	0%	10%	80%	$2,975	15	0.04
Exterior Lighting - Photosensor Control	Exterior Lighting	13%	0%	13%	45%	$90	8	0.19
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	16%	45%	$72	8	0.36
Water Heater - Faucet Aerators	Water Heating	4%	2%	38%	90%	$24	25	11.03
Water Heater - Pipe Insulation	Water Heating	6%	3%	8%	41%	$50	13	4.71
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	90%	95%	$48	10	11.33
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$15	10	19.30
Water Heater - Thermostat Setback	Water Heating	9%	5%	5%	75%	$40	5	3.70
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	1.31
Water Heater - Drainwater Heat Reocvery	Water Heating	9%	5%	1%	90%	$899	15	0.47
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	4.06
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	1.99
Home Energy Management System	Cooling	10%	0%	20%	68%	$250	20	3.16
Home Energy Management System	Space Heating	10%	5%	20%	68%	$250	20	3.16
Home Energy Management System	Interior Lighting	10%	5%	20%	68%	$250	20	3.16
Photovoltaics	Cooling	50%	0%	1%	48%	$15,800	15	0.12
Photovoltaics	Space Heating	25%	25%	1%	48%	$15,800	15	0.12
Pool - Pump Timer	Miscellaneous	60%	0%	55%	90%	$160	15	5.43
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.64
Advanced New Construction Designs	Cooling	40%	0%	2%	45%	$4,500	18	1.09
Advanced New Construction Designs	Space Heating	40%	40%	2%	45%	$4,500	18	1.09
Advanced New Construction Designs	Interior Lighting	20%	20%	2%	45%	$4,500	18	1.09
Energy Star Homes	Cooling	20%	0%	12%	75%	$5,000	18	0.75
Energy Star Homes	Space Heating	20%	20%	12%	75%	$5,000	18	0.75
Energy Star Homes	Interior Lighting	20%	20%	12%	75%	$5,000	18	0.75
Water Heater - Heat Pump	Water Heating	30%	15%	0%	25%	$1,500	15	0.94
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$3,675	15	1.53
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$13,769	15	1.14

Note: Costs are per household.

Table C-15 Energy-Efficiency Measure Data — Multi Family, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	33%	100%	$100	4	0.62
Ceiling Fan - Installation	Cooling	10%	0%	18%	75%	$80	15	0.77
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$100	4	1.12
Insulation - Ducting	Cooling	2%	0%	50%	75%	$200	18	1.18
Insulation - Ducting	Space Heating	2%	2%	50%	75%	$200	18	1.18
Thermostat - Clock/Programmable	Cooling	8%	0%	77%	80%	$114	11	2.29
Thermostat - Clock/Programmable	Space Heating	5%	3%	77%	80%	$114	11	2.29
Doors - Storm and Thermal	Cooling	1%	0%	19%	75%	$180	12	0.66
Doors - Storm and Thermal	Space Heating	2%	2%	19%	75%	$180	12	0.66
Insulation - Ceiling	Cooling	12%	0%	27%	48%	$152	20	10.12
Insulation - Ceiling	Space Heating	16%	16%	27%	48%	$152	20	10.12
Insulation - Radiant Barrier	Cooling	2%	0%	5%	90%	$923	12	0.50
Insulation - Radiant Barrier	Space Heating	3%	3%	5%	90%	$923	12	0.50
Insulation - Wall Cavity	Cooling	2%	0%	4%	90%	$63	20	6.14
Insulation - Wall Cavity	Space Heating	4%	4%	4%	90%	$63	20	6.14
Insulation - Wall Sheathing	Cooling	1%	0%	55%	90%	$210	20	1.59
Insulation - Wall Sheathing	Space Heating	3%	3%	55%	90%	$210	20	1.59
Roofs - High Reflectivity	Cooling	8%	0%	0%	90%	$517	15	0.10
Windows - Reflective Film	Cooling	7%	0%	2%	45%	$167	10	0.17
Windows - High Efficiency/Energy Star	Cooling	13%	0%	100%	100%	$2,200	25	0.63
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	100%	100%	$2,200	25	0.63
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	6%	9%	$256	15	0.14
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	0%	10%	50%	$2,975	15	0.01
Exterior Lighting - Photosensor Control	Exterior Lighting	20%	0%	1%	45%	$90	8	0.04
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	11%	45%	$72	8	0.05
Water Heater - Faucet Aerators	Water Heating	5%	2%	11%	90%	$24	25	7.63
Water Heater - Pipe Insulation	Water Heating	6%	3%	0%	41%	$50	13	2.68
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	66%	75%	$48	10	6.45
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$15	10	10.99
Water Heater - Thermostat Setback	Water Heating	9%	5%	5%	75%	$40	5	2.11
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	0.75
Water Heater - Drainwater Heat Reocvery	Water Heating	9%	5%	1%	90%	$899	15	0.27
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	2.31
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	0.63
Home Energy Management System	Cooling	10%	0%	5%	68%	$250	20	3.19
Home Energy Management System	Space Heating	10%	5%	5%	68%	$250	20	3.19
Home Energy Management System	Interior Lighting	10%	5%	5%	68%	$250	20	3.19
Photovoltaics	Cooling	50%	0%	0%	12%	$7,900	15	0.26
Photovoltaics	Space Heating	25%	25%	0%	12%	$7,900	15	0.26
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.23
Advanced New Construction Designs	Cooling	40%	0%	2%	45%	$2,500	18	1.47
Advanced New Construction Designs	Space Heating	40%	40%	2%	45%	$2,500	18	1.47
Advanced New Construction Designs	Interior Lighting	20%	20%	2%	45%	$2,500	18	1.47
Water Heater - Heat Pump	Water Heating	30%	15%	0%	10%	$1,500	15	0.53
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,845	15	1.13
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$10,946	15	0.84

Note: Costs are per household.

Table C-16 Energy-Efficiency Measure Data — Mobile Home, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	59%	100%	$100	4	0.66
Ceiling Fan - Installation	Cooling	10%	0%	57%	75%	$80	15	0.95
Whole-House Fan - Installation	Cooling	9%	0%	4%	19%	$150	18	0.53
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	1.09
Insulation - Ducting	Cooling	3%	0%	50%	75%	$200	18	1.59
Insulation - Ducting	Space Heating	4%	4%	50%	75%	$200	18	1.59
Thermostat - Clock/Programmable	Cooling	8%	0%	57%	75%	$114	11	2.77
Thermostat - Clock/Programmable	Space Heating	8%	4%	57%	75%	$114	11	2.77
Doors - Storm and Thermal	Cooling	1%	0%	13%	75%	$180	12	0.49
Doors - Storm and Thermal	Space Heating	2%	2%	13%	75%	$180	12	0.49
Insulation - Ceiling	Cooling	3%	0%	79%	81%	$176	20	3.02
Insulation - Ceiling	Space Heating	8%	6%	79%	81%	$176	20	3.02
Insulation - Radiant Barrier	Cooling	2%	0%	25%	90%	$923	12	0.36
Insulation - Radiant Barrier	Space Heating	1%	1%	25%	90%	$923	12	0.36
Insulation - Wall Cavity	Cooling	2%	0%	20%	90%	$197	20	1.35
Insulation - Wall Cavity	Space Heating	3%	3%	20%	90%	$197	20	1.35
Insulation - Wall Sheathing	Cooling	1%	0%	64%	90%	$300	20	0.96
Insulation - Wall Sheathing	Space Heating	3%	3%	64%	90%	$300	20	0.96
Roofs - High Reflectivity	Cooling	5%	0%	5%	90%	$517	15	0.07
Windows - Reflective Film	Cooling	7%	0%	2%	45%	$167	10	0.21
Windows - High Efficiency/Energy Star	Cooling	12%	0%	85%	90%	$2,200	25	0.57
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	85%	90%	$2,200	25	0.57
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	67%	72%	$500	15	0.14
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	50%	10%	80%	$2,975	15	0.03
Exterior Lighting - Photosensor Control	Exterior Lighting	13%	0%	13%	45%	$90	8	0.17
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	16%	45%	$72	8	0.32
Water Heater - Faucet Aerators	Water Heating	4%	2%	57%	90%	$24	25	5.14
Water Heater - Pipe Insulation	Water Heating	6%	3%	8%	41%	$50	13	2.20
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	92%	95%	$48	10	5.28
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$15	10	9.00
Water Heater - Thermostat Setback	Water Heating	9%	5%	5%	75%	$40	5	1.72
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	0.61
Water Heater - Drainwater Heat Reocvery	Water Heating	9%	5%	1%	90%	$899	15	0.22
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	1.89
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	1.79
Home Energy Management System	Cooling	10%	0%	20%	68%	$250	20	2.94
Home Energy Management System	Space Heating	10%	5%	20%	68%	$250	20	2.94
Home Energy Management System	Interior Lighting	10%	5%	20%	68%	$250	20	2.94
Photovoltaics	Cooling	50%	0%	1%	48%	$15,800	15	0.10
Photovoltaics	Space Heating	25%	25%	1%	48%	$15,800	15	0.10
Pool - Pump Timer	Miscellaneous	60%	0%	35%	90%	$160	15	5.38
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.28
Advanced New Construction Designs	Cooling	30%	0%	2%	45%	$4,500	18	0.52
Advanced New Construction Designs	Space Heating	30%	30%	2%	45%	$4,500	18	0.52
Advanced New Construction Designs	Interior Lighting	20%	20%	2%	45%	$4,500	18	0.52
Energy Efficient Manufactured Homes	Cooling	20%	0%	10%	75%	$3,500	18	0.88
Energy Efficient Manufactured Homes	Space Heating	20%	20%	10%	75%	$3,500	18	0.88
Energy Efficient Manufactured Homes	Interior Lighting	20%	20%	10%	75%	$3,500	18	0.88
Water Heater - Heat Pump	Water Heating	30%	15%	0%	10%	$1,500	15	0.44
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,616	15	1.00
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$11,738	15	0.69

Note: Costs are per household.

Table C-17 Energy-Efficiency Measure Data — Limited Income, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Central AC - Maintenance and Tune-Up	Cooling	10%	0%	25%	100%	$100	4	0.65
Attic Fan - Installation	Cooling	1%	0%	15%	23%	$97	18	0.07
Attic Fan - Photovoltaic - Installation	Cooling	1%	0%	5%	11%	$200	19	0.07
Ceiling Fan - Installation	Cooling	10%	0%	33%	75%	$80	15	1.03
Whole-House Fan - Installation	Cooling	9%	0%	4%	19%	$150	18	0.58
Air Source Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	25%	90%	$125	4	0.87
Insulation - Ducting	Cooling	3%	0%	50%	75%	$210	18	1.47
Insulation - Ducting	Space Heating	4%	4%	50%	75%	$210	18	1.47
Thermostat - Clock/Programmable	Cooling	8%	0%	29%	30%	$114	11	2.54
Thermostat - Clock/Programmable	Space Heating	8%	4%	29%	30%	$114	11	2.54
Doors - Storm and Thermal	Cooling	1%	0%	19%	75%	$180	12	0.46
Doors - Storm and Thermal	Space Heating	2%	2%	19%	75%	$180	12	0.46
Insulation - Ceiling	Cooling	3%	0%	36%	48%	$152	20	3.20
Insulation - Ceiling	Space Heating	8%	6%	36%	48%	$152	20	3.20
Insulation - Radiant Barrier	Cooling	2%	0%	5%	90%	$923	12	0.36
Insulation - Radiant Barrier	Space Heating	1%	1%	5%	90%	$923	12	0.36
Insulation - Foundation	Cooling	3%	0%	4%	90%	$358	20	1.37
Insulation - Foundation	Space Heating	6%	6%	4%	90%	$358	20	1.37
Insulation - Wall Cavity	Cooling	2%	0%	4%	90%	$63	20	3.46
Insulation - Wall Cavity	Space Heating	3%	3%	4%	90%	$63	20	3.46
Insulation - Wall Sheathing	Cooling	1%	0%	59%	90%	$210	20	1.19
Insulation - Wall Sheathing	Space Heating	3%	3%	59%	90%	$210	20	1.19
Roofs - High Reflectivity	Cooling	5%	0%	0%	90%	$517	15	0.08
Windows - Reflective Film	Cooling	7%	0%	2%	45%	$167	10	0.23
Windows - High Efficiency/Energy Star	Cooling	12%	0%	78%	90%	$2,200	25	0.55
Windows - High Efficiency/Energy Star	Space Heating	7%	5%	78%	90%	$2,200	25	0.55
Interior Lighting - Occupancy Sensor	Interior Lighting	9%	5%	8%	9%	$256	15	0.17
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	50%	50%	10%	50%	$2,975	15	0.01
Exterior Lighting - Photosensor Control	Exterior Lighting	13%	0%	0%	45%	$90	8	0.06
Exterior Lighting - Timeclock Installation	Exterior Lighting	20%	0%	11%	45%	$72	8	0.10
Water Heater - Faucet Aerators	Water Heating	4%	2%	11%	90%	$24	25	6.84
Water Heater - Pipe Insulation	Water Heating	6%	3%	0%	41%	$50	13	2.92
Water Heater - Low Flow Showerheads	Water Heating	17%	9%	21%	75%	$48	10	7.03
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$15	10	11.97
Water Heater - Thermostat Setback	Water Heating	9%	5%	5%	75%	$40	5	2.29
Water Heater - Timer	Water Heating	8%	4%	5%	40%	$194	10	0.81
Water Heater - Drainwater Heat Reocvery	Water Heating	9%	5%	1%	90%	$899	15	0.29
Water Heater - Hot Water Saver	Water Heating	9%	4%	5%	50%	$35	5	2.52
Electronics - Reduce Standby Wattage	Electronics	5%	5%	5%	90%	$20	8	0.83
Home Energy Management System	Cooling	10%	0%	5%	68%	$250	20	2.50
Home Energy Management System	Space Heating	10%	5%	5%	68%	$250	20	2.50
Home Energy Management System	Interior Lighting	10%	5%	5%	68%	$250	20	2.50
Photovoltaics	Cooling	50%	0%	0%	48%	$7,900	15	0.20
Photovoltaics	Space Heating	25%	25%	0%	48%	$7,900	15	0.20
Pool - Pump Timer	Miscellaneous	60%	0%	35%	90%	$160	15	2.21
Trees for Shading	Cooling	1%	0%	10%	68%	$40	20	0.30
Advanced New Construction Designs	Cooling	30%	0%	2%	45%	$2,500	18	1.25
Advanced New Construction Designs	Space Heating	30%	30%	2%	45%	$2,500	18	1.25
Advanced New Construction Designs	Interior Lighting	20%	20%	2%	45%	$2,500	18	1.25
Water Heater - Heat Pump	Water Heating	30%	15%	0%	20%	$1,500	15	0.58
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$2,970	15	1.18
Furnace - Convert to Gas	Space Heating	100%	100%	0%	45%	$10,798	15	0.81

Note: Costs are per household.

APPENDIX | **D**

COMMERCIAL ENERGY EFFICIENCY EQUIPMENT AND MEASURE DATA

This appendix presents detailed information for all commercial and industrial energy efficiency equipment and measures that were evaluated in LoadMAP. Several sets of tables are provided.

Table D-1 provides brief descriptions for all equipment and measures that were assessed for potenital.

Tables D-2 through D-9 list the detailed unit-level data for the equipment measures for each of the C&I segments — small/medium commercial, large commercial, extra-large commercial, and extra-large industial — and for existing and new construction, respectively. Savings are in kWh/yr/sq.ft., and incremental costs are in $/sq.ft. The B/C ratio is zero if the measure represents the baseline technology or if the technology is not available in the first year of the forecast (2012). The B/C ratio is calculated within LoadMAP for each year of the forecast and is available once the technology or measure becomes available.

Tables D-10 through D-17 list the detailed unit-level data for the non-equipment energy efficiency measures for each of the segments and for existing and new construction, respectively. Because these measures can produce energy-use savings for multiple end-use loads (e.g., insulation affects heating and cooling energy use) savings are expressed as a percentage of the end-use loads. Base saturation indicates the percentage of buildings in which the measure is already installed. Applicability/Feasibility is the product of two factors that account for whether the measure is applicable to the building. Cost is expressed in $/sq.ft. The detailed measure-level tables present the results of the benefit/cost (B/C) analysis for the first year of the forecast. The B/C ratio is zero if the measure represents the baseline technology or if the measure is not available in the first year of the forecast (2012). The B/C ratio is calculated within LoadMAP for each year of the forecast and is available once the technology or measure becomes available.

Note that Tables D-2 through D-17 present information for Washington. For Idaho, savings and B/C ratios may be slightly different due to weather-related usage, differences in the states' market profiles, and different retail electricity prices. Although Idaho-specific values are not presented here, they are available within the LoadMAP files.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Cooling	Central Cooling Systems	Commercial buildings are often cooled with a central chiller plant that creates chilled water for distribution throughout the facility. Chillers can be air source or water source, which include heat rejection via a condenser loop and cooling tower. Because of the wide variety of system types and sizes, savings and cost values for efficiency improvements in chiller systems represent an average over air- and water-cooled systems, as well as screw, reciprocating, and centrifugal technologies. Under this simplified approach, each central system is characterized by an aggregate efficiency value (inclusive of chiller, pumps, motors and condenser loop equipment), in kW/ton with a further efficiency upgrade through the application of variable refrigerant flow technology.
Cooling	Chilled Water Variable Flow System	The chilled water variable flow system is essentially a single chilled water loop with variable volume and speed. A single set of pumps operated by a VSD eliminates the need for separate distribution pumps and makes the chilled water flow throughout the entire system be variable. The use of adjustable flow limiting valves is designed to optimize water flow. Such valves provide flow limiting, shut-off and adjustment functions, automatically compensating for changes in system pressure to maximize energy efficiency.
Cooling	Packaged Cooling Systems / Rooftop Units (RTUs) and Heat Pumps	Packaged cooling systems are simple to install and maintain, and are commonly used in small and medium-sized commercial buildings. Applications range from a single supply system with air intake filters, supply fan, and cooling coil, or can become more complex with the addition of a return air duct, return air fan, and various controls to optimize performance. For packaged RTUs, varying Energy Efficiency Ratios (EER) were considered, as well as ductless or "mini-split" systems with variable refrigerant flow. For heat pumps, units with increasing EER and COP levels were evaluated, as well as a ductless mini-split system.
Cooling	Packaged Terminal Air Conditioners (PTAC)	Window (or wall) mounted room air conditioners (and heat pumps) are designed to cool (or heat) a single room or space. This type of unit incorporates a complete air-cooled refrigeration and air-handling system in an individual package. Conditioned air is discharged in response to thermostatic control to meet room requirements. Each unit has a self-contained, air-cooled direct expansion (DX) cooling system, a heat pump or other fuel-based heating system and associated controls. The energy savings increase with each incremental increase in efficiency, measured in terms of EER level.
Space Heating	Convert to Gas	This fuel-switching measure is the replacement of an electric furnace with a gas furnace. This measure eliminates all prior electricity consumption and demand due to electric space heating. In this study, it is assumed this measure can be implemented only in buildings within 500 feet of a gas main.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Cooling, Space Heating, Interior Lighting	Energy Management System	An energy management system (EMS) allows managers/owners to monitor and control the major energy-consuming systems within a commercial building. At the minimum, the EMS can be used to monitor and record energy consumption of the different end-uses in a building, and can control operation schedules of the HVAC and lighting systems. The monitoring function helps building managers/owners to identify systems that are operating inefficiently so that actions can be taken to correct the problem. The EMS can also provide preventive maintenance scheduling that will reduce the cost of operations and maintenance in the long run. The control functionality of the EMS allows the building manager/owner to operate building systems from one central location. The operation schedules set via the EMS help to prevent building systems from operating during unwanted or unoccupied periods. This analysis assumes that this measure is limited to buildings with a central HVAC system.
Cooling, Space Heating	Economizer	Economizers allow outside air (when it is cool and dry enough) to be brought into the building space to meet cooling loads instead of using mechanically cooled interior air. A dual enthalpy economizer consists of indoor and outdoor temperature and humidity sensors, dampers, motors, and motor controls. Economizers are most applicable to temperate climates and savings will be smaller in extremely hot or humid areas.
Cooling	VSD on Water Pumps	The part-load efficiency of chilled water loop pumps can be improved substantially by varying the speed of the motor drive according to the building demand for cooling. There is also a reduction in piping losses associated with this measure that has a major impact on the energy use for a building. However, pump speeds can generally only be reduced to a minimum specified rate, because chillers and the control valves may require a minimum flow rate to operate. There are two major types of variable speed drives: mechanical and electronic. An additional benefit of variable-speed drives is the ability to start and stop the motor gradually, thus extending the life of the motor and associated machinery. This analysis assumes that electronic variable speed drives are installed.
Cooling	Turbocor Compressor	Turbocor compressors use oil-free magnetic bearings to reduce friction losses and couples that with a two-stage centrifugal compressor to reduce central chiller energy consumption.
Cooling	High-Efficiency Cooling Tower Fans	High efficiency cooling tower fans utilize variable frequency drives in the cooling tower design. VFDs improve fan performance by adjusting fan speed and rotation as conditions change.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Cooling	Condenser Water Temperature Reset	Chilled water reset controls save energy by improving chiller performance through increasing the supply chilled water temperature, which allows increased suction pressure during low load periods. Raising the chilled water temperature also reduces chilled water piping losses. However, the primary savings from the chilled water reset measure results from chiller efficiency improvement. This is due partly to the smaller temperature difference between chilled water and ambient air, and partly due to the sensitivity of chiller performance to suction temperature.
Cooling	Maintenance	Filters, coils, and fins require regular cleaning and maintenance for the heat pump or roof top unit to function effectively and efficiently throughout its years of service. Neglecting necessary maintenance leads to a steady decline in performance while energy use increases. Maintenance can increase the efficiency of poorly performing equipment by as much as 10%.
Cooling	Evaporative Precooler	Evaporative precooling can improve the performance of air conditioning systems, most commonly RTUs. These systems typically use indirect evaporative cooling as a first stage to pre-cool outside air. If the evaporative system cannot meet the full cooling load, the air steam is further cooled with conventional refrigerative air conditioning technology.
Cooling	Roof- High Reflectivity (Cool Roof)	The color and material of a building structure surface will determine the amount of solar radiation absorbed by that surface and subsequently transferred into a building. This is called solar absorptance. By using a material or painting the roof with a light color (and a lower solar absorptance), the roof will absorb less solar radiation and consequently reduce the cooling load.
Cooling, Space Heating	Green Roofs	A green roof covers a section or the entire building roof with a waterproof membrane and vegetative material. Like cool roofs, green roofs can reduce solar absorptance and they can also provide insulation. They also provide non-energy benefits by absorbing rainwater and thus reducing storm water run-off, providing wildlife habitat, and reducing so-called urban heat island effects.
Cooling, Space Heating, Ventilation	HVAC Retrocommissioning	Over time, the performance of complex mechanical systems providing heating and cooling to existing commercial spaces degrades as a result of inappropriate changes to or overrides of controls, deteriorating equipment, clogged filters, changing demands and schedules, and pressure imbalances. Retrocommissioning is a comprehensive analysis of an entire system in which an engineer assesses shortcomings in system performance, and then optimizes through a process of tune-up, maintenance, and reprogramming of control or automation software. Energy efficiency programs throughout the country promote retrocommissioning as a means of greatly reducing energy consumption in existing buildings.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Cooling, Space Heating, Ventilation, Interior Lighting	Comprehensive Retrocommissioning	Comprehensive retrocommissioning covers not only HVAC and lighting, but other existing building systems as well. For example, it can improve efficiency of non-HVAC motors, vertical transport systems, and domestic hot water systems.
Cooling, Space Heating, Ventilation, Interior Lighting/Exteri or Lighting	HVAC Commissioning Lighting Commissioning Comprehensive Commissioning	For new construction and major renovations, commissioning ensures that building systems are properly designed, specified, and installed to meet the design intent and provide high-efficiency performance. As the names suggests, HVAC Commissioning and Lighting Commissioning focus only on HVAC and lighting equipment and controls. Comprehensive commissioning addresses these systems but usually begins earlier in the design process, and may also address domestic hot water, non-HVAC fans, vertical transport, telecommunications, fire protection, and other building systems.
Cooling, Space Heating, Interior Lighting	Advanced New Construction Designs	Advanced new construction designs use an integrated approach to the design of new buildings to account for the interaction of building systems. Typically, architects and engineers work closely to specify the building orientation, building shell, building mechanical systems, and controls strategies with the goal of optimizing building energy efficiency and comfort. Options that may be evaluated and incorporated include passive solar strategies, increased thermal mass, daylighting strategies, and shading strategies, This measure was modeled for new construction only.
Cooling, Space Heating	Programmable Thermostat	A programmable thermostat can be added to most heating/cooling systems. They are typically used during winter to lower temperatures at night and in summer to increase temperatures during the afternoon. There are two-setting models, and well as models that allow separate programming for each day of the week. The energy savings from this type of thermostat are identical to those of a "setback" strategy with standard thermostats, but the convenience of a programmable thermostat makes it a much more attractive option. In this analysis, the baseline is assumed to have no thermostat setback.
Cooling, Space Heating	Duct Repair and Sealing	An ideal duct system would be free of leaks. Leakage in unsealed ducts varies considerably because of the differences in fabricating machinery used, the methods for assembly, installation workmanship, and age of the ductwork. Air leaks from the system to the outdoors result in a direct loss proportional to the amount of leakage and the difference in enthalpy between the outdoor air and the conditioned air. To seal ducts, a wide variety of sealing methods and products exist. Each has a relatively short shelf life, and no documented research has identified the aging characteristics of sealant applications. This analysis assumes that the baseline air loss from ducts has doubled, and conducting repair and sealing of the ducts will restore leakage from ducts to the original baseline level.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Cooling, Space Heating	Duct Insulation	Air distribution ducts can be insulated to reduce heating or cooling losses. Best results can be achieved by covering the entire surface area with insulation. Insulation material inhibits the transfer of heat through the air-supply duct. Several types of ducts and duct insulation are available, including flexible duct, pre-insulated duct, duct board, duct wrap, tacked, or glued rigid insulation, and waterproof hard shell materials for exterior ducts.
Cooling, Space Heating	Insulation – Radiant Barrier	Radiant barriers inhibit heat transfer by thermal radiation. When a radiant barrier is installed beneath the roofing material much of the heat radiated from a hot roof is reflected back to the roof limiting the amount of heat emitted downwards.
Cooling, Space Heating	High-Efficiency Windows	High-efficiency windows, such as those labeled under the ENERGY STAR Program, are designed to reduce a building's energy bill while increasing comfort for the occupants at the same time. High-efficiency windows have reducing properties that reduce the amount of heat transfer through the glazing surface. For example, some windows have a low-E coating, which is a thin film of metallic oxide coating on the glass surface that allows passage of short-wave solar energy through glass and prevents long-wave energy from escaping. Another example is double-pane glass that reduces conductive and convective heat transfer. There are also double-pane glasses that are gas-filled (usually argon) to further increase the insulating properties of the window.
Cooling, Space Heating	Ceiling and Wall Cavity Insulation	Thermal insulation is material or combinations of materials that are used to inhibit the flow of heat energy by conductive, convective, and radiative transfer modes. Thus, thermal insulation can conserve energy by reducing the heat loss or gain of a building. The type of building construction defines insulating possibilities. Typical insulating materials include: loose-fill (blown) cellulose; loose-fill (blown) fiberglass; and rigid polystyrene.
Ventilation	Cooking – Exhaust Hoods with Sensor Controls	Improved exhaust hoods involve installing variable-speed controls on commercial kitchen hoods. These controls provide ventilation based on actual cooking loads. When grills, broilers, stoves, fryers or other kitchen appliances are not being used, the controls automatically sense the reduced load and decrease the fan speed accordingly. This results in lower energy consumption because the system is only running as needed rather than at 100% capacity at all times.
Ventilation	Variable Air Volume	A variable air volume ventilation system modulates the air flow rate as needed based on the interior conditions of the building to reduce fan load, improve dehumidification, and reduce energy usage.
Ventilation	Fans – Energy Efficient Motors	High-efficiency motors are essentially interchangeable with standard motors, but differences in construction make them more efficient. Energy-efficient motors achieve their improved efficiency by reducing the losses that occur in the conversion of electrical energy to mechanical energy. This analysis assumes that the efficiency of supply fans is increased by 5% due to installing energy-efficient motors.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Ventilation	Fans – Variable Speed Control (VSD)	The part-load efficiency of ventilation fans can be improved substantially by varying the speed of the motor drive. There are two major types of variable speed controls: mechanical and electronic. An additional benefit of variable-speed controls is the ability to start and stop the motor gradually, thus extending the life of the motor and associated machinery. This analysis assumes that electronic variable speed controls are installed.
Water Heating	High-Efficiency Water Heater Systems	Efficient electric water heaters are characterized by a high recovery or thermal efficiency (percentage of delivered electric energy which is transferred to the water) and low standby losses (the ratio of heat lost per hour to the content of the stored water). Included in the savings associated with high-efficiency electric water heaters are timers that allow temperature setpoints to change with hot water demand patterns. For example, the heating element could be shut off throughout the night, increasing the overall energy factor of the unit. In addition, tank and pipe insulation reduces standby losses and therefore reduces the demands on the water heater. This analysis considers conventional electric water heaters with efficiency greater than 96%, as well as geothermal heat pump water heaters for effective efficiency greater than one. Solar water heating was evaluated as well.
Water Heating	Convert to Gas	This fuel-switching measure is the replacement of an electric water heater with a gas-fired water heater. This measure will eliminate all prior electricity consumption and demand due to electric water heating. In this study, it is assumed that this measure can be implemented only in buildings within 500 feet of a gas main.
Water Heating	Heat Pump Water Heater	Heat pump water heaters use heat pump technology to extract heat from the ambient surroundings and transfer it to a hot water tank. These devices are available as an alternative to conventional tank water heaters of 55 gallons or larger.
Water Heating	Faucet Aerators/Low Flow Nozzles	A faucet aerator or low flow nozzle spreads the stream from a faucet helping to reduce water usage. The amount of water passing through the aerator is measured in gallons per minute (GPM) and the lower the GPM the more water the aerator conserves.
Water Heating	Pipe Insulation	Insulating hot water pipes decreases the amount of energy lost during distribution of hot water throughout the building. Insulating pipes will result in quicker delivery of hot water and allows lowering the water heating set point. There are several different types of insulation, the most common being polyethylene and neoprene.
Water Heating	High-Efficiency Circulation Pump	A high efficiency circulation pump uses an electronically commutated motor (ECM) to improve motor efficiency over a larger range of partial loads. In addition, an ECM allows for improved low RPM performance with greater torque and smaller pump dimensions.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Water Heating	Tank Blanket/Insulation	Insulation levels on domestic hot water heaters can be increased by installing a fiberglass blanket on the outside of the tank. This increase in insulation reduces standby losses and thus saves energy. Water heater insulation is available either by the blanket or by square foot of fiberglass insulation with R-values ranging from 5 to 14.
Water Heating	Thermostat Setback	Installing a setback thermostat on the water heater can lead to significant energy savings during periods when there is no one in the building.
Water Heating	Hot Water Saver	A hot water saver is a plumbing device that attaches to the showerhead and that pauses the flow of water until the water is hot enough for use. The water is re-started by the flip of a switch.
Interior Lighting, Exterior Lighting	Lamp Replacement (Interior Screw-in, HID, and Linear Fluorescent Exterior Screw-in, HID, and Linear Fluorescent)	Commercial lighting differs from the residential sector in that efficiency changes typically require more than the simple purchase and quick installation of a screw-in compact fluorescent lamp. Restrictions regarding ballasts, fixtures, and circuitry limit the potential for direct substitution of one lamp type for another. However, such replacements do exist. For example, screw-in incandescent lamps can readily be replaced with CFLs or LEDs. Also, during the buildout for a leased office space, the management could decide to replace all T12 lamps and magnetic ballasts with T8/electronic ballast configurations. This type of decision-making is modeled on a stock turnover basis because of the time between opportunities for upgrades.
Interior Lighting, Exterior Lighting	Lighting Retrocommissioning	Lighting retrocommissioning projects in existing commercial buildings do not require an event such as a tenant turnover, a major renovation, or an update to electrical circuits to drive its adoption. Rather, a decision-maker can decide at any time to perform a comprehensive audit of a facility's lighting systems, followed by an upgrade of equipment (lamps, ballasts, fixtures, reflectors), controls (occupancy sensors, daylighting controls, and central automation).
Interior Lighting	Delamping and Install Reflectors	While sometimes included in lighting retrofit projects, delamping is often performed as a separate energy efficiency measure in which a lighting engineer analyzes the lighting provided by current systems compared to the requirements of building occupants. This often leads to the removal of unnecessary lamps corresponding to an overall reduction in energy usage. .In addition, installing a reflector in each fixture can improve light distribution from the remaining lamps.
Interior Lighting, Exterior Lighting	Lighting Time Clocks and Timers	While outdoor lighting is typically required only at night, in many cases lighting remains on during daylight hours. A simple timer can set a diurnal schedule for outdoor lighting and thus reduce the operating hours by as much as 50%.
Interior Lighting	Central Lighting Controls	Central lighting control systems provide building-wide control of interior lighting to ensure that lights are properly scheduled based on expected building occupancy. Individual zones or circuits can be controlled.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Interior Lighting	Photocell Controlled T8 Dimming Ballasts	Photocells, in concert with dimming ballasts, can detect when adequate daylighting is available and dim or turn off lights to reduce electricity consumption. Usually one photocell is used to control a group of fixtures, a zone, or a circuit.
Interior Lighting	Bi-Level Fixture with Occupancy Sensor	Bi-level fixtures with occupancy sensors detect when a space is unoccupied and reduce light output to a lower level. These devices
Interior Lighting	High Bay Fixtures	Fluorescent fixtures designed for high-bay applications have several advantages over similar HID fixtures: lower energy consumption, lower lumen depreciation rates, better dimming options, faster start-up and restrike, better color rendition, more pupil lumens, and reduced glare.
Interior Lighting	Occupancy Sensor	The installation of occupancy sensors allows lights to be turned off during periods when a space is unoccupied, virtually eliminating the wasted energy due to lights being left on. There are several types of occupancy sensors in the market.
Interior Lighting	LED Exit Lighting	The lamps inside exit signs represent a significant energy end-use, since they usually operate 24 hours per day. Many old exit signs use incandescent lamps, which consume approximately 40 watts per sign. The incandescent lamps can be replaced with LED lamps that are specially designed for this specific purpose. In comparison, the LED lamps consume approximately 2-5 watts.
Interior Lighting	Task Lighting	In commercial facilities, individual work areas can use task lighting instead of brightly lighting the entire area. Significant energy savings can be realized by focusing light directly where it is needed and lowering the general lighting level. An example of task lighting is the common desk lamp. A 25W desk lamp can be installed in place of a typical lamp in a fixture.
Interior Lighting, Cooling	Hotel Guestroom Controls	Hotel guestrooms can be fitted with occupancy controls that turn off energy-using equipment when the guest is not using the room. The occupancy controls comes in several forms, but this analysis assumes the simplest kind, which is a simple switch near the room's entry where the guest can deposit their room key or card. If the key or card is present, then lights, TV, and air conditioning can receive power and operate. When the guest leaves and takes the key, all equipment shuts off.
Exterior Lighting	Daylighting Controls	Daylighting controls use a photosensor to detect ambient light and turn off exterior lights accordingly.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Exterior Lighting	Photovoltaic Lighting	Outdoor photovoltaic (PV) lighting systems use PV panels (or modules), which convert sunlight to electricity. The electricity is stored in batteries for use at night. They can be cost effective relative to installing power cables and/or step down transformers for relatively small lighting loads. The "nightly run time" listings on most "off-the-shelf" products are based on specific sunlight conditions. Systems located in places that receive less sunlight than the system is designed for will operate for fewer hours per night than expected. Nightly run times may also vary depending on how clear the sky is on any given day. Shading of the PV panel by landscape features (vegetation, buildings, etc.) will also have a large impact on battery charging and performance. Open areas with no shading, such as parking lots, are ideal places where PV lighting systems can be used.
Exterior Lighting	Cold Cathode Lighting	Cold cathode lighting does not use an external heat source to provide thermionic emission of electrons. Cold cathode lighting is typically used for exterior signage or where temperatures are likely to drop below freezing.
Exterior Lighting	Induction Lamps	Induction lamps use a contactless bulb and rely on electromagnetic fields to transfer power. This allows for the lamp to utilize more efficient materials that would otherwise react with metal electrodes. In addition, the lack of an electrode significantly extends lamp life while reducing lumen depreciation.
Office Equipment	Desktop and Laptop Computing Equipment	ENERGY STAR labeled office equipment saves energy by powering down and "going to sleep" when not in use. ENERGY STAR labeled computers automatically power down to 15 watts or less when not in use and may actually last longer than conventional products because they spend a large portion of time in a low-power sleep mode. ENERGY STAR labeled computers also generate less heat than conventional models. The ClimateSavers Initiative, made up of leading computer processor manufacturers, has stated a goal of reducing power consumption in active mode by 50% by integrating innovative power management into the chip design process.
Office Equipment	Monitors	ENERGY STAR labeled office equipment saves energy by powering down and "going to sleep" when not in use. ENERGY STAR labeled monitors automatically power down to 15 watts or less when not in use.
Office Equipment	Servers	In addition to the "sleep" mode a reductions and the efficient processors being designed by members of the ClimateSavers Initiative, servers have additional energy-saving opportunities through "virtualization" and other architecture solutions that involve optimal matching of computation tasks to hardware requirements

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Office Equipment	Printers/Copiers/ Fax/ POS Terminals	ENERGY STAR labeled office equipment saves energy by powering down and "going to sleep" when not in use. ENERGY STAR labeled copiers are equipped with a feature that allows them to automatically turn off after a period of inactivity, reducing a copier's annual electricity costs by over 60%. High-speed copiers that include a duplexing unit that is set to automatically make double-sided copies can reduce paper costs and help to save trees.
Office Equipment	ENERGY STAR Power Supply	Power supplies with an efficient ac-dc or ac-ac conversion process can obtain the ENERGY STAR label. These devices can be used to power computers, phones, and other office equipment.
Refrigeration	Walk-in Refrigeration Systems	Standard compressors typically operate at approximately 65% efficiency. High-efficiency models are available that can improve compressor efficiency by 15%.
Refrigeration	Glass Door and Solid Door Refrigeration Units (Reach-in /Open Display Case/Vending Machine) Door Gasket Replacement High Efficiency Case Lighting	In addition to walk-in, "cold-storage" refrigeration, a significant amount of energy in the commercial sector can be attributed to "reach-in" units. These stand-alone appliances can range from a residential-style refrigerator/freezer unit in an office kitchen or the breakroom of a retail store to the refrigerated display cases in some grocery or convenience stores. As in the case of residential units, these refrigerators can be designed to perform at higher efficiency through a combination of compressor equipment upgrades, default temperature settings, and defrost patterns. Other measures for these units are replacing aging door gaskets that no longer adequately seal the case, and replacing inefficient display lights with CFL or LED systems to reduce internal heat gains in the cases.
Refrigeration	Open Display Case	Glass doors can be used to enclose multi-deck display cases for refrigerated items in supermarkets. In addition, more efficient units are designed to perform at higher efficiency through a combination of compressor equipment upgrades, default temperature settings, and defrost patterns.
Refrigeration	Anti-Sweat Heater/ Auto Door Closer Controls	Anti-sweat heaters are used in virtually all low-temperature display cases and many medium-temperature cases to control humidity and prevent the condensation of water vapor on the sides and doors and on the products contained in the cases. Typically, these heaters stay on all the time, even though they only need to be on about half the time. Anti-sweat heater controls can come in the form of humidity sensors or time clocks.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Refrigeration	Floating Head Pressure Controls	Floating head pressure control allows the pressure in the condenser to "float" with ambient temperatures. This method reduces refrigeration compression ratios, improves system efficiency and extends the compressor life. The greatest savings with a floating head pressure approach occurs when the ambient temperatures are low, such as in the winter season. Floating head pressure control is most practical for new installations. However, retrofits installation can be completed with some existing refrigeration systems. Installing floating head pressure control increases the capacity of the compressor when temperatures are low, which may lead to short cycling.
Refrigeration	Bare Suction Lines	Insulating bare suction lines reduces heat
Refrigeration	Night Covers	Night covers can be used on open refrigeration cases when a facility is closed or few customers are in the store.
Refrigeration	Strip Curtain	Strip curtains at the entrances to large walk-in coolers or freezers, such as those used in supermarkets, reduce air transfer between the refrigerated space and the surrounding space.
Refrigeration	Icemakers	In certain building types (restaurant, hotel), the production of ice is a significant usage of electricity. By optimizing the timing of ice production and the type of output to the specific application, icemakers are assumed to deliver electricity savings.
Refrigeration	Vending Machine - Controller	Cold beverage vending machines usually operate 24 hours a day regardless of whether the surrounding area is occupied or not. The result is that the vending machine consumes energy unnecessarily, because it will operate all night to keep the beverage cold even when there would be no customer until the next morning. A vending machine controller can reduce energy consumption without compromising the temperature of the vended product. The controller uses an infrared sensor to monitor the surrounding area's occupancy and will power down the vending machine when the area is unoccupied. It will also monitor the room's temperature and will re -power the machine at one to three hour intervals independent of occupancy to ensure that the product stays cold.
Food Service	Kitchen Equipment	Commercial cooking and food preparation equipment represent a significant contribution to energy consumption in restaurants and other food service applications. By replacing old units with efficient ones, this energy consumption can be greatly reduced. These measures include fryers, commercial ovens, dishwashers, hot food containers and miscellaneous other food preparation equipment. Savings range between 15 and 65%, depending on the specific unit being replaced.
Cooling, Space Heating, Interior Lighting, Food Preparation, Refrigeration	Custom Measures	Custom measures were included in the CPA analysis to serve as a "catch all" for measures for which costs and savings are not easily quantified and that could be part of a program such as Avista's existing Site-Specific incentive program. Costs and energy savings were assumed such that the measures passed the economic screen.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Miscellaneous	Non-HVAC motor	Because the Small/Medium Commercial and Large Commercial segments include some industrial customers, the CPA analysis included equipment upgrades for non-HVAC motors. This equipment measure also incorporates improvements for vertical transport. Premium efficiency motors reduce the amount of lost energy going into heat rather than power. Since less heat is generated, less energy is needed to cool the motor with a fan. Therefore, the initial cost of energy efficient motors is generally higher than for standard motors. However their life-cycle costs can make them far more economical because of savings they generate in operating expense. Premium efficiency motors can provide savings of 0.5% to 3% over standard motors. The savings results from the fact that energy efficient motors run cooler than their standard counterparts, resulting in an increase in the life of the motor insulation and bearing. In general, an efficient motor is a more reliable motor because there are fewer winding failures, longer periods between needed maintenance, and fewer forced outages. For example, using copper instead of aluminum in the windings, and increasing conductor cross-sectional area, lowers a motor's I2R losses.
Miscellaneous	Pumps – Variable Speed Control	The part-load efficiency of chilled and hot water loop pumps can be improved substantially by varying the speed of the motor drive according to the building demand for heating or cooling. There is also a reduction in piping losses associated with this measure that has a major impact on the heating loads and energy use for a building. However, pump speeds can generally only be reduced to a minimum specified rate, because chillers, boilers, and the control valves may require a minimum flow rate to operate. There are two major types of variable speed controls: mechanical and electronic. An additional benefit of variable-speed drives is the ability to start and stop the motor gradually, thus extending the life of the motor and associated machinery. This analysis assumes that electronic variable speed controls are installed.
Miscellaneous	Laundry – High Efficiency Clothes Washer	High efficiency clothes washers use designs that require less water. These machines use sensors to match the hot water needs to the load, preventing energy waste. There are two designs: top-loading and front-loading. Further energy and water savings can be achieved through advanced technologies such as inverter-drive or combination washer-dryer units.
Miscellaneous	ENERGY STAR Water Cooler	An ENERGY STAR water cooler has more insulation and improved chilling mechanisms, resulting in about half the energy use of a standard cooler.
Miscellaneous	Industrial Process Improvements	Because the Avista C&I sector segmentation was based on Avista's rate classes, the commercial building segments include a small percentage or industrial business types. This measure was included to account for energy efficiency potential that could be achieved through various process improvements at these customers.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Machine Drive.	Motors, Premium Efficiency	Premium efficiency motors reduce the amount of lost energy going into heat rather than power. Since less heat is generated, less energy is needed to cool the motor with a fan. Therefore, the initial cost of energy efficient motors is generally higher than for standard motors. However their life-cycle costs can make them far more economical because of savings they generate in operating expense. Premium efficiency motors can provide savings of 0.5% to 3% over standard motors. The savings results from the fact that energy efficient motors run cooler than their standard counterparts, resulting in an increase in the life of the motor insulation and bearing. In general, an efficient motor is a more reliable motor because there are fewer winding failures, longer periods between needed maintenance, and fewer forced outages. For example, using copper instead of aluminum in the windings, and increasing conductor cross-sectional area, lowers a motor's I2R losses. This analysis assumes 75% loading factor (for peak efficiency) for 1800 rpm motor. Hours of operation vary depending on horsepower size. In addition, improved drives and controls are assumed to be implemented along with the motors, resulting in savings as high as 10% of annual energy consumption
Machine Drive	Motors – Variable Frequency Drive	In addition to energy savings, VFDs increase motor and system life and provide a greater degree of control over the motor system. Especially for motor systems handling fluids, VFDs can efficiently respond to changing operating conditions.
Machine Drive	Magnetic Adjustable Speed Drive	To allow for adjustable speed operation, this technology uses magnetic induction to couple a drive to its load. Varying the magnetic slip within the coupling controls the speed of the output shaft. Magnetic drives perform best at the upper end of the speed range due to the energy consumed by the slip. Unlike traditional ASDs, magnetically coupled ASDs create no power distortion on the electrical system. However, magnetically coupled ASD efficiency is best when power needs are greatest. VFDs may show greater efficiency when the average load speed is below 90% of the motor speed, however this occurs when power demands are reduced.
Machine Drive	Compressed Air – System Controls, Optimization and Improvements, Maintenance	Controls for compressed air systems can shift load from two partially loaded compressors to one compressor in order to maximize compression efficiency and may also involve the addition of VFDs. Improvements include installing high-efficiency motors. Maintenance includes fixing air leaks and replacing air filters.
Machine Drive	Fan Systems – Controls, Optimization and Maintenance	Certain practices require a consistent flow rate, such as indoor air quality and clean room ventilation. To achieve this, fan flow controls can be used to maintain precise volume flow control ensuring a constant air delivery even on fluctuating pressure conditions. This is done through programmable circuitry to electronically control fan motor speed. Motors can be configured to accept a signal from a controller that would vary the flow rate in direct proportion to the signal.

Table D-1 Commercial and Industrial Energy-Efficiency Equipment/Measure Descriptions

End-Use	Energy Efficiency Measure	Description
Machine Drive	Pumping Systems – Controls, Optimization and Maintenance	Pumping systems optimization includes installing VFDs, correctly resizing the motors, and installing timers and automated on-off controls. Maintenance includes repairing diaphragms and fixing piping leaks.
Process	Process Cooling/Refrigeration	Because of the customized nature of industrial cooling and refrigeration applications, a variety of opportunities are summarized as a general improvement in cooling and cold storage equipment. Costs and savings were developed using average values for this group of measures from the Sixth Plan industrial supply curve workbooks.
Process	Process Heating	Because of the customized nature of industrial heating applications, a variety of opportunities are summarized as a general improvement in process heating equipment, such as arc furnaces. Costs and savings were developed using average values for this group of measures from the Sixth Plan industrial supply curve workbooks.
Process	Electrochemical Process	Because of the customized nature of industrial electrochemical applications, a variety of opportunities are summarized as a general improvement in equipment and processes. Costs and savings were developed using average values for this group of measures from the Sixth Plan industrial supply curve workbooks.
Process	Refrigeration – System Controls, Maintenance, and Optimization	Because refrigeration equipment performance degrades over time and control settings are frequently overridden, these measures account for savings that can be achieved through system maintenance and controls optimization.

Table D-2 Energy Efficiency Equipment Data — Small/Medium Comm., Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.29	$0.39	20	-
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.35	$0.50	20	0.51
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.73	$0.62	20	1.90
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.77	$0.74	20	1.39
Cooling	Central Chiller	Variable Refrigerant Flow	1.01	$11.57	20	0.07
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.22	$0.18	16	-
Cooling	RTU	EER 11.2	0.43	$0.35	16	-
Cooling	RTU	EER 12.0	0.57	$0.58	16	0.49
Cooling	RTU	Ductless VRF	0.69	$5.12	16	0.05
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.09	$0.08	14	0.86
Cooling	PTAC	EER 10.8	0.21	$0.16	14	1.00
Cooling	PTAC	EER 11	0.25	$0.43	14	0.43
Cooling	PTAC	EER 11.5	0.33	$0.96	14	0.27
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.57	$0.39	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.90	$1.18	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	1.20	$1.57	15	0.98
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.31	$1.96	15	0.68
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.46	$11.50	20	0.10
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.30	$1.22	15	1.07
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.23	$0.09	4	-
Interior Lighting	Interior Screw-in	CFL	0.94	$0.03	7	16.50
Interior Lighting	Interior Screw-in	LED	1.04	$1.18	12	0.84
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.30	($0.07)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.30	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.91	$0.25	6	1.73
Interior Lighting	Linear Fluorescent	T5	0.95	$0.43	6	1.06
Interior Lighting	Linear Fluorescent	LED	0.99	$3.74	15	0.33
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.14	$0.05	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.60	$0.02	7	17.60
Exterior Lighting	Exterior Screw-in	Metal Halides	0.60	$0.05	4	3.16
Exterior Lighting	Exterior Screw-in	LED	0.66	$0.64	12	0.90
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.22	($0.13)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.24	$0.55	9	0.37
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.01	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.04	$0.02	6	1.12
Exterior Lighting	Linear Fluorescent	T5	0.04	$0.03	6	0.69
Exterior Lighting	Linear Fluorescent	LED	0.05	$0.24	15	0.22
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.10	$0.02	15	5.23
Water Heating	Water Heater	Geothermal Heat Pump	1.33	$3.53	15	0.43
Water Heating	Water Heater	Solar	1.46	$3.03	15	0.55
Food Preparation	Fryer	Standard	-	$0.00	12	-
Food Preparation	Fryer	Efficient	0.03	$0.04	12	0.80
Food Preparation	Oven	Standard	-	$0.00	12	-

Note: Costs and savings are per sq. ft.

Table D-2 Energy Efficiency Equipment Data — Small/Med. Comm., Existing Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Oven	Efficient	0.39	$0.36	12	1.02
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.02	$0.05	12	0.36
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.40	$0.16	12	2.29
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.07
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	-	$0.09	18	-
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.16	$0.00	18	56.08
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.19	$0.02	18	9.87
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.00	$0.00	18	0.24
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.11	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.20	$0.00	10	46.48
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.05	$0.00	12	12.76
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.19	$0.00	4	23.04
Office Equipment	Desktop Computer	Climate Savers	0.27	$0.36	4	0.23
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	7.34
Office Equipment	Laptop Computer	Climate Savers	0.03	$0.12	4	0.08
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.12	$0.01	3	2.14
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.22	$0.00	4	19.68
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.09	$0.04	6	0.98
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.03	$0.00	4	2.96
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.05	$0.06	15	0.95
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.06	$0.06	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.07	$0.11	15	0.72
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.08	$0.11	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-3 Energy Efficiency Equipment Data — Large Commercial, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.30	$0.26	20	-
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.36	$0.33	20	0.83
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.75	$0.41	20	3.11
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.79	$0.49	20	2.28
Cooling	Central Chiller	Variable Refrigerant Flow	1.04	$7.63	20	0.11
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.22	$0.13	16	-
Cooling	RTU	EER 11.2	0.45	$0.25	16	-
Cooling	RTU	EER 12.0	0.59	$0.41	16	0.75
Cooling	RTU	Ductless VRF	0.72	$3.67	16	0.07
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.09	$0.09	14	0.86
Cooling	PTAC	EER 10.8	0.21	$0.17	14	1.00
Cooling	PTAC	EER 11	0.25	$0.46	14	0.43
Cooling	PTAC	EER 11.5	0.34	$1.03	14	0.27
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.46	$0.18	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.73	$0.55	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	0.97	$0.73	15	1.85
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.07	$0.91	15	1.28
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.19	$5.35	20	0.19
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.03	$1.22	15	0.86
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.19	$0.08	4	-
Interior Lighting	Interior Screw-in	CFL	0.78	$0.03	7	14.13
Interior Lighting	Interior Screw-in	LED	0.87	$1.11	12	0.72
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.31	($0.08)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.30	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.89	$0.25	6	1.66
Interior Lighting	Linear Fluorescent	T5	0.92	$0.42	6	1.02
Interior Lighting	Linear Fluorescent	LED	0.97	$3.67	15	0.32
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.08	$0.01	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.34	$0.01	7	34.02
Exterior Lighting	Exterior Screw-in	Metal Halides	0.34	$0.02	4	6.10
Exterior Lighting	Exterior Screw-in	LED	0.38	$0.19	12	1.73
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.19	($0.11)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.20	$0.45	9	0.37
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.01	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.04	$0.02	6	1.18
Exterior Lighting	Linear Fluorescent	T5	0.04	$0.03	6	0.72
Exterior Lighting	Linear Fluorescent	LED	0.05	$0.24	15	0.23
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.12	$0.02	15	5.71
Water Heating	Water Heater	Geothermal Heat Pump	1.54	$3.53	15	0.46
Water Heating	Water Heater	Solar	1.69	$3.03	15	0.60
Food Preparation	Fryer	Standard	-	$0.00	12	-
Food Preparation	Fryer	Efficient	0.07	$0.02	12	3.52
Food Preparation	Oven	Standard	-	$0.00	12	-

Note: Costs and savings are per sq. ft.

Table D-3 Energy Efficiency Equipment Data — Large Commercial, Existing Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Oven	Efficient	0.75	$0.46	12	1.43
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.07	$0.10	12	0.58
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.35	$0.30	12	0.99
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.01	$0.03	12	0.24
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	0.15	$1.26	18	0.13
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.13	$0.01	18	24.96
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.30	$0.08	18	4.39
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.00	$0.04	18	0.16
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.15	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.23	$0.00	10	20.70
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.11	$0.02	12	5.62
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.35	$0.00	4	47.46
Office Equipment	Desktop Computer	Climate Savers	0.50	$0.32	4	0.46
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	15.12
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.06	4	0.17
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.13	$0.01	3	4.41
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.19	$0.01	4	9.14
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.08	$0.02	6	2.02
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.01	$0.00	4	2.94
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.06	$0.06	15	0.92
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.06	$0.06	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.08	$0.13	15	0.69
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.09	$0.13	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-4 Energy Efficiency Equipment Data — Extra Large Commercial, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	-
Cooling	Central Chiller	0.60 kw/ton, COP 5.9	0.43	$0.09	20	-
Cooling	Central Chiller	0.58 kw/ton, COP 6.1	0.49	$0.18	20	0.66
Cooling	Central Chiller	0.55 kw/Ton, COP 6.4	0.57	$0.25	20	0.91
Cooling	Central Chiller	0.51 kw/ton, COP 6.9	0.69	$0.44	20	0.78
Cooling	Central Chiller	0.50 kw/Ton, COP 7.0	0.72	$0.53	20	0.69
Cooling	Central Chiller	0.48 kw/ton, COP 7.3	0.77	$0.62	20	0.68
Cooling	Central Chiller	Variable Refrigerant Flow	1.00	$10.92	20	0.05
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.20	$0.24	16	-
Cooling	RTU	EER 11.2	0.41	$0.45	16	-
Cooling	RTU	EER 12.0	0.53	$0.75	16	0.37
Cooling	RTU	Ductless VRF	0.65	$6.64	16	0.03
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.08	$0.06	14	1.09
Cooling	PTAC	EER 10.8	0.19	$0.12	14	1.28
Cooling	PTAC	EER 11	0.22	$0.32	14	0.55
Cooling	PTAC	EER 11.5	0.30	$0.71	14	0.34
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.50	$0.24	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.79	$0.73	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	1.06	$0.97	15	1.34
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.16	$1.21	15	0.93
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.29	$7.10	20	0.14
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.21	$1.22	15	1.01
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.30	$0.14	4	-
Interior Lighting	Interior Screw-in	CFL	1.25	$0.06	7	13.22
Interior Lighting	Interior Screw-in	LED	1.38	$1.90	12	0.67
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.13	($0.05)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.20	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.59	$0.21	6	1.31
Interior Lighting	Linear Fluorescent	T5	0.61	$0.35	6	0.80
Interior Lighting	Linear Fluorescent	LED	0.64	$3.08	15	0.25
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.02	$0.00	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.10	$0.00	7	37.00
Exterior Lighting	Exterior Screw-in	Metal Halides	0.10	$0.00	4	6.64
Exterior Lighting	Exterior Screw-in	LED	0.11	$0.05	12	1.89
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.26	($0.16)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.28	$0.64	9	0.37
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.00	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.01	$0.00	6	1.12
Exterior Lighting	Linear Fluorescent	T5	0.01	$0.01	6	0.69
Exterior Lighting	Linear Fluorescent	LED	0.01	$0.06	15	0.22
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.19	$0.02	15	9.79
Water Heating	Water Heater	Geothermal Heat Pump	2.47	$3.53	15	0.80
Water Heating	Water Heater	Solar	2.72	$3.03	15	1.02
Food Preparation	Fryer	Standard	-	$0.00	12	-

Note: Costs and savings are per sq. ft.

Table D-4 Energy Efficiency Equipment Data — Extra Large Commercial, Existing Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Fryer	Efficient	0.03	$0.00	12	6.02
Food Preparation	Oven	Standard	-	$0.00	12	-
Food Preparation	Oven	Efficient	0.85	$0.38	12	2.11
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.03	$0.04	12	0.57
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.17	$0.22	12	0.73
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.15
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	0.06	$0.05	18	1.42
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.04	$0.00	18	78.11
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.27	$0.02	18	12.81
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.01	$0.03	18	0.34
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.16	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.24	$0.00	10	68.21
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.05	$0.00	12	17.60
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.25	$0.00	4	32.37
Office Equipment	Desktop Computer	Climate Savers	0.35	$0.33	4	0.32
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	10.31
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.10	4	0.12
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.06	$0.00	3	3.01
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.11	$0.01	4	6.80
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.02	$0.01	6	1.38
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.00	$0.00	4	2.01
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.03	$0.03	15	1.02
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.04	$0.03	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.05	$0.07	15	0.76
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.05	$0.07	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-5 Energy Efficiency Equipment Data — Extra Large Industrial, Existing Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	-
Cooling	Central Chiller	0.60 kw/ton, COP 5.9	1.61	$0.33	20	-
Cooling	Central Chiller	0.58 kw/ton, COP 6.1	1.82	$0.66	20	0.68
Cooling	Central Chiller	0.55 kw/Ton, COP 6.4	2.15	$0.93	20	0.94
Cooling	Central Chiller	0.51 kw/ton, COP 6.9	2.58	$1.59	20	0.80
Cooling	Central Chiller	0.50 kw/Ton, COP 7.0	2.68	$1.92	20	0.71
Cooling	Central Chiller	0.48 kw/ton, COP 7.3	2.90	$2.25	20	0.70
Cooling	Central Chiller	Variable Refrigerant Flow	3.74	$39.62	20	0.06
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.56	$0.39	16	-
Cooling	RTU	EER 11.2	1.12	$0.73	16	-
Cooling	RTU	EER 12.0	1.47	$1.22	16	0.62
Cooling	RTU	Ductless VRF	1.79	$10.83	16	0.06
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.20	$0.06	14	2.79
Cooling	PTAC	EER 10.8	0.47	$0.11	14	3.27
Cooling	PTAC	EER 11	0.55	$0.31	14	1.41
Cooling	PTAC	EER 11.5	0.75	$0.69	14	0.87
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	1.07	$0.92	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	1.69	$2.75	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	2.25	$3.66	15	0.75
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	2.47	$4.58	15	0.52
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	2.74	$26.86	20	0.08
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	7.66	$1.22	15	6.38
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.09	$0.04	4	-
Interior Lighting	Interior Screw-in	CFL	0.38	$0.02	7	14.80
Interior Lighting	Interior Screw-in	LED	0.42	$0.52	12	0.75
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.46	($0.14)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.10	($0.01)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.31	$0.08	6	1.73
Interior Lighting	Linear Fluorescent	T5	0.32	$0.14	6	1.06
Interior Lighting	Linear Fluorescent	LED	0.33	$1.21	15	0.33
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.01	$0.00	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.02	$0.00	7	15.02
Exterior Lighting	Exterior Screw-in	Metal Halides	0.02	$0.00	4	2.69
Exterior Lighting	Exterior Screw-in	LED	0.03	$0.03	12	0.77
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.07	($0.04)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.08	$0.18	9	0.37
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.00	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.00	$0.00	6	1.16
Exterior Lighting	Linear Fluorescent	T5	0.00	$0.00	6	0.71
Exterior Lighting	Linear Fluorescent	LED	0.00	$0.01	15	0.22
Process	Process Cooling/Refrigera	Standard	-	$0.00	10	-
Process	Process Cooling/Refrigera	Efficient	18.88	$5.59	10	2.49
Process	Process Heating	Standard	-	$0.00	10	-
Process	Process Heating	Efficient	6.18	$0.57	10	7.97
Process	Electrochemical Process	Standard	-	$0.00	10	-

Note: Costs and savings are per sq. ft.

Table D-5 Energy Efficiency Equipment Data — Extra Large Industrial, Existing Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Process	Electrochemical Process	Efficient	13.16	$2.64	10	3.67
Machine Drive	Less than 5 HP	Standard	-	$0.00	10	-
Machine Drive	Less than 5 HP	High Efficiency	0.05	$0.02	10	2.08
Machine Drive	Less than 5 HP	Standard (2015)	0.07	$0.00	10	-
Machine Drive	Less than 5 HP	Premium	0.07	$0.03	10	1.66
Machine Drive	Less than 5 HP	High Efficiency (2015)	0.11	$0.02	10	-
Machine Drive	Less than 5 HP	Premium (2015)	0.14	$0.03	10	-
Machine Drive	5-24 HP	Standard	-	$0.00	10	-
Machine Drive	5-24 HP	High	0.11	$0.02	10	5.09
Machine Drive	5-24 HP	Premium	0.18	$0.03	10	4.07
Machine Drive	25-99 HP	Standard	-	$0.00	10	-
Machine Drive	25-99 HP	High	0.31	$0.02	10	13.72
Machine Drive	25-99 HP	Premium	0.49	$0.03	10	10.97
Machine Drive	100-249 HP	Standard	-	$0.00	10	-
Machine Drive	100-249 HP	High	0.12	$0.02	10	5.17
Machine Drive	100-249 HP	Premium	0.15	$0.03	10	3.44
Machine Drive	250-499 HP	Standard	-	$0.00	10	-
Machine Drive	250-499 HP	High	0.35	$0.02	10	15.66
Machine Drive	250-499 HP	Premium	0.47	$0.03	10	10.44
Machine Drive	500 and more HP	Standard	-	$0.00	10	-
Machine Drive	500 and more HP	High	0.59	$0.02	10	26.28
Machine Drive	500 and more HP	Premium	0.78	$0.03	10	17.52
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-6 Energy Efficiency Equipment Data — Small/Medium Commercial, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.29	$0.39	20	-
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.35	$0.50	20	0.51
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.73	$0.62	20	1.90
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.77	$0.74	20	1.39
Cooling	Central Chiller	Variable Refrigerant Flow	1.01	$11.57	20	0.07
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.22	$0.18	16	-
Cooling	RTU	EER 11.2	0.43	$0.35	16	-
Cooling	RTU	EER 12.0	0.57	$0.58	16	0.49
Cooling	RTU	Ductless VRF	0.69	$5.12	16	0.05
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.09	$0.08	14	0.86
Cooling	PTAC	EER 10.8	0.21	$0.16	14	1.00
Cooling	PTAC	EER 11	0.25	$0.43	14	0.43
Cooling	PTAC	EER 11.5	0.33	$0.96	14	0.27
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.57	$0.39	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.90	$1.18	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	1.20	$1.57	15	0.98
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.31	$1.96	15	0.68
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.46	$11.50	20	0.10
Combined Heating/Cooling	Heat Pump	Geothermal Heat Pump	1.75	$20.69	20	-
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.64	$1.22	15	1.35
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.20	$0.09	4	-
Interior Lighting	Interior Screw-in	CFL	0.85	$0.03	7	14.85
Interior Lighting	Interior Screw-in	LED	0.93	$1.18	12	0.76
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.27	($0.07)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.27	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.82	$0.25	6	1.56
Interior Lighting	Linear Fluorescent	T5	0.85	$0.43	6	0.95
Interior Lighting	Linear Fluorescent	LED	0.89	$3.74	15	0.30
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.13	$0.05	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.54	$0.02	7	15.84
Exterior Lighting	Exterior Screw-in	Metal Halides	0.54	$0.05	4	2.84
Exterior Lighting	Exterior Screw-in	LED	0.60	$0.64	12	0.81
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.20	($0.13)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.22	$0.55	9	0.33
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.01	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.04	$0.02	6	1.01
Exterior Lighting	Linear Fluorescent	T5	0.04	$0.03	6	0.62
Exterior Lighting	Linear Fluorescent	LED	0.04	$0.24	15	0.20
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.10	$0.02	15	5.23
Water Heating	Water Heater	Geothermal Heat Pump	1.33	$3.53	15	0.43
Water Heating	Water Heater	Solar	1.46	$3.03	15	0.55
Food Preparation	Fryer	Standard	-	$0.00	12	-
Food Preparation	Fryer	Efficient	0.03	$0.04	12	0.80

Note: Costs and savings are per sq. ft.

Table D-6 Energy Efficiency Equipment Data — Small/Medium Commercial, New Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Oven	Standard	-	$0.00	12	-
Food Preparation	Oven	Efficient	0.39	$0.36	12	1.02
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.02	$0.05	12	0.36
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.40	$0.16	12	2.29
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.07
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	-	$0.09	18	-
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.16	$0.00	18	56.08
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.19	$0.02	18	9.87
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.00	$0.00	18	0.24
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.11	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.20	$0.00	10	46.48
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.05	$0.00	12	12.76
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.19	$0.00	4	23.04
Office Equipment	Desktop Computer	Climate Savers	0.27	$0.36	4	0.23
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	7.34
Office Equipment	Laptop Computer	Climate Savers	0.03	$0.12	4	0.08
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.12	$0.01	3	2.14
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.22	$0.00	4	19.68
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.09	$0.04	6	0.98
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.03	$0.00	4	2.96
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.05	$0.06	15	0.95
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.06	$0.06	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.07	$0.11	15	0.72
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.08	$0.11	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-7 Energy Efficiency Equipment Data — Large Commercial, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	1.5 kw/ton, COP 2.3	-	$0.00	20	-
Cooling	Central Chiller	1.3 kw/ton, COP 2.7	0.32	$0.24	20	-
Cooling	Central Chiller	1.26 kw/ton, COP 2.8	0.39	$0.31	20	0.97
Cooling	Central Chiller	1.0 kw/ton, COP 3.5	0.80	$0.38	20	3.62
Cooling	Central Chiller	0.97 kw/ton, COP 3.6	0.85	$0.45	20	2.66
Cooling	Central Chiller	Variable Refrigerant Flow	1.12	$7.06	20	0.12
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.22	$0.13	16	-
Cooling	RTU	EER 11.2	0.45	$0.25	16	-
Cooling	RTU	EER 12.0	0.59	$0.41	16	0.75
Cooling	RTU	Ductless VRF	0.72	$3.67	16	0.07
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.09	$0.09	14	0.86
Cooling	PTAC	EER 10.8	0.21	$0.17	14	1.00
Cooling	PTAC	EER 11	0.25	$0.46	14	0.43
Cooling	PTAC	EER 11.5	0.34	$1.03	14	0.27
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.46	$0.18	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.73	$0.55	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	0.97	$0.73	15	1.85
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.07	$0.91	15	1.28
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.19	$5.35	20	0.19
Combined Heating/Cooling	Heat Pump	Geothermal Heat Pump	1.42	$9.62	20	-
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.30	$1.22	15	1.09
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.17	$0.08	4	-
Interior Lighting	Interior Screw-in	CFL	0.71	$0.03	7	12.72
Interior Lighting	Interior Screw-in	LED	0.78	$1.11	12	0.65
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.28	($0.08)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.27	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.80	$0.25	6	1.49
Interior Lighting	Linear Fluorescent	T5	0.83	$0.42	6	0.92
Interior Lighting	Linear Fluorescent	LED	0.87	$3.67	15	0.29
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.07	$0.01	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.31	$0.01	7	30.62
Exterior Lighting	Exterior Screw-in	Metal Halides	0.31	$0.02	4	5.49
Exterior Lighting	Exterior Screw-in	LED	0.34	$0.19	12	1.56
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.17	($0.11)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.18	$0.45	9	0.34
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.01	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.04	$0.02	6	1.06
Exterior Lighting	Linear Fluorescent	T5	0.04	$0.03	6	0.65
Exterior Lighting	Linear Fluorescent	LED	0.04	$0.24	15	0.20
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.12	$0.02	15	5.71
Water Heating	Water Heater	Geothermal Heat Pump	1.54	$3.53	15	0.46
Water Heating	Water Heater	Solar	1.69	$3.03	15	0.60
Food Preparation	Fryer	Standard	-	$0.00	12	-
Food Preparation	Fryer	Efficient	0.07	$0.02	12	3.52

Note: Costs and savings are per sq. ft.

Table D-7 Energy Efficiency Equipment Data — Large Commercial, New Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Oven	Standard	-	$0.00	12	-
Food Preparation	Oven	Efficient	0.75	$0.46	12	1.43
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.07	$0.10	12	0.58
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.35	$0.30	12	0.99
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.01	$0.03	12	0.24
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	0.15	$1.26	18	0.13
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.13	$0.01	18	24.96
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.30	$0.08	18	4.39
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.00	$0.04	18	0.16
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.15	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.23	$0.00	10	20.70
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.11	$0.02	12	5.62
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.35	$0.00	4	47.46
Office Equipment	Desktop Computer	Climate Savers	0.50	$0.32	4	0.46
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	15.12
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.06	4	0.17
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.13	$0.01	3	4.41
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.19	$0.01	4	9.14
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.08	$0.02	6	2.02
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.01	$0.00	4	2.94
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.06	$0.06	15	0.92
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.06	$0.06	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.08	$0.13	15	0.69
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.09	$0.13	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-8 Energy Efficiency Equipment Data — Extra Large Commercial, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	-
Cooling	Central Chiller	0.60 kw/ton, COP 5.9	0.43	$0.09	20	-
Cooling	Central Chiller	0.58 kw/ton, COP 6.1	0.49	$0.18	20	0.66
Cooling	Central Chiller	0.55 kw/Ton, COP 6.4	0.57	$0.25	20	0.91
Cooling	Central Chiller	0.51 kw/ton, COP 6.9	0.69	$0.44	20	0.78
Cooling	Central Chiller	0.50 kw/Ton, COP 7.0	0.72	$0.53	20	0.69
Cooling	Central Chiller	0.48 kw/ton, COP 7.3	0.77	$0.62	20	0.68
Cooling	Central Chiller	Variable Refrigerant Flow	1.00	$10.92	20	0.05
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.20	$0.24	16	-
Cooling	RTU	EER 11.2	0.41	$0.44	16	-
Cooling	RTU	EER 12.0	0.53	$0.73	16	0.37
Cooling	RTU	Ductless VRF	0.65	$6.51	16	0.04
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.08	$0.06	14	1.09
Cooling	PTAC	EER 10.8	0.19	$0.12	14	1.28
Cooling	PTAC	EER 11	0.22	$0.32	14	0.55
Cooling	PTAC	EER 11.5	0.30	$0.71	14	0.34
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	0.50	$0.24	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	0.79	$0.73	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	1.06	$0.97	15	1.34
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	1.16	$1.21	15	0.93
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	1.29	$7.10	20	0.14
Combined Heating/Cooling	Heat Pump	Geothermal Heat Pump	1.55	$12.77	20	-
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	1.52	$1.22	15	1.27
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.27	$0.14	4	-
Interior Lighting	Interior Screw-in	CFL	1.13	$0.06	7	11.90
Interior Lighting	Interior Screw-in	LED	1.24	$1.90	12	0.61
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.11	($0.05)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.18	($0.03)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.53	$0.21	6	1.18
Interior Lighting	Linear Fluorescent	T5	0.55	$0.35	6	0.72
Interior Lighting	Linear Fluorescent	LED	0.58	$3.08	15	0.23
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.02	$0.00	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.09	$0.00	7	33.30
Exterior Lighting	Exterior Screw-in	Metal Halides	0.09	$0.00	4	5.97
Exterior Lighting	Exterior Screw-in	LED	0.10	$0.05	12	1.70
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.24	($0.16)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.25	$0.64	9	0.33
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.00	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.01	$0.00	6	1.01
Exterior Lighting	Linear Fluorescent	T5	0.01	$0.01	6	0.62
Exterior Lighting	Linear Fluorescent	LED	0.01	$0.06	15	0.19
Water Heating	Water Heater	Baseline (EF=0.90)	-	$0.00	15	-
Water Heating	Water Heater	High Efficiency (EF=0.95)	0.19	$0.02	15	9.79
Water Heating	Water Heater	Geothermal Heat Pump	2.47	$3.53	15	0.80
Water Heating	Water Heater	Solar	2.72	$3.03	15	1.02

Note: Costs and savings are per sq. ft.

Table D-9 Energy Efficiency Equipment Data — Extra Large Commercial, New Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Food Preparation	Fryer	Standard	-	$0.00	12	-
Food Preparation	Fryer	Efficient	0.03	$0.00	12	6.02
Food Preparation	Oven	Standard	-	$0.00	12	-
Food Preparation	Oven	Efficient	0.85	$0.38	12	2.11
Food Preparation	Dishwasher	Standard	-	$0.00	12	-
Food Preparation	Dishwasher	Efficient	0.03	$0.04	12	0.57
Food Preparation	Hot Food Container	Standard	-	$0.00	12	-
Food Preparation	Hot Food Container	Efficient	0.17	$0.22	12	0.73
Food Preparation	Food Prep	Standard	-	$0.00	12	-
Food Preparation	Food Prep	Efficient	0.00	$0.03	12	0.15
Refrigeration	Walk in Refrigeration	Standard	-	$0.00	18	-
Refrigeration	Walk in Refrigeration	Efficient	0.06	$0.05	18	1.42
Refrigeration	Glass Door Display	Standard	-	$0.00	18	-
Refrigeration	Glass Door Display	Efficient	0.04	$0.00	18	78.11
Refrigeration	Solid Door Refrigerator	Standard	-	$0.00	18	-
Refrigeration	Solid Door Refrigerator	Efficient	0.27	$0.02	18	13.75
Refrigeration	Open Display Case	Standard	-	$0.00	18	-
Refrigeration	Open Display Case	Efficient	0.01	$0.03	18	0.34
Refrigeration	Vending Machine	Base	-	$0.00	10	-
Refrigeration	Vending Machine	Base (2012)	0.13	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency	0.16	$0.00	10	-
Refrigeration	Vending Machine	High Efficiency (2012)	0.24	$0.00	10	68.21
Refrigeration	Icemaker	Standard	-	$0.00	12	-
Refrigeration	Icemaker	Efficient	0.05	$0.00	12	17.60
Office Equipment	Desktop Computer	Baseline	-	$0.00	4	-
Office Equipment	Desktop Computer	Energy Star	0.25	$0.00	4	32.37
Office Equipment	Desktop Computer	Climate Savers	0.35	$0.33	4	0.32
Office Equipment	Laptop Computer	Baseline	-	$0.00	4	-
Office Equipment	Laptop Computer	Energy Star	0.02	$0.00	4	10.31
Office Equipment	Laptop Computer	Climate Savers	0.04	$0.10	4	0.12
Office Equipment	Server	Standard	-	$0.00	3	-
Office Equipment	Server	Energy Star	0.06	$0.00	3	3.01
Office Equipment	Monitor	Standard	-	$0.00	4	-
Office Equipment	Monitor	Energy Star	0.11	$0.01	4	6.80
Office Equipment	Printer/copier/fax	Standard	-	$0.00	6	-
Office Equipment	Printer/copier/fax	Energy Star	0.02	$0.01	6	1.38
Office Equipment	POS Terminal	Standard	-	$0.00	4	-
Office Equipment	POS Terminal	Energy Star	0.00	$0.00	4	2.01
Miscellaneous	Non-HVAC Motor	Standard	-	$0.00	15	-
Miscellaneous	Non-HVAC Motor	Standard (2015)	0.01	$0.00	15	-
Miscellaneous	Non-HVAC Motor	High Efficiency	0.03	$0.03	15	1.02
Miscellaneous	Non-HVAC Motor	High Efficiency (2015)	0.04	$0.03	15	-
Miscellaneous	Non-HVAC Motor	Premium	0.05	$0.07	15	0.76
Miscellaneous	Non-HVAC Motor	Premium (2015)	0.05	$0.07	15	-
Miscellaneous	Other Miscellaneous	Miscellaneous	-	$0.00	5	-
Miscellaneous	Other Miscellaneous	Miscellaneous (2013)	0.00	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-9 Energy Efficiency Equipment Data — Extra Large Industrial, New Vintage

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Cooling	Central Chiller	0.75 kw/ton, COP 4.7	-	$0.00	20	-
Cooling	Central Chiller	0.60 kw/ton, COP 5.9	1.61	$0.33	20	-
Cooling	Central Chiller	0.58 kw/ton, COP 6.1	1.82	$0.66	20	0.68
Cooling	Central Chiller	0.55 kw/Ton, COP 6.4	2.15	$0.93	20	0.94
Cooling	Central Chiller	0.51 kw/ton, COP 6.9	2.58	$1.59	20	0.80
Cooling	Central Chiller	0.50 kw/Ton, COP 7.0	2.68	$1.92	20	0.71
Cooling	Central Chiller	0.48 kw/ton, COP 7.3	2.90	$2.25	20	0.70
Cooling	Central Chiller	Variable Refrigerant Flow	3.74	$39.62	20	0.06
Cooling	RTU	EER 9.2	-	$0.00	16	-
Cooling	RTU	EER 10.1	0.56	$0.39	16	-
Cooling	RTU	EER 11.2	1.12	$0.74	16	-
Cooling	RTU	EER 12.0	1.47	$1.23	16	0.62
Cooling	RTU	Ductless VRF	1.79	$10.88	16	0.06
Cooling	PTAC	EER 9.8	-	$0.00	14	-
Cooling	PTAC	EER 10.2	0.20	$0.06	14	2.79
Cooling	PTAC	EER 10.8	0.47	$0.11	14	3.27
Cooling	PTAC	EER 11	0.55	$0.31	14	1.41
Cooling	PTAC	EER 11.5	0.75	$0.69	14	0.87
Combined Heating/Cooling	Heat Pump	EER 9.3, COP 3.1	-	$0.00	15	-
Combined Heating/Cooling	Heat Pump	EER 10.3, COP 3.2	1.07	$0.92	15	-
Combined Heating/Cooling	Heat Pump	EER 11.0, COP 3.3	1.69	$2.75	15	-
Combined Heating/Cooling	Heat Pump	EER 11.7, COP 3.4	2.25	$3.66	15	0.75
Combined Heating/Cooling	Heat Pump	EER 12, COP 3.4	2.47	$4.58	15	0.52
Combined Heating/Cooling	Heat Pump	Ductless Mini-Split System	2.74	$26.86	20	0.08
Combined Heating/Cooling	Heat Pump	Geothermal Heat Pump	3.29	$48.32	20	-
Space Heating	Electric Resistance	Standard	-	$0.00	25	-
Space Heating	Furnace	Standard	-	$0.00	18	-
Ventilation	Ventilation	Constant Volume	-	$0.00	15	-
Ventilation	Ventilation	Variable Air Volume	9.66	$1.22	15	8.05
Interior Lighting	Interior Screw-in	Incandescents	-	$0.00	4	-
Interior Lighting	Interior Screw-in	Infrared Halogen	0.08	$0.04	4	-
Interior Lighting	Interior Screw-in	CFL	0.34	$0.02	7	13.32
Interior Lighting	Interior Screw-in	LED	0.38	$0.52	12	0.68
Interior Lighting	HID	Metal Halides	-	$0.00	6	-
Interior Lighting	HID	High Pressure Sodium	0.41	($0.14)	9	1.00
Interior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Interior Lighting	Linear Fluorescent	T8	0.09	($0.01)	6	1.00
Interior Lighting	Linear Fluorescent	Super T8	0.28	$0.08	6	1.56
Interior Lighting	Linear Fluorescent	T5	0.29	$0.14	6	0.96
Interior Lighting	Linear Fluorescent	LED	0.30	$1.21	15	0.30
Exterior Lighting	Exterior Screw-in	Incandescent	-	$0.00	4	-
Exterior Lighting	Exterior Screw-in	Infrared Halogen	0.01	$0.00	4	-
Exterior Lighting	Exterior Screw-in	CFL	0.02	$0.00	7	13.52
Exterior Lighting	Exterior Screw-in	Metal Halides	0.02	$0.00	4	2.42
Exterior Lighting	Exterior Screw-in	LED	0.02	$0.03	12	0.69
Exterior Lighting	HID	Metal Halides	-	$0.00	6	-
Exterior Lighting	HID	High Pressure Sodium	0.07	($0.04)	9	1.00
Exterior Lighting	HID	Low Pressure Sodium	0.07	$0.18	9	0.33
Exterior Lighting	Linear Fluorescent	T12	-	$0.00	6	-
Exterior Lighting	Linear Fluorescent	T8	0.00	($0.00)	6	1.00
Exterior Lighting	Linear Fluorescent	Super T8	0.00	$0.00	6	1.05
Exterior Lighting	Linear Fluorescent	T5	0.00	$0.00	6	0.64
Exterior Lighting	Linear Fluorescent	LED	0.00	$0.01	15	0.20
Process	Process Cooling/Refrigera	Standard	-	$0.00	10	-
Process	Process Cooling/Refrigera	Efficient	18.88	$5.59	10	2.49
Process	Process Heating	Standard	-	$0.00	10	-
Process	Process Heating	Efficient	6.18	$0.57	10	7.97

Note: Costs and savings are per sq. ft.

Table D-9 Energy Efficiency Equipment Data — Extra Large Industrial, New Vintage (Cont.)

End Use	Technology	Efficiency Definition	Savings (kWh/yr)	Incremental Cost	Lifetime (yrs)	BC Ratio
Process	Electrochemical Process	Standard	-	$0.00	10	-
Process	Electrochemical Process	Efficient	13.16	$2.64	10	3.67
Machine Drive	Less than 5 HP	Standard	-	$0.00	10	-
Machine Drive	Less than 5 HP	High Efficiency	0.05	$0.02	10	2.08
Machine Drive	Less than 5 HP	Standard (2015)	0.07	$0.00	10	-
Machine Drive	Less than 5 HP	Premium	0.07	$0.03	10	1.66
Machine Drive	Less than 5 HP	High Efficiency (2015)	0.11	$0.02	10	-
Machine Drive	Less than 5 HP	Premium (2015)	0.14	$0.03	10	-
Machine Drive	5-24 HP	Standard	-	$0.00	10	-
Machine Drive	5-24 HP	High	0.11	$0.02	10	5.09
Machine Drive	5-24 HP	Premium	0.18	$0.03	10	4.07
Machine Drive	25-99 HP	Standard	-	$0.00	10	-
Machine Drive	25-99 HP	High	0.31	$0.02	10	13.72
Machine Drive	25-99 HP	Premium	0.49	$0.03	10	10.97
Machine Drive	100-249 HP	Standard	-	$0.00	10	-
Machine Drive	100-249 HP	High	0.12	$0.02	10	5.17
Machine Drive	100-249 HP	Premium	0.15	$0.03	10	3.44
Machine Drive	250-499 HP	Standard	-	$0.00	10	-
Machine Drive	250-499 HP	High	0.35	$0.02	10	15.66
Machine Drive	250-499 HP	Premium	0.47	$0.03	10	10.44
Machine Drive	500 and more HP	Standard	-	$0.00	10	-
Machine Drive	500 and more HP	High	0.59	$0.02	10	26.28
Machine Drive	500 and more HP	Premium	0.78	$0.03	10	17.52
Miscellaneous	Miscellaneous	Miscellaneous	-	$0.00	5	-

Note: Costs and savings are per sq. ft.

Table D-10 Energy Efficiency Measure Data — Small/Med. Comm., Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	14%	90%	$0.08	4	0.75
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.20
Chiller - Chilled Water Reset	Cooling	14%	0%	0%	0%	$0.86	4	0.08
Chiller - Chilled Water Variable-Flow System	Cooling	5%	0%	0%	0%	$0.86	10	0.07
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	0%	$0.90	20	0.70
Chiller - VSD	Cooling	27%	0%	0%	0%	$1.17	20	0.48
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	0%	0%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	10%	0%	0%	0%	$0.87	14	0.18
Cooling - Economizer Installation	Cooling	6%	0%	45%	49%	$0.15	15	0.71
Heat Pump - Maintenance	Combined Heating/Cooling	7%	7%	10%	95%	$0.03	4	5.00
Insulation - Ducting	Cooling	6%	0%	9%	50%	$0.41	20	0.71
Insulation - Ducting	Space Heating	3%	1%	9%	50%	$0.41	20	0.71
Repair and Sealing - Ducting	Cooling	2%	0%	5%	25%	$0.38	15	0.45
Repair and Sealing - Ducting	Space Heating	2%	1%	5%	25%	$0.38	15	0.45
Energy Management System	Cooling	6%	0%	24%	75%	$0.35	14	0.72
Energy Management System	Space Heating	5%	3%	24%	75%	$0.35	14	0.72
Energy Management System	Interior Lighting	2%	1%	24%	75%	$0.35	14	0.72
Cooking - Exhaust Hoods with Sensor Control	Ventilation	25%	13%	1%	15%	$0.04	10	7.36
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.38
Fans - Variable Speed Control	Ventilation	15%	5%	8%	90%	$0.20	10	0.89
Retrocommissioning - HVAC	Cooling	9%	0%	15%	90%	$0.60	4	0.50
Retrocommissioning - HVAC	Space Heating	9%	6%	15%	90%	$0.60	4	0.50
Retrocommissioning - HVAC	Ventilation	9%	6%	15%	90%	$0.60	4	0.50
Pumps - Variable Speed Control	Miscellaneous	1%	0%	0%	34%	$0.44	10	1.01
Thermostat - Clock/Programmable	Cooling	5%	0%	34%	50%	$0.13	11	1.12
Thermostat - Clock/Programmable	Space Heating	5%	1%	34%	50%	$0.13	11	1.12
Insulation - Ceiling	Cooling	2%	0%	10%	18%	$0.64	20	0.70
Insulation - Ceiling	Space Heating	17%	4%	10%	18%	$0.64	20	0.70
Insulation - Radiant Barrier	Cooling	3%	0%	7%	13%	$0.26	20	0.81
Insulation - Radiant Barrier	Space Heating	5%	2%	7%	13%	$0.26	20	0.81
Roofs - High Reflectivity	Cooling	15%	0%	2%	95%	$0.18	15	1.47
Windows - High Efficiency	Cooling	5%	0%	61%	75%	$0.44	20	0.63
Windows - High Efficiency	Space Heating	3%	2%	61%	75%	$0.44	20	0.63
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	81%	90%	$0.65	8	0.34
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	1%	45%	$0.50	8	0.90
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	2%	50%	$0.11	8	1.36
Interior Fluorescent - Delamp and Install Reflectors	Interior Lighting	20%	10%	18%	25%	$0.50	11	0.97
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.50	8	0.36
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.70	11	1.73
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	7%	45%	$0.20	8	1.11
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.26
Interior Screw-in - Task Lighting	Interior Lighting	7%	4%	25%	75%	$0.24	5	0.09
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	9%	56%	$0.20	8	0.56
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	8%	90%	$0.01	9	4.28
Water Heater - Pipe Insulation	Water Heating	6%	3%	46%	50%	$0.28	15	0.37
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	0%	$0.11	10	0.64
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	40%	50%	$0.02	10	5.87
Water Heater - Thermostat Setback	Water Heating	4%	2%	5%	75%	$0.11	10	0.47
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	0%	$0.02	5	1.56
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	0%	75%	$0.20	16	1.10
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	18%	38%	$0.35	16	1.25
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.10
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.21
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	1.02
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.00
Retrocommissioning - Comprehensive	Cooling	12%	0%	40%	90%	$0.70	4	0.71
Retrocommissioning - Comprehensive	Space Heating	12%	9%	40%	90%	$0.70	4	0.71
Retrocommissioning - Comprehensive	Interior Lighting	12%	9%	40%	90%	$0.70	4	0.71
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	61.20
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.09
LED Exit Lighting	Interior Lighting	2%	2%	9%	86%	$0.00	10	12.75
Retrocommissioning - Lighting	Interior Lighting	9%	6%	5%	90%	$0.10	5	1.59
Retrocommissioning - Lighting	Exterior Lighting	9%	6%	5%	90%	$0.10	5	1.59
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.00
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.37
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	8.10
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	36.95
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	0%	0%	$0.14	8	0.33
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.95
Industrial Process Improvements	Miscellaneous	10%	8%	0%	23%	$0.52	10	1.16
Custom Measures	Cooling	10%	0%	10%	45%	$1.50	15	0.59
Custom Measures	Space Heating	10%	8%	10%	45%	$1.50	15	0.59
Custom Measures	Interior Lighting	10%	6%	10%	45%	$1.50	15	0.59
Custom Measures	Food Preparation	10%	7%	10%	45%	$1.50	15	0.59
Custom Measures	Refrigeration	10%	5%	10%	45%	$1.50	15	0.59
Water Heater - Heat Pump	Water Heating	30%	15%	0%	19%	$0.80	15	0.69
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$4.00	15	0.54
Furnace - Convert to Gas	Space Heating	100%	100%	0%	47%	$8.04	15	1.08

Note: Costs are per sq. ft.

Table D-11 Energy Efficiency Measure Data — Large Commercial, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	27%	90%	$0.06	4	1.30
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.21
Chiller - Chilled Water Reset	Cooling	19%	0%	15%	75%	$0.18	4	0.50
Chiller - Chilled Water Variable-Flow System	Cooling	5%	0%	30%	34%	$0.18	10	0.31
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	66%	$0.90	20	0.64
Chiller - VSD	Cooling	32%	0%	15%	66%	$1.17	20	0.52
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	15%	41%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	9%	0%	5%	75%	$0.18	14	0.76
Cooling - Economizer Installation	Cooling	11%	0%	44%	49%	$0.15	15	1.29
Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	10%	95%	$0.06	4	3.04
Insulation - Ducting	Cooling	3%	0%	8%	50%	$0.41	20	0.52
Insulation - Ducting	Space Heating	3%	1%	8%	50%	$0.41	20	0.52
Repair and Sealing - Ducting	Cooling	2%	0%	5%	25%	$0.38	15	0.43
Repair and Sealing - Ducting	Space Heating	2%	1%	5%	25%	$0.38	15	0.43
Energy Management System	Cooling	23%	0%	37%	90%	$0.35	14	2.63
Energy Management System	Space Heating	18%	12%	37%	90%	$0.35	14	2.63
Energy Management System	Interior Lighting	9%	6%	37%	90%	$0.35	14	2.63
Cooking - Exhaust Hoods with Sensor Control	Ventilation	13%	7%	1%	11%	$0.04	10	2.97
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.11
Fans - Variable Speed Control	Ventilation	15%	5%	2%	90%	$0.20	10	0.71
Retrocommissioning - HVAC	Cooling	12%	0%	15%	90%	$0.30	4	0.72
Retrocommissioning - HVAC	Space Heating	12%	9%	15%	90%	$0.30	4	0.72
Retrocommissioning - HVAC	Ventilation	9%	6%	15%	90%	$0.30	4	0.72
Pumps - Variable Speed Control	Miscellaneous	1%	0%	0%	34%	$0.13	10	1.05
Thermostat - Clock/Programmable	Cooling	5%	0%	33%	50%	$0.13	11	1.02
Thermostat - Clock/Programmable	Space Heating	5%	1%	33%	50%	$0.13	11	1.02
Insulation - Ceiling	Cooling	1%	0%	9%	30%	$0.85	20	0.45
Insulation - Ceiling	Space Heating	12%	3%	9%	30%	$0.85	20	0.45
Insulation - Radiant Barrier	Cooling	2%	0%	7%	13%	$0.26	20	0.64
Insulation - Radiant Barrier	Space Heating	5%	2%	7%	13%	$0.26	20	0.64
Roofs - High Reflectivity	Cooling	5%	0%	2%	75%	$0.08	15	1.08
Windows - High Efficiency	Cooling	12%	0%	72%	75%	$0.88	20	0.74
Windows - High Efficiency	Space Heating	11%	8%	72%	75%	$0.88	20	0.74
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	86%	90%	$0.65	8	0.34
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	1%	45%	$0.45	8	0.96
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	2%	13%	$0.29	8	0.42
Interior Fluorescent - Delamp and Install Reflectors	Interior Lighting	30%	15%	17%	38%	$0.50	11	1.40
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.40	8	0.43
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.63	11	1.85
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	13%	45%	$0.20	8	1.10
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.21
Interior Screw-in - Task Lighting	Interior Lighting	10%	5%	10%	75%	$0.24	5	0.13
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	9%	56%	$0.20	8	0.55
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	3%	90%	$0.03	9	1.62
Water Heater - Pipe Insulation	Water Heating	6%	3%	0%	0%	$0.28	15	0.42
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	23%	$0.11	10	0.70
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$0.04	10	3.28
Water Heater - Thermostat Setback	Water Heating	4%	2%	0%	0%	$0.11	10	0.52
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	3%	$0.04	5	0.88
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	0%	75%	$0.20	16	0.58
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	38%	45%	$0.35	16	0.95
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.65
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.37
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	0.65
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.96
Retrocommissioning - Comprehensive	Cooling	12%	0%	40%	90%	$0.35	4	1.06
Retrocommissioning - Comprehensive	Space Heating	12%	9%	40%	90%	$0.35	4	1.06
Retrocommissioning - Comprehensive	Interior Lighting	12%	9%	40%	90%	$0.35	4	1.06
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	68.11
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.11
LED Exit Lighting	Interior Lighting	2%	2%	9%	86%	$0.00	10	12.29
Retrocommissioning - Lighting	Interior Lighting	9%	6%	5%	90%	$0.05	5	3.07
Retrocommissioning - Lighting	Exterior Lighting	9%	6%	5%	90%	$0.05	5	3.07
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.52
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.14
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	6.50
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	33.94
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	1%	2%	$0.14	8	0.32
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.78
Industrial Process Improvements	Miscellaneous	10%	8%	0%	5%	$0.52	10	1.18
Custom Measures	Cooling	10%	0%	10%	45%	$0.90	15	0.99
Custom Measures	Space Heating	10%	8%	10%	45%	$0.90	15	0.99
Custom Measures	Interior Lighting	10%	8%	10%	45%	$0.90	15	0.99
Custom Measures	Food Preparation	10%	8%	10%	45%	$0.90	15	0.99
Custom Measures	Refrigeration	10%	8%	10%	45%	$0.90	15	0.99
Water Heater - Heat Pump	Water Heating	30%	15%	0%	28%	$0.80	15	0.77
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	0%	$4.00	15	0.59
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$6.00	15	1.04

Note: Costs are per sq. ft.

Table D-12 Energy Efficiency Measure Data — Extra Large Comm., Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	47%	90%	$0.06	4	1.15
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.19
Chiller - Chilled Water Reset	Cooling	15%	0%	30%	75%	$0.09	4	0.79
Chiller - Chilled Water Variable-Flow System	Cooling	8%	0%	30%	34%	$0.09	10	1.00
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	75%	$0.90	20	0.66
Chiller - VSD	Cooling	28%	0%	3%	75%	$1.17	20	0.47
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	25%	37%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	9%	0%	0%	75%	$0.09	14	1.49
Cooling - Economizer Installation	Cooling	11%	0%	73%	81%	$0.15	15	1.20
Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	5%	95%	$0.06	4	2.91
Insulation - Ducting	Cooling	8%	0%	2%	50%	$0.41	20	0.77
Insulation - Ducting	Space Heating	3%	1%	2%	50%	$0.41	20	0.77
Repair and Sealing - Ducting	Cooling	5%	0%	5%	25%	$0.38	15	0.65
Repair and Sealing - Ducting	Space Heating	5%	3%	5%	25%	$0.38	15	0.65
Energy Management System	Cooling	12%	0%	80%	90%	$0.35	14	1.21
Energy Management System	Space Heating	9%	6%	80%	90%	$0.35	14	1.21
Energy Management System	Interior Lighting	5%	3%	80%	90%	$0.35	14	1.21
Cooking - Exhaust Hoods with Sensor Control	Ventilation	13%	7%	1%	8%	$0.04	10	3.46
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.30
Fans - Variable Speed Control	Ventilation	15%	5%	2%	90%	$0.20	10	0.83
Retrocommissioning - HVAC	Cooling	12%	0%	15%	90%	$0.20	4	1.00
Retrocommissioning - HVAC	Space Heating	12%	9%	15%	90%	$0.20	4	1.00
Retrocommissioning - HVAC	Ventilation	9%	6%	15%	90%	$0.20	4	1.00
Pumps - Variable Speed Control	Miscellaneous	1%	0%	1%	34%	$0.44	10	1.01
Thermostat - Clock/Programmable	Cooling	3%	0%	25%	50%	$0.13	11	0.69
Thermostat - Clock/Programmable	Space Heating	3%	1%	25%	50%	$0.13	11	0.69
Insulation - Ceiling	Cooling	1%	0%	2%	9%	$0.85	20	0.48
Insulation - Ceiling	Space Heating	12%	3%	2%	9%	$0.85	20	0.48
Insulation - Radiant Barrier	Cooling	1%	0%	2%	13%	$0.26	20	0.57
Insulation - Radiant Barrier	Space Heating	4%	2%	2%	13%	$0.26	20	0.57
Roofs - High Reflectivity	Cooling	10%	0%	0%	95%	$0.18	15	0.90
Windows - High Efficiency	Cooling	6%	0%	95%	100%	$2.10	20	0.37
Windows - High Efficiency	Space Heating	2%	2%	95%	100%	$2.10	20	0.37
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	78%	90%	$0.65	8	0.26
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	3%	45%	$0.40	8	0.72
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	2%	10%	$0.29	8	0.45
Interior Fluorescent - Delamp and Install Reflectors	Interior Lighting	30%	15%	3%	25%	$0.50	11	0.93
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.20	8	0.57
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.56	11	1.38
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	42%	45%	$0.20	8	0.84
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.23
Interior Screw-in - Task Lighting	Interior Lighting	10%	5%	5%	75%	$0.24	5	0.18
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	12%	56%	$0.20	8	0.42
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	2%	90%	$0.03	9	2.66
Water Heater - Pipe Insulation	Water Heating	6%	3%	0%	0%	$0.28	15	0.70
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	23%	$0.11	10	1.19
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$0.04	10	5.48
Water Heater - Thermostat Setback	Water Heating	4%	0%	0%	0%	$0.11	10	0.72
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	0%	$0.04	5	1.45
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	10%	75%	$0.20	16	0.02
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	10%	38%	$0.35	16	0.34
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.13
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.28
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	0.29
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.18
Retrocommissioning - Comprehensive	Cooling	12%	0%	40%	90%	$0.25	4	1.21
Retrocommissioning - Comprehensive	Space Heating	12%	9%	40%	90%	$0.25	4	1.21
Retrocommissioning - Comprehensive	Interior Lighting	12%	9%	40%	90%	$0.25	4	1.21
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	39.11
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.12
LED Exit Lighting	Interior Lighting	2%	2%	9%	86%	$0.00	10	18.34
Retrocommissioning - Lighting	Interior Lighting	9%	6%	5%	90%	$0.05	5	2.54
Retrocommissioning - Lighting	Exterior Lighting	9%	6%	5%	90%	$0.05	5	2.54
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.04
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.61
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	6.95
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	20.31
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	0%	0%	$0.14	8	0.47
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.07
Industrial Process Improvements	Miscellaneous	10%	8%	0%	0%	$0.52	10	1.11
Custom Measures	Cooling	10%	0%	10%	45%	$0.67	15	1.09
Custom Measures	Space Heating	10%	8%	10%	45%	$0.67	15	1.09
Custom Measures	Interior Lighting	10%	8%	10%	45%	$0.67	15	1.09
Custom Measures	Food Preparation	10%	8%	10%	45%	$0.67	15	1.09
Custom Measures	Refrigeration	10%	8%	10%	45%	$0.67	15	1.09
Water Heater - Heat Pump	Water Heating	30%	15%	0%	41%	$0.80	15	1.28
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	0%	$4.00	15	1.00
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$4.00	15	1.66

Note: Costs are per sq. ft.

Table D-13 Energy Efficiency Measure Data — Extra Large Industrial, Existing Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Refrigeration - System Controls	Process	11%	8%	5%	34%	$0.40	10	18.09
Refrigeration - System Maintenance	Process	3%	2%	5%	34%	$0.00	10	2,067.93
Refrigeration - System Optimization	Process	15%	11%	5%	34%	$0.80	10	12.92
Motors - Variable Frequency Drive	Machine Drive	13%	9%	25%	38%	$0.10	10	3.38
Motors - Magnetic Adjustable Speed Drives	Machine Drive	13%	9%	25%	38%	$0.10	10	3.38
Compressed Air - System Controls	Machine Drive	9%	7%	5%	34%	$0.40	10	0.59
Compressed Air - System Optimization and Improvements	Machine Drive	13%	9%	5%	34%	$0.80	10	0.42
Compressed Air - System Maintenance	Machine Drive	3%	2%	5%	34%	$0.20	10	0.34
Compressed Air - Compressor Replacement	Machine Drive	5%	4%	5%	34%	$0.20	10	0.68
Fan System - Controls	Machine Drive	4%	3%	10%	38%	$0.35	10	0.11
Fan System - Controls	Machine Drive	4%	3%	10%	38%	$0.35	10	0.11
Fan System - Optimization	Machine Drive	6%	5%	10%	38%	$0.70	10	0.08
Fan System - Optimization	Machine Drive	6%	5%	10%	38%	$0.70	10	0.08
Fan System - Maintenance	Machine Drive	1%	1%	10%	38%	$0.15	10	0.07
Fan System - Maintenance	Machine Drive	1%	1%	10%	38%	$0.15	10	0.07
Pumping System - Controls	Machine Drive	5%	4%	5%	34%	$0.38	12	0.43
Pumping System - Optimization	Machine Drive	13%	9%	5%	34%	$0.75	12	0.54
Pumping System - Maintenance	Machine Drive	2%	1%	5%	34%	$0.19	10	0.27
RTU - Maintenance	Cooling	14%	0%	22%	90%	$0.06	4	3.18
Chiller - Chilled Water Reset	Cooling	14%	0%	30%	75%	$0.09	4	2.69
Chiller - Chilled Water Variable-Flow System	Cooling	5%	0%	30%	34%	$0.20	10	1.05
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	67%	$0.90	20	2.48
Chiller - VSD	Cooling	26%	0%	15%	67%	$1.17	20	1.68
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	25%	50%	$0.04	10	0.03
Chiller - Condenser Water Temprature Reset	Cooling	10%	0%	0%	75%	$0.20	14	2.72
Cooling - Economizer Installation	Cooling	6%	0%	29%	34%	$0.15	15	2.02
Heat Pump - Maintenance	Combined Heating/Cooling	7%	7%	2%	95%	$0.03	4	8.67
Insulation - Ducting	Space Heating	6%	6%	12%	50%	$0.41	20	1.01
Insulation - Ducting	Cooling	3%	0%	12%	50%	$0.41	20	1.01
Repair and Sealing - Ducting	Cooling	2%	0%	5%	25%	$0.38	15	0.63
Repair and Sealing - Ducting	Space Heating	2%	1%	5%	25%	$0.38	15	0.63
Energy Management System	Cooling	6%	0%	11%	90%	$0.35	14	1.09
Energy Management System	Space Heating	5%	3%	11%	90%	$0.35	14	1.09
Energy Management System	Interior Lighting	2%	1%	11%	90%	$0.35	14	1.09
Fans - Energy Efficient Motors	Ventilation	5%	5%	2%	90%	$0.14	10	2.94
Fans - Variable Speed Control	Ventilation	15%	5%	3%	90%	$0.20	10	5.29
Retrocommissioning - HVAC	Cooling	12%	0%	1%	70%	$0.25	4	1.54
Retrocommissioning - HVAC	Space Heating	12%	9%	1%	70%	$0.25	4	1.54
Retrocommissioning - HVAC	Ventilation	9%	6%	1%	70%	$0.25	4	1.54
Pumps - Variable Speed Control	Machine Drive	5%	4%	0%	34%	$0.44	10	0.31
Thermostat - Clock/Programmable	Cooling	5%	0%	59%	70%	$0.13	11	2.11
Thermostat - Clock/Programmable	Space Heating	5%	1%	59%	70%	$0.13	11	2.11
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	84%	90%	$0.65	8	0.17
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	2%	27%	$0.08	8	0.46
Interior Fluorescent - Delamp and Install Reflectors	Interior Lighting	20%	10%	17%	38%	$0.50	11	0.31
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	38%	$0.20	11	1.95
LED Exit Lighting	Interior Lighting	2%	2%	9%	86%	$0.00	10	4.00
Retrocommissioning - Lighting	Interior Lighting	9%	6%	9%	70%	$0.05	5	1.44
Retrocommissioning - Lighting	Exterior Lighting	9%	6%	9%	70%	$0.05	5	1.44
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	15%	45%	$0.20	8	0.55
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.07
Interior Screw-in - Task Lighting	Interior Lighting	7%	4%	10%	75%	$0.24	5	0.03
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	2%	56%	$0.20	8	0.27
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	0.46
Custom Measures	Cooling	10%	0%	10%	45%	$1.60	15	1.63
Custom Measures	Space Heating	10%	8%	10%	45%	$1.60	15	1.63
Custom Measures	Interior Lighting	10%	8%	10%	45%	$1.60	15	1.63
Custom Measures	Machine Drive	10%	8%	10%	45%	$1.60	15	1.63
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$4.00	15	2.67

Note: Costs are per sq. ft.

Table D-14 Energy Efficiency Measure Data — Small/Medium Comm., New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	14%	90%	$0.08	4	0.82
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.18
Chiller - Chilled Water Reset	Cooling	11%	0%	0%	0%	$0.86	4	0.06
Chiller - Chilled Water Variable-Flow System	Cooling	4%	0%	0%	0%	$0.86	10	0.05
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	0%	$0.90	20	0.63
Chiller - VSD	Cooling	26%	0%	0%	0%	$1.17	20	0.42
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	0%	0%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	8%	0%	0%	0%	$0.87	14	0.13
Cooling - Economizer Installation	Cooling	6%	0%	45%	49%	$0.15	15	0.65
Heat Pump - Maintenance	Combined Heating/Cooling	7%	7%	10%	95%	$0.03	4	4.32
Insulation - Ducting	Cooling	5%	0%	9%	50%	$0.41	20	0.64
Insulation - Ducting	Space Heating	3%	1%	9%	50%	$0.41	20	0.64
Energy Management System	Cooling	5%	0%	24%	75%	$0.35	14	0.55
Energy Management System	Space Heating	2%	1%	24%	75%	$0.35	14	0.55
Energy Management System	Interior Lighting	2%	1%	24%	75%	$0.35	14	0.55
Cooking - Exhaust Hoods with Sensor Control	Ventilation	25%	13%	1%	15%	$0.04	10	7.04
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.32
Fans - Variable Speed Control	Ventilation	15%	5%	8%	90%	$0.20	10	0.85
Commissioning - HVAC	Cooling	5%	0%	40%	75%	$0.90	25	0.33
Commissioning - HVAC	Space Heating	5%	4%	40%	75%	$0.90	25	0.33
Commissioning - HVAC	Ventilation	5%	4%	40%	75%	$0.90	25	0.33
Pumps - Variable Speed Control	Miscellaneous	1%	0%	5%	34%	$0.44	10	1.01
Thermostat - Clock/Programmable	Cooling	5%	0%	34%	50%	$0.13	11	1.06
Thermostat - Clock/Programmable	Space Heating	5%	1%	34%	50%	$0.13	11	1.06
Insulation - Ceiling	Cooling	1%	0%	10%	81%	$0.16	20	1.60
Insulation - Ceiling	Space Heating	15%	4%	10%	81%	$0.16	20	1.60
Insulation - Radiant Barrier	Cooling	2%	0%	7%	13%	$0.26	20	0.76
Insulation - Radiant Barrier	Space Heating	6%	2%	7%	13%	$0.26	20	0.76
Roofs - High Reflectivity	Cooling	7%	0%	5%	95%	$0.09	15	1.25
Windows - High Efficiency	Cooling	5%	0%	61%	75%	$0.35	20	0.69
Windows - High Efficiency	Space Heating	3%	2%	61%	75%	$0.35	20	0.69
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	81%	90%	$0.65	8	0.31
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	1%	45%	$0.38	8	1.07
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	10%	75%	$0.09	8	1.50
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.50	8	0.32
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.70	11	1.56
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	7%	45%	$0.20	8	1.00
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.24
Interior Screw-in - Task Lighting	Interior Lighting	7%	4%	25%	75%	$0.24	5	0.08
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	9%	56%	$0.20	8	0.50
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	8%	90%	$0.01	9	4.22
Water Heater - Pipe Insulation	Water Heating	4%	2%	46%	50%	$0.28	15	0.24
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	0%	$0.11	10	0.63
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	40%	50%	$0.02	10	5.80
Water Heater - Thermostat Setback	Water Heating	4%	0%	10%	75%	$0.11	10	0.38
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	0%	$0.02	5	1.53
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	0%	75%	$0.20	16	1.09
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	18%	38%	$0.35	16	1.24
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.09
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.20
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	1.02
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.00
Commissioning - Comprehensive	Cooling	10%	0%	40%	75%	$1.25	25	0.83
Commissioning - Comprehensive	Space Heating	10%	7%	40%	75%	$1.25	25	0.83
Commissioning - Comprehensive	Interior Lighting	10%	7%	40%	75%	$1.25	25	0.83
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	61.07
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.08
LED Exit Lighting	Interior Lighting	2%	2%	85%	86%	$0.00	10	11.83
Commissioning - Lighting	Interior Lighting	5%	4%	30%	75%	$0.20	25	1.54
Commissioning - Lighting	Exterior Lighting	5%	4%	30%	75%	$0.20	25	1.54
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.00
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.23
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	7.30
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	36.95
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	0%	0%	$0.14	8	0.30
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.95
Advanced New Construction Designs	Cooling	40%	0%	5%	75%	$2.00	35	2.01
Advanced New Construction Designs	Space Heating	40%	30%	5%	75%	$2.00	35	2.01
Advanced New Construction Designs	Interior Lighting	25%	19%	5%	75%	$2.00	35	2.01
Insulation - Wall Cavity	Cooling	1%	0%	10%	68%	$0.34	20	0.72
Insulation - Wall Cavity	Space Heating	10%	2%	10%	68%	$0.34	20	0.72
Roofs - Green	Cooling	7%	0%	2%	11%	$1.00	30	0.26
Roofs - Green	Space Heating	4%	3%	2%	11%	$1.00	30	0.26
Industrial Process Improvements	Miscellaneous	10%	8%	0%	23%	$0.52	10	1.16
Custom Measures	Cooling	8%	0%	10%	45%	$1.50	15	0.45
Custom Measures	Space Heating	8%	6%	10%	45%	$1.50	15	0.45
Custom Measures	Interior Lighting	8%	6%	10%	45%	$1.50	15	0.45
Custom Measures	Food Preparation	8%	6%	10%	45%	$1.50	15	0.45
Custom Measures	Refrigeration	8%	6%	10%	45%	$1.50	15	0.45
Water Heater - Heat Pump	Water Heating	30%	15%	0%	19%	$0.80	15	0.68
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	50%	$4.00	15	0.53
Furnace - Convert to Gas	Space Heating	100%	100%	0%	47%	$8.04	15	1.01

Note: Costs are per sq. ft.

Table D-15 Energy Efficiency Measure Data — Large Commercial, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	27%	90%	$0.06	4	1.13
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.19
Chiller - Chilled Water Reset	Cooling	18%	0%	30%	75%	$0.18	4	0.42
Chiller - Chilled Water Variable-Flow System	Cooling	5%	0%	30%	34%	$0.18	10	0.28
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	66%	$0.90	20	0.61
Chiller - VSD	Cooling	32%	0%	15%	66%	$1.17	20	0.50
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	15%	41%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	8%	0%	25%	75%	$0.18	14	0.63
Cooling - Economizer Installation	Cooling	11%	0%	44%	49%	$0.15	15	1.19
Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	10%	95%	$0.06	4	2.72
Insulation - Ducting	Cooling	4%	0%	8%	50%	$0.41	20	0.56
Insulation - Ducting	Space Heating	3%	1%	8%	50%	$0.41	20	0.56
Energy Management System	Cooling	21%	0%	48%	90%	$0.35	14	2.10
Energy Management System	Space Heating	8%	5%	48%	90%	$0.35	14	2.10
Energy Management System	Interior Lighting	9%	6%	48%	90%	$0.35	14	2.10
Cooking - Exhaust Hoods with Sensor Control	Ventilation	13%	7%	1%	11%	$0.04	10	2.84
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.07
Fans - Variable Speed Control	Ventilation	15%	5%	2%	90%	$0.20	10	0.68
Commissioning - HVAC	Cooling	5%	0%	50%	75%	$0.85	25	0.30
Commissioning - HVAC	Space Heating	5%	4%	50%	75%	$0.85	25	0.30
Commissioning - HVAC	Ventilation	5%	4%	50%	75%	$0.85	25	0.30
Pumps - Variable Speed Control	Miscellaneous	1%	0%	5%	34%	$0.13	10	1.05
Thermostat - Clock/Programmable	Cooling	5%	0%	33%	50%	$0.13	11	0.97
Thermostat - Clock/Programmable	Space Heating	5%	1%	33%	50%	$0.13	11	0.97
Insulation - Ceiling	Cooling	1%	0%	75%	81%	$0.35	20	0.60
Insulation - Ceiling	Space Heating	10%	3%	75%	81%	$0.35	20	0.60
Insulation - Radiant Barrier	Cooling	1%	0%	7%	13%	$0.26	20	0.56
Insulation - Radiant Barrier	Space Heating	5%	2%	7%	13%	$0.26	20	0.56
Roofs - High Reflectivity	Cooling	4%	0%	5%	95%	$0.05	15	1.28
Windows - High Efficiency	Cooling	12%	0%	72%	75%	$0.88	20	0.72
Windows - High Efficiency	Space Heating	11%	8%	72%	75%	$0.88	20	0.72
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	86%	90%	$0.65	8	0.30
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	1%	45%	$0.34	8	1.14
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	10%	19%	$0.19	8	0.57
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.40	8	0.39
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.63	11	1.66
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	13%	45%	$0.20	8	0.99
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.19
Interior Screw-in - Task Lighting	Interior Lighting	10%	5%	10%	75%	$0.24	5	0.11
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	9%	56%	$0.20	8	0.49
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	3%	90%	$0.03	9	1.60
Water Heater - Pipe Insulation	Water Heating	4%	2%	0%	0%	$0.28	15	0.27
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	23%	$0.11	10	0.69
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$0.04	10	3.23
Water Heater - Thermostat Setback	Water Heating	4%	0%	0%	0%	$0.11	10	0.44
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	3%	$0.04	5	0.87
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	0%	75%	$0.20	16	0.58
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	38%	45%	$0.35	16	0.94
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.63
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.35
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	0.65
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.94
Commissioning - Comprehensive	Cooling	10%	0%	40%	75%	$1.00	25	0.96
Commissioning - Comprehensive	Space Heating	10%	7%	40%	75%	$1.00	25	0.96
Commissioning - Comprehensive	Interior Lighting	10%	7%	40%	75%	$1.00	25	0.96
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	67.83
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.09
LED Exit Lighting	Interior Lighting	2%	2%	85%	86%	$0.00	10	11.13
Commissioning - Lighting	Interior Lighting	5%	4%	60%	75%	$0.15	25	1.99
Commissioning - Lighting	Exterior Lighting	5%	4%	60%	75%	$0.15	25	1.99
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.52
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.03
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	5.86
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	33.94
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	1%	2%	$0.14	8	0.29
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.78
Advanced New Construction Designs	Cooling	40%	0%	5%	75%	$2.00	35	1.84
Advanced New Construction Designs	Space Heating	40%	30%	5%	75%	$2.00	35	1.84
Advanced New Construction Designs	Interior Lighting	25%	19%	5%	75%	$2.00	35	1.84
Insulation - Wall Cavity	Cooling	1%	0%	9%	68%	$0.78	20	0.43
Insulation - Wall Cavity	Space Heating	10%	2%	9%	68%	$0.78	20	0.43
Roofs - Green	Cooling	4%	0%	2%	13%	$1.00	15	0.08
Roofs - Green	Space Heating	2%	2%	2%	13%	$1.00	15	0.08
Industrial Process Improvements	Miscellaneous	10%	8%	0%	5%	$0.52	10	1.18
Custom Measures	Cooling	8%	0%	10%	45%	$0.90	15	0.73
Custom Measures	Space Heating	8%	6%	10%	45%	$0.90	15	0.73
Custom Measures	Interior Lighting	8%	6%	10%	45%	$0.90	15	0.73
Custom Measures	Food Preparation	8%	6%	10%	45%	$0.90	15	0.73
Custom Measures	Refrigeration	8%	6%	10%	45%	$0.90	15	0.73
Water Heater - Heat Pump	Water Heating	30%	15%	0%	28%	$0.80	15	0.76
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	0%	$4.00	15	0.58
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$6.00	15	0.98

Note: Costs are per sq. ft.

Table D-16 Energy Efficiency Measure Data — Extra Large Commercial, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
RTU - Maintenance	Cooling	14%	0%	47%	90%	$0.06	4	1.02
RTU - Evaporative Precooler	Cooling	10%	0%	0%	0%	$0.88	15	0.17
Chiller - Chilled Water Reset	Cooling	12%	0%	60%	75%	$0.09	4	0.61
Chiller - Chilled Water Variable-Flow System	Cooling	8%	0%	30%	34%	$0.09	10	0.95
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	75%	$0.90	20	0.64
Chiller - VSD	Cooling	28%	0%	3%	75%	$1.17	20	0.45
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	25%	37%	$0.04	10	0.01
Chiller - Condenser Water Temprature Reset	Cooling	8%	0%	25%	75%	$0.09	14	1.28
Cooling - Economizer Installation	Cooling	11%	0%	73%	81%	$0.15	15	1.14
Heat Pump - Maintenance	Combined Heating/Cooling	10%	10%	5%	95%	$0.06	4	2.61
Insulation - Ducting	Cooling	7%	0%	2%	50%	$0.41	20	0.71
Insulation - Ducting	Space Heating	3%	1%	2%	50%	$0.41	20	0.71
Energy Management System	Cooling	11%	0%	80%	90%	$0.35	14	0.94
Energy Management System	Space Heating	4%	2%	80%	90%	$0.35	14	0.94
Energy Management System	Interior Lighting	5%	3%	80%	90%	$0.35	14	0.94
Cooking - Exhaust Hoods with Sensor Control	Ventilation	13%	7%	1%	8%	$0.04	10	3.31
Fans - Energy Efficient Motors	Ventilation	5%	5%	11%	90%	$0.05	10	1.24
Fans - Variable Speed Control	Ventilation	15%	5%	2%	90%	$0.20	10	0.80
Commissioning - HVAC	Cooling	5%	0%	50%	75%	$0.70	25	0.42
Commissioning - HVAC	Space Heating	5%	4%	50%	75%	$0.70	25	0.42
Commissioning - HVAC	Ventilation	5%	4%	50%	75%	$0.70	25	0.42
Pumps - Variable Speed Control	Miscellaneous	1%	0%	1%	34%	$0.44	10	1.01
Thermostat - Clock/Programmable	Cooling	3%	0%	25%	50%	$0.13	11	0.67
Thermostat - Clock/Programmable	Space Heating	3%	1%	25%	50%	$0.13	11	0.67
Insulation - Ceiling	Cooling	1%	0%	2%	81%	$0.35	20	0.68
Insulation - Ceiling	Space Heating	10%	3%	2%	81%	$0.35	20	0.68
Insulation - Radiant Barrier	Cooling	1%	0%	2%	13%	$0.26	20	0.47
Insulation - Radiant Barrier	Space Heating	2%	1%	2%	13%	$0.26	20	0.47
Roofs - High Reflectivity	Cooling	10%	0%	5%	95%	$0.18	15	0.85
Windows - High Efficiency	Cooling	6%	0%	95%	100%	$1.69	20	0.38
Windows - High Efficiency	Space Heating	2%	2%	95%	100%	$1.69	20	0.38
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	78%	90%	$0.65	8	0.23
Interior Lighting - Photocell Controlled T8 Dimming Ballasts	Interior Lighting	25%	13%	3%	45%	$0.30	8	0.86
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	10%	15%	$0.19	8	0.61
Interior Fluorescent - Bi-Level Fixture w/Occupancy Sensor	Interior Lighting	10%	5%	10%	23%	$0.20	8	0.52
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	23%	$0.56	11	1.24
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	42%	45%	$0.20	8	0.76
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.20
Interior Screw-in - Task Lighting	Interior Lighting	10%	5%	25%	75%	$0.24	5	0.16
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	12%	56%	$0.20	8	0.38
Water Heater - Faucet Aerators/Low Flow Nozzles	Water Heating	4%	1%	2%	90%	$0.03	9	2.63
Water Heater - Pipe Insulation	Water Heating	6%	3%	0%	0%	$0.28	15	0.69
Water Heater - High Efficiency Circulation Pump	Water Heating	5%	4%	0%	23%	$0.11	10	1.18
Water Heater - Tank Blanket/Insulation	Water Heating	9%	5%	0%	0%	$0.04	10	5.43
Water Heater - Thermostat Setback	Water Heating	4%	0%	0%	0%	$0.11	10	0.71
Water Heater - Hot Water Saver	Water Heating	5%	1%	0%	0%	$0.04	5	1.43
Refrigeration - Anti-Sweat Heater/Auto Door Closer	Refrigeration	5%	3%	10%	75%	$0.20	16	0.02
Refrigeration - Floating Head Pressure	Refrigeration	7%	4%	10%	38%	$0.35	16	0.32
Refrigeration - Door Gasket Replacement	Refrigeration	4%	2%	5%	75%	$0.10	8	0.12
Insulation - Bare Suction Lines	Refrigeration	3%	2%	5%	75%	$0.10	8	0.26
Refrigeration - Night Covers	Refrigeration	6%	3%	5%	75%	$0.05	8	0.27
Refrigeration - Strip Curtain	Refrigeration	4%	2%	5%	56%	$0.02	8	0.17
Commissioning - Comprehensive	Cooling	10%	0%	40%	75%	$0.80	25	1.05
Commissioning - Comprehensive	Space Heating	10%	7%	40%	75%	$0.80	25	1.05
Commissioning - Comprehensive	Interior Lighting	10%	7%	40%	75%	$0.80	25	1.05
Office Equipment - Energy Star Power Supply	Office Equipment	1%	1%	10%	95%	$0.00	7	38.86
Vending Machine - Controller	Refrigeration	15%	11%	2%	10%	$0.27	10	1.10
LED Exit Lighting	Interior Lighting	2%	2%	85%	86%	$0.00	10	16.52
Commissioning - Lighting	Interior Lighting	5%	4%	60%	75%	$0.10	25	2.47
Commissioning - Lighting	Exterior Lighting	5%	4%	60%	75%	$0.10	25	2.47
Refrigeration - High Efficiency Case Lighting	Refrigeration	4%	2%	5%	75%	$0.20	8	0.04
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	1.45
Exterior Lighting - Induction Lamps	Exterior Lighting	3%	3%	5%	56%	$0.00	5	6.26
Laundry - High Efficiency Clothes Washer	Miscellaneous	0%	0%	5%	10%	$0.00	10	20.31
Interior Lighting - Hotel Guestroom Controls	Interior Lighting	10%	5%	0%	0%	$0.14	8	0.42
Miscellaneous - Energy Star Water Cooler	Miscellaneous	0%	0%	5%	95%	$0.00	8	1.07
Advanced New Construction Designs	Cooling	40%	0%	5%	75%	$2.00	35	1.67
Advanced New Construction Designs	Space Heating	40%	30%	5%	75%	$2.00	35	1.67
Advanced New Construction Designs	Interior Lighting	25%	19%	5%	75%	$2.00	35	1.67
Insulation - Wall Cavity	Cooling	1%	0%	2%	68%	$0.09	20	1.73
Insulation - Wall Cavity	Space Heating	10%	2%	2%	68%	$0.09	20	1.73
Roofs - Green	Cooling	10%	0%	2%	13%	$1.00	15	0.20
Roofs - Green	Space Heating	5%	3%	2%	13%	$1.00	15	0.20
Industrial Process Improvements	Miscellaneous	10%	8%	0%	0%	$0.52	10	1.11
Custom Measures	Cooling	8%	0%	10%	45%	$0.67	15	0.81
Custom Measures	Space Heating	8%	6%	10%	45%	$0.67	15	0.81
Custom Measures	Interior Lighting	8%	6%	10%	45%	$0.67	15	0.81
Custom Measures	Food Preparation	8%	6%	10%	45%	$0.67	15	0.81
Custom Measures	Refrigeration	8%	6%	10%	45%	$0.67	15	0.81
Water Heater - Heat Pump	Water Heating	30%	15%	0%	41%	$0.80	15	1.27
Water Heater - Convert to Gas	Water Heating	100%	100%	0%	0%	$4.00	15	1.00
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$4.00	15	1.57

Note: Costs are per sq. ft.

Table D-17 Energy Efficiency Measure Data — Extra Large Industrial, New Vintage

Measure	Enduse	Energy Savings	Demand Savings	Base Saturation	Appl./ Feas.	Cost	Lifetime	BC Ratio
Refrigeration - System Controls	Process	11%	8%	5%	34%	$0.40	10	18.09
Refrigeration - System Maintenance	Process	3%	2%	5%	34%	$0.00	10	2,067.93
Refrigeration - System Optimization	Process	15%	11%	5%	34%	$0.80	10	12.92
Motors - Variable Frequency Drive	Machine Drive	13%	9%	25%	38%	$0.10	10	3.38
Motors - Magnetic Adjustable Speed Drives	Machine Drive	13%	9%	25%	38%	$0.10	10	3.38
Compressed Air - System Controls	Machine Drive	9%	7%	5%	34%	$0.40	10	0.59
Compressed Air - System Optimization and Improvements	Machine Drive	13%	9%	5%	34%	$0.80	10	0.42
Compressed Air - System Maintenance	Machine Drive	3%	2%	5%	34%	$0.20	10	0.34
Compressed Air - Compressor Replacement	Machine Drive	5%	4%	5%	34%	$0.20	10	0.68
Fan System - Controls	Machine Drive	4%	3%	10%	38%	$0.35	10	0.11
Fan System - Controls	Machine Drive	4%	3%	10%	38%	$0.35	10	0.11
Fan System - Optimization	Machine Drive	6%	5%	10%	38%	$0.70	10	0.08
Fan System - Optimization	Machine Drive	6%	5%	10%	38%	$0.70	10	0.08
Fan System - Maintenance	Machine Drive	1%	1%	10%	38%	$0.15	10	0.07
Fan System - Maintenance	Machine Drive	1%	1%	10%	38%	$0.15	10	0.07
Pumping System - Controls	Machine Drive	5%	4%	5%	34%	$0.38	12	0.42
Pumping System - Optimization	Machine Drive	13%	9%	5%	34%	$0.75	12	0.54
Pumping System - Maintenance	Machine Drive	2%	1%	5%	34%	$0.19	10	0.27
RTU - Maintenance	Cooling	14%	0%	22%	90%	$0.06	4	2.82
Chiller - Chilled Water Reset	Cooling	14%	0%	60%	75%	$0.09	4	2.53
Chiller - Chilled Water Variable-Flow System	Cooling	4%	0%	30%	34%	$0.20	10	0.80
Chiller - Turbocor Compressor	Cooling	30%	0%	0%	67%	$0.90	20	2.40
Chiller - VSD	Cooling	27%	0%	25%	67%	$1.17	20	1.63
Chiller - High Efficiency Cooling Tower Fans	Cooling	0%	0%	25%	50%	$0.04	10	0.04
Chiller - Condenser Water Temprature Reset	Cooling	10%	0%	5%	75%	$0.20	14	2.60
Cooling - Economizer Installation	Cooling	6%	0%	29%	34%	$0.15	15	1.92
Heat Pump - Maintenance	Combined Heating/Cooling	7%	7%	2%	95%	$0.03	4	7.76
Insulation - Ducting	Space Heating	5%	5%	12%	50%	$0.41	20	0.95
Insulation - Ducting	Cooling	3%	0%	12%	50%	$0.41	20	0.95
Energy Management System	Cooling	5%	0%	11%	90%	$0.35	14	0.88
Energy Management System	Space Heating	2%	1%	11%	90%	$0.35	14	0.88
Energy Management System	Interior Lighting	2%	1%	11%	90%	$0.35	14	0.88
Fans - Energy Efficient Motors	Ventilation	5%	5%	2%	90%	$0.14	10	2.81
Fans - Variable Speed Control	Ventilation	15%	5%	3%	90%	$0.34	10	2.97
Commissioning - HVAC	Cooling	5%	0%	60%	75%	$0.70	25	0.92
Commissioning - HVAC	Space Heating	5%	4%	60%	75%	$0.70	25	0.92
Commissioning - HVAC	Ventilation	5%	4%	60%	75%	$0.70	25	0.92
Pumps - Variable Speed Control	Machine Drive	5%	4%	0%	34%	$0.44	10	0.31
Thermostat - Clock/Programmable	Cooling	5%	0%	59%	70%	$0.13	11	2.02
Thermostat - Clock/Programmable	Space Heating	5%	1%	59%	70%	$0.13	11	2.02
Interior Lighting - Central Lighting Controls	Interior Lighting	10%	5%	84%	90%	$0.65	8	0.15
Exterior Lighting - Daylighting Controls	Exterior Lighting	30%	0%	10%	40%	$0.08	8	0.42
Interior Fluorescent - High Bay Fixtures	Interior Lighting	50%	25%	10%	38%	$0.20	11	1.76
LED Exit Lighting	Interior Lighting	2%	2%	85%	86%	$0.00	10	3.72
Commissioning - Lighting	Interior Lighting	5%	4%	60%	75%	$0.10	25	1.41
Commissioning - Lighting	Exterior Lighting	5%	4%	60%	75%	$0.10	25	1.41
Interior Lighting - Occupancy Sensors	Interior Lighting	10%	5%	15%	45%	$0.20	8	0.50
Exterior Lighting - Photovoltaic Installation	Exterior Lighting	75%	75%	5%	13%	$0.92	5	0.06
Interior Screw-in - Task Lighting	Interior Lighting	7%	4%	10%	75%	$0.24	5	0.03
Interior Lighting - Time Clocks and Timers	Interior Lighting	5%	3%	2%	56%	$0.20	8	0.25
Exterior Lighting - Cold Cathode Lighting	Exterior Lighting	1%	1%	5%	25%	$0.00	5	0.41
Advanced New Construction Designs	Cooling	40%	0%	5%	75%	$2.00	35	2.67
Advanced New Construction Designs	Space Heating	40%	30%	5%	75%	$2.00	35	2.67
Advanced New Construction Designs	Interior Lighting	25%	19%	5%	75%	$2.00	35	2.67
Custom Measures	Cooling	8%	0%	10%	45%	$1.60	15	1.28
Custom Measures	Space Heating	8%	6%	10%	45%	$1.60	15	1.28
Custom Measures	Interior Lighting	8%	6%	10%	45%	$1.60	15	1.28
Custom Measures	Machine Drive	8%	6%	10%	45%	$1.60	15	1.28
Furnace - Convert to Gas	Space Heating	100%	100%	0%	0%	$4.00	15	2.51

Note: Costs are per sq. ft.

APPENDIX | E

REFERENCES

American Home Appliance Manufacturers, "Today's Energy Standards for Refrigerators Reflect Consensus by Advocates, Industry to Increase Appliance Efficiency," September 27, 2010 press release, http://www.aham.org/ht/a/GetDocumentAction/i/50432.

Appliance Standards Awareness Project; http://www.standardsasap.org.

Avista Corporation, *2009 Electric Integrated Resource Plan*, August 31, 2009.

Avista Corporation, *System Load Research Project* report, March 2010, prepared by KEMA.

California Public Utilities Commission, Database for Energy Efficient Resources (DEER), 2009, http://www.deeresources.com.

Dun and Bradstreet Data, ZapData, http://www.dnb.com and http://www.zapdata.com.

California Energy Commission, *Residential Appliance Saturation Survey* (RASS), 2010, http://www.energy.ca.gov/appliances/rass/.

California Energy Commission, Commercial End-Use Survey (CEUS), 2006, http://www.energy.ca.gov/ceus/.

Electric Power Research Institute, *Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S. EPRI National Potential Study*, 2009.

ELEEK Lamping Guide; http://www.eleekinc.com.

Energy Information Administration, *Annual Energy Outlook 2011-ER*, December 2010, http://www.eia.doe.gov/forecasts/aeo/early_introduction.cfm#key.

Energy Information Administration, *EIA Technology Forecast Updates – Residential and Commercial Building Technologies – Reference Case, Second Edition (Revised)*, Navigant Consulting, September 2007.

Energy Information Administration, *EIA Technology Forecast Updates – Residential and Commercial Building Technologies – Reference Case*, Navigant Consulting, September 2008.

Energy Information Administration, *Annual Electric Power Industry Report*, EIA Form 861.

Energy Independence and Security Act of 2007. Pub. L. 110-140. 19 December 2007. Stat. 121.1492.

Environmental Protection Agency and U.S. Department of Energy, ENERGY STAR Program, http://www.energystar.gov.

Federal Energy Regulatory Commission, *A National Assessment of Demand Response Potential*, June 2009, http://www.ferc.gov/industries/electric/indus-act/demand-response/dr-potential.asp.

Forsyth, G., et al., *Assessing Heating Assistance Programs in Spokane County*, January 2010.

Forsyth, G., *Estimation and Analysis of At-risk Households* (presentation), Eastern Washington University, undated.

Global Energy Partners, Building Energy Simulation Tool (BEST).

Global Energy Partners, Energy Market Profiles Database.

Global Energy Partners, Database of Energy Efficiency Measures (DEEM).

Global Energy Partners, EnergyShape™ Database.

Grainger Catalog Volume 398, 2007–2008.

*Inland Power & Light Customer Energy Efficiency Study Executive Summary Repor*t, Robinson Research, January 2009.

Mills, E., *Building Commissioning, A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions*, Lawrence Berkeley National Laboratory, July 21, 2009, http://cx.lbl.gov/documents/2009-assessment/LBNL-Cx-Cost-Benefit.pdf.

National Action Plan for Energy Efficiency, *National Action Plan for Energy Efficiency Vision for 2025: Developing a Framework for Change*, 2007, www.epa.gov/eeactionplan.

Northwest Energy Efficiency Alliance, *2009 Northwest Commercial Building Stock Assessment* (10-211), http://neea.org/research/reportdetail.aspx?ID=546.

Northwest Energy Efficiency Alliance, *Single-Family Residential Existing Construction Stock Assessment*, Market Research Report, E07-179 (10/2007), http://neea.org/research/reportdetail.aspx?ID=194.

Northwest Power and Conservation Council, *Sixth Power Plan Conservation Supply Curve Workbooks*, 2010, http://www.nwcouncil.org/energy/powerplan/6/supplycurves/default.htm.

Robinson Research, *Inland Power & Light Customer Energy Efficiency Study Executive Summary Report,* January 2009.

RS Means, *Building Construction Cost Data,* 2011.

RS Means, *Facilities Maintenance and Repair Cost Data, 2011*.

RS Means, *Green Buildings Project Planning & Cost Estimating Third Edition*, 2011.

RS Means, *Mechanical Construction Costs, 2011*.

Spokane County, https://edis.commerce.state.nc.us/docs/countyProfile/WA/53063.pdf

U. S. Census Bureau, American Community Survey, http://www.census.gov/acs/www/.

U. S. Census Bureau, 2007 Economic Census, http://www.census.gov/econ/census07/.

U. S. Census Bureau, Population Estimates, http://www.census.gov/popest/cities/SUB-EST2009-4.htm.

U. S. Census Bureau, Quick Facts, http://quickfacts.census.gov/qfd/download_data.html

U. S. Census Bureau, http://www.census.gov/eos/www/naics/.

U.S. Department of Energy's Appliances and Commercial Equipment Standards Program: http://www1.eere.energy.gov/buildings/appliance_standards/index.html.

U.S. Department of Energy Building Technologies Program, *Multi Year Program Plan – Building Regulatory Programs - Energy Efficiency and Renewable Energy*, October 2010.

U.S Department of Health and Human Services, LIHEAP Clearinghouse, http://liheap.ncat.org/profiles/povertytables/FY2010/popstate.htm.

U.S. Green Building Council, *LEED New Construction & Major Renovation*, 2008.

Washington Office of Financial Management, *Long-term Forecast of Washington Personal Income*, http://www.ofm.wa.gov/economy/longterm/2009/lt09ch4.pdf and http://www.ofm.wa.gov/economy/hhinc/.

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2011 Electric Integrated Resource Plan

Appendix E – North Idaho Transmission Study

AVISTA

Interoffice Memorandum
System Planning

MEMO: SP-2011-08 Rev A
DATE: August 11, 2011
TO: James Gall, IRP Group
FROM: Reuben Arts
SUBJECT: 500 MW of New Generation in the Rathdrum Area

Introduction

Based on initial 2011 IRP analysis 200 MW of new capacity is required in 2019-2020 and an additional 300 MW of capacity in the 2022-2024 time period. North Idaho is one of several potential locations this capacity could be added, but requires further detail to understand its potential.

Problem Statement

The IRP group is specifically interested in the cost for both the point of integration (POI) station and associated system upgrades, to integrate the new generation with the following options:

1. Cabinet-Rathdrum 230 kV transmission line (assume 5 miles from Rathdrum)
2. Rathdrum-Boulder 230 kV transmission line (assume Lancaster looped in, and assume the generation is half way between Lancaster and Rathdrum)
3. Rathdrum-Beacon 230 kV transmission line (assume 1-2 miles from Rathdrum)
4. Double Tap, Rathdrum-Boulder and Rathdrum-Beacon 230 kV transmission lines (again assume Lancaster is looped in and that the new generation will tap between Lancaster and Rathdrum)
5. Mixed location. 300 MW at the least cost option (between 1 and 4) and an additional 200 MW on the Cabinet-Rathdrum 230 kV transmission line.
6. Other Transmission Alternatives

Power Flow Analysis

The case that was used to highlight the impacts of an additional 500 MW in the Rathdrum area was the WECC approved and Avista modified light summer high flow case (AVA-11ls1ae-12BA1251-WOH4277). The West of Hatwai path typically experiences high flows during light Avista load hours. High West of Hatwai flows tend to coincide with high Western Montana Hydro generation, high Boundary generation, high flows on Montana to Northwest, and light loads in Eastern Washington, North Idaho, and Montana. Existing Clark Fork RAS is in place, and assumed armed, since the Western Montana Hydro (WMH) complex is greater than 1450 MW. Since the New Project would require significant Avista system transmission changes, and RAS changes, the results are listed as though RAS were not armed. This does affect the results of some contingencies, but ultimately does not change the conclusions of this memo.

Option 1

Perhaps one of the worst performing arrangements is option 1.This option immediately requires another line, or a line reconductor, from the 500 MW project back to Rathdrum. In order to stay within N-0 thermal limits the project can only be 175 MW without any system upgrades. In a high flow, N-0 scenario, the line segment from the project back to Rathdrum loads to around 163%, which is roughly 272 MW overloaded. There are a handful of N-1 and N-2 contingencies that cause significant thermal violations, the worst N-1 being the loss of the 230 kV transmission line from the new project to Rathdrum. See Figure 1

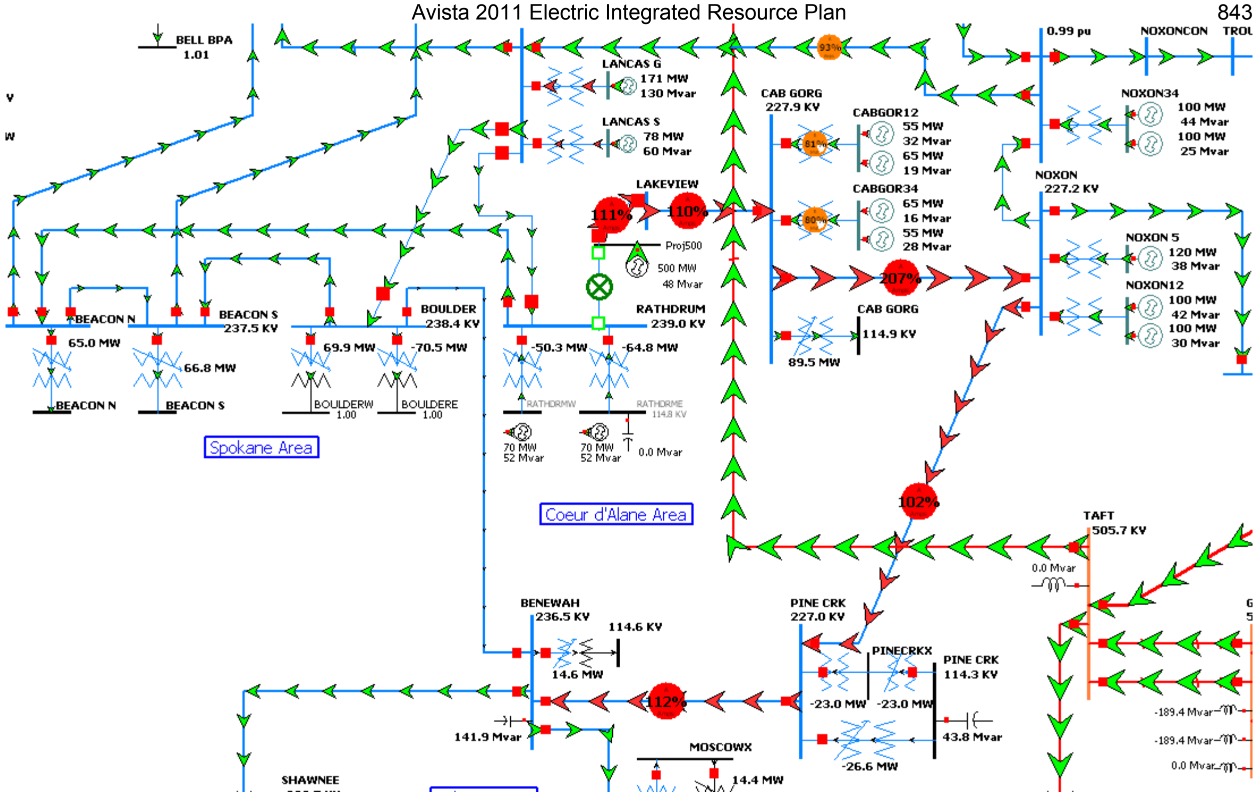

Figure 1 – N-1 Contingency

In addition to this worst case outage there are two N-2 scenarios that cause fairly significant problems as well. The Beacon-Rathdrum and Boulder-Lancaster-Rathdrum 230 kV transmission lines share a common structure for the majority of the line lengths. Losing both lines to the west of Lancaster causes the Bell S3-Lancaster 230 kV transmission line to overload. Losing both lines to the east of Lancaster, causes nearly the same scenario as shown in Figure 1.

To alleviate these overloads three new 230 kV transmission lines, would need to be built. First the Rathdrum-New Project 230 kV transmission line must be reconductored at a cost of roughly $2.25M. Second, A 230 kV transmission line, with new right-of-way, must be built from the New Project to Lancaster. The estimated distance for this line is roughly 5 miles. The estimated loaded cost for this line, including a new line position at Lancaster and at the New Project, is roughly $9M. Finally, another 230 kV transmission line, again with new right-of-way, is required from Lancaster to Boulder. This line length is estimate at roughly 15 miles. The estimated loaded cost of the new line, including new line positions, is roughly $17M. New right-of-way in this area will be difficult to obtain, which would have the potential of more than doubling costs.

RAS may be a viable solution. If at all possible RAS should be a last resort. Unlike improving our transmission system, RAS does not provide operational flexibility and in some cases can compound the impacts of future generation needs. However, it does represent the cheapest solution and is therefore listed as solution 1.

Option 1	N-0 Max. Output	Facility Requirement[1]	Total[2] ($000)
Solution 1	500 MW	Reconductor 230 kV transmission line from new station to Rathdrum, New 230 kV DB-DB Station and RAS[3]	13,250
Solution 2	500 MW	Reconductor from Rathdrum-New Project. New line from Lancaster to New Project. New line from Lancaster to Boulder, New 230 kV DB-DB Station	36,250

Option 2

This option would tap the Rathdrum-Boulder, or what soon will be the Rathdrum-Lancaster-Boulder, 230 kV transmission line. This options has no N-0 issues at the full requested 500 MW. There are a handful of N-1 and N-2 contingencies that cause significant thermal violations, the worst being the loss of the Lancaster-Boulder & Rathdrum-Beacon 230 kV transmission lines. These lines share a common structure and therefore represent a credible N-2 scenario. This outage causes the Lancaster-Bell S3 230 kV transmission line to load to 189%, or roughly 450 MW above its thermal limit. See Figure 2.

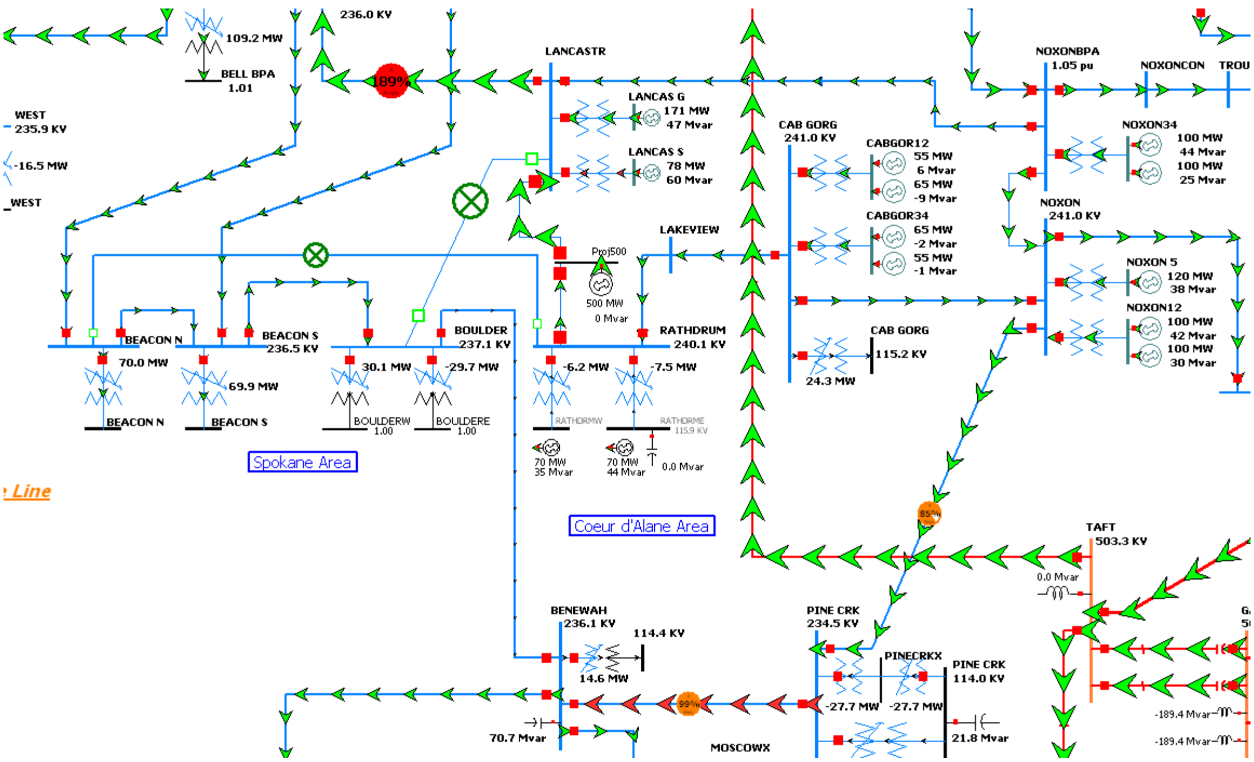

Figure 2 - N-2 Contingency

To alleviate these overloads two new 230 kV transmission lines, would need to be built. A 230 kV transmission line, with new right-of-way, must be built from the New Project to Lancaster. The estimated distance for this line is roughly 3 miles. The estimated loaded cost for this line, including a new line position at Lancaster and at the New Project, is roughly $8M. Another 230 kV transmission line, again with new right-of-way, is required from Lancaster to Boulder. This line length is estimate at roughly 15 miles. The estimated loaded cost of the new line, including new line positions, is roughly $17M. New right-of-way in this area will be difficult to obtain, which would have the potential of more than doubling costs.

[1] Cost estimates do not include costs of the radial line to the POI, the generator or generator station if applicable.
[2] Total is for network and direct assigned costs, are in 2011 dollars, and is +/- 50%.
[3] The RAS portion is a worst case scenario where another fiber loop is required. $3M allocated for RAS.

RAS may be a viable solution. If at all possible RAS should be a last resort. Unlike improving our transmission system, RAS does not provide operational flexibility and in some cases can compound the impacts of future generation needs. However, it does represent the cheapest solution and is therefore listed as solution 1.

Option 2	N-0 Max. Output	Facility Requirement[4]	Total[5] ($000)
Solution 1	500 MW	New 230 kV DB-DB Station and RAS[6]	11,000
Solution 2	500 MW	New line from Lancaster to New Project. New line from Lancaster to Boulder, New 230 kV DB-DB Station	33,000

Option 3

This option taps the Rathdrum-Beacon 230 kV transmission line. Again, this options has no N-0 issues at the full requested 500 MW. There are a handful of N-1 and N-2 contingencies that cause significant thermal violations, the worst being the loss of the Beacon-New Project & Rathdrum-Lancaster 230 kV transmission lines. These lines share a common structure and therefore represent a credible N-2 scenario. This outage forces the entire proposed 500 MW toward Cabinet and Noxon. This causes overloads on the Cabinet-Noxon and Pine Creek-Benewah 230 kV transmission lines. See Figure 3.

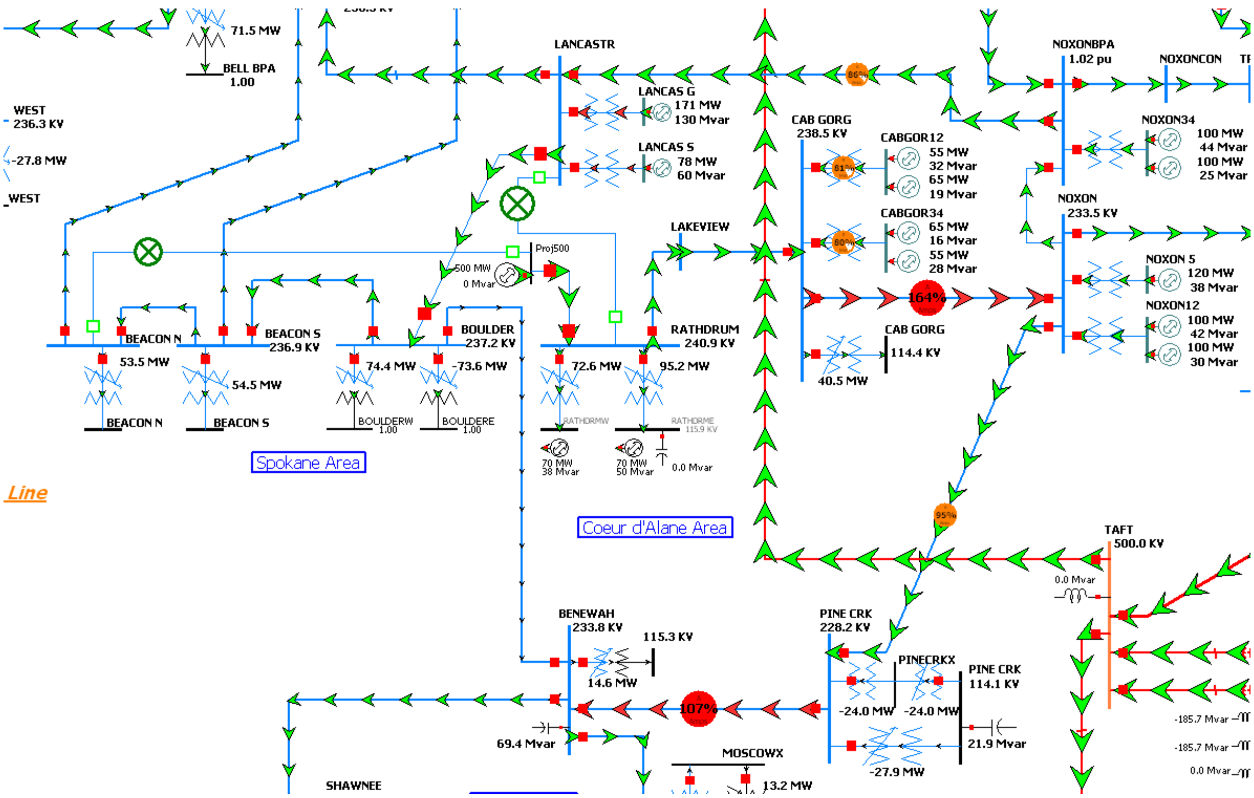

Figure 3 - N-2 Contingency

[4] Cost estimates do not include costs of the radial line to the POI, the generator or generator station if applicable.
[5] Total is for network and direct assigned costs, are in 2011 dollars, and is +/- 50%.
[6] The RAS portion is a worst case scenario where another fiber loop is required. $3M allocated for RAS.

To alleviate these overloads two new 230 kV transmission lines, would need to be built. A 230 kV transmission line, with new right-of-way, must be built from the New Project to Lancaster. The estimated distance for this line is roughly 3 miles. The estimated loaded cost for this line, including a new line position at Lancaster and at the New Project, is roughly $8M. Another 230 kV transmission line, again with new right-of-way, is required from Lancaster to Boulder. This line length is estimate at roughly 15 miles. The estimated loaded cost of the new line, including new line positions, is roughly $17M. New right-of-way in this area will be difficult to obtain, which would have the potential of more than doubling costs.

RAS may be a viable solution. If at all possible RAS should be a last resort. Unlike improving our transmission system, RAS does not provide operational flexibility and in some cases can compound the impacts of future generation needs. However, it does represent the cheapest solution and is therefore listed as solution 1.

Option 3	N-0 Max. Output	Facility Requirement[7]	Total[8] ($000)
Solution 1	500 MW	New 230 kV DB-DB Station and RAS[9]	11,000
Solution 2	500 MW	New line from Lancaster to New Project. New line from Lancaster to Boulder, New 230 kV DB-DB Station	33,000

Option 4

This option taps the Rathdrum-Beacon & Rathdrum-Lancaster 230 kV transmission lines. This options has no N-0 issues at the full requested 500 MW. There are a handful of N-1 and N-2 contingencies that cause significant thermal violations, the worst being the loss of the Beacon-New Project & Lancaster-New Project 230 kV transmission lines. These lines share a common structure and therefore represent a credible N-2 scenario. This outage forces the entire proposed 500 MW toward Cabinet and Noxon. This causes overloads on the Cabinet-Noxon and Pine Creek-Benewah 230 kV transmission lines. (Very similar to Figure 3 on the previous page).

To alleviate these overloads two new 230 kV transmission lines, would need to be built. A 230 kV transmission line, with new right-of-way, must be built from the New Project to Lancaster. The estimated distance for this line is roughly 3 miles. The estimated loaded cost for this line, including a new line position at Lancaster and at the New Project, is roughly $8M. Another 230 kV transmission line, again with new right-of-way, is required from Lancaster to Boulder. This line length is estimate at roughly 15 miles. The estimated loaded cost of the new line, including new line positions, is roughly $17M. New right-of-way in this area will be difficult to obtain, which would have the potential of more than doubling costs.

RAS may be a viable solution. If at all possible RAS should be a last resort. Unlike improving our transmission system, RAS does not provide operational flexibility and in some cases can compound the impacts of future generation needs. However, it does represent the cheapest solution and is therefore listed as solution 1.

Option 4	N-0 Max. Output	Facility Requirement	Total ($000)
Solution 1	500 MW	New 230 kV DB-DB Station and RAS	15,000
Solution 2	500 MW	New line from Lancaster to New Project. New line from Lancaster to Boulder, New 230 kV DB-DB Station	37,000

[7] Cost estimates do not include costs of the radial line to the POI, the generator or generator station if applicable.
[8] Total is for network and direct assigned costs, are in 2011 dollars, and is +/- 50%.
[9] The RAS portion is a worst case scenario where another fiber loop is required. $3M allocated for RAS.

Option 5

This option taps the Rathdrum-Beacon & Rathdrum-Cabinet 230 kV transmission lines. A new switching station is required for each tap. A 300 MW generating station would be on the Beacon-Rathdrum 230 kV transmission line and 200 MW would be on the Rathdrum-Cabinet 230 kV transmission line. This option has no N-0 issues at the full requested 500 MW. There are a handful of N-1 and N-2 contingencies that cause significant thermal violations, the worst being the loss of the Beacon-New Project & Lancaster-Rathdrum 230 kV transmission lines. These lines share a common structure and therefore represent a credible N-2 scenario. This outage forces the entire proposed 500 MW toward Cabinet and Noxon. This causes overloads on the Cabinet-Noxon and Pine Creek-Benewah 230 kV transmission lines. (Very similar to what was shown in Figure 3).

To alleviate these overloads three new 230 kV transmission lines, would need to be built. A 230 kV transmission line, with new right-of-way, must be built from the New Project (300MW piece) to Lancaster. The estimated distance for this line is roughly 5 miles. The estimated loaded cost for this line, including a new line position at Lancaster and at the New Project, is roughly $9M. Another 230 kV transmission line, again with new right-of-way, is required from Lancaster to Boulder. This line length is estimate at roughly 15 miles. The estimated loaded cost of the new line, including new line positions, is roughly $17M. Finally, for the loss of the Rathdrum-New Project (200MW piece) 230 kV transmission line, causes the Cabinet-Noxon 230 kV transmission line to load to 117%. To alleviate this overload a new line, with new right-of-way must be built back to Rathdrum. The estimated loaded cost of this 5 mile line, along with associated line positions, is $9M. New right-of-way in this area will be difficult to obtain, which would have the potential of more than doubling costs.

RAS may be a viable solution. If at all possible RAS should be a last resort. Unlike improving our transmission system, RAS does not provide operational flexibility and in some cases can compound the impacts of future generation needs. However, it does represent the cheapest solution and is therefore listed as solution 1.

Option 5	N-0 Max. Output	Facility Requirement[10]	Total[11] ($000)
Solution 1	500 MW	Two New 230 kV DB-DB Stations and RAS[12]	22,000
Solution 2	500 MW	Two New 230 kV DB-DB Stations, New line from Lancaster to New Project (300MW). New line from Lancaster to Boulder, New line from New Project (200MW) to Rathdrum	51,000

Option 6 – Other Transmission Alternatives

In addition to the five options listed, there are a few more options that may seem to be intuitive interconnection points. These integration options are:

a. Lancaster 230 kV (BPA) switching station
b. Rathdrum 230/115/13.2 kV substation
c. Cabinet-Rathdrum & Noxon-Lancaster 230 kV transmission lines
d. Bell-Taft 500 kV transmission line

Option 6a - Connecting to the Lancaster 230 kV switching station would save Avista the cost of a new switching station. It would also negate the need for a new transmission line, with associated right-of-way, from the new project to Lancaster. The estimated savings, adding the previously quoted loaded costs, less

[10] Cost estimates do not include costs of the radial line to the POI, the generator or generator station if applicable.
[11] Total is for network and direct assigned costs, are in 2011 dollars, and is +/- 50%.
[12] The RAS portion is a worst case scenario where another fiber loop is required. $3M allocated for RAS.

the added cost of connecting to Lancaster, is $13M[13]. This does not take into account any fees associated with connecting to BPA. This option assumes there is room in the Lancaster substation to accept the new line position. If Lancaster substation cannot accommodate the new line position, the cost savings to interconnect at Lancaster may be negligible or non-existent.

This option would still have all the contingency issues and associated upgrades similar to Option 2.

Option 6b - Connecting to the Rathdrum substation saves the cost of building another switching station. All contingency results are nearly identical to connecting the project to option 2 or option 3. The estimated savings of this option is $4M[14]. This option assumes there is room in the Rathdrum substation to accept the new line position. If Rathdrum substation cannot accommodate the new line position, the cost savings to interconnect at Rathdrum may be negligible or non-existent.

Option 6c – Tapping the Cabinet-Rathdrum & Noxon-Lancaster 230 kV transmission lines does improve the network performance, in comparison to tapping only the Cabinet-Rathdrum 230 kV transmission line. However, this option still requires all the same network upgrades that option 1 requires since it is still possible to have an N-2 situation where the generation of the New Project, Noxon and Cabinet is separated from the Coeur d'Alene/Spokane load. (See Figure 1). This option is listed for completeness.

Option 6d - Connecting solely to the Bell-Taft 500 kV transmission line cannot be done without RAS and possibly some network upgrades on BPA's system. In addition to the network upgrades that would likely be required on BPA's system, Avista would also be financially liable to pay wheeling fees from the new project across BPA's lines to Avista's load. If the project is connected to both BPA's Bell-Taft 500 kV transmission line and Avista's Rathdrum area 230 kV system, effectively avoiding wheeling charges, both RAS and significant network upgrades will be required. Due to the cost of a new 500 kV substation, associated RAS and the potentially large cost of network upgrades on BPA's 500 kV system, this option is not recommended.

Conclusion

Of the formally identified options, options 2 and 3 represent the least cost and best performing options. Of the other transmission alternatives, the Lancaster switching station, followed by the Rathdrum substation, interconnection options represent the least cost and best performing alternative options. The following favorable options are:

- Option 2: $11-33M (RAS only vs System Upgrades)[15]
- Option 3: $11-33M (RAS only vs System Upgrades)[15]
- Lancaster Alternative Option: $7-20M (RAS only vs System Upgrades)
- Rathdrum Alternative Option: $7-33M (RAS only vs System Upgrades)

[13] Assumes a network upgrade solution would be pursued, instead of a RAS only solution.
[14] This $4M savings would be for either a RAS only or a network upgrade solution.
[15] If the new project is interconnected to the west of Lancaster, the Lancaster-New Project 230 kV transmission line is not needed. Hence the network upgrade cost would be reduced by $8M.

2011 Electric Integrated Resource Plan

Appendix F – 2011 Electric IRP New Resource Table for Transmission

2011 Avista IRP

New Resource Table For Transmission

Resource	Resource Location	POR or Local Area	POD	Start	Stop	Capacity MW	Year Total
Noxon 4 (incremental)	Noxon, MT	Noxon, MT	AVA System	4/1/2012	Indefinite	14.0	
Wind	Oaksdale, WA	Thorton	AVA System	8/1/2012	Indefinite	102.0	116.0
Lancaster CCCT	Rathdrum, ID	Bell/Westside	AVA System	1/1/2013	10/31/2026	125.0	
Lancaster CCCT	Rathdrum, ID	Mid-C	AVA System	1/1/2013	10/31/2026	150.0	275.0
Coyote Springs 2	Boardman, OR	Coyote Springs 2	AVA System	5/1/2018	Indefinite	16.0	16.0
SCCT	TBD	TBD	AVA System	1/1/2019	Indefinite	86.3	86.3
Wind	Reardan, WA	Reardan	AVA System	1/1/2020	Indefinite	60.0	60.0
Wind	Reardan, WA	Reardan	AVA System	1/1/2021	Indefinite	60.0	
SCCT	TBD	TBD	AVA System	1/1/2021	Indefinite	86.3	146.3
CCCT	TBD	TBD	AVA System	1/1/2024	Indefinite	280.8	280.8
CCCT	TBD	TBD	AVA System	11/1/2026	Indefinite	280.8	280.8
SCCT	TBD	TBD	AVA System	1/1/2030	Indefinite	47.8	47.8
					Total	1309	1309

August 18, 2011