2019 Electric Integrated Resource Plan

Technical Advisory Committee Meeting No. 5 Agenda

Tuesday, October 15, 2019
Conference Room 130

Topic	Time	Staff
Introductions, Updates and TAC 4 Recap	9:30	Lyons
Energy Imbalance Market Update	10:00	Kinney
Break	11:00	
Storage and Ancillary Service Analysis	11:15	Shane
Lunch	12:00	
Preliminary Preferred Resource Strategy	1:00	Gall
Break	2:00	
Preliminary Portfolio Scenario Results	2:15	Gall
Adjourn	3:30	

2020 Electric IRP
TAC Meeting Introductions and Recap

John Lyons, Ph.D.
Fifth Technical Advisory Committee Meeting
October 15, 2019

Integrated Resource Planning

The Integrated Resource Plan (IRP):

- Required by Idaho and Washington every other year
- Guides resource strategy over the next twenty years
- Current and projected load & resource position
- Resource strategies under different future policies
  - Generation resource choices
  - Conservation / demand response
  - Transmission and distribution integration
  - Avoided costs
- Market and portfolio scenarios for uncertain future events and issues

Technical Advisory Committee

- The public process piece of the IRP – input on what to study, how to study, and review of assumptions and results
- Wide range of participants in all or some of the process
- Open forum while balancing need to get through all of the topics
- Welcome requests for studies or different assumptions.
  - Time or resources may limit the studies we can do
  - The earlier study requests are made, the more accommodating we can be
  - June 15, 2019 was the latest to be able to complete studies in time for publication
- Planning team is available by email or phone for questions or comments between the TAC meetings

TAC #4 Recap – August 6, 2019

- Introductions and TAC 3 Recap, Lyons
- Washington SB 5116 and IRP Updates, Lyons
- Energy and Peak Load Forecast Update, Forsyth
- Natural Gas Price Forecast, Pardee
- Electric Price Forecast, Gall
- Existing Resource Overview, Lyons
- Final Resource Needs Assessment, Lyons

- Meeting minutes available on IRP web site at: https://www.myavista.com/about-us/our-company/integrated-resource-planning

Today's Agenda

9:30 – Introductions and TAC 4 Recap, Lyons

10:00 – Energy Imbalance Market Update, Kinney

11:00 – Break

11:15 – Storage and Ancillary Service Analysis, Shane

Noon – Lunch

1:00 – Preliminary Preferred Resource Strategy, Gall

2:00 – Break

2:15 – Preliminary Portfolio Scenario Results, Gall

3:30 – Adjourn

Future TAC Topics

- TAC 6: Tuesday, November 19, 2019
  - Review of final PRS
  - Market scenario results (continued)
  - Final Portfolio scenario results
  - Carbon cost abatement supply curves
  - 2020 IRP Action Items

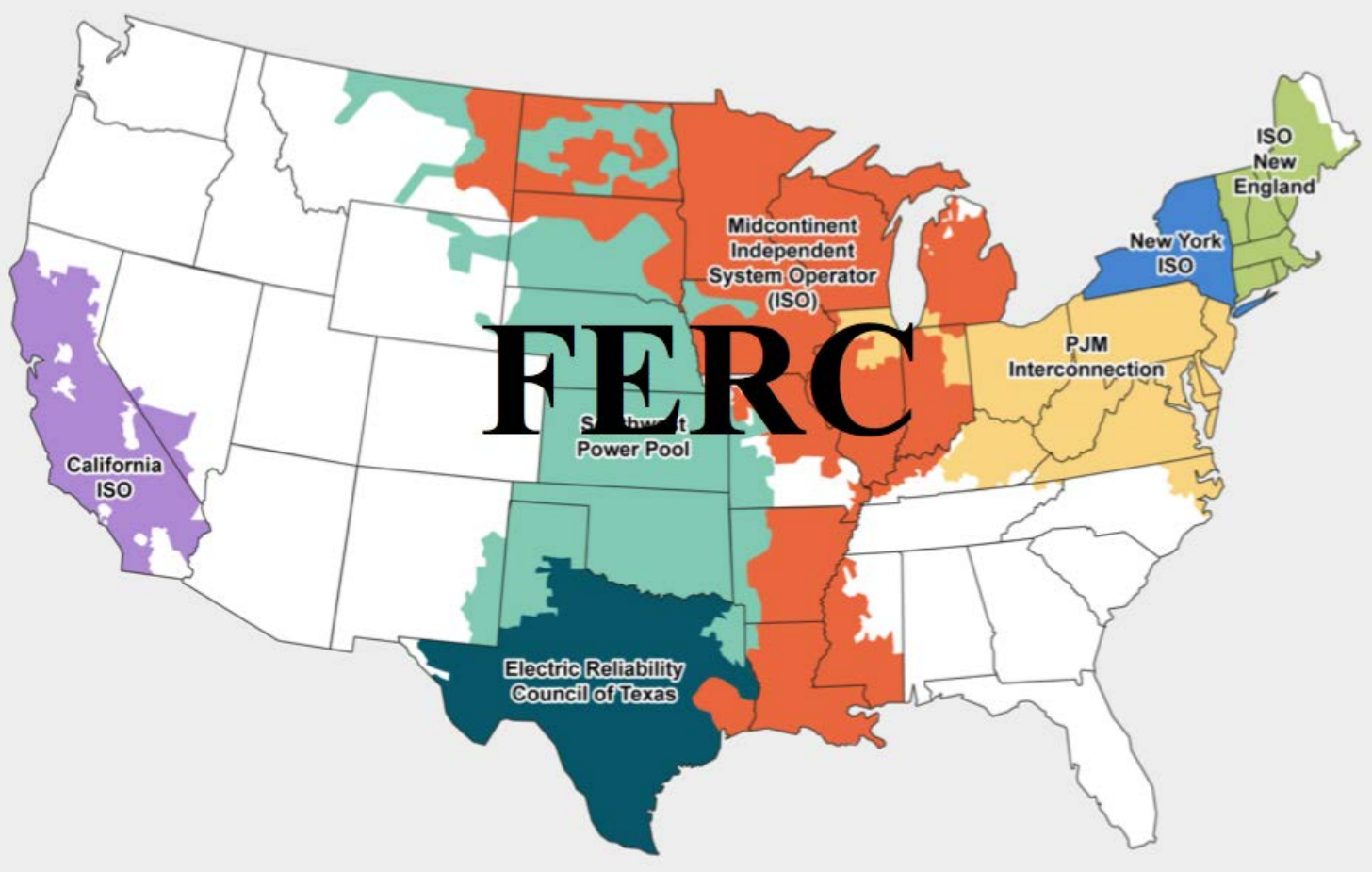
2020 Electric IRP
Energy Imbalance Market Update

Scott Kinney, Director of Power Supply
Fifth Technical Advisory Committee Meeting
October 15, 2019

Discussion

- Market Operations Today
  - NW bilateral market
  - California Independent System Operator (CAISO) market
- Western Energy Imbalance Market (EIM)
  - How the EIM works
  - Current participants
- Avista's Decision to join the EIM
  - Drivers
  - Costs and benefits
- Project Status

Organized Electric Markets



NW Bilateral Market

- No organized market
- Utilities operate individually
  - Buy/sell with counterparties or through electronic clearing house
    - Monthly, day ahead and hourly
  - Utilities hold extra resources to meet forecast error
    - Can’t take advantage of regional load/resource diversity
  - Must meet all NERC compliance requirements
  - Perform transmission planning
  - Facilitate transmission tariff and sales
- Less efficient

The CAISO Market

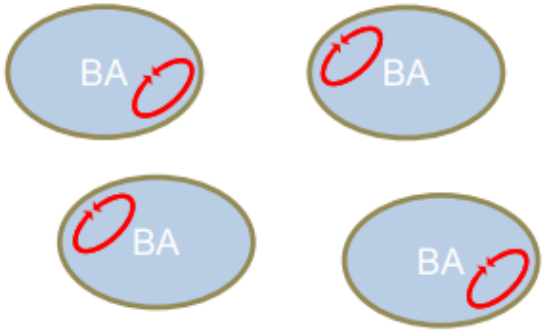
- The California Independent System Operator (CAISO) runs a full organized energy market in California
- Based in Folsom, CA, operational since 1998
- Utilities maintain ownership of generation and transmission assets
- CAISO ensures sufficient resources to meet CA load
  - Balancing Authority for members
  - Day ahead dispatch plan
  - Real-time resource dispatch
- Conducts long-term transmission planning
- Facilitates transmission tariff and sales

What is the Western Energy Imbalance Market?

- Operational since 2014 – CAISO and PacifiCorp
- The EIM is an economic based 5 minute in-hour regional resource dispatch program
  - Allows participants to lower energy costs
    - Dispatch less expensive resources to meet in-hour load obligations
    - Increase revenue through the bidding of excess energy
    - Monetize resources traditionally held for regulating reserves
  - The EIM dispatches the most economic resource across its entire market footprint every 5 minutes based on bid prices to balance in-hour load and generation

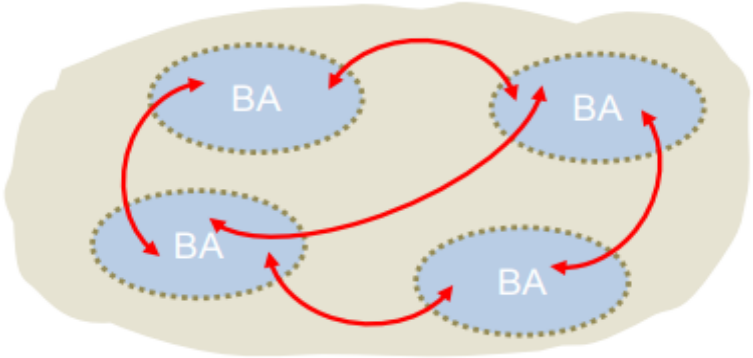
Why EIM?

Prior to EIM:
Each BA must balance loads and resources w/in its borders.



- Limited pool of balancing resources
- Inflexibility
- High levels of reserves
- Economic inefficiencies
- Increased costs to integrate wind/solar

In an EIM:
The market dispatches resources across BAs to balance energy

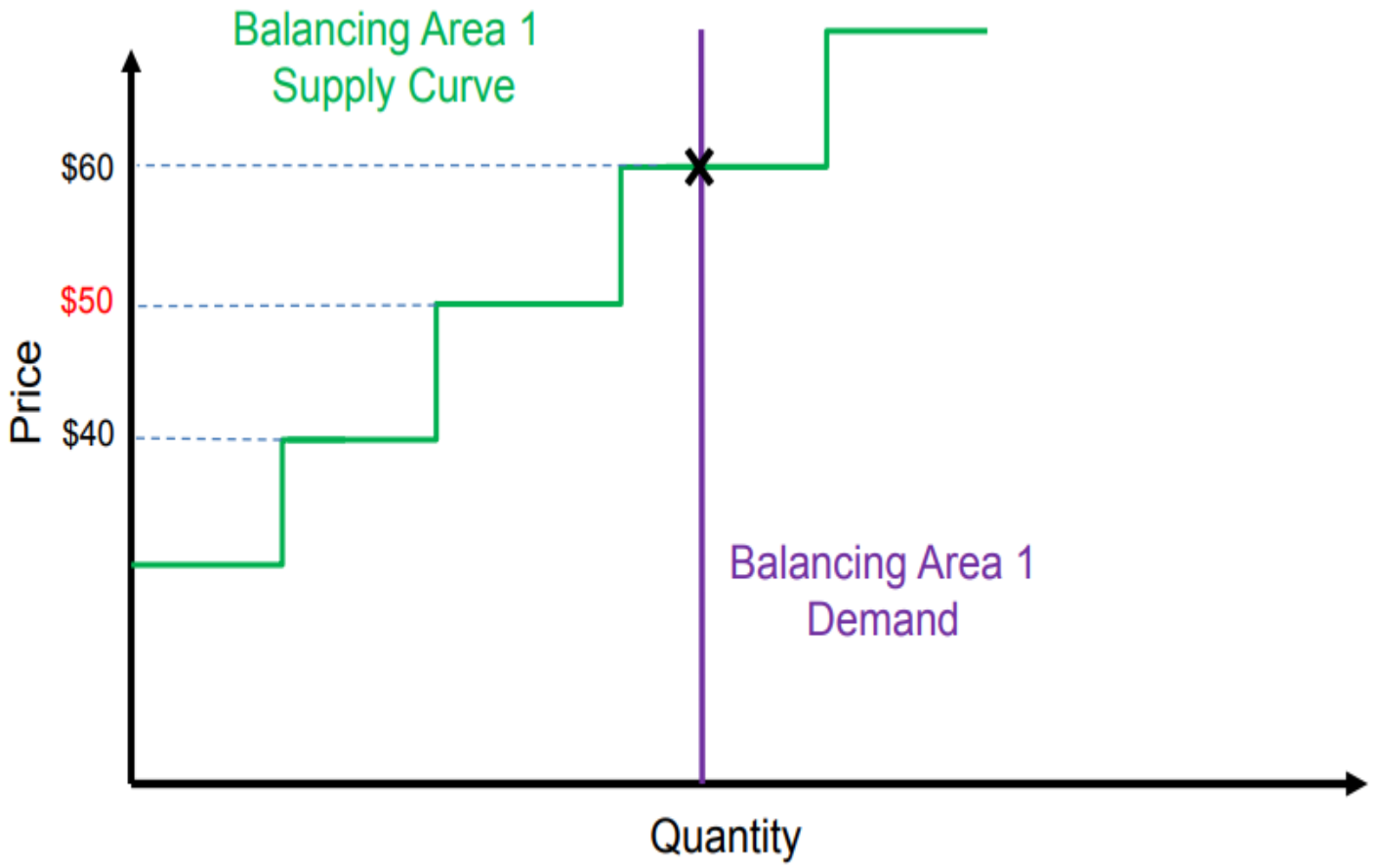


- Diversity of balancing resources
- Increased flexibility
- Decreased flexible reserves
- More economically efficient
- Decreased integration costs

How the EIM Works

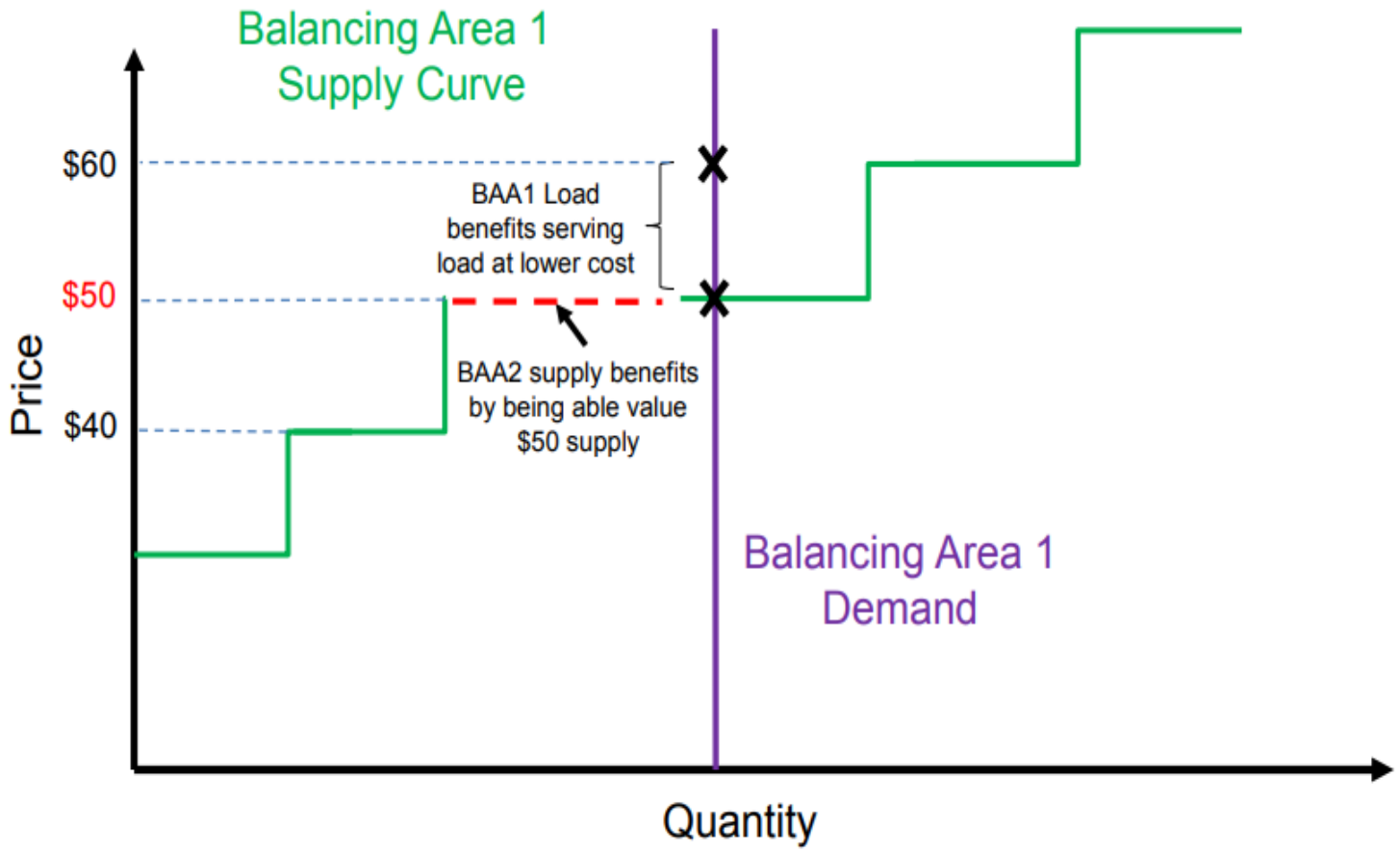
- Participants must show they can meet load obligations prior to the operating hour, no leaning on the market
- Participants voluntarily submit resource availability, min/max, ramp rates and price curves
- CAISO runs a security constraint (i.e. transmission) economic dispatch every 5 minutes to obtain the optimal economic and reliable resource solution for the EIM footprint
- Transmission congestion leads to price differentials
- CAISO sends a 5 minute dispatch request to selected resources to meet overall footprint load obligation
- Generators and load are assigned a locational marginal price based on the economic dispatch and transmission congestion

EIM Supply Transfers Benefit Both Areas



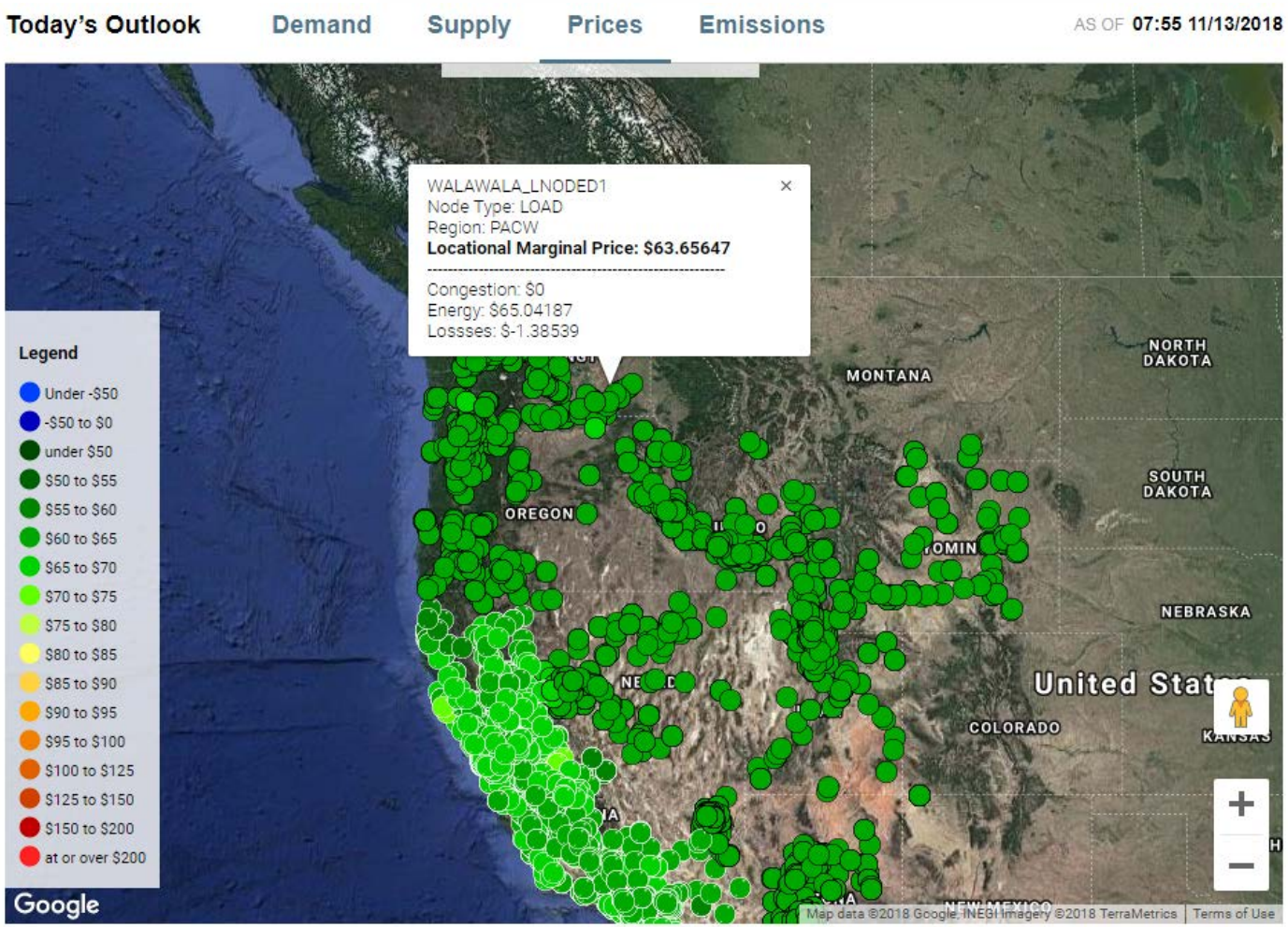
$50 supply from balancing area 2 displaces $60 supply in balancing area 1

EIM Supply Transfers Benefit Both Areas

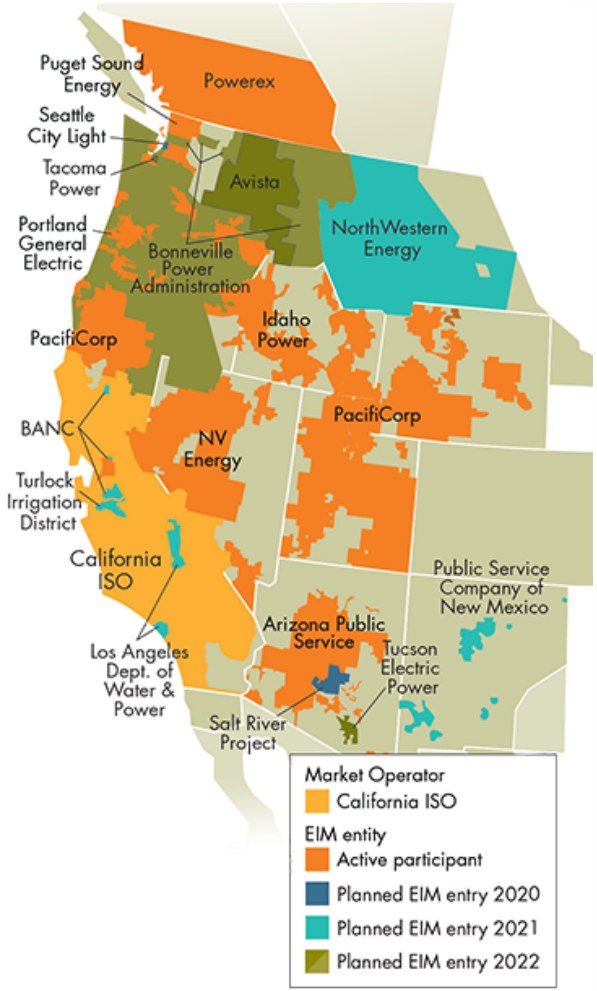


$50 supply from balancing area 2 displaces $60 supply in balancing area 1

http://www.caiso.com/TodaysOutlook/Pages/prices.aspx



EIM Participants



80% of WECC load

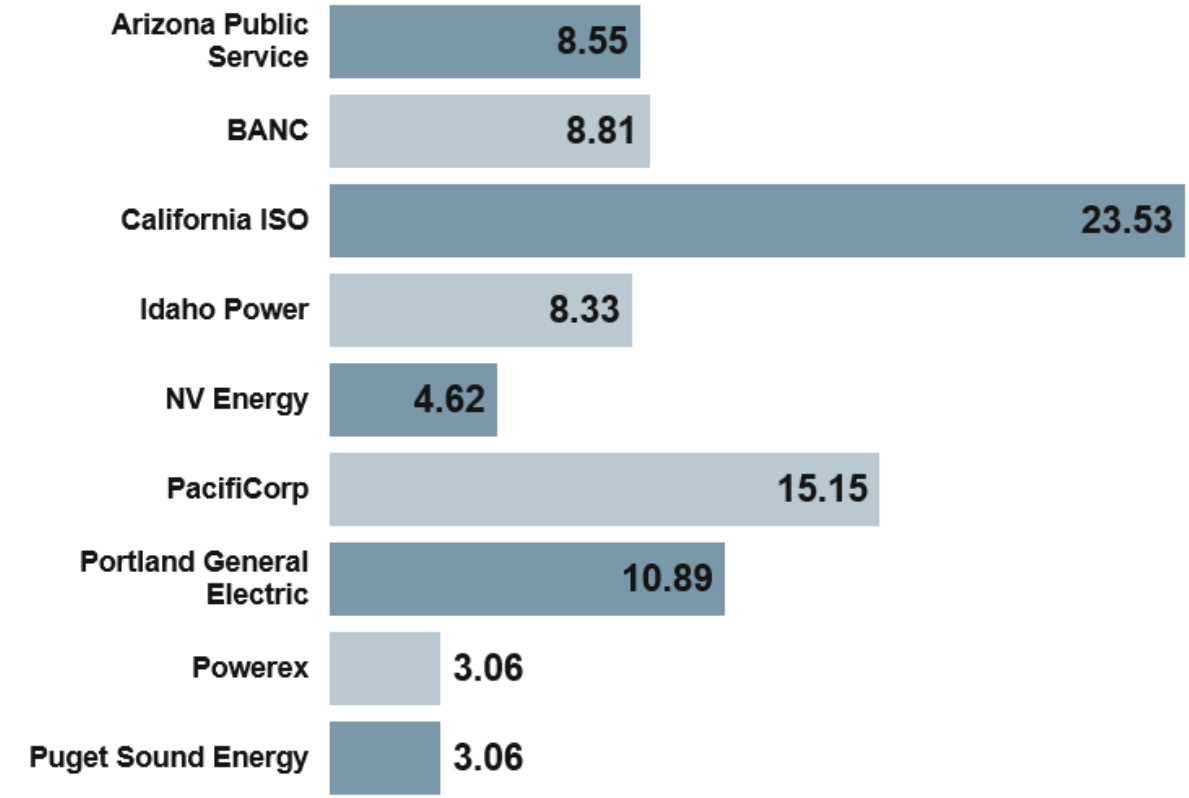
- Members - CAISO, PAC, NVE, PSE, APS, PGE, IPC, Powerex, BANC (SMUD)
- Committed
  - 2020 – SCL, SRP
  - 2021 – PNM, NWE, LADWP, TID
  - 2022 – Avista, TEC, Tacoma, BPA

EIM Gross Benefits

$86m savings in Q2 2019

Read full report >> Read news release >>

(millions $)



TOTAL **$736.26m**

gross benefits since Nov 2014

Market Monitoring Phase 2015-2018

- Limited needs and risks
  - Small renewable penetration
  - Economics not compelling
  - Other large technology projects
- Monitor market development
  - Engage in public processes and meetings
- EIM Entity outreach and site visits
- CAISO Scheduling Coordinator certification
  - June 2016
- Infrastructure evaluation

Avista Decision Drivers and Risks

- In-hour market liquidity risks
  - 2018 summer issues
  - NWE joining in 2021, BPA planning to join in 2022
- Renewable energy integration
  - Rattlesnake Wind contract - 145 MWs end of 2020
  - Transmission interconnection queue >1000MW
  - Avista's clean energy goals
  - State policies and regulations
    - WA Clean Energy Bill
    - WA PURPA changes

Avista Decision Drivers and Risks cont.

- Economics
  - Customer benefits
  - Risks of not joining
    - Reduction in current optimization opportunities
    - Higher resource dispatch costs

Avista EIM Costs and Benefits

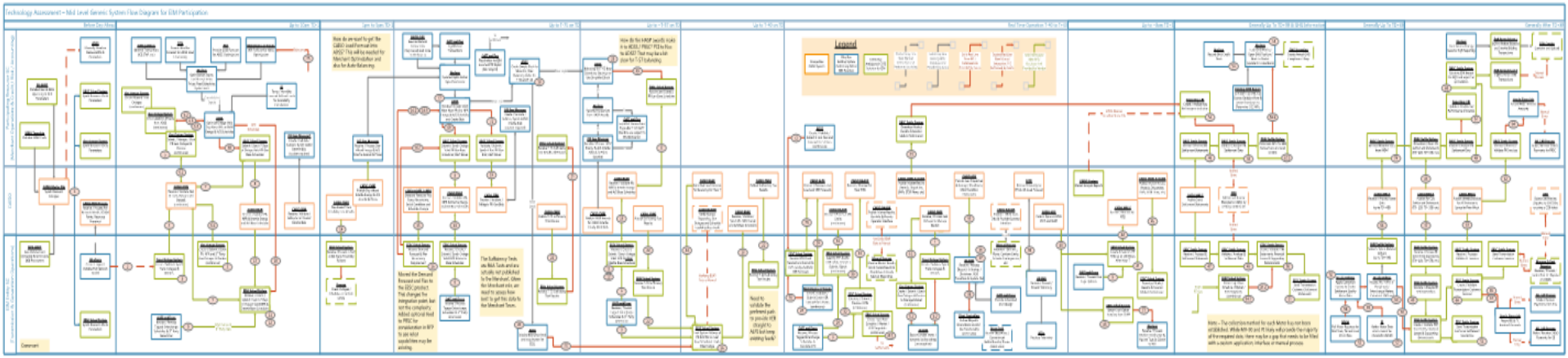
- Estimated EIM costs
  - $21 – 26 M start-up
  - $3.5 – 4.0 M on-going
- Anticipate 12+ new FTE for on-going support
- Estimated annual benefits
  - Full range $ 2 – 12 M
  - Expected range $3.5 - 9.2 M
  - Base $5.8 M

Utility EIM Cost/Benefit Comparison ($M)

	PAC	NVE	PSE	APS	PGE	IPC	AVA
Actual Costs	21.0	11.5+	22.0	16.0	22.0	12.0+	21.5
Studied Benefits	35.1	10.8	14.1	4.9	3.5	4.1	5.8
2018 Actual Benefits	61.7	25.6	13.7	45.3	27.6	26.9	?

Project Status

- Officer approval on April 15 to join EIM
  - Go-live April 1, 2022
- CAISO Contract
  - Signed Integration Agreement on April 25
- System Integrator – Utilicast
- Current efforts
  - Upgrade/replace meters and generation controls
  - Expand telecomm networks
  - Request For Proposals for EIM applications
    - Issued Outage Management RFP on August 13
    - Issued Bid to Bill RFP on September 17
  - ADSS enhancements
  - Staffing plan and training



2020 Electric IRP
Storage and Ancillary Services Analysis

Xin Shane, Senior Power Supply Analyst
Fifth Technical Advisory Committee Meeting
October 15, 2019

Challenges of Energy Storage Valuation

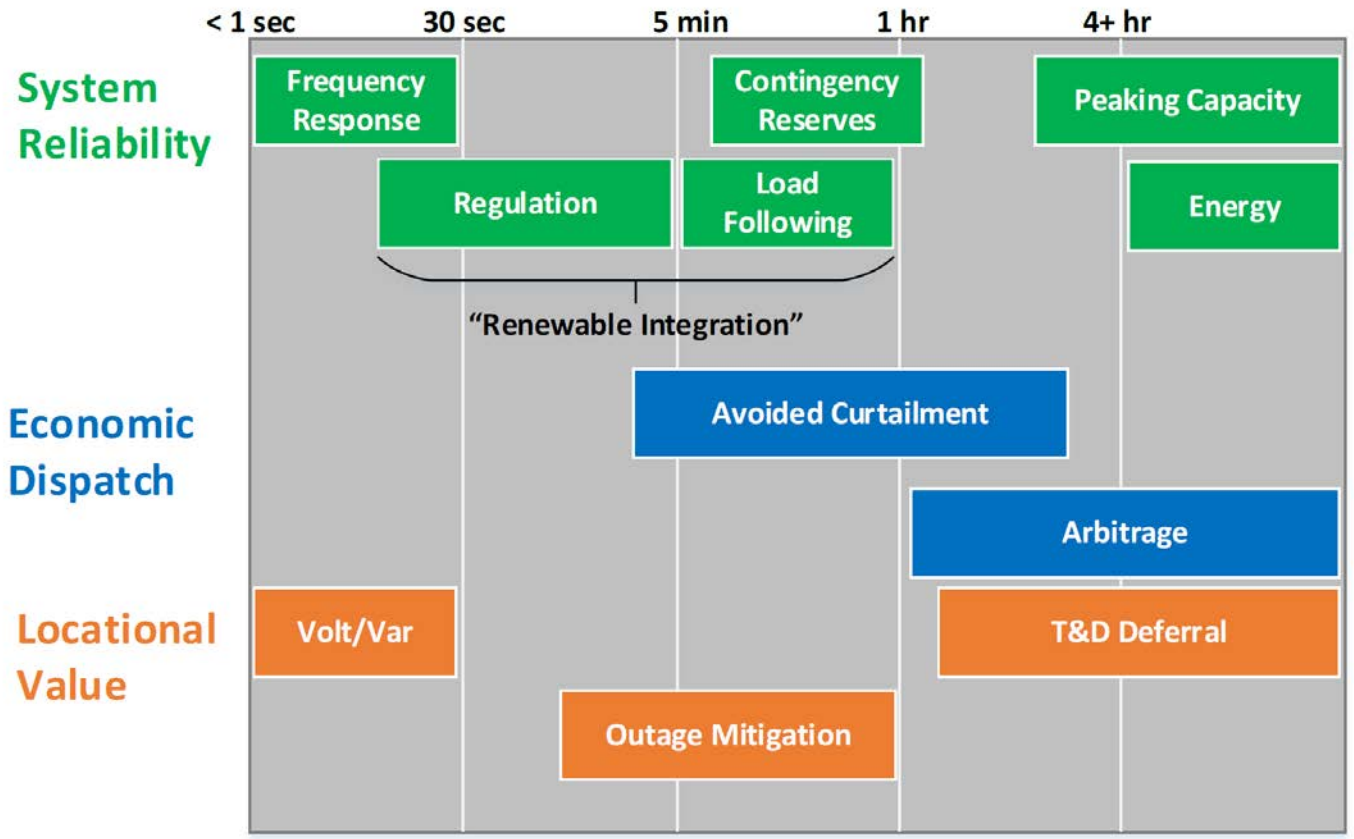


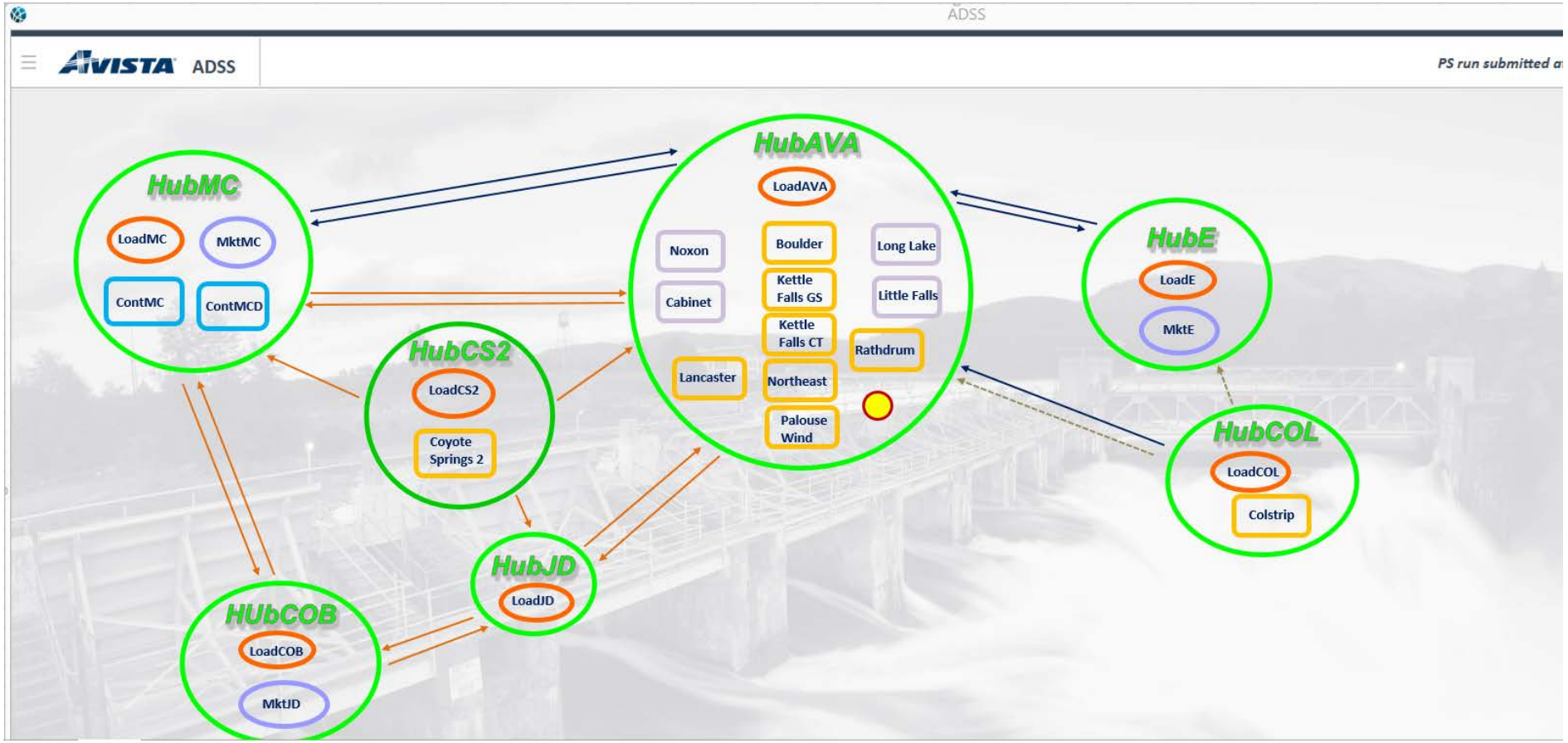
Figure 1: Key value streams within the power system and their associated timescales of action.

Source: Northwest Power and Conservation Council white paper on the value of energy storage to the future power system

Value Stream Definition

- **Frequency Response:** Automatic generator response to grid frequency excursions
- **Contingency Reserves:** Reserves available for grid emergencies
- **Regulation:** Instant response to system load fluctuations
- **Load Following:** Follows system load fluctuations
- **Arbitrage:** Store energy when price is low and discharge when price is high
- **Avoided Curtailment:** Storing energy during times of oversupply to avoid generation curtailment
- **Peaking Capacity:** Ensure sufficient capacity to meet forecast peak demand
- **Energy:** Optimizes energy timing to meet load
- **T&D Deferral:** Reduce loading on transmission paths and loading on distribution circuits during peak demand periods
- **Volt/Var:** Provide reactive power within the distribution system to maintain nominal grid voltage and enhance the power carrying capability of transmission system
- **Outage Mitigation:** Help with unplanned outages with back-up power for reliability and resilience

Avista Decision Support System

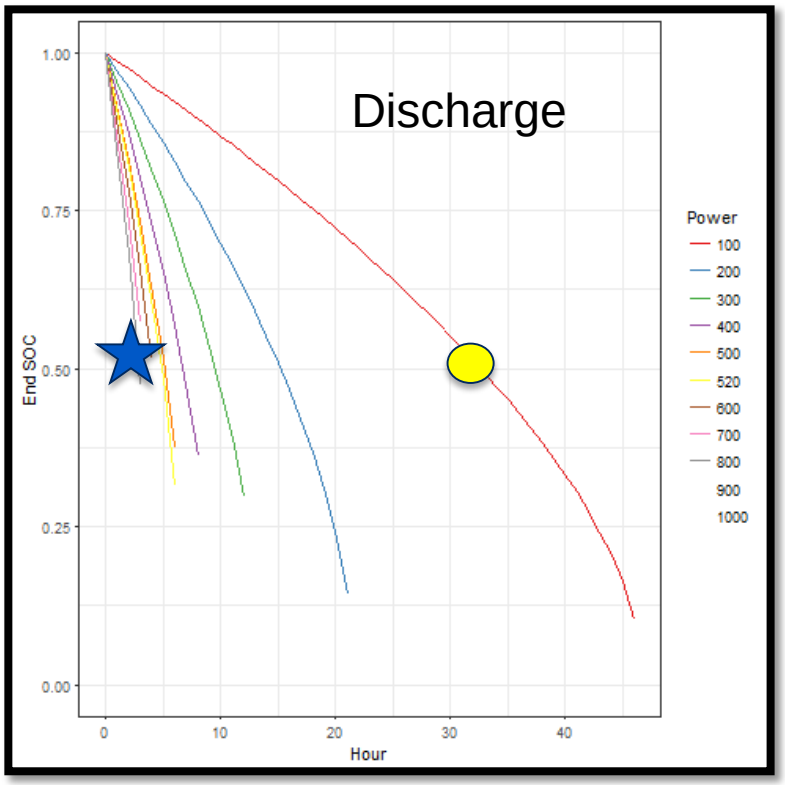


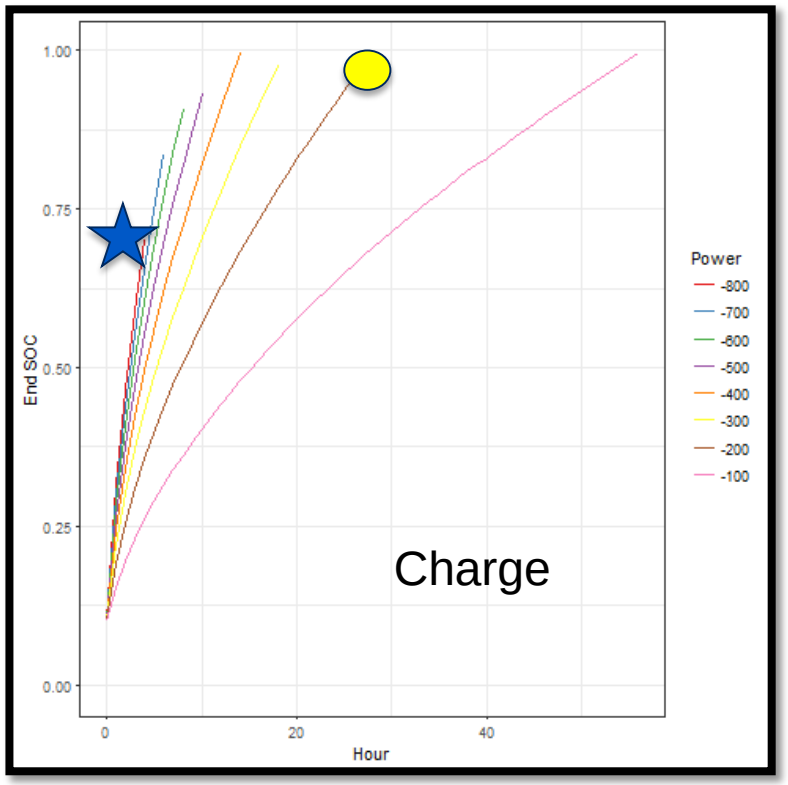
Battery Study Overview

- Turner Energy Storage Project – 1 MW, 3.7 MWh vanadium redox flow battery
- Partnered with PNNL to study operational use cases for the Clean Energy Funds grant.
- Study focuses on regulation and reserves

Turner Energy Storage Project, Pullman, WA

Battery Operating Characteristics





State of Charge (SOC) – An expression of the present battery capacity as a percentage of maximum capacity.

Power – instantaneous kilowatts.

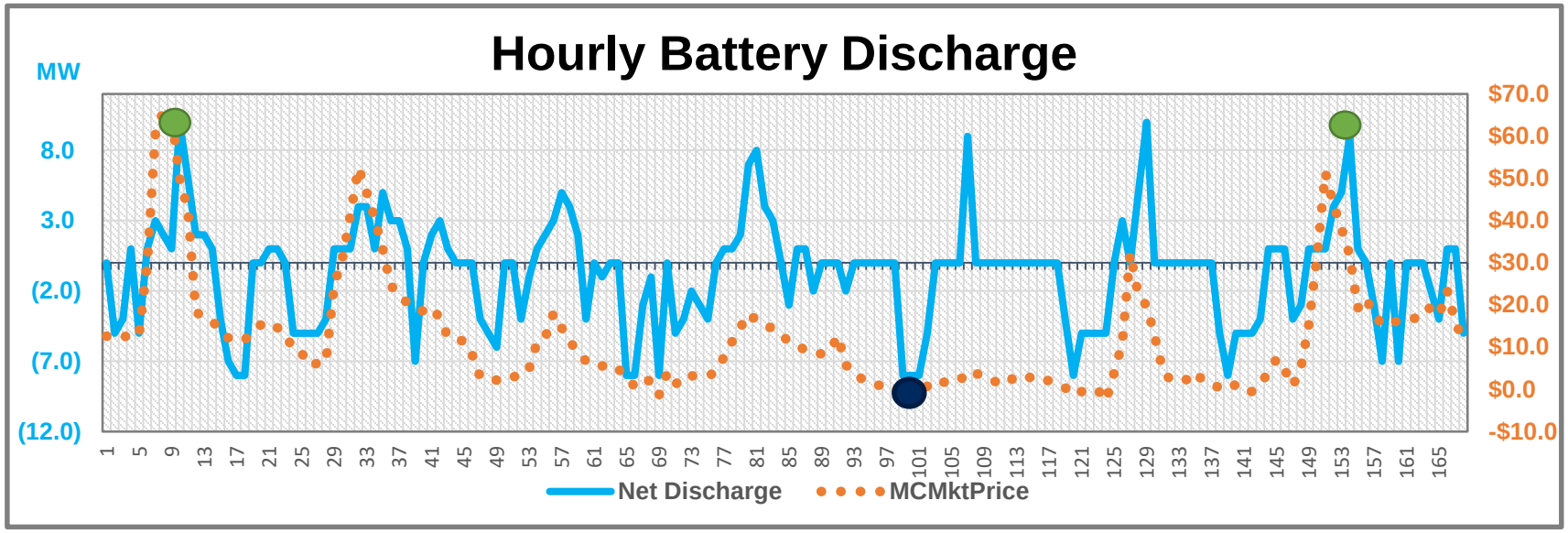
Modeling Overview

Targeted Battery Rating

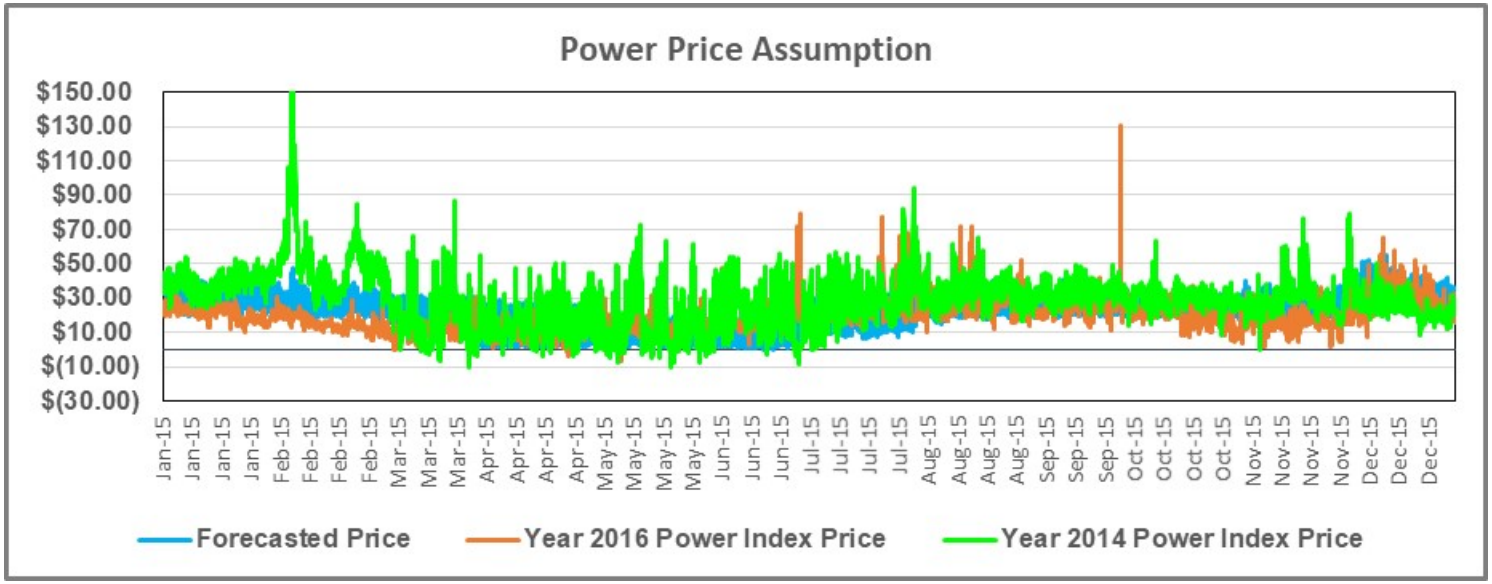
- Max Capacity – 1.0 MW
- Max Storage – 3.7 MWh

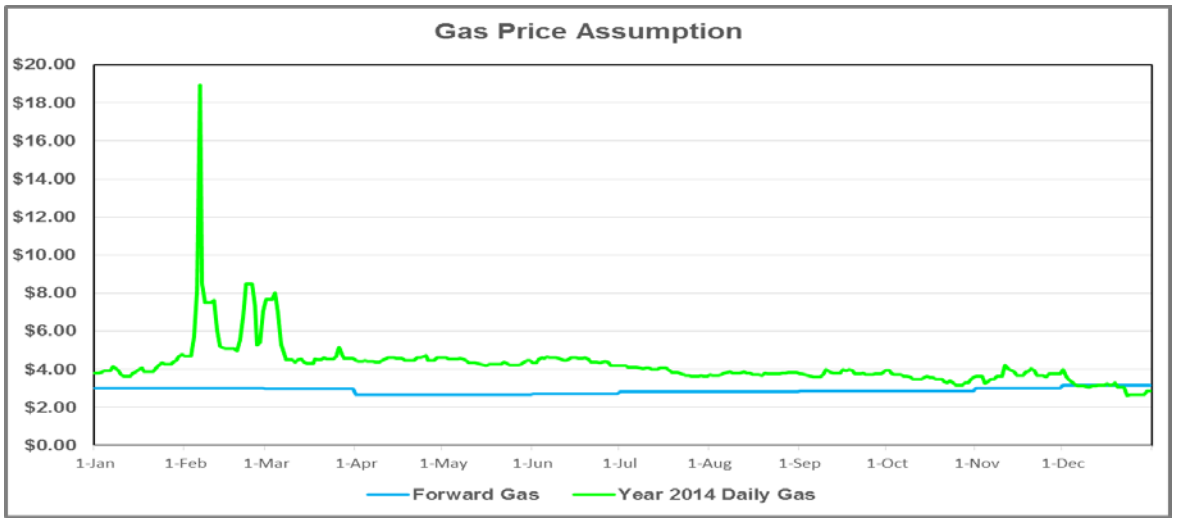
Applied Battery in Model

- Max Capacity – 10 MW
- Max Storage – 37 MWh



Price Volatility Impact





Benefit Evaluation

Scenario	Power Price	Gas Price	Benefits
1st Run	Forecasted	Monthly Forward	$5.00/kW-yr
2nd Run	Year 2016 Power Index Price	Monthly Forward	$6.63/kW-yr
3rd Run	Year 2014 Power Index Price	Year 2014 Daily	$36.32/kW-yr

Pumped Hydro Study

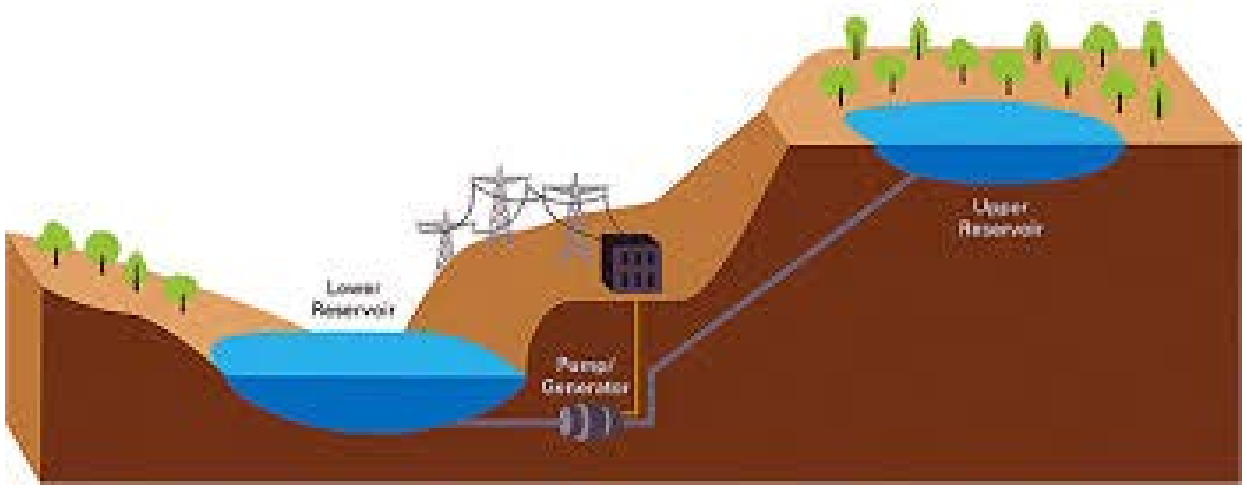
Operating Characteristics

Estimated Unit Pumping Efficiencies (3 × 400 MW)

Component	Efficiency
Pump	92.0%
Motor	98.5%
Transformer	99.0%
Total Station Pumping Efficiency	89.7%

Estimated Unit Generating Efficiencies (3 × 400 MW)

Flow (cfs)	Pump-Turbine	Generator-Motor	Transformer	Total Station Generating Efficiency
1,400	86.3%	98.5%	99.0%	84.2%
1,600	88.6%	98.5%	99.0%	86.4%
1,800	89.5%	98.5%	99.0%	87.2%
2,000	89.8%	98.5%	99.0%	87.5%
2,200	89.8%	98.5%	99.0%	87.6%
2,400	89.4%	98.5%	99.0%	87.1%

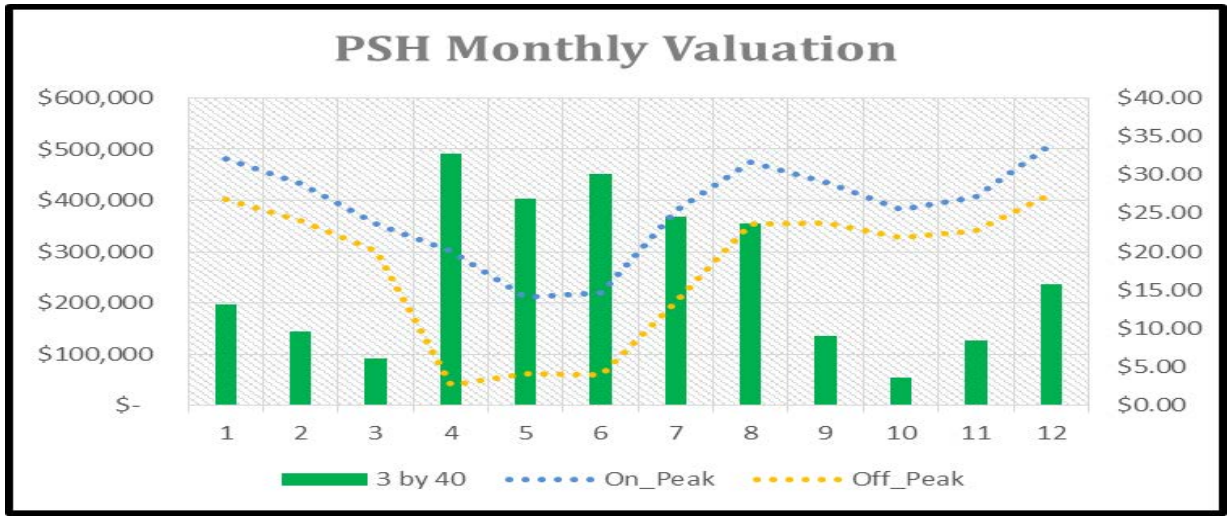


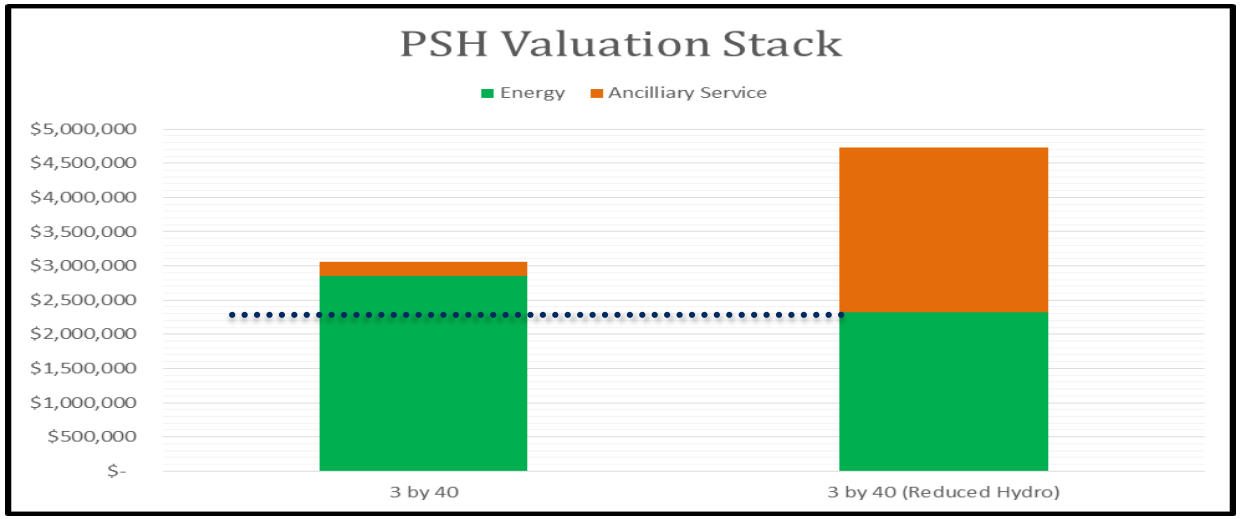
Pumped Hydro Scenarios and Results

System	Configuration	Target Project Scaling	Incremental Value ($)	Incremental Value ($/kw-yr)
Avista System	3 by 400 MW	100%	$19,412,500	$ 16.18
Avista System	3 by 100 MW	25%	$ 6,772,468	$ 22.57
Avista System	3 by 40 MW	10%	$ 3,057,399	$ 25.48
Avista System	3 by 20 MW	5%	$ 1,598,433	$ 26.64
Hydro Reduction	3 by 40 MW	10%	$ 4,730,827	$ 39.42

Noxon 1	120	Cabinet 1	65	Long Lake 1	22	Little Fall 1	8.5
Noxon 2	120	Cabinet 2	78	Long Lake 2	22	Little Fall 2	8.5
Noxon 3	120	Cabinet 3	79	Long Lake 3	22	Little Fall 3	8.5
Noxon 4	120	Cabinet 4	68	Long Lake 4	22	Little Fall 4	8.5
Noxon 5	135						

Pumped Hydro Incremental Value Results





Future Energy Storage Analyses

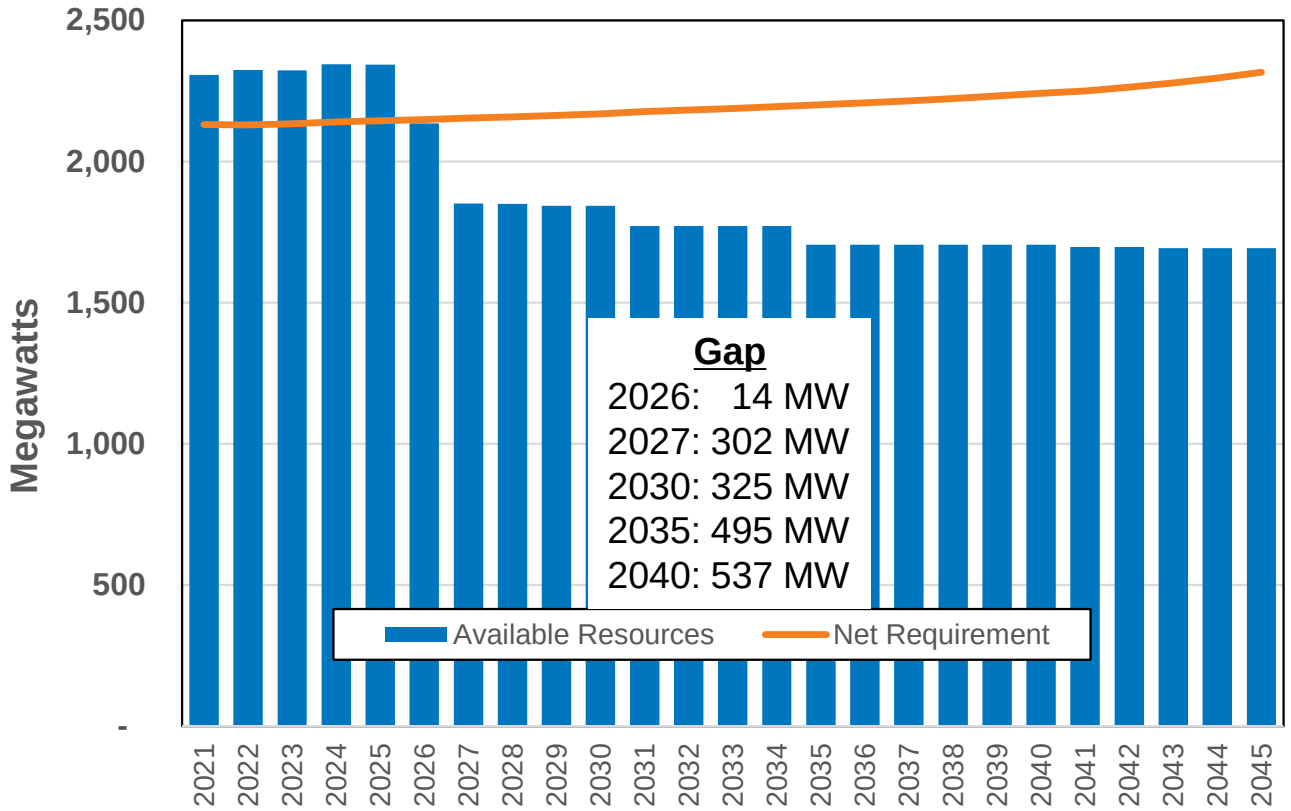
- Re-evaluate energy storage options in a shorter term energy market
- Analyze different energy storage technologies
- Updated pumped storage hydropower technologies
- Study with different levels of wind and solar penetration

2020 Electric Integrated Resource Plan
DRAFT “Preferred” Resource Strategy

James Gall, IRP Manager
Fifth Technical Advisory Committee Meeting
October 15, 2019

What Are Avista's Physical Resource Needs?

Main focus: Winter Peak (e.g. cold week in January)



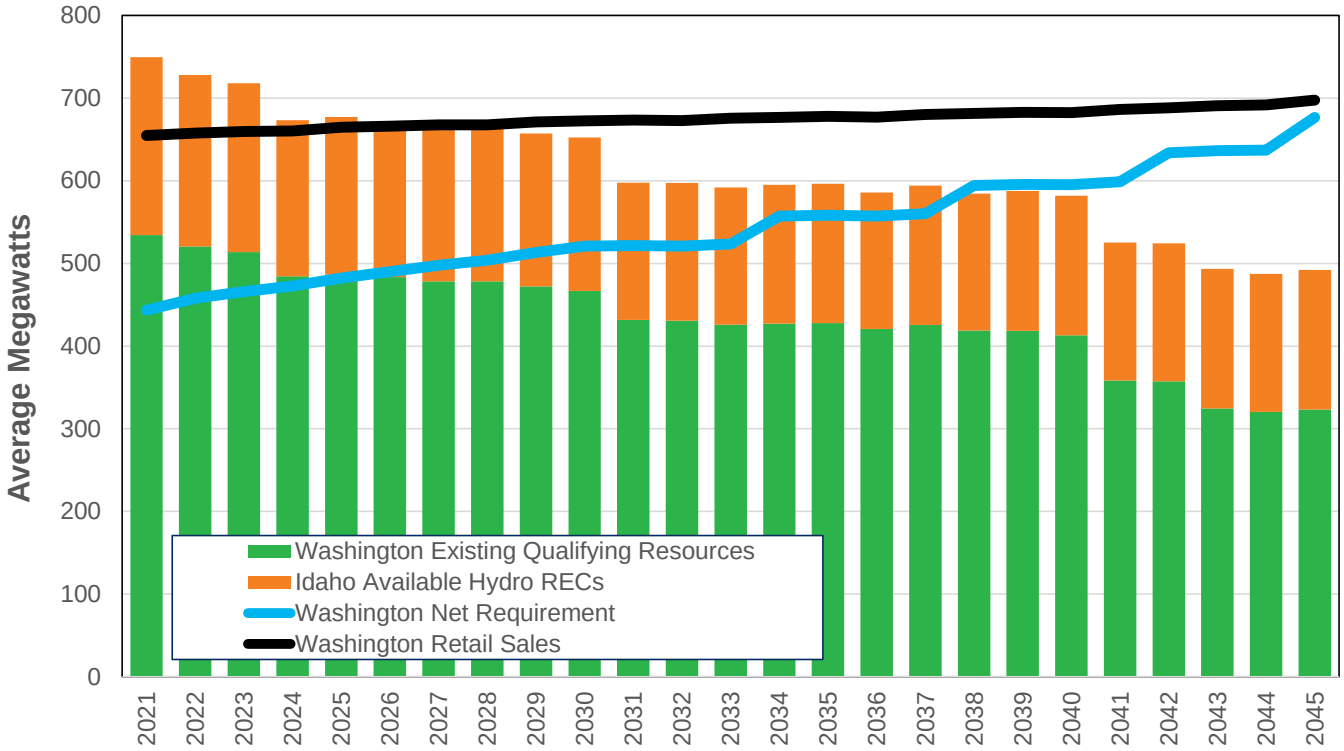
Key Losses:
Colstrip: 2025*
Lancaster: 2026
Mid-C: 2030
Northeast: 2035

Avista is also short in summer and on an annual average basis beginning in 2027

* Colstrip is assumed offline at the end of 2025 for planning purposes only. Avista's ultimate decisions regarding Colstrip are still to be determined.

Washington SB5116 Clean Requirements

2026: Colstrip can no longer serve Washington Load
2030: 80% energy delivered over a four-year period is clean and 20% can be RECs
2045: Goal to be 100% clean (will require new technology to stay under cost cap)



Gap

2030: 54 aMW
2035: 130 aMW
2040: 182 aMW
2045: 353 aMW

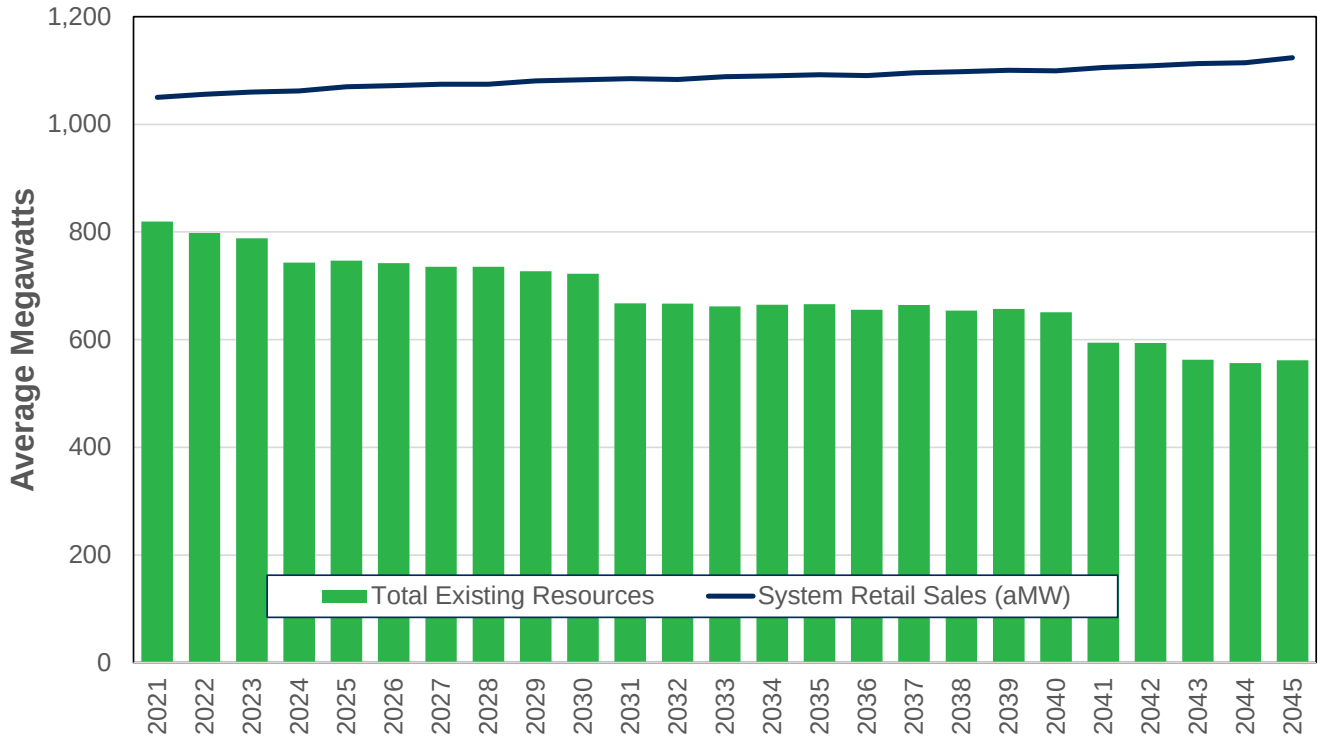
Key Losses:

Mid-C: 2030
Lind: 2039
Rattlesnake: 2040
Palouse: 2043

 Assumes: Idaho customers sell offsets to Washington Customers

Avista's Clean Electricity Goal

2027: 100% net clean portfolio wide (cost effective considerations)
2045: 100% clean (cost effective considerations and technology)



Gap

2027: 339 aMW
2030: 360 aMW
2035: 426 aMW
2040: 448 aMW
2045: 562 aMW

Resource Options

Clean

- Wind (WA/OR/MT)
- Solar (WA/ID/OR)
- Biomass (WA/ID)
- Hydro Upgrades (MS, LL)
- Hydro (Mid-C)
- ~~Hydro (BPA)~~
- Geothermal
- Nuclear
- Energy Efficiency
- Demand Response

Other

- Natural Gas CT
- Natural Gas CCCT
- Storage
  - Pumped hydro
  - Lithium-ion batteries
  - Liquid air
  - Hydrogen
  - Flow batteries
- ~~Regional Transmission~~

Preferred Resource Strategy Decision Process

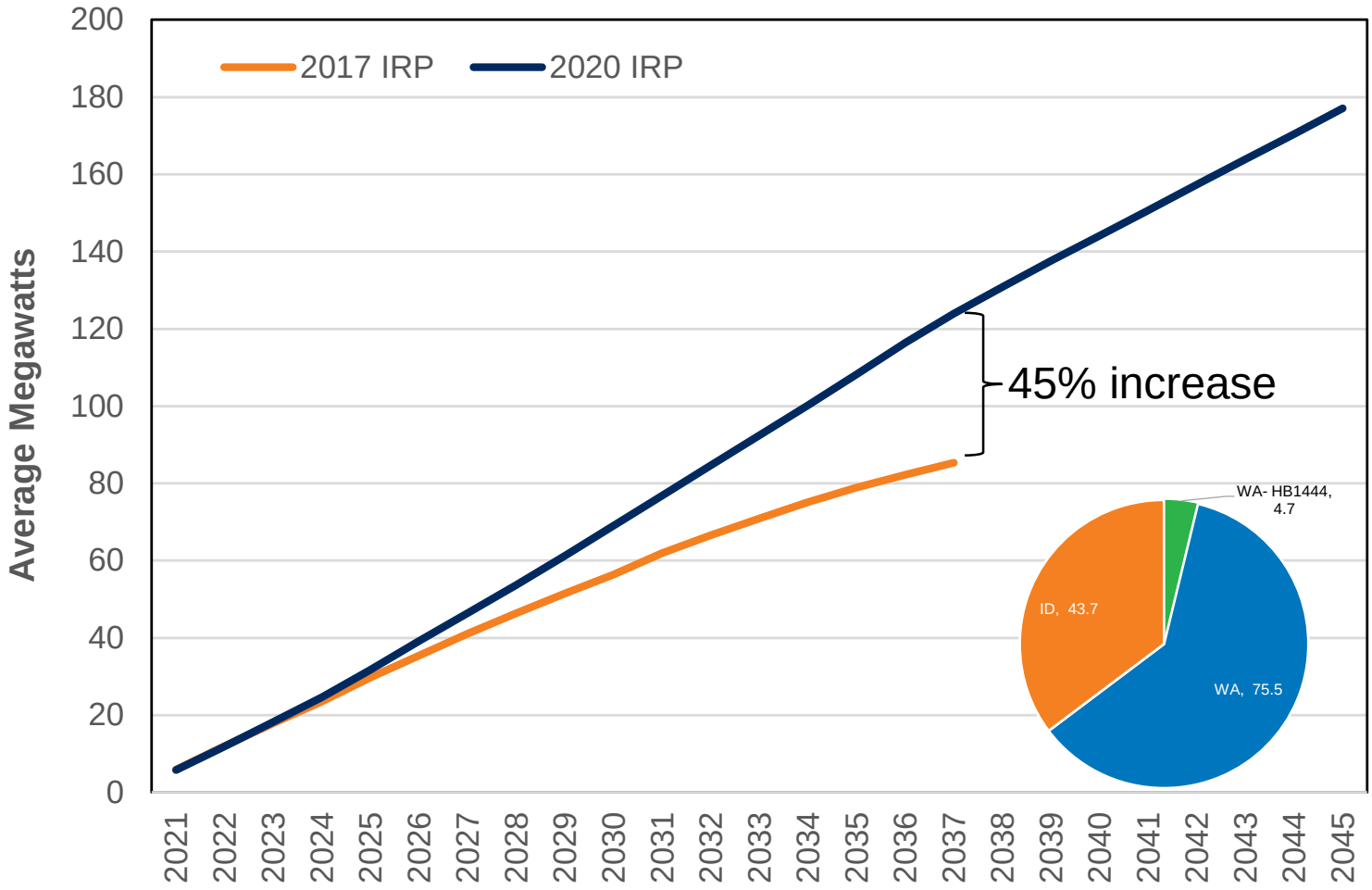
- Uses Mixed Integer Program (MIP) to find least cost solution meeting capacity, energy, and renewable constraints for the system between 2021 and 2045.

- Only known model with full co-optimization of energy efficiency and demand response with supply side resources.
  - Capable of co-optimization of T&D system with power system

- Accounts for societal preference Washington state planning criteria
  - (Social Cost of Carbon, 10% cost advantage from energy efficiency, upstream pipeline emissions, etc.)

- Non-modeled utility revenue requirements assumes an increase of two percent per year.

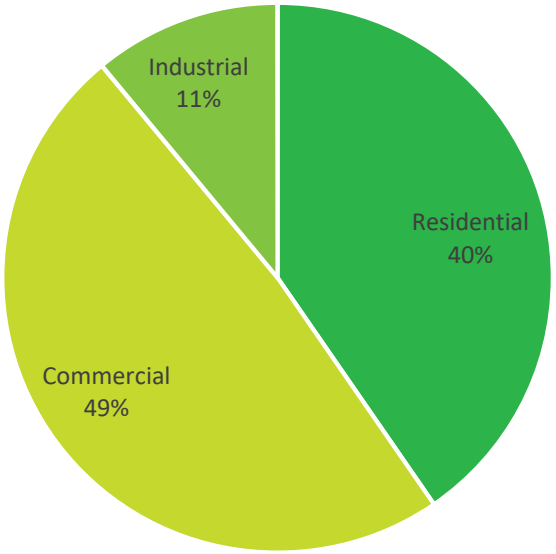
Energy Efficiency Results



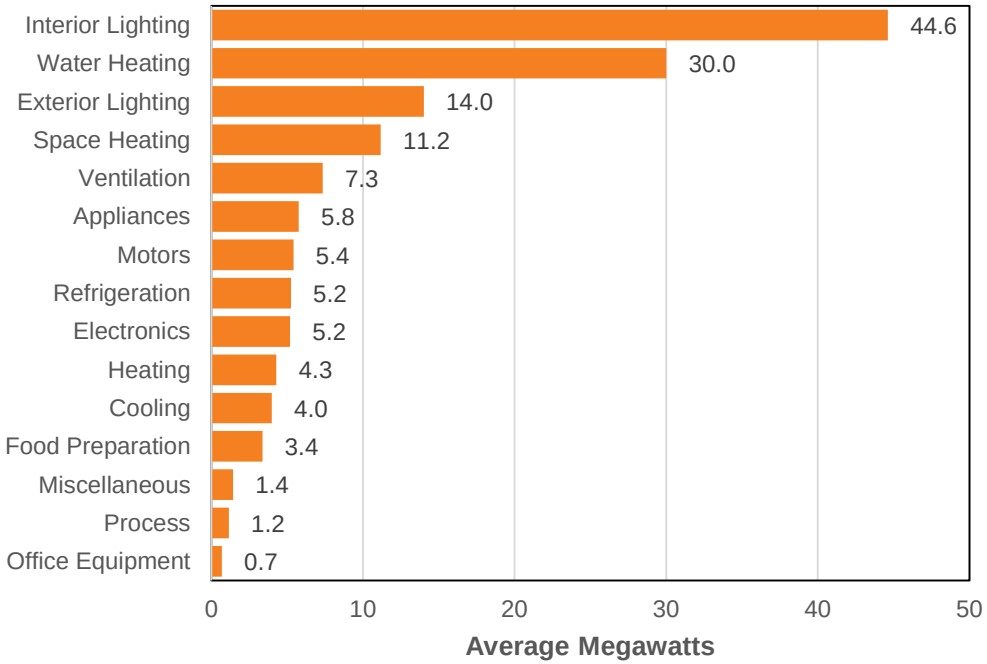
Note: excludes T&D losses

Where is the Cost Effective Energy Efficiency Savings?

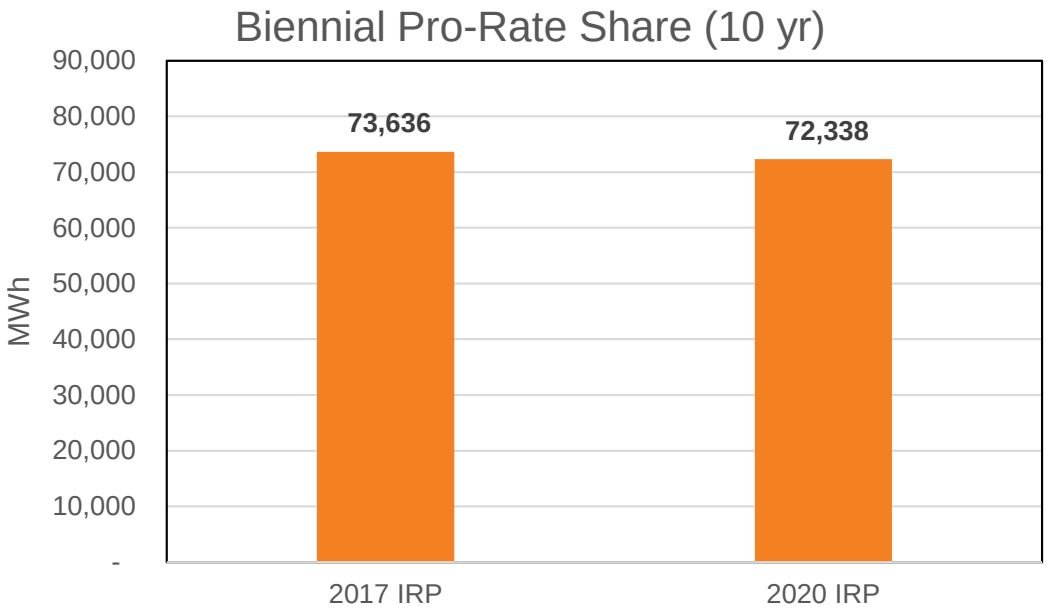
2040 Customer Class Savings



2040 Cumulative Savings

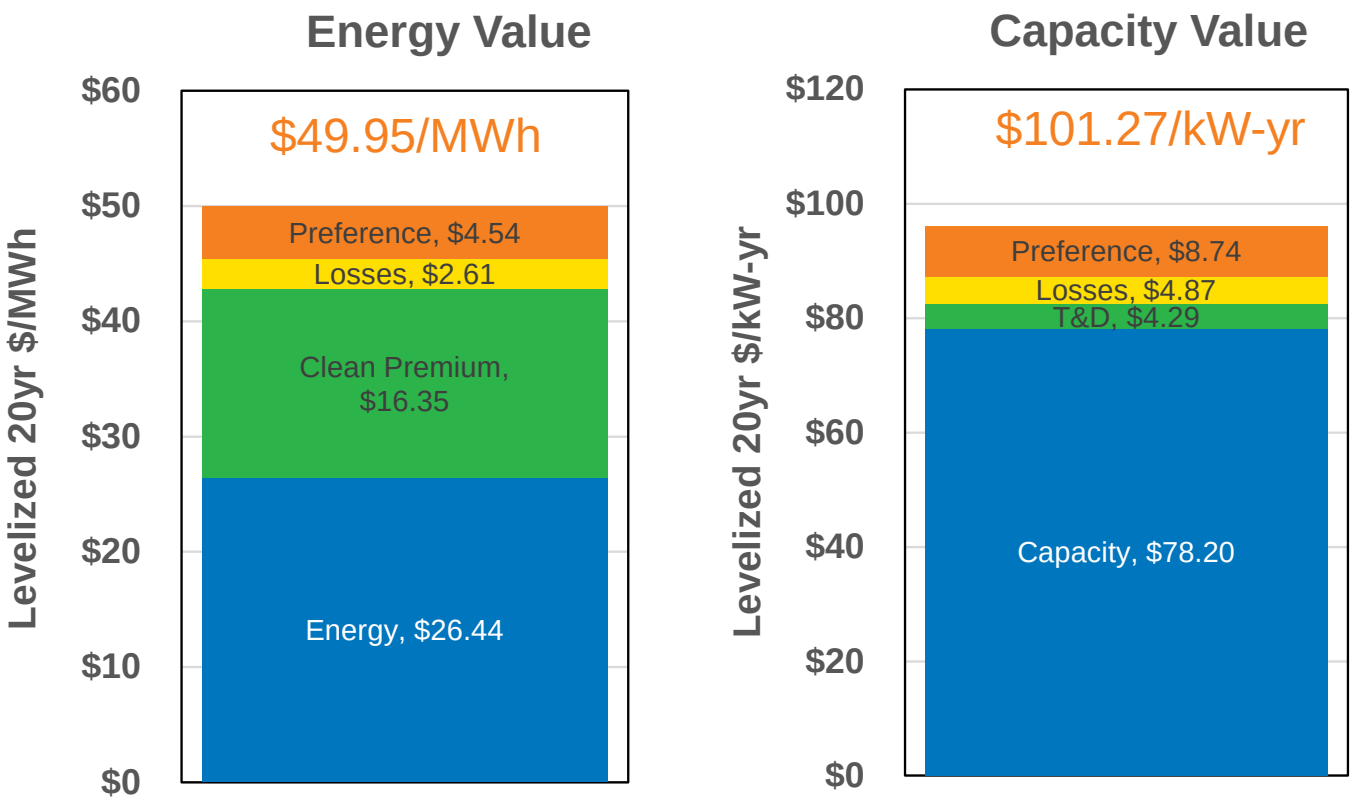


Washington Biennial EIA Energy Efficiency Goal (2021/22)

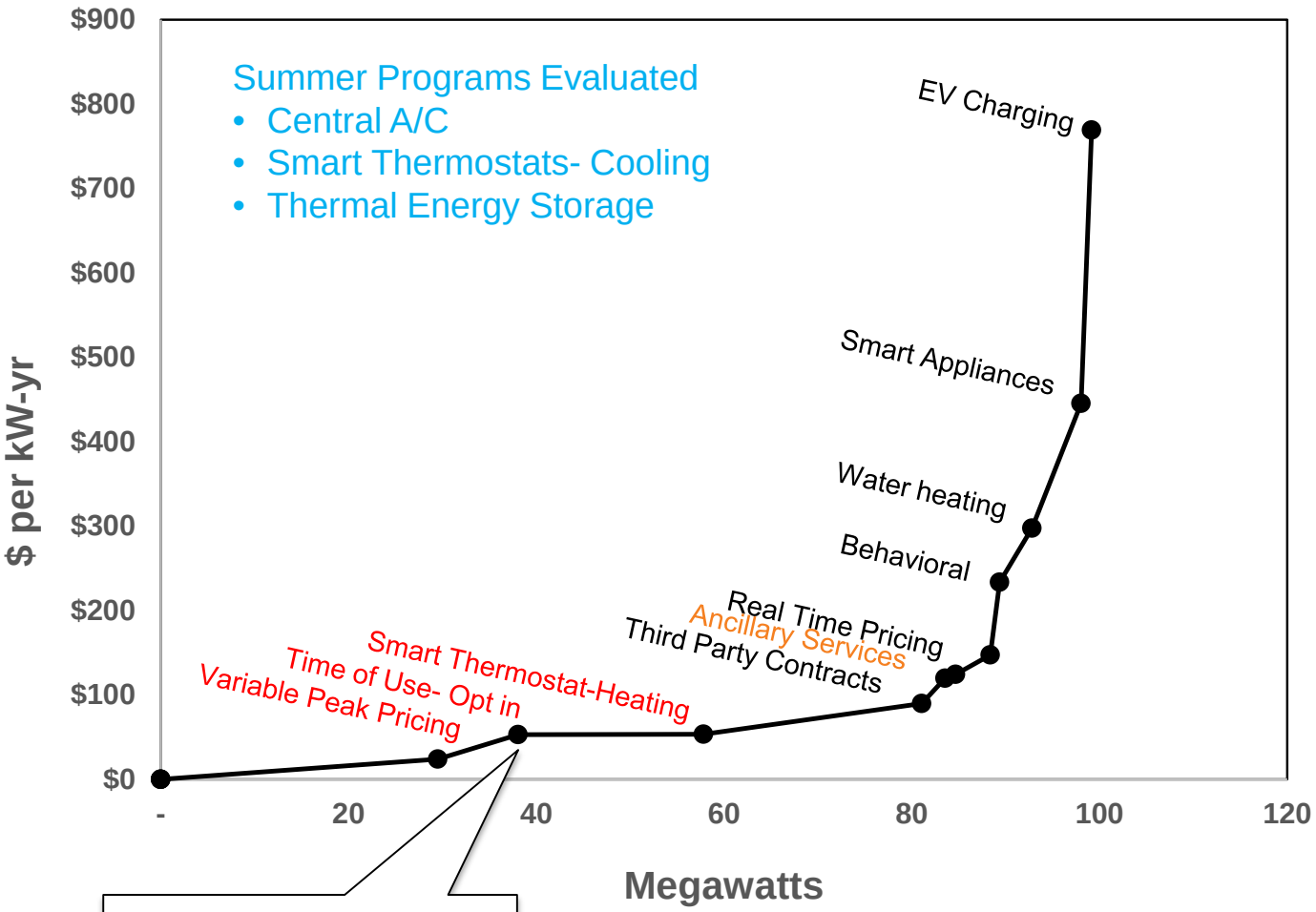


Biennial Conservation Approved Target (MWh)	Based on 2020 IRP	Based on 2017 IRP
CPA Pro-Rata Share	72,338	73,636
Behavioral Program Savings	N/A	15,386
Distribution and Street Light Efficiency	504	749
EIA Target	72,842	89,771
Decoupling Threshold	3,642	4,489
Total Utility Conservation Goal	76,484	94,260
Excluded Programs (NEEA)	-14,016	-9,986
Utility Specific Conservation Goal	62,468	84,274
Decoupling Threshold	-3,642	-4,489
EIA Penalty Threshold	58,826	79,785

Energy Efficiency Avoided Cost



Demand Response



Cost Effective Start Dates Shown in Red

2026: Variable Peak Pricing
2029: Time of Use
2029: Industrial Load Control
2030: Smart Thermostats
2043: Ancillary Services (TBD)

2022-2025 Generation Action Plan

- 2022- 2023 RFP
  - Early acquisition to take advantage of tax credits
  - Anticipate 300 MW Wind PPA (84 aMW)
    - 100 MW in MT and 200 MW in NW
    - locations depend on transmission availability
  - Solar could replace wind depending on pricing and future price shape forecasts
  - Potential for additional resource acquisitions in support of Avista's clean electricity goal subject to reliability and affordability considerations.
- 2024: Kettle Falls Upgrade
  - Incrementally increase Kettle Falls generating capability by installing larger sized equipment as part of modernization
- 2025: 222 MW, Colstrip removed
  - Per CETA, Colstrip will not serve Washington loads after 12/31/2025
  - The plants future for Idaho customers or wholesale transactions is yet to be determined

2026-2030 Generation Action Plan

- 2026: 150 MW, Pumped Hydro
  - Assumes low cost, long duration pumped hydro solution is available.
  - If resource is not available or price exceeds cost effectiveness tests, siting a similar sized NG peaker is the next least cost option.
  - Sizing will depend on reliability requirements of future power supply system.
- 2026: 24 MW, Rathdrum Upgrade
  - Increases each unit by 6 MW using a supplemental compression technology or alternative technology.
- 2026: Lancaster PPA expires in October
- 2027: 200 MW, MT Wind
  - Utilizes Colstrip transmission,
  - if not available additional NG and renewables are required.
- 2027: 8 MW, Post Falls Upgrade
  - Increase generating capability as part of modernization project to maintain FERC licensing requirements.

2031-2040 Generation Action Plan

- 2031: Attempt to renew Mid-C PPA contracts
- 2033: 25 MW x 16 hour Liquid Air Storage (or lowest cost alternative)
- 2035: Northeast CT retires
- 2035: 68 MW Long Lake 2nd Powerhouse
  - Seek certification as an eligible resource
    - either as 2nd powerhouse and/or reconfiguration of single new powerhouse.
  - Begin licensing process
  - Optimize the site for cost, capacity, and environmental concerns
  - Earlier on-line date may be possible
  - NG Peaker and renewable resource would be alternative to this project
- 2036: 25 MW x 16 hour Liquid Air Storage (or lowest cost alternative)
- 2038: 25 MW x 16 hour Liquid Air Storage (or lowest cost alternative)
- 2039: 25 MW x 16 hour Liquid Air Storage (or lowest cost alternative)

2040-45 Generation Action Plan

- 2041: 25 MW x 16 hour Liquid Air Storage (or lowest cost alternative)
- 2042-2045: 300 MW Wind PPA Replacement
  - Existing PPAs begin to expire
  - Repowering is likely necessary
- 2043: 25 MW x 16 hour Liquid Air Storage (or lowest cost alternative)
- 2042-2045: 250 MW x 4 hour, Lithium-ion (or lowest cost alternative)
- 2044: 50 MW, solar w/ 50 MW x 4 hour storage

DRAFT Preferred Resource Strategy

Load reduction of 152 aMW due to Energy Efficiency by 2040

2021-2030

2022: 100 MW, MT Wind
2022: 100 MW, NW Wind
2023: 100 MW, NW Wind
2024: 12 MW, Kettle Falls Upgrade
2026: 222 MW, Colstrip removed
2026: 150 MW, Pumped Hydro
2026: 24 MW, Rathdrum Upgrade
2026: 257 MW, Lancaster PPA expires
2026-2030: 85 MW, Demand Response
2027: 200 MW, MT Wind
2027: 8 MW, Post Falls Upgrade

2031-2040

2031: 75 MW, Mid-C PPA Renew
2033: 25 MW x 16 hr Liquid Air Storage
2035: 55 MW, Northeast CT retires
2035: 68 MW, Long Lake 2nd Powerhouse
2036: 25 MW x 16 hr, Liquid Air Storage
2038: 25 MW x 16 hr, Liquid Air Storage
2039: 25 MW x 16 hr, Liquid Air Storage

2041-2045

2041: 25 MW x 16 hr, Liquid Air Storage
2042-2045: 300 MW Wind PPA Renew
2043: 25 MW x 16 hr, Liquid Air Storage
2043: 2.5 MW, Demand Response
2042-2045: 225 MW x 4 hr, Lithium-ion
2044: 50 MW, Solar w/ 50 MW x 4hr, Storage

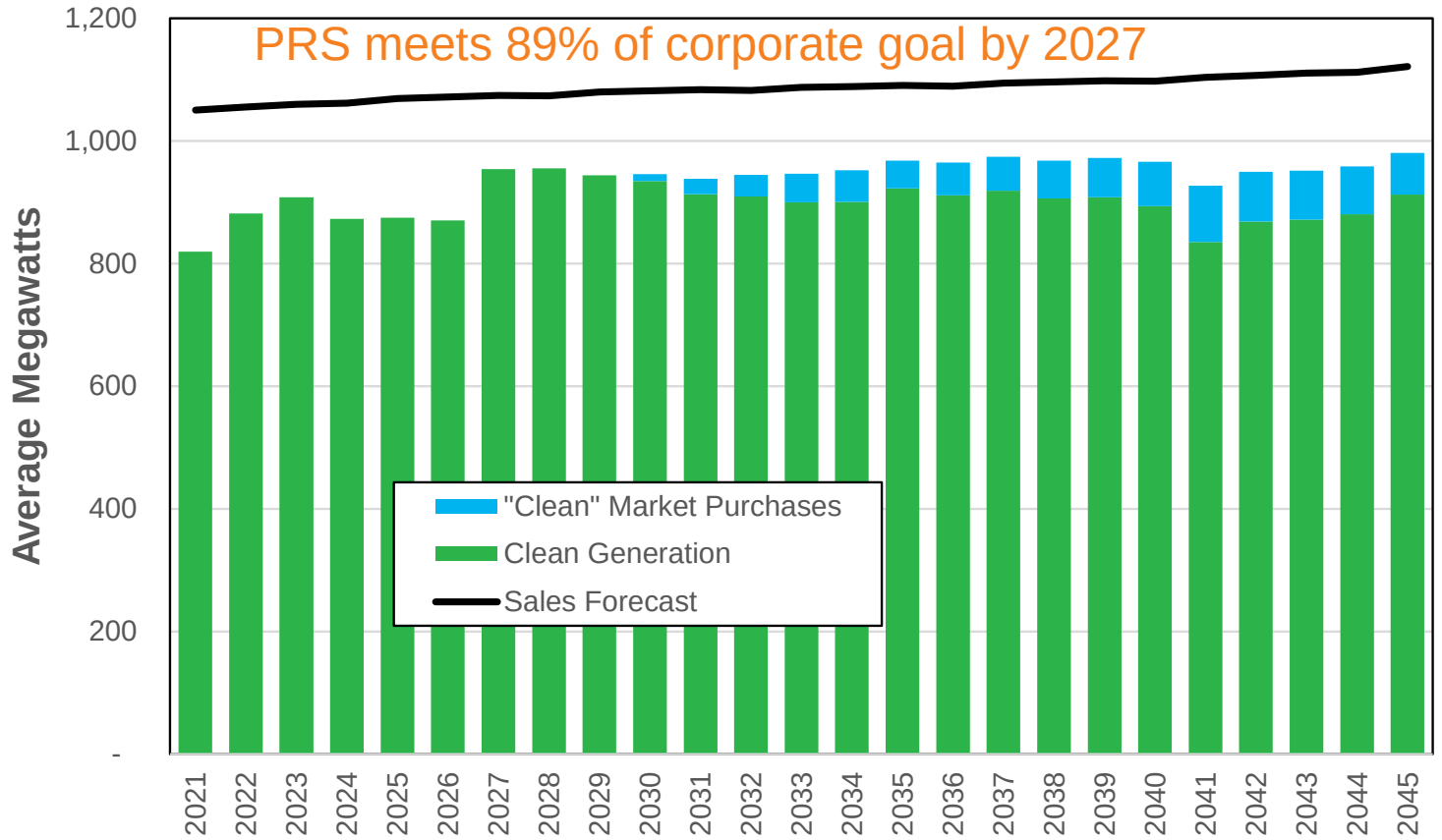
Reliability Study Results

- 14% planning margin without Colstrip and non-dispatchable resources is too low.
- LOLP analysis was re-studied without Colstrip to determine the required planning margin to achieve 5% LOLP with NG CTs- this resulted in a ~16% planning margin
- The resulting draft reliability metrics for the PRS are:

Reliability Metric	Draft PRS Result	TAC 2 Adequate System Result
LOLP	7.0%	4.9%
LOLH	3.10	1.85
LOLE	0.25	0.16
EUE	552.3 MWh	318.7 MWh

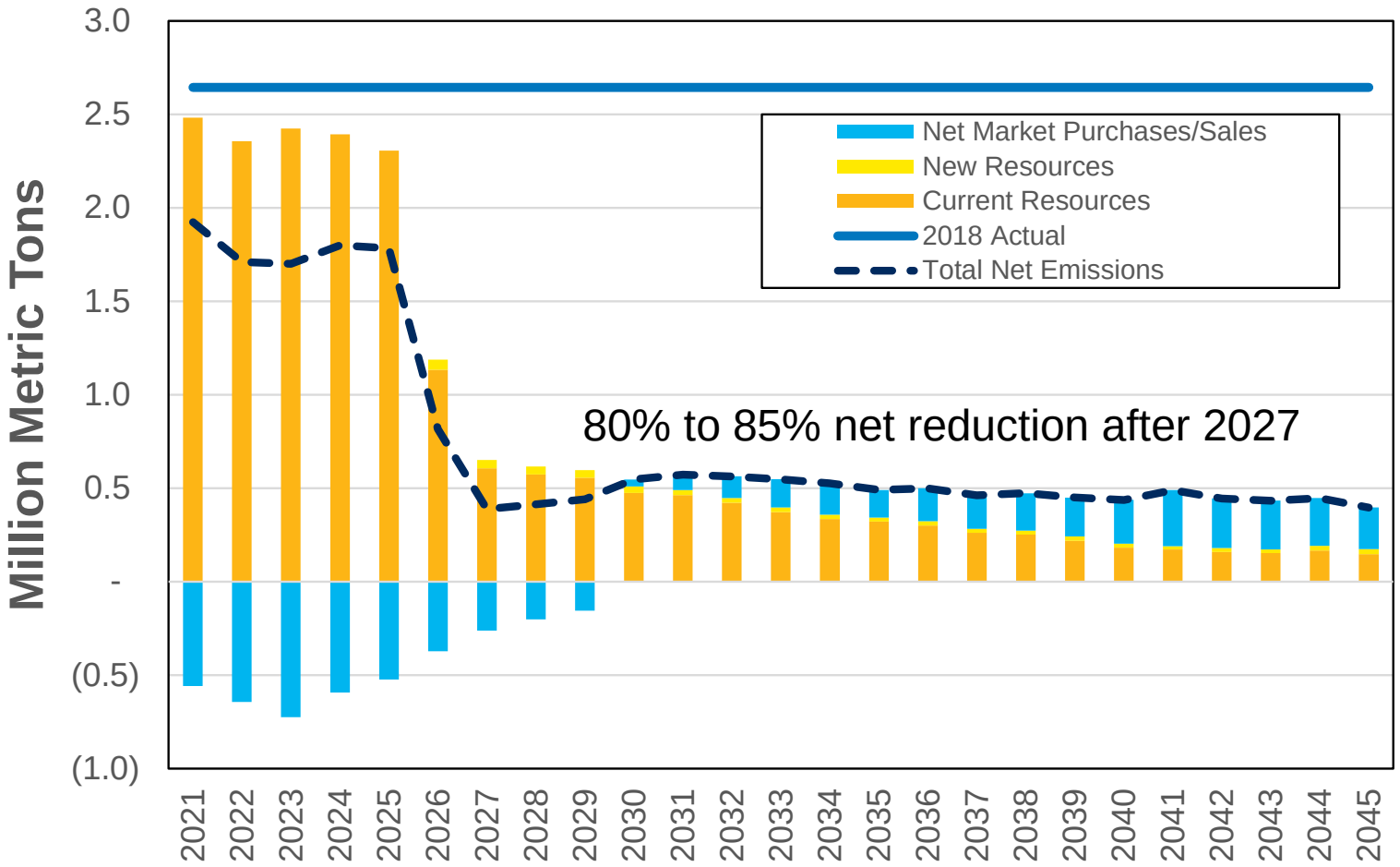
PRS Comparison to Corporate Clean Electricity Goal

Goal: Serve customers with 100% cost effective clean electricity

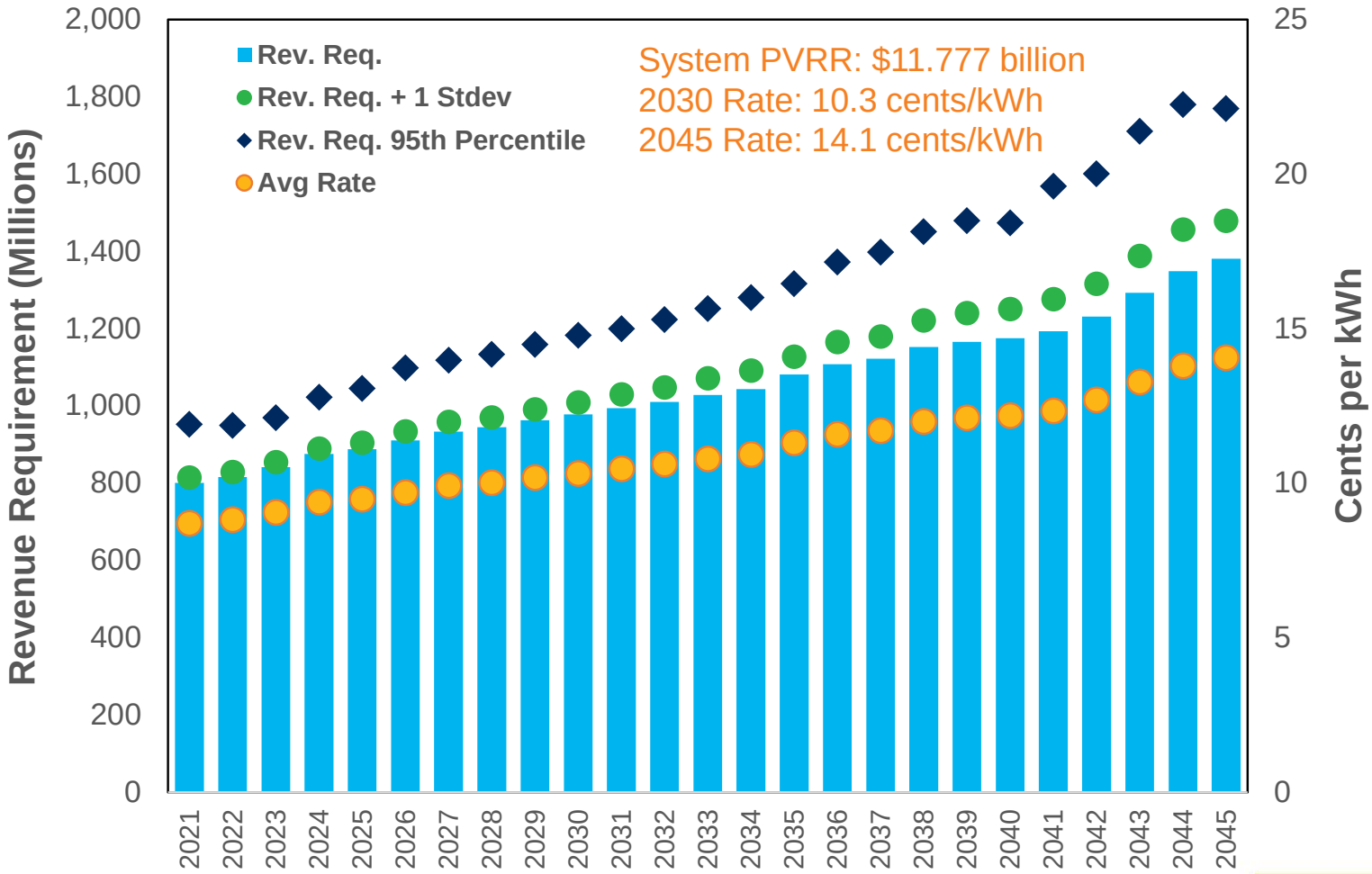


Notes:
1) Prior to 2030, Avista is a net energy seller to the market
2) "Clean" market purchases is measured as the regional generation mix's CO_2 mix compared to a CCCT

PRS: Greenhouse Gas Emissions Forecast

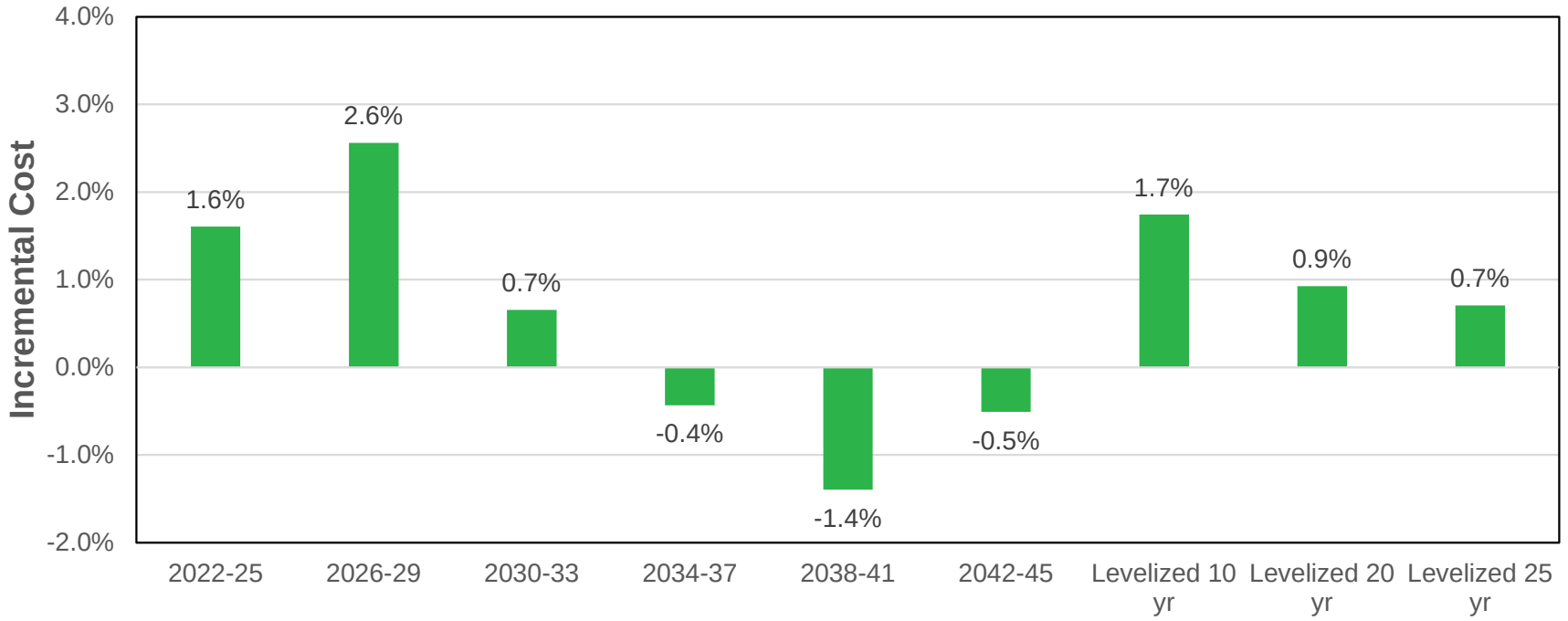


PRS: Cost/Rate Forecast



Note: Assumes non-power supply modelled costs escalate at 2 percent per year

Cost Comparison between PRS and LC Portfolio w/o CETA



Notes: State allocation factors and resource designation will affect these results for each state

Avoided Cost of Generation Calculation Methodology

- **Energy value:** hourly mark to market value of delivered energy in the wholesale market (i.e. Mid-C index).

- **Capacity value:** total portfolio revenue requirement difference between a portfolio meeting capacity targets versus a portfolio only relying on the spot energy market. The difference is divided by the added capacity additions (MW) to estimate $ per kW. Rates are levelized and tilted to begin with first deficit.

- **Clean premium:** total portfolio revenue requirement difference between a portfolio meeting CETA versus a portfolio only meeting the capacity requirements. This difference is divided by added generated MWh. Rates are levelized and tilted to begin with first expected acquisition year.

- **Clean premium with tax incentives:** Same as clean premium calculation except the federal tax subsidies continue.

Avoided Costs

Year	Energy Flat ($/MWh)	Energy On-Peak ($/MWh)	Energy Off-Peak ($/MWh)	Clean Premium ($/MWh)	Clean Premium (w/ Tax Incentive) ($/MWh)	Capacity ($/kW-year)
2021	19.67	22.64	15.71	0.00	0.00	0.0
2022	19.98	22.75	16.28	9.33	0.78	0.0
2023	20.44	23.05	16.98	9.52	0.79	0.0
2024	21.61	24.09	18.28	9.71	0.81	0.0
2025	22.76	25.19	19.50	9.90	0.83	0.0
2026	24.27	26.40	21.43	10.10	0.84	97.3
2027	23.57	25.27	21.30	10.30	0.86	99.3
2028	25.02	26.26	23.35	10.51	0.88	101.2
2029	25.92	26.80	24.73	10.72	0.89	103.3
2030	26.72	27.08	26.25	10.93	0.91	105.3
2031	29.46	29.66	29.21	11.15	0.93	107.4
2032	29.78	29.95	29.54	11.38	0.95	109.6
2033	31.22	30.74	31.89	11.60	0.97	111.8
2034	32.83	31.94	34.06	11.83	0.99	114.0
2035	33.66	32.64	35.05	12.07	1.01	116.3
2036	35.82	34.82	37.16	12.31	1.03	118.6
2037	36.12	34.58	38.19	12.56	1.05	121.0
2038	38.81	37.40	40.76	12.81	1.07	123.4
2039	38.60	37.13	40.57	13.07	1.09	125.9
2040	38.52	36.80	40.84	13.33	1.11	128.4
2041	39.09	37.74	40.92	13.59	1.13	131.0
2042	38.98	37.99	40.31	13.87	1.16	133.6
2043	40.24	39.51	41.21	14.14	1.18	136.2
2044	46.10	45.29	47.15	14.43	1.20	139.0
2045	43.94	43.11	45.05	14.71	1.23	141.8
15 yr Levelized	**24.58**	**26.11**	**22.55**	**9.38**	**0.78**	**58.5**
20 yr Levelized	**26.44**	**27.55**	**24.98**	**9.87**	**0.82**	**67.8**
25 yr Levelized	**27.86**	**28.77**	**26.66**	**10.27**	**0.86**	**74.3**

Challenges and Considerations

- Ultimate disposition of Colstrip
- State resource allocation
- Achieving Avista clean electricity goal
- Transmission needs and issues
  - Integration of transmission & distribution needs into a fully Integrated Resource Plan
  - System impacts of third party generation resources
- Storage issues
  - Physical requirements for resource adequacy and grid reliability
  - Economic needs for integration of renewable generation
  - Storage technology and cost improvements
- Rulemaking and permitting impacts on the preferred resource options
- Market development to accommodate increased variable generation and acquisition

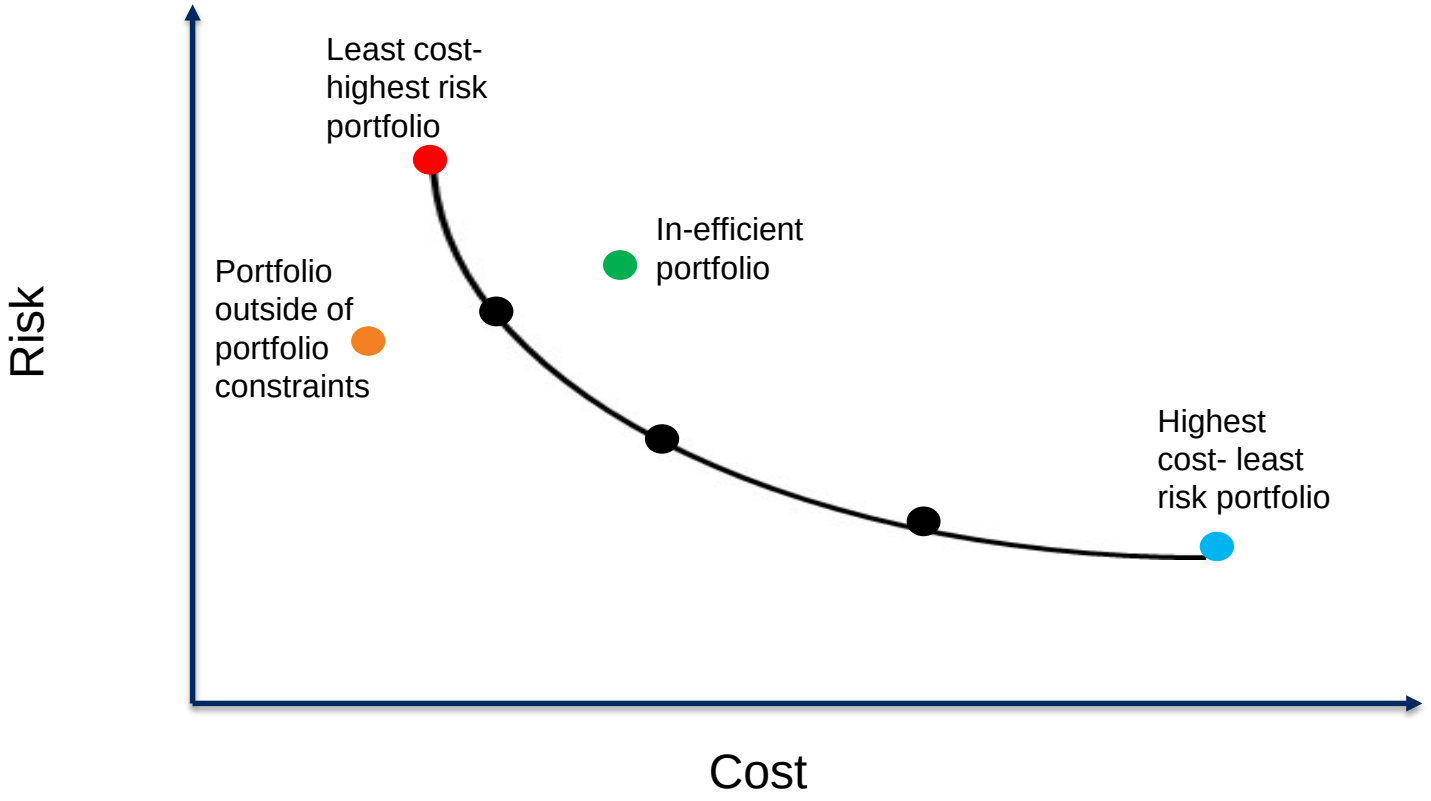
2020 Electric Integrated Resource Plan
Draft Portfolio Scenario Analysis

James Gall, IRP Manager
Fifth Technical Advisory Committee Meeting
October 15, 2019

Scenario Overview

- Use same electric price forecast- but different resource assumptions.
- Use optimization to create portfolio, but use different constraints for each scenario.
- View financial results of each portfolio along with resource selection.
- Portfolio results with different market assumptions will be provided at the next TAC meeting.
- No reliability analysis are completed for portfolio scenarios.

Efficient Frontier Overview

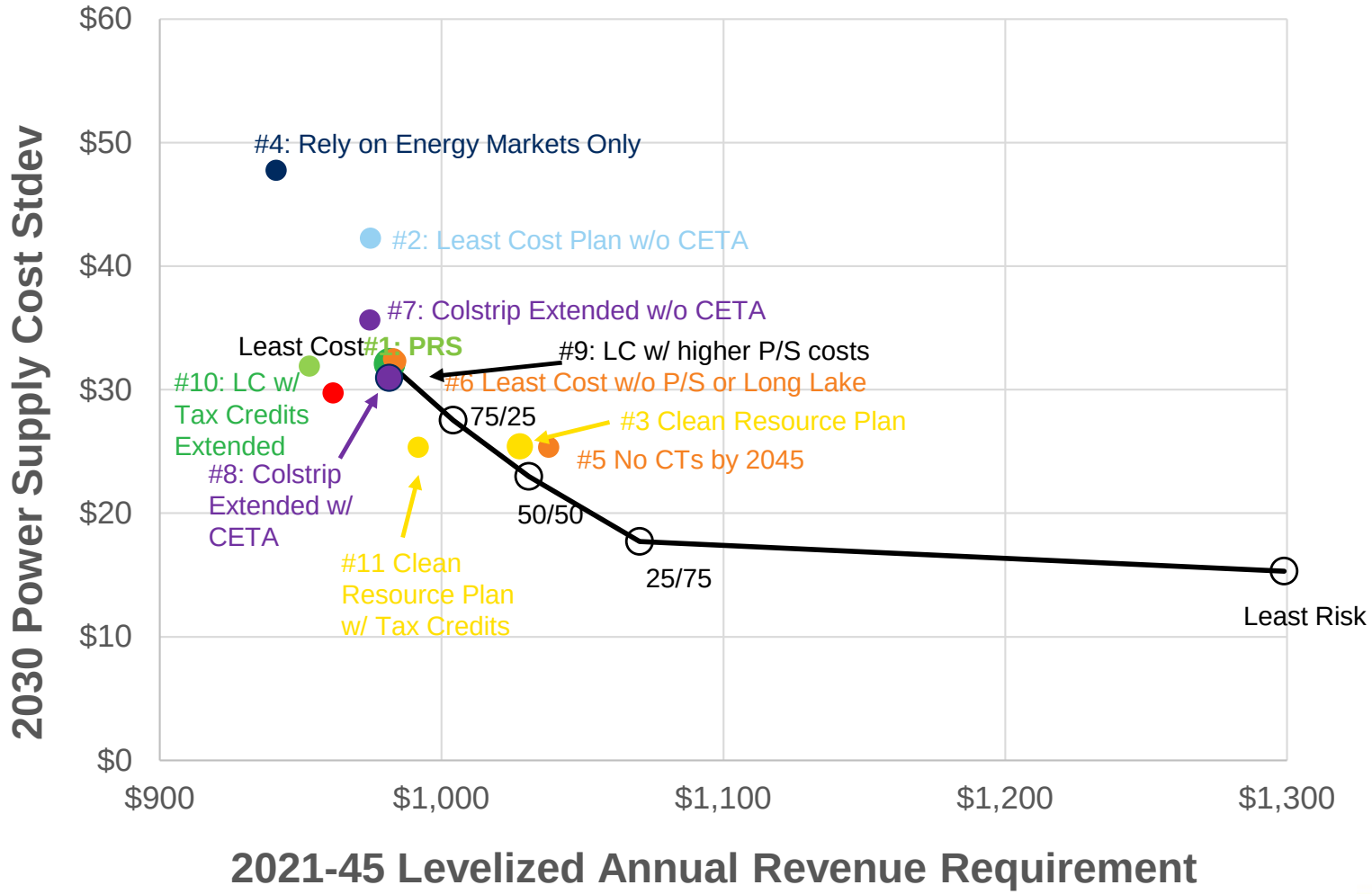


Scenarios

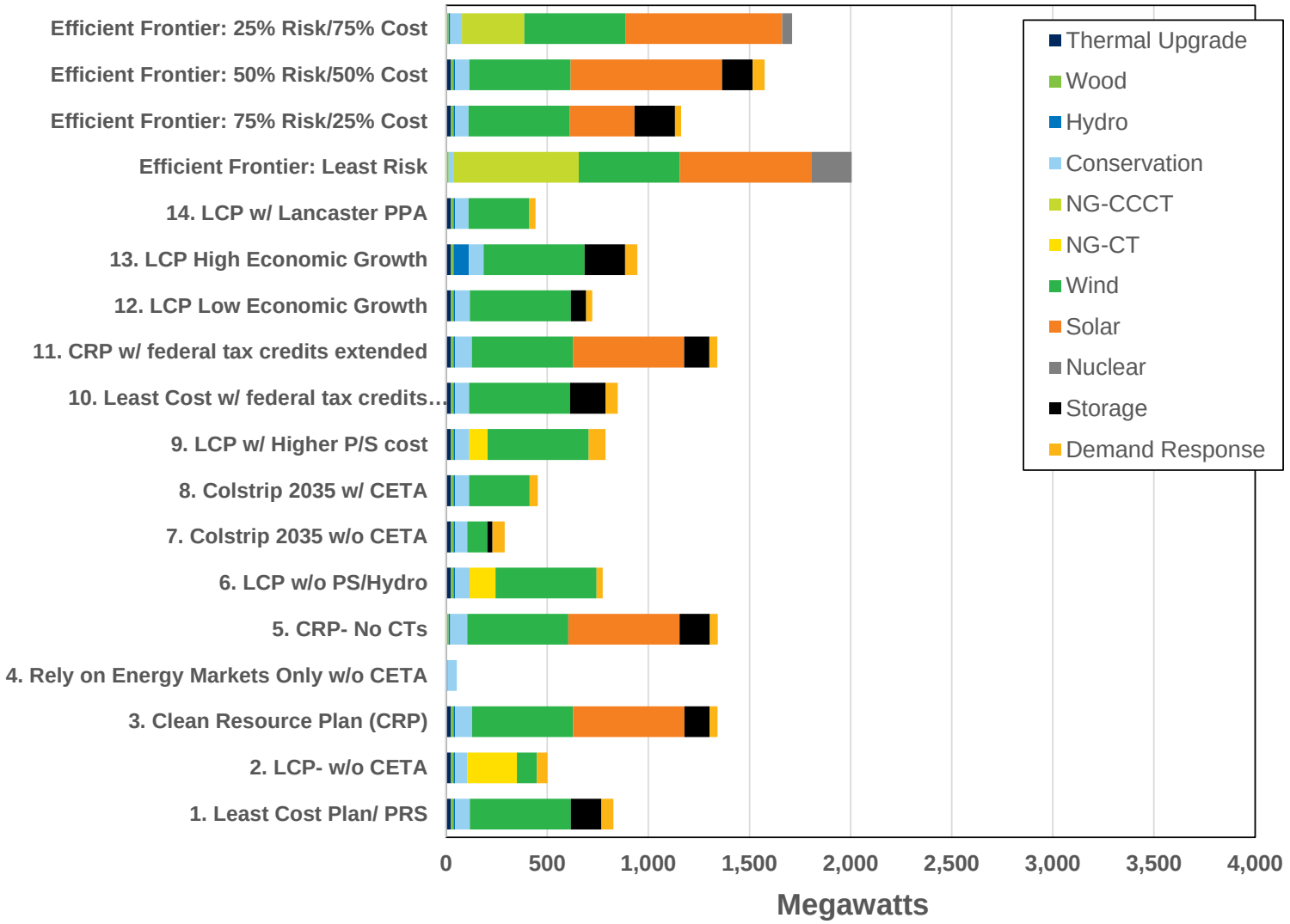
1. Preferred Resource Strategy
2. Least Cost Plan- w/o CETA
3. Clean Resource Plan: 100% net clean by 2027
4. Rely on energy markets only (no capacity or renewable additions) w/o CETA
5. 100% net clean by 2027, and no CTs by 2045
6. Least Cost Plan w/o pumped storage or Long Lake as options
7. Colstrip extended to 2035 w/o CETA
8. Colstrip extended to 2035 w/ CETA
9. Least Cost Plan w/ higher pumped storage cost
10. Least Cost w/ federal tax credits extended
11. Clean Resource Plan w/ federal tax credits extended
12. Least Cost Plan w/ low load growth (flat loads- low economic/population growth)
13. Least Cost Plan w/ high load growth (high economic/population growth)
14. Least Cost Plan w/ Lancaster PPA extended five years *(financials will not be public)*

Others: Efficient frontier portfolio (least risk, 75/25, 50/50, and 25/75)

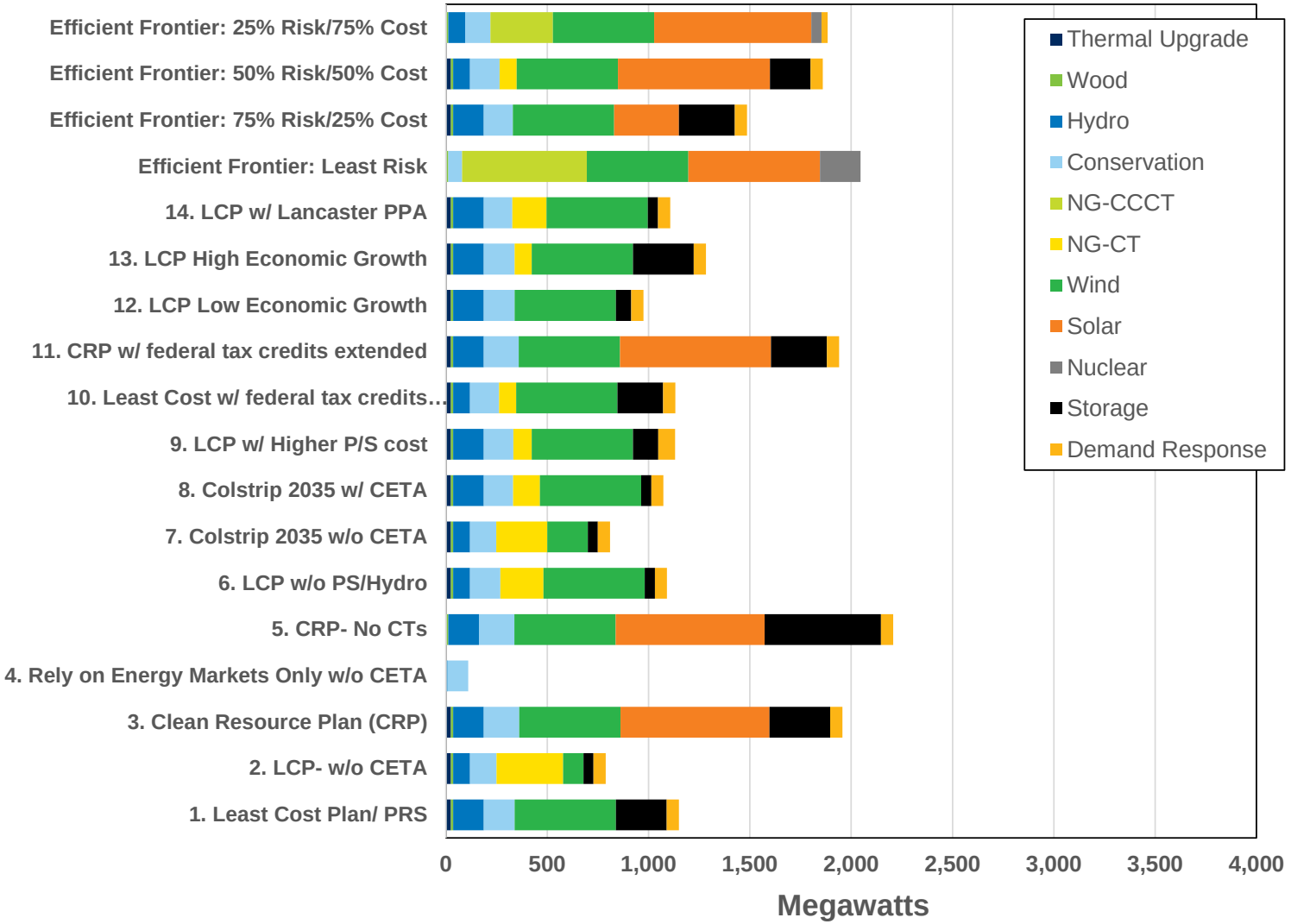
Efficient Frontier Results



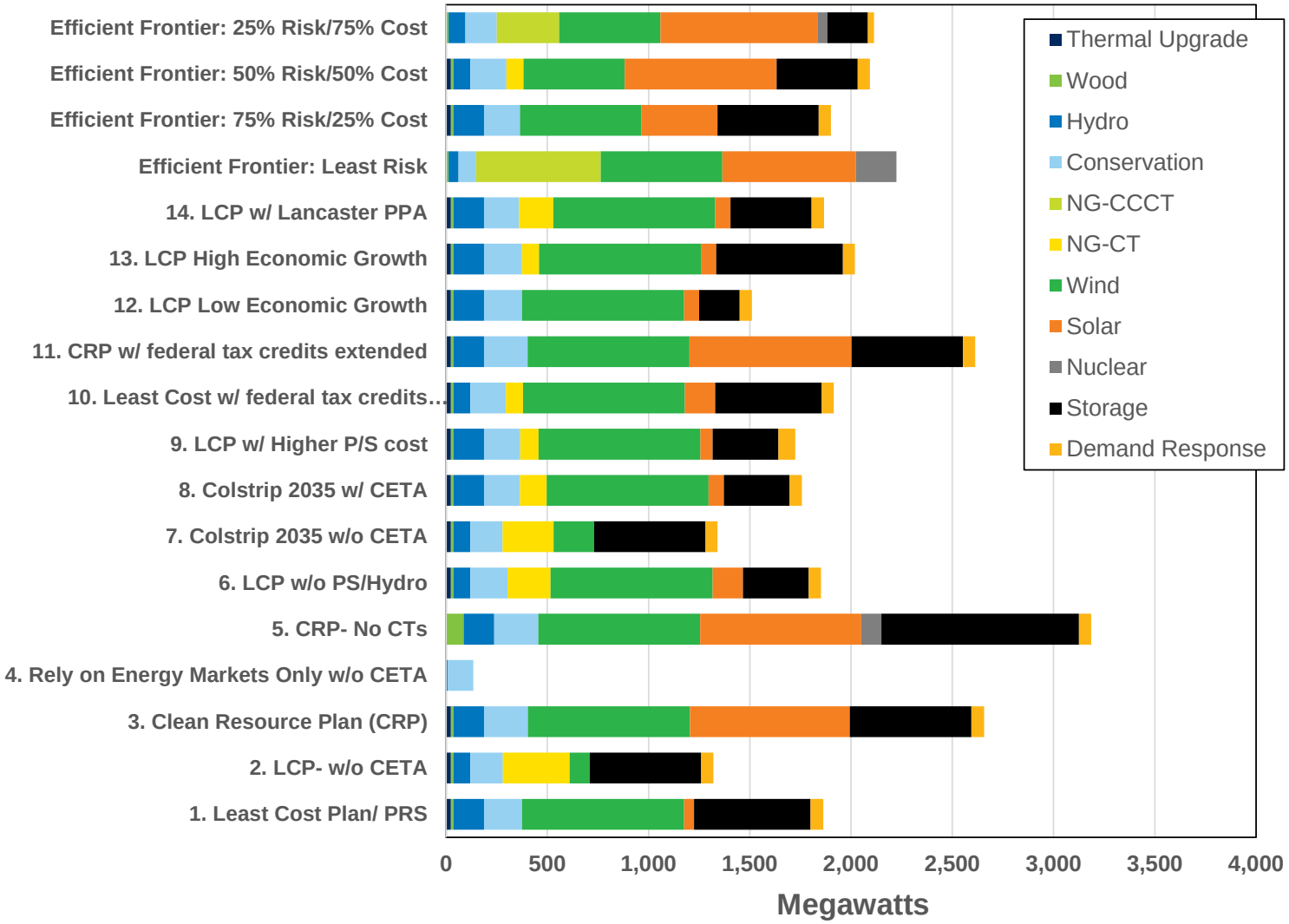
2030 Portfolio Resource Selection



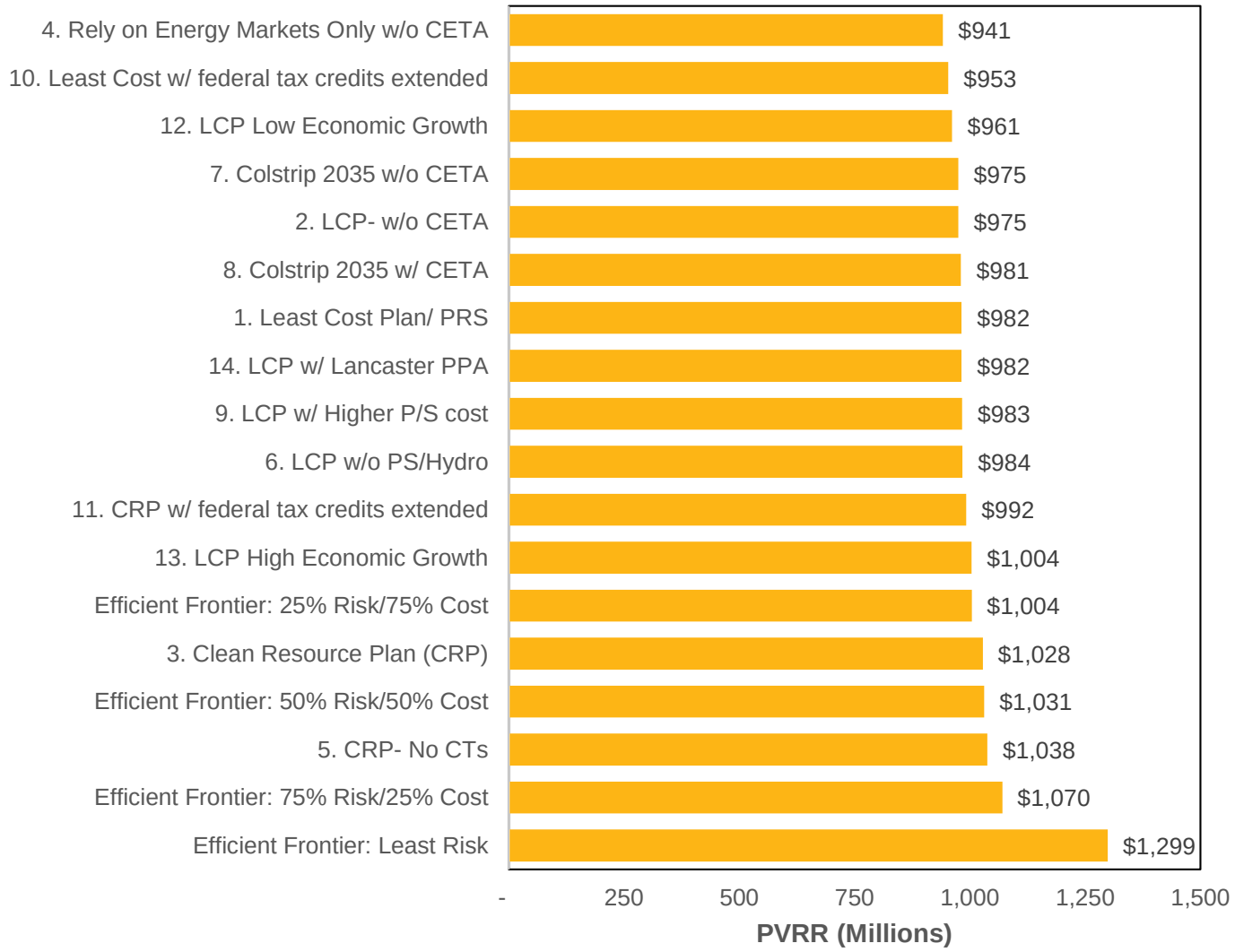
2040 Portfolio Resource Selection



2045 Portfolio Resource Selection

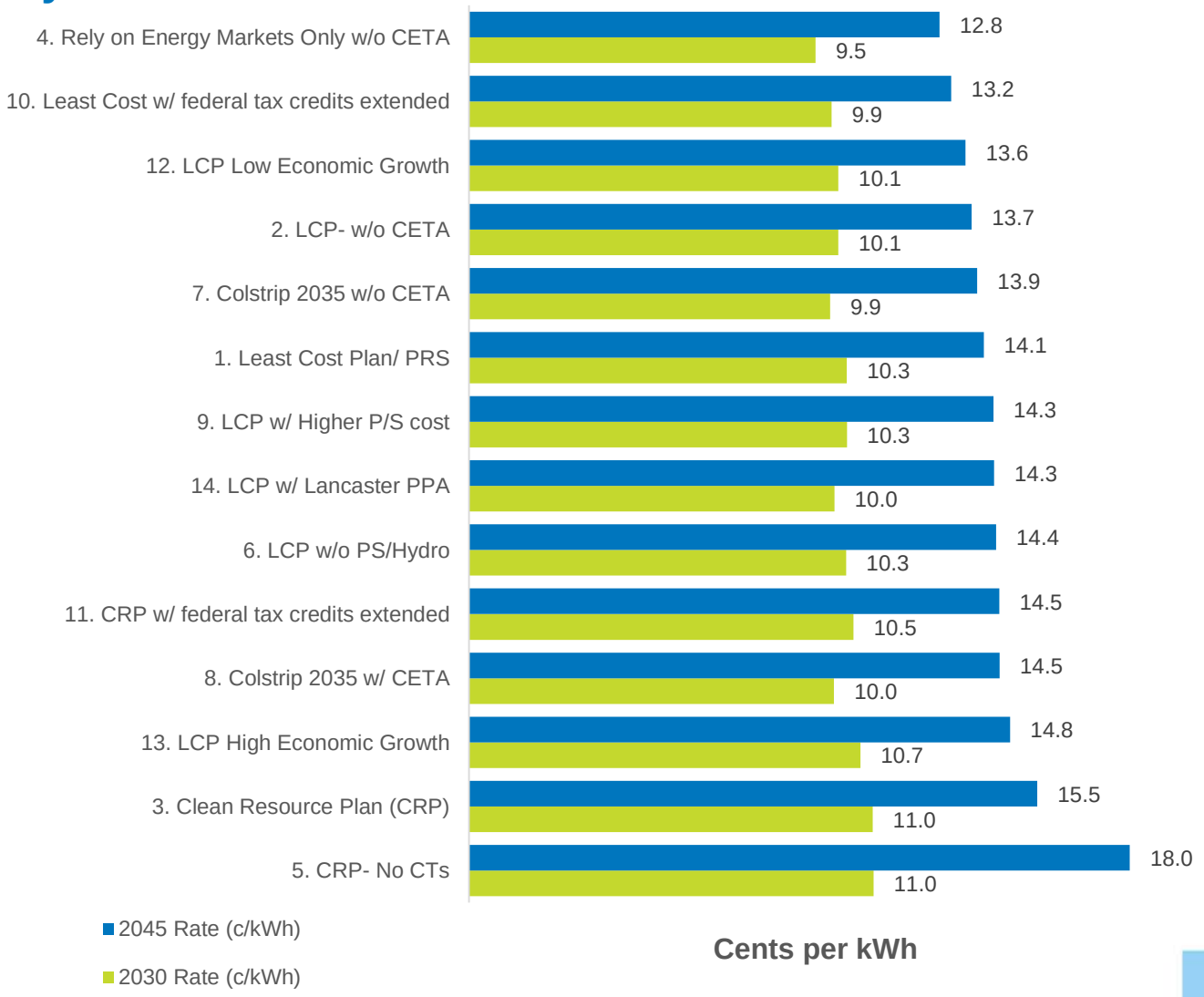


Annual Cost Comparison



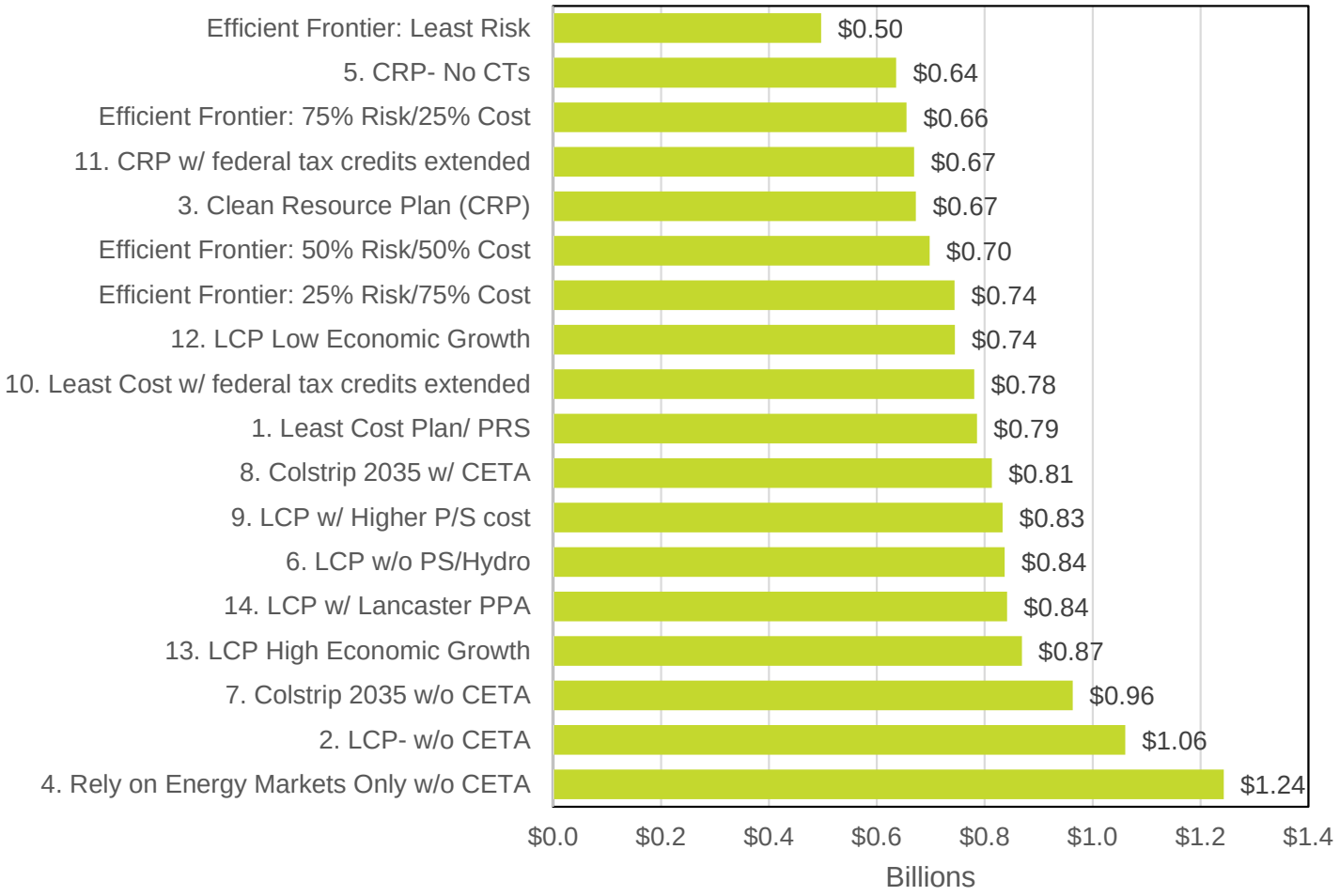
Rate Comparison

sorted by 2045 rates



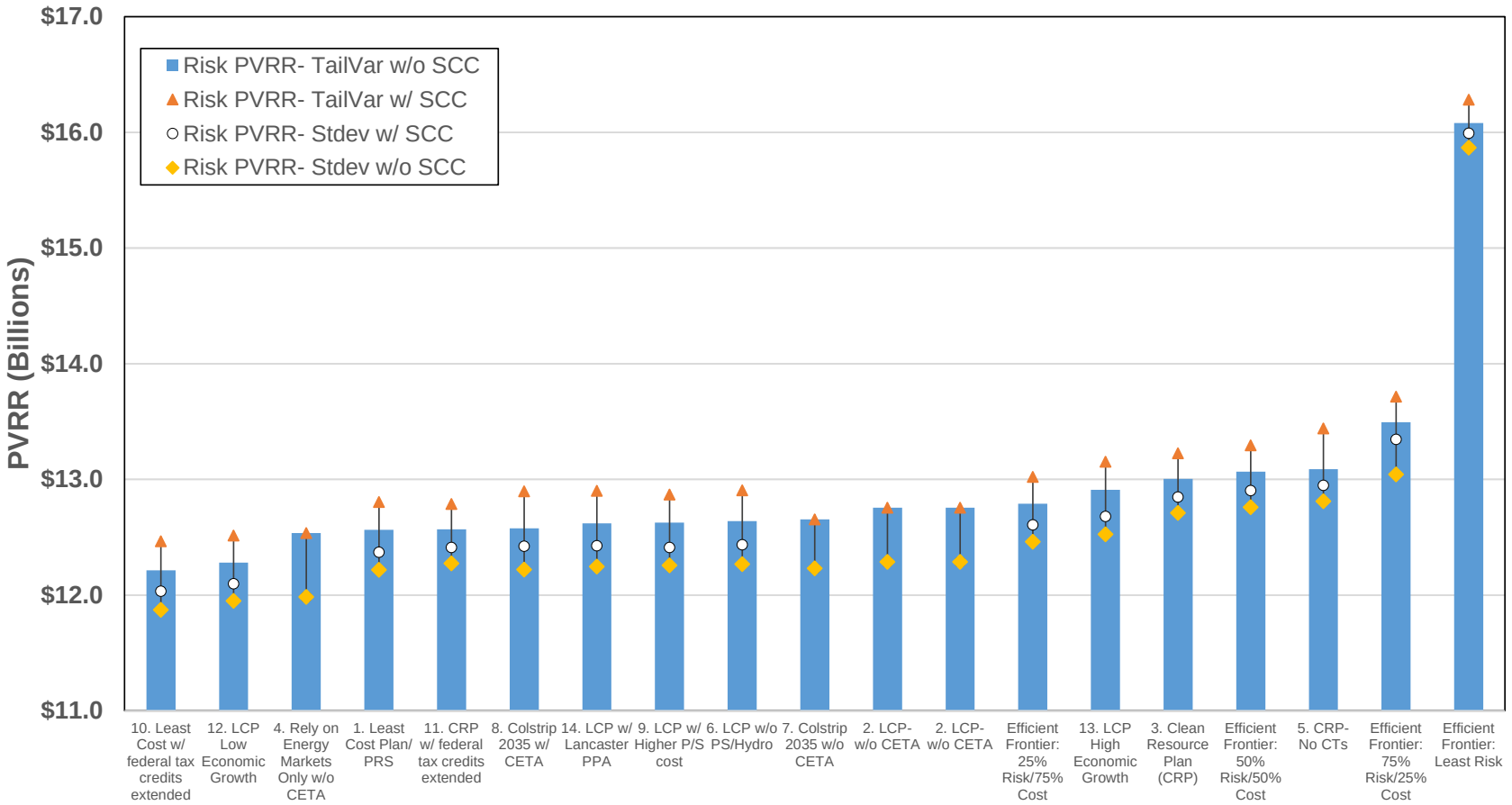
Portfolio Tail Risk

(95th percentile minus expected cost, excludes Social Cost of Carbon)

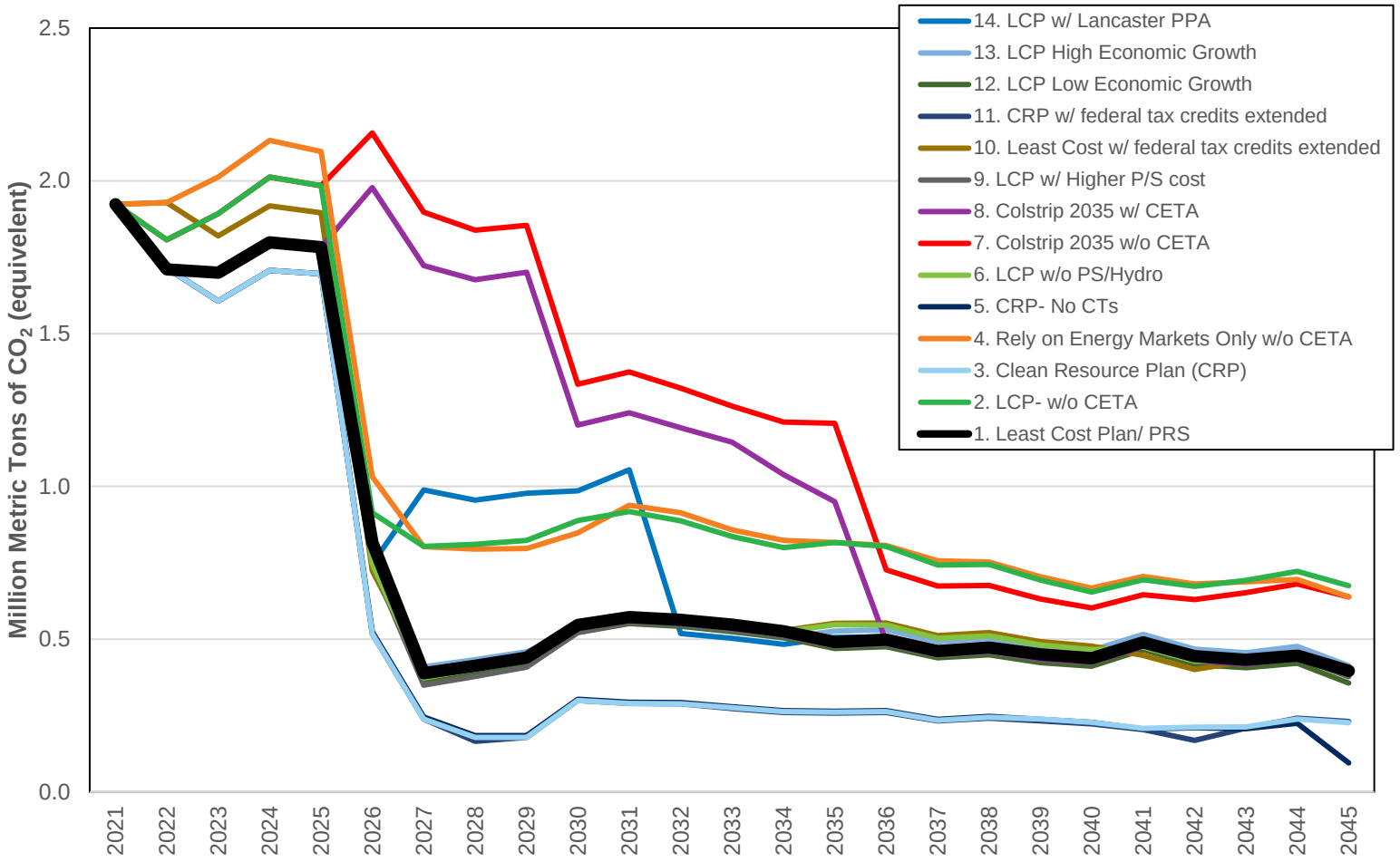


PVRR Risk Adjusted Comparison

Sorted by TailVar w/o Social Cost of Carbon (SCC)

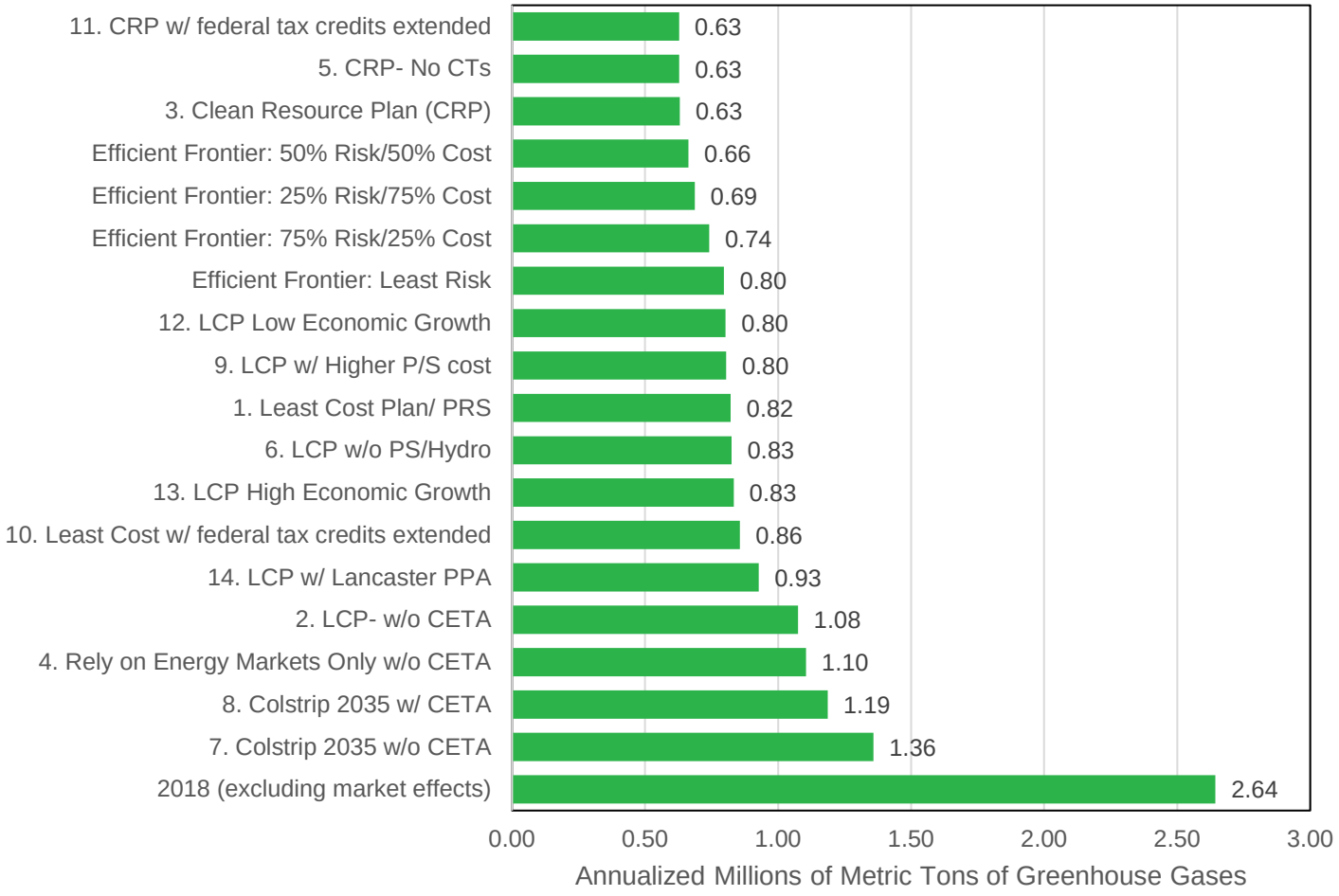


Annual Greenhouse Gas Comparison

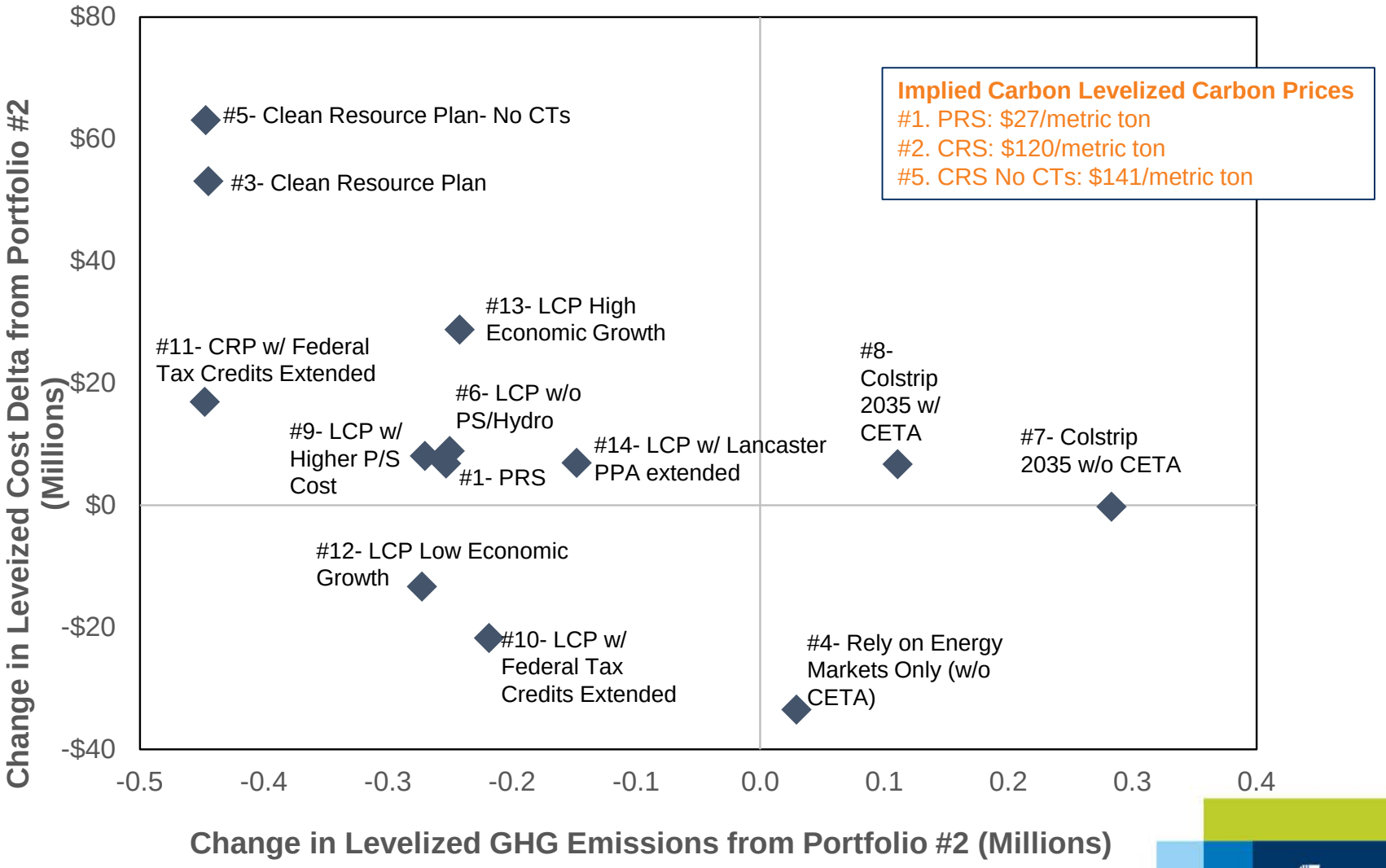


Annualized Greenhouse Gas Emissions

(Levelized using 2.5% discount rate)



Cost vs GHG Emissions



Scenario Results Summary Table

Portfolio Number	Portfolio name	Cost 2021-2045 (PVRR) (millions)	Cost 2021-2030 (PVRR) (millions)	2030 Risk (millions)	2030 Rate (c/kWh)	2045 Rate (c/KWh)	Levelized R.R.
1	Preferred Resource Strategy	$11,777	$6,303	$32.1	10.3	14.1	981.7
2	Least Cost Plan- w/o CETA	$11,695	$6,195	$42.3	10.1	13.7	974.8
3	Clean Resource Plan: 100% net clean by 2027	$12,333	$6,447	$25.4	11.0	15.5	1,027.9
4	Rely on Energy Markets Only (no capacity or renewable additions)	$11,293	$6,058	$47.8	9.5	12.8	941.3
5	100% net clean by 2027, and no CTs by 2045	$12,452	$6,453	$25.3	11.0	18.0	1,037.9
6	Least Cost Plan w/o pumped storage or Long Lake as options	$11,802	$6,281	$32.3	10.3	14.4	983.7
7	Colstrip extended to 2035 w/o CETA	$11,692	$6,176	$35.6	9.9	13.9	974.6
8	Colstrip extended to 2035 w/ CETA	$11,764	$6,234	$30.9	10.0	14.5	980.6
9	Least Cost Plan w/ higher pumped storage cost	$11,792	$6,281	$32.5	10.3	14.3	982.9
10	Least Cost w/ federal tax credits extended	$11,434	$6,183	$31.9	9.9	13.2	953.1
11	Clean Resource Plan w/ federal tax credits extended	$11,898	$6,297	$25.4	10.5	14.5	991.8
12	Least Cost Plan w/ low economic growth	$11,535	$6,241	$29.7	10.1	13.6	961.5
13	Least Cost Plan w/ high economic growth	$12,041	$6,369	$34.4	10.7	14.8	1,003.6

Note: Costs do not include Social Cost of Carbon

Appendix

Detailed Resource Portfolios

1) Preferred Resource Strategy

Least Reasonable Cost Plan

Load reduction of 152 aMW due to Energy Efficiency by 2040

2021-2030

2022: 100 MW, MT Wind
2022: 100 MW, NW Wind
2023: 100 MW, NW Wind
2024: 12 MW, Kettle Falls Upgrade
2026: 222 MW, Colstrip removed
2026: 150 MW, Pumped Hydro
2026: 24 MW, Rathdrum Upgrade
2026: 257 MW, Lancaster PPA expires
2026-2030: 85 MW, Demand Response
2027: 200 MW, MT Wind
2027: 8 MW, Post Falls Upgrade

2031-2040

2031: 75 MW, Mid-C PPA Renew
2033: 25 MW x 16 hr, Liquid Air Storage
2035: 55 MW, Northeast CT retired
2035: 68 MW, Long Lake 2nd Powerhouse
2036: 25 MW x 16 hr, Liquid Air Storage
2038: 25 MW x 16 hr, Liquid Air Storage
2039: 25 MW x 16 hr, Liquid Air Storage

2041-2045

2041: 25 MW x 16 hr, Liquid Air Storage
2042-2045: 300 MW Wind PPA Renew
2043: 25 MW x 16 hr, Liquid Air Storage
2043: 2.5 MW, Demand Response
2042-2045: 225 MW x 4 hr, Lithium-ion
2044: 50 MW, Solar w/ 50 MW x 4hr, Storage

2) Least Cost Plan

w/o CETA

Load reduction of 131 aMW due to Energy Efficiency by 2040

2021-2030

2022: 100 MW, MT Wind
2026: 12 MW, Kettle Falls Upgrade
2026: 222 MW, Colstrip removed
2026: 24 MW, Rathdrum Upgrade
2026: 257 MW, Lancaster PPA expires
2026-2030: 52 MW, Demand Response
2027: 8 MW, Post Falls Upgrade
2027: 245 MW, Natural Gas CT

2031-2040

2031: 75 MW, Mid-C PPA Renew
2033: 25 MW, Demand Response
2035: 55 MW, Northeast CT retired
2035: 84 MW, Natural Gas CT
2036: 9 MW, Demand Response
2038: 25 MW x 16 hr, Liquid Air Storage
2040: 25 MW x 16 hr, Liquid Air Storage

2041-2045

2041-2042: 50 MW x 16 hr, Liquid Air Storage
2043-2045: 450 MW x 4 hr, Lithium-ion

3) Clean Resource Plan

100% net clean by 2030

Load reduction of 175 aMW due to Energy Efficiency by 2040

2021-2030

2022: 100 MW, MT Wind
2022: 150 MW, NW Solar
2023: 200 MW, NW Wind
2024: 12 MW, Kettle Falls Upgrade
2026: 222 MW, Colstrip removed
2026: 125 MW, Pumped Hydro
2026: 24 MW, Rathdrum Upgrade
2026: 200 MW, MT Wind
2026: 257 MW, Lancaster PPA expires
2025-2030: 39 MW, Demand Response
2027: 8 MW, Post Falls Upgrade
2027-2029: 300 MW, NW Solar
2028-2030: 100 MW, Solar

2031-2040

2031: 75 MW, Mid-C PPA Renew
2031: 68 MW Long Lake 2nd Powerhouse
2033: 50 MW, NW Solar
2035: 55 MW, Northeast CT retired
2036-2040: 125 MW Solar w/ 125 MW x 4 hr. Storage
2038: 10 MW Solar
2039: 50 MW x 4 hr, Liquid Air Storage
2033-2040: 46 MW, Demand Response

2041-2045

2041-2043: 300 MW Wind PPA Renew
2042-2044: 75 MW x 16 hr Liquid Air Storage
2045: 5 MW Solar
2045: 50 MW Solar w/ 50 MW x 4 hr Storage
2045: 50 MW x 4 hr, Lithium-ion

4) Rely on Energy Markets Only
(no capacity or renewable additions)

Load reduction of 102 aMW due to Energy Efficiency by 2040

2021-2030

2026: 222 MW, Colstrip removed
2026: 257 MW, Lancaster PPA expires
2027: 8 MW, Post Falls Upgrade

2031-2040

2035: 55 MW, Northeast CT retired

2041-2045

5) 100% Net Clean by 2027
and No CTs by 2045

Load reduction of 174 aMW due to Energy Efficiency by 2040

2021-2030

2022: 150 MW, Solar
2022: 100 MW, MT Wind
2023: 200 MW, NW Wind
2024: 12 MW, Kettle Falls Upgrade
2026: 222 MW, Colstrip removed
2026: 150 MW, Pumped Hydro
2026: 200 MW, MT Wind
2026: 257 MW, Lancaster PPA expires
2025-2027: 39 MW, Demand Response
2027: 8 MW, Post Falls Upgrade
2027-2029: 300 MW, NW Solar
2028-2030: 100 MW, NW Solar

2031-2040

2031: 75 MW, Mid-C PPA Renew
2031: 68 MW, Long Lake 2nd Powerhouse
2033: 50 MW, NW Solar
2033-2035: 46 MW, Demand Response
2035: 55 MW, Northeast CT retired
2036-2040: 135 MW Solar w/ 125 MW x 4 hr, Storage
2039-2040: 250 MW x 16 hr Liquid Air Storage
2040: 50 MW Pumped Hydro
2035: 154 MW, Rathdrum CTs removed

2041-2045

2041-2043: 300 MW Wind PPA Renew
2043: 9 MW, Kettle Falls CT removed
2043: 25 MW, Boulder Park removed
2043-2045: 50 MW x 4 hr, Lithium-ion
2042-2044: 125 MW x 16 hr Liquid Air Storage
2045: 10 MW Solar
2045: 50 MW Solar w/ 50 MW x 4 hr, Storage
2045: 175 MW Pumped Hydro
2045: 100 MW Small Nuclear
2045: 75 MW Biomass
2045: 302 MW, Coyote Springs 2 removed

6) Least Cost Plan

w/o pumped storage or Long Lake

Load reduction of 149 aMW due to Energy Efficiency by 2040

2021-2030

2022: 100 MW, MT Wind
2022: 100 MW, NW Wind
2023: 100 MW, NW Wind
2024: 12 MW, Kettle Falls Upgrade
2026: 222 MW, Colstrip removed
2026: 24 MW, Rathdrum Upgrade
2026: 257 MW, Lancaster PPA expires
2027: 129 MW, Natural Gas CT
2027: 30 MW, Demand Response
2027: 200 MW, MT Wind
2027: 8 MW, Post Falls Upgrade

2031-2040

2031: 75 MW, Mid-C PPA Renew
2031-2032: 55 MW, Demand Response
2035: 55 MW, Northeast CT retired
2035: 84 MW, Natural Gas CT
2039: 25 MW x 16 hr Liquid Air Storage
2040: 25 MW x 16 hr Liquid Air Storage

2041-2045

2041-2045: 300 MW Wind PPA Renew
2042: 25 MW x 16 hr, Liquid Air Storage
2043-2045: 150 MW Solar w/ 150 MW x 4 hr, Storage
2044-2045: 75 MW x 4 hr, Lithium-ion
2044: 25 MW x 16 hr Liquid Air Storage

7) Colstrip Extended to 2035 w/o CETA

Load reduction of 129 aMW due to Energy Efficiency by 2040

2021-2030

2022: 100 MW, MT Wind
2026: 12 MW, Kettle Falls Upgrade
2026: 25 MW, Pumped Hydro
2026: 24 MW, Rathdrum Upgrade
2026: 257 MW, Lancaster PPA expires
2027: 8 MW, Post Falls Upgrade
2028-2030: 61 MW, Demand Response

2031-2040

2031: 75 MW, Mid-C PPA Renew
2035: 25 MW, Demand Response
2035: 55 MW, Northeast CT retired
2035: 222 MW, Colstrip removed
2035-2036: 252 MW, Natural Gas CT
2036: 100 MW, MT Wind
2040: 25 MW x 16 hr Liquid Air Storage

2041-2045

2041: 25 MW x 16 hr Liquid Air Storage
2042: 25 MW x 16 hr Liquid Air Storage
2042-2045: 450 MW x 4 hr, Lithium-ion

8) Colstrip Extended to 2035 w/ CETA

Load reduction of 143 aMW due to Energy Efficiency by 2040

2021-2030

2022: 100 MW, MT Wind
2022: 100 MW, NW Wind
2023: 100 MW, NW Wind
2024: 12 MW, Kettle Falls Upgrade
2026: 24 MW, Rathdrum Upgrade
2026: 257 MW, Lancaster PPA expires
2027: 8 MW, Post Falls Upgrade
2028: 39 MW, Demand Response

2031-2040

2031: 75 MW, Mid-C PPA Renew
2032-2035: 46 MW, Demand Response
2035: 55 MW, Northeast CT retired
2035: 222 MW, Colstrip removed
2035: 68 MW, Long Lake 2nd Powerhouse
2036: 200 MW, MT Wind
2036: 132 MW, Natural Gas CT
2038: 25 MW x 16 hr Liquid Air Storage
2040: 25 MW x 16 hr Liquid Air Storage

2041-2045

2041: 25 MW x 16 hr Liquid Air Storage
2042-2045: 300 MW Wind PPA Renew
2043: 25 MW x 16 hr Liquid Air Storage
2042-2045: 75 MW, Solar w/ 75 MW x 4 hr, Storage
2042-2045: 125 MW x 4 hr, Lithium-ion Storage
2045: 25 MW x 16 hr Liquid Air Storage

9) Least Cost Plan

w/ higher pumped storage cost

Load reduction of 155 aMW due to Energy Efficiency by 2040

2021-2030

2022: 100 MW, MT Wind
2022: 100 MW, NW Wind
2023: 100 MW, NW Wind
2024: 12 MW, Kettle Falls Upgrade
2025-2028: 109 MW, Demand Response
2026: 222 MW, Colstrip removed
2026: 24 MW, Rathdrum Upgrade
2026: 257 MW, Lancaster PPA expires
2027: 90 MW, Natural Gas CT
2027: 200 MW, MT Wind
2027: 8 MW, Post Falls Upgrade

2031-2040

2031: 75 MW, Mid-C PPA Renew
2032: 25 MW x 16 hr Liquid Air Storage
2035: 55 MW, Northeast CT retired
2035: 68 MW, Long Lake 2nd Powerhouse
2035-2040: 100 MW x 16 hr Liquid Air Storage

2041-2045

2041: 25 MW x 16 hr Liquid Air Storage
2042-2045: 300 MW, Wind PPA Renew
2043: 25 MW x 16 hr Liquid Air Storage
2044: 25 MW x 16 hr Liquid Air Storage
2044: 10 MW, Solar
2044: 25 MW x 4 hr, Lithium-ion
2045: 50 MW x 4 hr, Lithium-ion
2045: 50 MW Solar w/ 50 MW x 4 hr Storage

10) Least Cost Plan

w/ Federal Tax Credits Extended

Load reduction of 144 aMW due to Energy Efficiency by 2040

2021-2030

2023: 200 MW, NW Wind
2024: 12 MW, Kettle Falls Upgrade
2026: 222 MW, Colstrip removed
2026: 24 MW, Rathdrum Upgrade
2026: 200 MW, MT Wind
2026: 175 MW Pumped Hydro
2026: 283 MW, Lancaster PPA expires
2027: 100 MW, MT Wind
2027: 8 MW, Post Falls Upgrade
2027-2030: 60 MW, Demand Response

2031-2040

2031: 75 MW, Mid-C PPA Renew
2032: 25 MW, Demand Response
2035: 84 MW, Natural Gas CT
2035: 55 MW, Northeast CT retired
2038: 25 MW x 16 hr Liquid Air Storage
2040: 25 MW x 16 hr Liquid Air Storage

2041-2045

2041: 25 MW x 16 hr Liquid Air Storage
2041-2042: 300 MW, Wind PPA Renew
2043: 25 MW, Pumped Hydro
2044-2045: 150 MW NW Solar
2044-2045: 150 MW, Solar w/ 150 MW x 4 hr Storage
2044-2045: 100 MW x 4 hr, Lithium-ion

11) Clean Resource Plan

w/ Federal Tax Credits Extended

Load reduction of 173 aMW due to Energy Efficiency by 2040

2021-2030

2022: 100 MW, MT Wind
2022: 150 MW, NW Solar
2023: 200 MW, NW Wind
2024: 12 MW, Kettle Falls Upgrade
2025-2026: 39 MW, Demand Response
2026: 222 MW, Colstrip removed
2026: 200 MW, MT Wind
2026: 125 MW, Pumped Hydro
2026: 24 MW, Rathdrum Upgrade
2026: 257 MW, Lancaster PPA expires
2027-2029: 300 MW, NW Solar
2027: 8 MW, Post Falls Upgrade
2028: 50 MW, Solar
2028: 50 MW, Solar

2031-2040

2031: 75 MW, Mid-C PPA Renew
2031: 68 MW, Long Lake 2nd Powerhouse
2033: 60 MW, Solar
2033-2035: 46 MW, Demand Response
2035: 55 MW, Northeast CT retired
2036-2040: 135 MW, Solar w/ 125 MW x 4 hr Storage
2039: 25 MW x 16 hr Liquid Air Storage

2041-2045

2041-2042: 300 MW Wind PPA Renew
2043: 25 MW x 16 hr Liquid Air Storage
2043-2045: 200 MW x 4 hr, Lithium-ion
2045: 55 MW, Solar w/ 50 MW x 4 hr of Storage

12) Least Cost Plan

w/ Low Economic Growth

Load reduction of 152 aMW due to Energy Efficiency by 2040

2021-2030

2022: 100 MW, MT Wind
2022: 100 MW, NW Wind
2023: 100 MW, NW Wind
2024: 12 MW, Kettle Falls Upgrade
2025-2027: 55 MW, Demand Response
2026: 222 MW, Colstrip removed
2026: 75 MW, Pumped Hydro
2026: 24 MW, Rathdrum Upgrade
2026: 257 MW, Lancaster PPA expires
2027: 200 MW, MT Wind
2027: 8 MW, Post Falls Upgrade

2031-2040

2031: 75 MW, Mid-C PPA Renew
2035: 55 MW, Northeast CT retired
2035: 68 MW Long Lake 2nd Powerhouse
2038-2039: 30 MW Demand Response

2041-2045

2041: 25 MW x 4 hr, Lithium-ion
2042-2045: 300 MW Wind PPA Renew
2043: 25 MW x 16 hr Liquid Air Storage
2044-2045: 75 MW Solar w/ 75 MW x 4 hr Storage

13) Least Cost Plan

w/ High Economic Growth

Load reduction of 152 aMW due to Energy Efficiency by 2040

2021-2030

2022: 100 MW, MT Wind
2022: 100 MW, NW Wind
2023: 100 MW, NW Wind
2024: 12 MW, Kettle Falls Upgrade
2025-2029: 85 MW, Demand Response
2026: 222 MW, Colstrip removed
2026: 200 MW, Pumped Hydro
2026: 24 MW, Rathdrum Upgrade
2026: 257 MW, Lancaster PPA expires
2027: 200 MW, MT Wind
2027: 8 MW, Post Falls Upgrade
2030: 68 MW Long Lake 2nd Powerhouse

2031-2040

2031-2033: 75 MW, Mid-C PPA Renew
2035: 84 MW Natural Gas CT
2035: 55 MW, Northeast CT retired
2037-2040: 100 MW x 16 hr Liquid Air Storage

2041-2045

2041-43: 100 MW x 16 hr Liquid Air Storage
2042-2045: 300 MW Wind PPA Renew
2043-2045: 125 MW x 4 hr, Lithium-ion
2044: 25 MW Pumped Hydro
2044-2045: 75 MW Solar w/ 75 MW x 4 hr Storage

DRAFT

14) Least Cost Plan w/ Lancaster PPA Extended Five Years

Load reduction of 141 aMW due to Energy Efficiency by 2040

2021-2030

2022: 100 MW, MT Wind
2022: 100 MW, NW Wind
2023: 100 MW, NW Wind
2024: 12 MW, Kettle Falls Upgrade
2026: 222 MW, Colstrip removed
2026: 24 MW, Rathdrum Upgrade
2027: 8 MW, Post Falls Upgrade
2030: 30 MW, Demand Response

2031-2040

2031-2032: 75 MW, Mid-C PPA Renew
2031-2032: 55 MW Demand Response
2032: 257 MW, Lancaster PPA expires
2032: 200 MW MT Wind
2032: 84 MW Natural Gas CT
2032: 68 MW Long Lake 2nd Powerhouse
2035: 55 MW, Northeast CT retired
2035: 84 MW Natural Gas CT
2038: 25 MW x 16 hr Liquid Air Storage
2040: 25 MW x 16 hr Liquid Air Storage

2041-2045

2041: 25 MW, Solar w/ 25 MW x 4 hr Storage
2041: 25 MW x 16 hr Liquid Air Storage
2042-2045: 300 MW, Wind PPA Renew
2042-2045: 225 MW x 4 hr, Lithium-ion
2043: 25 MW x 16 hr Liquid Air Storage
2044: 50 MW, Solar w/ 50 MW x 4 hr Storage
2045: 2.5 MW, Demand Response

Least Risk Plan

Load reduction of 67 aMW due to Energy Efficiency by 2040

2021-2030

2022: 150 MW, NW Solar
2022: 100 MW, MT Wind
2023: 200 MW, NW Wind
2024: 12 MW, Kettle Falls Upgrade
2026: 222 MW, Colstrip removed
2026: 257 MW, Lancaster PPA expires
2027: 308 MW, Natural Gas CCCT
2027-2028: 200 MW, MT Wind
2028-2030: 300 MW, NW Solar
2029-2030: 200 MW, NW Solar
2029-2030: 200 MW, Small Nuclear
2030: 308 MW, Natural Gas CCCT

2031-2040

2035: 55 MW, Northeast CT retired

2041-2045

2045: 5 MW, Solar
2045: 100 MW, NW Wind
2043-45: 50 MW, Mid-C PPA Renew

Note: The least Least Risk Portfolio minimizes risk for 2030

25% Risk/ 75% Cost Plan

Load reduction of 143 aMW due to Energy Efficiency by 2040

2021-2030

2022: 50 MW, NW Solar
2022: 100 MW, MT Wind
2022: 100 MW, NW Wind
2023: 100 MW, NW Solar
2023: 100 MW, NW Wind
2024: 12 MW, Kettle Falls Upgrade
2026: 222 MW, Colstrip removed
2026: 175 MW, Pumped Hydro
2026: 24 MW, Rathdrum Upgrade
2026: 257 MW, Lancaster PPA expires
2027: 30 MW, Demand Response
2027: 200 MW, MT Wind
2027: 8 MW, Post Falls Upgrade
2030: 170 MW, Solar w/ 25 MW x 4 hr Storage

2031-2040

2031: 75 MW, Mid-C PPA Renew
2032: 55 MW, Demand Response
2035: 55 MW, Northeast CT retired
2035: 68 MW, Long Lake 2nd Powerhouse
2036: 25 MW x 16 hr Liquid Air Storage
2038: 25 MW x 16 hr Liquid Air Storage
2039: 25 MW x 16 hr Liquid Air Storage

2041-2045

2041: 25 MW x 16 hr Liquid Air Storage
2042: 25 MW x 16 hr Liquid Air Storage
2043: 25 MW, Pumped Hydro
2044: 5 MW
2044: 25 MW x 4 hr, Lithium-ion
2044: 25 MW x 16 hr Liquid Air Storage
2045: 50 MW, Solar w/ 50 MW x 4 hr Storage
2045: 100 MW, NW Wind
2045: 50 MW x 4 hr, Lithium-ion

50% Risk/ 50% Cost Plan

Load reduction of 146 aMW due to Energy Efficiency by 2040

2021-2030

2022: 100 MW, MT Wind
2022: 150 MW, NW Solar
2023: 200 MW, NW Wind
2024: 12 MW, Kettle Falls Upgrade
2026: 222 MW, Colstrip removed
2026: 150 MW, Pumped Hydro
2026: 24 MW, Rathdrum Upgrade
2026: 257 MW, Lancaster PPA expires
2026-2030: 60 MW, Demand Response
2027: 200 MW, MT Wind
2027: 8 MW, Post Falls Upgrade
2028-2030: 300 MW, Solar w/ 300 MW x 4hr storage

2031-2040

2031: 75 MW, Mid-C PPA Renew
2031: 25 MW, Demand Response
2035: 84 MW, Natural Gas CT
2035: 55 MW, Northeast CT retired
2038: 25 MW x 16 hr Liquid Air Storage
2040: 25 MW x 16 hr Liquid Air Storage

2041-2045

2041-2044: 100 MW x 16 hr Liquid Air Storage
2043-2044: 75 MW x 4 hr, Lithium-ion
2044: 50 MW, solar w/ 50 MW x 4hr storage
2045: 25 MW Pumped Hydro

75% Risk/ 25% Cost Plan

Load reduction of 125 aMW due to Energy Efficiency by 2040

2021-2030

2022: 100 MW, MT Wind
2022: 150 MW, NW Solar
2023: 200 MW, NW Wind
2024: 12 MW, Kettle Falls Upgrade
2026: 222 MW, Colstrip removed
2026: 25 MW, NW Solar
2026: 257 MW, Lancaster PPA expires
2027: 308 MW, Natural Gas CCT
2027: 200 MW, MT Wind
2027: 8 MW, Post Falls Upgrade
2028-2030: 300 MW, Solar w/ 300 MW x 4hr storage)
2030: 50 MW, Small Nuclear

2031-2040

2035-2039: 75 MW, Mid-C PPA Renew
2035: 55 MW, Northeast CT retired
2039: 30 MW, Demand Response

2041-2045

2042: 25 MW, Demand Response
2043: 25 MW, Pumped Hydro
2044: 150 MW x 4 hr, Lithium-ion
2045: 25 MW, Pumped Hydro

Future Scenarios For Next TAC meeting

- Alternative load forecasts
  - Electrification and roof top solar
  - Economic cycles
- Electric market price scenarios
  - Each of the previous scenarios w/ alternative prices
  - Least cost strategies w/ alternative prices
- Other scenarios?
  - For this IRP or the next

Carbon Abatement Curve Proposal

- Use “Expected Case” market forecast
  - No change to capacity build
  - Add generator/load in 100 MW in NW area
  - Estimate “system” emission reduction by difference between 2030 expected case and sensitivity
- Estimate cost of reduction concept
- Calculate the estimated societal $/metric ton
- Abatement options in Avista’s system
  - **Generation** sources:
    - Add: solar, wind, hydro, storage, storage + renewable
    - Remove: CCCT, CT, coal
  - **End uses:** water heater, furnaces, (to NG, away from NG), energy efficiency
  - **Transportation:** Electric vehicle vs gasoline/diesel
- Results at next TAC meeting