2025 Electric Integrated Resource Plan

Technical Advisory Committee Meeting Technical Modeling Workshop
Agenda

Tuesday, June 25, 2024
Virtual Meeting – 9:00 am to 12:00 pm PTZ

Topic	**Staff**
PRiSM Model Tour	James Gall
New Resource Cost Model	Michael Brutocao
ARAM Model Tour	Mike Hermanson

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PRiSM Model Overview

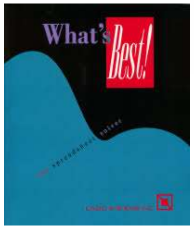
James Gall, Manager of Resource Planning
2025 Electric IRP, Technical Modeling Workshop
June 25, 2024

What is PRiSM?

- Preferred Resource Strategy Model
- Mixed Integer Program (MIP) used to select new resources to meet resource needs of our customers

Excel — The user interface

LINDO SYSTEMS INC.



The solver interface

GUROBI OPTIMIZATION — The solver

AVISTA

What is new in PRiSM for this IRP?

- Added simplified natural gas LDC system to objective function
  - Model has option to electrify gas customers
  - Impacts to gas/electric system cost and loads are included
- Changed Demand Response options to be valued as a reduction to load rather than a resource
- Includes minimum flexible resource constraint from VER study
- Add new “indicators” – job growth and resource diversity metrics

Objective Function

Minimize: (WA "Societal" $NPV_{2026\text{-}45}$) + (ID $NPV_{2026\text{-}45}$) + (NG LDC $NPV_{2026\text{-}45}$)

Where:

WA $NPV_{2026\text{-}45}$ = Market Value of Load + Existing & Future Resource Cost/Operating Margin + Social Cost of Carbon + EE TRC + NEI
ID $NPV_{2026\text{-}45}$ = Market Value of Load + Existing & Future Resource Cost/Operating Margin + EE UTC
NG LDC $NPV_{2026\text{-}45}$ = Market Value of Load + Existing & Future Resource Cost/Operating Margin

Subject to:

Generation/Gas Supply Availability & Timing
Energy Efficiency Potential
Demand Response Potential
Monthly Peak Requirements
Monthly Energy Requirements
Monthly Clean Energy Targets

Optimization Tolerance: 0.00001 or 1,500 seconds (Note: certain studies longer solution times allowed)

Optimized Cost vs. Actual Costs

- Objective function includes social costs that are not part of utility revenue requirement.
- This is used for resource optimization only.
- Social costs may include:
  - Energy Efficiency
    - TRC
    - Non-energy impacts
    - Power Act 10% adder
    - T&D Savings
  - Social Cost of Carbon

- Actual costs illustrate expected cost ratepayers will pay.
- Estimate annual revenue requirements.
- Estimate average rates.

Aurora Integration

- Aurora's price forecast and resource dispatch are inputs into PRiSM.
- Each **supply resource's** operations is included by iteration.
  - Includes MWh, GHG, Revenue, Fuel Cost, VOM costs.
- **Avista load and existing contracts** are also entered in totals.
- **Energy efficiency** load shapes are marked to market and used for the energy value of these programs.
- **Demand response** options are not modeled in Aurora, but use hourly price results for a market value.

Energy Efficiency

Washington

- AEG provides EE potential by year and program
  - Monthly peak savings
  - Monthly energy savings
- Electrical savings are grossed up for T&D losses
- Benefit of T&D Capital Avoidance ($25.38 per kW-yr)
- Total Resource Cost (TRC) test
- Add value for non-energy impacts by measure
- Power Act 10% adder for energy and capacity value
- Social Cost of Carbon using regional incremental emission rates per MWh
- Included in L&R constraints to avoid new supply resource options

Idaho

- AEG provides EE potential by year and program
  - Monthly peak savings
  - Monthly energy savings
- Electrical savings are grossed up for T&D losses
- Benefit of T&D Capital Avoidance ($25.38 per kW-yr)
- Utility Cost Test (UCT) for cost effectiveness
- Included in L&R constraints to avoid new supply resource options

Demand Response

- Programs available in each state determined by AEG.
- AEG estimated capital amortized over 5 years and a levelized cost is created by combining the O&M costs.
- Projects must ramp in over time.
- Energy arbitrage and savings will be included using hourly optimization model.
  - 10% preference adder included for Washington.
- QCC is 100% for 6 hours of reduction.
  - QCC is reduced by 20% by 2045
- Planning margin is added to QCC value to evaluate resource as a load reduction rather a resource.

Supply-Side Options

- Uses levelized fixed and variable costs for potentially owned resources (i.e., natural gas, storage).
- Uses PPA $/MWh or $/kW-yr costs for resources.
- All generation costs are available on the IRP website.
- Resources must be added in increments of probable size of actual acquisition- not any value- this assumption can increase cost or change resource strategy.
- Resources requiring a “pipeline” have surrogate pipe/storage costs included.

Transmission

- Resources have either a capital investment or a wheeling charge.
- Locations with transmission constraints with large buildouts have a lower cost transmission charge until the constraint is triggered creating a higher transmission charge.
  - For example: For wind resources, the first 500 MW can be added at $24/kW then must pay $258 million for next incremental wind addition.

Equity Provisions For Washington

- Non-Energy Impacts are included in the optimization
  - Energy efficiency, emissions costs (direct/indirect), safety, induced economic operations
  - Induced economic growth from construction is not included except for a “cost” on out of state resources
  - Maximum Benefit Scenario will have all costs on local resources (27% of CAPEX)
- Named Community Fund Constraints
  - $2 million per year must be spent on Low Income Energy Efficiency above cost effective selections
  - $400,000 minimum DER solar/storage investment above cost effective values
- Customer Benefits Indicators are an output of the model

Resource Adequacy Modeling

ARAM – Avista Resource Adequacy Model

Mike Hermanson, Senior Power Supply Analyst
Electric IRP, TAC Technical Modeling Workshop
June 25, 2024

Overview

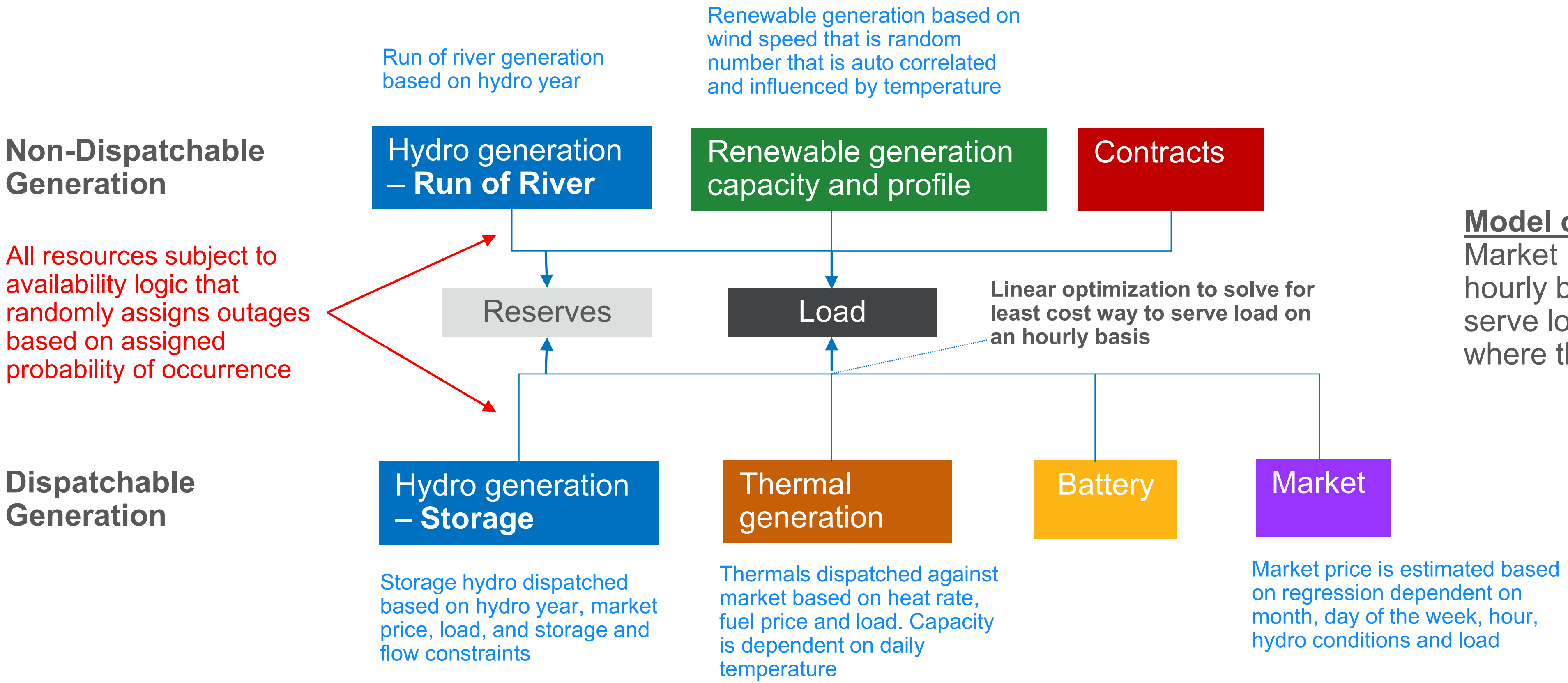
- Purpose of the Avista Resource Adequacy Model (ARAM) is to use Monte Carlo analysis techniques to test the ability of a set of resource's ability to meet load and reserve requirements.

- The model is run at an hourly time step. At each time step generators are called upon to meet load and reserve requirements, subject to unique constraints of each generator type, e.g. how much generation is available for a specific water year for a specific month or how much generation is available during a hot summer afternoon from a combined cycle CT.

- There is a range of input data that is selected at random:
  - Water year
  - Load year
  - VER production
  - Forced outages

Modeling Framework

- Excel based model with VBA code and linear optimization Excel Add-in What's Best!



Model output:
Market purchases on an hourly basis required to serve load and any hours where there is a loss of load

Modeling Framework - Hydro

Water Year – selected randomly provides monthly MW available

																3.8%	3.8%	15.0%	15.0%	0.00%
																525	507	736	375	451
		Water year	ACTUAL YEAR	Actual Month Number	PSTF	UFLS	MNRO	NMLE	CABN	NOXN	LNGL	LITF	Grant PUD	Chelan PUD	Douglas PUD	PRPD	WANA	RCKR	RCKI	WELS
22	10/1/1993	1993	1993	10	3	2	4	10	71	106	25	10	25	111	0	364	309	471	270	290.80
23	11/1/1993	1993	1993	11	9	9	13	13	64	92	39	16	35	143	0	485	435	617	335	394.50
24	12/1/1993	1993	1993	12	7	9	12	14	73	107	48	20	37	147	0	514	466	639	344	410.50
25	1/1/1994	1994	1994	1	6	8	12	11	79	117	46	19	27	112	0	383	332	474	273	293.80
26	2/1/1994	1994	1994	2	6	8	12	12	57	85	55	23	26	113	0	377	319	479	277	301.00
27	3/1/1994	1994	1994	3	11	9	13	17	75	109	50	21	27	111	0	375	326	465	272	293.80
28	4/1/1994	1994	1994	4	14	8	14	26	151	228	87	36	31	139	0	421	393	602	326	358.00
29	5/1/1994	1994	1994	5	15	9	14	24	228	402	81	34	48	204	0	632	646	919	439	539.40
30	6/1/1994	1994	1994	6	5	5	8	8	168	248	44	18	51	203	0	678	667	931	424	585.20
31	7/1/1994	1994	1994	7	3	3	5	5	84	127	27	11	37	159	0	479	487	716	341	462.60
32	8/1/1994	1994	1994	8	3	4	6	8	52	73	25	10	27	136	0	348	370	600	305	378.00
33	9/1/1994	1994	1994	9	6	7	9	9	36	52	21	9	28	120	0	395	342	510	287	328.80
34	10/1/1994	1994	1994	10	7	9	11	5	50	73	27	11	23	103	0	334	277	435	255	268.80

Storage Hydro – Optimizes Dispatch to constraints

								2,764					
	Noxon Rapids Pond												
Date	Start	MWh Allocation	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Spill	End	Constraint	Limit High	Constraint	Limit Low
/10/2030	6,999	85	0	0	54	0	63	0	6,968	<=	10134	>=	0
/10/2030	6,968	85	0	0	54	0	44	0	6,956	<=	10134	>=	0
/10/2030	6,956	85	0	0	18	0	79	0	6,943	<=	10134	>=	0
/10/2030	6,943	85	0	0	0	0	63	0	6,966	<=	10134	>=	0
/10/2030	6,966	85	0	0	0	0	63	0	6,989	<=	10134	>=	0
/10/2030	6,989	85	0	0	0	0	63	0	7,011	<=	10134	>=	0
/10/2030	7,011	85	0	0	0	0	84	0	7,012	<=	10134	>=	0
/10/2030	7,012	85	54	54	54	25	116	0	6,795	<=	10134	>=	0
/10/2030	6,795	85	0	0	54	0	66	0	6,760	<=	10134	>=	0
/10/2030	6,760	85	0	0	33	0	90	0	6,723	<=	10134	>=	0
/10/2030	6,723	85	0	0	0	0	63	0	6,745	<=	10134	>=	0
/10/2030	6,745	85	0	0	0	0	63	0	6,768	<=	10134	>=	0
/10/2030	6,768	85	0	0	0	0	34	0	6,819	<=	10134	>=	0
/10/2030	6,819	85	0	5	0	0	63	0	6,837	<=	10134	>=	0
/11/2030	6,837	116	12	0	54	0	61	0	6,825	<=	10134	>=	0
/11/2030	6,825	116	10	0	54	0	62	0	6,815	<=	10134	>=	0
/11/2030	6,815	116	10	0	54	0	35	0	6,832	<=	10134	>=	0

Run of River uses monthly amounts for specific water year

Post Falls	Upper Falls	Monroe Street	Nine Mile
13.6	8.9	13.8	21.8
13.6	8.9	13.8	21.8
13.6	8.9	13.8	21.8
13.6	8.9	13.8	21.8
13.6	8.9	13.8	21.8
13.6	8.9	13.8	21.8
13.6	8.9	13.8	21.8
13.6	8.9	13.8	21.8
13.6	8.9	13.8	21.8
13.6	8.9	13.8	21.8
13.6	8.9	13.8	21.8
13.6	8.9	13.8	21.8
13.6	8.9	13.8	21.8
13.6	8.9	13.8	21.8
13.6	8.9	13.8	21.8
13.6	8.9	13.8	21.8
13.6	8.9	13.8	21.8
13.6	8.9	13.8	21.8

Modeling Framework - Thermal

Thermal output is temperature dependent, therefore the capacity available is dependent on the temperature year selected

	Coyote Springs 2	Coyote Springs 2 Duct Burner	Lancaster	Lancaster Duct Burner	Rathdrum 1	Rathdrum 2	Northeast A	Northeast B	Kettle Falls CT	Boulder Park 1	Boulder Park 2	Boulder Park 3	Boulder Park 4	Boulder Park 5
15	298	27	258	25	86	86	0	0	0	4.4	4.4	4.4	4.4	4.4
16	297	27	257	25	86	86	0	0	0	4.4	4.4	4.4	4.4	4.4
17	298	27	257	25	86	86	0	0	0	4.4	4.4	4.4	4.4	4.4
18	298	27	257	25	85	85	0	0	0	4.4	4.4	4.4	4.4	4.4
19	298	27	257	25	85	85	0	0	0	4.4	4.4	4.4	4.4	4.4
20	298	27	256	25	85	85	0	0	0	4.4	4.4	4.4	4.4	4.4
21	298	27	256	25	84	84	0	0	0	4.4	4.4	4.4	4.4	4.4
22	298	27	256	25	84	84	0	0	0	4.4	4.4	4.4	4.4	4.4
23	297	27	255	25	84	84	0	0	0	4.4	4.4	4.4	4.4	4.4
24	297	27	255	25	84	84	0	0	0	4.4	4.4	4.4	4.4	4.4
25	297	27	255	25	83	83	0	0	0	4.4	4.4	4.4	4.4	4.4
26	297	27	254	25	83	83	0	0	0	4.4	4.4	4.4	4.4	4.4
27	296	27	254	25	83	83	0	0	0	4.4	4.4	4.4	4.4	4.4
28	296	27	253	25	83	83	0	0	0	4.4	4.4	4.4	4.4	4.4
29	296	27	253	25	82	82	0	0	0	4.4	4.4	4.4	4.4	4.4
30	296	27	253	25	82	82	0	0	0	4.4	4.4	4.4	4.4	4.4
31	295	27	252	25	82	82	0	0	0	4.4	4.4	4.4	4.4	4.4
32	295	27	252	25	81	81	0	0	0	4.4	4.4	4.4	4.4	4.4
33	294	27	251	25	81	81	0	0	0	4.4	4.4	4.4	4.4	4.4
34	294	27	251	25	81	81	0	0	0	4.4	4.4	4.4	4.4	4.4

A regression model produces a market price and thermals are dispatched to that price

			11,072.50	44.29								
1	2	3		5	6	7	8	9	10	11	12	
Date	Hour	Hour Type	Market Heat Rate	Market Price	Coyote Springs 2	Coyote Springs 2 Duct Burner	Lancaster	Lancaster Duct Burner	Rathdrum 1	Rathdrum 2	Northeast A	Nor
1/1/2030	1	0	12,734	50.94	32.3	34.1	30.1	34.7	46.9	46.9	57.9	
1/1/2030	2	0	12,488	49.95	32.3	34.1	30.1	34.7	46.9	46.9	57.9	
1/1/2030	3	0	12,451	49.81	32.3	34.1	30.1	34.7	46.9	46.9	57.9	
1/1/2030	4	0	12,510	50.04	32.3	34.1	30.1	34.7	46.9	46.9	57.9	
1/1/2030	5	0	12,808	51.23	32.3	34.1	30.1	34.7	46.9	46.9	57.9	
1/1/2030	6	0	13,150	52.60	32.3	34.1	30.1	34.7	46.9	46.9	57.9	
1/1/2030	7	0	13,702	54.81	32.3	34.1	30.1	34.7	46.9	46.9	57.9	
1/1/2030	8	0	14,220	56.88	32.3	34.1	30.1	34.7	46.9	46.9	57.9	
1/1/2030	9	0	14,456	57.82	32.3	34.1	30.1	34.7	46.9	46.9	57.9	
1/1/2030	10	0	14,644	58.58	32.3	34.1	30.1	34.7	46.9	46.9	57.9	
1/1/2030	11	0	14,854	59.42	32.3	34.1	30.1	34.7	46.9	46.9	57.9	
1/1/2030	12	0	14,814	59.26	32.3	34.1	30.1	34.7	46.9	46.9	57.9	
1/1/2030	13	0	14,706	58.82	32.3	34.1	30.1	34.7	46.9	46.9	57.9	
1/1/2030	14	0	14,627	58.51	32.3	34.1	30.1	34.7	46.9	46.9	57.9	

Modeling Framework - Wind

VER production is based on each projects capacity and then specific hourly values are correlated to temperature and autocorrelated hour to hour.

															6.6%			23.3%			11.2%	
					Capacity	105.3	100	140	0			6.19			9.00			7.52			6.99	
Type	Month	Date	Hour Type	Hour	Temp	Palouse	Montana	Rattle Snake	Project 1	Project 2	Total	Palouse Wind Speed	Palouse Adjustment		Montana Wind Speed	Montana Adjustment		RattleSnake Wind Speed	RattleSnake Adjustment		Project 1 Wind Speed	Project 1 Adjustment
&0	1	1/1/2030	0	1	2.2	0%	23%	87%	0%	14%	145.1	1.02	(0.17)		7.15	(0.08)		14.85	(0.12)		2.60	0.22
&0	1	1/1/2030	0	2	0	0%	23%	87%	0%	12%	145.1	1.05	0.04		7.04	(0.10)		15.08	0.23		2.62	0.02
&0	1	1/1/2030	0	3	-1.8	0%	27%	87%	0%	12%	148.6	1.11	0.06		7.36	0.32		15.37	0.29		2.36	(0.26)
&0	1	1/1/2030	0	4	-3.1	0%	27%	87%	0%	12%	148.6	1.21	0.10		7.19	(0.17)		15.31	(0.06)		2.50	0.14
&0	1	1/1/2030	0	5	-3.9	0%	27%	87%	0%	0%	148.6	1.26	0.05		7.22	0.02		15.23	(0.07)		2.56	0.06
&0	1	1/1/2030	0	6	-4	0%	23%	87%	0%	0%	145.1	1.13	(0.13)		7.19	(0.03)		15.19	(0.04)		2.56	(0.00)
&1	1	1/1/2030	1	7	-3.4	0%	23%	87%	0%	0%	145.1	1.21	0.08		6.96	(0.22)		15.14	(0.05)		2.58	0.02
&1	1	1/1/2030	1	8	-2.3	0%	20%	87%	0%	0%	142.1	1.24	0.03		6.81	(0.16)		15.04	(0.10)		2.51	(0.07)
&1	1	1/1/2030	1	9	-0.6	0%	20%	87%	0%	34%	142.1	1.26	0.02		6.82	0.01		14.96	(0.08)		2.52	0.01
&1	1	1/1/2030	1	10	1.4	0%	20%	87%	0%	38%	142.1	1.28	0.02		6.76	(0.06)		14.72	(0.24)		2.34	(0.18)
&1	1	1/1/2030	1	11	3.7	0%	23%	87%	0%	0%	145.1	1.41	0.13		7.10	0.33		14.63	(0.09)		2.28	(0.06)
&1	1	1/1/2030	1	12	5.9	0%	58%	87%	100%	12%	180.3	1.52	0.11		9.46	(0.23)		14.93	0.28		14.40	0.06
&1	1	1/1/2030	1	13	8.1	0%	58%	87%	100%	43%	180.3	1.36	(0.16)		9.45	(0.01)		14.91	(0.03)		14.51	0.11
&1	1	1/1/2030	1	14	9.8	0%	100%	87%	0%	4%	222.1	1.55	0.19		15.35	(0.07)		18.15	(0.15)		1.67	0.08
&1	1	1/1/2030	1	15	11.1	0%	100%	87%	0%	6%	222.1	1.43	(0.12)		15.69	0.34		18.37	0.22		1.72	0.05
&1	1	1/1/2030	1	16	11.9	0%	100%	87%	0%	6%	222.1	1.46	0.03		15.52	(0.17)		18.48	0.11		1.46	(0.26)
&1	1	1/1/2030	1	17	12	0%	100%	87%	0%	4%	222.1	1.53	0.07		15.56	0.04		18.70	0.23		1.52	0.06
&1	1	1/1/2030	1	18	11.4	0%	100%	87%	0%	6%	222.1	1.52	(0.01)		15.57	0.01		18.96	0.25		1.51	(0.01)
&1	1	1/1/2030	1	19	10.2	0%	100%	87%	0%	4%	222.1	1.39	(0.13)		15.50	(0.07)		18.99	0.04		1.58	0.07
&1	1	1/1/2030	1	20	8.5	0%	100%	87%	0%	6%	222.1	1.29	(0.10)		15.53	0.03		19.17	0.18		1.69	0.11
&1	1	1/1/2030	1	21	6.5	0%	100%	87%	0%	6%	222.1	1.25	(0.04)		15.40	(0.13)		18.96	(0.21)		1.67	(0.02)
&1	1	1/1/2030	1	22	4.2	0%	100%	87%	0%	4%	222.1	1.27	0.02		15.32	(0.08)		19.04	0.08		1.74	0.08
&0	1	1/1/2030	0	23	2	0%	100%	87%	0%	6%	222.1	1.54	0.26		15.21	(0.11)		19.05	0.01		1.84	0.10
&0	1	[illegible]	0	24	[illegible]	0%	100%	87%	0%	6%	222.1	[illegible]	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]

AVISTA

Modeling Framework - Load

Hourly load values are developed in a separate regression model that produces hourly loads based on temperature, day of week, holiday vs non-holiday, etc.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
Date	Hour	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Date	Hour	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
1/1/2030	1	-1198	-961	-1089	-997	-1097	-1351	-966	-922	-1011	-1038	-1025	-1002	-1037	-1214	-1067	-943	-912	-975	-1080
1/1/2030	2	-1225	-940	-1097	-986	-1043	-1381	-951	-903	-977	-1029	-997	-1006	-1014	-1233	-1052	-924	-885	-939	-1066
1/1/2030	3	-1261	-934	-1119	-987	-1007	-1418	-951	-899	-959	-1032	-983	-1022	-1007	-1263	-1051	-918	-871	-920	-1065
1/1/2030	4	-1298	-945	-1149	-998	-1017	-1444	-961	-910	-969	-1049	-991	-1037	-1027	-1297	-1058	-923	-880	-932	-1079
1/1/2030	5	-1345	-977	-1194	-1030	-1048	-1486	-992	-942	-1000	-1085	-1022	-1071	-1065	-1343	-1088	-952	-910	-965	-1113
1/1/2030	6	-1417	-1046	-1265	-1098	-1117	-1557	-1060	-1011	-1068	-1154	-1089	-1140	-1135	-1414	-1155	-1019	-978	-1034	-1181
1/1/2030	7	-1494	-1131	-1344	-1183	-1201	-1636	-1145	-1096	-1153	-1237	-1175	-1223	-1217	-1492	-1241	-1105	-1063	-1118	-1265
1/1/2030	8	-1537	-1192	-1392	-1244	-1264	-1687	-1207	-1157	-1216	-1295	-1239	-1282	-1273	-1537	-1306	-1171	-1127	-1179	-1325
1/1/2030	9	-1523	-1205	-1384	-1257	-1278	-1682	-1221	-1170	-1230	-1301	-1254	-1292	-1277	-1526	-1322	-1190	-1142	-1192	-1335
1/1/2030	10	-1495	-1209	-1363	-1261	-1283	-1665	-1226	-1174	-1235	-1298	-1261	-1291	-1269	-1500	-1331	-1201	-1150	-1194	-1335
1/1/2030	11	-1458	-1206	-1335	-1258	-1282	-1639	-1225	-1172	-1234	-1287	-1262	-1283	-1255	-1467	-1334	-1206	-1151	-1190	-1329
1/1/2030	12	-1412	-1194	-1298	-1244	-1272	-1603	-1214	-1159	-1224	-1267	-1253	-1266	-1231	-1425	-1326	-1202	-1142	-1177	-1312
1/1/2030	13	-1373	-1183	-1265	-1233	-1263	-1572	-1204	-1149	-1215	-1250	-1245	-1250	-1210	-1388	-1320	-1198	-1135	-1165	-1298
1/1/2030	14	-1334	-1168	-1232	-1218	-1249	-1540	-1190	-1134	-1201	-1229	-1233	-1231	-1187	-1351	-1309	-1190	-1123	-1149	-1280
1/1/2030	15	-1297	-1148	-1201	-1198	-1231	-1507	-1172	-1115	-1183	-1205	-1216	-1209	-1162	-1316	-1293	-1176	-1105	-1129	-1258
1/1/2030	16	-1295	-1156	-1201	-1206	-1239	-1508	-1180	-1122	-1192	-1210	-1224	-1215	-1166	-1315	-1302	-1187	-1114	-1137	-1265
1/1/2030	17	-1340	-1203	-1246	-1253	-1286	-1553	-1228	-1170	-1239	-1256	-1272	-1262	-1212	-1360	-1351	-1235	-1162	-1184	-1312
1/1/2030	18	-1388	-1247	-1292	-1297	-1330	-1602	-1272	-1213	-1283	-1301	-1316	-1306	-1257	-1408	-1394	-1278	-1205	-1227	-1357
1/1/2030	19	-1389	-1235	-1289	-1286	-1318	-1600	-1260	-1202	-1271	-1293	-1303	-1297	-1249	-1408	-1380	-1263	-1192	-1216	-1347
1/1/2030	20	-1377	-1204	-1271	-1254	-1285	-1583	-1227	-1170	-1237	-1265	-1269	-1268	-1223	-1393	-1346	-1226	-1158	-1184	-1317
1/1/2030	21	-1368	-1169	-1256	-1221	-1249	-1569	-1191	-1135	-1201	-1237	-1232	-1238	-1197	-1383	-1307	-1184	-1121	-1151	-1286
1/1/2030	22	-1347	-1117	-1226	-1169	-1195	-1538	-1137	-1082	-1147	-1192	-1176	-1190	-1155	-1358	-1250	-1124	-1064	-1099	-1238
1/1/2030	23	-1327	-1061	-1197	-1113	-1138	-1506	-1081	-1027	-1090	-1145	-1116	-1140	-1111	-1334	-1188	-1060	-1005	-1045	-1186

Reserves

- Spin and non-spin reserves are based on generation, load, regulation, and flex ramp for VERs. Reserve requirements are calculated on an hourly basis and optimization is utilized to determine how reserves are met.

Reserves

Flex Ramp Up Regresssion Coefficients			
Intercept	97.28334	Load	0.0080
Total Solar Production	0.464152		
Total Wind Production	0.103225		

Reserve Calculations

Assumed Values

Date	Hour	Hour Type	Load Regulation	Flex Ramp UP	Rathdrum 1	Rathdrum 2	Northeast A	Northeast B	New Resource Peaker	New Resource Peaker
				345.3	Non-Spin	Non-Spin	Non-Spin	Non-Spin	Non-Spin	Non-Spin
1/1/2030	1	0	10	124.2	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	2	0	10	124.2	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	3	0	10	124.7	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	4	0	10	124.8	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	5	0	10	125.2	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	6	0	10	125.4	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	7	0	10	126.0	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	8	0	10	126.1	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	9	0	10	127.1	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	10	0	10	126.9	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	11	0	10	126.5	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	12	0	10	130.0	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	13	0	10	129.7	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	14	0	10	133.7	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	15	0	10	134.1	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	16	0	10	134.0	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	17	0	10	133.5	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	18	0	10	133.9	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	19	0	10	133.9	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	20	0	10	133.7	0.0	0.0	0.0	0.0	0.0	0.0

Date	Hour	Cabinet 1	Cabinet 2	Cabinet 3	Cabinet 4	Noxon 1	Noxon 2	Noxon 3	Noxon 4	Noxon 5	Long Lake 1	Long Lake 2	Long Lake 3	Long Lake 4
		Non-Spin	Non-Spin	Non-Spin	Non-Spin	Non-Spin	Non-Spin	Non-Spin	Non-Spin	Non-Spin	Non-Spin	Non-Spin	Non-Spin	Non-Spin
1/1/2030	1	56.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	2	55.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	3	56.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	57.2	0.0	0.0	0.0	0.0
1/1/2030	5	58.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	61.7	0.0	0.0	0.0	0.0
1/1/2030	7	64.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	8	66.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.1	0.0	0.0	0.0	0.0
1/1/2030	10	65.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	64.8	0.0	0.0	0.0	0.0	0.0
1/1/2030	12	64.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	63.7	0.0	0.0	0.0	0.0
1/1/2030	14	64.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	62.9	0.0	0.0	0.0	0.0
1/1/2030	16	62.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/1/2030	17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	64.5	0.0	0.0	0.0	0.0	0.0
1/1/2030	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.2	0.0	0.0	0.0	0.0	0.0
1/1/2030	19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.1	0.0	0.0	0.0	0.0	0.0
1/1/2030	20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	65.6	0.0	0.0	0.0	0.0	0.0

Operations

- Operations sheet brings all of the pieces together to determine if load and reserves have been met.
- Includes market purchases and sales, demand response, contracts,

ew ge	Washington Industrial	Industrial Load Reduction	TOU	VPP	On-Peak Market Purchase	Off-Peak Market Purchase	On-Peak Market Sale	Off-Peak Market Sale	Reserve Call	Unserved Energy	Net Position
	3%										
	-82.8	0	0	0	0	0	0	120		0.0	0
	-82.8	0	0	0	0	0	0	103	0	0.0	0
	-82.8	0	0	0	0	0	0	98	0	0.0	0
	-82.8	0	0	0	0	0	0	77	0	0.0	0
	-82.8	0	0	0	0	0	0	37	0	0.0	0
	-82.8	0	0	0	0	10	0	0	0	0.0	0
	-82.8	0	0	0	0	108	0	0	0	0.0	0
	-82.8	0	0	0	0	165	0	0	0	0.0	0
	-82.8	0	0	0	0	162	0	0	0	0.0	0
	-82.8	0	0	0	0	151	0	0	0	0.0	0
	-82.8	0	0	0	0	130	0	0	0	0.0	0
	-82.8	0	0	0	0	62	0	0	0	0.0	0
	-82.8	0	0	0	0	38	0	0	0	0.0	0
	-82.8	0	0	0	0	0	0	34	0	0.0	0
	-82.8	0	0	0	0	0	0	61	0	0.0	0
	-82.8	0	0	0	0	0	0	59	0	0.0	0
	-82.8	0	0	0	0	0	0	12	0	0.0	0
	-82.8	0	0	0	0	35	0	0	0	0.0	0
	-82.8	0	0	0	0	31	0	0	0	0.0	0
	-82.8	0	0	0	0	7	0	0	0	0.0	0
	-82.8	0	0	0	0	0	0	14	0	0.0	0
	-82.8	0	0	0	0	0	0	52	0	0.0	0
	-82.8	0	0	0	0	0	0	109	0	0.0	0

BO	BP	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC
67	68	69	70	71	72	73	74	75	76	77	78	79	80	
							Market Cap							
						All Hours	1000	1000	5	Low				
						Constained Hours	330	330	83	High				
											Demand Response			
Total		Balance	On-Peak Market Sale Constraint	Off-Peak Market Sale Constraint	On-Peak Market Purchase Constraint	Off-Peak Market Purchase Constraint	On-Peak Max	Off-Peak Max	Regional Power Constraint	Industrial Hour	Public Hour	Industrial Constraint	VPP	
0		=	<=	<=	=<=	<=	0	330	1			<=	=<=	
0		=	<=	<=	=<=	<=	0	330	1			<=	=<=	
0		=	<=	<=	=<=	<=	0	330	1			<=	=<=	
0		=	<=	<=	=<=	<=	0	330	1			<=	=<=	
0		=	<=	<=	=<=	<=	0	330	1			<=	=<=	
0		=	<=	<=	=<=	<=	0	330	1			<=	=<=	
0		=	<=	<=	=<=	<=	0	330	1			<=	=<=	
0		=	<=	<=	=<=	<=	0	330	1			<=	=<=	
0		=	<=	<=	=<=	<=	0	330	1			<=	=<=	
0		=	<=	<=	=<=	<=	0	330	1			<=	=<=	
0		=	<=	<=	=<=	<=	0	330	1			<=	=<=	
0		=	<=	<=	=<=	<=	0	330	1			<=	=<=	
0		=	<=	<=	=<=	<=	0	330	1			<=	=<=	
0		=	<=	<=	=<=	<=	0	330	1			<=	=<=	
0		=	<=	<=	=<=	<=	0	330	1			<=	=<=	
0		=	<=	<=	=<=	<=	0	330	1			<=	=<=	
0		=	<=	<=	=<=	<=	0	330	1			<=	=<=	
0		=	<=	<=	=<=	<=	0	330	1			<=	=<=	

Analysis Approach

- Utilizes Monte Carlo Methods
  - Run 1,000 simulations of 1 year at an hourly time step.
  - Determine how many time during the simulation there was a loss of load or reserve requirements could not be met.
  - Calculate Metrics:
    - **LOLP** – *Loss of Load Probability*: Calculated by counting the number of iterations where there is unserved load or unmet reserves and dividing by the total number of iterations.
    - **LOLE** – *Loss of Load Expectation:* Calculated by counting the days where there is unserved load or unmet reserves and dividing by the total number of iterations.
    - **LOLEV** – *Loss of Load Expected Events*: Calculated by counting the number of consecutive blocks of unserved load or unmet reserves and dividing by the number of iterations.
    - **LOLH** – *Loss of Load Hours:* Calculated by summing the number of hours with unserved load or unmet reserves and dividing by the total number of iterations.
    - **EUE** – *Expected Unserved Energy:* Calculated by summing all of the unserved MWhs over the study period and dividing by the number of iterations. Two versions are presented one with unmet reserves and one without.