2020 Electric Integrated Resource Plan

Technical Advisory Committee Meeting No. 4 Agenda

Tuesday, August 6, 2019
Conference Room 130

Topic	Time	Staff
Introductions and TAC 3 Recap	9:00	Lyons
Washington SB 5116 and IRP Updates	9:10	Lyons
Energy and Peak Load Forecast Update	9:30	Forsyth
Natural Gas Price Forecast	11:00	Pardee
Lunch	12:00	
Electric Price Forecast	1:00	Gall
Existing Resource Overview	2:00	Lyons
Final Resource Needs Assessment	3:00	Lyons
Adjourn	4:00	

2020 Electric IRP
TAC Meeting Introductions and Recap

John Lyons, Ph.D.
Fourth Technical Advisory Committee Meeting
August 6, 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 at 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 #3 Recap – April 16, 2019

- Introductions and TAC 2 Recap, Lyons
- Regional Legislative Update, Lyons
- IRP Transmission Planning Studies, Rolstad
- Distribution Planning Within the IRP, Fisher
- Conservation Potential Assessment, AEG
- Demand Response Potential Assessment, AEG
- Pullman Smart Grid Demonstration Project, Doege
- E3 Study – Resource Adequacy in the Pacific Northwest, Gall

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

Today's Agenda

9:00 – Introductions and TAC 3 Recap, Lyons

9:10 – Washington SB 5116 and IRP Updates, Lyons

9:30 – Energy and Peak Load Forecast Update, Forsyth

11:00 – Natural Gas Price Forecast, Pardee

Noon – Lunch

1:00 – Electric Price Forecast, Gall

2:00 – Existing Resource Overview, Lyons

3:00 – Final Resource Needs Assessment, Lyons

4:00 – Adjourn

Future TAC Topics

- TAC 5: Tuesday, October 15, 2019
  - Ancillary services and intermittent generation analysis
  - Energy Imbalance Market analysis
  - Review Preliminary PRS
  - Market scenario results
  - Preliminary Portfolio scenario results

- 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

Washington SB 5116 and IRP Updates

John Lyons, Ph.D.
Fourth Technical Advisory Committee Meeting
August 6, 2019

Clean Energy Transformation Act (CETA)

- E2SSB 5116 Clean Energy Transformation Act (CETA)
- No coal serving Washington customers after 2025 or earlier
- Carbon neutrality beginning in 2030
  - 80% or greater clean energy requirement
  - Alternate compliance options for up to 20%
  - Penalties for non-compliance unless out of utility's control or for reliability
  - Four-year compliance periods beginning with 2030-33
- 100% clean energy 2045
- 2% incremental cost cap
- Many areas of additional rule making are required and discussed later

Other CETA Provisions

- A utility extending service to new customers through condemnation must comply with the clean energy standard and Energy Independence Act (EIA)
- Utilities must assess and plan for obtaining enough funds to meet 60% of low-income energy assistance need by 2030 and 90% by 2050
- By January 1, 2022, the company must begin filing four-year clean energy implementation plans with the UTC
- Affirms the UTC authority to use alternative ratemaking mechanisms
- Clarifies the identification of used and useful property during a rate period for up to four years
- Allows deferred accounting for up to three years for major projects in a utilities clean energy action plan as part of its IRP
- Allows an imputed return on power purchase agreements of no less than the cost of debt and no more than the authorized rate of return
- Includes federal incremental hydroelectricity in the definition of an eligible renewable resource under the EIA
- Extends sales and use tax breaks for renewable resource until 2030 provided specific labor standards are met

CETA Rule Making

- WUTC opened Docket U-190485 for implementation of legislation passed in the 2019 legislative session
- Phase 0: July 1, 2019 to August 30, 2019
  - Initiate rulemaking processes
  - Docket U-190531: Inquiry into Valuation of Public Service Company Property Used and Useful after Rate Effective Date
  - Timeline finalized after public comment
  - Close IRP Rulemaking Docket No. U-161024, incorporate IRP procedural rules, RFP rules and Distributions System Planning in this docket
- Phase 1: August 2019 to January 1, 2021
  - Results due by January 1, 2021
- Phase 2: Beginning January 1, 2021
  - Results due on or before June 30, 2022

Phase 1

- Publication of social cost of carbon with inflation rate
- Issue policy statement for Valuation of Public Service Company Property Used and Useful after Rate Effective Date (U-190531)
- Start four rulemakings and one policy statement
- IRP Updates
  - IRP inputs, structure, public involvement process, outputs of Clean Energy Action Plans, social cost of carbon, equitable distribution of benefits, and assessment informed by cumulative impact analysis
- Used and useful standard policy statement
- EIA rulemaking
  - Equitable distribution, definitions of low-income and energy assistance need, low-income efficiency target, and updated hydro eligibility and tracking
- Clean Energy Implementation Plan (CEIP) rulemaking
  - Guidelines, equitable distribution of benefits, and incremental cost methodology
- Acquisition rulemaking
  - Existing RFP work, ensure new standard met for construction and acquisition of property and the provision of electric service, and resource adequacy

Phase 2 and Additional Projects

Start four rulemakings

1. Cumulative impact analysis
2. Carbon and electricity markets
3. Natural gas conservation
4. Natural gas IRP

Additional projects without statutory deadlines

- Interconnection standard
- Capital budgeting
- Distribution system planning
- Reliability and resiliency
- Demand response policy statement
- Pricing signals policy statement
- Pilot projects policy statement
- Rate making adequacy inquiry

Load and Economic Forecasts: Redux

Grant D. Forsyth, Ph.D.
Chief Economist
Fourth Technical Advisory Committee Meeting
August 6, 2019

Main Topic Areas

- **Service Area Economy**
- **Peak Load Forecast**
- **Long-run Forecast**

Painting: Jan Steen, 1640, Netherlands. *As the Old Sing, Pipe the Young*.

Service Area Economy

Grant D. Forsyth, Ph.D.
Chief Economist
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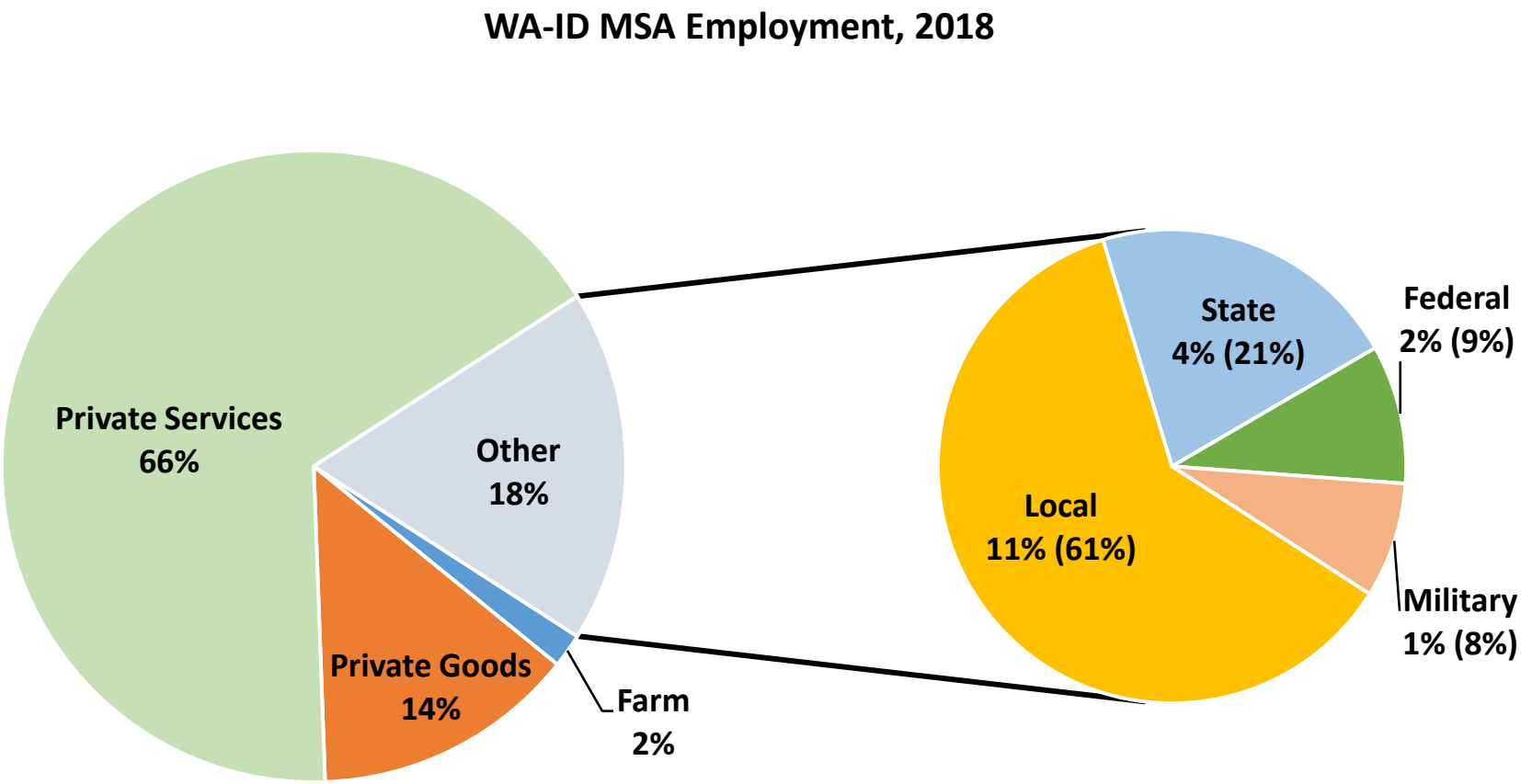
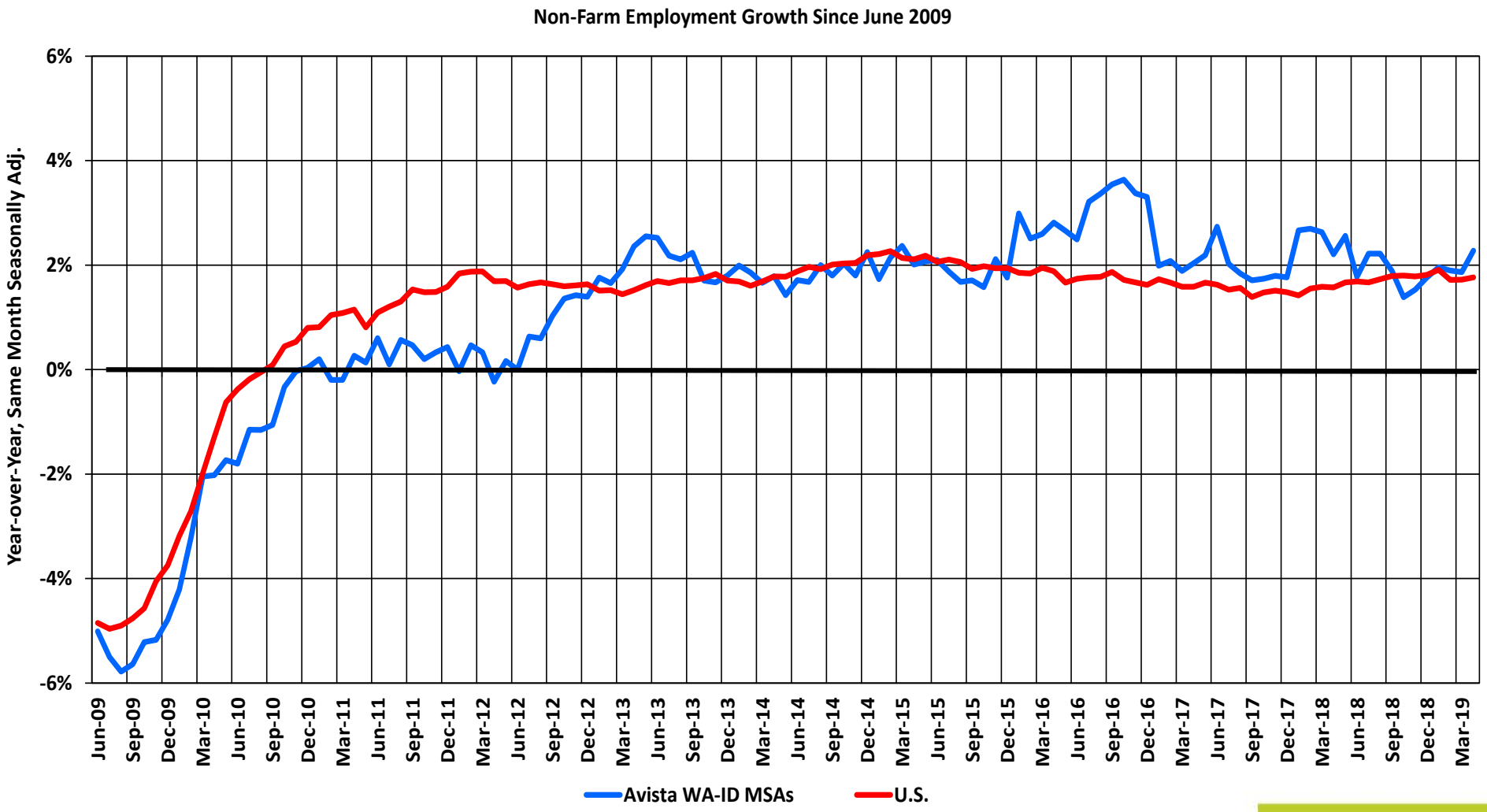
Distribution of Employment: Services and Government are Dominant



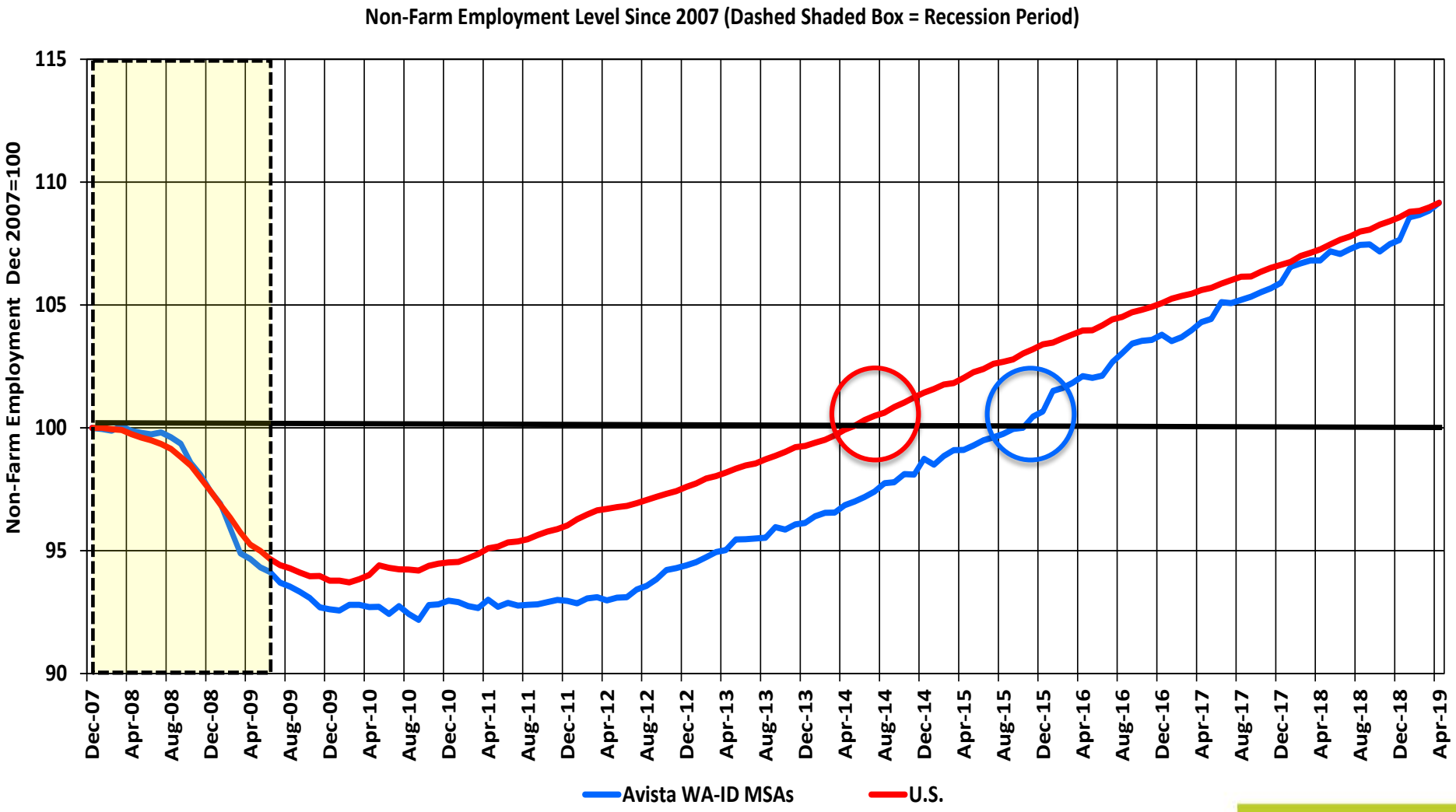
Source: BLS, BEA and author's calculations.

Non-Farm Employment Growth, 2009-2019



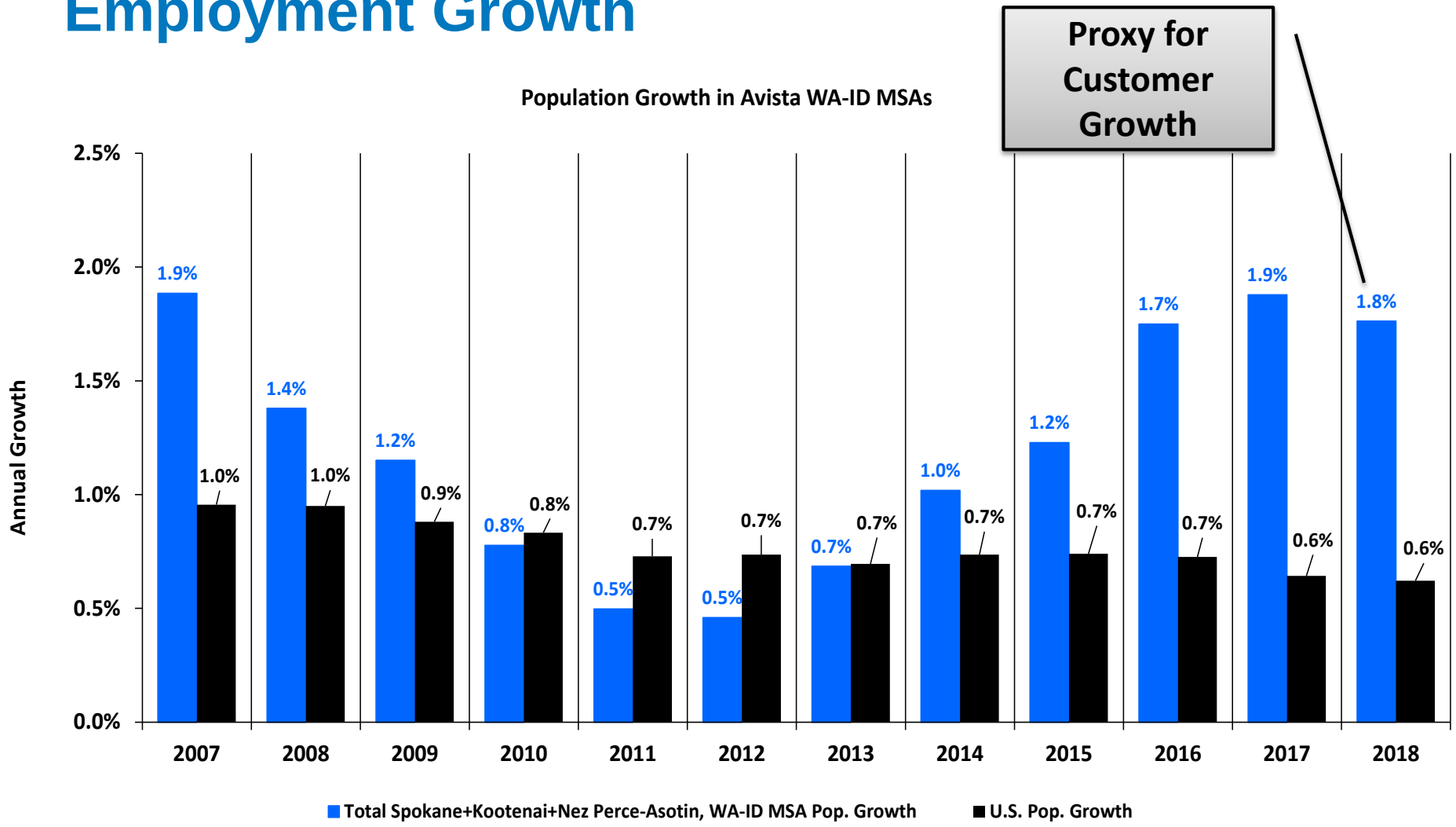
Source: BLS and author's calculations.

Non-Farm Employment: Finally Catching Up



Source: BLS and author's calculations.

Population Growth: Recovering with Employment Growth



Source: BEA, U.S. Census, and author's calculations.

Peak Load Forecast

Grant D. Forsyth, Ph.D.
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The Basic Model

- **Monthly time-series regression model that initially excludes certain industrial loads.**

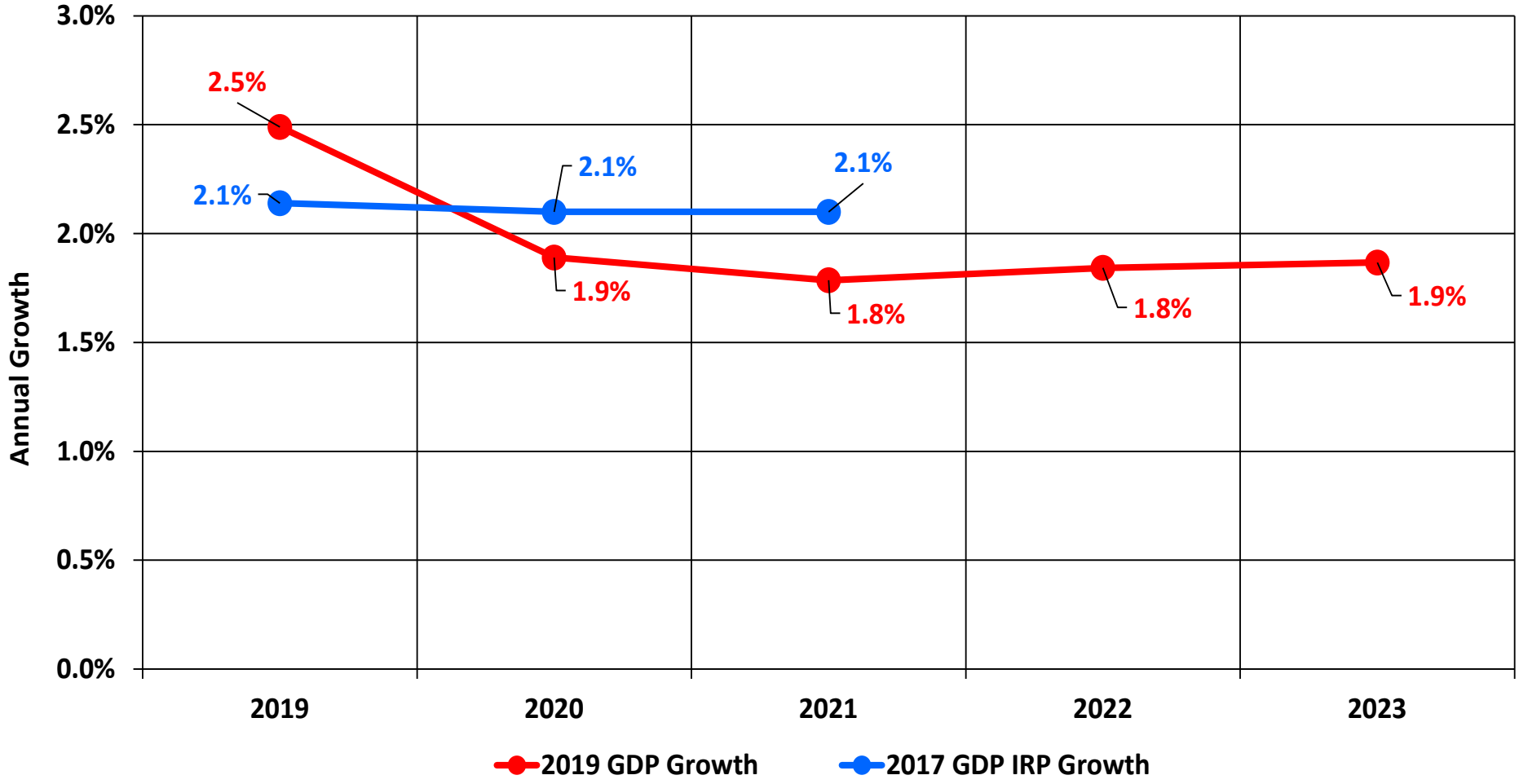
- **Based on monthly peak MW loads since 2004. The peak is pulled from hourly load data for each day for each month.**

- **Explanatory variables include HDD-CDD and monthly and day-of-week dummy variables. The level of real U.S. GDP is the primary economic driver in the model—the higher GDP, the higher peak loads. *Model was recently recalibrated to allow GDP impact to differ between winter and summer.* The historical impacts of DSM programs are "trended" into the forecast.**

- **The coefficients of the model are used to generate a distribution of peak loads by month based on historical max/min temperatures, holding GDP constant. An expected peak load can then be calculated for the current year (e.g., 2019). Model confirms Avista is a winter peaking utility for the forecast period; however, the summer peak is growing at a faster than the winter peak.**

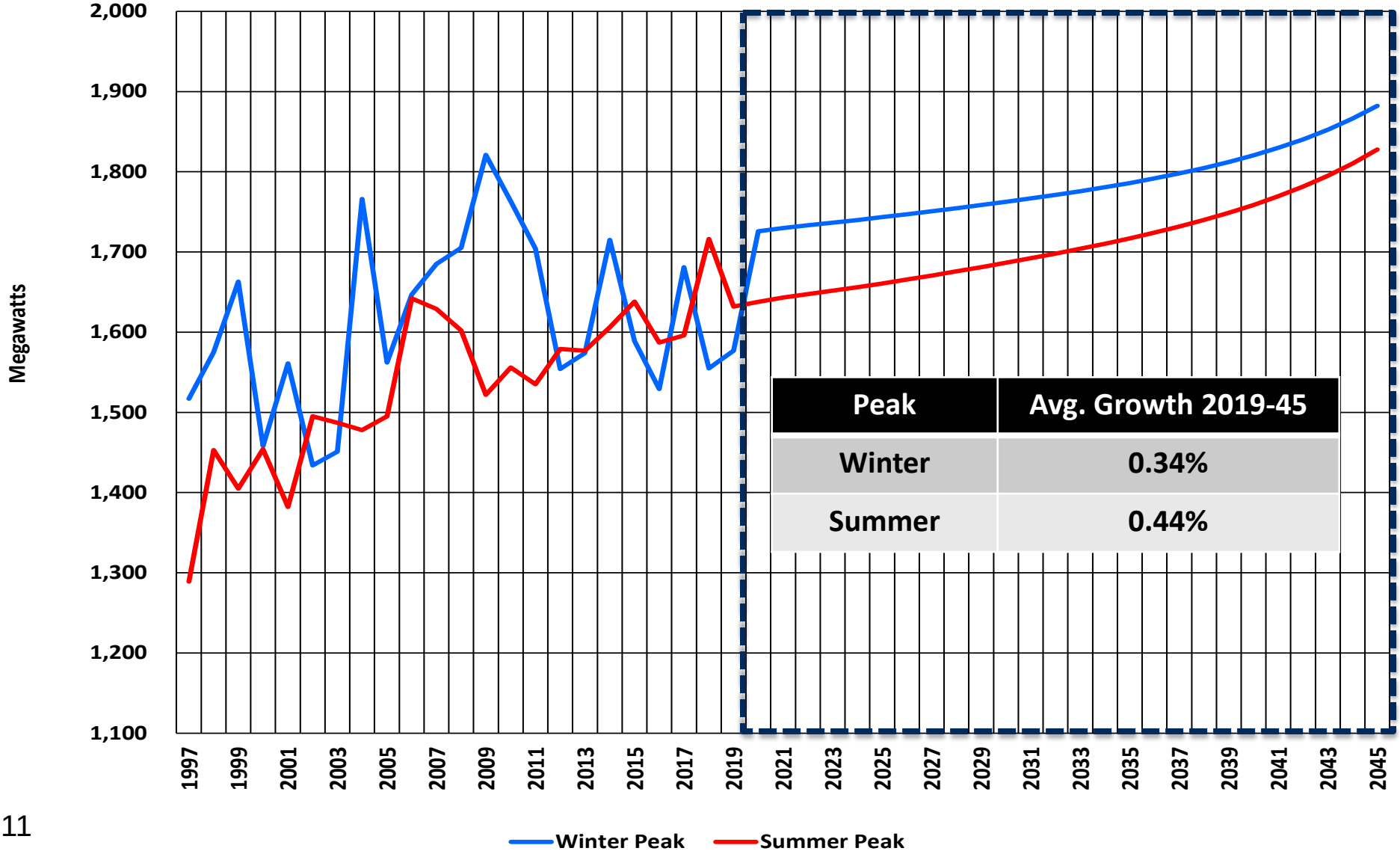
- **The model is also used to calculate the long-run growth rate of peak loads for summer and winter using a forecast of GDP growth under the "*ceteris paribus*" assumption for weather and other factors.**

GDP Growth Assumptions: 2019 IRP vs. 2017 IRP



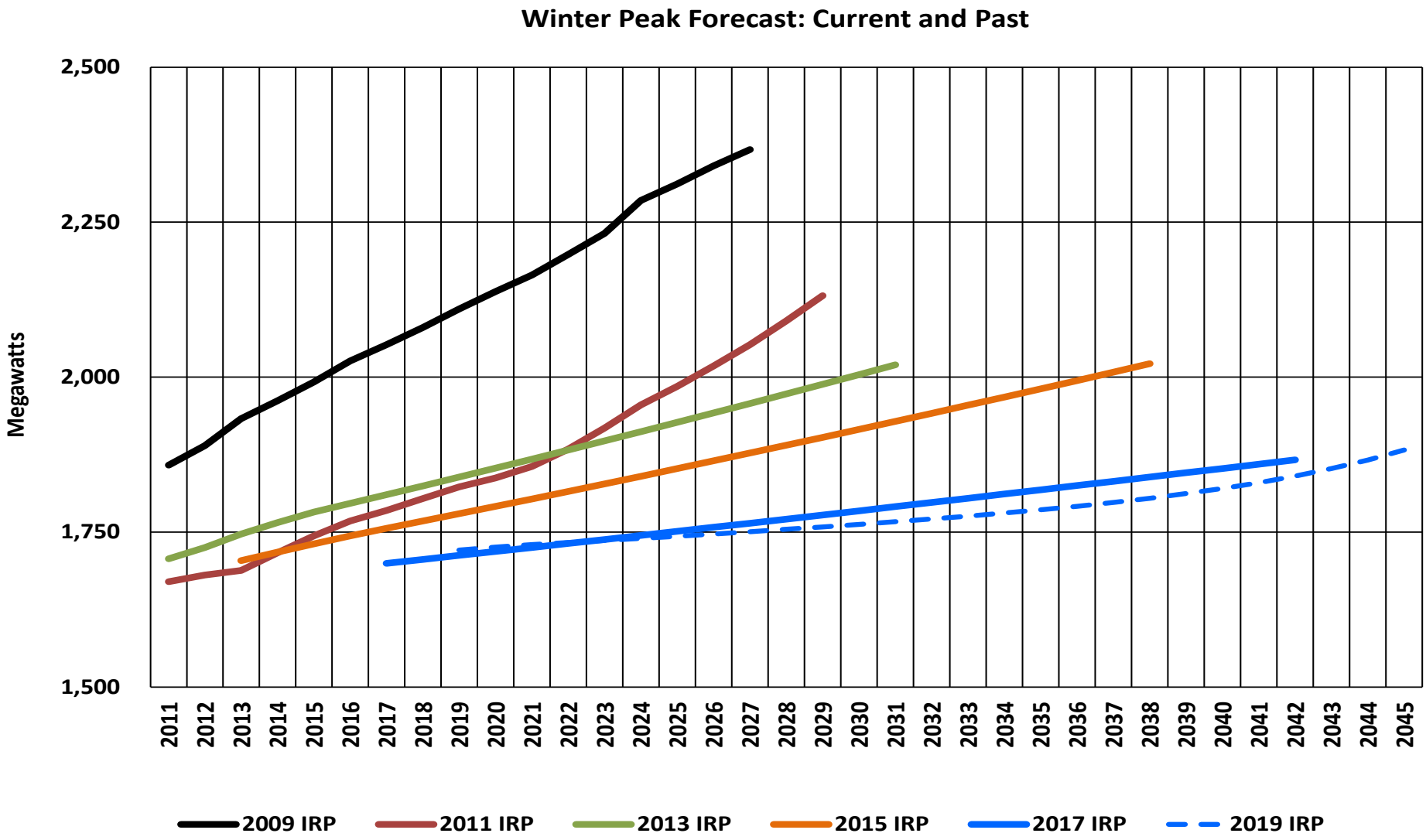
Source: Various and author's calculations.

Current Peak Load Forecasts for Winter and Summer, 2019-2045

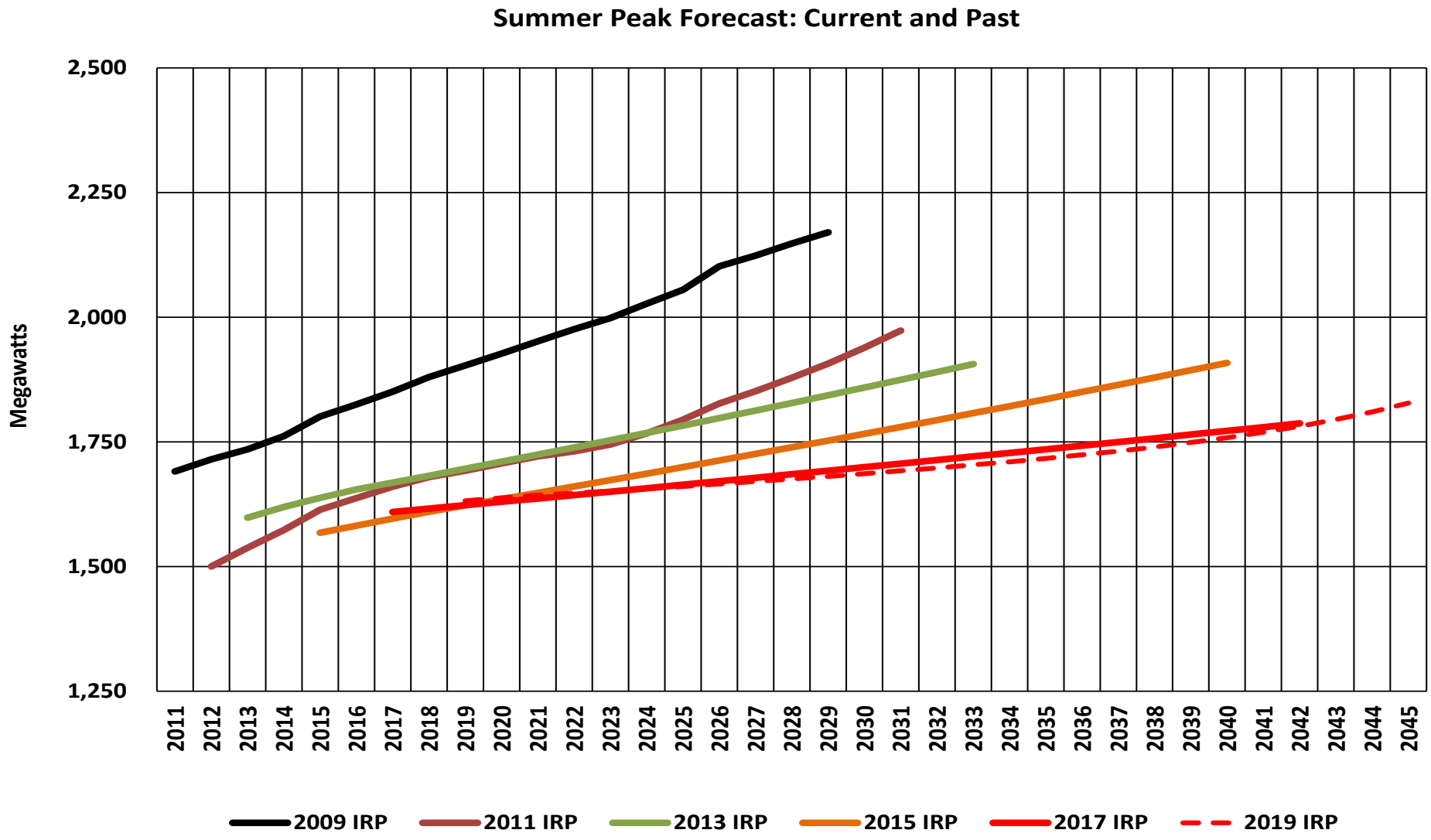


Peak	Avg. Growth 2019-45
Winter	0.34%
Summer	0.44%

Current and Past Peak Load Forecasts for Winter Peak, 2011-2043



Current and Past Peak Load Forecasts for Summer Peak, 2011-2045



Long-Term Load Forecast

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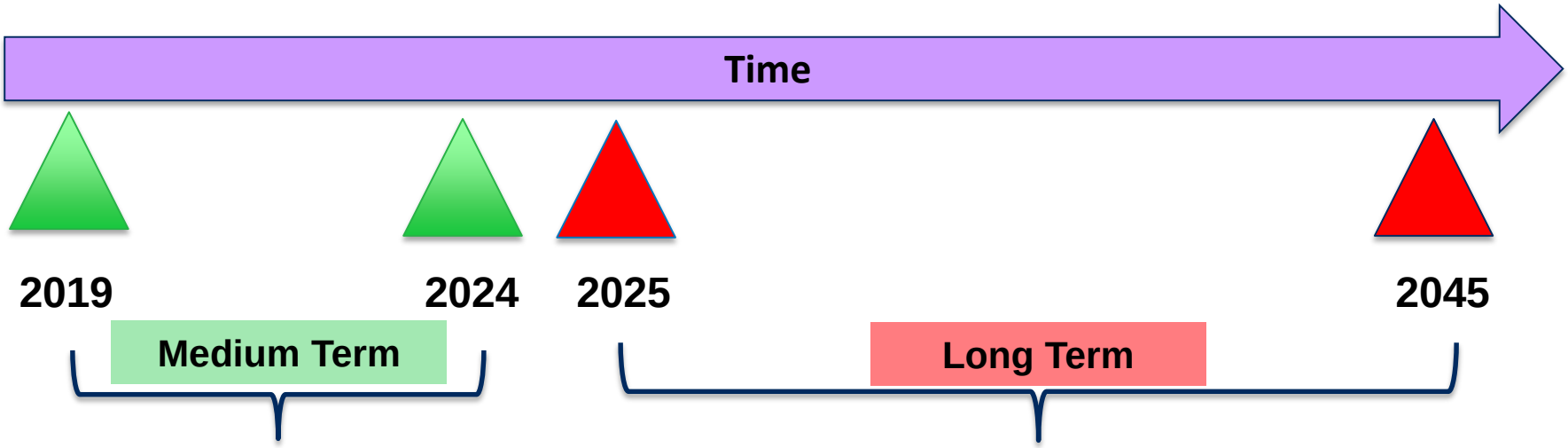
Basic Forecast Approach



1) Monthly econometric model by schedule for each class.
2) Customer and UPC forecasts.
3) 20-year moving average for "normal weather."
4) Economic drivers: GDP, industrial production, employment growth, population, price, natural gas penetration, and ARIMA error correction.
5) Native load (energy) forecast derived from retail load forecast.

1) Boot strap off medium term forecast.
2) Apply long-run load growth relationships to develop simulation model for high/low scenarios.
3) Include different scenarios for renewable penetration with controls for price elasticity, EV/PHEVs, and natural gas penetration.

The Long-Term Residential Relationship, 2020-2040

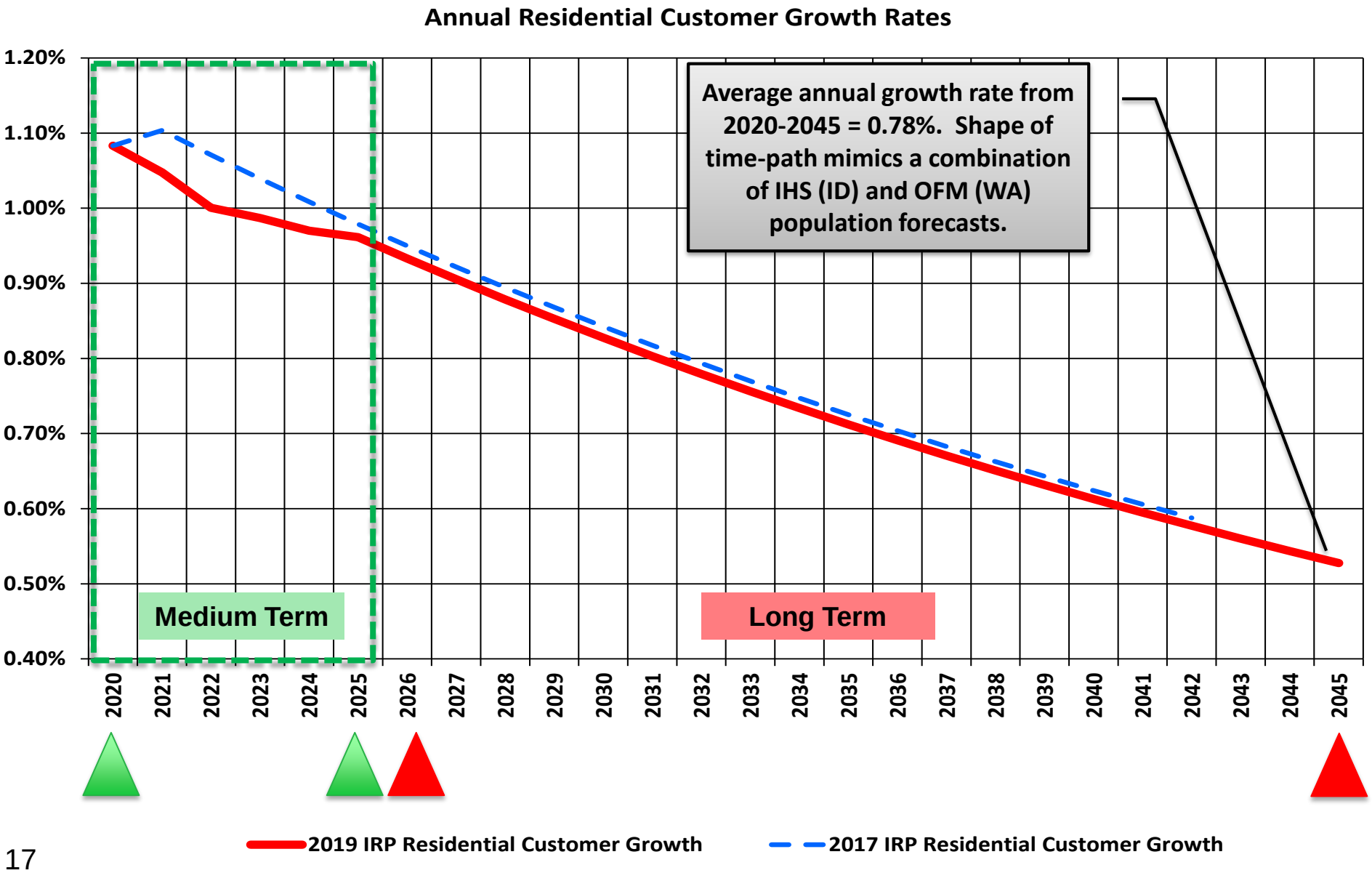
Load = Customers X Use Per Customer (UPC)

Load Growth ≈ Customer Growth + UPC Growth

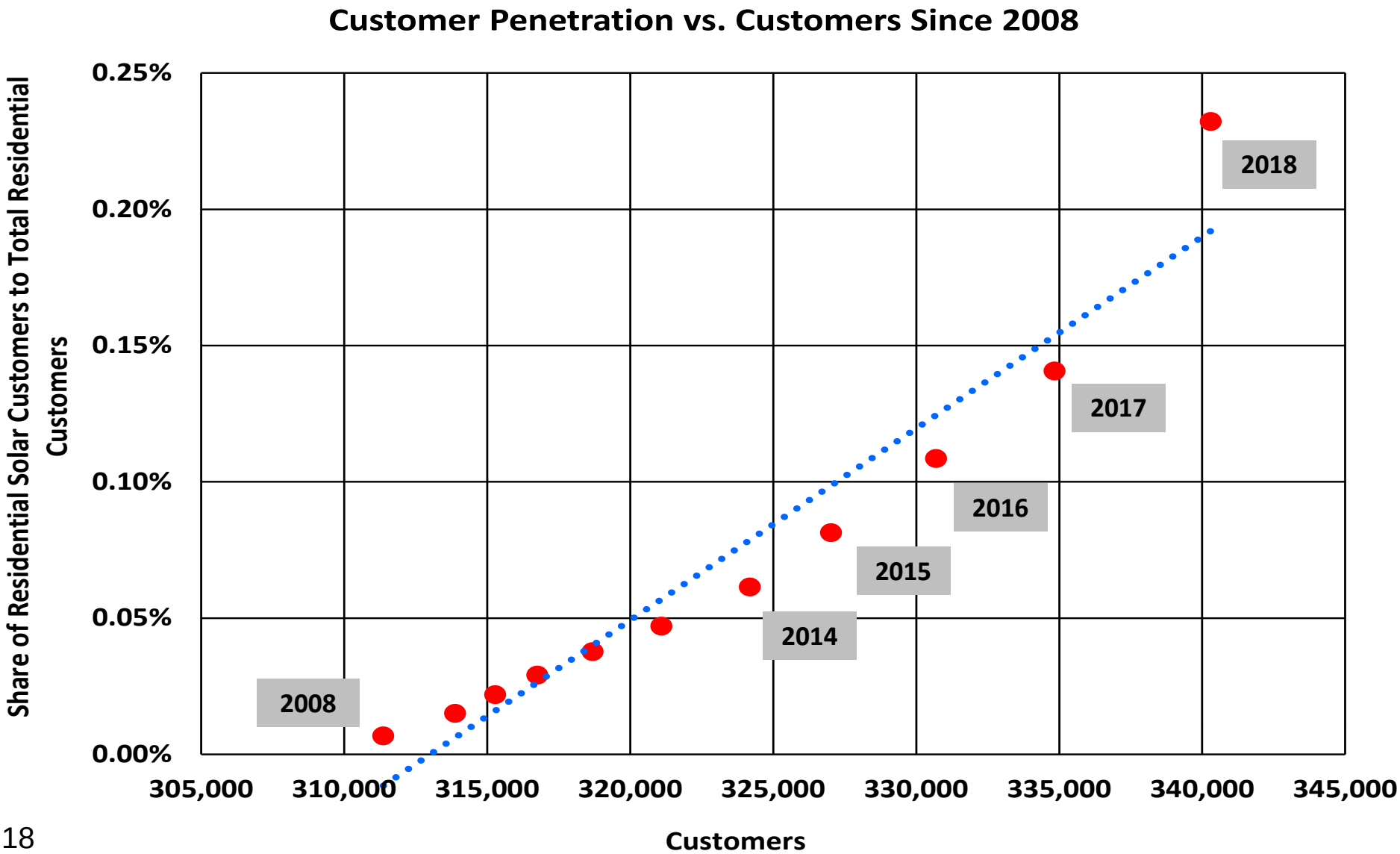
Assumed to be same as population growth, commercial growth will follow residential, and slow decline in industrial.

Assumed to be a function of multiple factors including renewable penetration, gas penetration, and EVs/PHEVs.

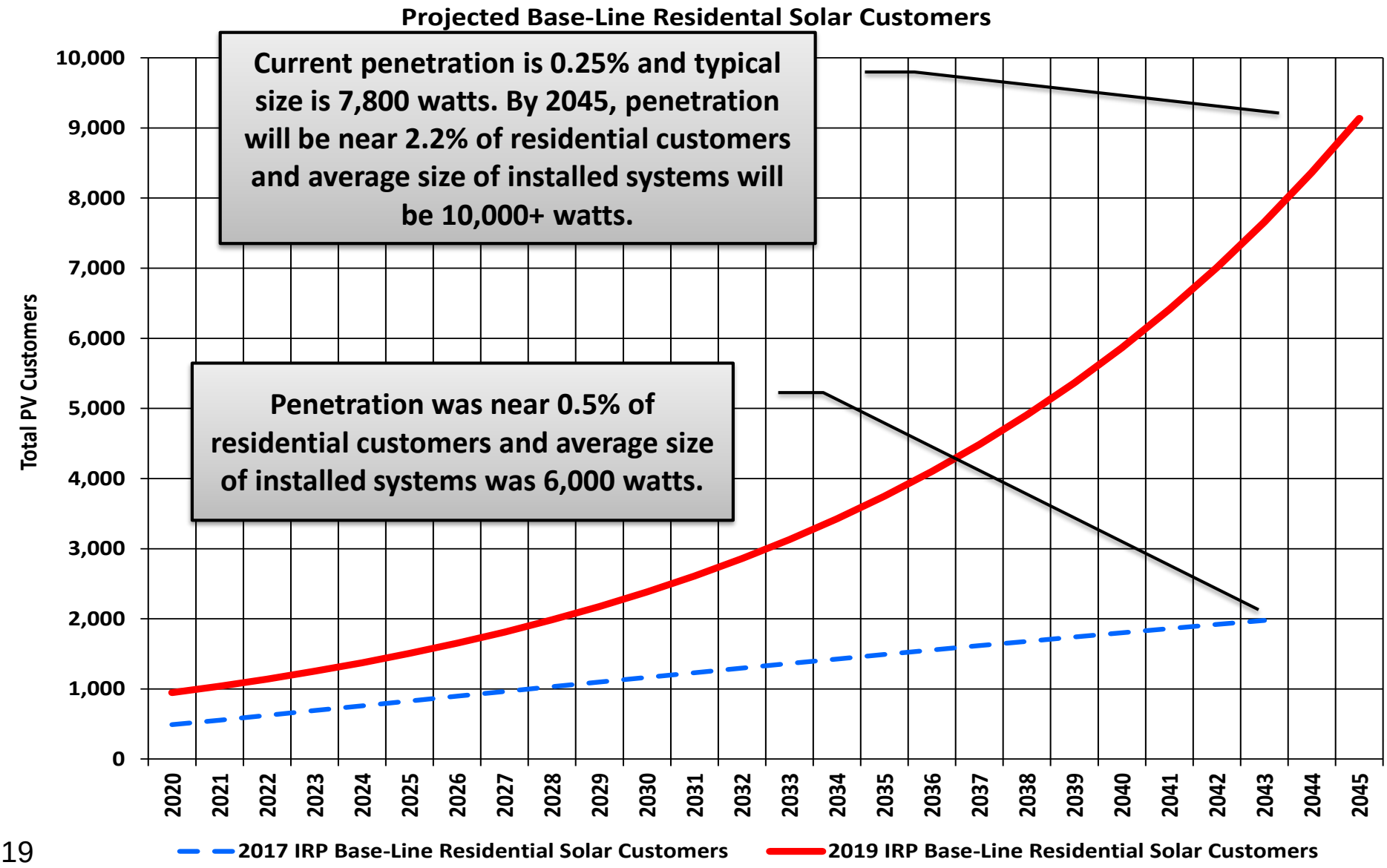
Residential Customer Growth, 2020-2045



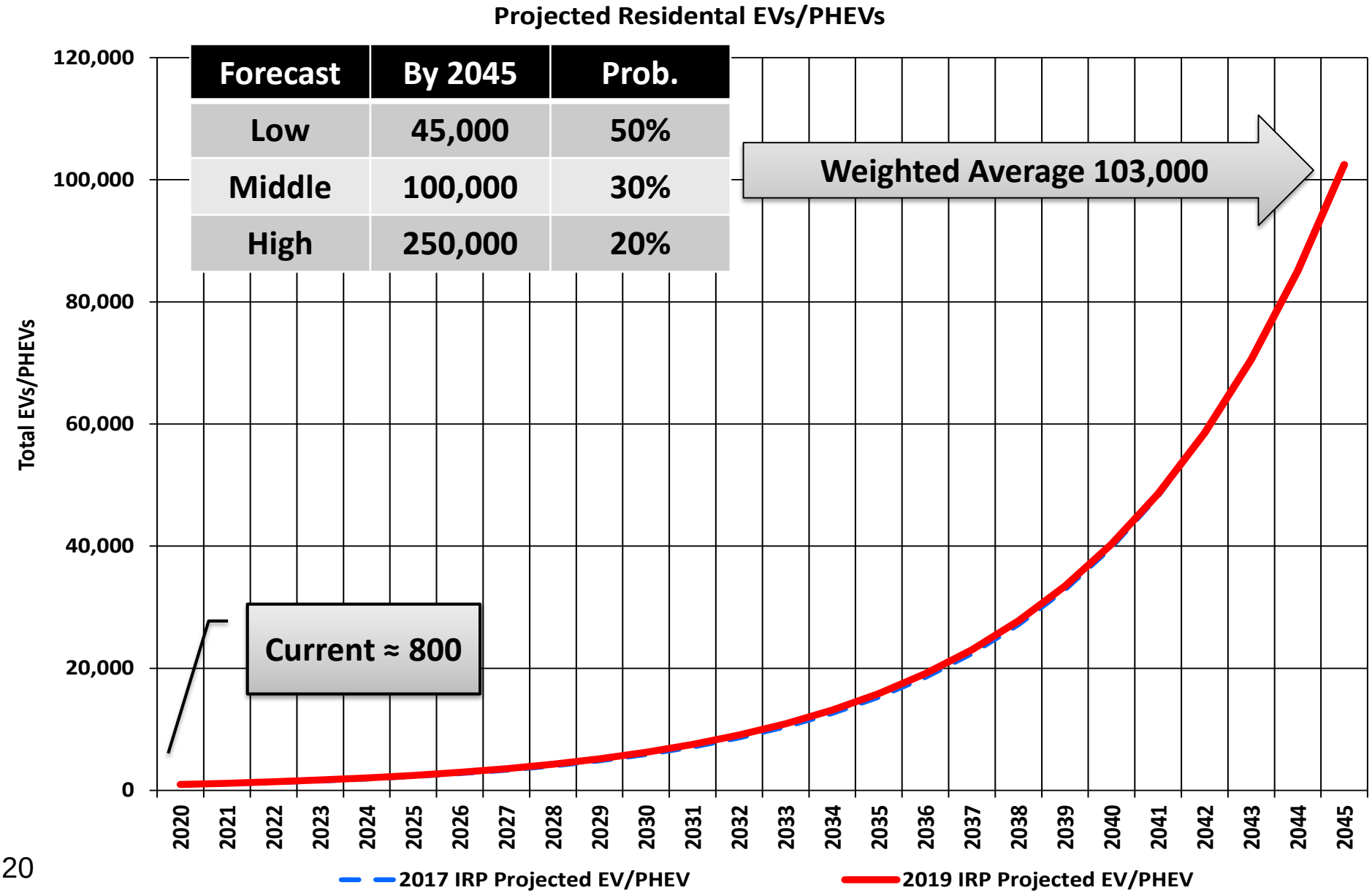
Residential Solar Penetration, 2008-2018



Residential Solar Penetration, 2020-2045

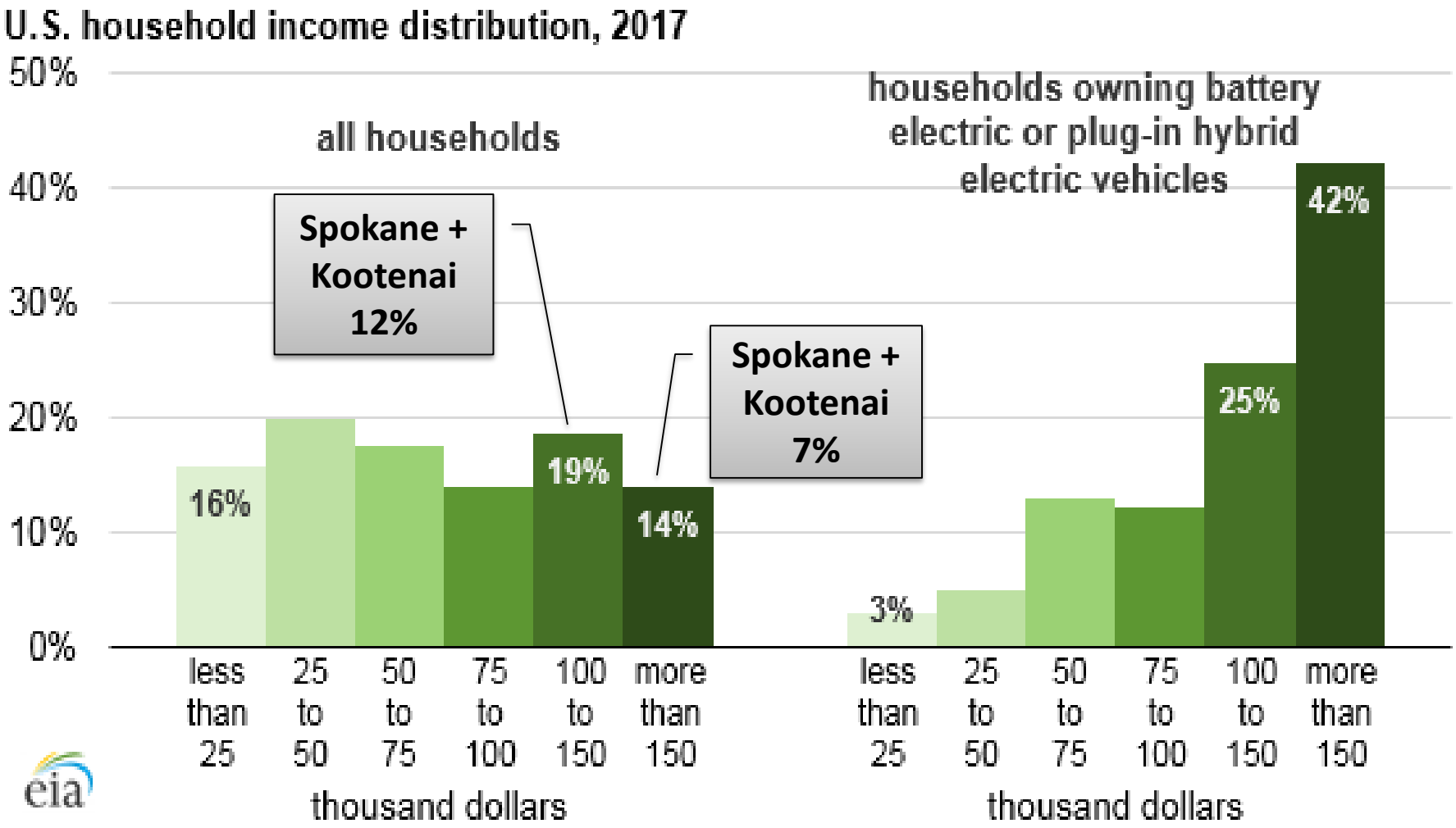


Residential EVs/PHEVs, 2020-2045



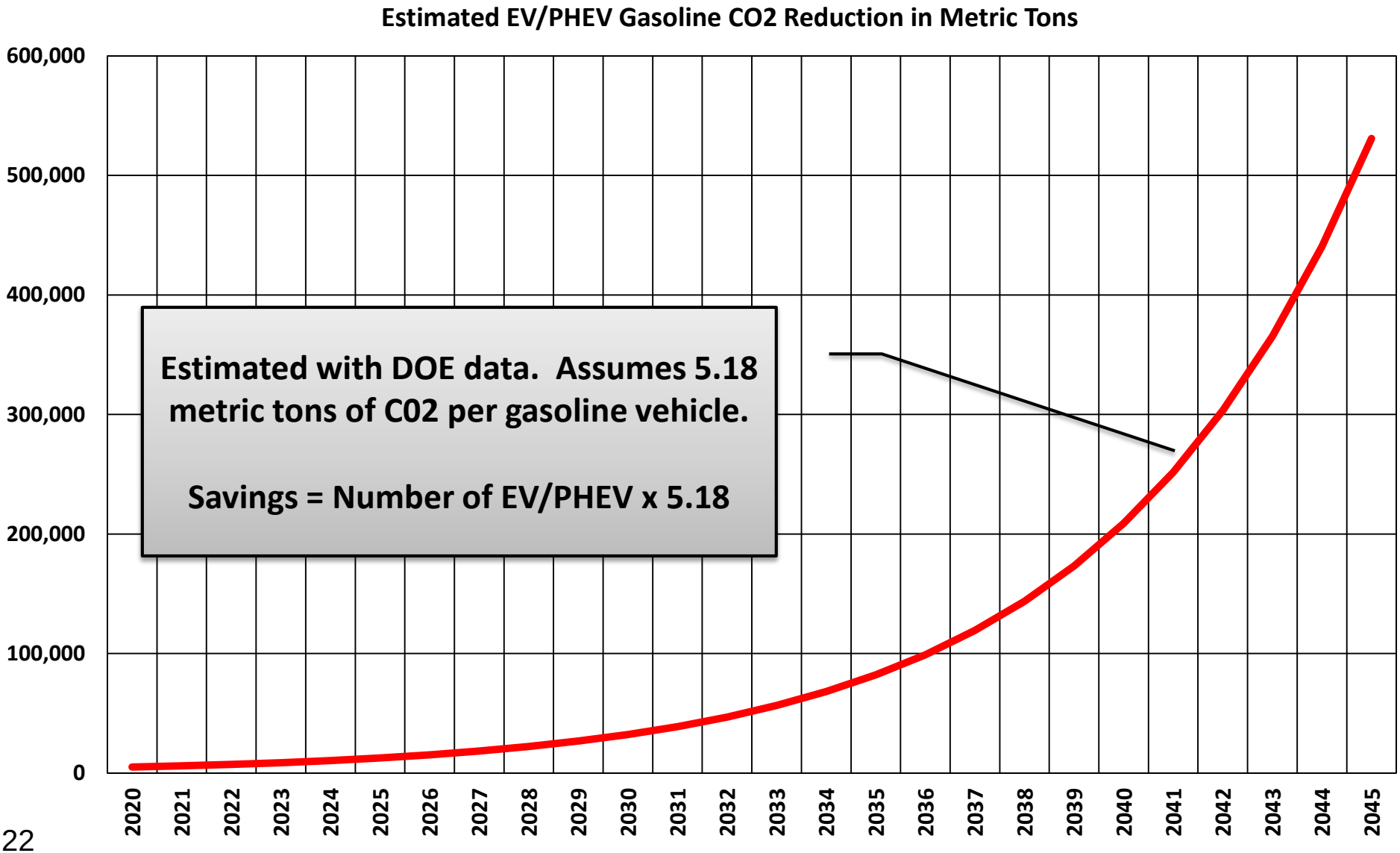
Forecast	By 2045	Prob.
Low	45,000	50%
Middle	100,000	30%
High	250,000	20%

Residential EVs/PHEVs by Household Income

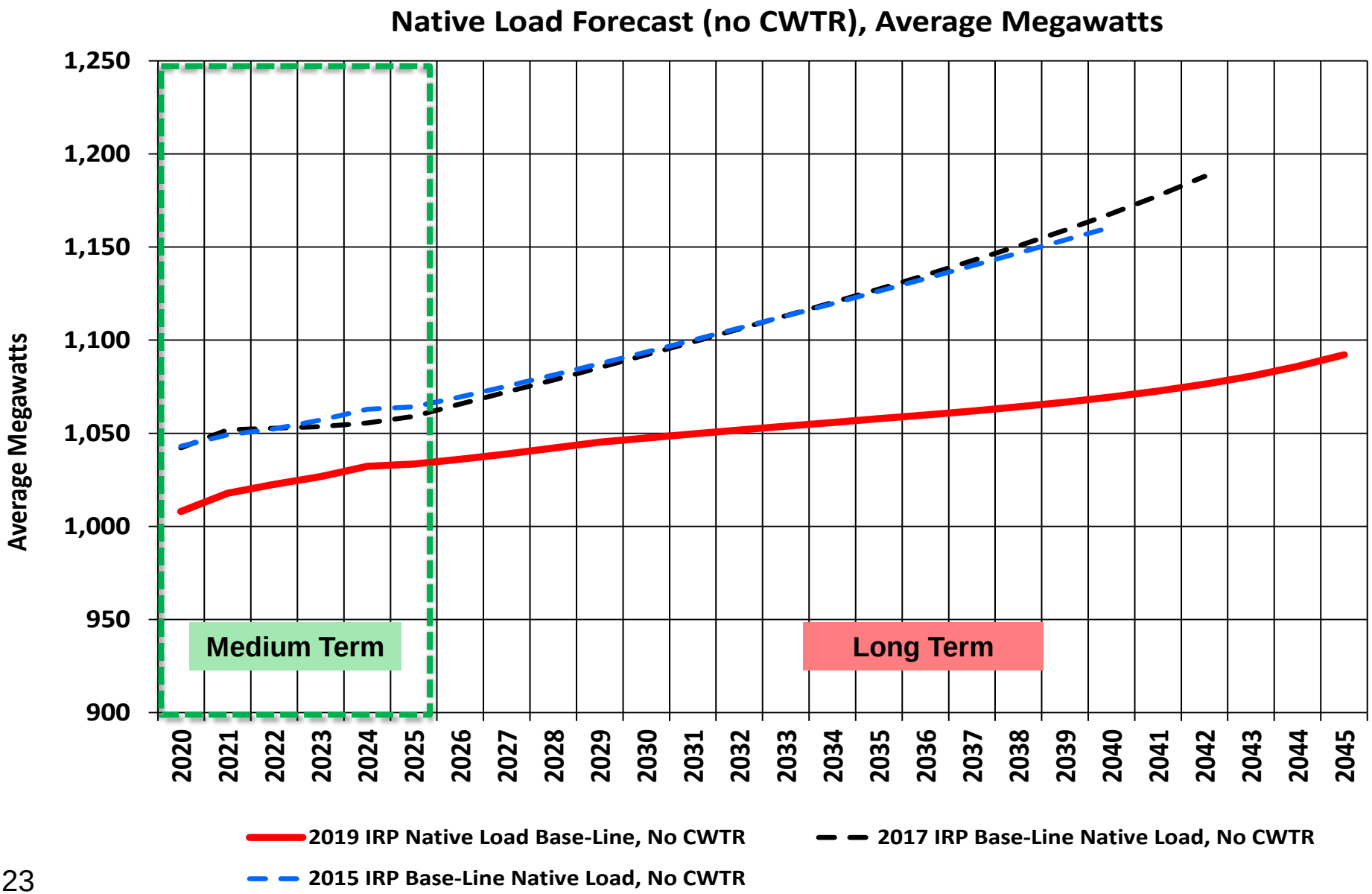


Source: EIA, *Today in Energy*, May 2018. Regional data from U.S. Census

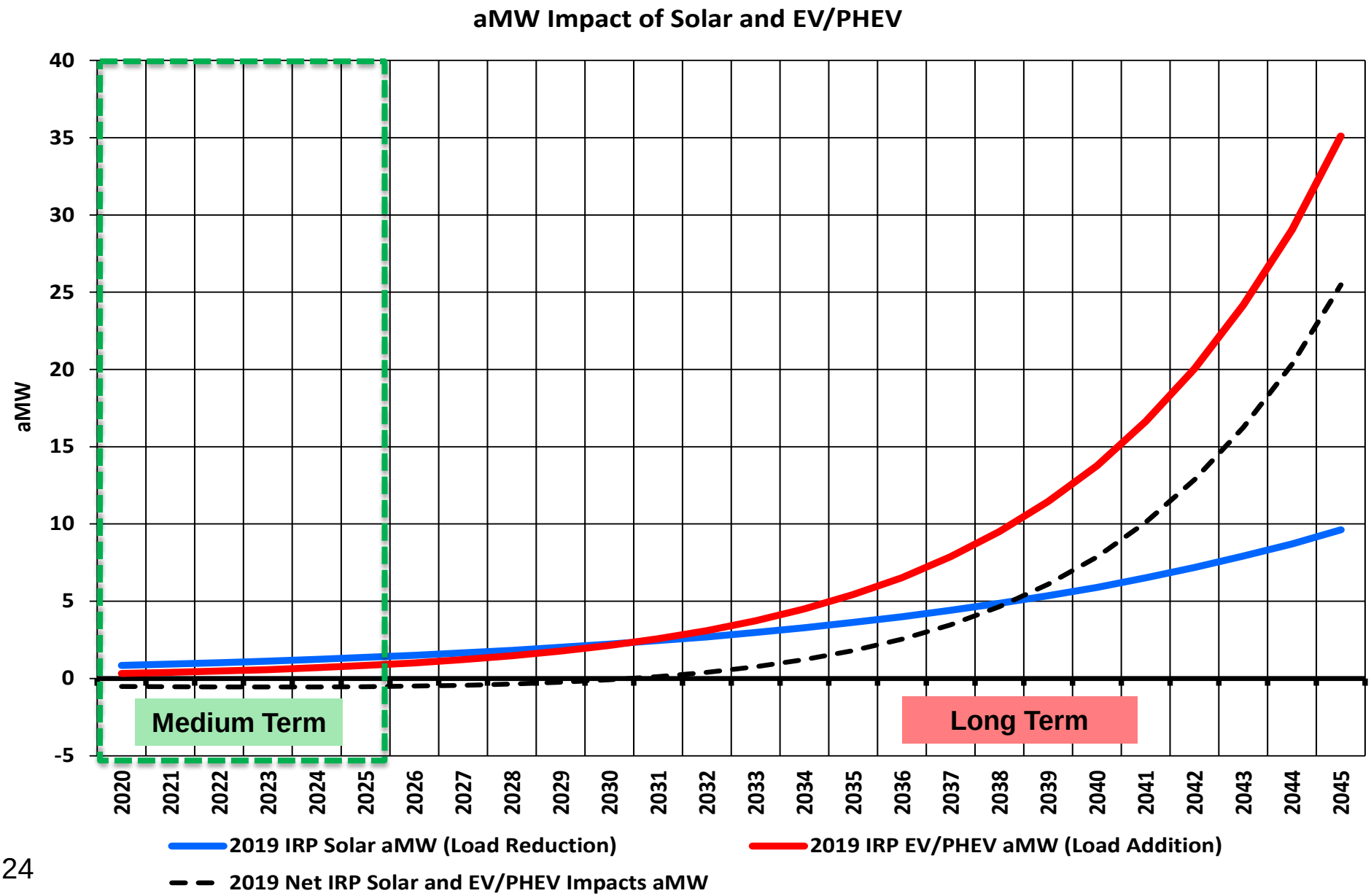
EV/PHEV Gasoline CO2 Savings Avista Service Territory



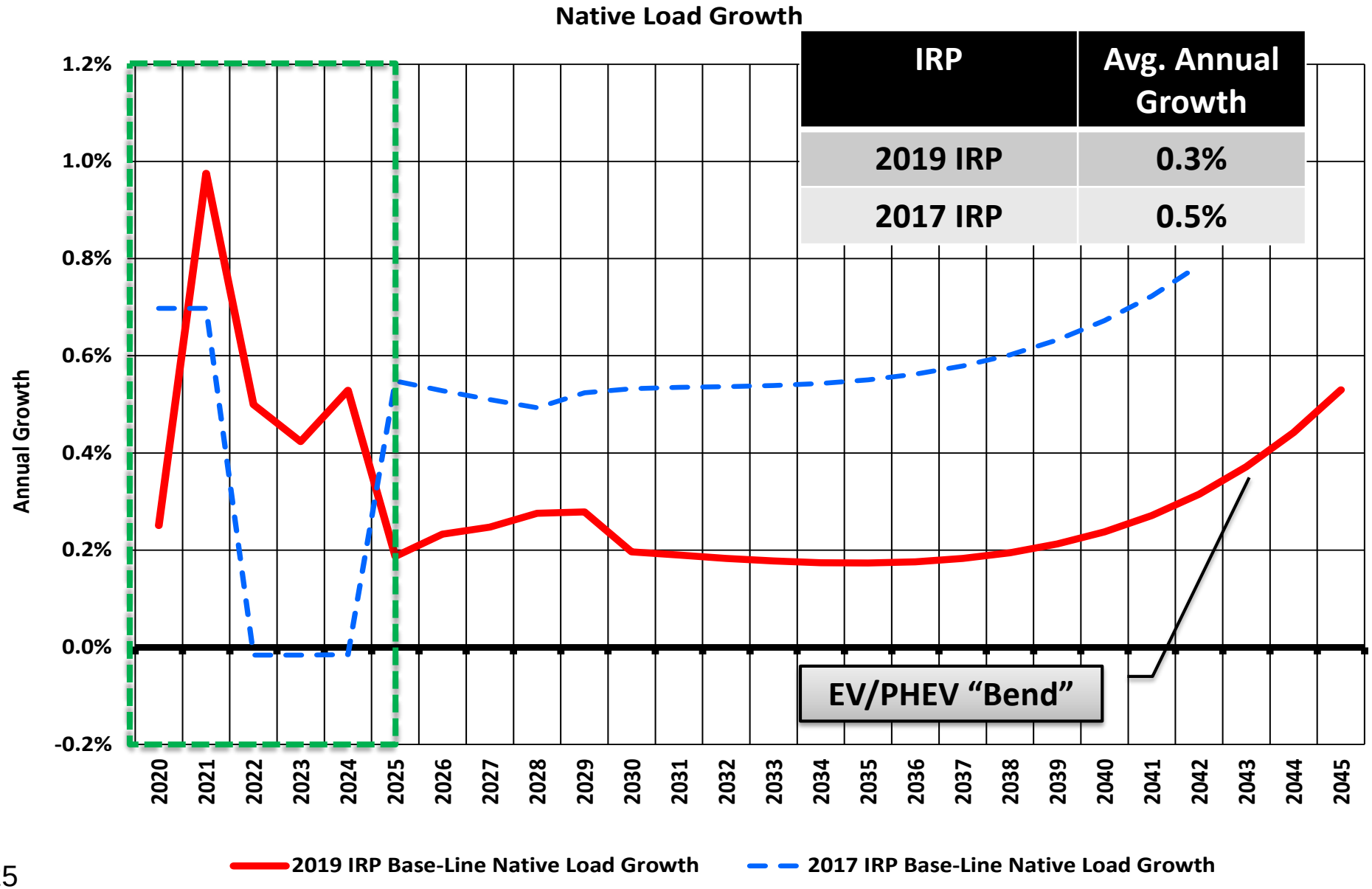
Native Load Forecast, 2020-2045



Net Solar and EV/PHEV Impact, 2020-2045

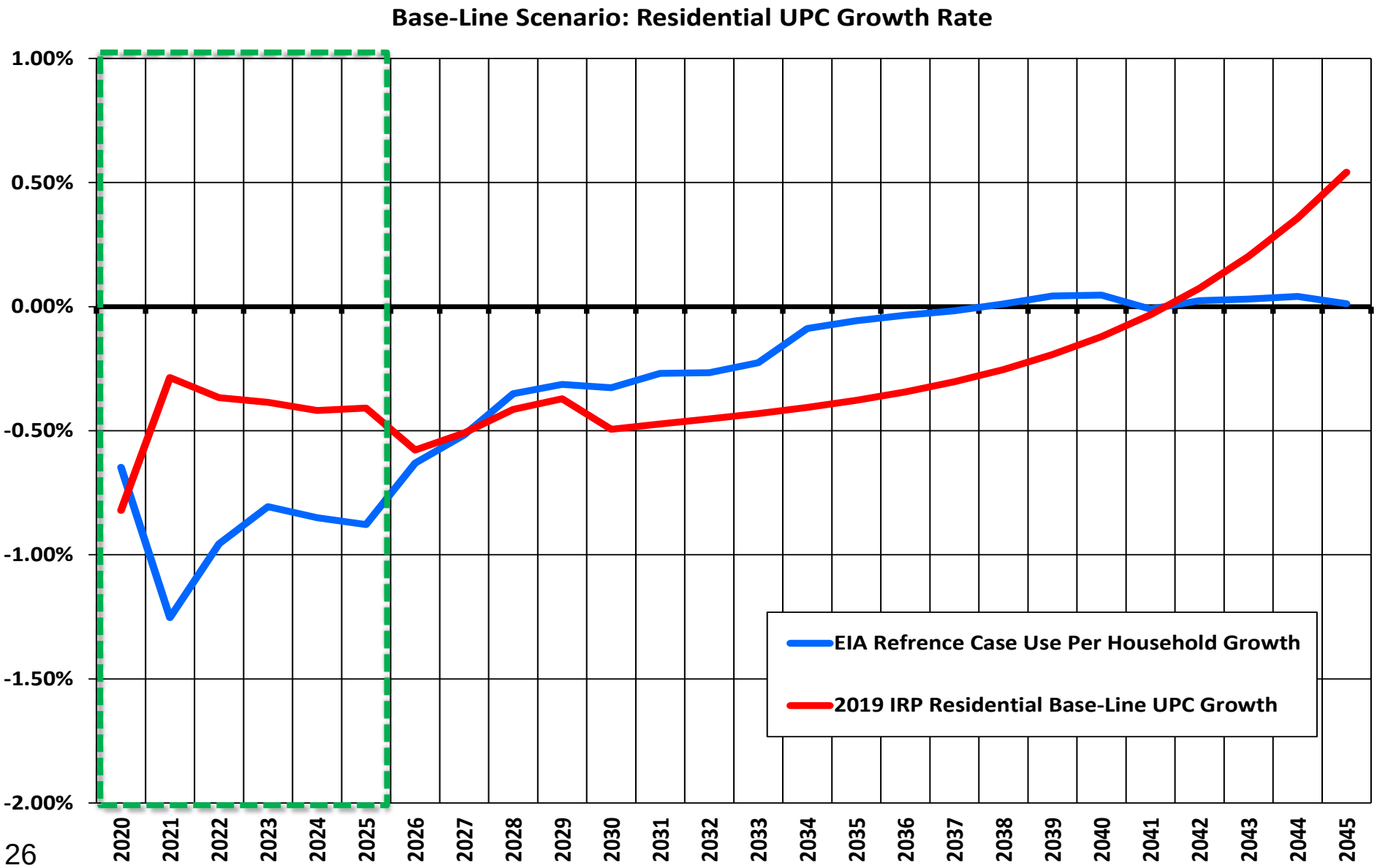


Native Load Growth Forecast, 2020-2045



IRP	Avg. Annual Growth
2019 IRP	0.3%
2017 IRP	0.5%

Residential UPC Growth: 2020-2045



Long-Term Load Forecast: Conservation Adjustment

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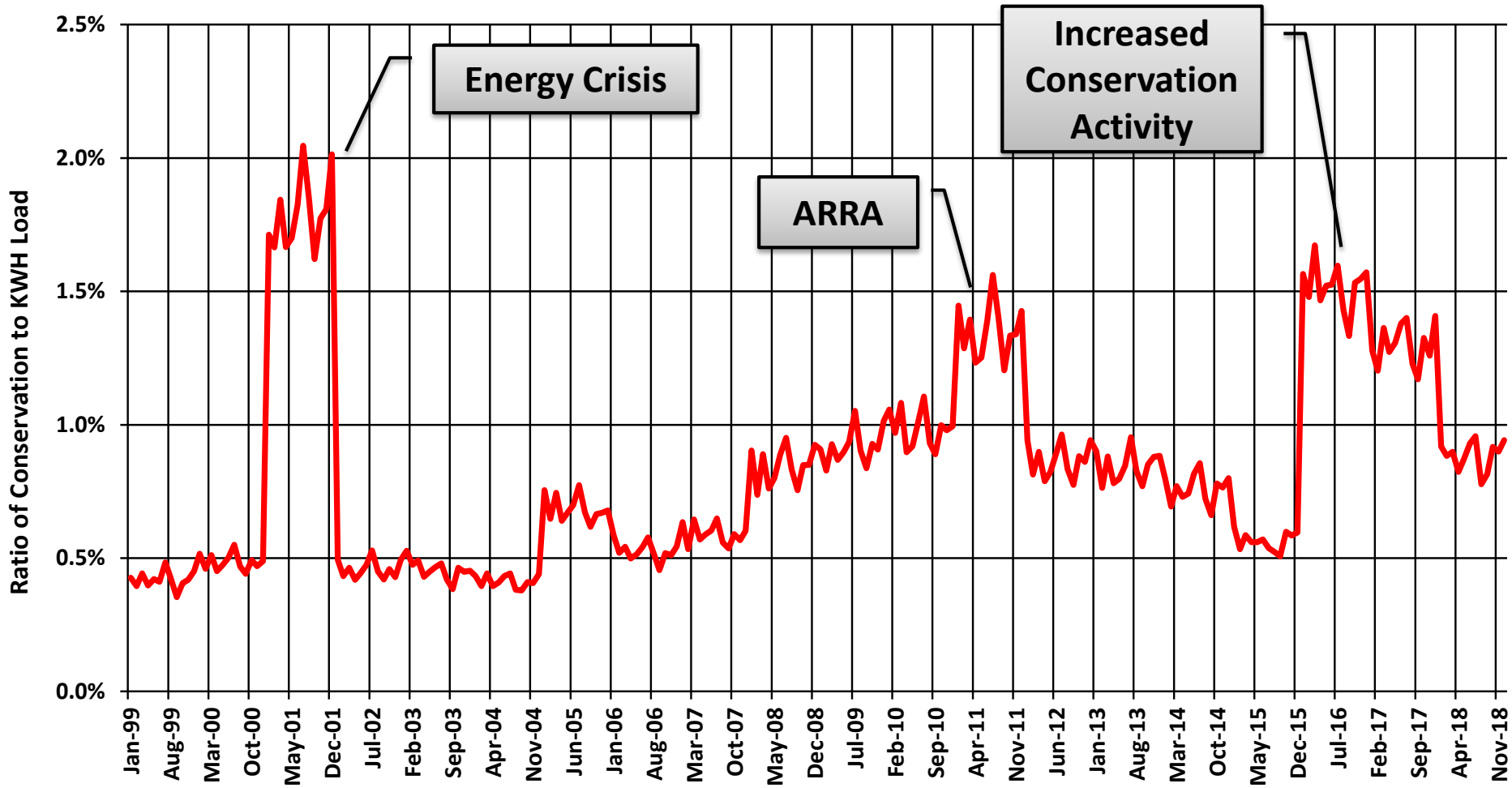
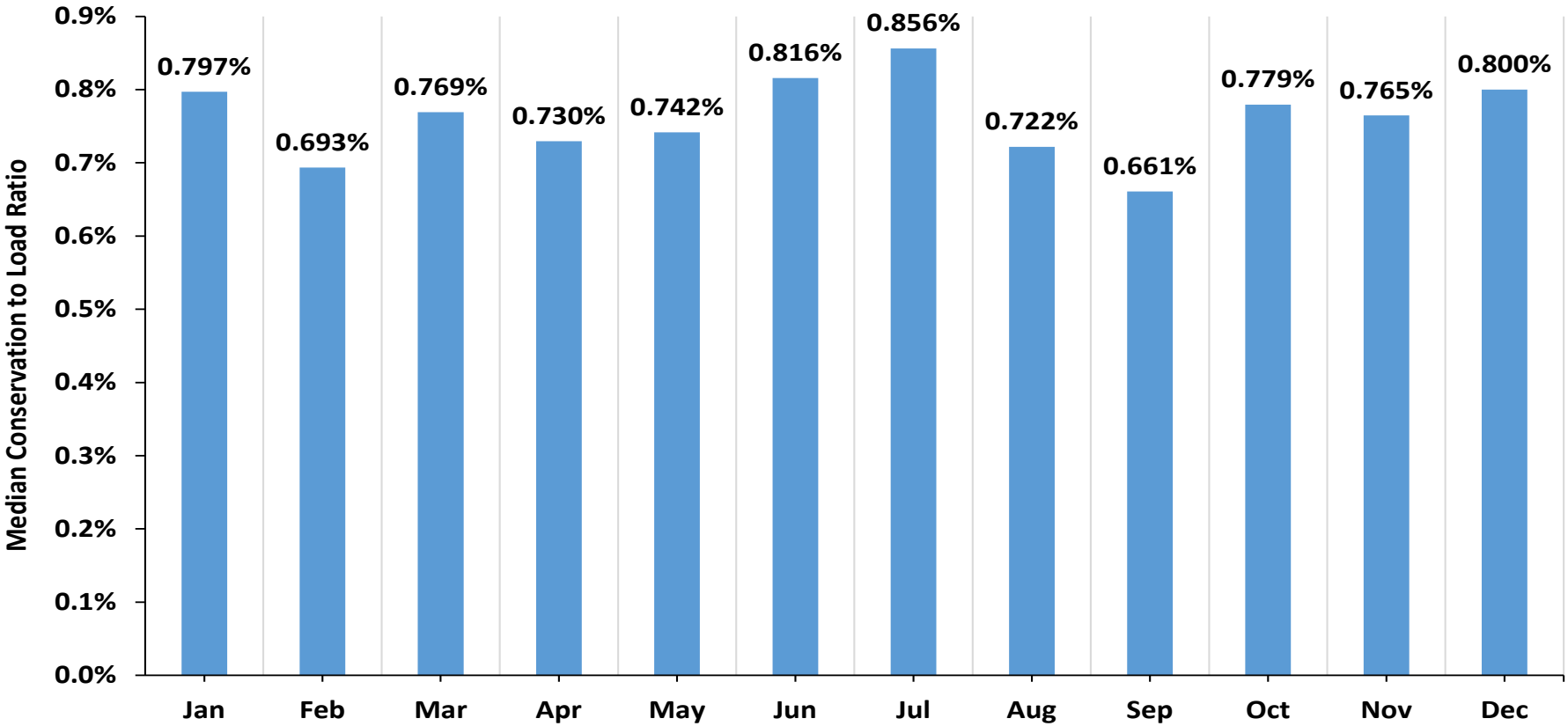
Monthly Conservation as a Share of Total Actual Retail Load: Navigant Estimates



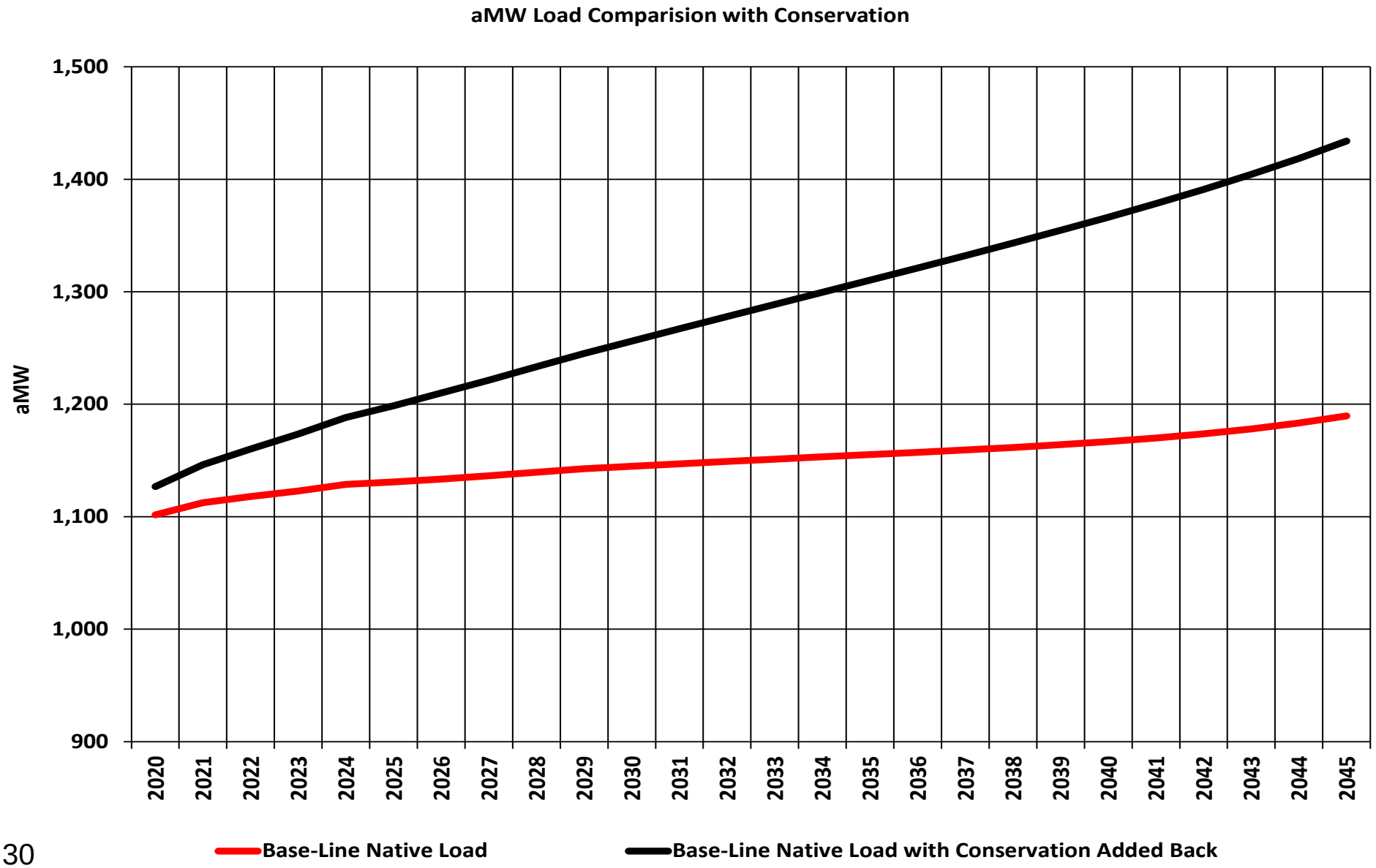
$$\text{Ratio} = \frac{Estimated\ Conservation\ Month\ t, Year\ y}{Actual\ KWH\ Load\ Month\ t, Year\ Y}$$

Median Monthly Conservation as a Share of Total Actual Retail Load: Navigant Estimates



$$Median\ Ratio\ Month\ t = Median\left(\frac{Estimated\ Conservation\ Month\ t}{Actual\ KWH\ Load\ Month\ t}\right),\ excluding\ 2001$$

Comparison of Native Load Forecasts, 2020-2045



Natural Gas

Tom Pardee, Manager of Natural Gas Planning
Fourth Technical Advisory Committee Meeting
August 6, 2019

Agenda

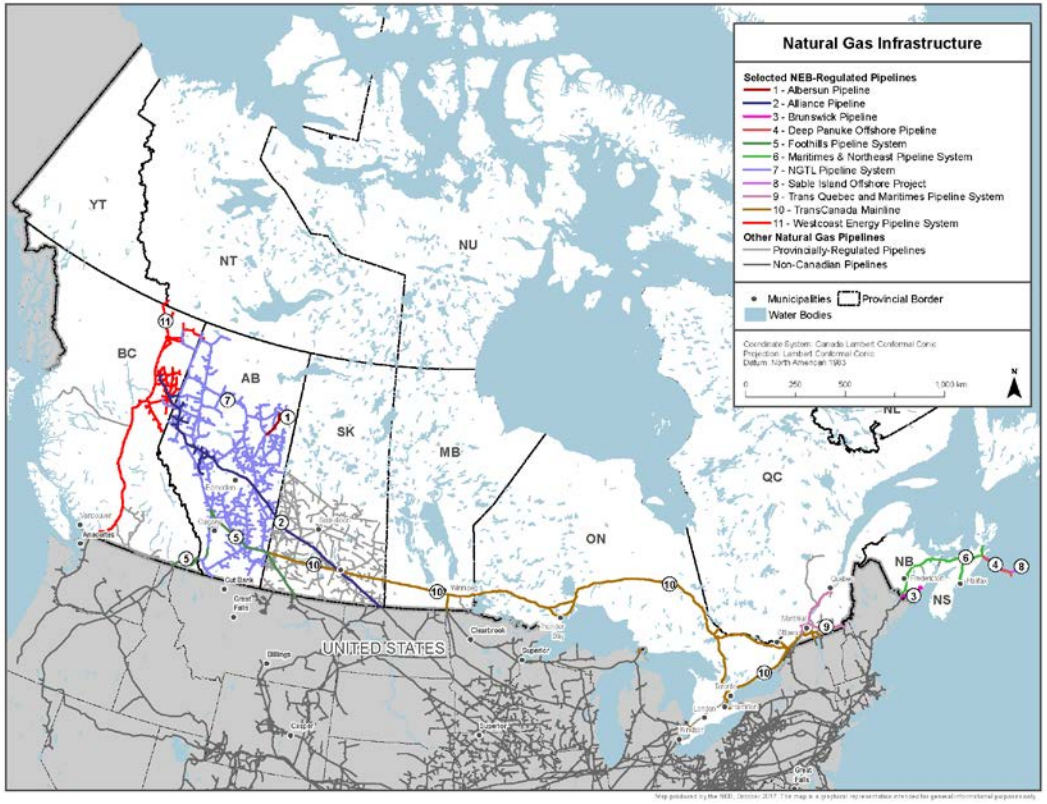
- Market Dynamics
- Pipeline Transportation
- Renewable Natural Gas (RNG)

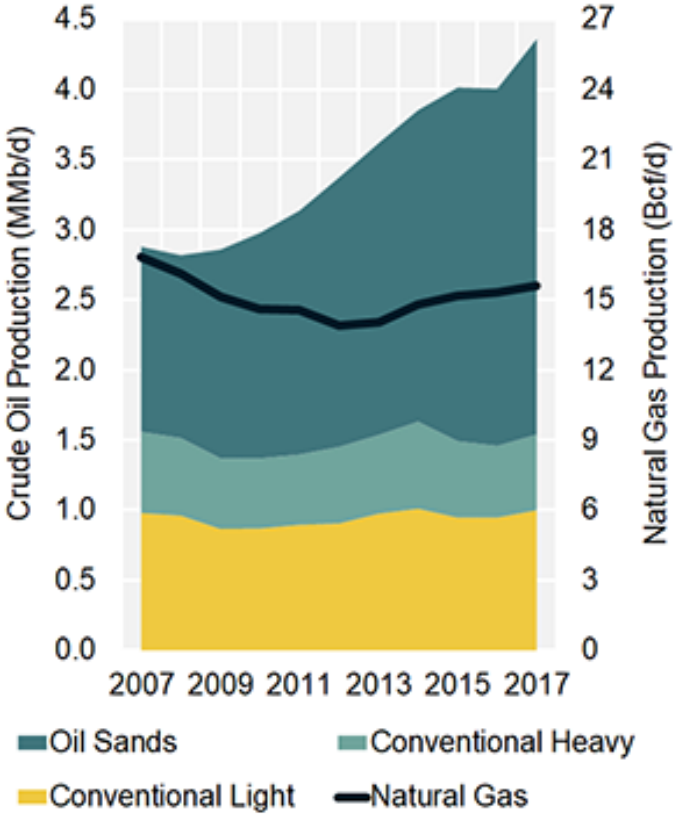
Avista Natural Gas Service Areas, Gas Fields, Trading Hubs and Major Pipelines

as of 3/31/2015

Canada

Canada Natural Gas Production

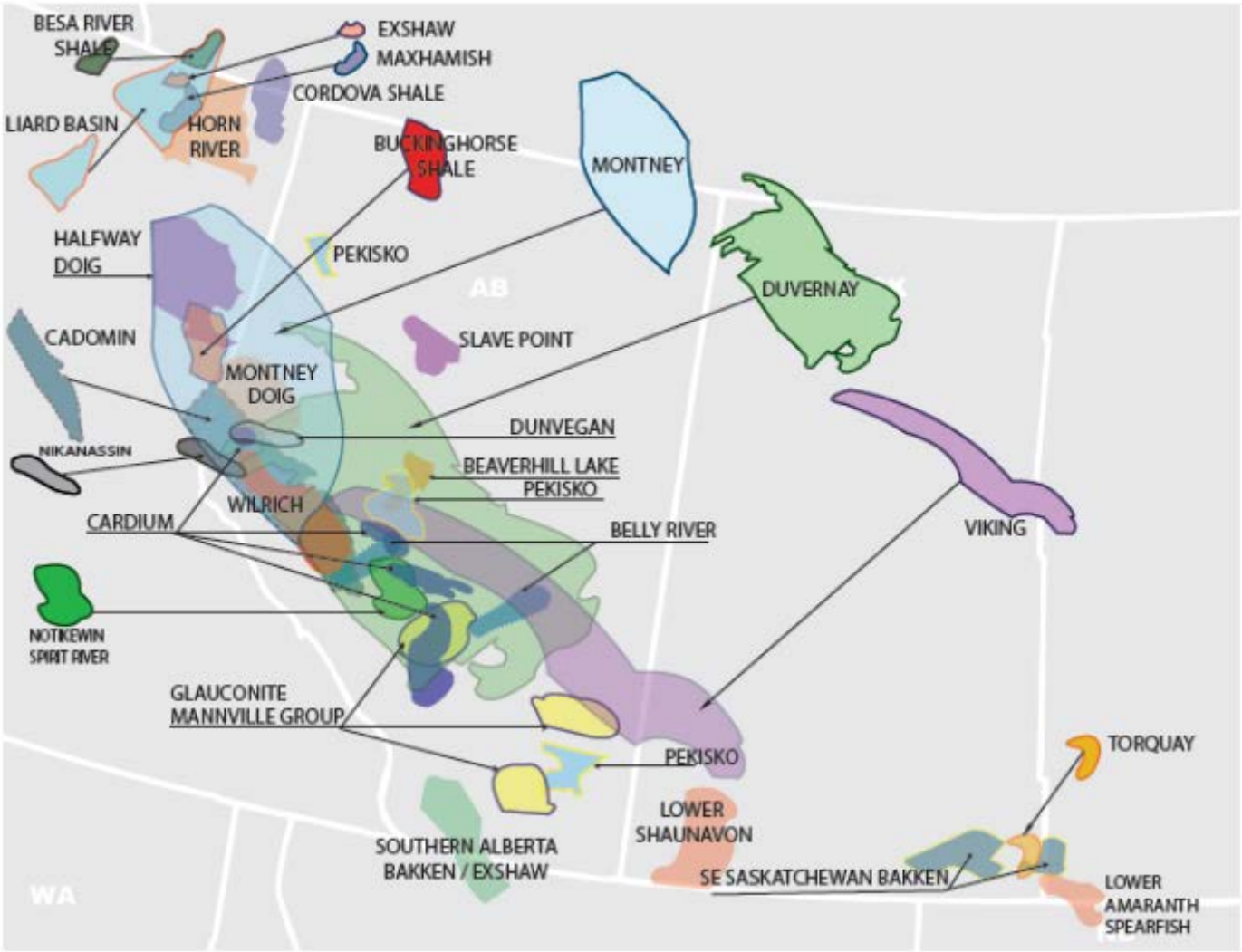




British Columbia
0.5 Bcf per day

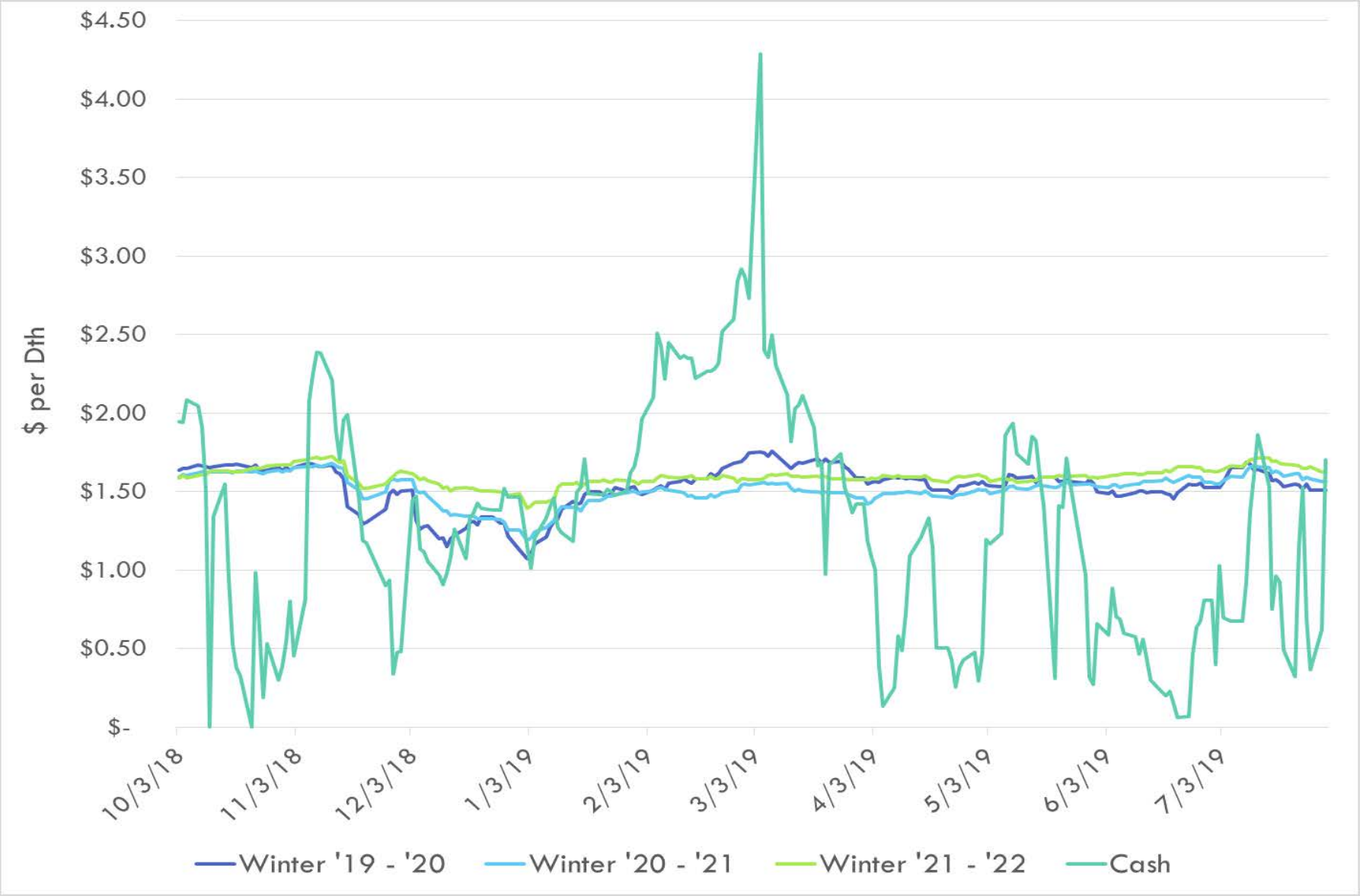
Alberta 15
Bcf per day

WESTERN CANADA RESOURCE PLAYS



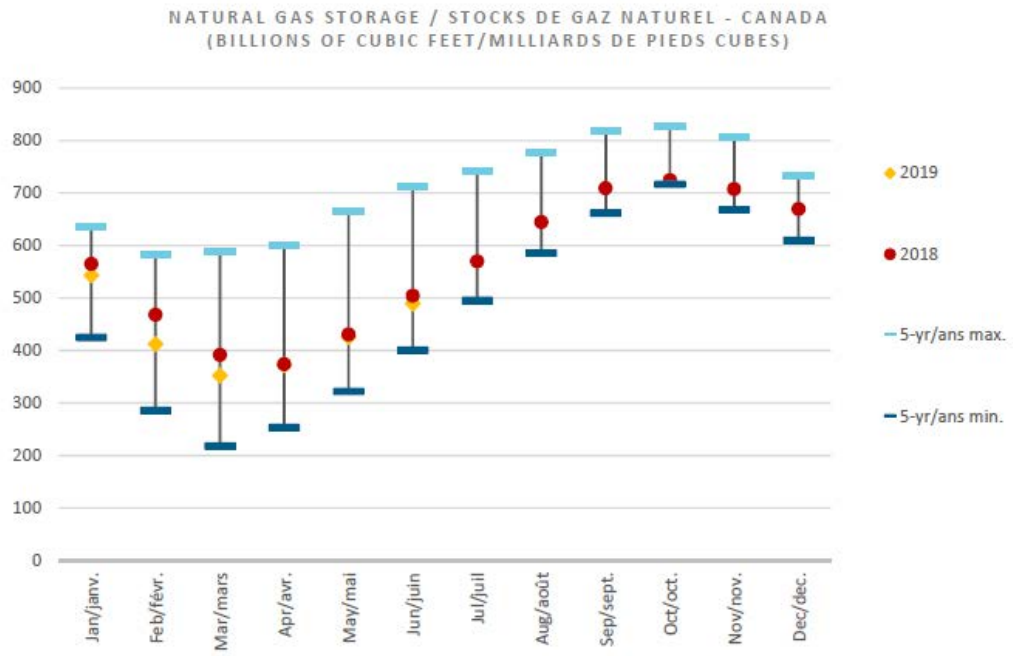
<u>300 Years</u> of resources at current levels

AECO cash vs. forwards



Canadian Natural Gas Storage

bcf/mpc	Jan/janv.	Feb/févr.	Mar/mars	Apr/avr.	May/mai	Jun/juin	Jul/juil	Aug/août	Sep/sept.	Oct/oct.	Nov/nov.	Dec/dec.
2019	543	412	352	372	426	490						
2018	565	468	391	374	431	504	570	644	709	724	707	669
2017	607	531	462	493	540	609	674	733	798	826	792	695
2016	635	583	589	601	664	712	740	776	818	815	807	704
2015	481	362	336	379	461	533	601	664	730	768	765	732
2014	425	286	218	253	322	401	495	586	662	717	668	610
2013	615	519	453	448	521	585	659	732	791	830	766	599
2012	658	596	594	607	668	708	729	769	812	819	793	725
5-yr/ans max.	635	583	589	601	664	712	740	776	818	826	807	732
5-yr/ans min.	425	286	218	253	322	401	495	586	662	717	668	610



Source: CGA

LNG Canada

<u>Daily liquefaction:</u>

3.5 Bcf Or

1,025,749 MWh

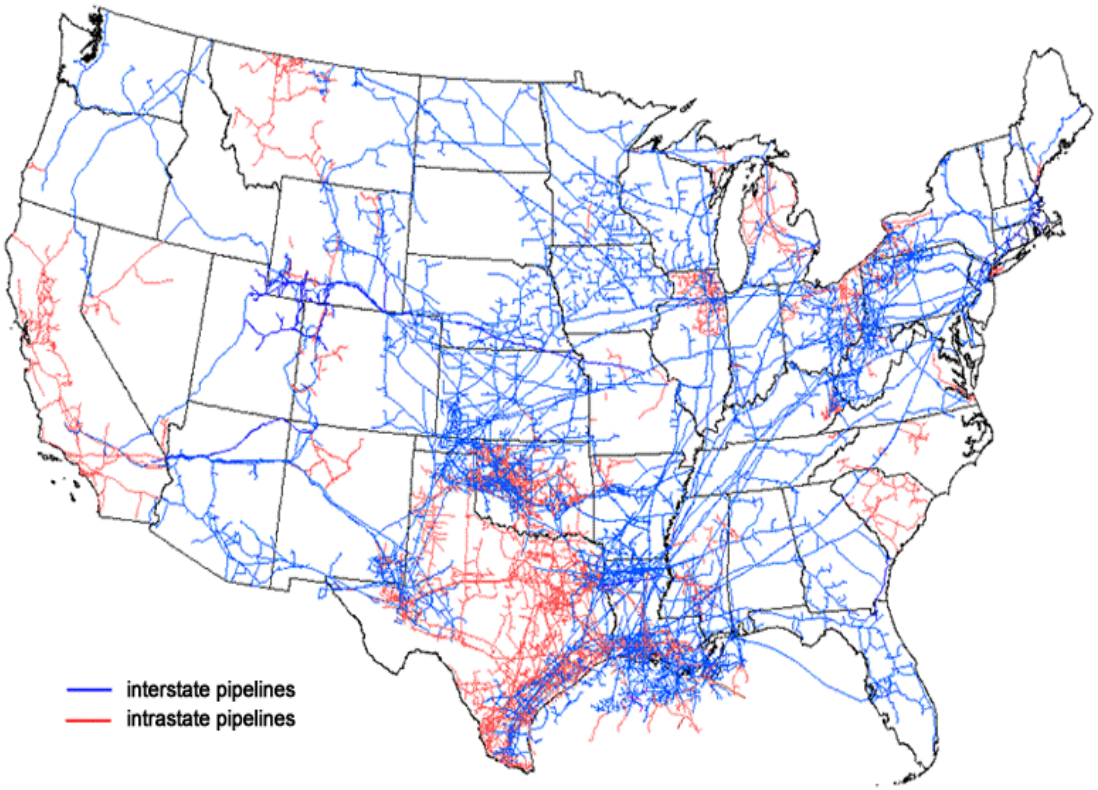
LNG used to displace coal in China would reduce CO_2 emissions by 60 to 90 million tonnes/year. This is equivalent to...

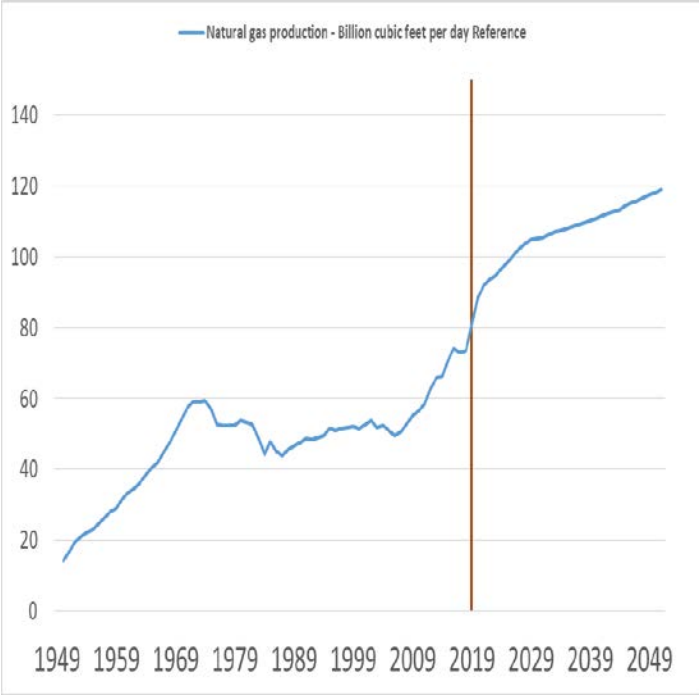
Source: https://www.lngcanada.ca/about-lng-canada/

US

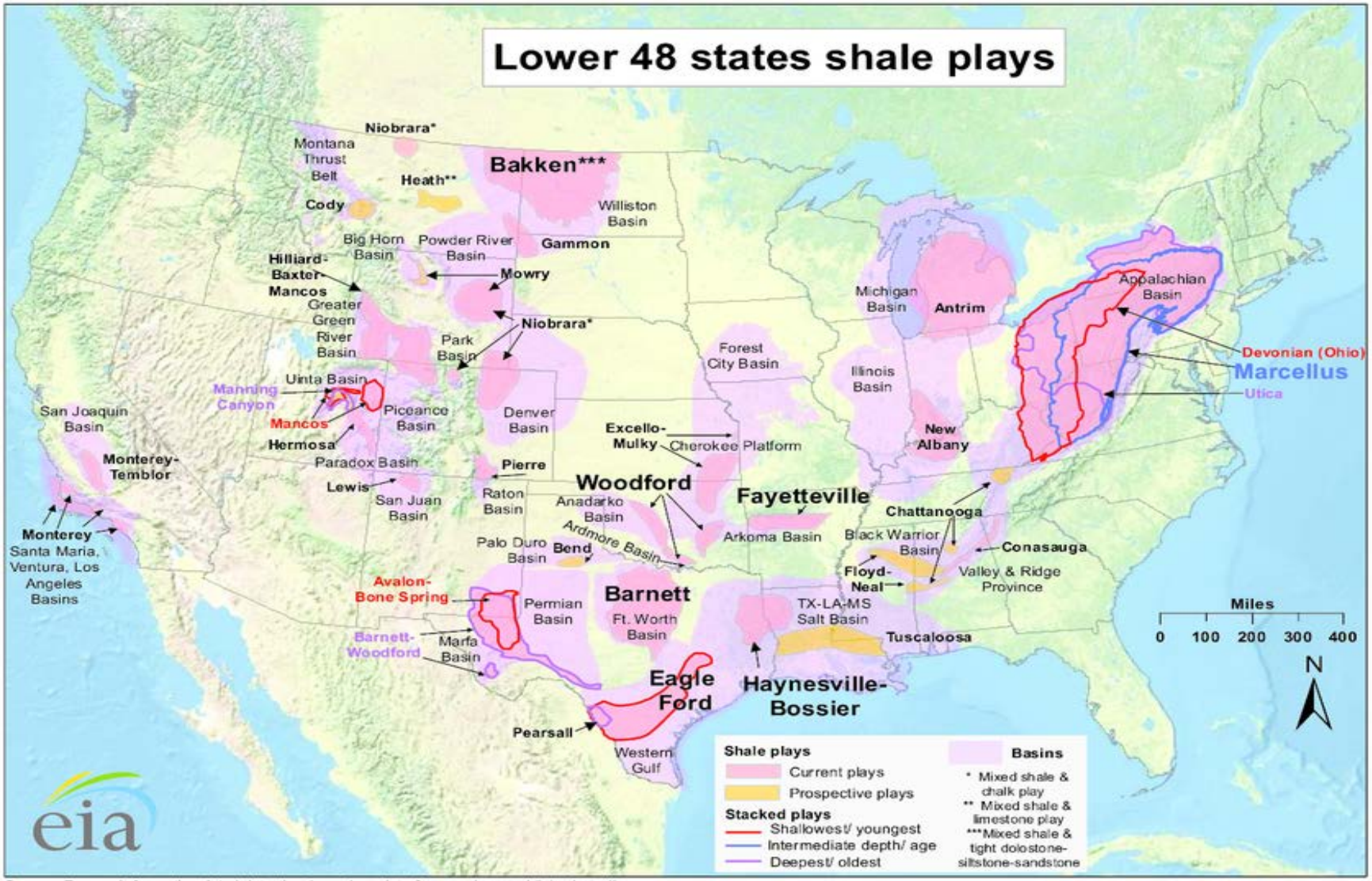
US Natural Gas Production

Map of U.S. interstate and intrastate natural gas pipelines





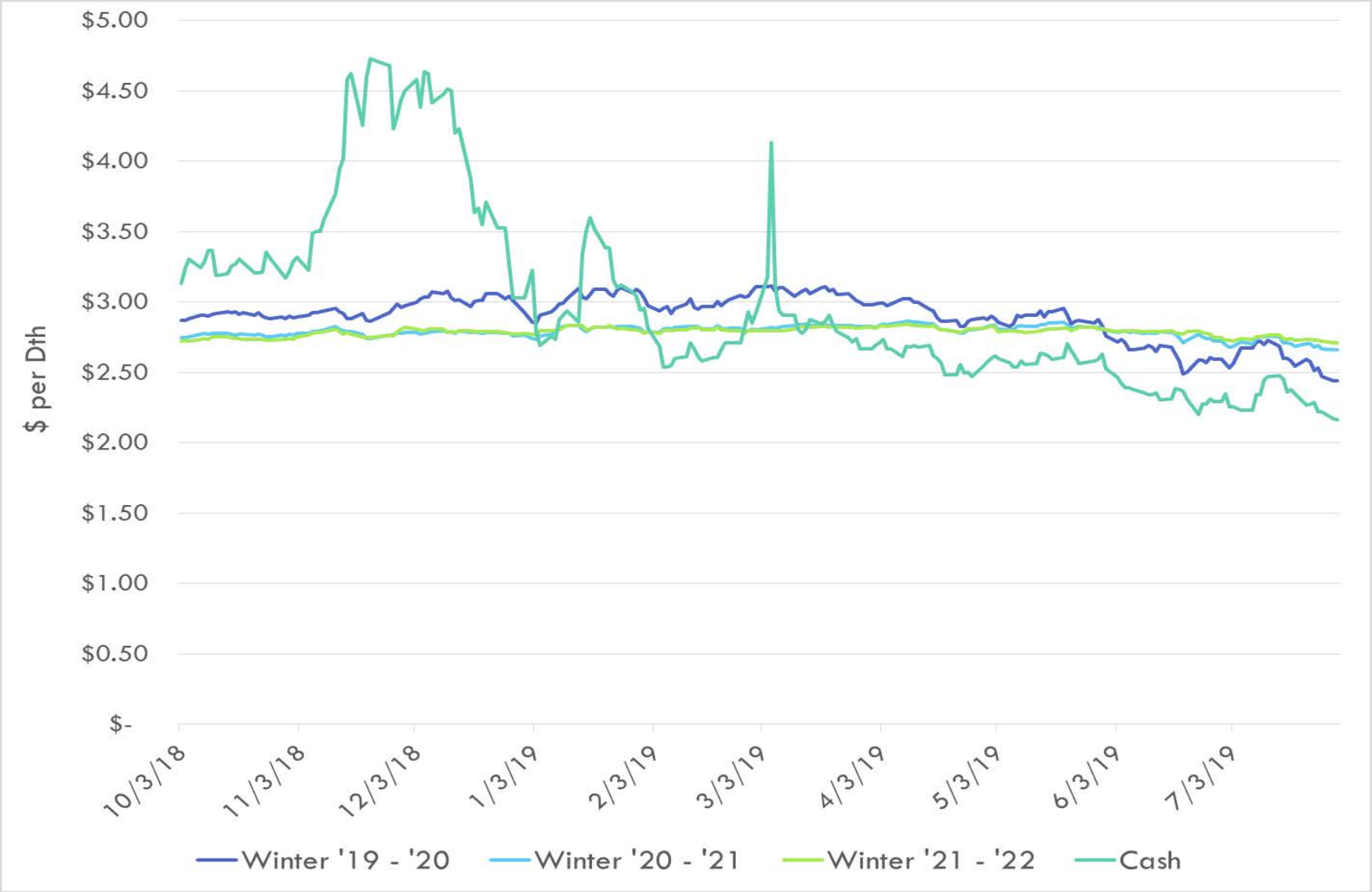
Source: EIA



Source: Energy Information Administration based on data from various published studies.
Updated: May 9, 2011

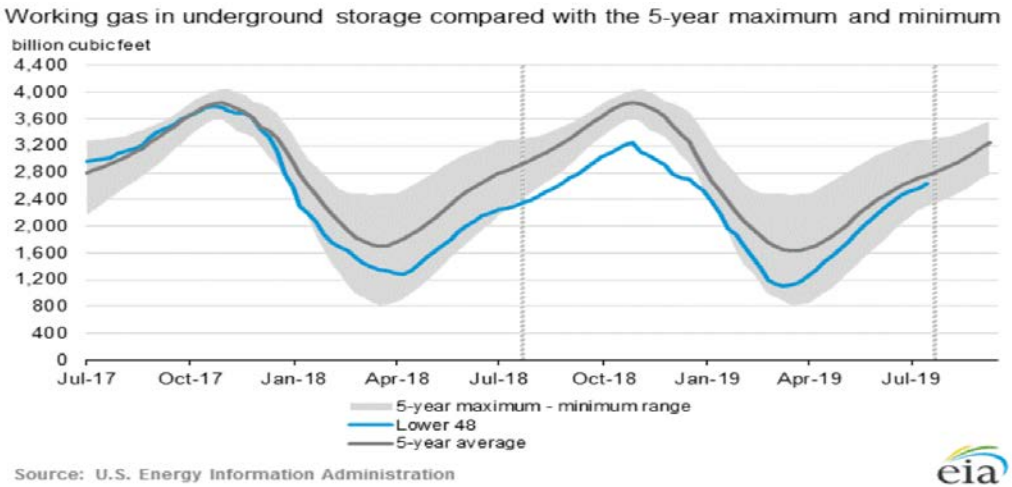
80 Years of resources at current levels

Henry Hub cash vs. forwards

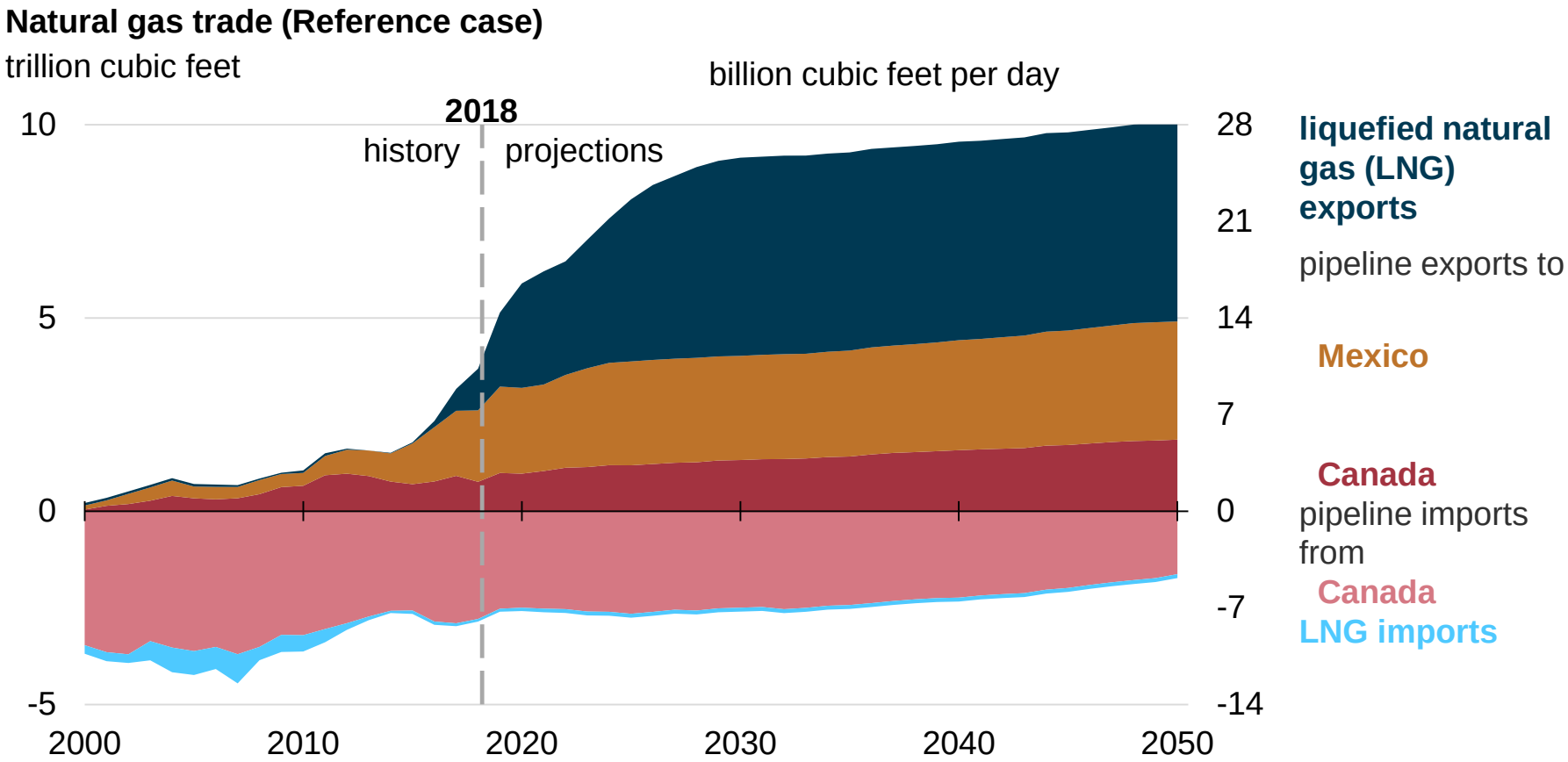


US Natural Gas Storage

	Stocks billion cubic feet (Bcf)				Historical Comparisons: Year ago (07/26/18)		Historical Comparisons: 5-year average (2014-18)	
Region	**07/26/19**	**07/19/19**	**net change**	**implied flow**	**Bcf**	**% change**	**Bcf**	**% change**
East	597	575	22	22	548	8.9	625	-4.5
Midwest	677	650	27	27	548	23.5	677	0.0
Mountain	156	151	5	5	146	6.8	174	-10.3
Pacific	270	271	-1	-1	250	8.0	294	-8.2
South Central	934	921	13	13	809	15.5	987	-5.4
Salt	226	229	-3	-3	207	9.2	268	-15.7
Nonsalt	708	692	16	16	602	17.6	719	-1.5
Total	**2,634**	**2,569**	**65**	**65**	**2,300**	**14.5**	**2,757**	**-4.5**

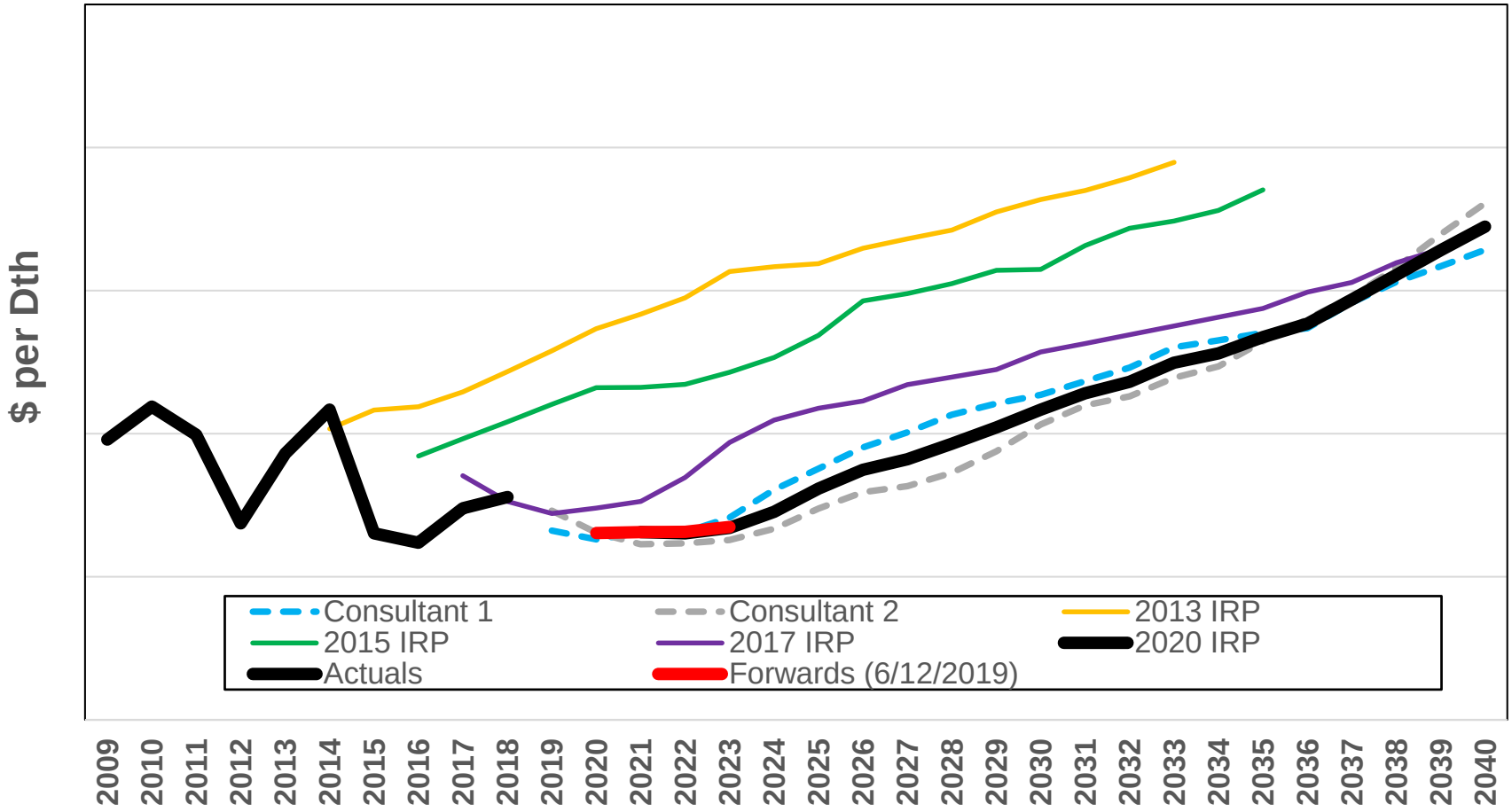


U.S. net exports of natural gas continue to grow in the Reference case—



Source: EIA AEO 2019

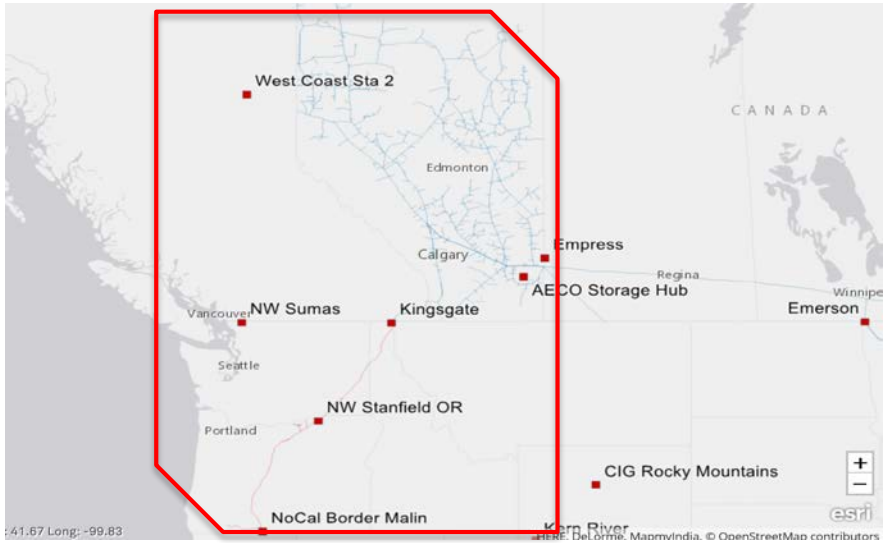
2020 IRP Henry Hub Natural Gas Price Forecast: 2021-2040: $3.99 per Dth



Pipeline Transportation

Fugitive Emissions

- Unintended emissions from facilities or activities (e.g., construction) that "could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening."



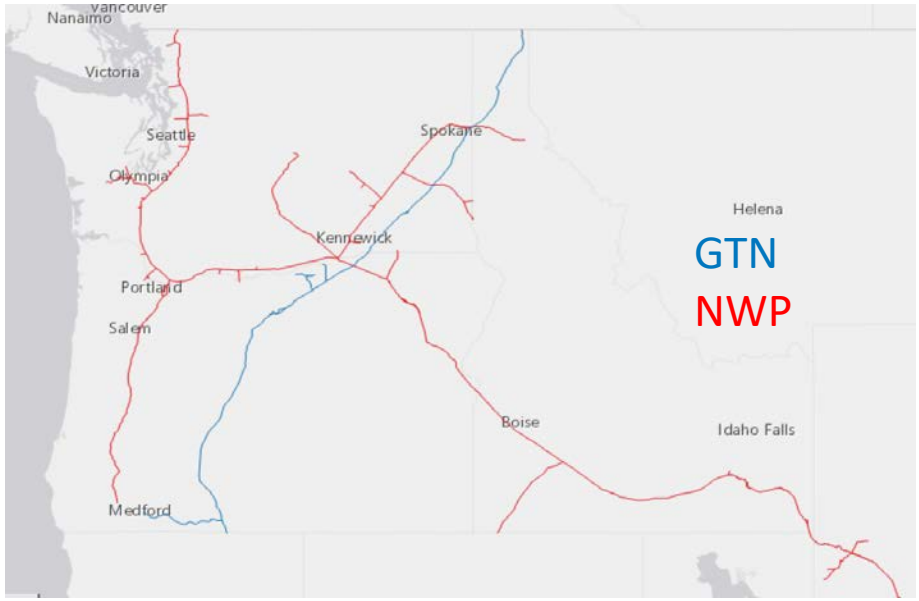
Fugitive emissions estimated at 0.783%

*This figure includes all emissions from production, transport & lost and unaccounted for gas

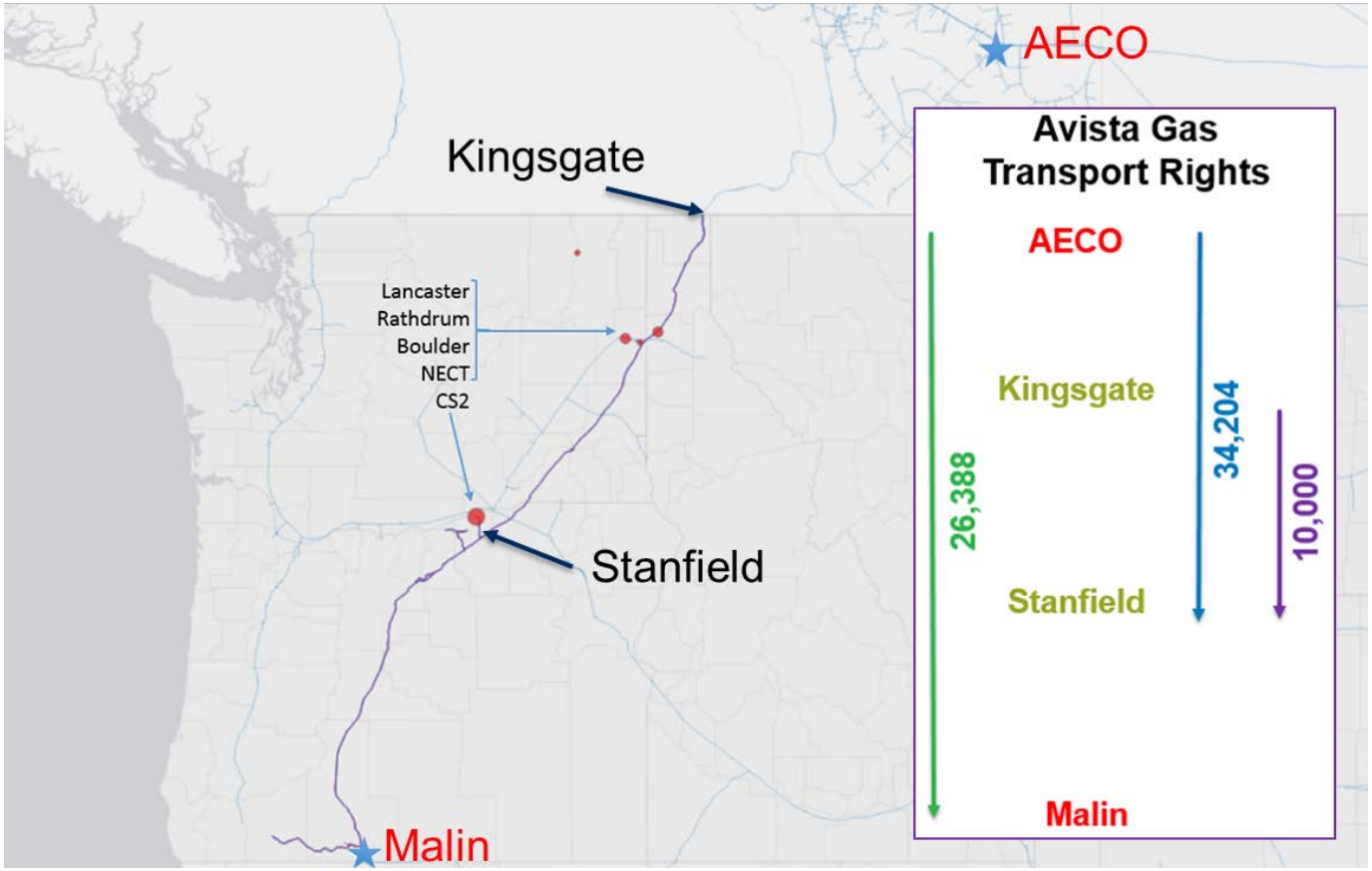
Source – NEB for Canadian infrastructure and EIA for US infrastructure

GTN & NWP Fully Subscribed

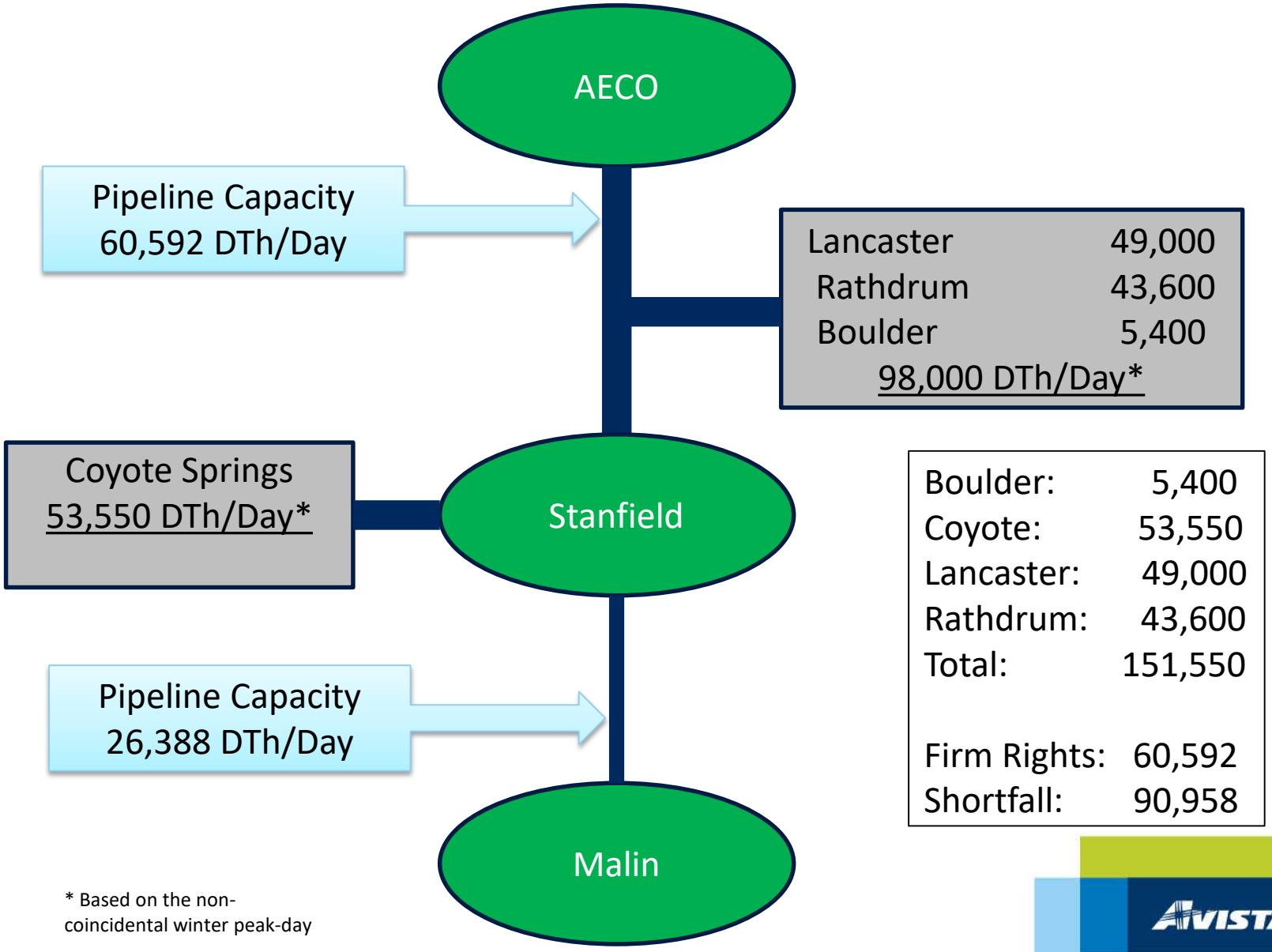
- Contractually both pipelines are now fully subscribed.
- Canadian producers signed up for new contracts in order to get natural gas out of Canada and into more lucrative markets.



Avista Transport for Electric Generation

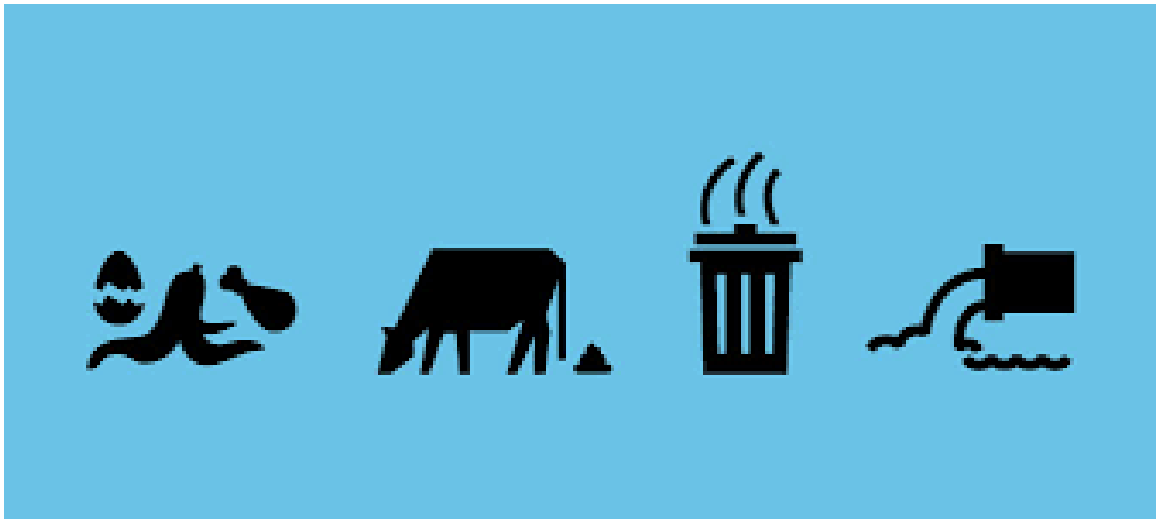


Current Transport & Gas Generation

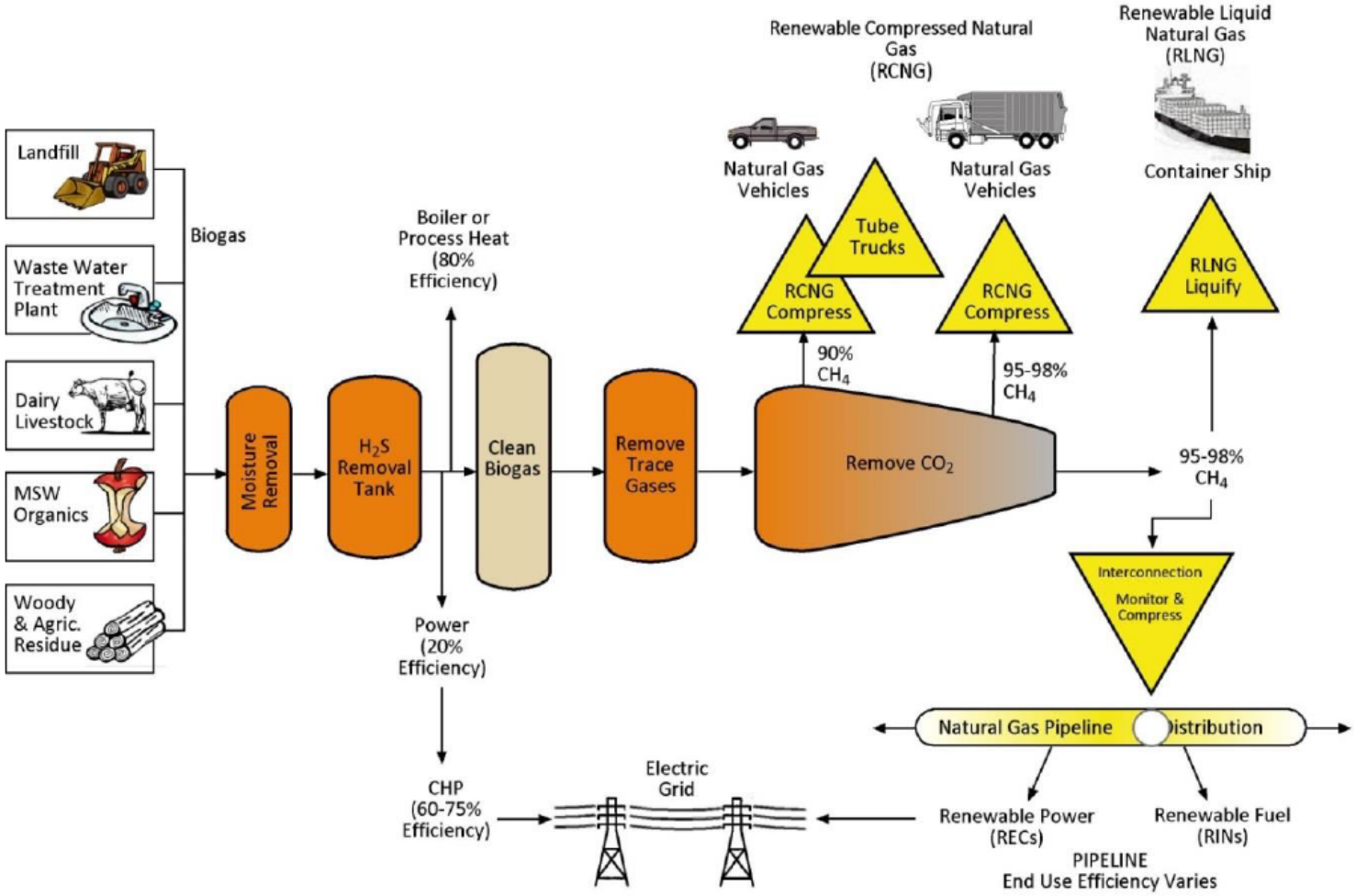


* Based on the non-coincidental winter peak-day

Renewable Natural Gas (RNG)



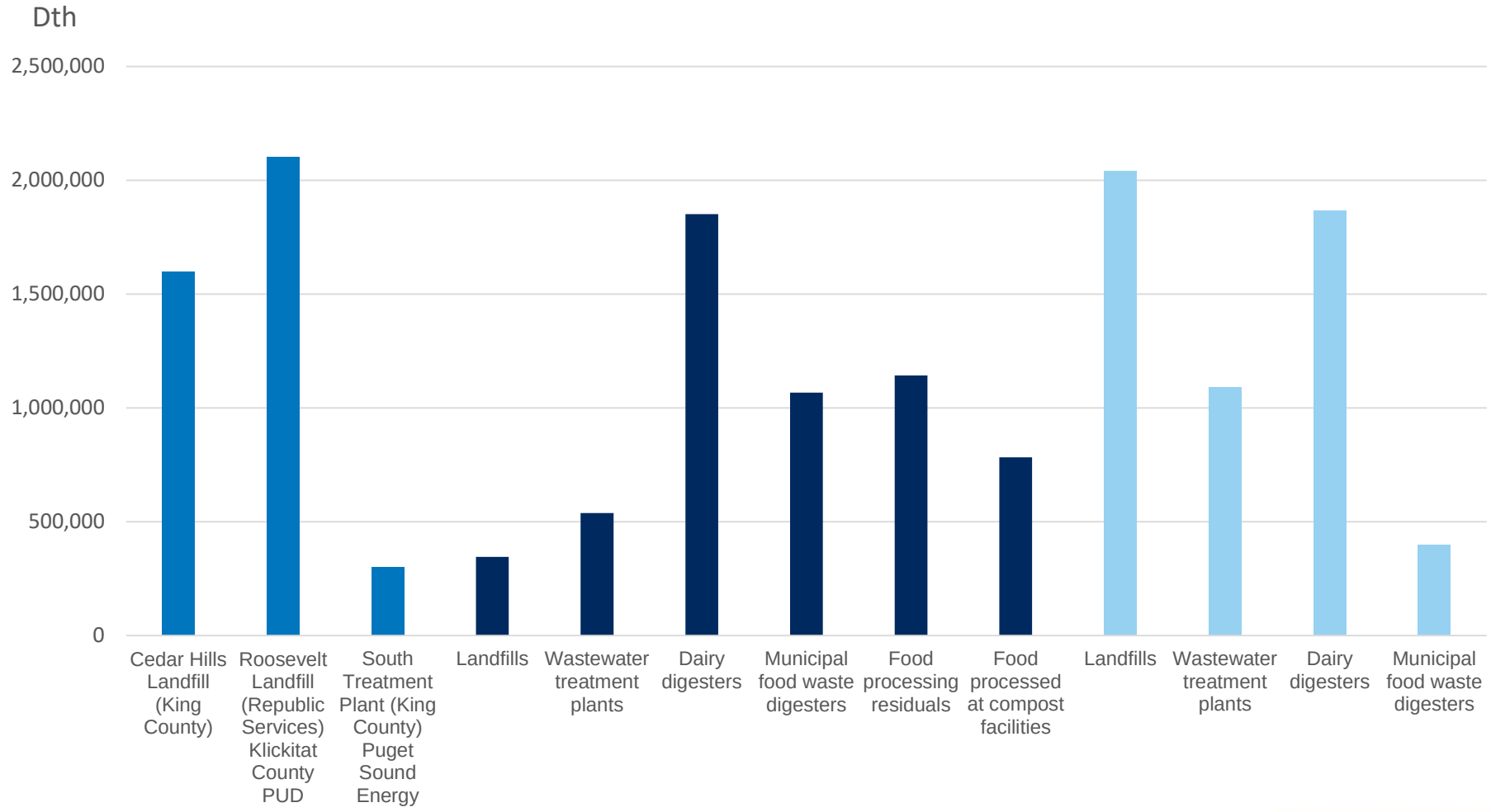
RNG Process Overview



Source: Promoting RNG in WA State

WA RNG Report (HB 2580)

Existing Projects
Near Term Projects
Medium Term Projects



WSU Energy Program, Harnessing Renewable Natural Gas for Low-Carbon Fuel: A Roadmap for Washington State

*Released December 1, 2018

Renewable Natural Gas Comparison to Non-Renewable Natural Gas Reserves

WA RNG Potential	Bcf	dth	dth/day
Current	3.9	4,002,400	10,965
Near-Term	5.2	5,395,010	14,781
Mid-Term	5.6	5,729,010	15,696
Total	14.7	15,126,420	41,442
Avista Natural Gas Consumption			
Avista Power Load 2018	23.4	24,114,712	66,068
Avista LDC Load 2018	33.4	34,456,500	94,401
Total Avista Consumption		58,571,212	160,469
Gas Consumption of CS2			50,000
North American Gas Reserves			
Canadian Gas Reserves (300 years)	1,828,891	1,885,586,517,900	
U.S. Gas Reserves (80 years)	2,459,000	2,535,229,000,000	
Total NA Gas Reserves	4,287,891	4,420,815,517,900	
WA RNG Potential Share of NA Gas Reserves			**0.0003%**

AVISTA

NREL Estimates – Idaho RNG

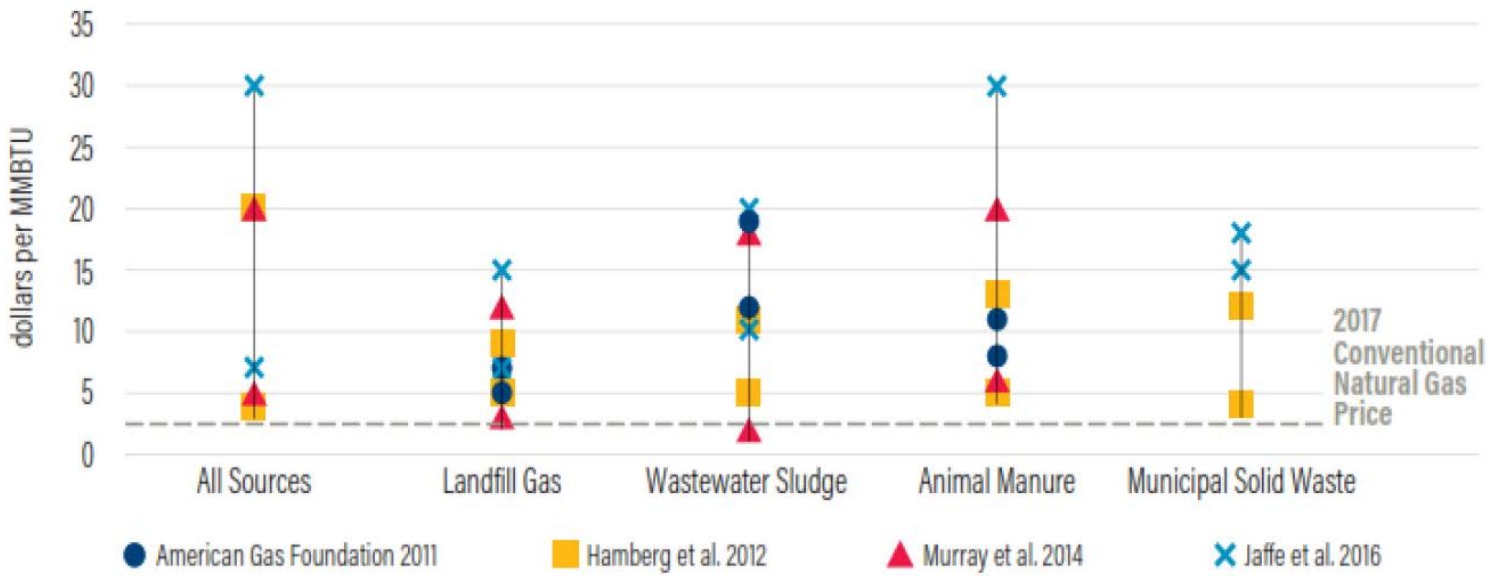
Total Potential Annual Production = 32 Bcf

Source – Anaerobic	MMBtu per Year
Landfills	3,712,221
Wastewater Treatment	6,196,531
Agriculture Manure	20,220,571
Source-Separated Organics (Solid Waste)	2,311,354
Total	**32,440,676**

National Renewable Energy Laboratory, NREL Biofuels Atlas

RNG $ per Dth/MMBtu

Avista Owned and Operated	ID - WA 2035 Premium Estimate ($ / Dth)
RNG - Landfills	$7 - $10
RNG - Waste Water Treatment Plants (WWTP)	$12 - $22
RNG - Agriculture Manure	$28 - $53
RNG - Food Waste	$29 - $53

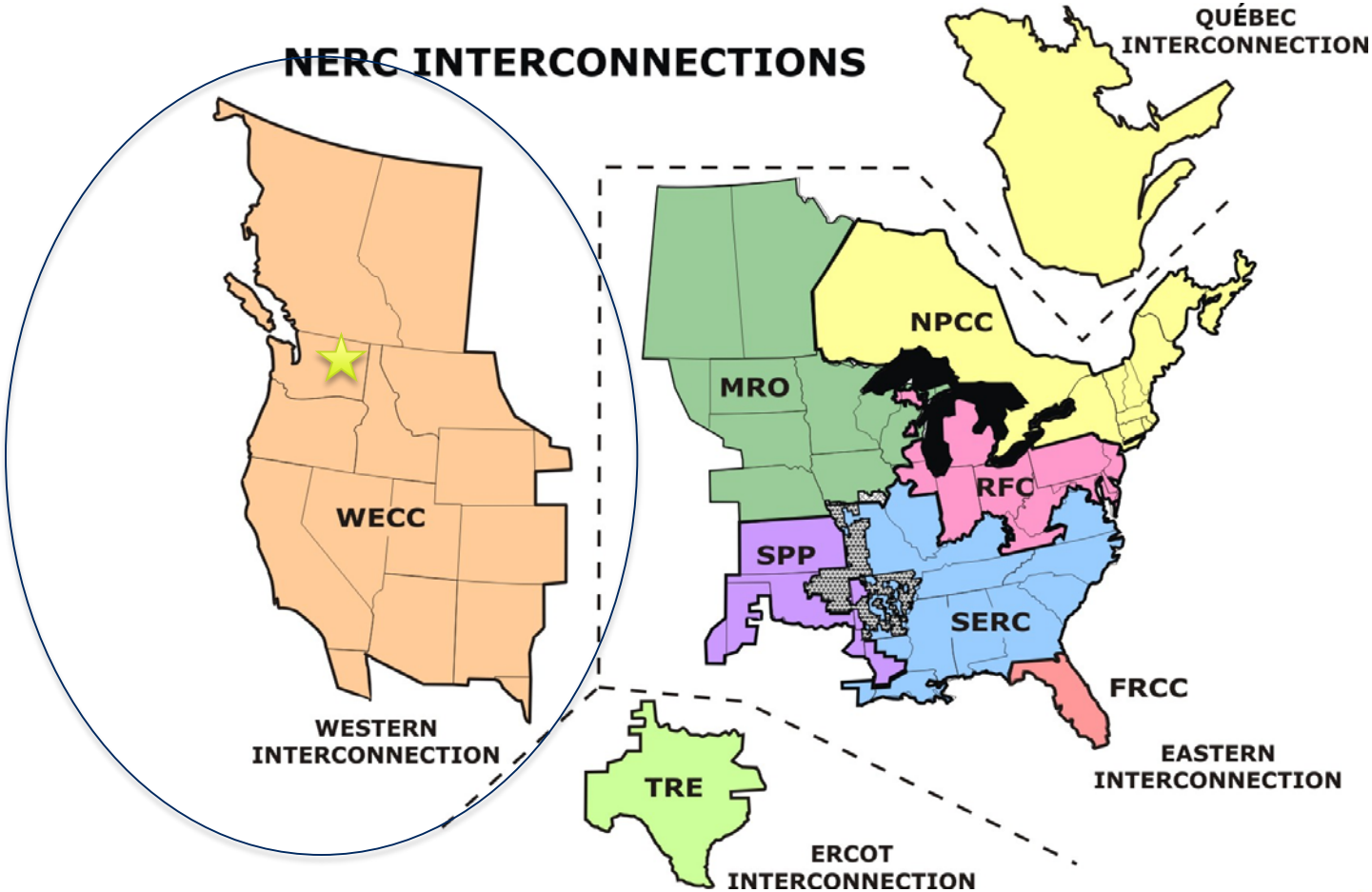


Source: Promoting RNG in WA State

2020 IRP Electric Market Price Forecast

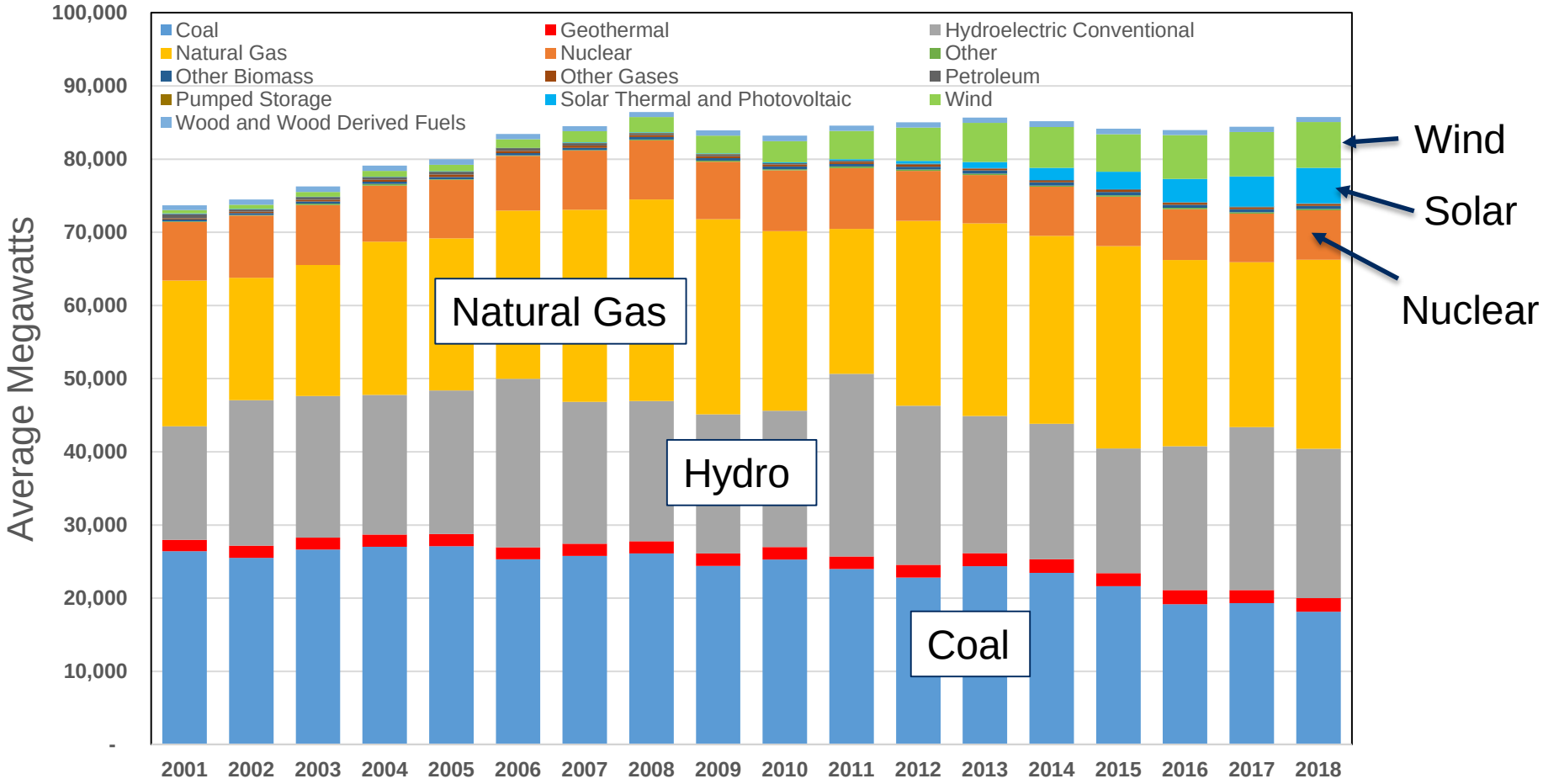
James Gall, IRP Manager
Fourth Technical Advisory Committee Meeting
August 6, 2019

Our Region



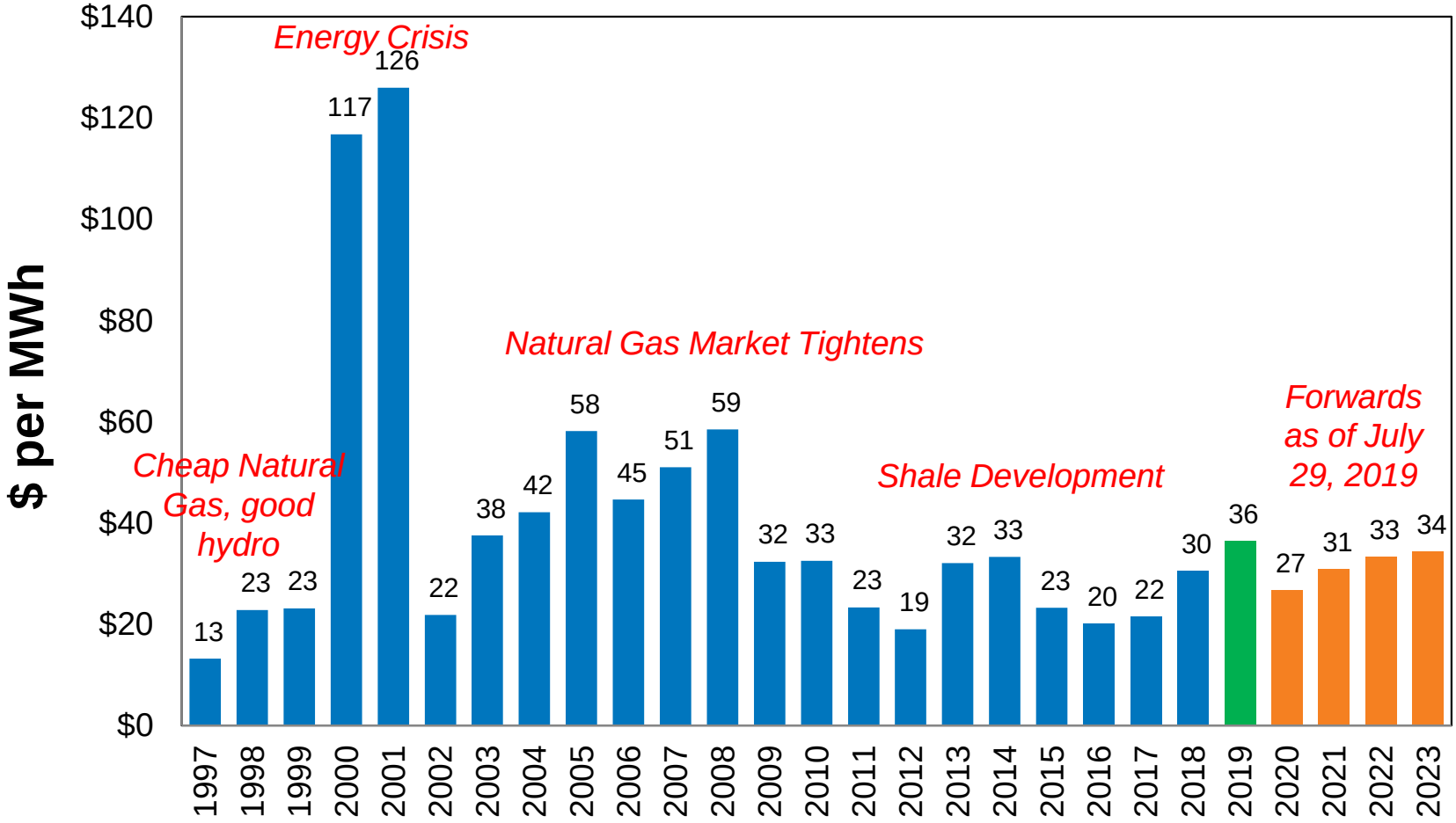
Source: NERC

US Western Interconnect Generation



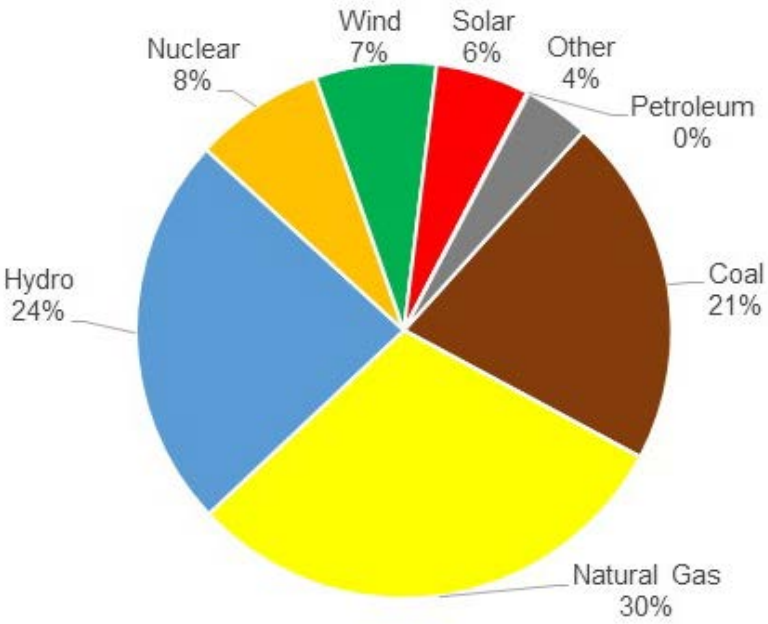
Source: EIA Data

Mid-Columbia Flat Firm Price Index History

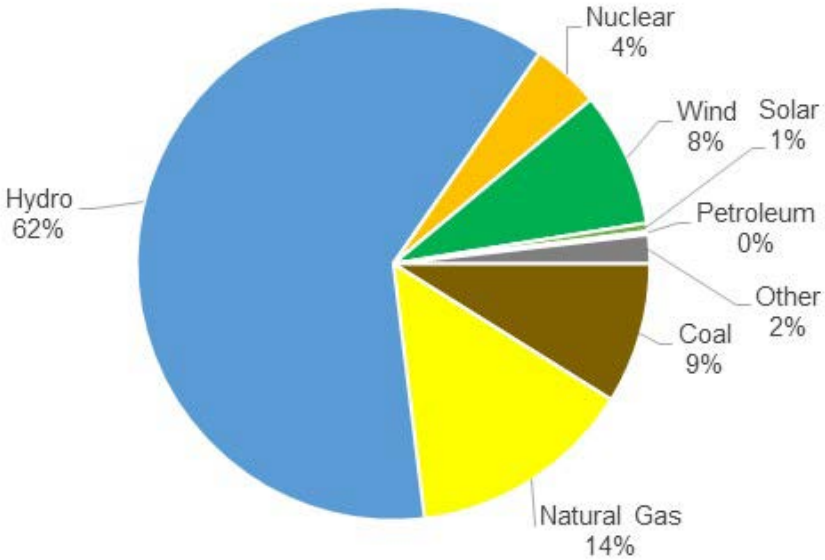


2018 Fuel Mix Comparison (NW vs West)

US Western Interconnect

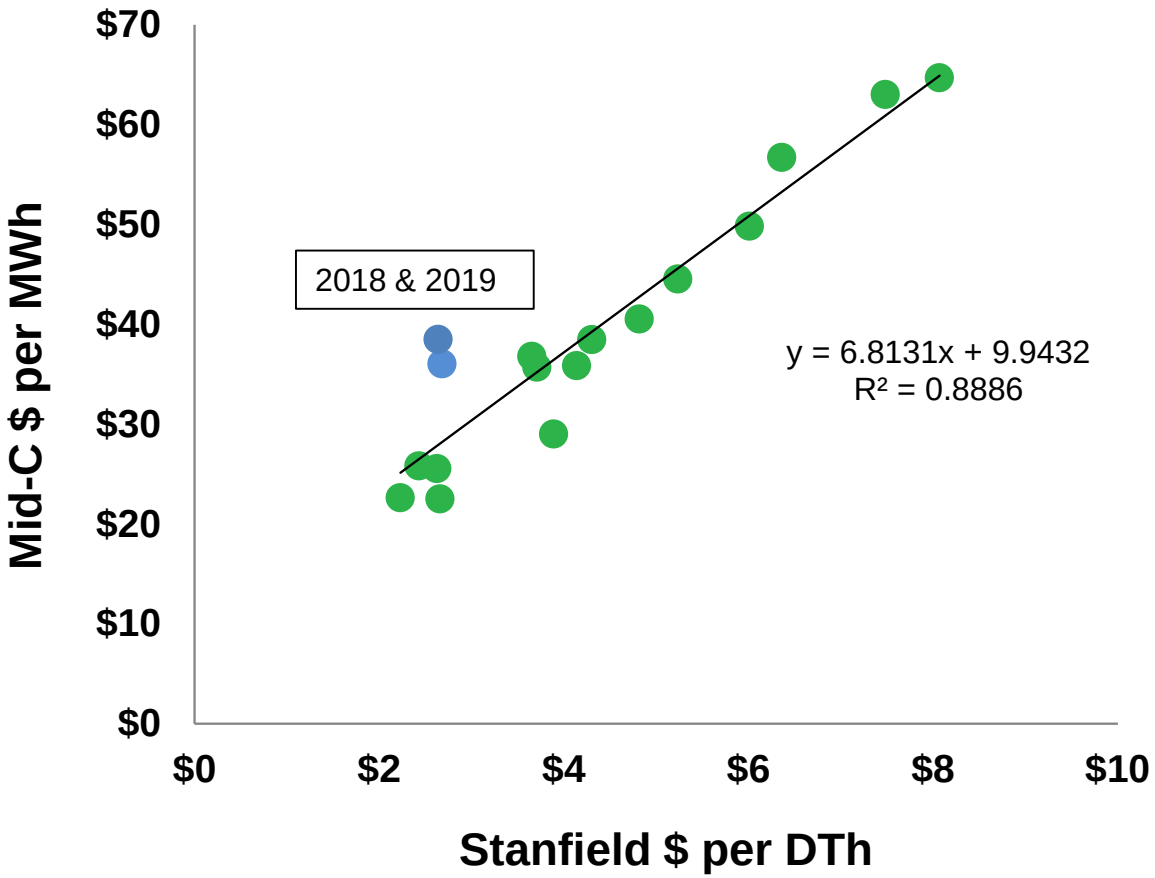


Northwest Four States

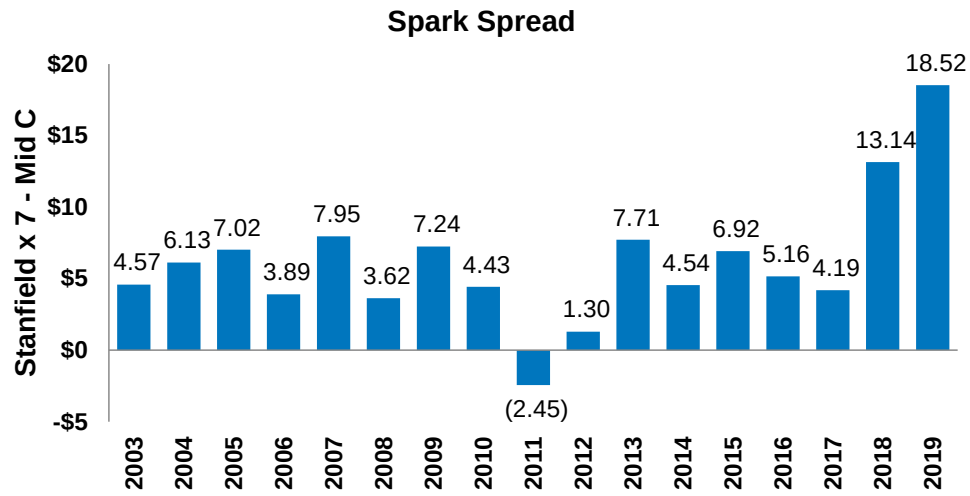


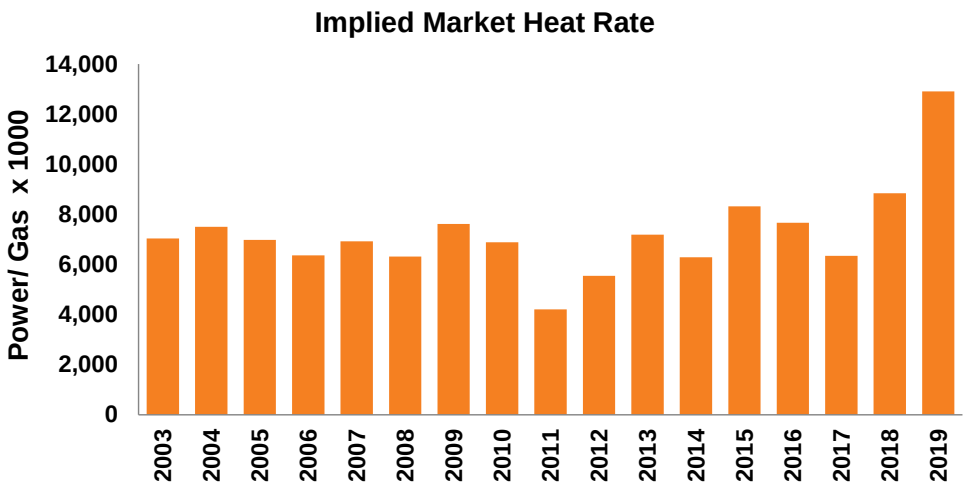
Source: EIA Data

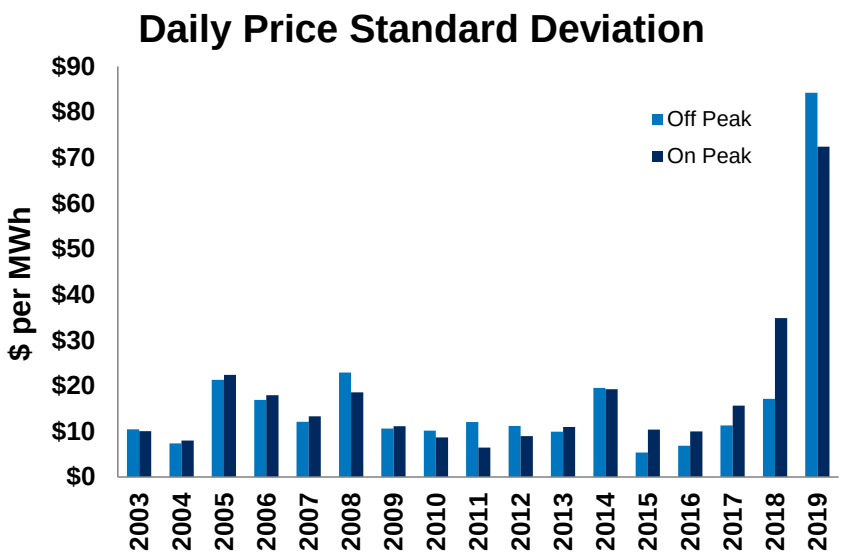
Natural Gas vs. On-Peak Electric Prices (2003-19)



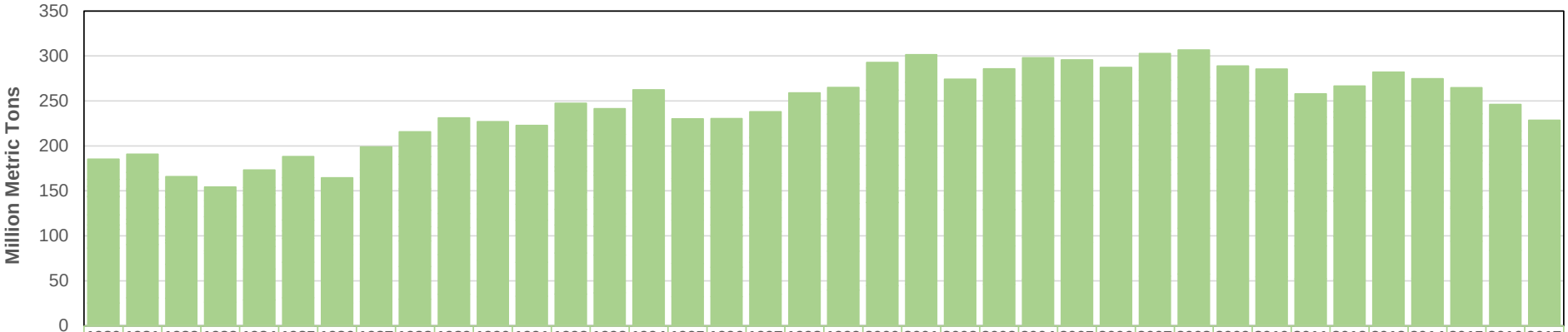
Market Indicators







Western Greenhouse Gas Emissions Power Industry

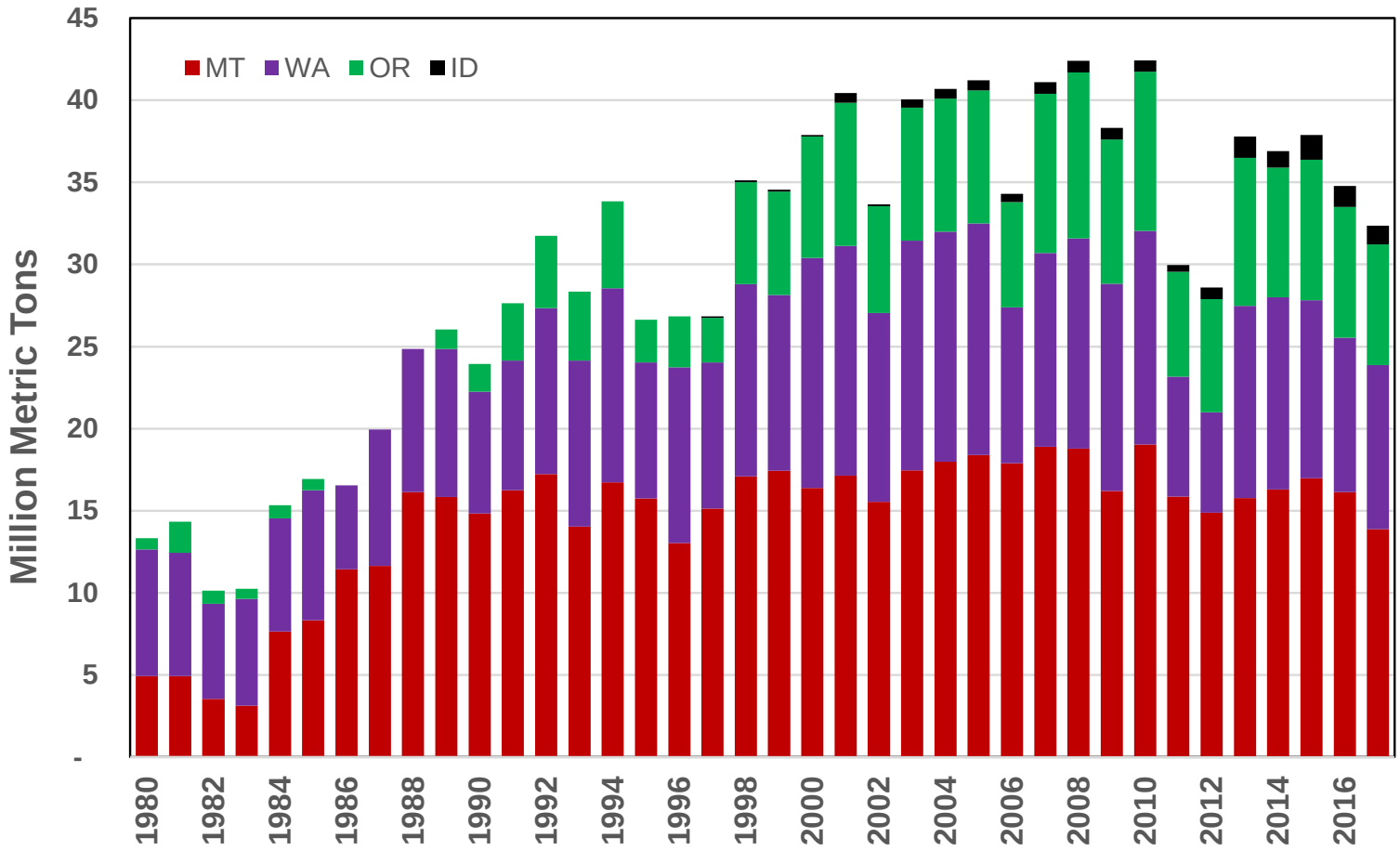


	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
WY	22	20	17	15	19	24	17	26	27	25	28	27	30	29	31	28	29	29	31	30	31	31	30	30	30	29	29	30	30	30	29	26	29	31	30	29	29	29
WA	8	8	6	7	7	8	5	8	9	9	7	8	10	10	12	8	11	9	12	11	14	14	12	14	14	14	10	12	13	13	13	7	6	12	12	11	9	10
UT	11	11	11	11	12	14	15	25	27	28	29	28	30	31	32	30	30	31	32	33	33	33	34	35	35	36	36	38	39	36	35	34	32	35	34	33	28	27
OR	1	2	1	1	1	1	-	-	-	1	2	4	4	4	5	3	3	3	6	6	7	9	7	8	8	8	6	10	10	9	10	6	7	9	8	9	8	7
NM	20	19	21	24	23	24	21	23	24	26	25	21	24	25	26	25	26	27	27	28	29	28	27	29	29	30	30	29	28	28	25	26	25	24	21	20	19	19
NV	11	13	14	13	15	12	16	15	18	17	17	18	19	18	20	18	20	19	21	22	25	24	21	23	25	26	17	17	18	18	17	15	15	15	16	14	14	12
MT	5	5	4	3	8	8	11	12	16	16	15	16	17	14	17	16	13	15	17	17	16	17	16	17	18	18	18	19	19	16	19	16	15	16	16	17	16	14
ID	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1
CO	21	23	24	23	25	27	26	27	28	30	31	30	31	32	33	32	34	34	35	36	39	41	40	40	40	41	42	43	41	38	40	39	39	39	38	37	37	36
CA	61	59	38	31	34	40	27	37	37	44	40	38	46	42	50	37	33	36	39	43	53	58	44	43	46	42	47	50	51	48	44	36	48	46	46	44	37	28
AZ	25	31	31	26	29	31	25	27	29	35	33	33	35	37	38	32	32	35	38	40	45	46	45	46	52	51	53	55	58	52	54	52	51	55	53	50	47	45

1980: 185 MMT
1990: 227 MMT
2008: 307 MMT
2017: 228 MMT

Source: EPA
Adjusted for plants in the Western Interconnect system

Northwest Greenhouse Gas Emissions



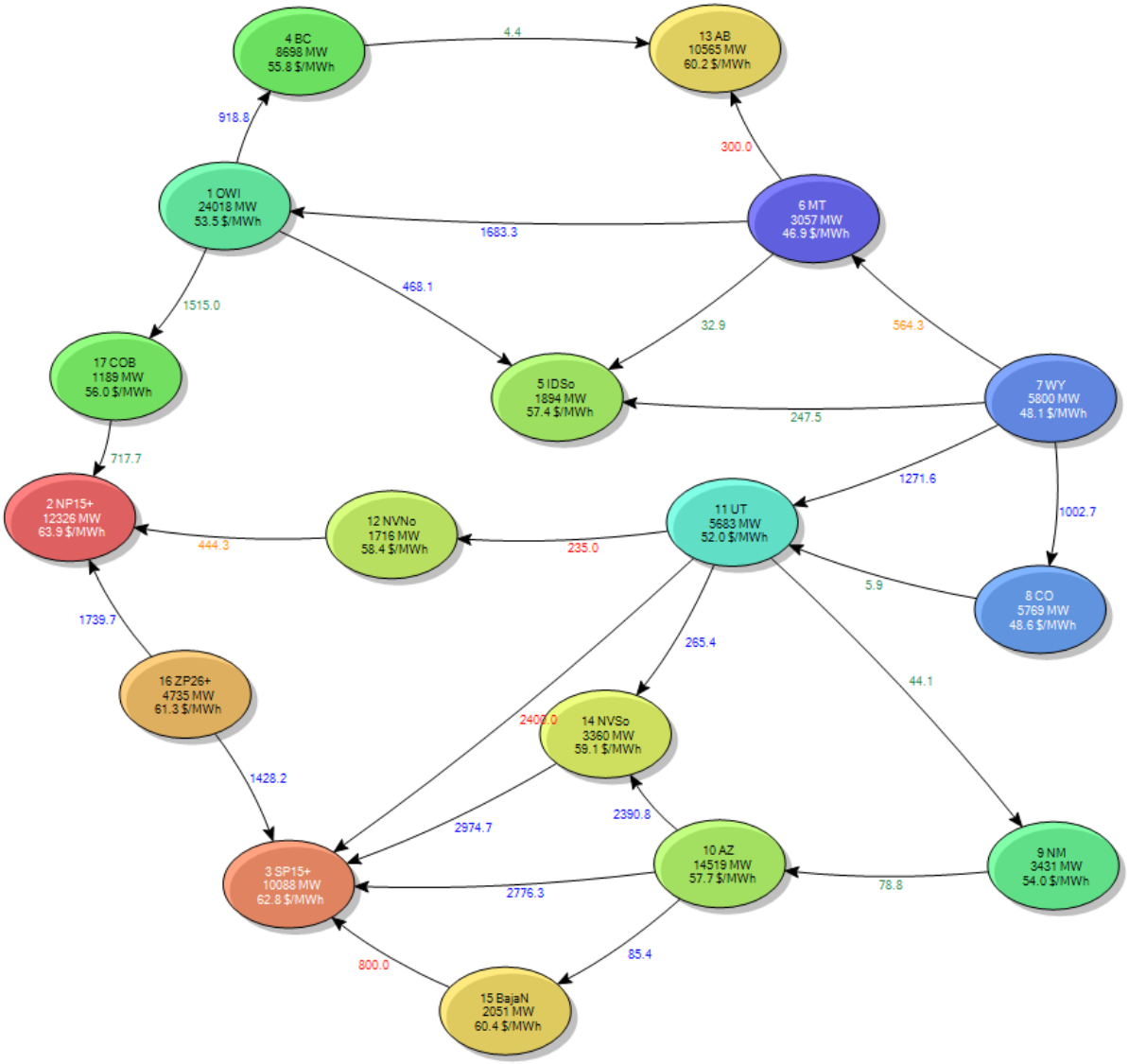
Electric Market Modeling

- 3rd party software- Aurora by Energy Exemplar
- Electric market fundamentals- production cost model
- Simulates generation dispatch to meet load
- Outputs:
  - Market prices (electric & emission)
  - Regional energy mix
  - Transmission usage
  - Greenhouse gas emissions
  - Power plant margins, generation levels, fuel costs
  - Avista's variable power supply costs

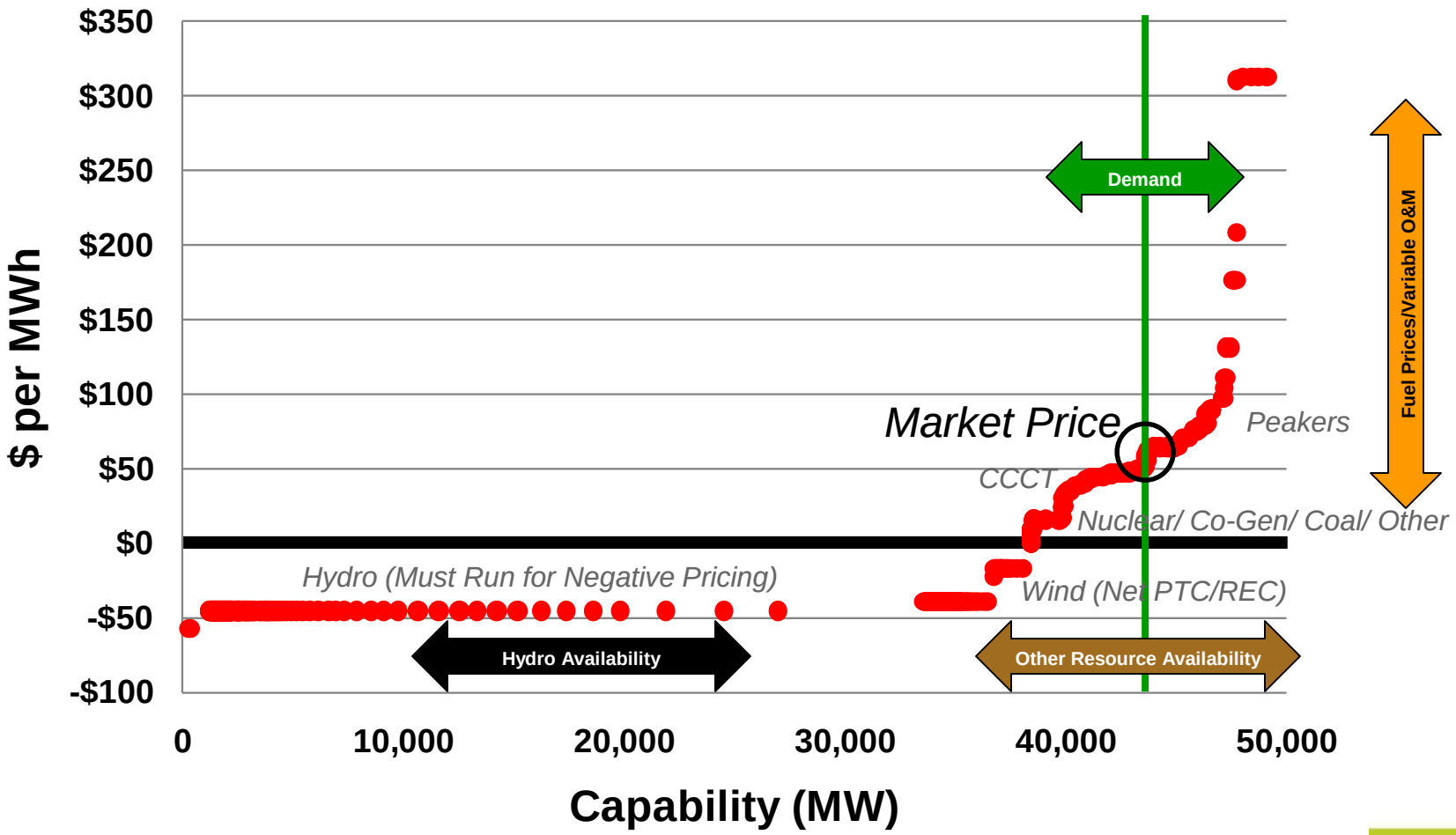
Stochastic Approach

- Simulate Western Electric market hourly for next 25 years (2021-45)
  - That is 175,248 hours for each study
- Model 500 potential outcomes
  - Variables include fuel prices, loads, wind, hydro, outages, and inflation
  - Simulating 87.6 million hours
- Run time is about 14+ days on 20 processors
- Why do we do this?
  - Allows for complete financial evaluation of resource alternatives
  - Without stochastic prices we cannot account for tail risk

Modeled Western Interconnect Topology



How Aurora derives hourly prices



Note: minimum price is negative $25/ MWh (2018$)

Approach to New Resource Selection

- Baseline
  - 3rd party consultant new resource outlook
  - known retirements
- Policy Constraints
  - California, BC, and Alberta include CO_2 price adder
  - OR: Emissions Cap (3.6 million tons)
  - WA: CETA: resources & social cost of carbon
  - ID: Clean Power Plan Emission's Intensity (delayed)
  - No new coal-fired generation
  - Uses existing state Renewable Portfolio Standards
- Resource Adequacy
  - Achieve close to 1-in-20 loss of load probability (LOLP/LOLE)

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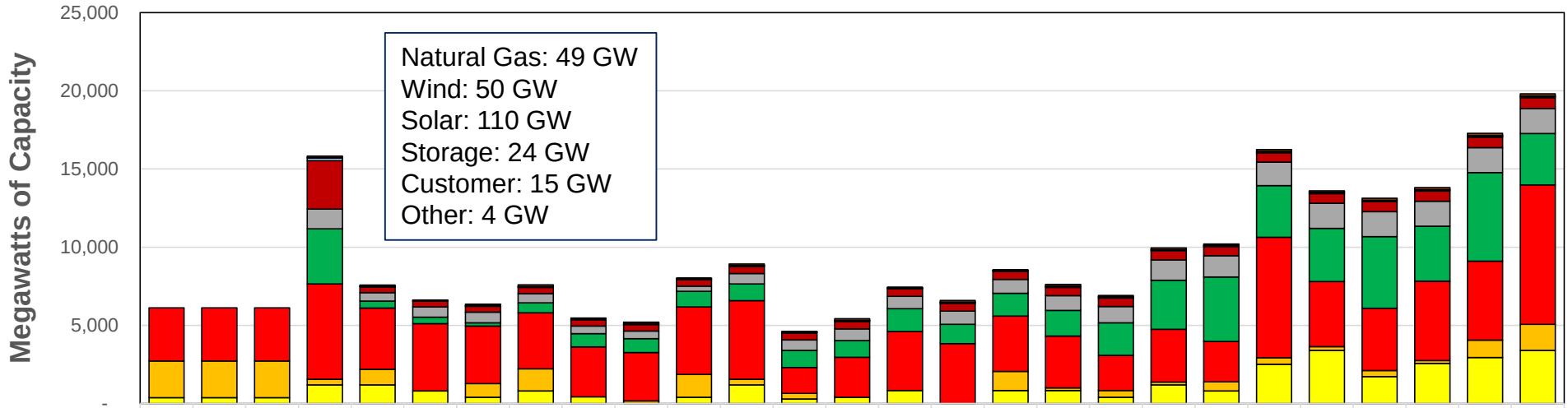
New Resources Forecast- US West



	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Geothermal	-	-	-	90	70	24	76	104	52	104	26	104	26	104	26	104	26	104	76	114	86	124	96	134	140	156	160
Biomass	-	-	-	18	11	35	36	35	37	35	36	36	36	34	34	37	34	34	36	35	36	34	34	37	34	34	36
Hydro	-	-	-	182	40	19	23	30	29	25	29	30	28	40	31	36	39	58	51	56	54	51	58	56	56	56	58
Consumer Gen	-	-	-	3,092	357	367	378	390	402	414	427	439	452	466	480	494	510	525	541	557	574	592	610	628	647	667	687
Storage	-	-	-	1,267	551	659	667	587	480	480	331	671	660	748	795	849	897	941	1,050	1,308	1,358	1,500	1,600	1,598	1,600	1,601	1,600
Wind	-	-	-	3,522	445	419	215	640	846	896	993	1,070	1,095	1,070	1,462	1,236	1,450	1,632	2,078	3,145	4,127	3,308	3,399	4,576	3,510	5,656	3,294
Solar	3,400	3,400	3,400	6,102	3,915	4,304	3,676	3,582	3,195	3,082	4,313	5,029	1,662	2,562	3,778	3,834	3,539	3,320	2,240	3,367	2,583	7,705	4,168	3,985	5,079	5,052	8,910
NG Peaker	2,353	2,353	2,353	350	988	-	880	1,422	-	175	1,467	350	350	-	-	-	1,230	175	440	175	587	412	237	400	175	1,111	1,659
NG CCCT	371	371	371	1,200	1,200	800	400	800	429	-	400	1,200	300	400	829	-	829	829	400	1,200	800	2,516	3,403	1,716	2,574	2,945	3,403

Note 1: 2019-2021 additions are spread evenly between the 3 years, these are all added in 2021 for modeling purposes

Note 2: Storage is assumed to be a blend of technologies, average of 3 hours duration in 2021, ramping to 6 hours average duration by 2045

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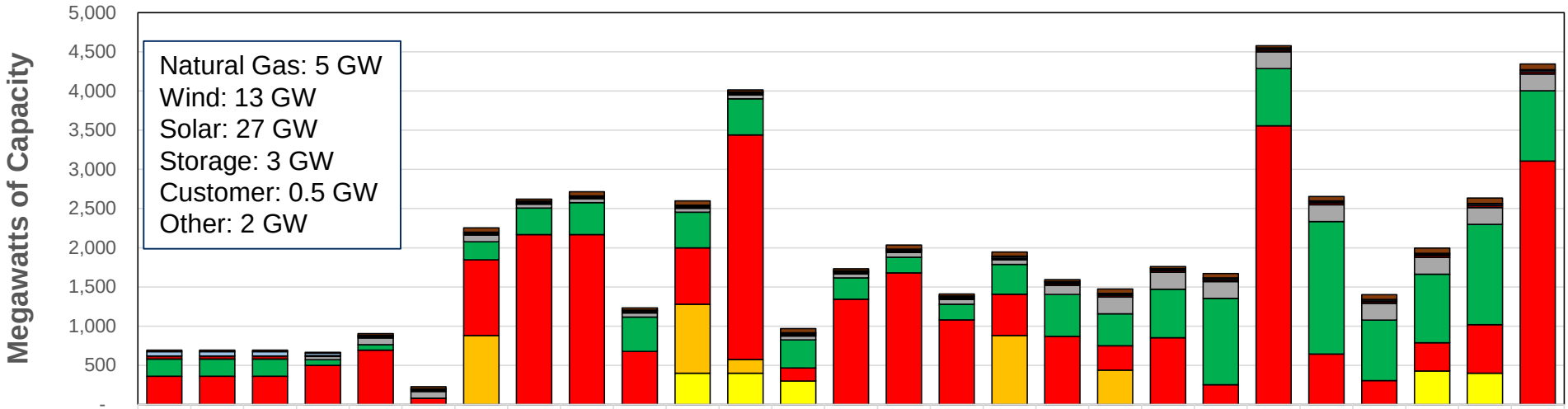
New Resources Forecast- Northwest States



	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Geothermal	19	19	19	-	24	26	54	26	54	26	54	26	54	26	54	26	54	26	54	26	54	26	54	60	66	70	72
Biomass	-	-	-	11	11	10	11	11	11	10	12	10	10	10	11	10	10	10	11	10	10	10	11	10	10	10	11
Hydro	58	58	58	31	11	13	13	14	12	13	13	14	16	15	15	18	19	19	19	18	19	19	19	18	19	19	18
Consumer Gen	36	36	36	11	11	12	12	13	13	14	14	14	15	15	16	17	17	18	19	19	20	21	22	23	23	25	26
Storage	-	-	-	42	86	85	86	51	51	52	52	51	50	52	60	60	60	116	213	215	214	214	213	214	213	214	214
Wind	219	219	219	70	69	4	231	337	408	439	454	462	358	270	200	199	379	537	408	619	1,100	732	1,692	772	874	1,280	898
Solar	362	362	362	501	694	77	966	2,169	2,167	678	719	2,863	167	1,345	1,680	1,081	528	869	310	853	254	3,555	643	305	361	618	3,105
NG Peaker	-	-	-	-	-	-	880	-	-	-	880	175	-	-	-	-	880	-	440	-	-	-	-	-	-	-	-
NG CCCT	-	-	-	-	-	-	-	-	-	-	400	400	300	-	-	-	-	-	-	-	-	-	-	-	429	400	-

Note 1: 2019-2021 additions are spread evenly between the 3 years, these are all added in 2021 for modeling purposes

Note 2: Storage is assumed to be a blend of technologies, average of 3 hours duration in 2021, ramping to 6 hours average duration by 2045

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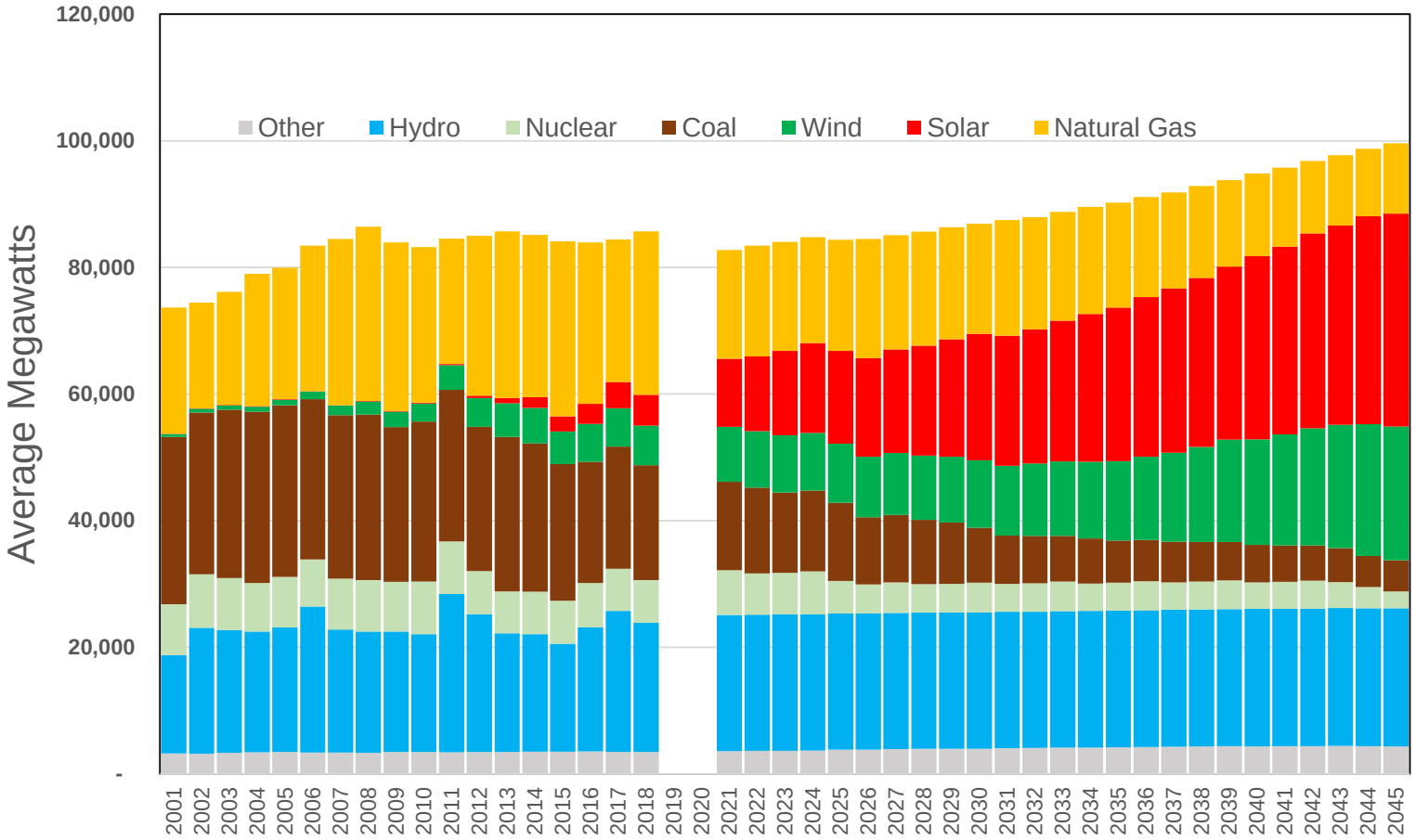
Resource Type Mix Forecast
(US Western Interconnect)



Fuel Type	2045 minus 2018 aGW
Natural Gas	-14.7
Hydro	+1.4
Solar	+28.7
Wind	+14.9
Other	+0.9
Coal	-13.2
Nuclear	-4.1

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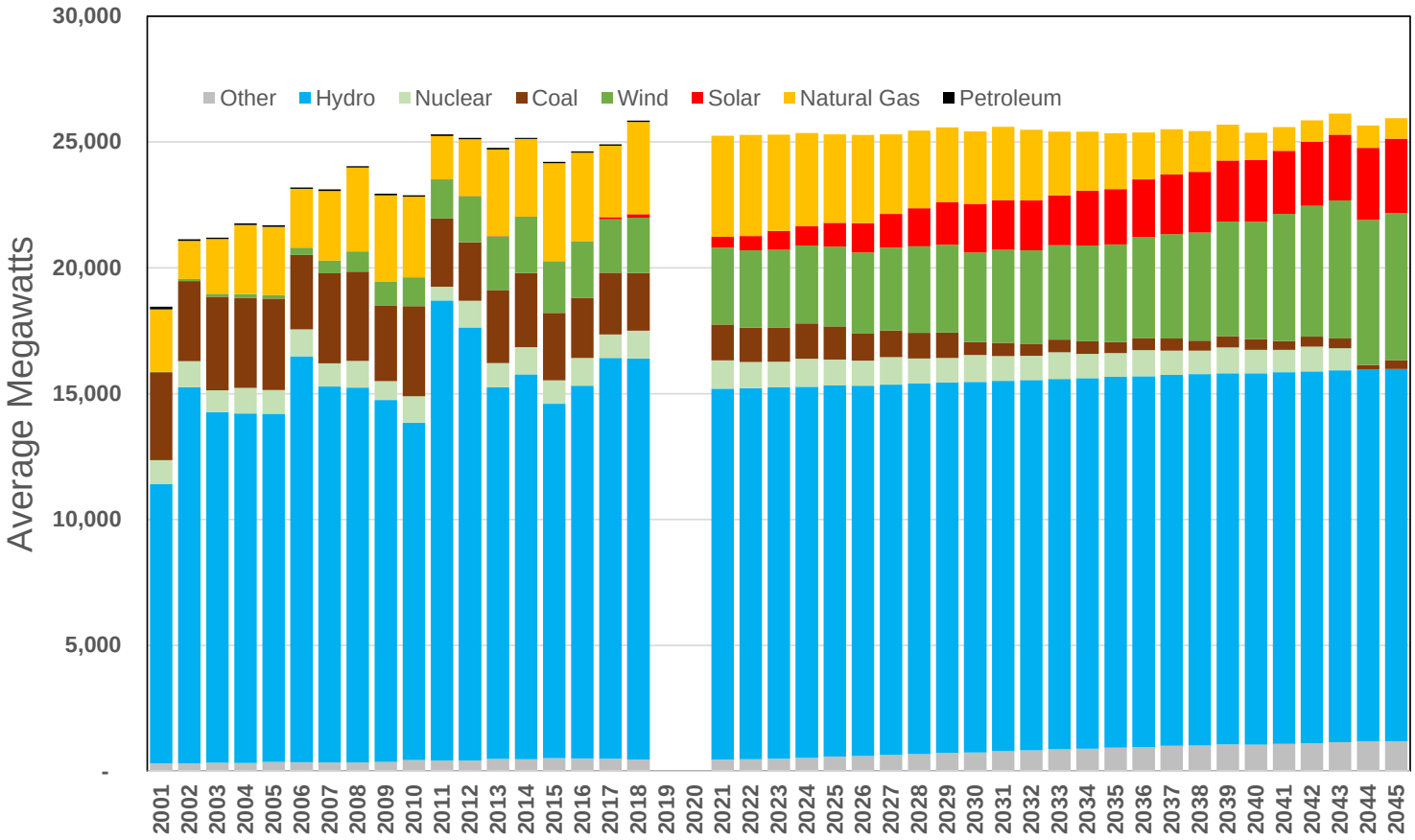
Resource Type Mix Forecast
(NW States)



Fuel Type	2045 minus 2018 aGW
Natural Gas	-2.8
Hydro*	-1.1
Solar	+2.8
Wind	+3.6
Other	+0.7
Coal	--1.9
Nuclear	-1.1

Note: Hydro change is due to actual hydro vs. average hydro

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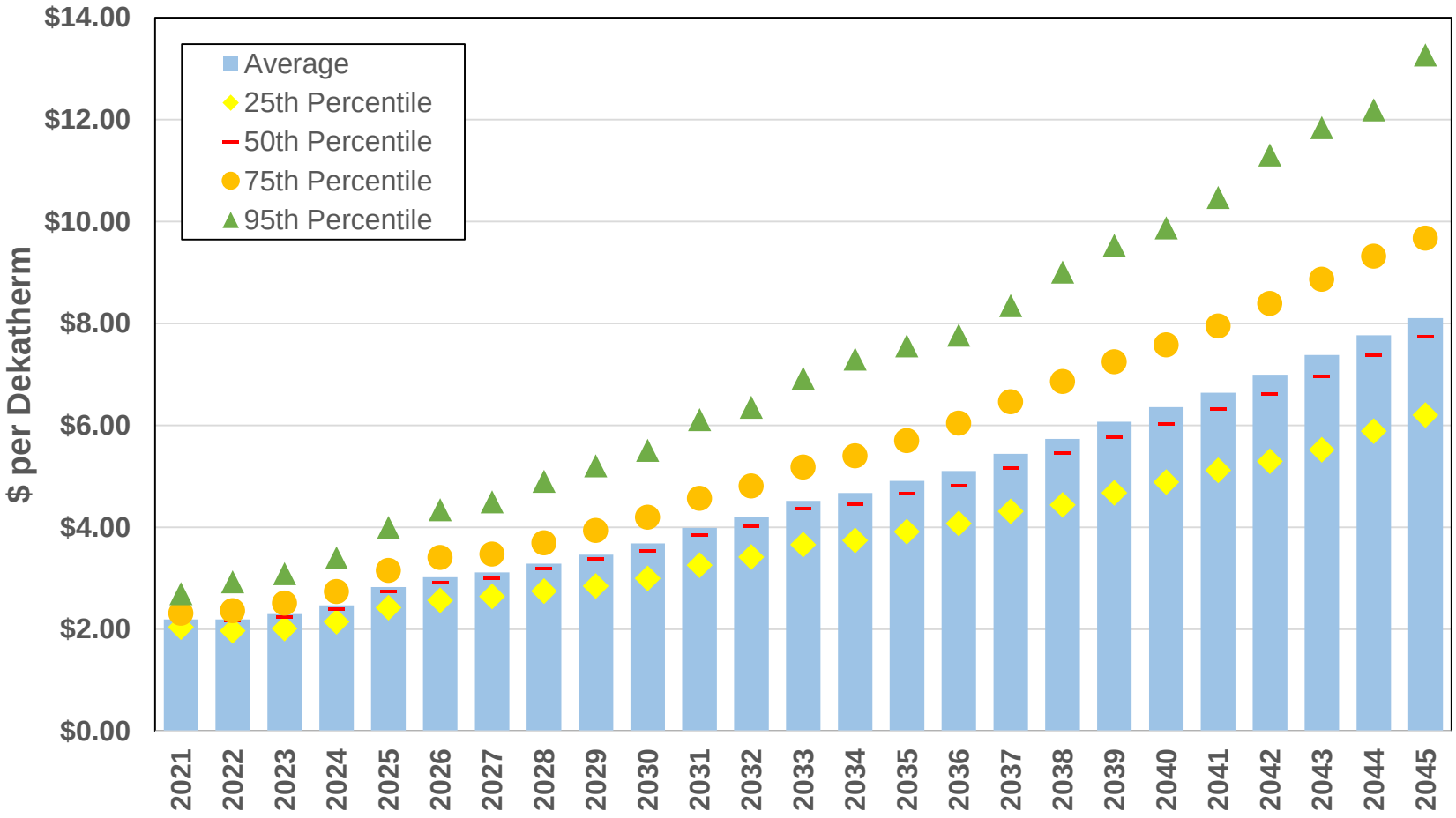
Stanfield Natural Gas Price Forecast



20-year levelized price: $3.98/Dth

25-year levelized price: $4.66/Dth

Note: Coefficient of variation (stdev/mean) in 2021 is 13%, in 2040, the volatility increases to 32%

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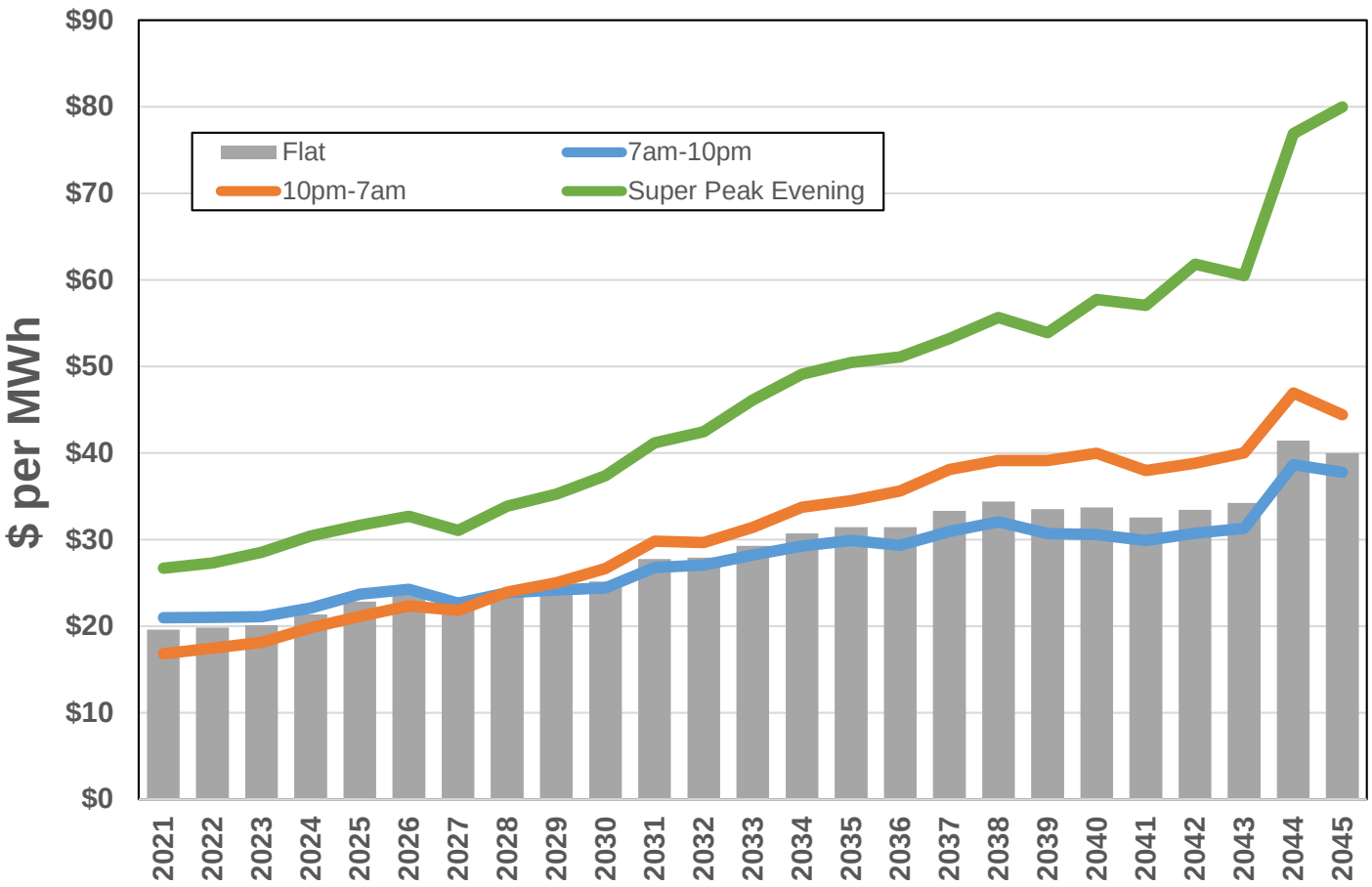
Mid-Columbia Electric Price Forecast
(Deterministic)



Levelized Prices

	20 year	25 year
Flat:	$25.03/MWh	$26.06/MWh
On Peak:	$25.07/MWh	$25.92/MWh
Off Peak:	$24.99/MWh	$26.25/MWh

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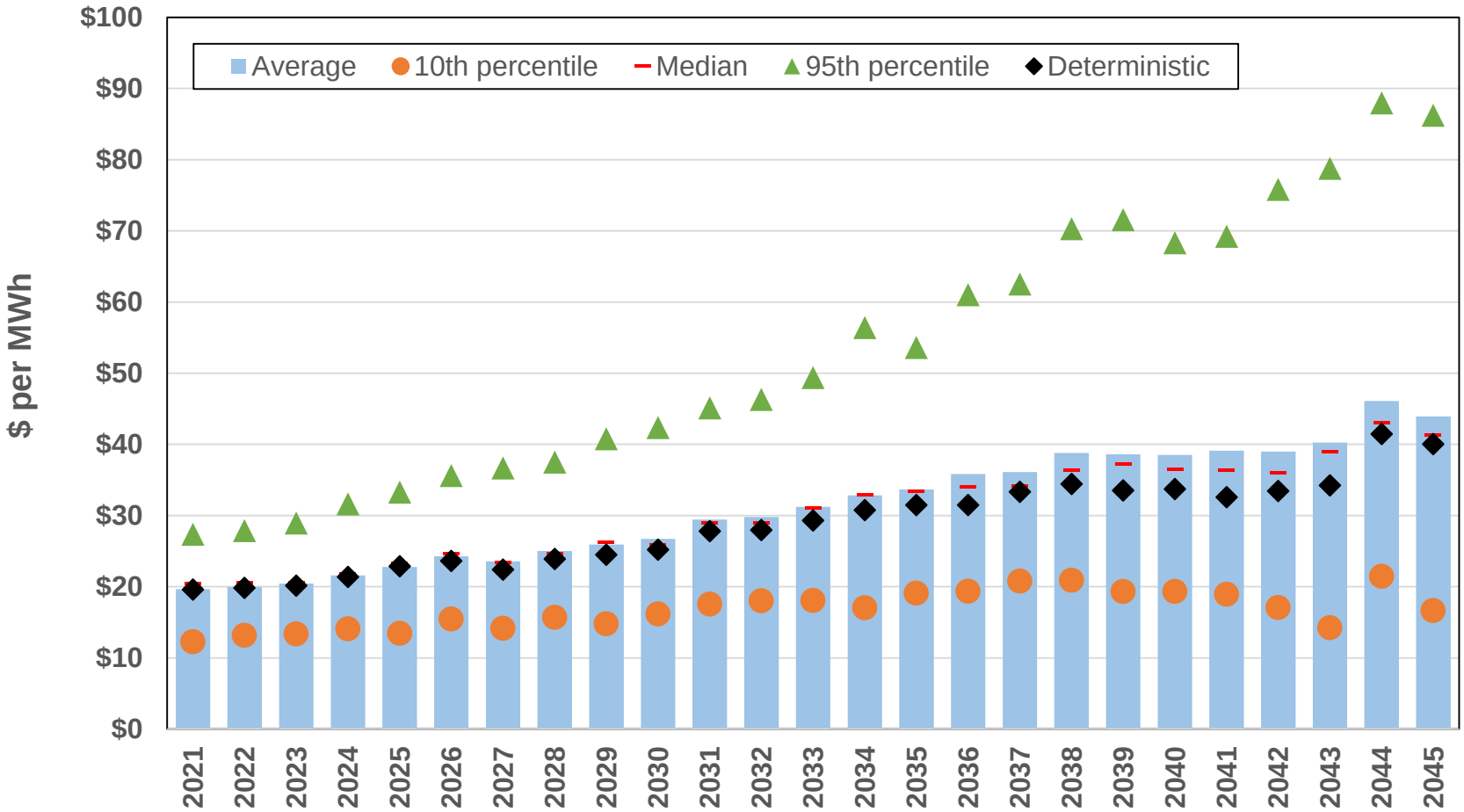
Mid-Columbia Electric Price Forecast

(Stochastic Flat Price Statistics)



20yr Levelized: $26.39 per MWh, 25 yr Levelized: $27.79 per MWh

Note: Coefficient of variation (stdev/mean) in 2021 is 28%, in 2040, the volatility increases to 42%

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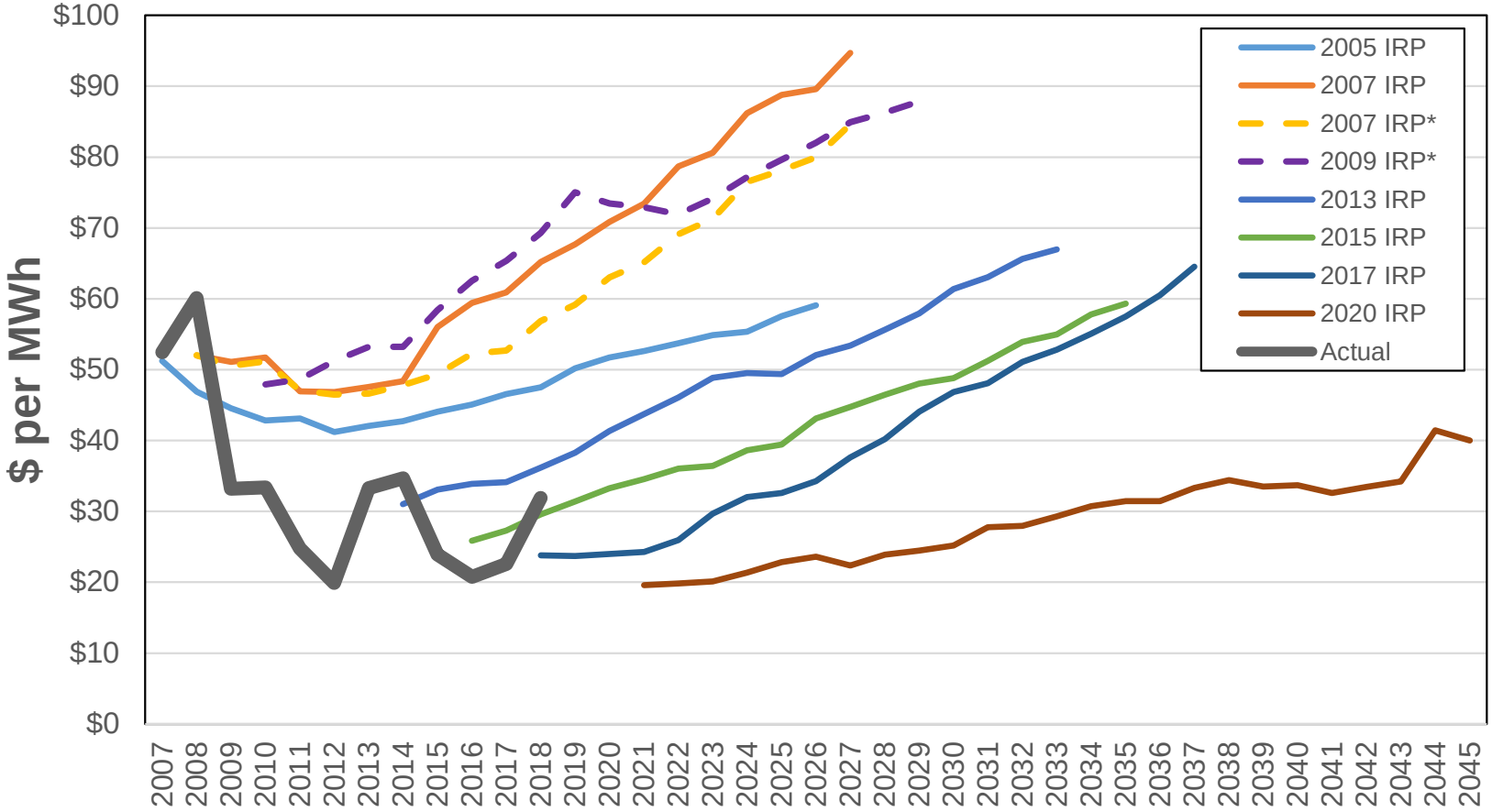
Historical IRP Price Forecasts (Annual Flat Prices)



Note: * Represents IRP forecast expected cases without carbon “taxes” in plant dispatch

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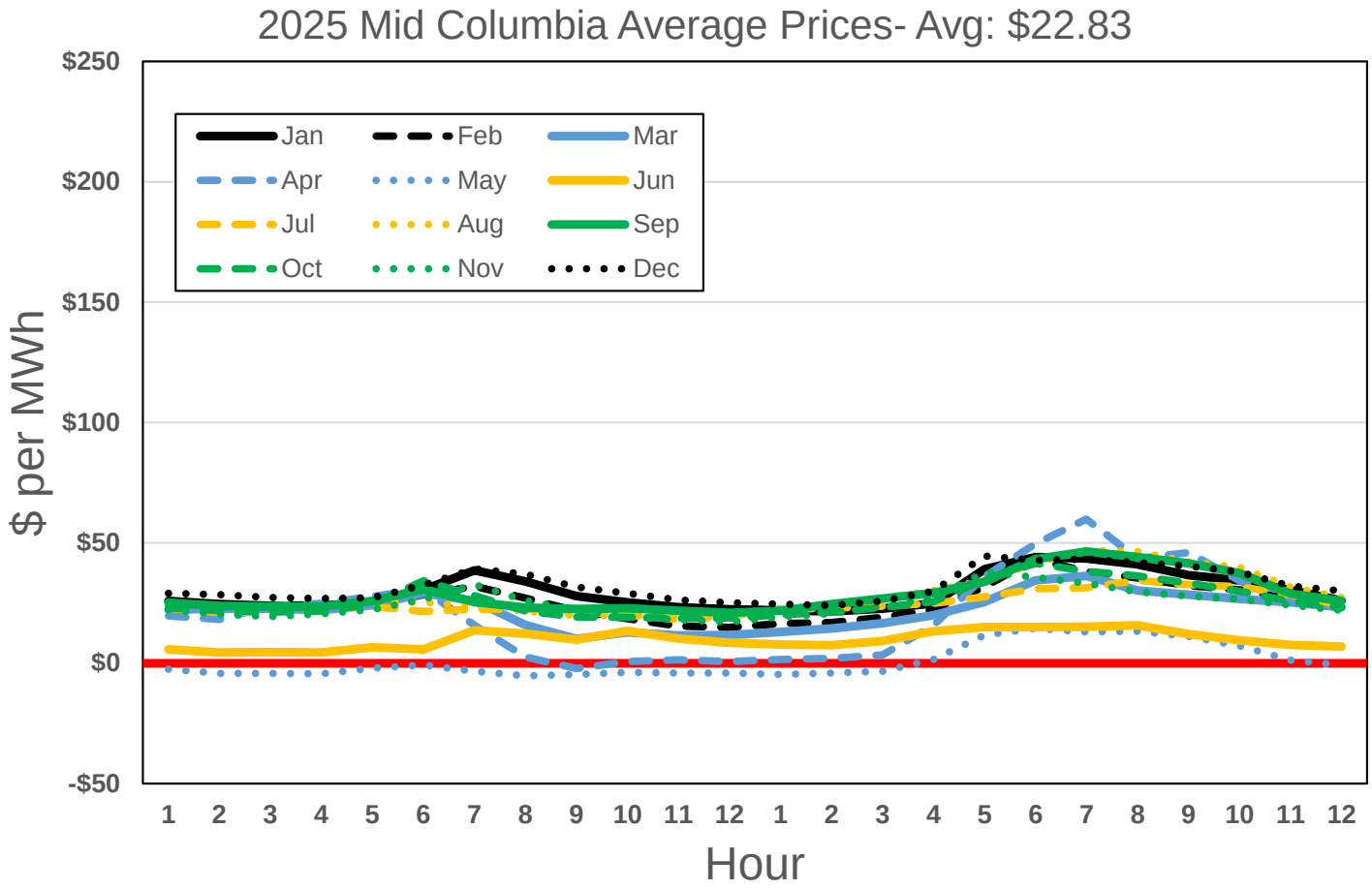
Hourly Price Shape



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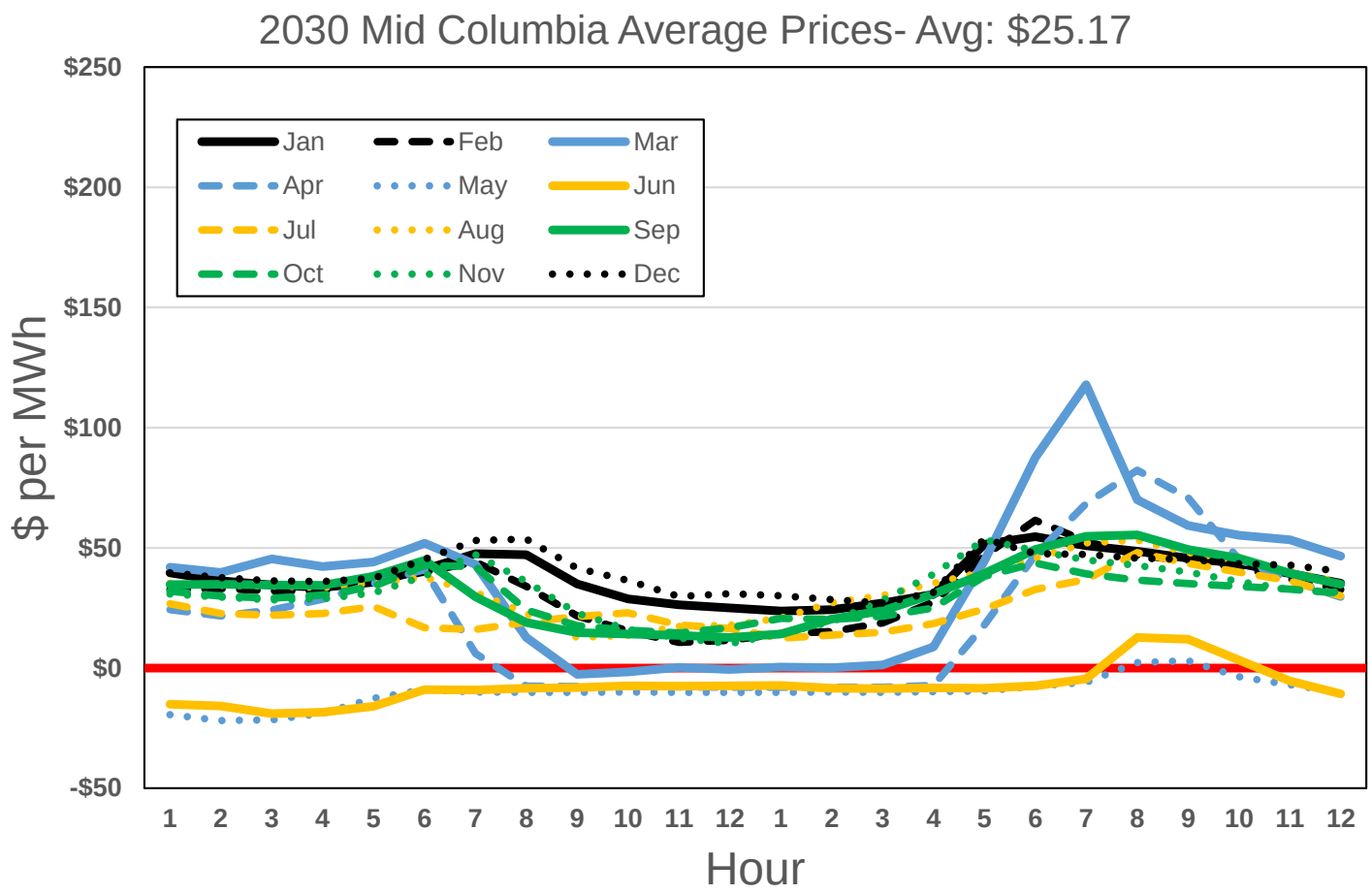
Hourly Price Shape



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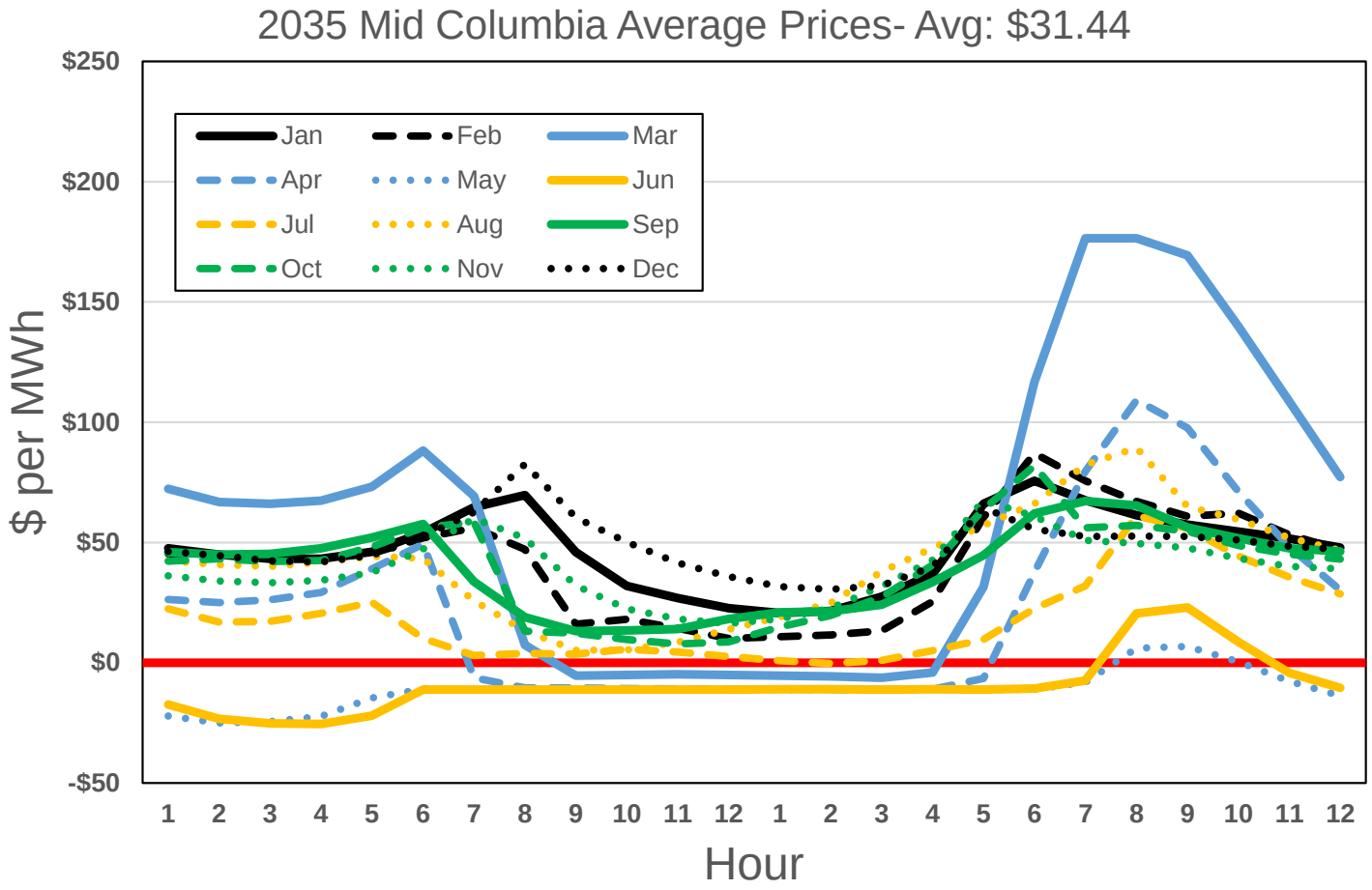
Hourly Price Shape



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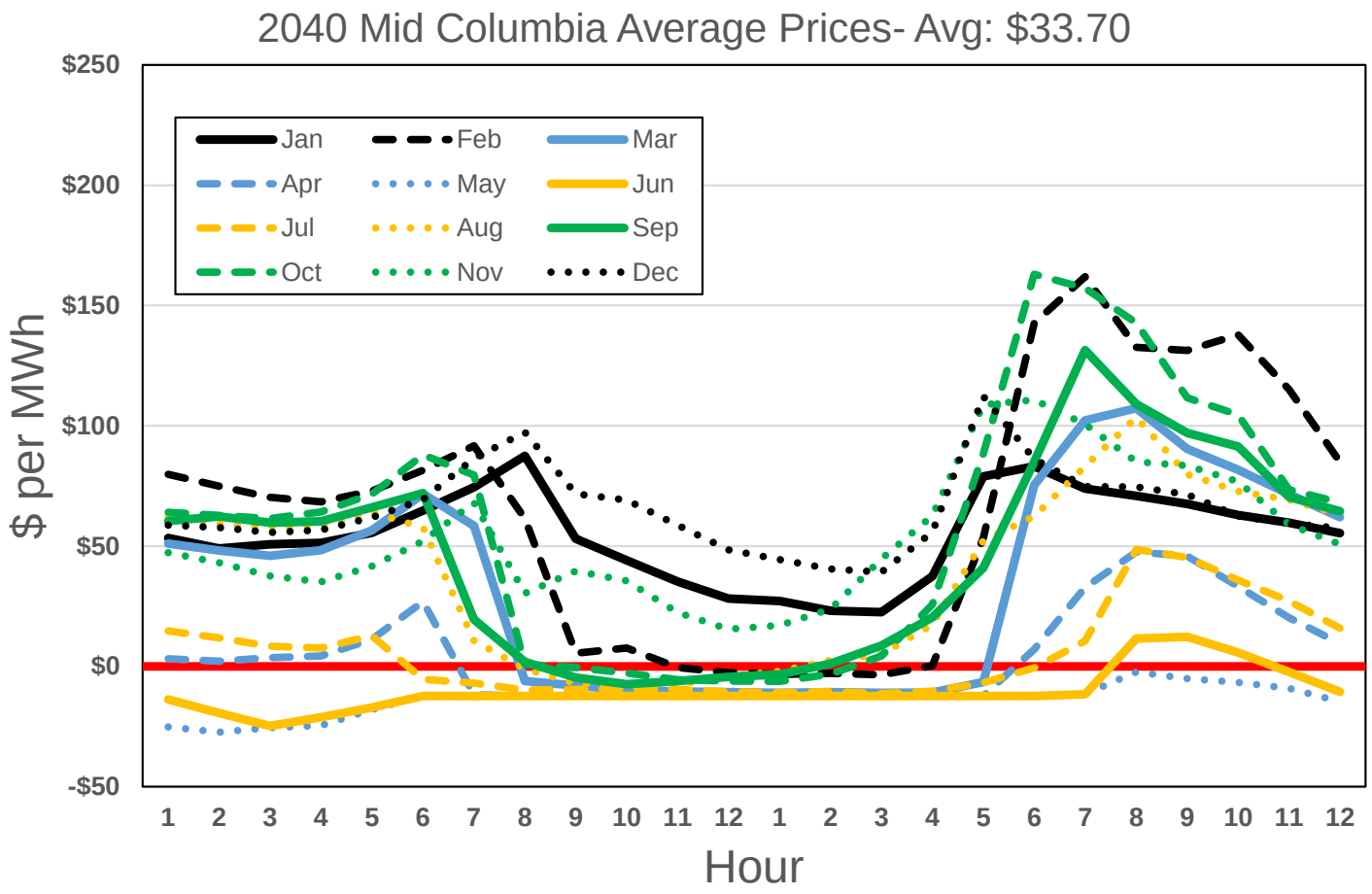
Hourly Price Shape



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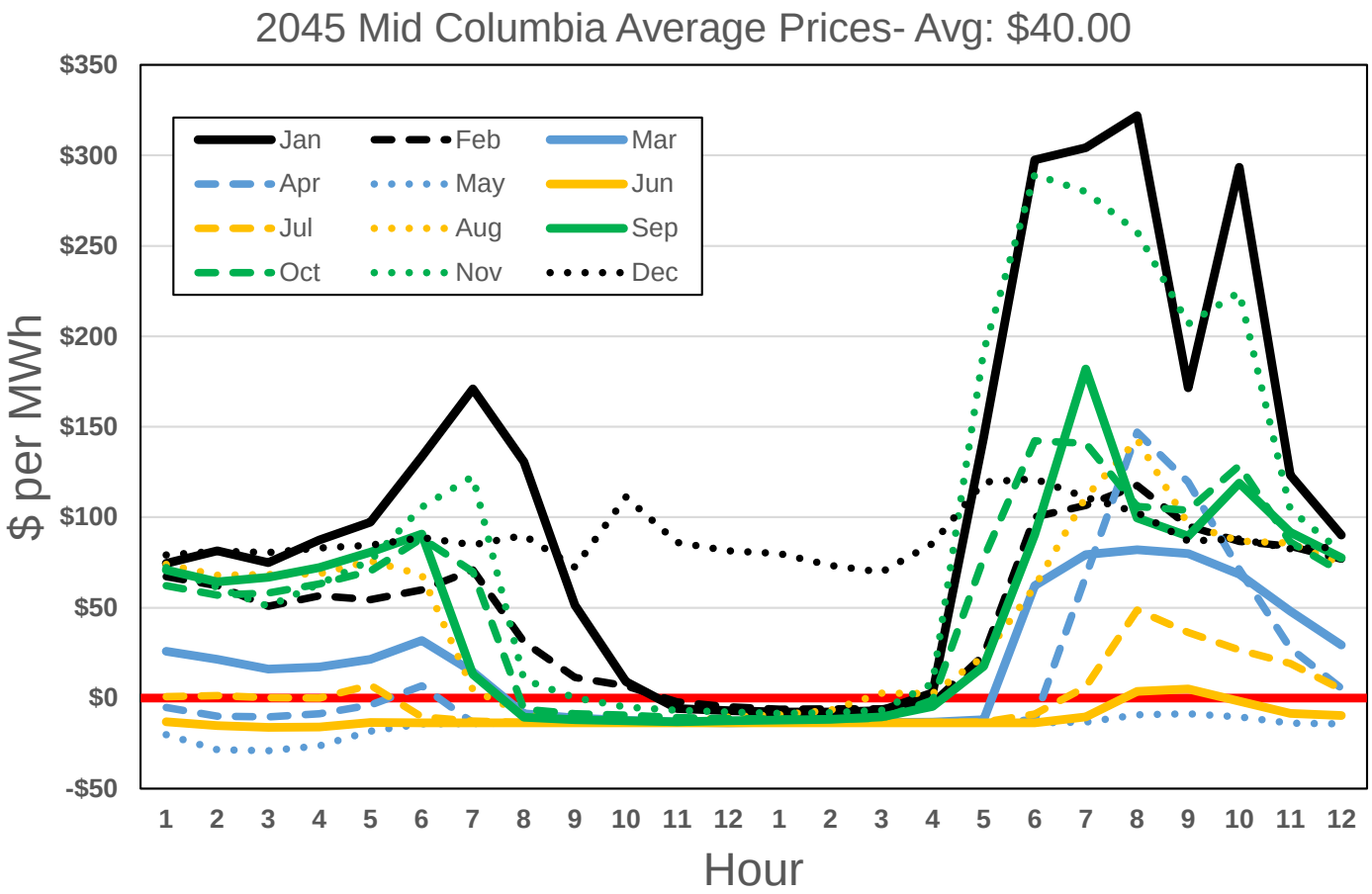
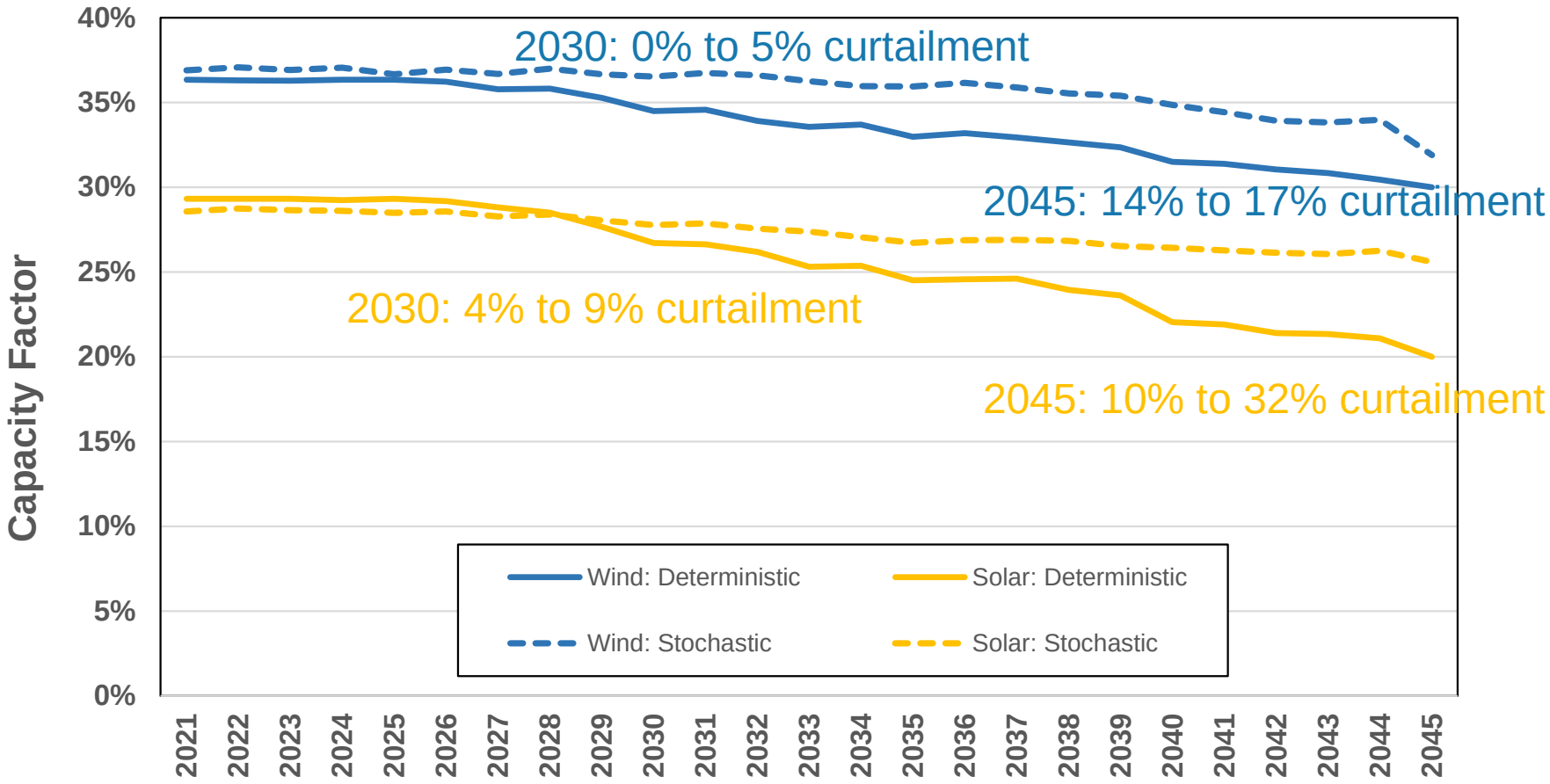
Hourly Price Shape



Renewable Curtailments



Note: Both wind and solar use a -$8.00/MWh + inflation variable charge + PTC if available

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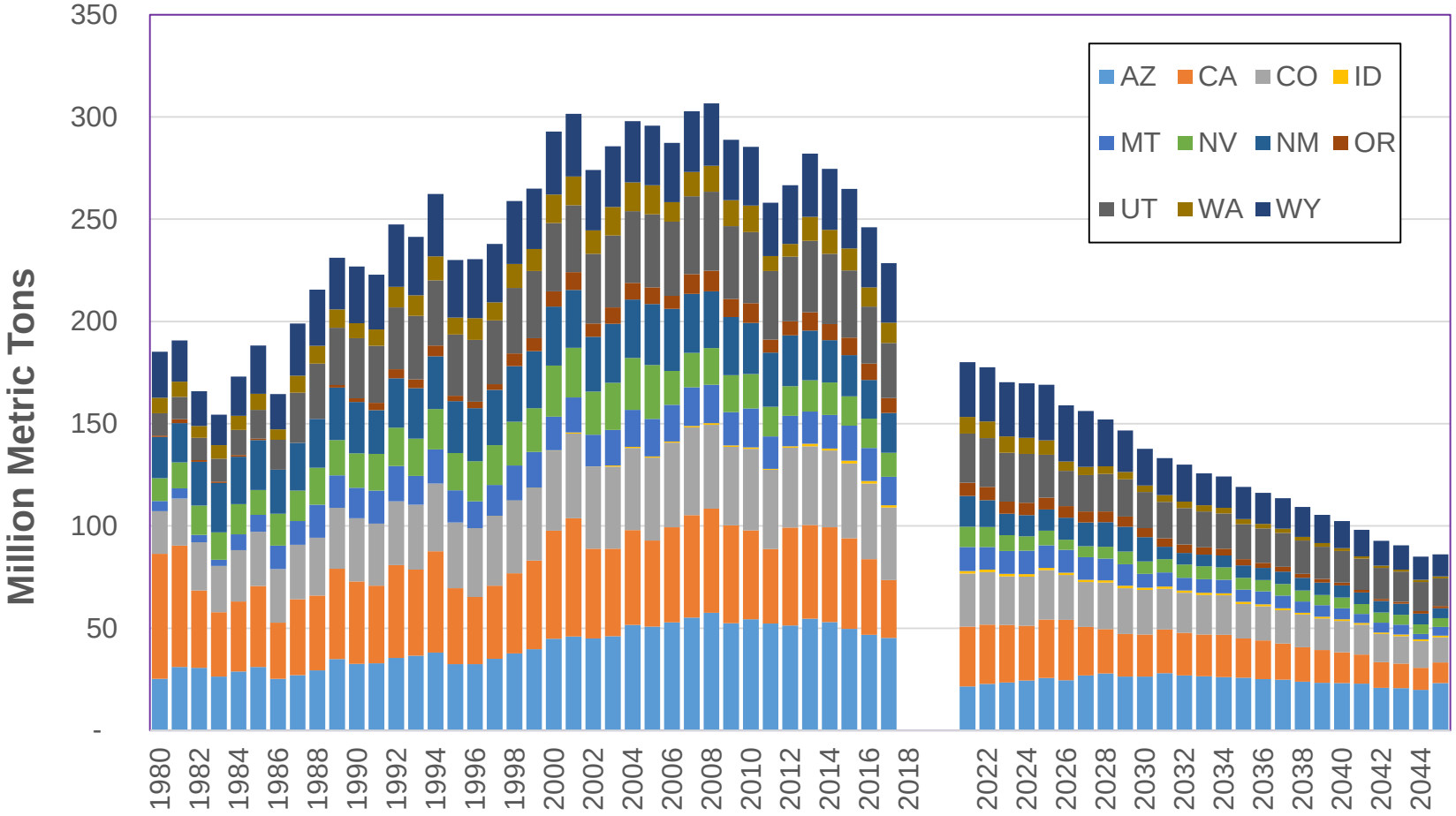
Greenhouse Gas Emissions Forecast

(US Western Interconnect Total)



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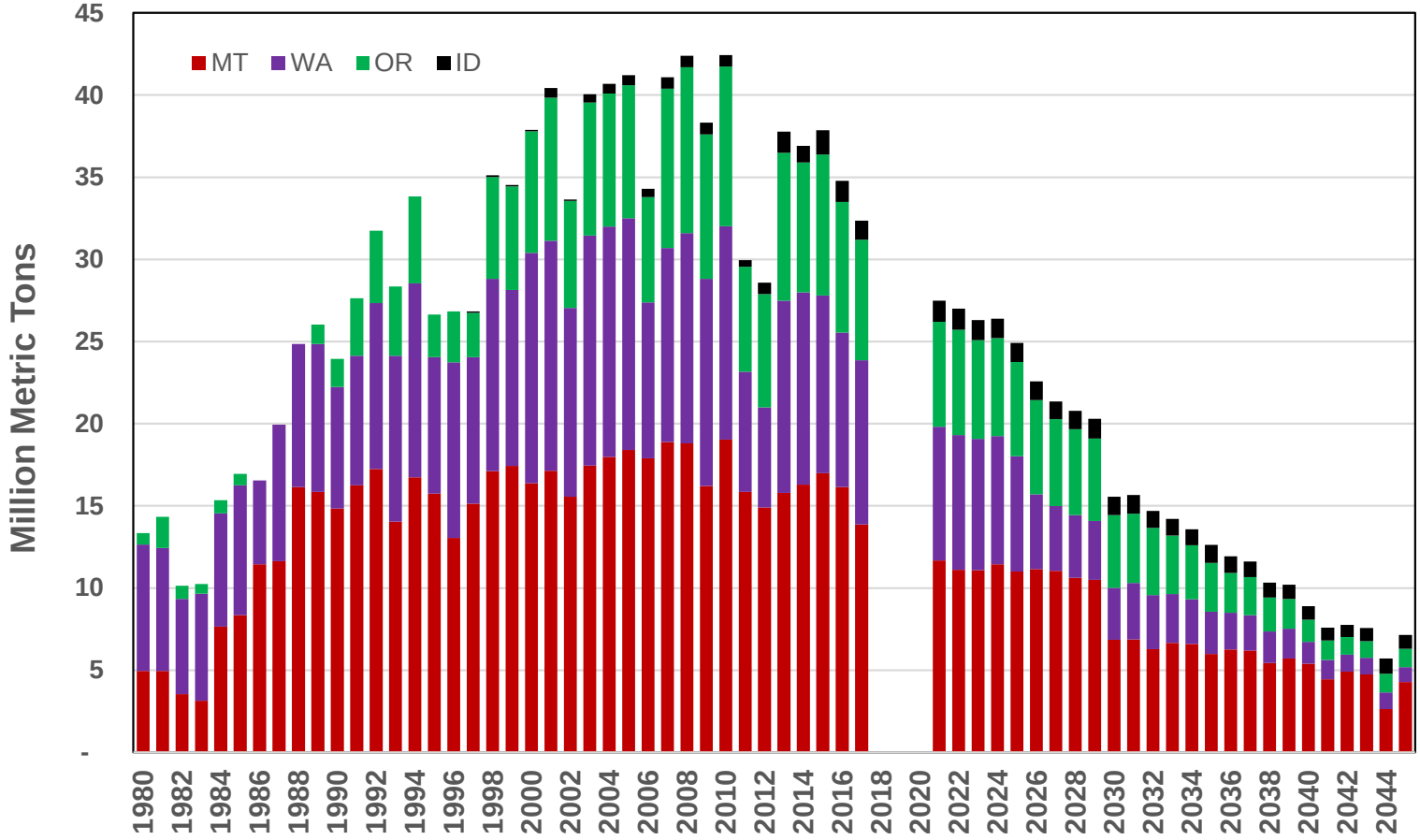
Greenhouse Gas Emissions Forecast

(Northwest- WA,OR,ID,MT)



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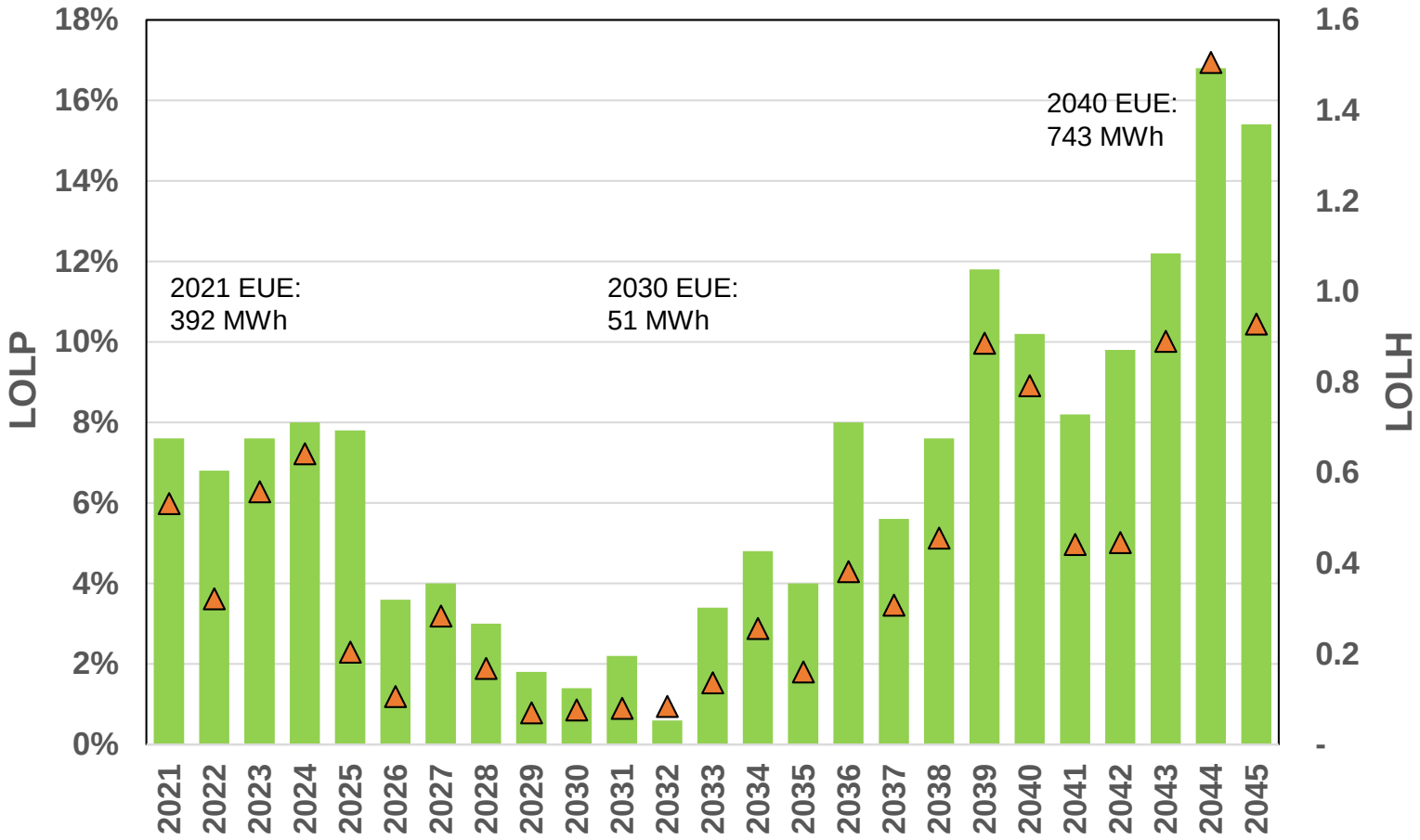
Regional Resource Adequacy

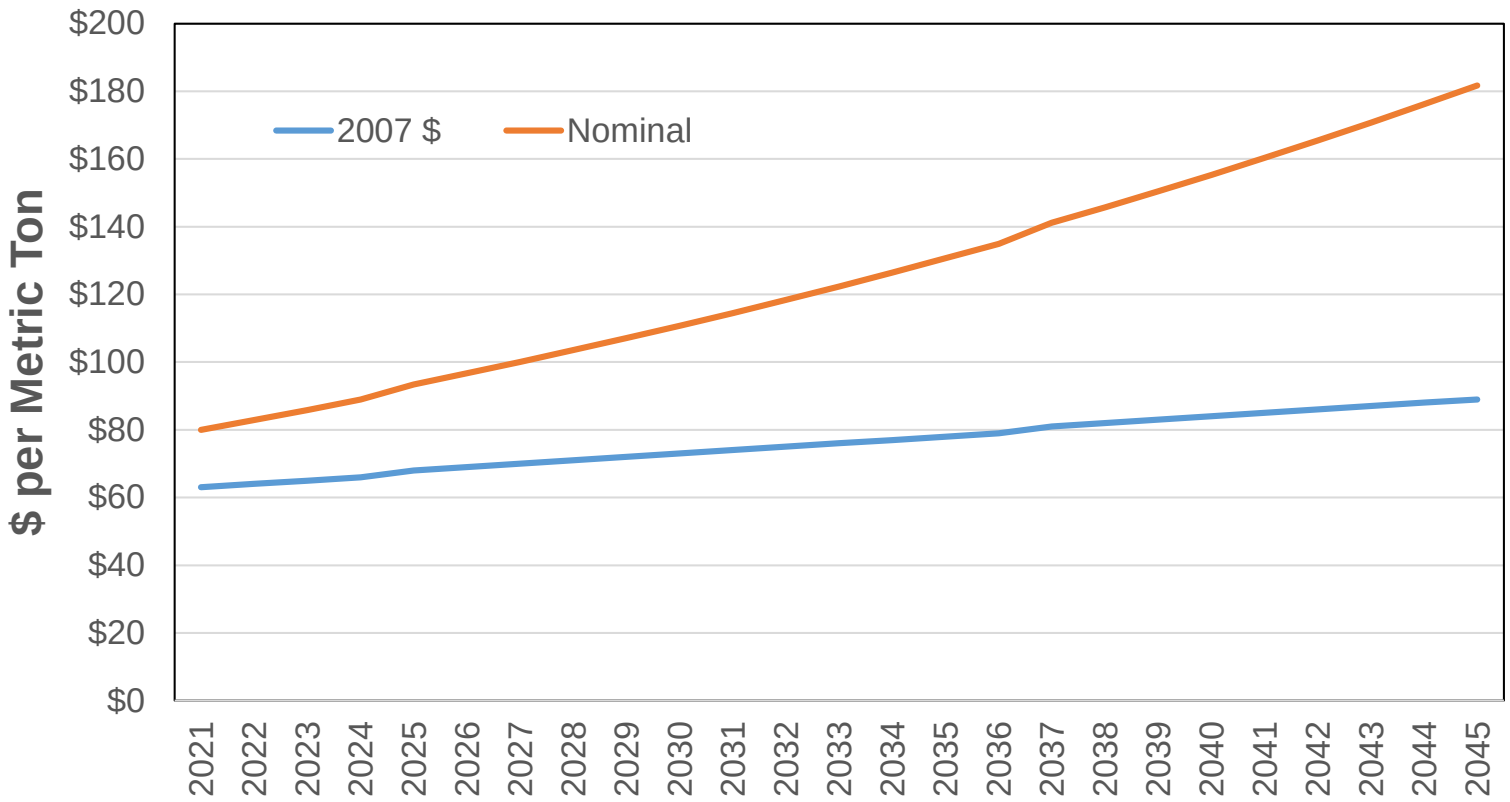


Resource adequacy results are not detailed enough to judge regional resource adequacy and are used for price forecasting only

Electric Price Forecast Scenarios

- Social Cost of Carbon in Dispatch
- No CETA resource build
- Low Natural Gas Prices
- High Natural Gas Prices

Social Cost of Carbon Price Forecast



Note: Inflation from 2007 uses CPI between 2007 and 2018, then 2% per year

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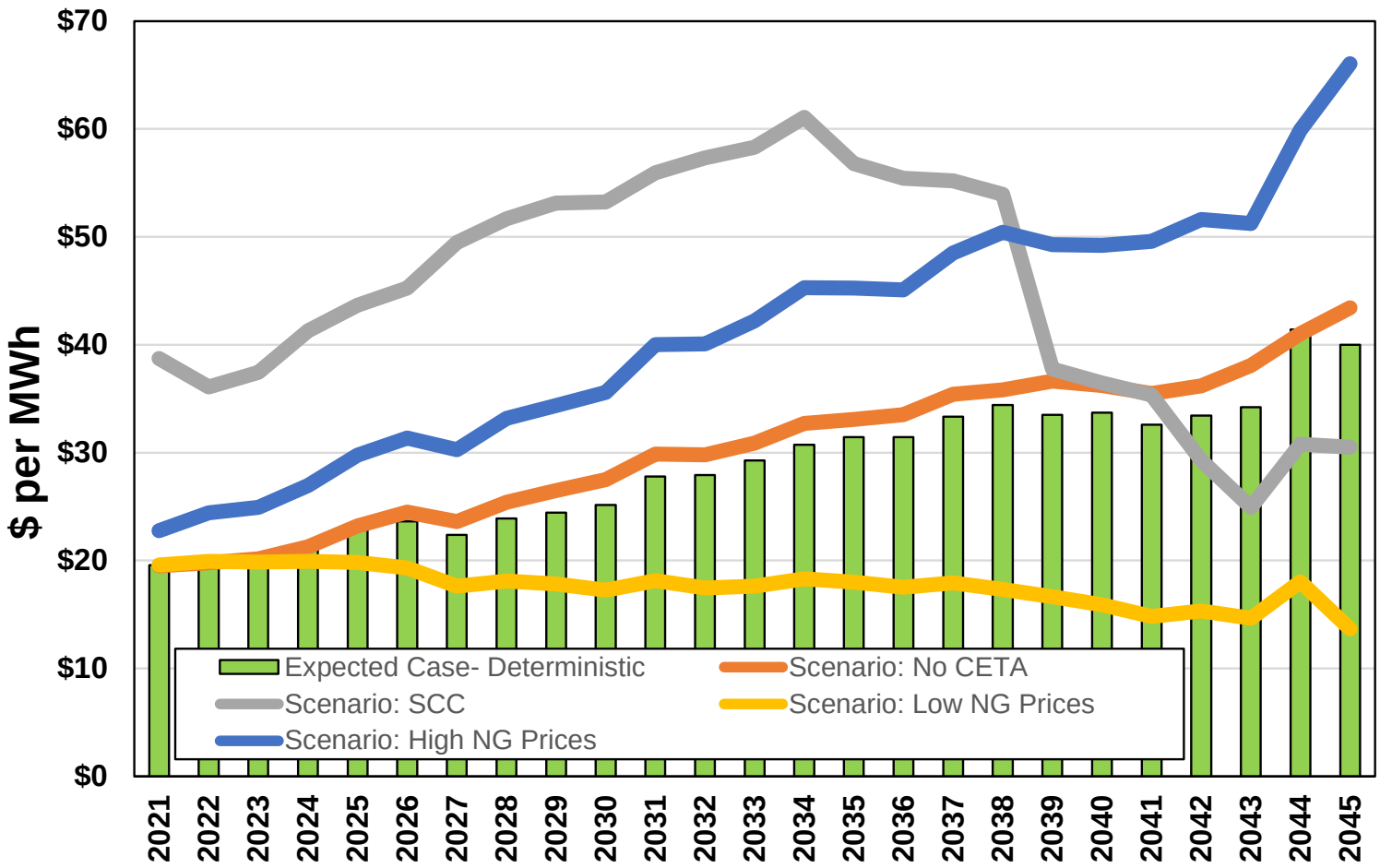
Scenario Price Forecast Results



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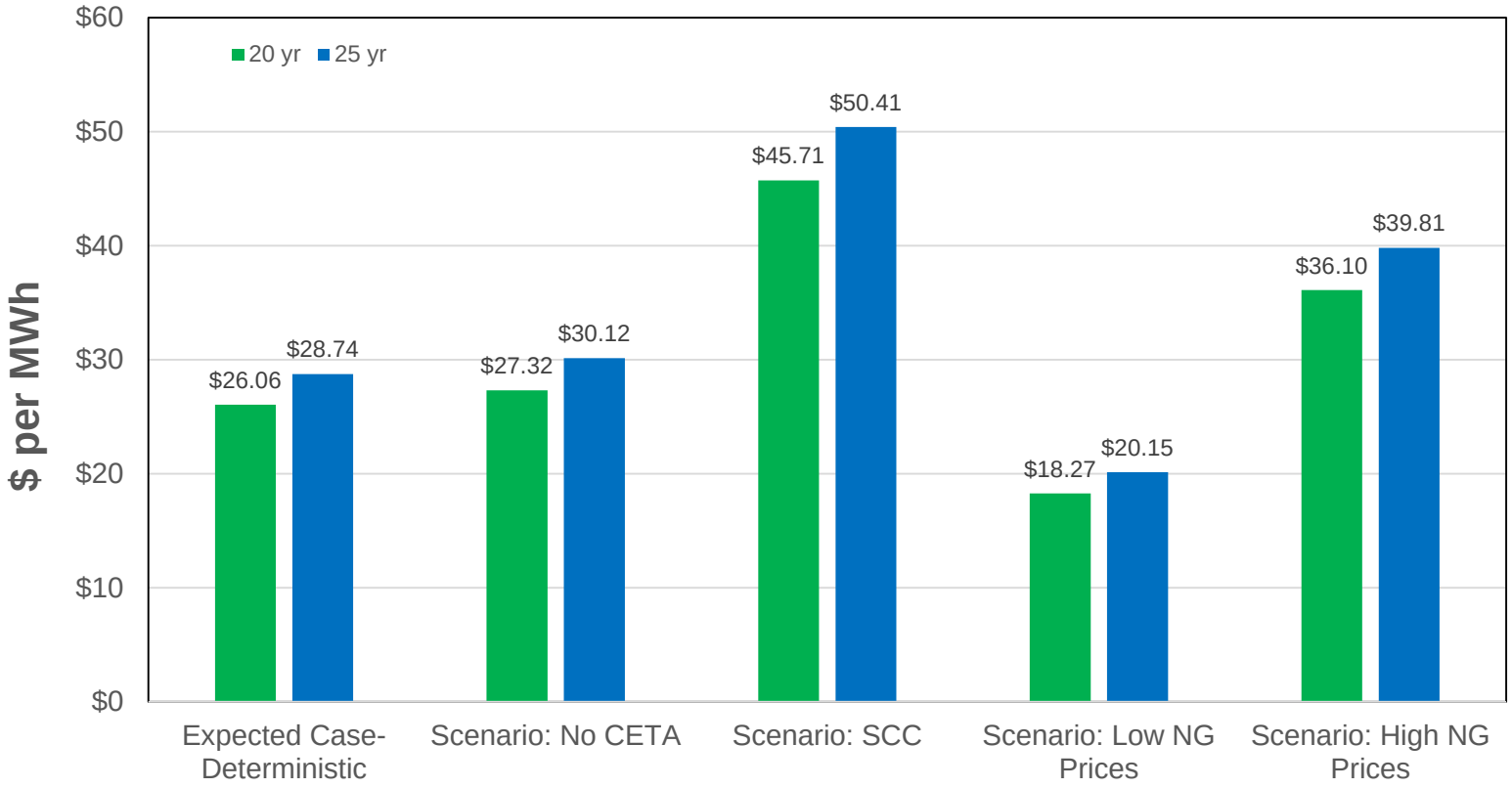
Scenario Levelized Prices



US Western Interconnect Generation Mix Forecast by Scenario (2040)

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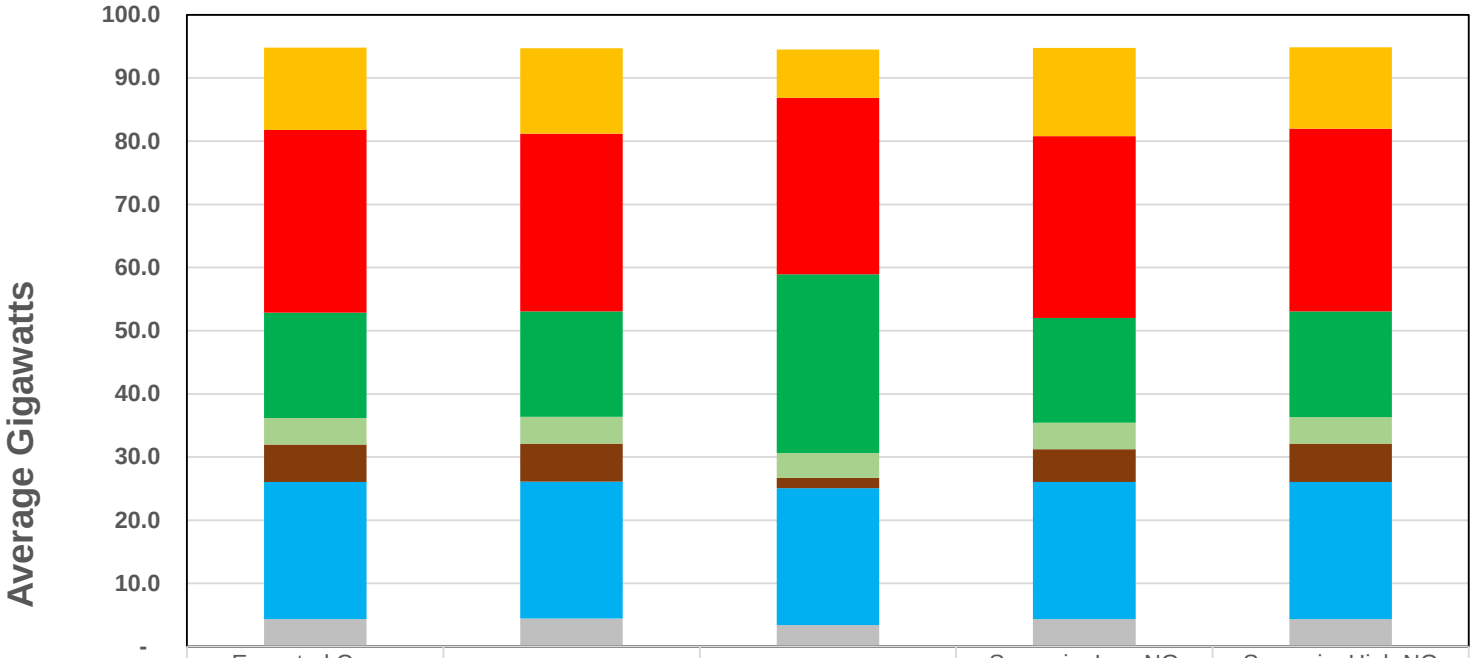

	Expected Case-Deterministic	Scenario: No CETA	Scenario: SCC	Scenario: Low NG Prices	Scenario: High NG Prices
Natural Gas	13.0	13.5	7.7	13.9	12.9
Solar	28.9	28.1	27.9	28.8	28.9
Wind	16.7	16.7	28.3	16.6	16.7
Nuclear	4.2	4.2	4.0	4.2	4.2
Coal	5.9	6.0	1.6	5.2	6.1
Hydro	21.7	21.7	21.7	21.7	21.7
Other	4.4	4.4	3.4	4.4	4.3

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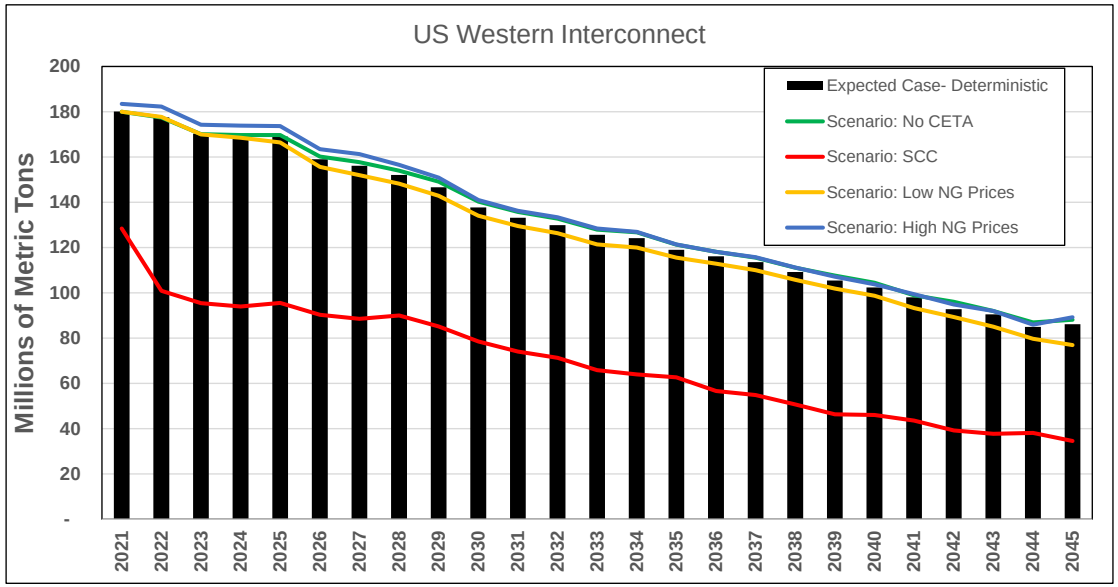
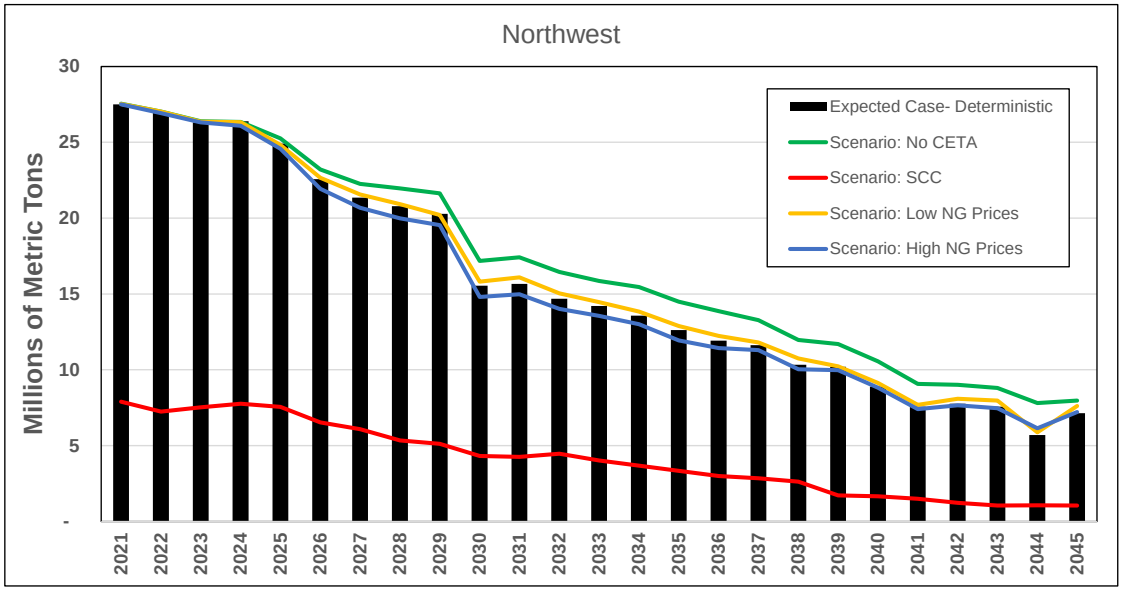
GHG Emission Forecast





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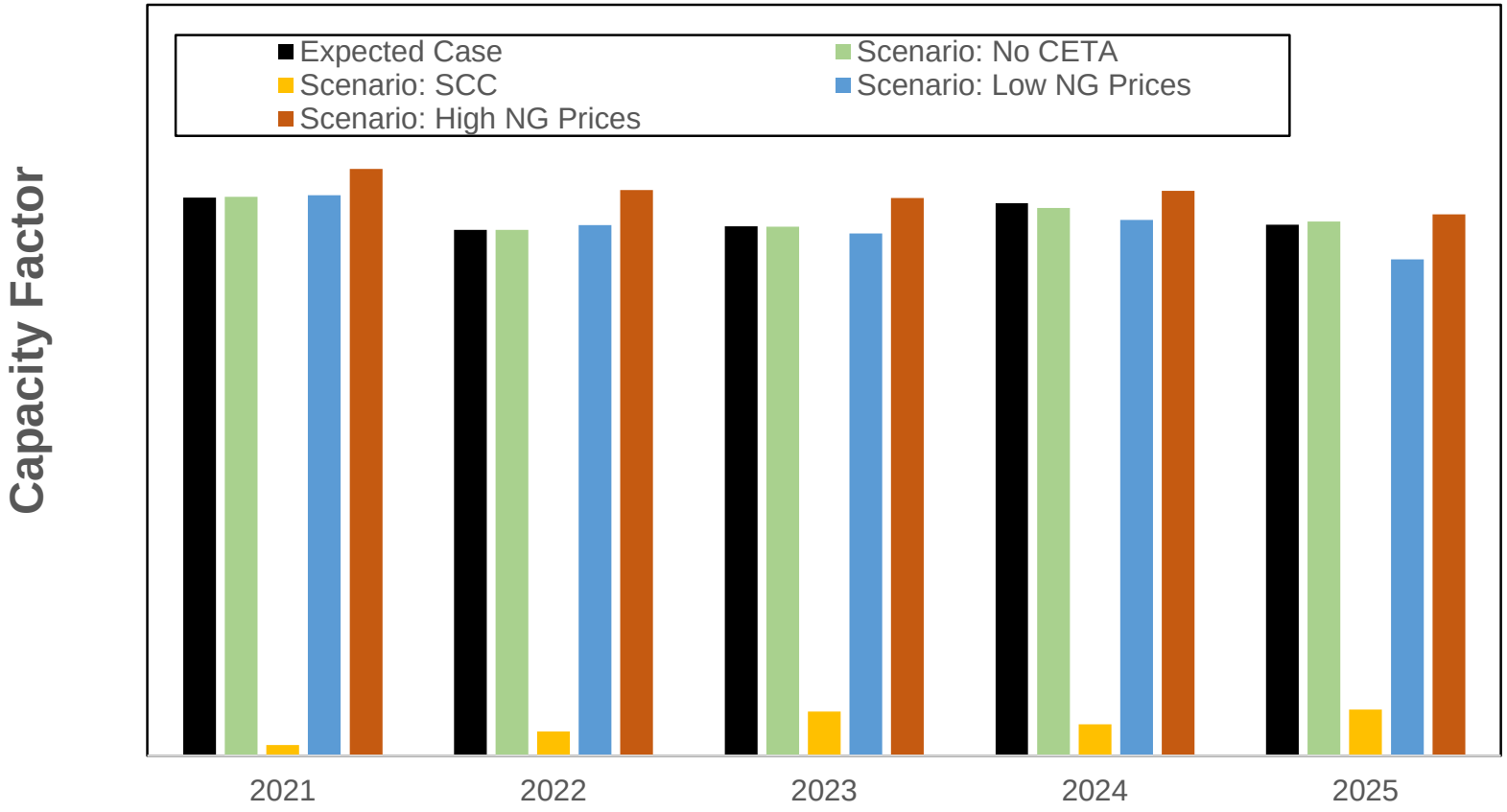
Colstrip Dispatch



Existing Thermal Resource Overview

Darrell Soyars, Manager of Corporate Environmental Compliance
John Lyons, Ph.D.
Fourth Technical Advisory Committee Meeting
August 6, 2019

Purpose

- Review major environmental regulatory programs that may impact current and future operations
- This is not intended to be a discussion or debate about past practices or current approach to achieve compliance with these programs
- Questions are welcome within the scope of this presentation

Colstrip Environmental Considerations

Colstrip Ownership Information

Colstrip Basic Data			Colstrip Ownership Percentages					
Colstrip Unit #	Size (MW)	Year Online	Avista	NorthWestern Energy, LLC	PacifiCorp	Portland General Electric	Talen Energy, LLC	Puget Sound Energy
Unit #1	333	1975	0%	0%	0%	0%	50%	50%
Unit #2	333	1976	0%	0%	0%	0%	50%	50%
Unit #3	805	1984	15%	0%	10%	20%	30%	25%
Unit #4	805	1986	15%	30%	10%	20%	0%	25%
Total	2,094		11%	11%	7%	14%	25%	32%

- Generating Units 1 and 2: 333 MW each scheduled to shut down end of 2019, required to shut down by July 2022
- Generating Units 3 and 4: 805 MW each
  - Assumed to operate until 2040, depreciation varies by owner
  - Will not be serving Washington loads after 2025

Air Quality – Montana Mercury Rule

- Program established 2010, mercury site-wide annual average below 0.9 lb/Tbtu
- Colstrip installed mercury oxidizer/sorbent injection system in 2010
- MDEQ recently concurred with our pollution equipment technology review
- Units 3 & 4 operate in the 0.8 lb/Tbtu range
- No major changes expected

Air Quality – Mercury Air Toxics Rule

Mercury Air Toxics (MATS) Rule:

- Program established 2016
- Particulate Matter (PM) used as a surrogate for air toxics
- PM site-wide 30-day rolling average below 0.030 lb/MMBtu
- PM and mercury are controlled by existing wet scrubbing equipment with injection
- Units 3 & 4 typically operate in the 0.024 lb/MMBtu range
- Both units exceeded permit limitations during second quarter testing in June 2018
- Root cause analysis led to corrective actions; reachieved compliance in September 2018
- Expect MDEQ penalty for emissions exceedances
- No major changes expected

Air Quality – Regional Haze Rule

- Program established 1999, Improve visibility in Class 1 areas
- Federal plan for Montana was vacated by courts in 2015
- NOx is controlled by LoNOx burners, Overfire air and Smartburn
- MDEQ issued progress plan in 2017, now ready to take leadership of program
- Request for Colstrip analysis due in late 2019 for next planning period
- Regional unit shutdowns would indicate that emissions are below glide path
- No changes or additional pollution controls expected

Air Quality

- Affordable Clean Energy (ACE) Rule
  - Program established 9/16/19, replacement for Clean Power Plan (CPP)
    - Reduce CO_2 emissions by Heat Rate Improvements (HRI)
    - MDEQ will determine future limitations based on evaluation of HRI technologies
    - Cost and remaining useful life consideration
    - MDEQ must submit plan by July 2022, unit compliance by 2024
    - Impacts are unknown at this time

Water Use

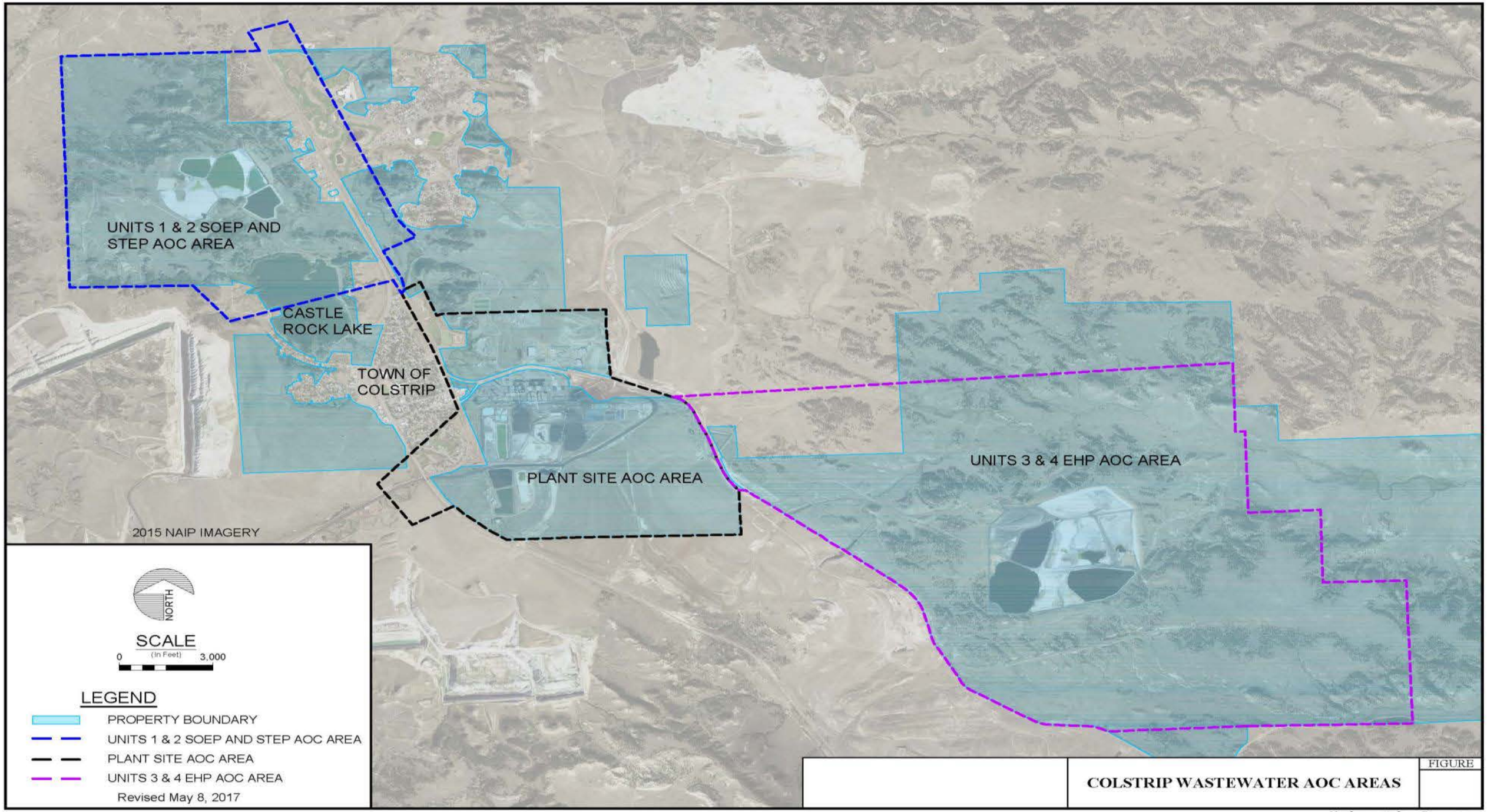
- Raw water is withdrawn from the Yellowstone River to Castle Rock Lake (a.k.a., the Surge Pond) via a 29-mile long pipeline.
- From the Surge Pond, water is piped to holding tanks at the Plant Site for use in boilers, cooling towers and scrubber systems.
- Fly ash from the scrubber system is transported to paste plants which remove excess water and deposit paste in disposal cells.
- Bottom ash is transported to holding ponds, dewatered, and then transported to disposal cells for evaporation.
- Clearwater from paste plants and dewatering is recirculated for reuse.
- All water is reused or lost through evaporation - Zero discharge facility.

Three Storage Areas

- The *Plant Site* contains Generating Units 1 through 4 and several associated ponds (Avista share)

- The *Units 3 & 4 EHP* contains several ponds for the disposal of fly ash scrubber slurry/paste from Generating Units 3 and 4, and bottom ash from Generating Units 1 through 4, and is located approximately 2.5 miles southeast of the Plant Site. (Avista share)

- The *Units 1 & 2 SOEP/STEP* contains several ponds for the disposal of fly ash scrubber slurry/paste from Generating Units 1 and 2, and is located approximately 2 miles northwest of the Plant Site. (No Avista share)



FIGURE

COLSTRIP WASTEWATER AOC AREAS

UPDATE TIME: 8:50 AM
JBERGIN\BIL\20170508\I:\LAND PROJECTS\TALEN\1207116\1207116B006.DWG

Hydrometrics, Inc.
Consulting Scientists and Engineers

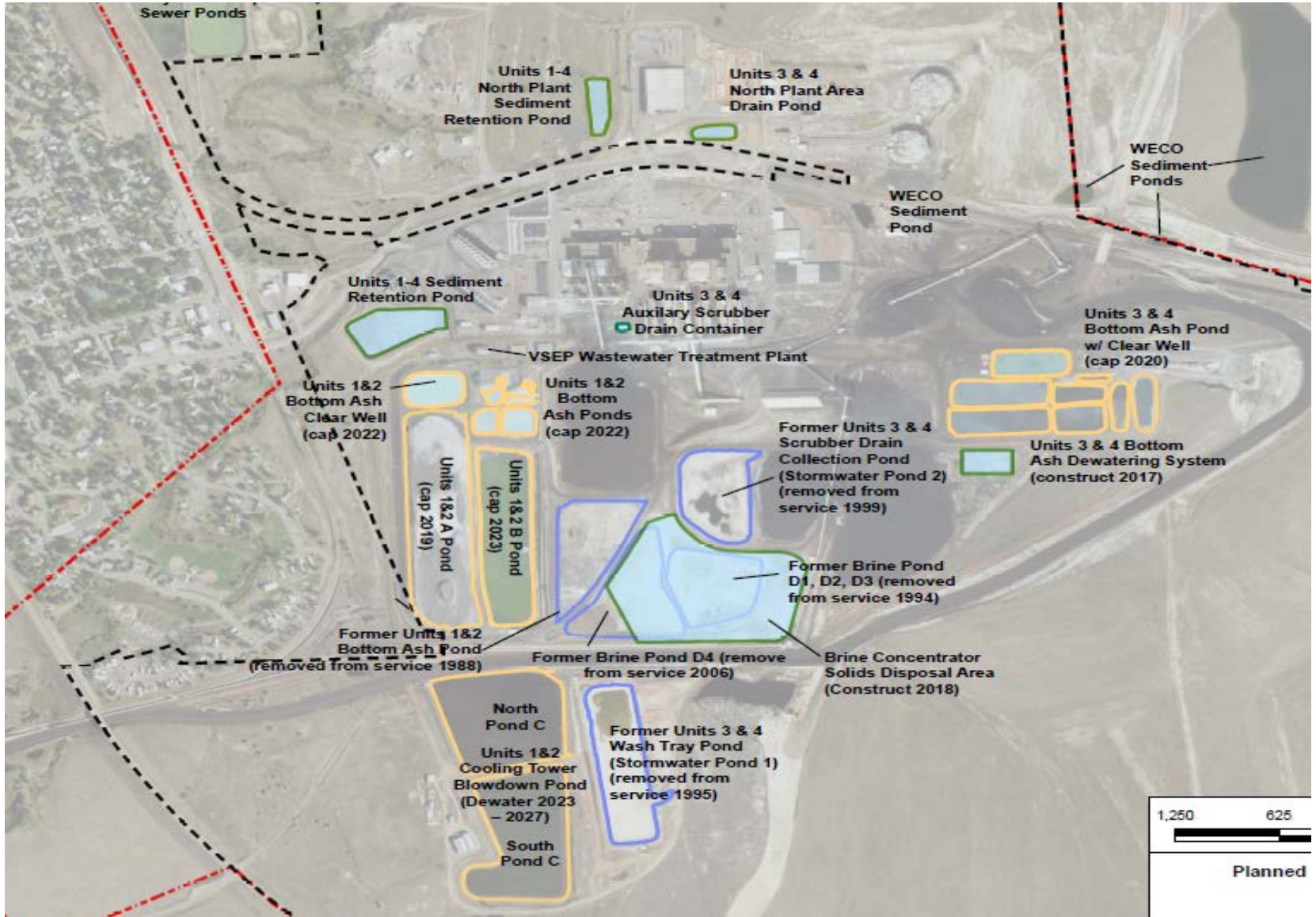
Management Drivers

- Regulatory programs
  - The Site Certificate originally issued including the amended 12(d) stipulation under the Major Facility Siting Act in Montana, Nov. 1975.
  - Administrative Order on Consent (AOC) Regarding Impacts Related to Wastewater Facilities, MDEQ (July 2012), Settlement agreement entered (2016).
  - Federal Coal Combustion Residual (CCR) Rule, 40 Code of Federal Regulations (CFR), April 2015.
- Operational facility
  - Units 1 and 2 announced early shutdown at the end of 2019.
  - Units 3 and 4 must maintain on-going operations
  - Convert to dry ash storage by the end of 2022.

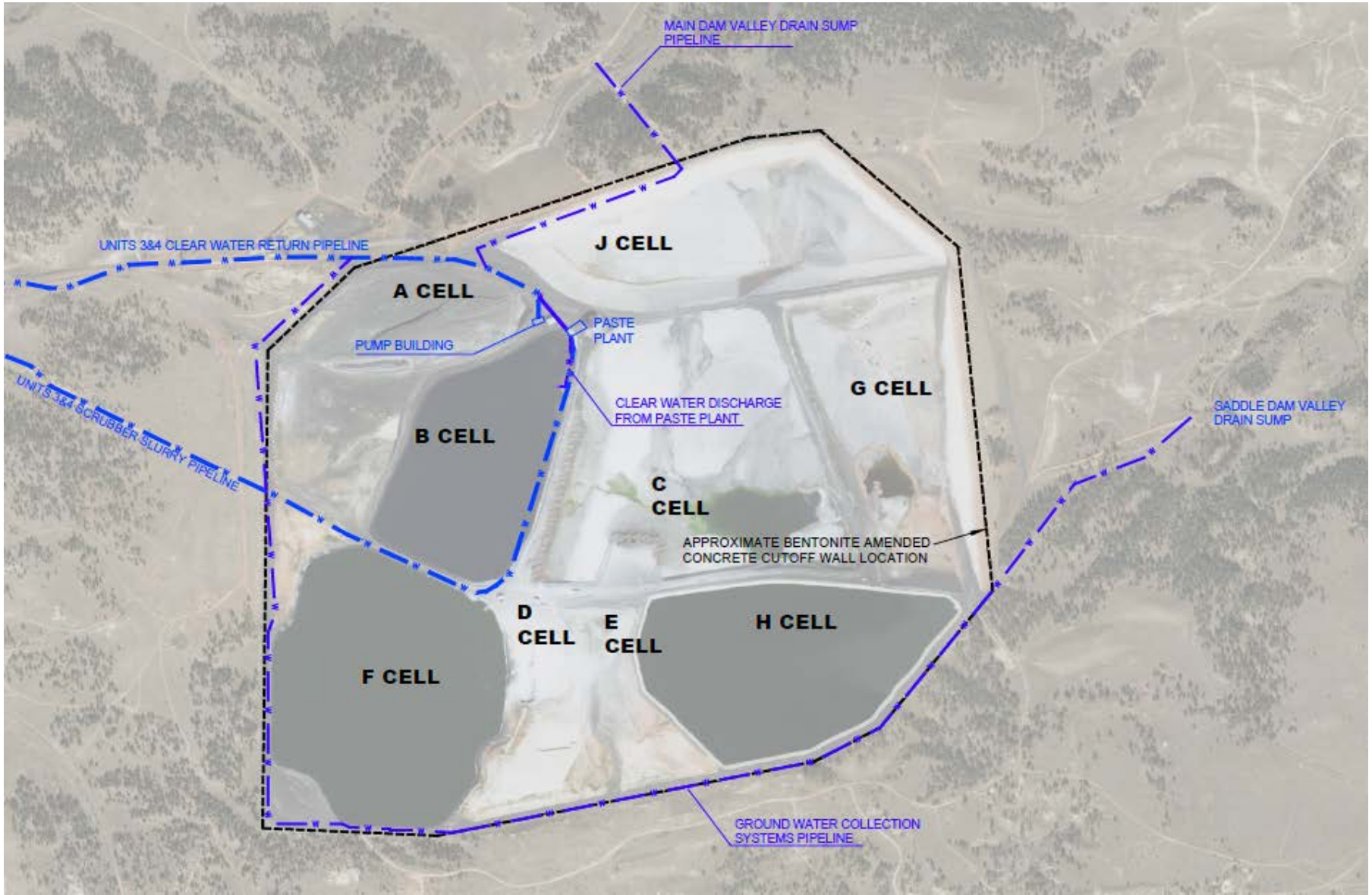
Strategic Water Planning

- Master Plan originally developed in November 2015, Executive Summary (Sept. 2016) is available on MDEQ-AOC website:
- http://deq.mt.gov/DEQAdmin/mfs/ColstripSteamElectricStation
- AOC public process will select actions to be performed and requires Financial Assurance (FA) of approved plan amounts.
- AOC Process>Site Characterization>Cleanup Criteria and Risk Assessment>Remedy Evaluation>Implement the selected remediation
- CCR Requirements tracking:
- https://www.talenenergy.com/generation/fossil-fuels/ccr-colstrip

Plant Site Ponds



Colstrip Units 3 & 4 Evaporative Ponds



Major Water Activities

- Must remove Boron, Chloride and Sulfate in groundwater
- Achieve source control
  - Close existing ash storage ponds
  - Build water treatment system
  - Dry ash storage
- Install and operate groundwater treatment system
- Achieve clean-up criteria
- Must take place regardless of plant operation

Avista's Financial Assurance Share

- Plant Site area
  - Remedy Plan – $5,841,000 posted 12/21/18
  - Closure Plan – $383,713 posted 2/1/19
- Units 3 & 4
  - Remedy Plan – currently under review, expected late 2019
  - Closure Plan – $6,793,050 posted 2/1/19
- Annual bond reconciliation required

Colstrip Fuel Contract

- Coal supplier has emerged from bankruptcy and agreed to honor the current contract, which ends 12/31/19
- New contract is being negotiated and results will be used to model Colstrip in this IRP

Modeled Colstrip Costs

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Fixed O&M	10.3	9.4	9.7	10.1	11.2					
Coal Combustion Residuals O&M	0.4	0.6	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Existing Capital Revenue Requirement – WA	12.1	11.3	10.5	9.8	9.1	0.4				
Existing Capital Revenue Requirement – ID	5.9	5.5	5.1	4.8	4.5	4.2	3.9	0.2		
Traditional Capital Spending (Expensed)	9.4	3.2	4.2	9.5	6.4					
Asset Retirement Obligation Capital Revenue Requirement	1.7	1.7	1.6	1.6	1.5	1.5	1.4	1.4	1.3	1.3
Coal Combustion Residuals Master Plan Capital Revenue Requirement	0.5	0.6	0.9	1.1	1.1	1.0	1.0	1.0	0.9	0.9
Total	**40.3**	**32.3**	**32.9**	**37.8**	**34.7**	**8.0**	**7.2**	**3.5**	**3.1**	**3.1**

Table does not include fuel and variable O&M costs

Coal Combustion Residuals O&M and Master Plan Capital Revenue Requirement, and Asset Retirement Obligation Capital Revenue Requirement continue through 2045

Lancaster Power Purchase Agreement

- Current PPA ends in October 2026
- Directly connect to either AVA or BPA transmission system
- Avista controls firm GTN transportation rights
- This IRP will evaluate an extension of this contract

Thermal Plant Book Value and Remaining Depreciation

Thermal Plant	Book Value (millions)	Remaining Life (years)
Boulder Park	$ 17.4	20
Colstrip Units 3 and 4	$ 121.4	See Note
Coyote Springs 2	$ 124.8	21
Kettle Falls CT	$ 3.7	24
Northeast	$ 0.6	<2
Rathdrum	$ 36.5	14

- This table includes land, total generation and transmission/interconnection
- Remaining life is for the generation, transmission may differ
- Numbers are from the end of 2018 and may change as pieces depreciate or new capital is added
- Colstrip modeling will use a 2025 for Washington and 2027 for Idaho

2020 Electric IRP
Final Resource Need Assessment

John Lyons, Ph.D.
Fourth Technical Advisory Committee Meeting
August 6, 2019

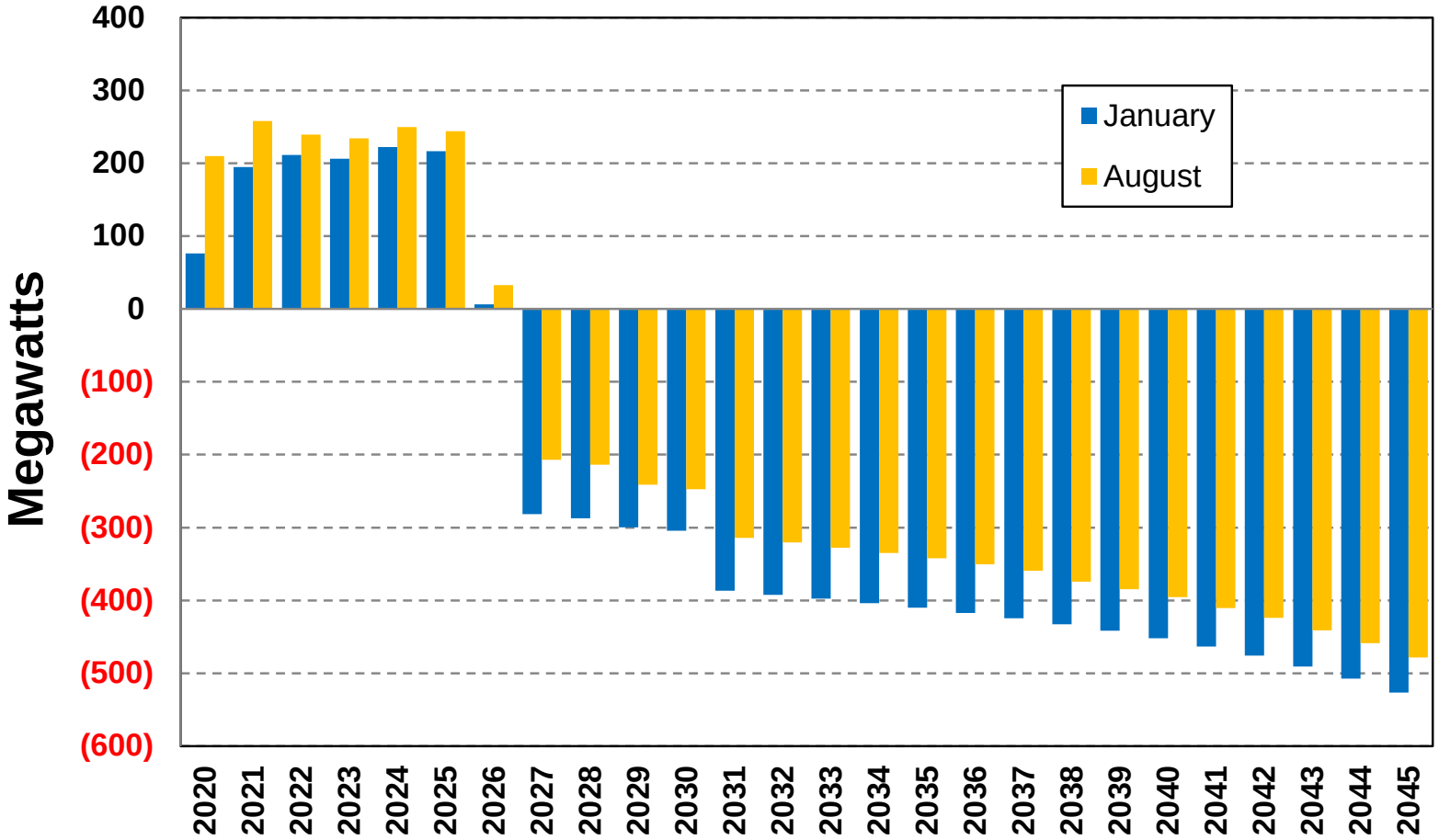
Agenda

- 2020 IRP Load & Resource Balance
- Avista's Clean Energy Goals
- Energy Independence Act Renewable Requirement Forecast
- Clean Energy Transformation Act Forecast

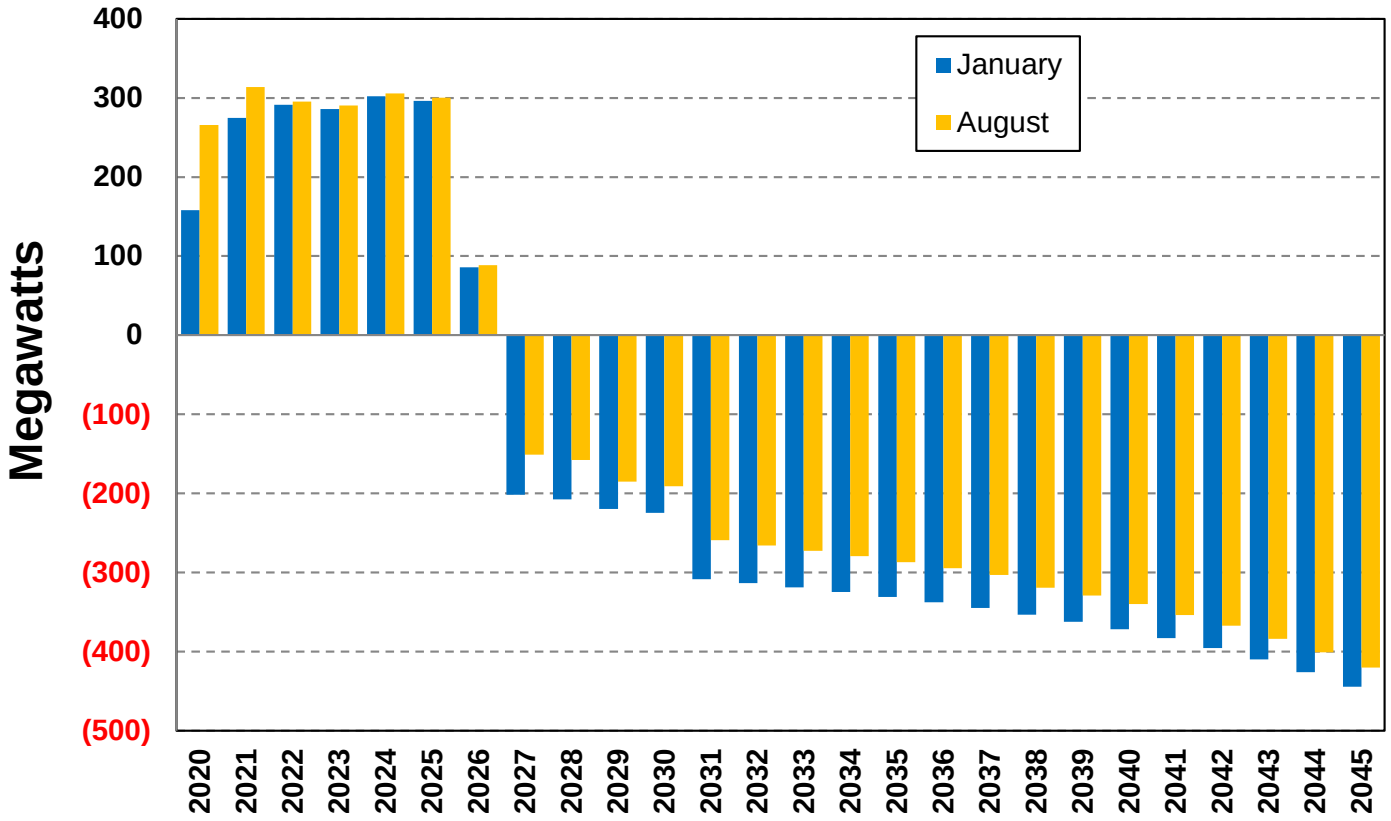
Load & Resource Methodology Review

- Sum resource capabilities against loads
- Resource plans are subject to 5% LOLP analysis – determines planning margins
- Capacity
  - Planning Margin (14% Winter, 7% Summer)
  - Operating Reserves and Regulation (~8%)
  - Reduced by planned outages for maintenance
  - Plant to largest deficit months between 1- and 18-hour analyses
- Energy
  - Reduced by planned and forced outages
  - Maximum *potential* thermal generation over the year
  - 80-year hydro average, adjusted down to 10th percentile

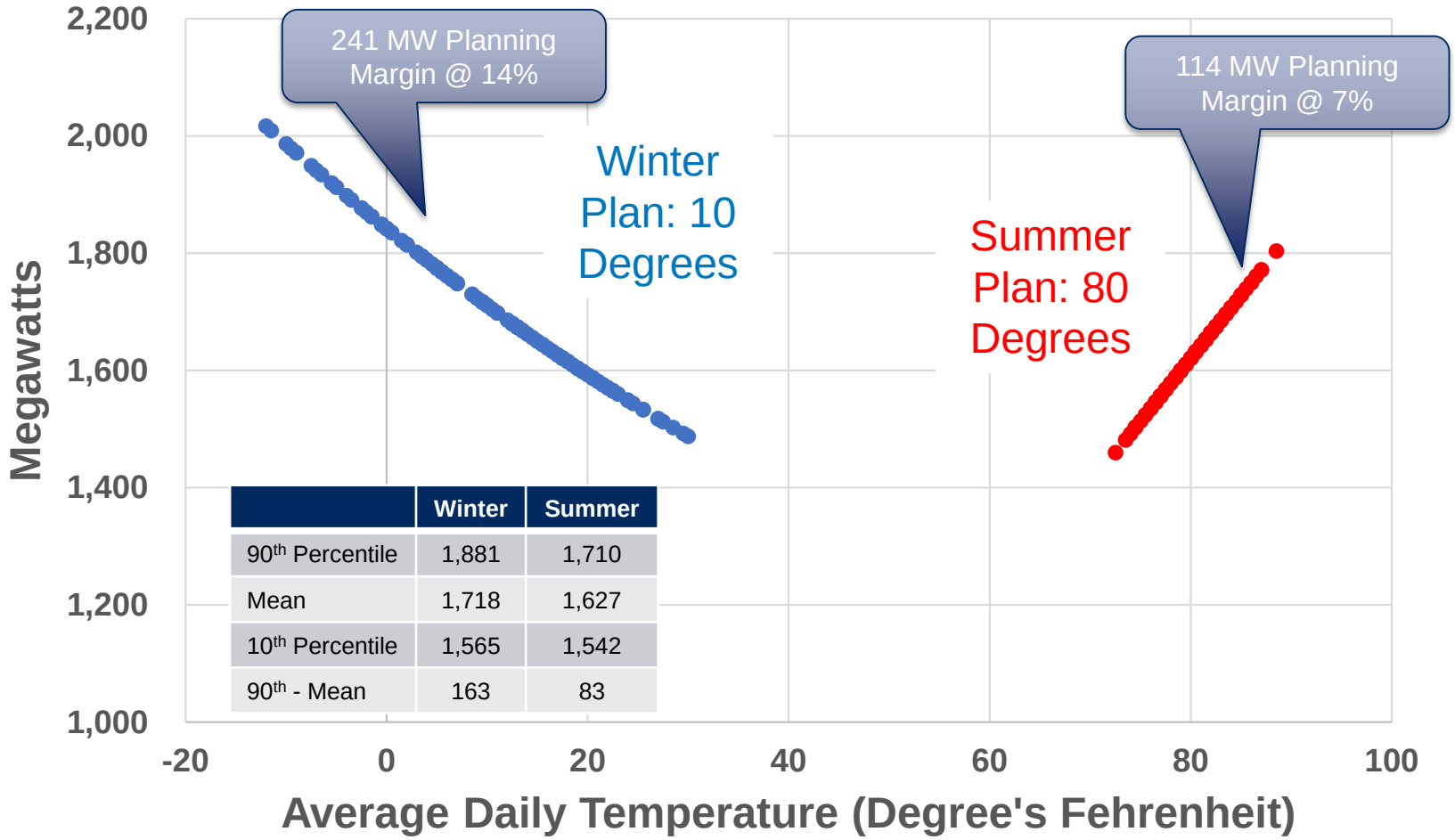
One Hour Peak Load & Resource Position



18-Hour Sustained Peak L&R

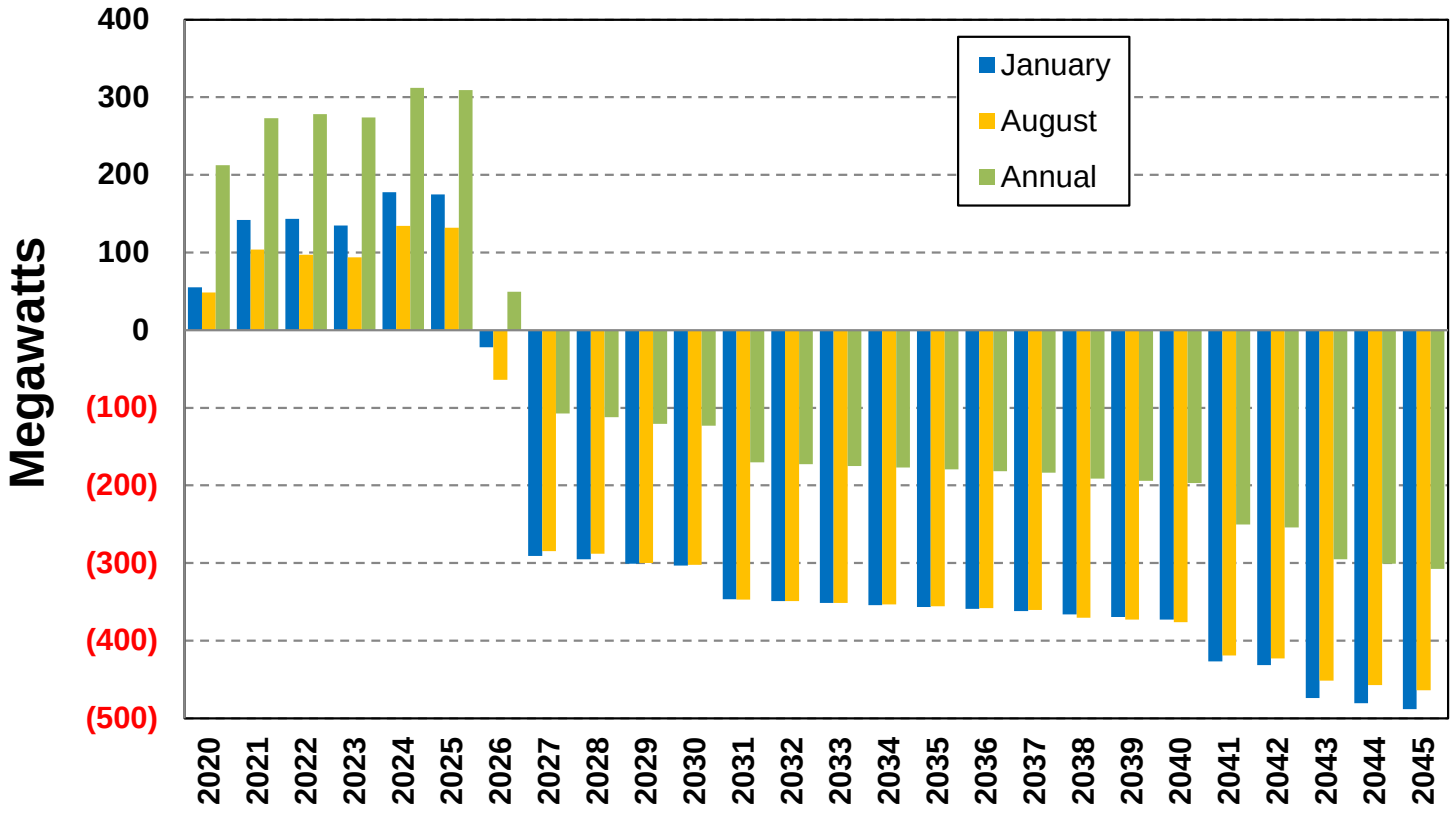


Load Variability (Temperature Variation)



	Winter	Summer
90th Percentile	1,881	1,710
Mean	1,718	1,627
10th Percentile	1,565	1,542
90th - Mean	163	83

Energy Load & Resource Position



Avista's Clean Energy Goal

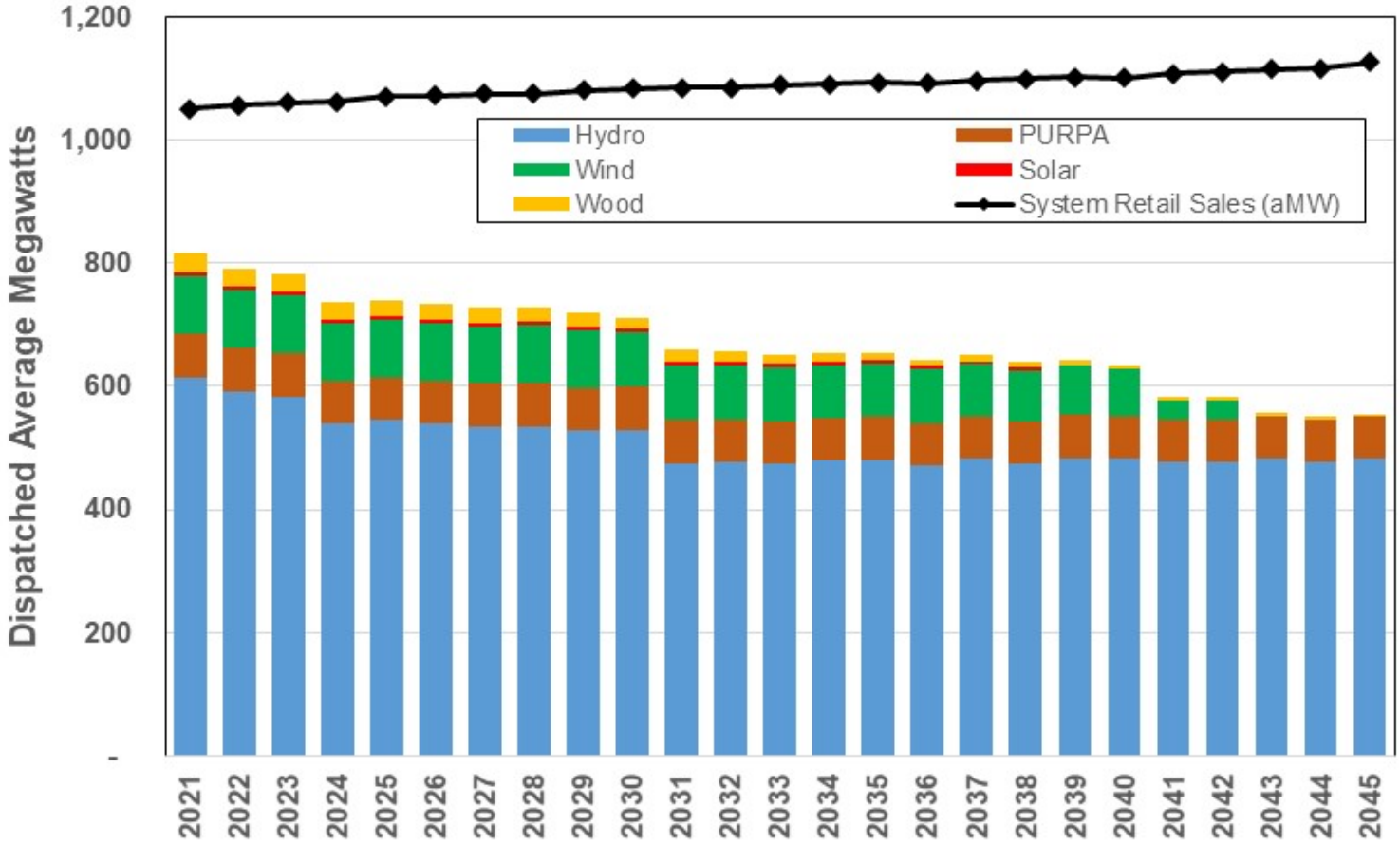
Goals

- 2027 – 100% carbon-neutral
- 2045 – 100% clean electricity

How we will get there

- It's not just about generation – various solutions are necessary
- Maintain focus on reliability and affordability
- Natural gas plays an important part of a clean energy future
- Cost effective technologies need to emerge and mature

Avista Corporate Clean Energy Goals

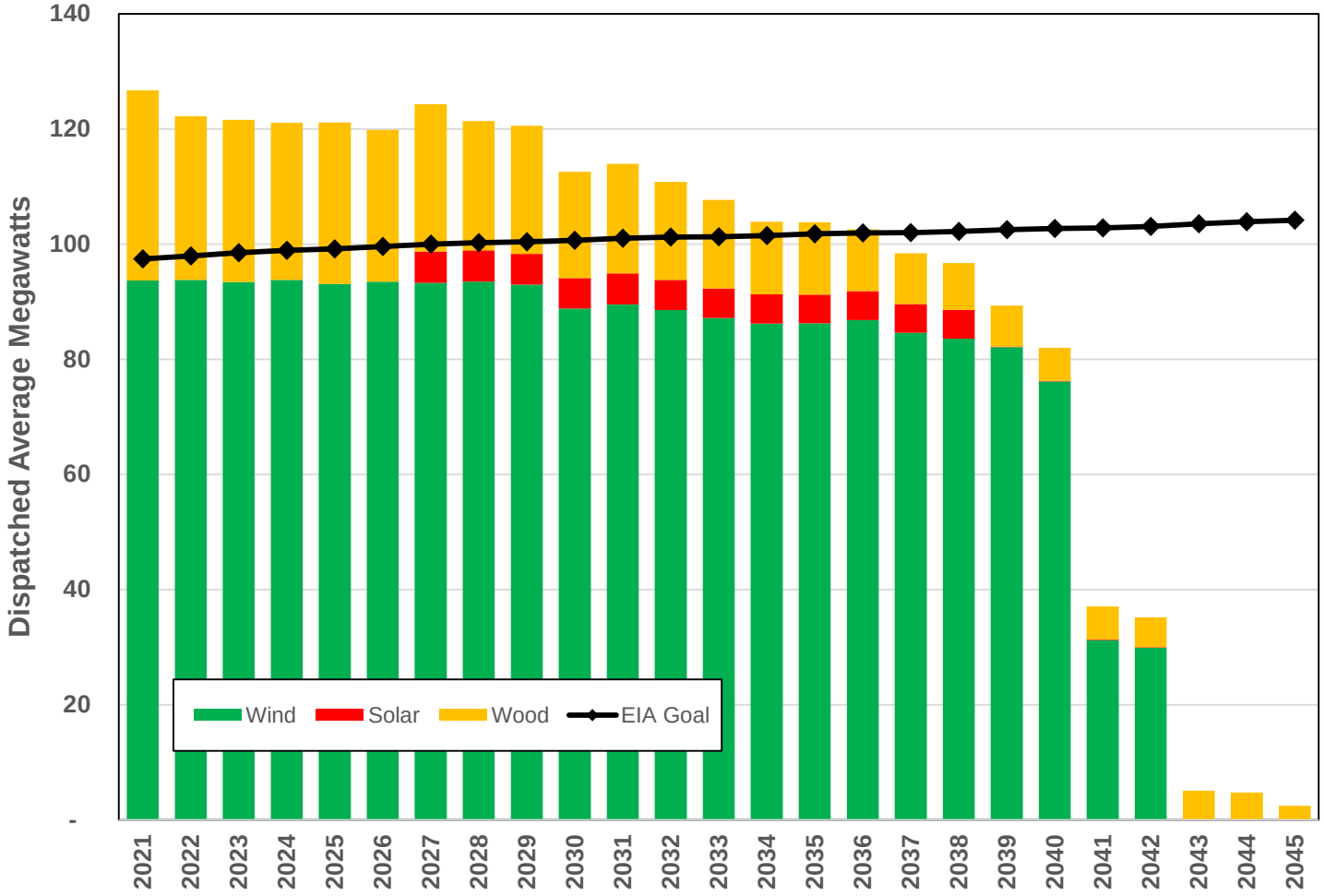


Washington State Clean Energy Goals

- Energy Independence Act or Initiative 937
  - 15% of Washington retail load after 2020
  - Qualifying resources less any forward sales obligations
  - Banking provisions mitigate year-to-year variation
  - Addition of qualifying BPA and Wanapum, which are not included in the chart. Will update when amounts are known.

- Clean Energy Transformation Act

Washington Energy Independence Act



Avista's Washington CETA Goals