Impacts of BP-18 Southern Intertie Rate Increase

BP-20 Workshop – July 25, 2018

Presented by Northern California Utilities

Sacramento Municipal Utility District, Transmission Agency of Northern California, and Turlock Irrigation District

Background

- Hourly southbound transmission rate on Southern Intertie increased by about 270% in October 2017:
  - BP-16 rate: $3.53/MWh
  - BP-18 rate: $9.56/MWh

- Analyses undertaken in 2018
  - Relying on models that BPA itself uses to set rates
  - Impacts on market-clearing energy prices in California and the Northwest
  - Impacts on BPA's firm power rates in the Northwest

Analyses

- Market-clearing energy prices at NP-15, SP-15, Mid-C, Palo Verde
  - With and without increase in hourly transmission rate
  - ***Using AURORAxmp: BPA's market price forecast model***
  - "AURORAxmp® is a widely used, reliable, and transparent tool relied on by hundreds of clients globally to forecast energy prices. As such, forecasts produced by AURORAxmp® provide for a reasonable projection of secondary energy revenue for BPA." (BP-18-E-BPA-20, p. 3)
- Recalculation of Priority Firm Tier 1 rate (PF-1)
  - Adjust prices at Mid-C for BPA's secondary energy sales, balancing transactions, augmentation purchases, and firm surplus sales
  - Adjust CAISO revenue credit, using BPA's methodology
  - ***Using RAM2018: BPA's rate calculation model***
- Estimation of the impact on the PF-1 rate
- Comparison of rate impact with risk of Southern Intertie cost underrecovery

BPA's Reliance on Aurora Price Forecasts

- Spot market energy price forecasts are used by BPA for several purposes:
  - Secondary energy sales revenue credit;
  - Firm surplus sales revenue credit;
  - Augmentation purchase costs;
  - Load balancing costs;
  - Energy export revenue credit.
  - And more (see BP-18-FS-BPA-04, pp. 1-2 for a longer list)
- BPA is overall "net long" on an annual basis, so *higher* Mid-C prices lead to *higher* revenue credits and a *lower* PF rate, *but also vice versa*
- Did the transmission rate increase affect revenue credits and thus the PF rate?

Aurora Analysis: Metrics

- Daily/hourly spot clearing prices at major trading hubs in the WECC, including Mid-C, NP-15, SP-15, and Palo Verde;
- Daily and monthly volumes of energy transacted at each hub;
- Changes in generation dispatch across the West (specific units to be identified); and
- Changes in emissions across the West (aggregated);
- One-year snapshot only; no retirements and no new generation added.

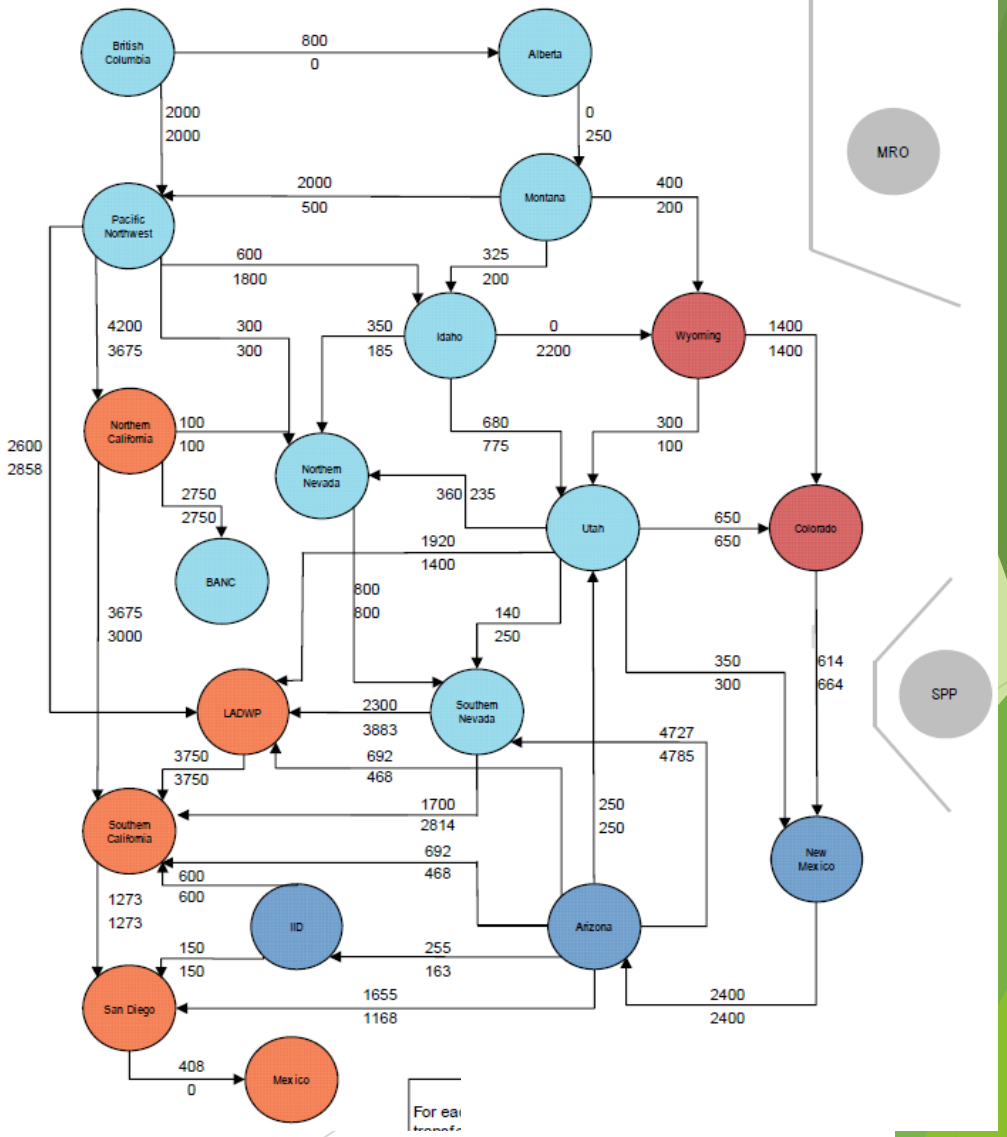
WECC Summer Zonal Topology Diagram

Source: 2016 Power Supply Assessment released by WECC in December 2016.

WECC's Assessment aggregates BA-based load and resource forecasts into geographic sub-regions, with conservative (i.e., low) power transfer capability limits between the sub-regions that reflect normal operating limits.

Aurora uses the WECC topology.

Legend
For each transfer limit, the top number is the transfer capability (MW) in the direction of the arrow. The bottom number is the transfer capability in the opposite direction of the arrow.



Aurora's Use of Hurdle Rates

- Aurora meets load across the WECC at the lowest cost by finding the least-cost combination of generation to meet load.
- Hurdle rates help determine if resources can economically provide power to a neighboring zone or zones. Hurdle rates are added to a generator's dispatch cost and the zone is evaluated as a potential resource to serve a neighboring zone's load. If the clearing price for the destination zone is higher than the sum of the clearing price in the zone where the resource is located plus the hurdle rate, Aurora dispatches the resource to the neighboring zone. Such dispatch continues up to transmission limits.
  - For example, if Zone A has energy available at $20/MWh and Zone B can provide its own power at $22/MWh, then power will be transferred from A to B over a line with a $1/MWh hurdle rate, yielding Zone A and Zone B prices of $20/MWh. If the hurdle rate increases to $3/MWh, then the generator in Zone A cannot economically export to Zone B.
- Hurdle rates are collected by WECC from transmission owners and BAs and used in production cost modeling.

Hurdle Rates in WECC's Common Case

Table 2. 2026 Interregional Hurdle Rates (2016$)

From	To	Direction		From	To	Direction	
		→	←			→	←
AB_AESO	BC_BCHA	$2.14	$7.11	SW_AZPS	CA_CISO	$3.95	$10.98
AB_AESO	NW_NWE+	$2.14	$4.74	SW_AZPS	CA_IID	$3.95	$3.32
NW_AVA	NW_BPAT+	$2.53	$1.91	SW_AZPS	CA_LDWP	$3.95	$5.84
NW_AVA	NW_PACW	$2.53	$3.08	SW_AZPS	SW_PNM	$3.95	$4.16
NW_AVA	NW_PGE	$2.53	$2.53	SW_AZPS	SW_SRP	$3.95	$2.08
NW_BPAT+	BC_BCHA	$1.91	$7.11	SW_AZPS	SW_TEPC	$3.95	$3.57
NW_BPAT+	CA_BANC+	$1.91	$2.53	SW_AZPS	SW_WALC	$3.95	$1.91
NW_BPAT+	CA_CISO	$1.91	$10.98	SW_NVE	CA_CISO	$6.96	$10.98
NW_BPAT+	CA_LDWP	$1.91	$5.84	SW_NVE	CA_LDWP	$6.96	$5.84
NW_BPAT+	NW_PACW	$1.91	$3.08	SW_NVE	SW_WALC	$6.96	$1.91
NW_BPAT+	NW_PGE	$1.91	$2.53	SW_PNM	SW_EPE	$4.16	$4.16
NW_BPAT+	NW_PSEI	$1.91	$2.53	SW_PNM	SW_WALC	$4.16	$1.91
NW_BPAT+	SW_NVE	$1.91	$6.96	SW_SRP	CA_CISO	$2.08	$10.98
NW_NWE+	BS_PACE	$4.74	$3.08	SW_SRP	SW_TEPC	$2.08	$3.57
NW_NWE+	NW_AVA	$4.74	$2.53	SW_SRP	SW_WALC	$2.08	$1.91
NW_NWE+	NW_BPAT+	$4.74	$1.91	SW_TEPC	SW_EPE	$3.57	$4.16
NW_NWE+	RM_WACM	$4.74	$4.98	SW_TEPC	SW_PNM	$3.57	$4.16
NW_PACW	CA_CISO	$3.08	$10.98	SW_WALC	CA_CISO	$1.91	$10.98
NW_PACW	NW_PGE	$3.08	$2.53	SW_WALC	CA_IID	$1.91	$3.32
BS_IPCO	NW_AVA	$2.67	$2.53	SW_WALC	CA_LDWP	$1.91	$5. 84
BS_IPCO	NW_BPAT+	$2.67	$1.91	SW_WALC	SW_TEPC	$1.91	$3.57
BS_IPCO	NW_PACW	$2.67	$3.08	CA_CISO	CA_BANC+	$10.98	$2.53
BS_IPCO	NW_PGE	$2.67	$2.53	CA_IID	CA_CISO	$3.32	$10.98
BS_IPCO	SW_NVE	$2.67	$6.96	CA_LDWP	CA_CISO	$5.84	$10.98
BS_PACE	BS_IPCO	$3.08	$2.67	SW_TH_PV	CA_CISO	$0.00	$10.98
BS_PACE	CA_LDWP	$3.08	$5.84	SW_TH_PV	SW_AZPS	$0.00	$3.95
BS_PACE	RM_WACM	$3.08	$4.98	SW_TH_PV	SW_SRP	$0.00	$2.08
BS_PACE	SW_AZPS	$3.08	$3.95	SW_TH_Mead	SW_WALC	$0.00	$1.91
BS_PACE	SW_NVE	$3.08	$6.96	SW_TH_Mead	SW_NVE	$0.00	$6.96
BS_PACE	SW_WALC	$3.08	$1.91	SW_TH_Mead	SW_AZPS	$0.00	$3.95
RM_PSCO	SW_PNM	$3.09	$4.16	SW_TH_Mead	SW_SRP	$0.00	$2.08
RM_WACM	RM_PSCO	$4.98	$3.09	SW_TH_Mead	CA_CISO	$0.00	$10.98
RM_WACM	SW_PNM	$4.98	$4.16	SW_TH_Mead	CA_LDWP	$0.00	$5.84
RM_WACM	SW_WALC	$4.98	$1.91	CA_CFE	CA_CISO	$2.31	$10.98

The 2026 Common Case uses hurdle rates developed from three perspectives, according to WECC:

Tariff rates: trade policy-based charges applied to power transfers between TEPPC regions;

Wheeling rates: charges paid to the owner of a transmission line for the right to transport power across the line;

Model validation: interregional charges modeled to calibrate to actual volumes of interregional transfers.

Carbon Adjustment for Energy Imported by California

California requires utilities to account for emissions related to power they import from out of state. Therefore, the total hurdle rate for power going into California is the base hurdle rate from WECC plus a carbon premium. BPA adjusts wheeling rates for exports to incorporate the carbon adder (BP-18-FS-BPA-04, section 2.3.9).

Total Hurdle Rate ($/MWh) = Base Hurdle Rate from WECC ($/MWh) + Carbon Adder ($/MWh)

Carbon Adder ($/MWh) = California CO2 Price($/tonne) emission intensity (tonne/MWh)*

Following BPA's approach, we multiplied the current California carbon allowance price ($14.60/tonne) by 0.428, the emission intensity for "unspecified sources" (Mandatory Reporting Requirements for GHG emissions, Section 95111). The carbon adder is $6.25/MWh.

Hurdle Rate Calculations

WECC uses a southbound hurdle rate of $1.91/MWh on the Intertie ($2016), although that is not a posted wheeling rate. To minimize changes, we used the WECC hurdle rate:

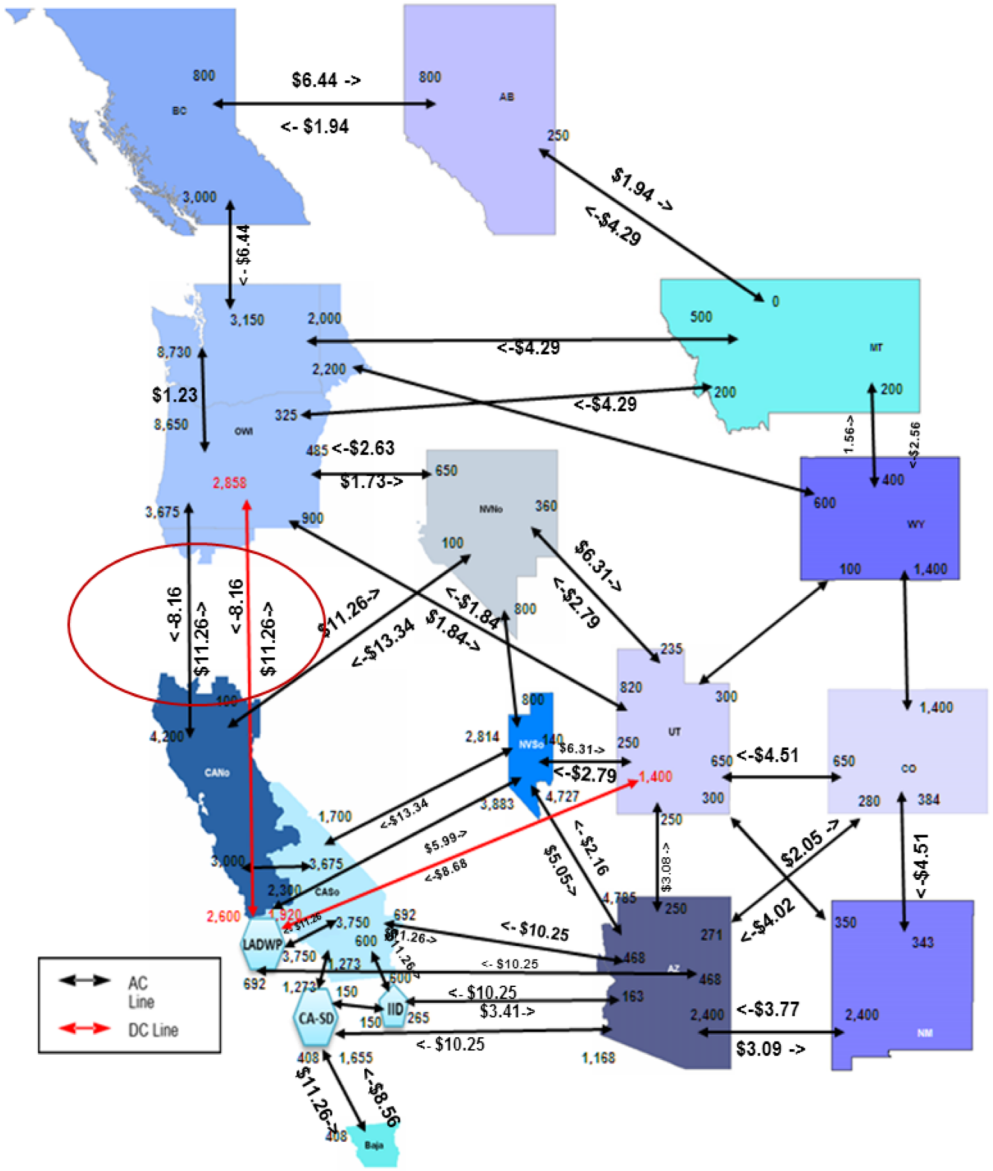
The hourly southbound rate increased by 270%, so we multiplied $1.91/MWh by 2.70 for the Change Case, and then included the carbon adder ($6.25/MWh).

Base Case Hurdle Rate = $1.91 x (1+2.5%)* + $6.25 = $8.16
Change Case Hurdle Rate = $1.91 x 2.7 x (1+2.5%)* + $6.25 = $11.50 (rounded down)

No other hurdle rates reported by WECC (or any other model inputs) were altered, to isolate the effect of the increase in BPA's Southern Intertie hourly rate.

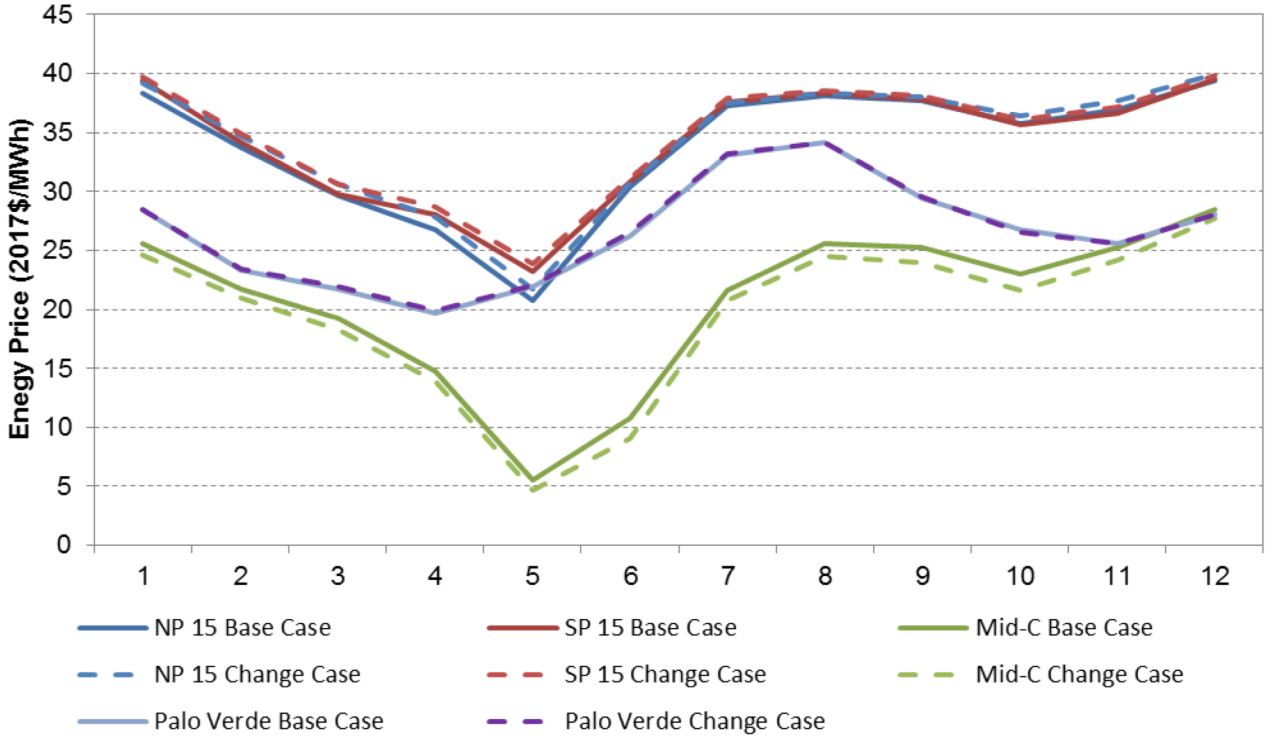
*Inflation adjustment from $2016 to $2017 = 2.5%, to match other Aurora inputs.

Hurdle Rates: Base Case and Change Case



Zone Out	Zone In	Wheeling Rate Base case ($/MWh)	Wheeling Rate Change case ($/MWh)
Oregon	CA-N	8.16	11.50
Oregon	CA-S	8.16	11.50
Nevada South	CA-S	13.34	13.34
Arizona	CA-S	10.25	10.25
Baja Ca	CA-S	8.56	8.56
CA-N	Oregon	11.26	11.26
CA-S	Arizona	11.26	11.26
CA-S	NevadaSouth	11.26	11.26
CA-S	BajaCa	3.41	3.41
CA-S	Utah	0.77	0.77
CA-S	Oregon	5.99	5.99

Resulting Energy Prices ($/MWh)



The increase of the hurdle rate from Oregon to California causes spot market power prices in California to go up and prices at the Mid-C hub to fall. (Annual averages are shown below.)

Region	NP 15	SP 15	Mid-C	Palo Verde
Base Case	33.74	34.26	20.58	26.59
Change Case	34.39	34.72	19.53	26.66
Difference	0.65	0.46	-1.05	0.07

Changes in Power Flows (MWh)

From	To	Transfer Volume Base Case (MWh)	Transfer Volume Change Case (MWh)	Difference (MWh)
Oregon	CA-N	16,698,720	11,272,779	(5,425,941)
Oregon	CA-S	4,290,669	2,869,731	(1,420,938)
NevadaSouth	CA-S	46,591	52,560	5,969
Arizona	CA-S	5,791,271	6,556,800	765,529
BajaCa	CA-S	8,244	-	(8,244)
CA-N	Oregon	392,320	286,928	(105,393)
CA-S	Arizona	1,118,275	935,774	(182,501)
CA-S	NevadaSouth	9,788	19,813	10,025
CA-S	BajaCa	3,496,626	3,590,683	94,057
CA-S	Utah	16,871	5,686	(11,185)
CA-S	Oregon	575,518	508,847	(66,671)

The increase in the hurdle rate from Oregon to California causes the annual energy export volume on the Southern Intertie to decrease by about 33%.

Changes in Generation (MWh)

Difference

Fuel Type	CA- N	CA-S	Arizona	Oregon	Washington Idaho	Nevada	Rest of WECC US	Total
Coal	8,649	408,385	-183,979	-75,852	69,885	-14,197	-566,106	-353,216
Gas CC	1,391,216	1,819,390	138,217	-1,788,174	-968,478	74,531	-333,880	332,823
Gas Peaker	567,773	642,393	7,759	-114,241	-256,140	4,878	-302,502	549,920
Nuclear	79,763	0	4,933	0	-138,806	0	0	-54,109
Oil	0	0	0	-413	0	0	0	-413
Hydro	-1,366	14,215	-1,361	189	-391,233	2,531	-790	-377,815
Wind	-553	0	-17	0	-79,980	149	301	-80,101
Solar	-6,191	-2,279	2,224	-5,108	-10	4,872	132	-6,360
DGSolar	0	0	0	0	0	0	0	0
Other	30,504	29,447	142	-44,585	-49,933	398	-1,696	-35,723
Total	2,069,794	2,911,551	-32,081	-2,028,185	-1,814,694	73,162	-1,204,541	-24,995

% Difference

Fuel Type	CA- N	CA-S	Arizona	Oregon	Washington Idaho	Nevada	Rest of WECC US	Total
Coal	5.1%	5.0%	-1.3%	-1.7%	0.8%	-1.3%	-0.8%	-0.3%
Gas CC	9.0%	4.9%	0.4%	-17.6%	-10.4%	0.4%	-0.8%	0.2%
Gas Peaker	6.1%	3.3%	0.1%	-25.6%	-11.9%	0.1%	-2.2%	1.0%
Nuclear	0.5%	0.0%	0.0%	0.0%	-1.7%	0.0%	0.0%	-0.1%
Oil	0.0%	0.0%	0.0%	-1.6%	0.0%	0.0%	0.0%	-1.6%
Hydro	0.0%	0.1%	0.0%	0.0%	-0.4%	0.1%	0.0%	-0.2%
Wind	0.0%	0.0%	0.0%	0.0%	-1.1%	0.1%	0.0%	-0.2%
Solar	-0.1%	0.0%	0.0%	-1.4%	-0.4%	0.1%	0.0%	0.0%
DGSolar	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Other	0.4%	0.3%	0.2%	-3.2%	-4.4%	0.0%	0.0%	-0.1%
Total	1.8%	2.2%	0.0%	-2.8%	-1.4%	0.2%	-0.7%	0.0%

Gas-fired generation is affected the most. Gas plants in California run more due to the higher cost of imports from the NW. Gas CCGTs and CTs in the NW run less due to lower prices at the Mid-C hub.

Carbon Emissions (tons)

Base Case								
Fuel Type	CaliforniaNorth	CaliforniaSouth	Arizona	Oregon	WashingtonIdaho	Nevada	Rest of WECC US	Total
Coal	182,444	8,542,390	15,298,032	5,039,569	11,036,167	1,186,624	82,762,410	124,047,636
Gas CC	6,924,782	16,780,143	16,420,694	4,487,679	4,226,052	8,340,529	17,894,129	75,074,008
Gas Peaker	4,875,461	10,748,531	5,514,784	270,228	1,179,665	2,487,266	8,219,435	33,295,370
Total	11,982,688	36,071,064	37,233,510	9,797,475	16,441,884	12,014,419	108,875,974	232,417,014
Change Case								
Fuel Type	CaliforniaNorth	CaliforniaSouth	Arizona	Oregon	WashingtonIdaho	Nevada	Rest of WECC US	Total
Coal	192,669	8,968,014	15,113,755	4,953,720	11,125,041	1,173,029	82,124,546	123,650,774
Gas CC	7,549,962	17,604,624	16,482,696	3,694,771	3,787,889	8,373,759	17,741,517	75,235,217
Gas Peaker	5,148,095	11,075,614	5,518,715	199,493	1,037,519	2,489,098	8,049,909	33,518,443
Total	12,890,725	37,648,252	37,115,165	8,847,985	15,950,448	12,035,886	107,915,972	232,404,434
Differences								
Fuel Type	CaliforniaNorth	CaliforniaSouth	Arizona	Oregon	WashingtonIdaho	Nevada	Rest of WECC US	Total
Coal	10,224	425,624	(184,277)	(85,848)	88,874	(13,595)	(637,864)	(396,862)
Gas CC	625,179	824,481	62,001	(792,908)	(438,163)	33,230	(152,612)	161,209
Gas Peaker	272,634	327,083	3,931	(70,734)	(142,146)	1,832	(169,526)	223,074
Total	908,038	1,577,188	(118,344)	(949,491)	(491,436)	21,467	(960,002)	(12,580)

SO_2 and NOx Emissions (tons)

NOx Difference

Fuel Type	CaliforniaNorth	CaliforniaSouth	Arizona	Oregon	WashingtonIdaho	Nevada	Rest of WECC US	Total
Coal	13	718	(140)	(110)	(98)	(84)	(1,275)	(977)
Gas CC	135	177	13	(171)	(94)	7	(33)	34
Gas Peaker	37	37	1	(7)	(19)	-	(16)	33
Total	185	932	(126)	(288)	(212)	(77)	(1,324)	(910)
Total %	8%	5%	-1%	-3%	-1%	-3%	-1%	0%

SO2 Differences

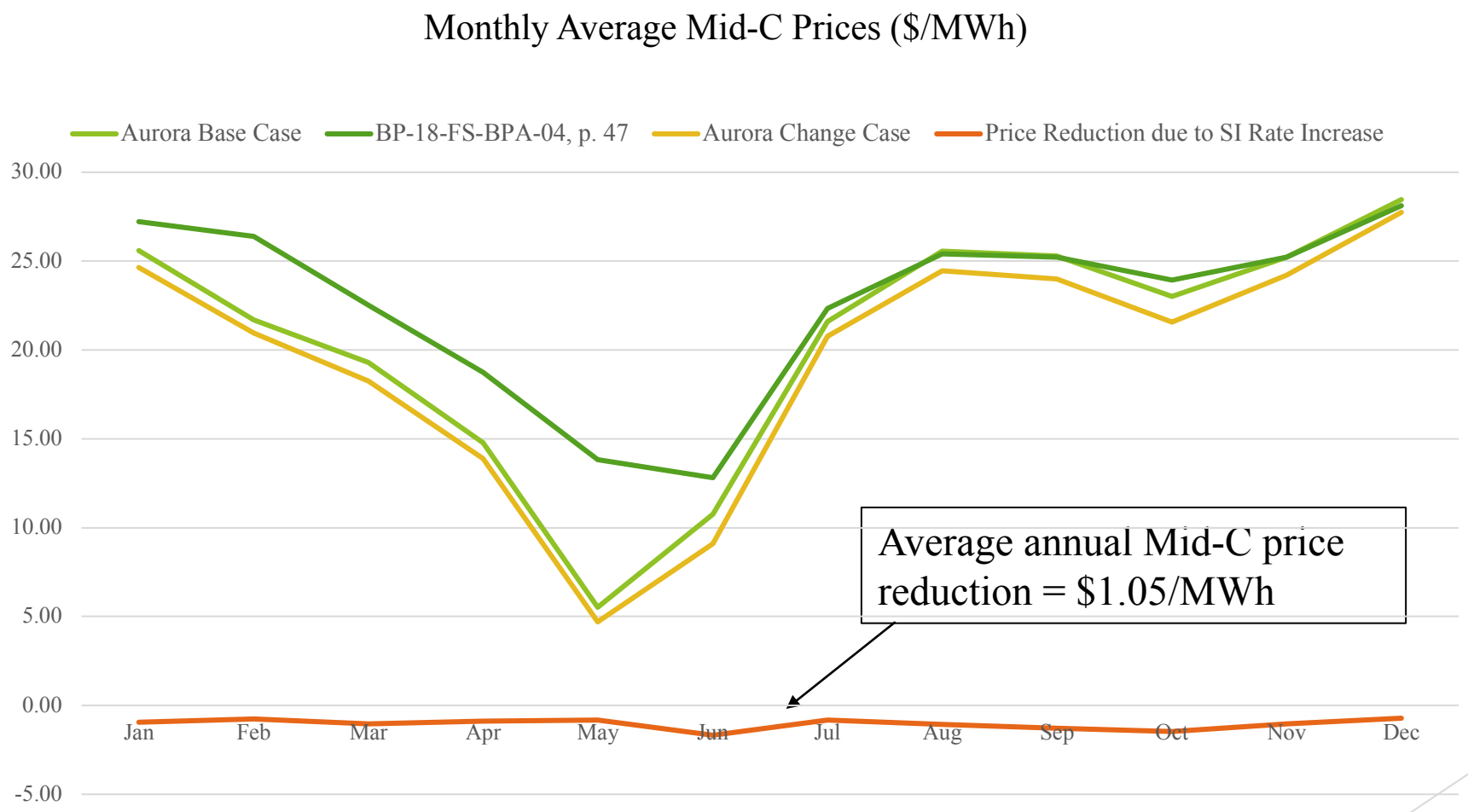
Fuel Type	CaliforniaNorth	CaliforniaSouth	Arizona	Oregon	WashingtonIdaho	Nevada	Rest of WECC US	Total
Coal	19	102	(315)	(99)	(30)	(114)	(903)	(1,340)
Gas CC	-	-	-	-	-	-	-	-
Gas Peaker	-	-	-	-	-	-	-	-
Total	19	102	(315)	(99)	(30)	(114)	(903)	(1,340)
Total %	5%	4%	-2%	-2%	0%	-9%	-1%	-1%

Effect of Lower Mid-C Price Forecast on PF-1 Rate

- Validate: check Aurora results against BPA's final studies in BP-18
- Adjust inputs to RAM2018 to reflect increase in SI wheeling rate
  - Increase Mid-C prices to offset effects of SI rate increase
- Compare PF-1 rates with and without the higher SI wheeling rate
  - Ignore PF-X and IP rates
- Consider non-federal secondary revenues
- Note: current power rates reflect the increase in the SI hourly wheeling rate:

  "To estimate hourly north to south reservations in the rate period, BPA assumed the hourly non-firm [Southern Intertie wheeling] rate would be $10.00 mills/kWh." (BP-18-FS-BPA-08, p. 27)

Aurora Mid-C Prices vs. BP-18 Final Study



Adjustments to RevSim Inputs to RAM2018

- RAM2018 inputs from RevSim ($/MWh, annual averages)

	2018		2019
Augmentation Price $	27.26	$	26.99
Firm Surplus Price $	23.14	$	22.83
Secondary Sales Price $	19.35	$	19.62
Balancing Price $	18.77	$	17.44

- **Validation check:** BPA's average secondary sales price *with* SI rate increase ($19.49) is almost identical to SMUD's estimate of Mid-C prices *with* SI rate increase ($19.53)
- **Simple adjustment to RAM2018:** increase each value by $1/MWh, to show what the PF rate would be *without* the SI rate increase
- Ignores seasonal variation, but secondary sales volumes swamp all other transaction types

Impact on PF Tier 1 due to SI Rate Increase

- Average Slice & Non-Slice Tier 1 rate *with* SI rate increase
  - $36.86/MWh (RAM2018)
- Average Slice & Non-Slice Tier 1 rate *without* SI rate increase
  - $36.58/MWh (adjusted RAM2018)
- Impact on current PF rate: increase of $0.28/MWh
- Tier 1 energy sales: 118,552,000 MWh
- Impact on cost of PF power: increase of $33.2 million/rate period

Non-Federal Secondary Revenues

- Seattle: $60-$100 million/year (annual report)
- Tacoma: nearly $50 million in 2017
- EWEB: about $40 million/year
- IOUs: annual revenues not easily accessible

- Lower Mid-C prices (about 5% lower) reduce secondary revenues for non-federal utilities that are “annual net long”

Is the PF Rate Increase an Insurance Premium?

- Basic financial argument in BP-18 for higher hourly IS wheeling rate
  - Risk of shift to short-term wheeling service from long-term contracts
- Comparison: PF rate increase vs. risk of IS cost underrecovery
  - Entire IS annual revenue requirement is about $100 million
  - Risk of underrecovery is not 100% of $100 million, but something less
    - "The long-term IS risk distribution results in standard deviations of $1.1 million for FY 2018 and $1.3 million for FY 2019." (FS-BPA-05, p. 93)
    - 95% confidence that revenues will almost exactly equal cost
  - PF rate increase is about $33 million due to IS rate increase
- NW utility customers are paying over $33 million/rate period to avoid a *much* smaller risk of IS cost underrecovery

Who Benefits from the SI Rate Increase?

- Entities that are net short on an annual basis: obligations and opportunities exceed existing resources
- Entities with thermal resources that can be displaced by Mid-C energy

But not

- Sellers, like BPA, that are net long on an annual basis
- Buyers and sellers that rely on hourly transmission capacity to move power from the Northwest to California
- Entities whose Southern Intertie capacity rights (contract or owned) are already tied up in long-term contracts to deliver specific resources to California
- BPA's power and transmission customers in the Northwest

West Coast Market Integration

- BPA is working on initiatives to improve the operation of West Coast energy markets and increase trade
  - Studies with the CAISO of operational changes
  - Possible investments in Intertie capacity increases unrelated to existing TSRs
  - Possible participation in Western EIM
  - Integration of Montana renewable energy
- CAISO also has high export fees, which restrict exports
  - BPA has raised the issue of whether CAISO's export fees are too high
- Impacts of hurdle rates
  - High hurdle rates reduce trade, increase the frequency of curtailments of carbon-free energy, and raise carbon emissions
  - All hurdle rates and export fees should be scrutinized for impacts on energy markets