

Benefits of the SPP RTO Expansion into the WEIS Footprint

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SEPTEMBER 20, 2022



Introduction

Study Objective:

Estimate the benefits of the SPP RTO Expansion into the WEIS Footprint

Overview:

- Measured the incremental benefits of moving from WEIS to the SPP RTO
- Updated the input data and assumptions from the 2020 Brattle study commissioned by SPP*

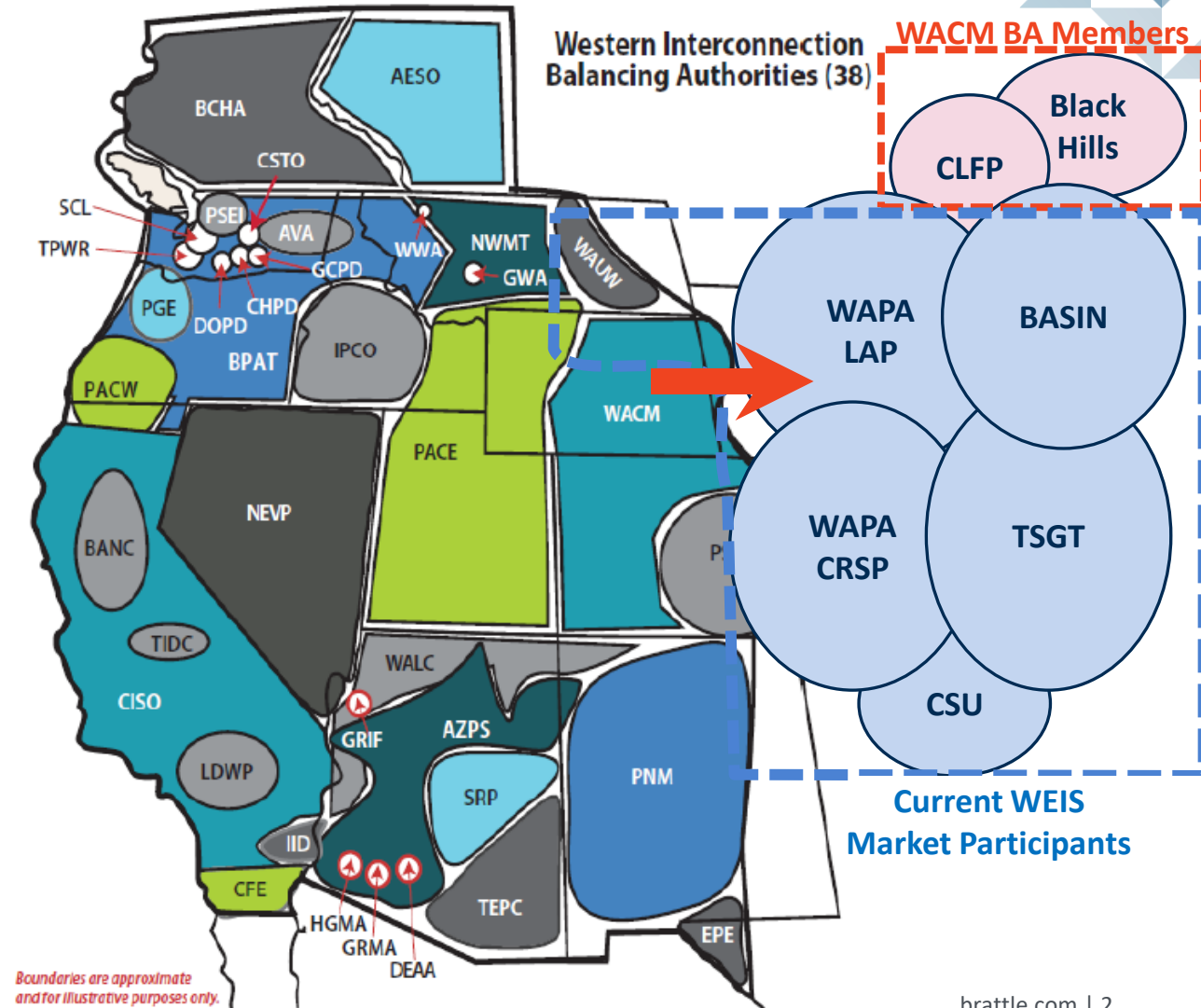
Changes between the 2022 study and the 2020 study:

- Expanded the WEIS and RTO footprint to include Colorado Springs Utilities
- Updated resources plans, market rules, fuel prices, and system conditions
- Included a low hydro sensitivity
- Added planned expansion in renewable generation for neighboring entities
- Incorporated day-ahead and real-time forecast error for renewable generation and consumer demand

Overview of 2022 RTO Study

Methodology:

- Utilized an integrated East-West model based on the WECC 2028 Anchor Dataset (ADS) and SPP data
- Leveraged the same modeling approach as the 2020 SPP study and the same 2028 future test year
- Disaggregated the WACM BA into participant areas; simulating the benefits of the RTO for each participant in WACM and WAUW
- Analyzed two cases:
 - **Status Quo Case:** Current WEIS market participants.*
 - **RTO Case:** Current WEIS market participants join the SPP RTO.*

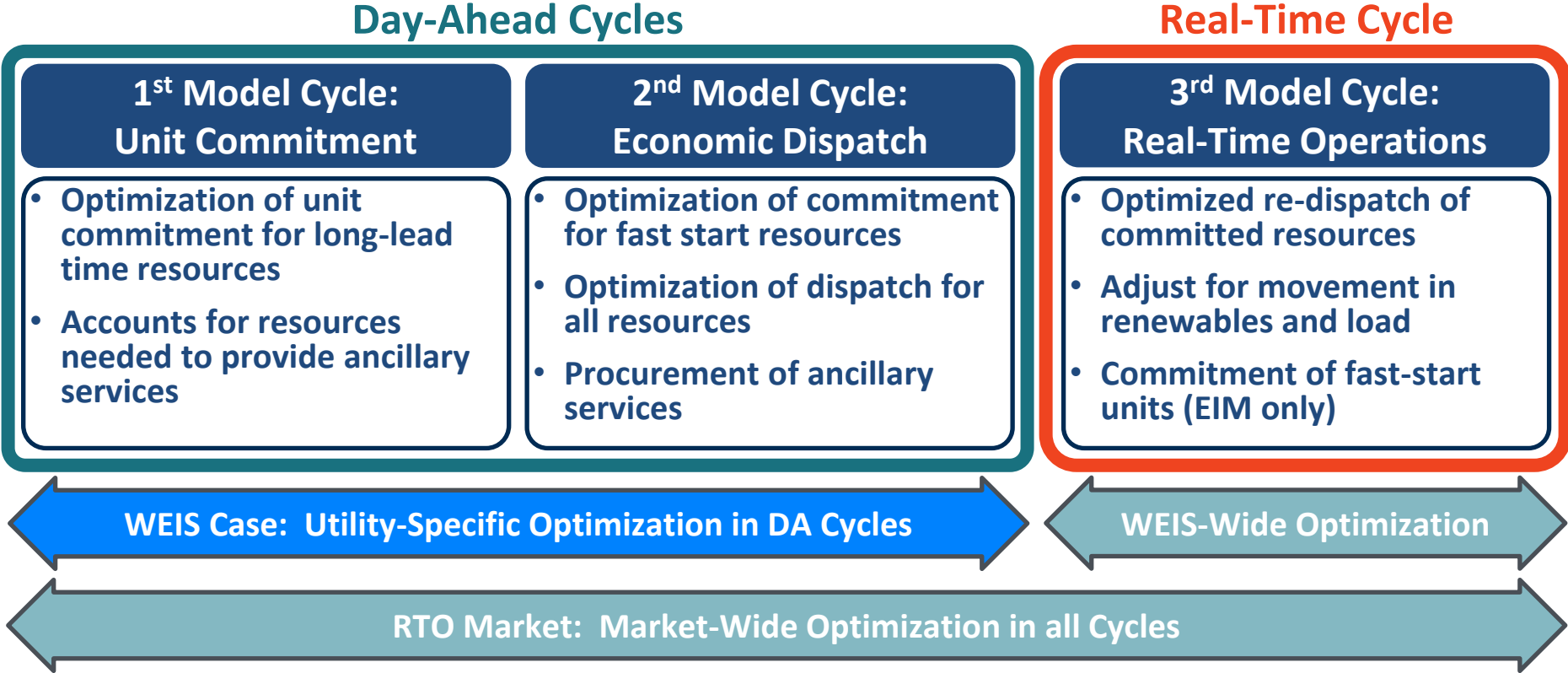


*Current WEIS market participants include Basin Electric (Westside), Colorado Springs Utilities, Deseret, Tri-State, Municipal Energy Agency of Nebraska, WAPA Upper Great Plains (Westside), WAPA Loveland Area Projects, and WAPA Colorado River Storage Project.

Overview of 2022 RTO Study

Independent decision cycles in the model allow for simulation of real-time markets like the WEIS and WEIM with day-ahead bilateral trading and utility-specific unit commitment

- In the RTO Case, the model conducts footprint-wide (Eastside and Westside) optimization across all cycles, including day-ahead unit commitment, dispatch, and real-time dispatch



2022 Updates to 2020 SPP Study

- Addition of **12 GW of renewable capacity** in systems neighboring the WEIS reflecting updated resource plans
- **Optimized DC Ties** in the bilateral market **with a \$10 hurdle** instead of using historical flows.
 - In both the 2020 and 2022 RTO cases, the hurdle for participating DC ties was removed.
- **DC ties modeled as part of RTO include Miles City, Stegall, and Sidney**
 - Basin’s portion of the Rapid City DC tie not included in the RTO for the 2022 study
- **Colorado Springs Utilities** modeled as part of WEIS and RTO
- **Day-Ahead to Real-Time forecast error included** for load and renewables
 - In the WEIS and SPP, based on historical data
- **Natural Gas prices increased** by about \$1.5/MMBtu
 - Prices average about \$4/MMBtu in Colorado,
 - Prices in other regions across the WECC and SPP adjusted to preserve basis differential with CO hub
- Simulated a **Low Hydro Case** to reflect drought conditions

Capacity Changes to WEIS Neighbors			
Area	New Solar (MW Added)	New Wind (MW Added)	New Battery (MW Added)
PSCO	-	360	276
Pacificorp	2,600	2,700	1,200
PNM	-	879	1052
AZPS	1,400	851	730
Total	4,000	4,790	3,258

Adjusted Production Cost and Wheeling Benefits



Key Benefit Metric: Adjusted Production Cost

Adjusted Production Cost (APC) is a standard metric used to capture the direct variable energy-related costs from a customer impact perspective

The APC is the sum of production costs and purchased power less off-system sales revenue:

(+) Production costs (fuel, startup, variable O&M, GHG as applicable) for generation owned or contracted by the load-serving entities

(+) Cost of bilateral and market purchases valued at the BAA load-weighted energy price

(-) Revenues from bilateral and market sales valued at the BAA generation-weighted energy price

** EIM purchases and sales are valued based on energy prices in the EIM-simulation cycle.*

All other pre-EIM market purchases and sales are valued based on energy prices in the dispatch cycle.

The APC is calculated for the “Base Case” (without new market) and for the “Change Case” (with new market) to determine the APC-portion of savings due to the new market

– Note: the APC metric does not capture benefits (or costs) associated with wheeling revenues and trading gains

Key Benefit Metric: Wheeling Revenues

Wheeling revenues for each WEIS participant are calculated based on simulated wheel-through transactions in both the WEIS and RTO cases

- In the WEIS case, wheeling revenues are calculated based on the individual utility-specific OATT rates and simulated bilateral transactions for all WEIS participants
- In the RTO case, wheeling revenues are calculated using the ATRR-weighted OATT rate of all the individual WEIS participants' rates
- De-pancaking of wheeling fees between WEIS participants in the RTO case leads to a reduction in wheeling revenues for the WEIS participants, which is made up for with additional off system sales revenues

APC and Wheeling Revenue Benefits Summary

Westside APC benefits: \$68 million/year to \$81 million/year
Eastside APC benefits: \$3 million/year to \$8 million/year

The total net benefits for the Westside range from 13% to 18% of total Adjusted Production Costs for the WEIS footprint

Benefits Summary by Scenario
(In \$ Millions)

Benefit Metric	Westside		Eastside		Combined	
	Base WEIS vs. Base RTO	Low Hydro WEIS vs. Low Hydro RTO	Base WEIS vs. Base RTO	Low Hydro WEIS vs. Low Hydro RTO	Base WEIS vs. Base RTO	Low Hydro WEIS vs. Low Hydro RTO
APC Benefit	\$68	\$81	\$3	\$8	\$71	\$89
Wheeling Benefit	-\$15	-\$16	\$0	\$0	-\$15	-\$16
Net APC & Wheeling	\$53	\$65	\$3	\$8	\$56	\$73

Base Scenario APC Benefit of the RTO: Westside

In the **Base Scenario**, the Westside participants make increased market sales at higher prices, creating APC benefit of \$68 million/year

In the RTO, Westside participants make 1.4 TWh more market sales, at ~\$7-13/MWh higher prices than in the WEIS

- The APC benefits for the total Westside footprint are **\$68 million/year (26%)** in the RTO Case

Adjusted Production Cost Comparison for the Westside Footprint

Cost Components	GWh			\$/MWh			Total (\$1000s/Year)		
	WEIS Case	RTO Case	Difference	WEIS Case	RTO Case	Difference	WEIS Case	RTO Case	Difference
Production	33,481	34,817	1,336	\$9.81	\$10.60	\$0.78	\$328,599	\$369,000	\$40,400
Purchases									
<i>Bilateral Market/Day-Ahead Market</i>	3,752	3,776	24	\$35.35	\$33.71	-\$1.64	\$132,630	\$127,303	-\$5,327
<i>Real-Time Market</i>	503	567	64	\$37.61	\$43.42	\$5.81	\$18,902	\$24,605	\$5,703
Sales									
<i>Bilateral Market/Day-Ahead Market</i>	7,416	9,072	1,656	\$27.45	\$34.37	\$6.92	\$203,579	\$311,853	\$108,274
<i>Real-Time Market</i>	629	397	-232	\$21.85	\$35.21	\$13.36	\$13,737	\$13,977	\$240
Total	29,691	29,691	0	\$8.85	\$6.57	-\$2.28	\$262,816	\$195,078	-\$67,738
% Change in APC									-25.8%

Base Scenario APC Benefit of the RTO: Eastside

In the **Base Scenario**, the Eastside footprint receives an APC benefit of \$3 million/year in the RTO scenario

The Eastside footprint makes purchases at a slightly lower average price and sales at a slightly higher average price in the RTO, giving the Eastside footprint a benefit.

Adjusted Production Cost Comparison for the Eastside Footprint

Cost Components	GWh			\$/MWh			Total (\$1000s/Year)		
	WEIS Case	RTO Case	Difference	WEIS Case	RTO Case	Difference	WEIS Case	RTO Case	Difference
Production	302,409	302,880	471	\$16.47	\$16.49	\$0.02	\$4,982,105	\$4,995,442	\$13,336
Purchases									
<i>Bilateral Market/Day-Ahead Market</i>	41,001	40,819	-183	\$42.08	\$42.00	-\$0.09	\$1,725,407	\$1,714,236	-\$11,171
<i>Real-Time Market</i>	4,996	4,927	-69	\$36.75	\$36.67	-\$0.08	\$183,590	\$180,694	-\$2,896
Sales									
<i>Bilateral Market/Day-Ahead Market</i>	54,859	54,987	128	\$28.63	\$28.51	-\$0.11	\$1,570,434	\$1,567,850	-\$2,584
<i>Real-Time Market</i>	4,786	4,878	91	\$34.98	\$35.32	\$0.33	\$167,441	\$172,267	\$4,826
Total	288,760	288,760	0	\$17.85	\$17.84	-\$0.01	\$5,153,228	\$5,150,255	-\$2,973
% Change in APC									-0.1%

Low Hydro APC Benefit of the RTO: Westside

The RTO allows participants to make increased market sales at higher prices than in the WEIS, creating a net benefit of \$81 million/year

The Low Hydro Sensitivity sees higher total net benefits, in dollar terms but smaller in percentage terms

- The APC benefits for the total Westside footprint are **\$81 million/year (18%)** in the RTO Case
- Total GWh of production declines, but total cost of production remains almost the same as the Base Case
- Purchases increase from ~4,000 GWh in the Base Case to **~9,000 GWh in the Low Hydro case**

Adjusted Production Cost Comparison for WEIS Footprint

Cost Components	GWh			\$/MWh			Total (\$1000s/Year)		
	WEIS Case	RTO Case	Difference	WEIS Case	RTO Case	Difference	WEIS Case	RTO Case	Difference
Production	28,242	29,710	1,469	\$11.38	\$12.36	\$0.98	\$321,436	\$367,152	\$45,716
Purchases									
<i>Bilateral Market/Day-Ahead Market</i>	8,302	8,307	5	\$36.55	\$35.45	-\$1.10	\$303,429	\$294,433	-\$8,996
<i>Real-Time Market</i>	498	564	66	\$39.39	\$45.44	\$6.05	\$19,618	\$25,616	\$5,998
Sales									
<i>Bilateral Market/Day-Ahead Market</i>	6,731	8,503	1,771	\$26.75	\$35.69	\$8.95	\$180,038	\$303,499	\$123,461
<i>Real-Time Market</i>	619	387	-232	\$22.71	\$36.20	\$13.50	\$14,064	\$14,018	-\$45
Total	29,691	29,691	0	\$15.17	\$12.45	-\$2.72	\$450,381	\$369,683	-\$80,698
% Change in APC									-17.9%

Low Hydro APC Benefit of the RTO: Eastside

The APC benefit for the Eastside changes from the Base Case, giving SPP a net benefit of \$8 million/year

The APC benefits for the Eastside footprint increase due to the RTO expansion under the Low Hydro Case, for a total of \$8 million/year

- We have not calculated any other benefits for any SPP members, such as reduction in admin fees

Adjusted Production Cost Comparison for the Eastside Footprint

Cost Components	GWh			\$/MWh			Total (\$1000s/Year)		
	WEIS Case	RTO Case	Difference	WEIS Case	RTO Case	Difference	WEIS Case	RTO Case	Difference
Production	301,265	301,851	586	\$16.68	\$16.67	-\$0.01	\$5,025,645	\$5,031,260	\$5,614
Purchases									
<i>Bilateral Market/Day-Ahead Market</i>	41,208	40,957	-251	\$42.32	\$42.38	\$0.06	\$1,743,762	\$1,735,577	-\$8,186
<i>Real-Time Market</i>	4,989	4,914	-76	\$36.99	\$36.89	-\$0.10	\$184,548	\$181,260	-\$3,288
Sales									
<i>Bilateral Market/Day-Ahead Market</i>	53,886	54,104	218	\$28.78	\$28.66	-\$0.12	\$1,550,718	\$1,550,602	-\$115
<i>Real-Time Market</i>	4,816	4,858	42	\$35.37	\$35.55	\$0.17	\$170,347	\$172,677	\$2,331
Total	288,760	288,760	0	\$18.12	\$18.09	-\$0.03	\$5,232,891	\$5,224,817	-\$8,075
% Change in APC									-0.2%

2020 SPP Study: Westside Results

The 2020 SPP Study indicated \$16 million in APC benefits (87.6% of APC) for the Westside footprint

Benefits for the Westside footprint were driven primarily by decreased purchase costs and increased sales.

2020 Study Adjusted Production Cost Comparison for WEIS Footprint

Cost Components	GWh			\$/MWh			Total (\$1000s/Year)		
	Status Quo	RTO	Difference	Status Quo	RTO	Difference	Status Quo	RTO	Difference
Production	28,150	29,731	1,581	\$8.54	\$9.21	\$0.67	\$240,386	\$273,820	\$33,434
Purchases									
<i>DA and Bilateral Market</i>	2,531	2,540	9	\$34.95	\$31.74	-\$3.22	\$88,464	\$80,611	-\$7,854
<i>Real-Time Market</i>	1,433	24	-1,409	\$12.49	\$16.24	\$3.75	\$17,903	\$395	-\$17,507
Sales									
<i>DA and Bilateral Market</i>	4,405	5,086	680	\$28.50	\$28.13	-\$0.37	\$125,543	\$143,065	\$17,522
<i>Real-Time Market</i>	515	16	-498	\$19.92	\$14.45	-\$5.47	\$10,255	\$237	-\$10,018
Adtnl. Wheeling-Out Revenue									\$16,687
Total	27,193	27,193	0	\$7.76	\$7.78	\$0.02	\$210,954	\$211,524	-\$16,118 -7.64%

2020 SPP Study: Eastside Results

The 2020 SPP Study indicated \$17 million in APC benefits moving from the WEIS to RTO (0.3% of APC) for the Eastside footprint

Benefits for the SPP East footprint were driven primarily by increased sales across the DC Ties into the WECC at higher average prices

2020 Study Adjusted Production Cost Comparison for Southwest Power Pool Footprint

Cost Components	GWh			\$/MWh			Total (\$1000s/Year)		
	Status Quo	RTO	Difference	Status Quo	RTO	Difference	Status Quo	RTO	Difference
Production	249,127	249,960	832	\$16.28	\$16.17	-\$0.10	\$4,055,057	\$4,042,855	-\$12,202
Purchases									
<i>DA and Bilateral Market</i>	70,399	69,491	-907	\$28.81	\$29.36	\$0.55	\$2,028,220	\$2,040,084	\$11,864
<i>Real-Time Market</i>	1,316	867	-450	\$26.00	\$17.12	-\$8.88	\$34,224	\$14,837	-\$19,387
Sales									
<i>DA and Bilateral Market</i>	29,743	30,651	908	\$28.78	\$28.64	-\$0.13	\$855,877	\$878,009	\$22,132
<i>Real-Time Market</i>	2,339	906	-1,433	\$14.87	\$11.00	-\$3.87	\$34,780	\$9,965	-\$24,815
Total	288,760	288,760	0	\$18.10	\$18.04	-\$0.06	\$5,226,845	\$5,209,802	-\$17,043 -0.33%

Benefits from the 2022 Study Compared with the 2020 SPP Study

In the 2022 study, the Eastside sees APC benefits of \$3 to \$8 million/year, compared to \$17 million/year in the 2020 SPP Study; the Westside sees APC benefits of \$68 to \$81 million/year in the 2022 Study, compared to \$16 million/year in the 2020 SPP Study.

- In the 2022 study, there is less trading from SPP East to the WECC, which implies slightly lower APC reduction for the Eastside
 - The driver of this change is that the updated study includes changes to the resource mix in the WEIS and in neighboring WECC areas:
 - ▶ Resource plans for TSGT and CSU include significant new renewable resources
 - ▶ 12 GW of renewables added in PAC, AZPS, PNM, PSCO
 - ▶ Reduces the sale of SPP wind across the ties to the WECC;
 - The sale of excess renewable energy to neighboring areas in the WECC is being captured by the WEIS members (due to increased renewables in the WEIS footprint)
- Additional benefits not calculated include increased reliability and resiliency, system flexibility, and reduced administrative fees

Benefits Not Estimated in the Study

The production cost simulation model used in this study does not estimate several operational benefits typically experienced in RTOs

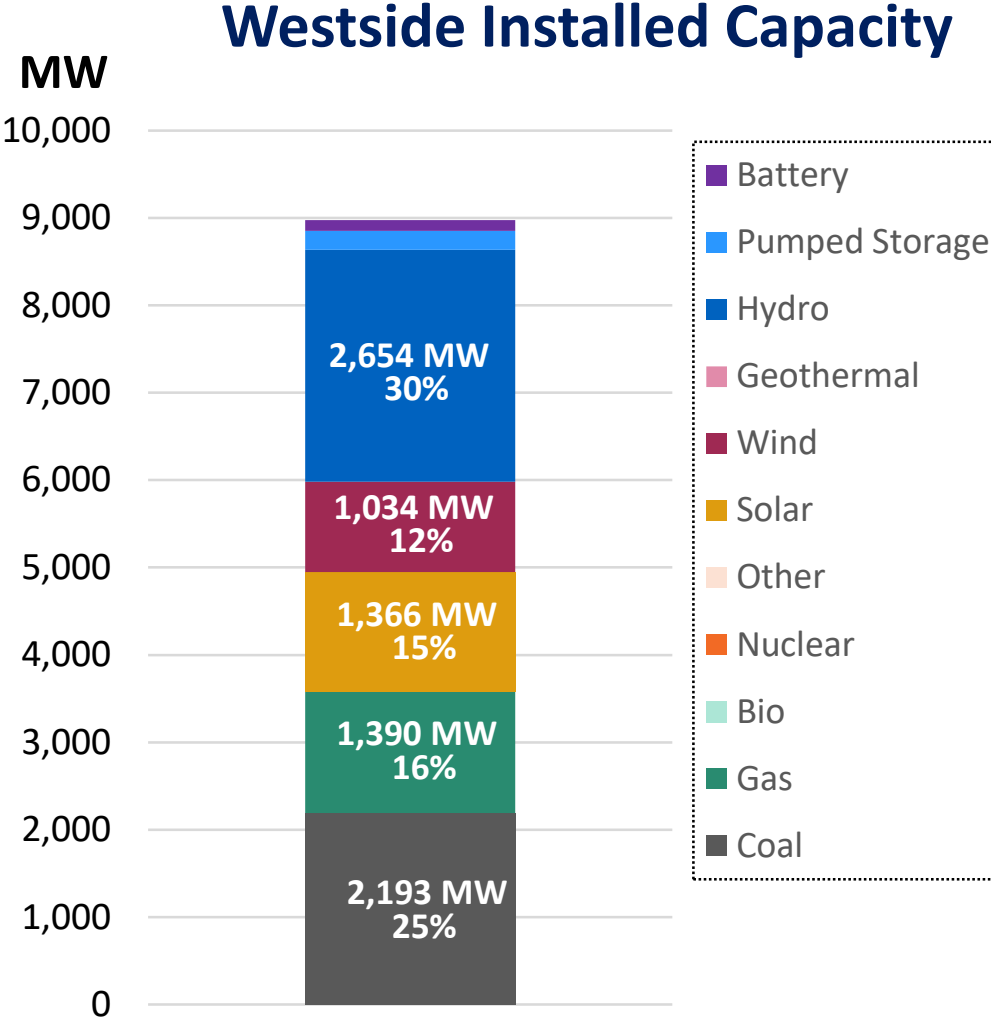
- The simulations in this study were conducted on an hourly basis, and do not capture benefits associated with intra-hour operational efficiencies
- The study uses normalized weather and load, normalized generation outages, DC Tie outages, and no AC transmission outages; which underestimates the benefits of a regional RTO
- Production cost benefits do not account for improvements in flexibility, reliability and resilience
- The reductions in needed operational reserves (e.g., regulation, load following, etc.) in an RTO are not accounted for in the study
- APC does not account for benefits of regional transmission planning and development
- Reduced administrative fees not included in the study

Additional Results



Installed Capacity in the Westside Footprint

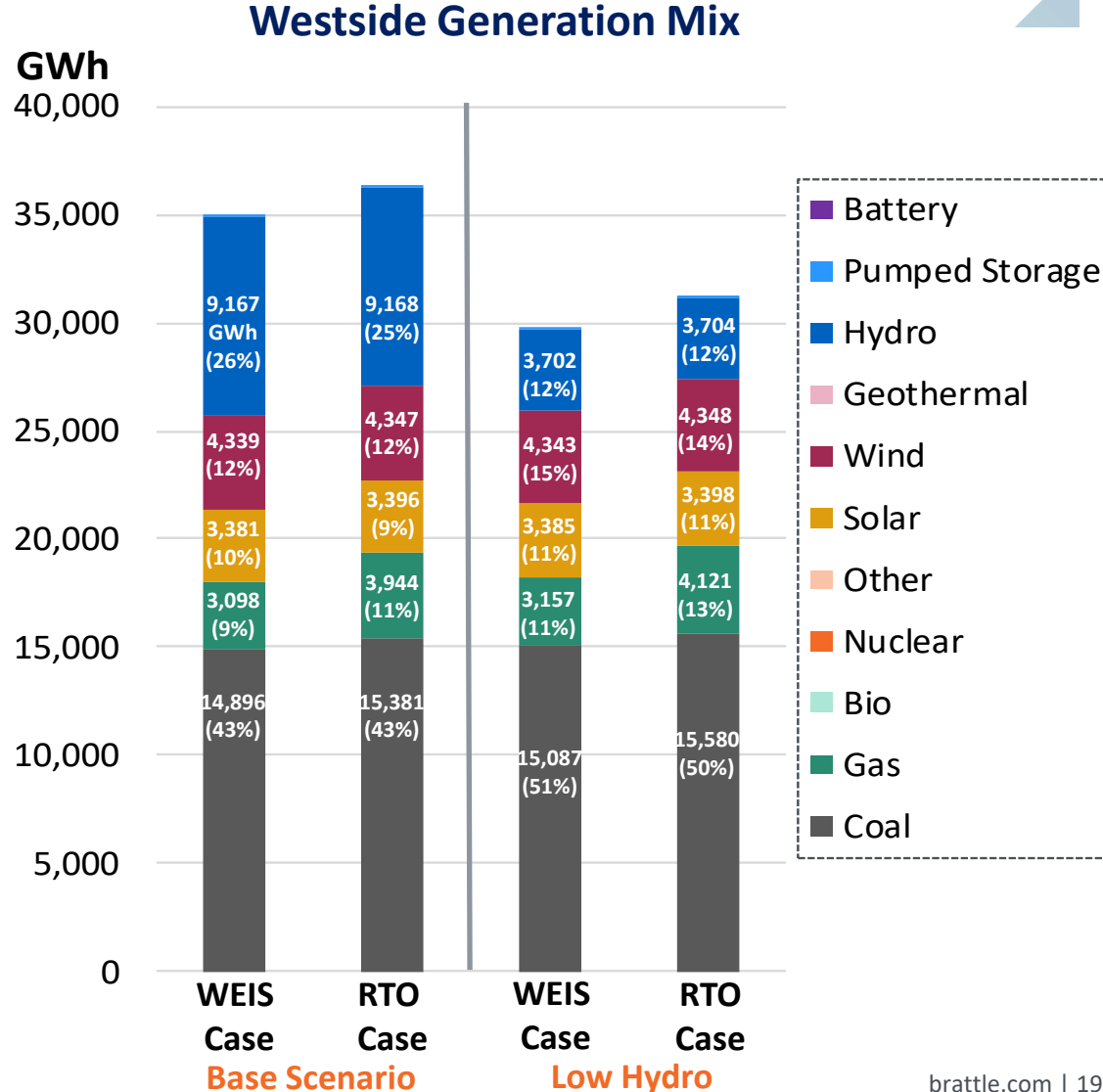
- Total Westside installed capacity of 8,977 MW in 2028 model
 - 30% hydro
 - 27% renewables
 - 16% natural gas
 - 25% coal
 - 3% storage (mostly hydro pumped-storage)



Generation Mix in the Westside Footprint

In the Westside Footprint, the generation mix in the base scenario WEIS case is 52% combined coal and gas

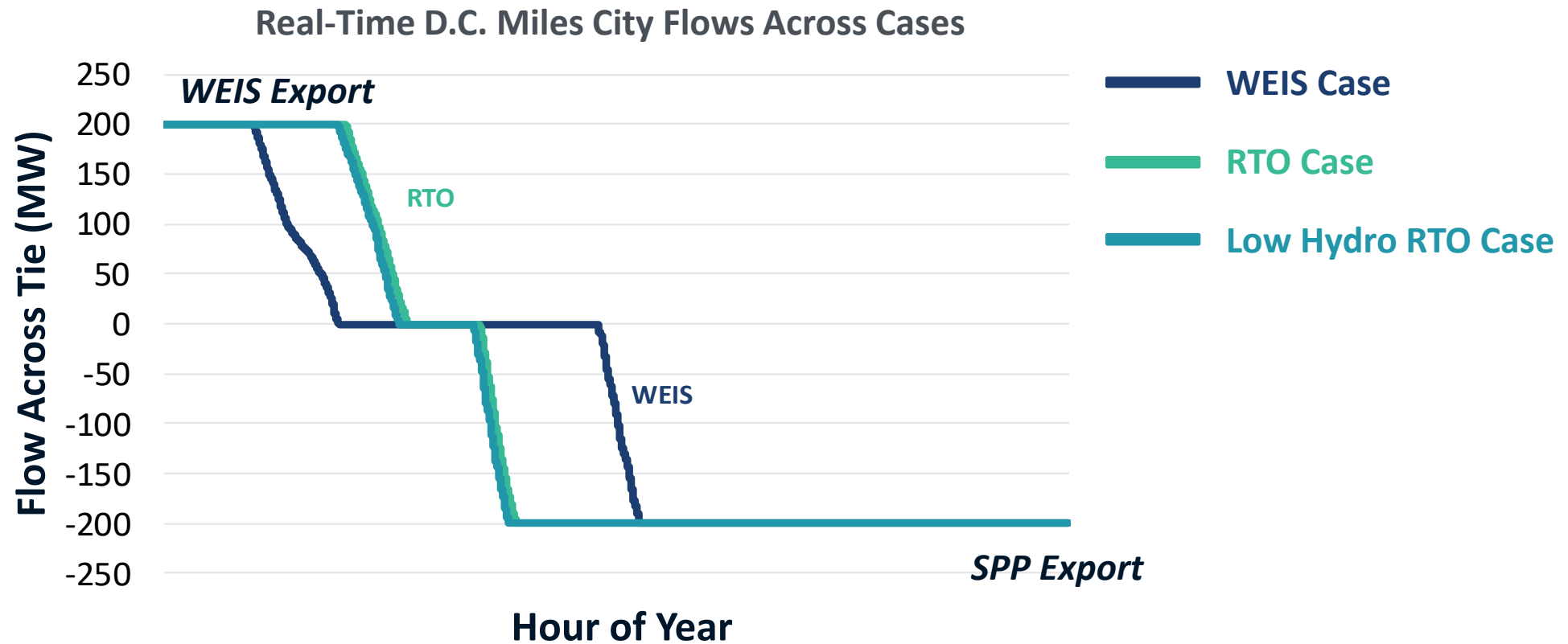
- In RTO case, generation mix changes slightly
 - Coal production increases
 - Gas generation increases by ~27% in the RTO case relative to the WEIS case, driven by increased off system sales
 - The RTO and WEIS cases have the same installed capacity of renewables, implying generation is the same except a small increase in due to reduction in curtailments in the RTO
 - Hydro generation drops ~60% between the Base and Low Hydro Scenarios



Miles City DC Tie Flows: WEIS vs. RTO Case

In the RTO case, exports grow in both directions on the Miles City tie

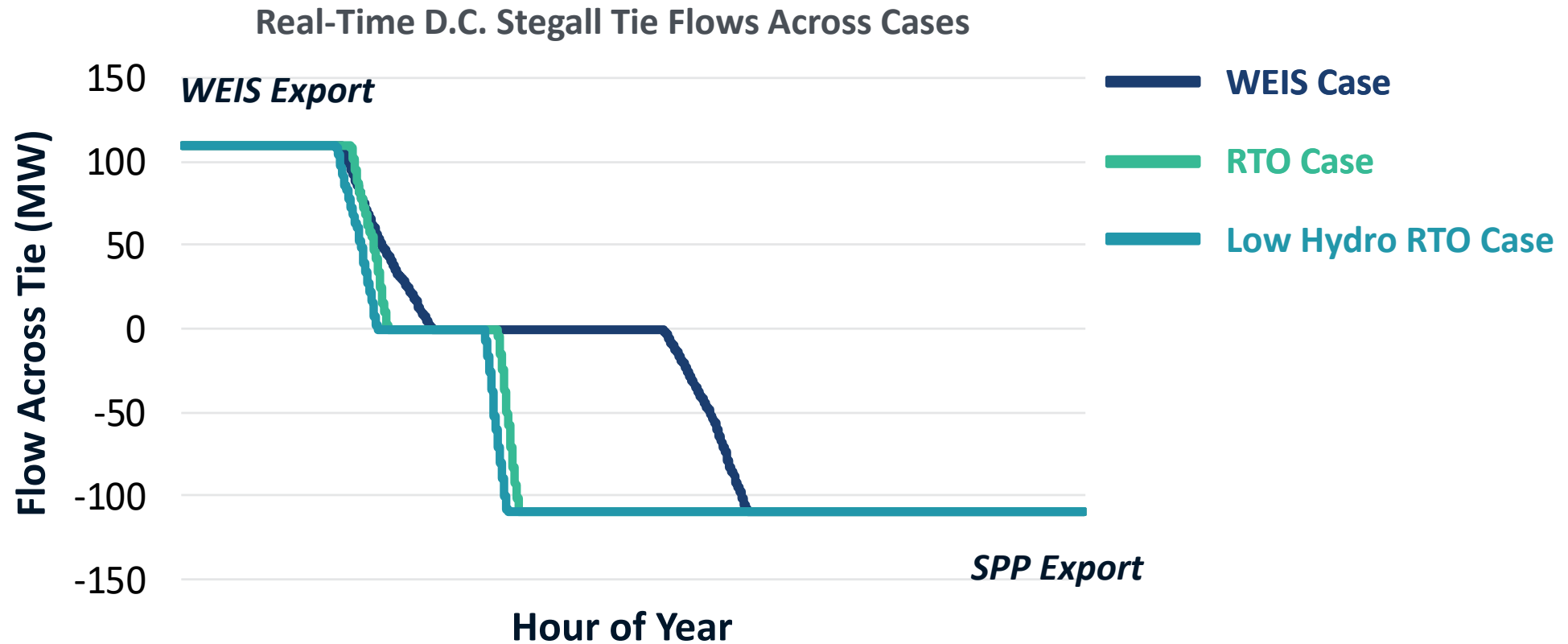
- West-to-east export binds 1,770 hours in RTO case (*1,693 in Low Hydro*)
- East-to-west export binds 5,361 hours in RTO case (*5,431 in Low Hydro*)



Stegall DC Tie Flows: WEIS vs. RTO Case

In the RTO case, SPP exports considerably more on the Stegall tie

- West-to-east export binds 1,645 hours in RTO case (*1,497 in Low Hydro*)
- East-to-west export binds 5,498 hours in RTO case (*5,613 in Low Hydro*)



Sidney DC Tie Flows: WEIS vs. RTO Case

In the RTO case, SPP exports considerably more on the Sidney tie

- West-to-east export binds 1,446 hours in RTO case (*1,336 in Low Hydro*)
- East-to-west export binds 5,352 hours in RTO case (*5,453 in Low Hydro*)

