



HELPING OUR MEMBERS WORK TOGETHER
TO KEEP THE LIGHTS ON... TODAY AND IN THE FUTURE.

2019 ITP Benchmarking

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July 12, 2018

Objective

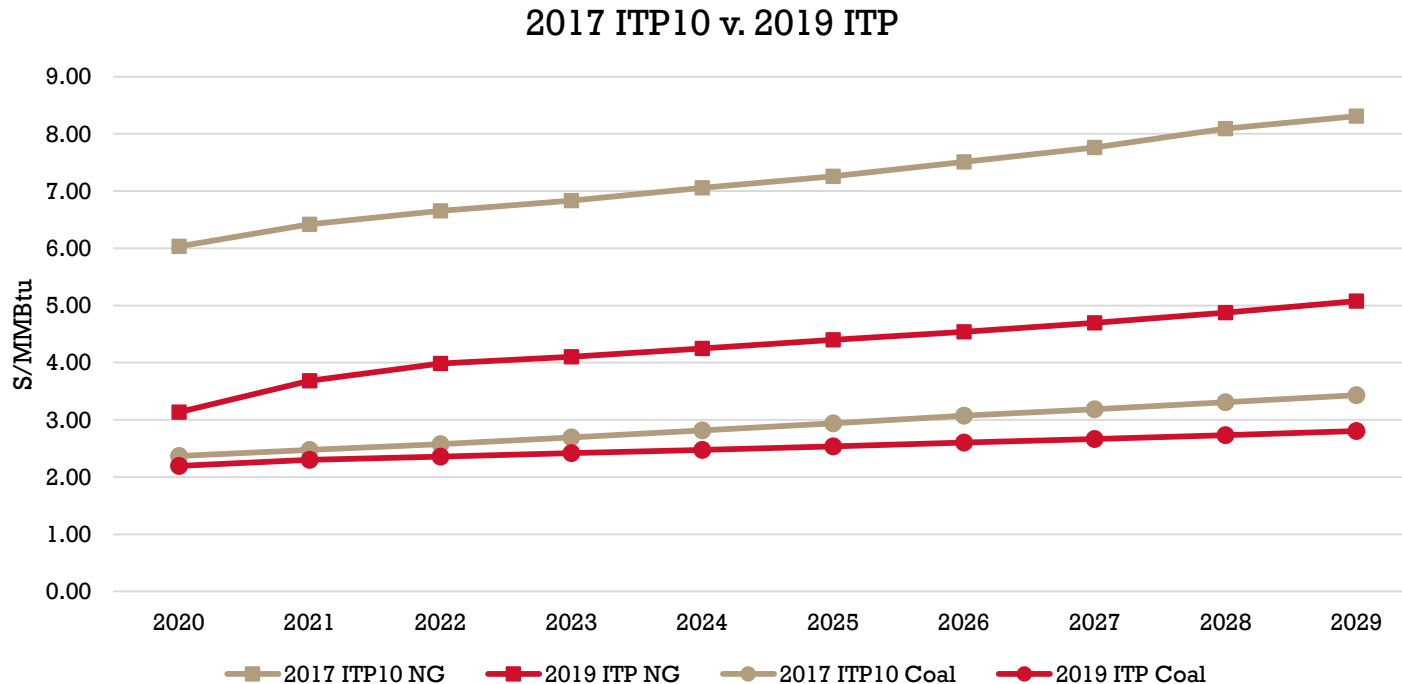
- Provide results of Benchmarking milestone
- Seek approval of completion of Benchmarking milestone

Benchmarking Results

- **Input Comparisons:**
 - Natural Gas and Coal Price
 - Annual Energy
 - Annual Capacity by Fuel Type
- **Capacity Factors & Average Energy Costs**
- **Renewable Output**
- **LMPs**
- **Interchange**
- **Adjusted Production Cost**
- **Generator Outages**
- **Reserve Margin**
- **Congestion**

- **Note: 2017 ITP10* indicates 2017 ITP10 PROMOD Simulations implementing the lower natural gas forecast being utilized in the 2019 ITP.**

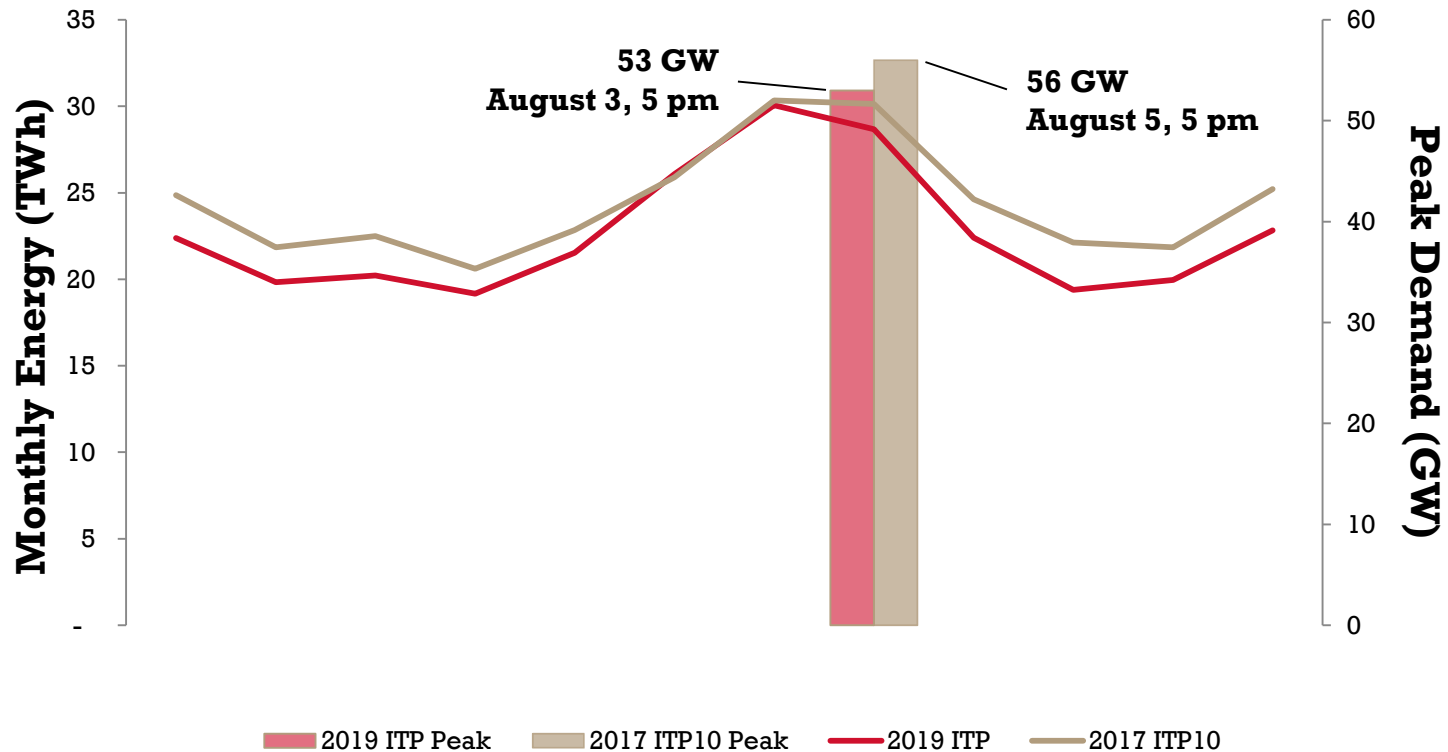
Natural Gas and Coal Price Comparison



- Coal forecast shown is the average of SPP Central, Nebraska, and KSMO coal forecasts.
- The natural gas price and coal price in the 2019 ITP model is lower than the 2017 ITP10 model.

Annual Energy Comparison

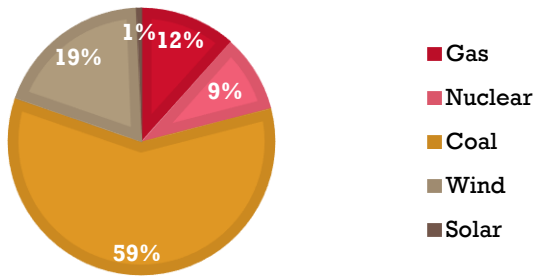
2017 ITP10 F3 2020 v. 2019 ITP Y2



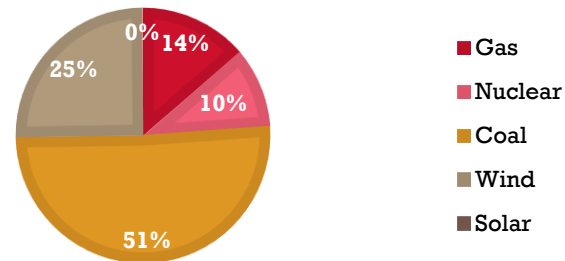
Model	2021 Coincident Peak Load (GW)	2021 Annual Energy (TWh)
2017 ITP10	56.0	292.9
2019 ITP	52.9	272.5

Energy and Capacity Comparison

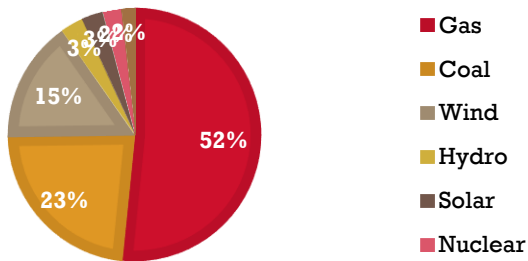
2017 ITP10 ANNUAL ENERGY BY FUEL TYPE



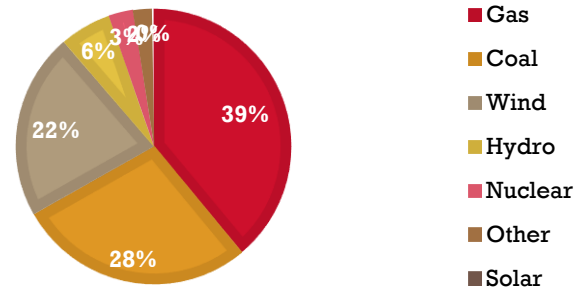
2019 ITP ANNUAL ENERGY BY FUEL TYPE



2017 ITP10 F3 2020 CAPACITY



2019 ITP Y2 CAPACITY



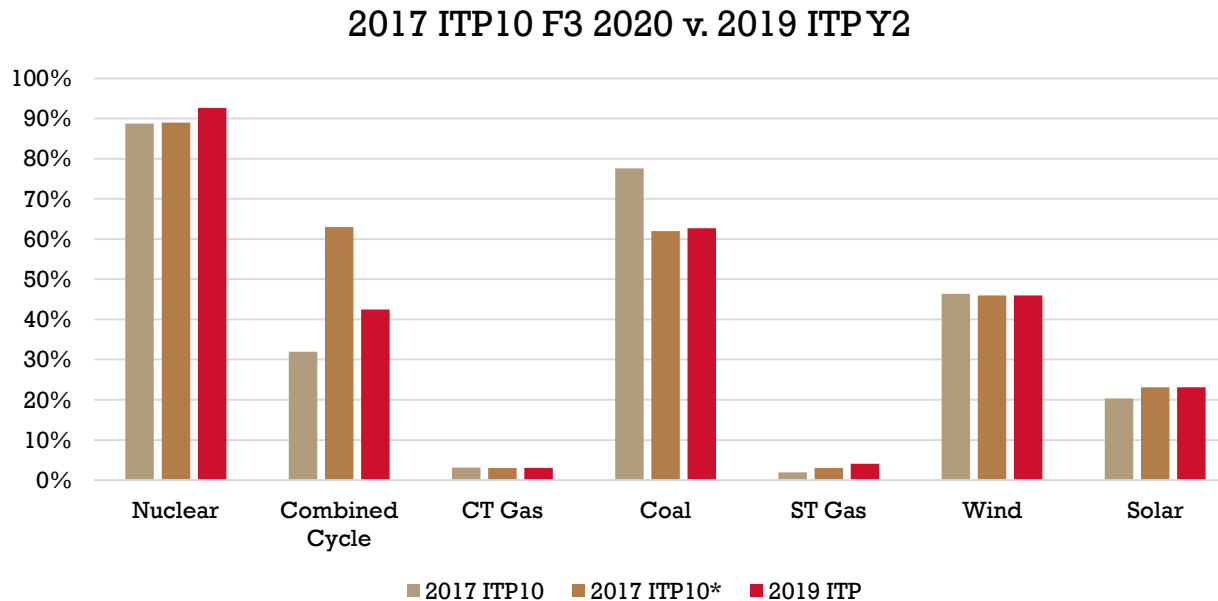
- The 2017 ITP10 energy and capacity charts include resource plan unit additions.

Capacity Factors and Average Energy Costs

Unit Type	Capacity Factor (Average)					Average Energy Cost (\$/MWh)		
	2014 EIA	2016 EIA	2017 ITP10 2020 F3	2017 ITP10* 2020 F3	2019 ITP Y2 (2021)	2017 ITP10 F3 2020	2017 ITP10* 2020 F3	2019 ITP Y2 (2021)
Nuclear	92%	92%	89%	89%	93%	\$15	\$15	\$15
Combined Cycle	50%	55%	32%	63%	41%	\$48	\$27	\$31
CT Gas	5%	8%	3%	3%	3%	\$76	\$40	\$44
Coal	60%	53%	78%	62%	61%	\$27	\$26	\$24
ST Gas	10%	12%	2%	3%	3%	\$72	\$44	\$41
Wind	34%	35%	46%	46%	46%			
Solar	26%	25%	20%	20%	23%			

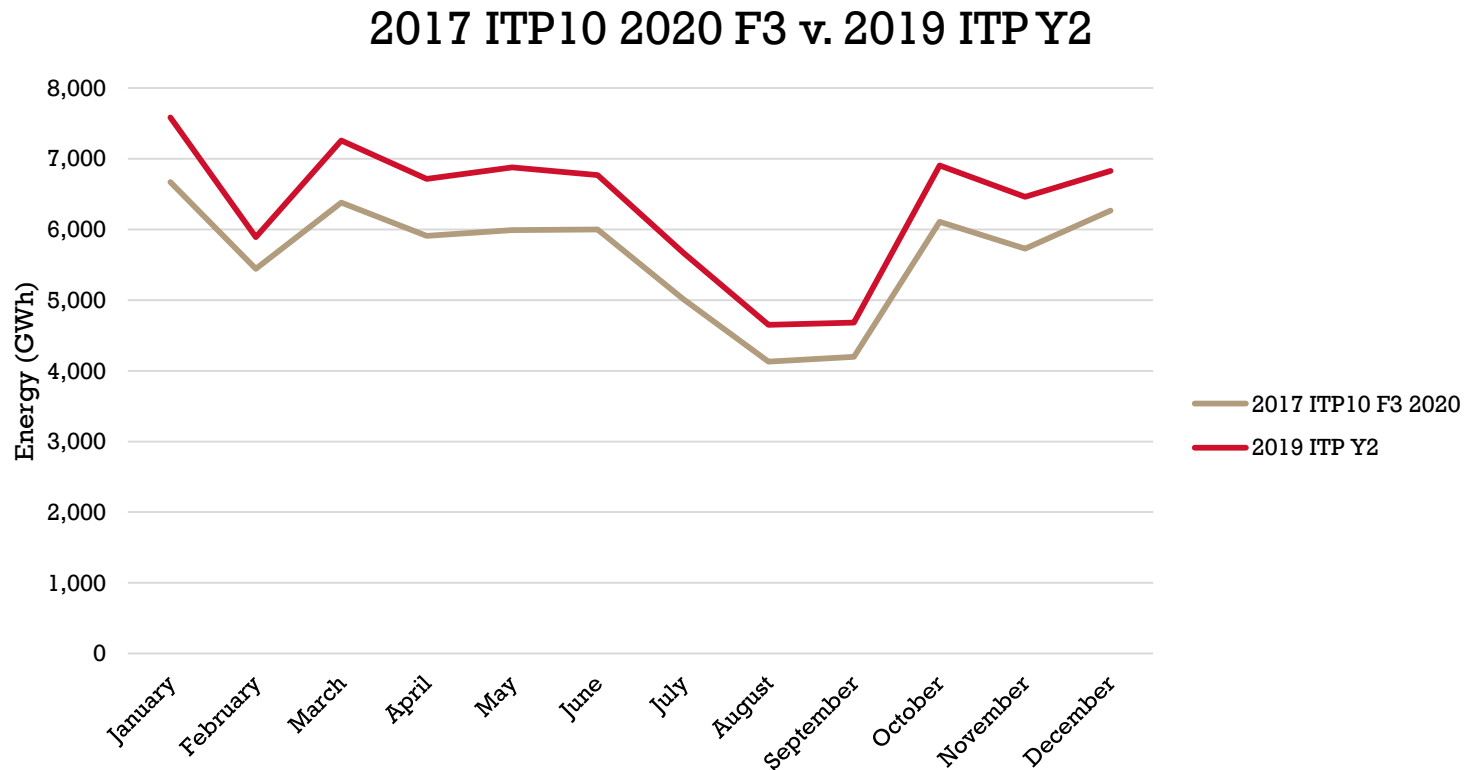
- Results shown are comparing Book of Flowgates event file simulations
- EIA capacity factors are taken from the Electric Power Monthly report published by EIA, and include resources outside of the SPP footprint as well as a lower gas price than is in the 2019 ITP model set.
- Capacity factors for the 2017 ITP10 model include resource plan unit additions.
- The price of natural gas in the 2019 ITP models is approximately half of the price of natural gas in the 2017 ITP10 models.
- The 2019 ITP models have more wind generation and lower a load forecast than the 2017 ITP10 models than the 2017 ITP10 models.

Capacity Factors by Unit Type



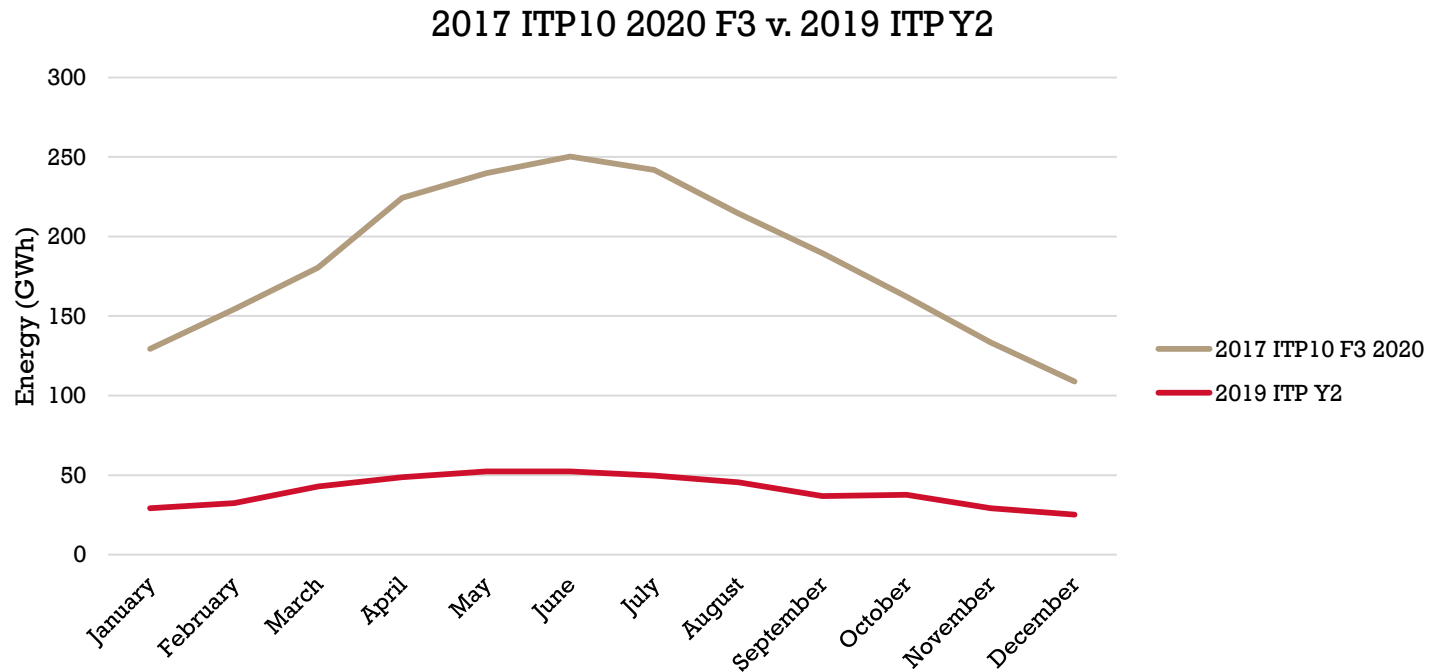
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SPP Wind Energy



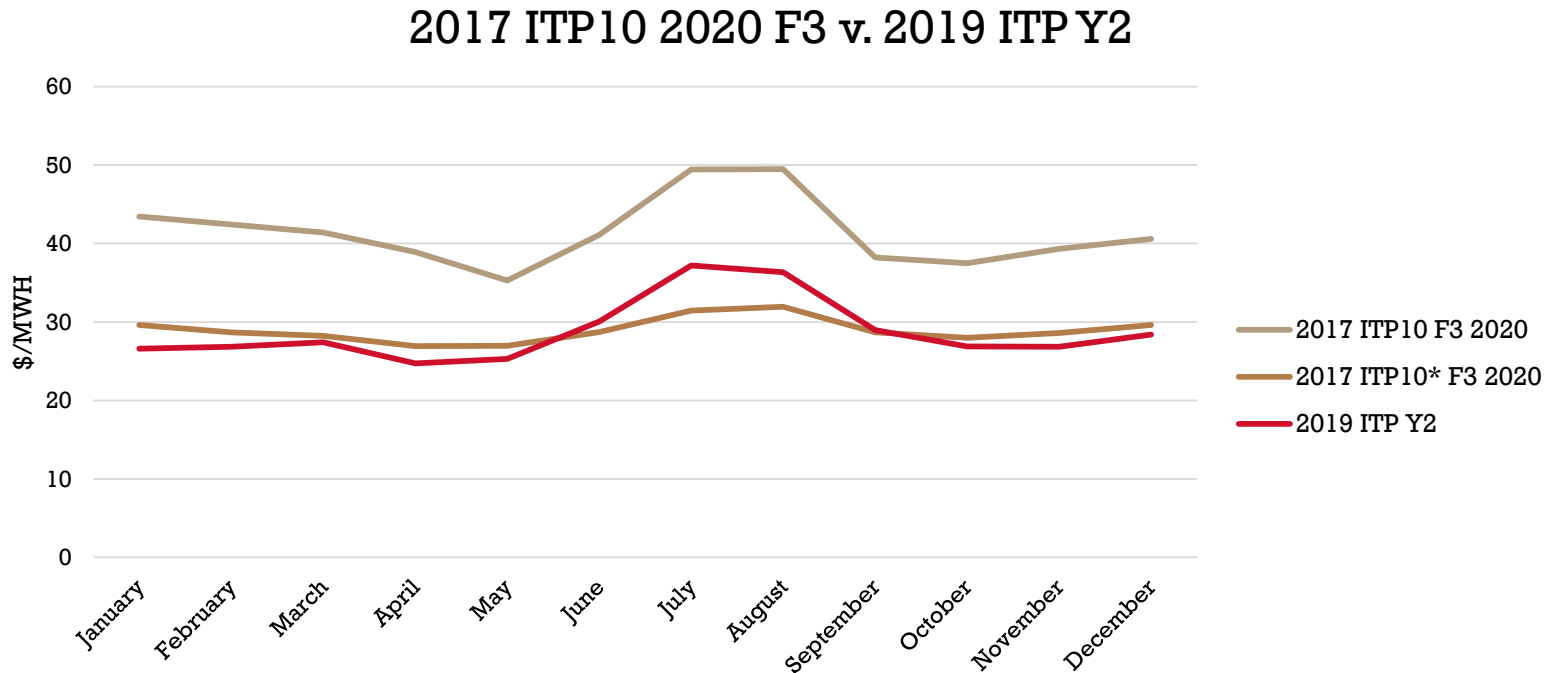
- Results shown are comparing Book of Flowgates event file simulations
- The 2017 ITP10 model includes wind resource plan additions
- The wind energy similarity between the two datasets is as expected based on the 2019 ITP Future definitions.

SPP Solar Energy



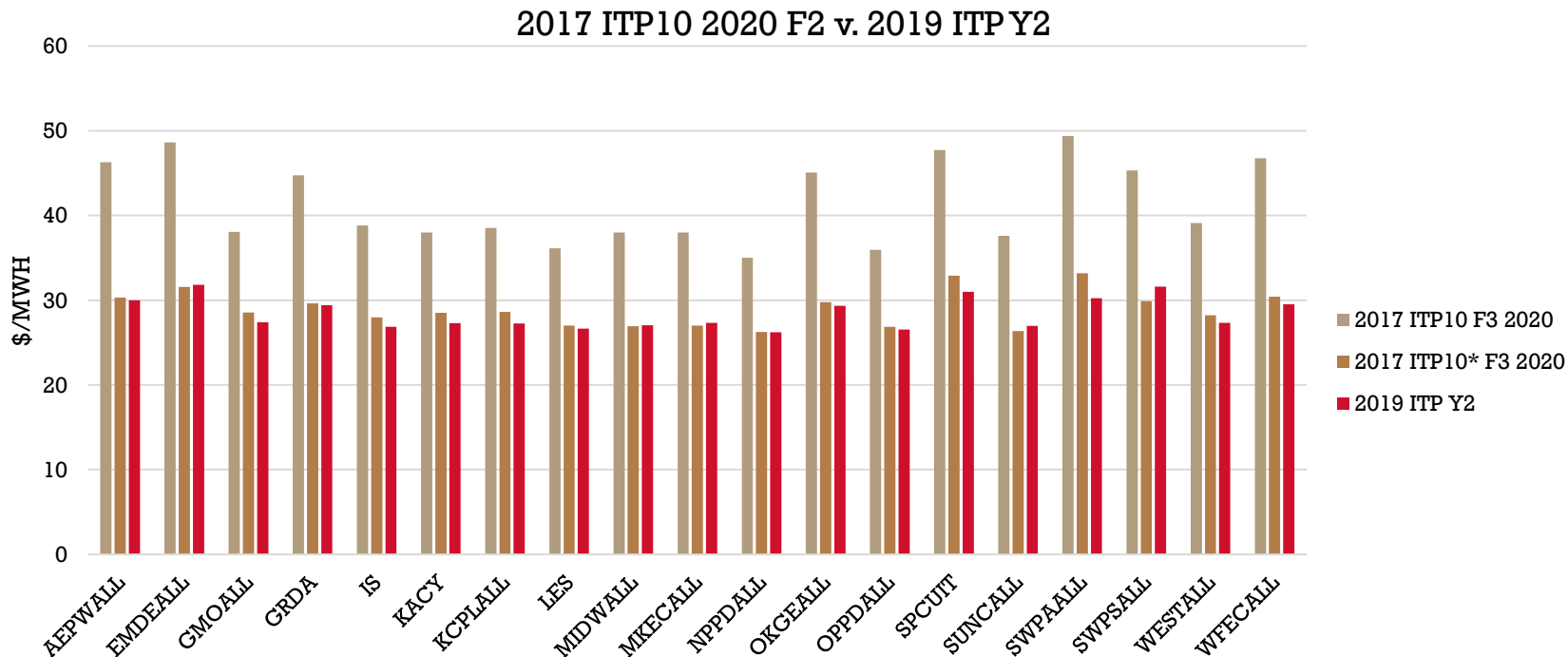
- Results shown are comparing Book of Flowgates event file simulations
- The 2019 ITP model uses the 2012 solar NREL dataset.
- The 2017 ITP10 model uses the 2006 solar NREL dataset.
- The 2017 ITP10 model includes utility scale and rooftop solar resource plan additions.

Monthly SPP Average LMP



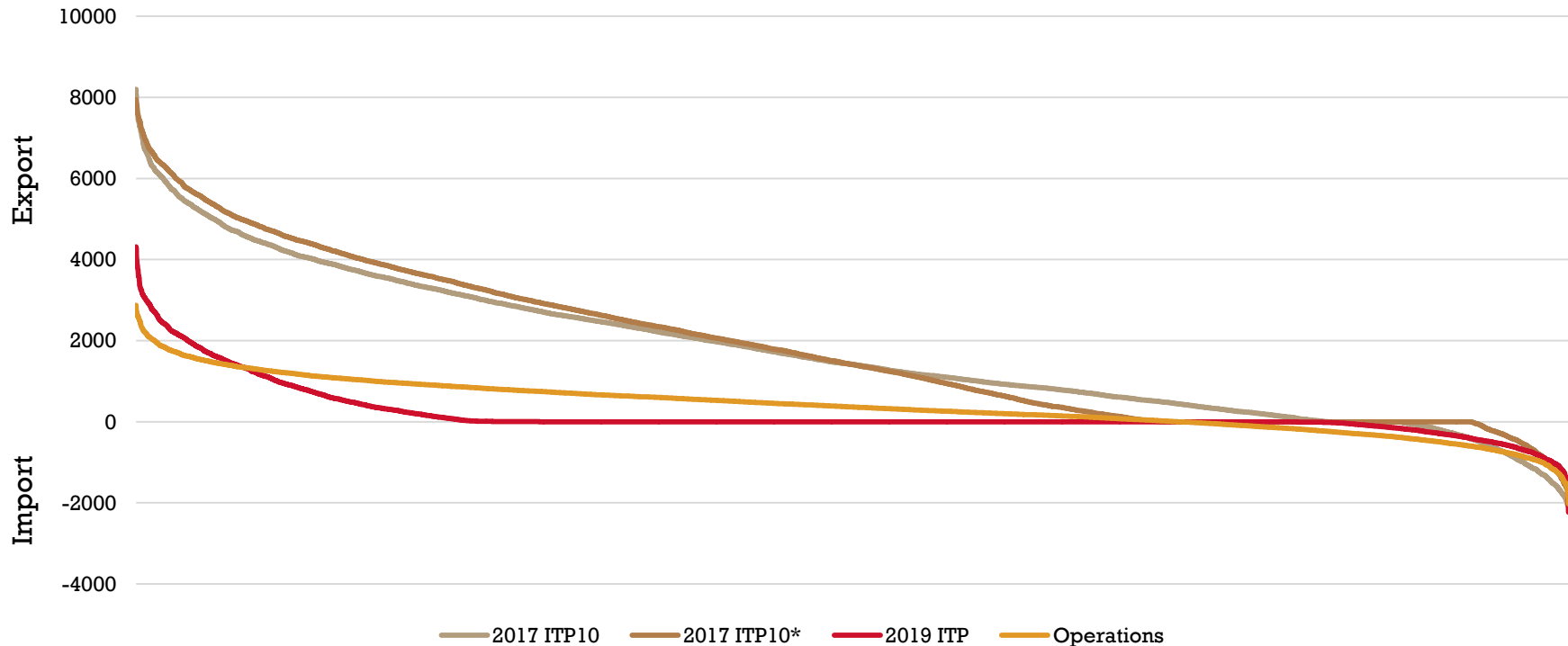
- Results shown are comparing Book of Flowgates event file simulations
- The decrease in the SPP average LMP in the 2019 ITP models is expected due to:
 - Lower natural gas price
 - Lower load forecast
 - Utilizing ABB parameters for generation units
- Applying the lower natural gas forecast to the 2017 ITP10 model decreases the SPP average LMP, aligning more with the 2019 ITP model.

Annual Average LMP by Zone



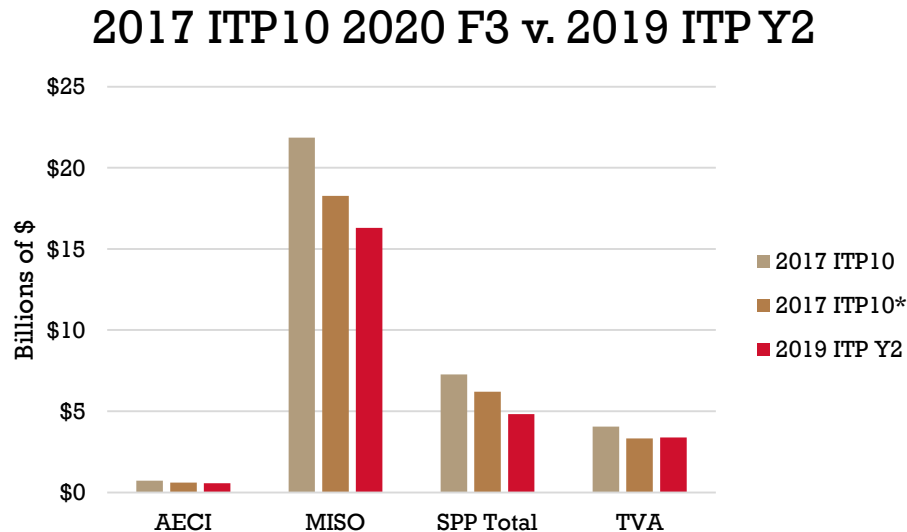
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Interchange



- The graph depicts hourly interchange plotted in order of magnitude.
- PROMOD results shown are comparing Book of Flowgates event file simulations
 - The positive values represent hours that have more generation than load (export)
 - The negative values represent hours that have more load than generation (import)
- Operations data is reflective of 2017 SPP Net Actual Interchange.
- The change in hurdle rate methodology between the 2017 ITP10 and 2019 ITP models (nodal hurdle rates v zonal hurdle rates) result in more hours with zero net interchange in the 2019 ITP model.
- SPP is a net exporter in all instances plotted above.

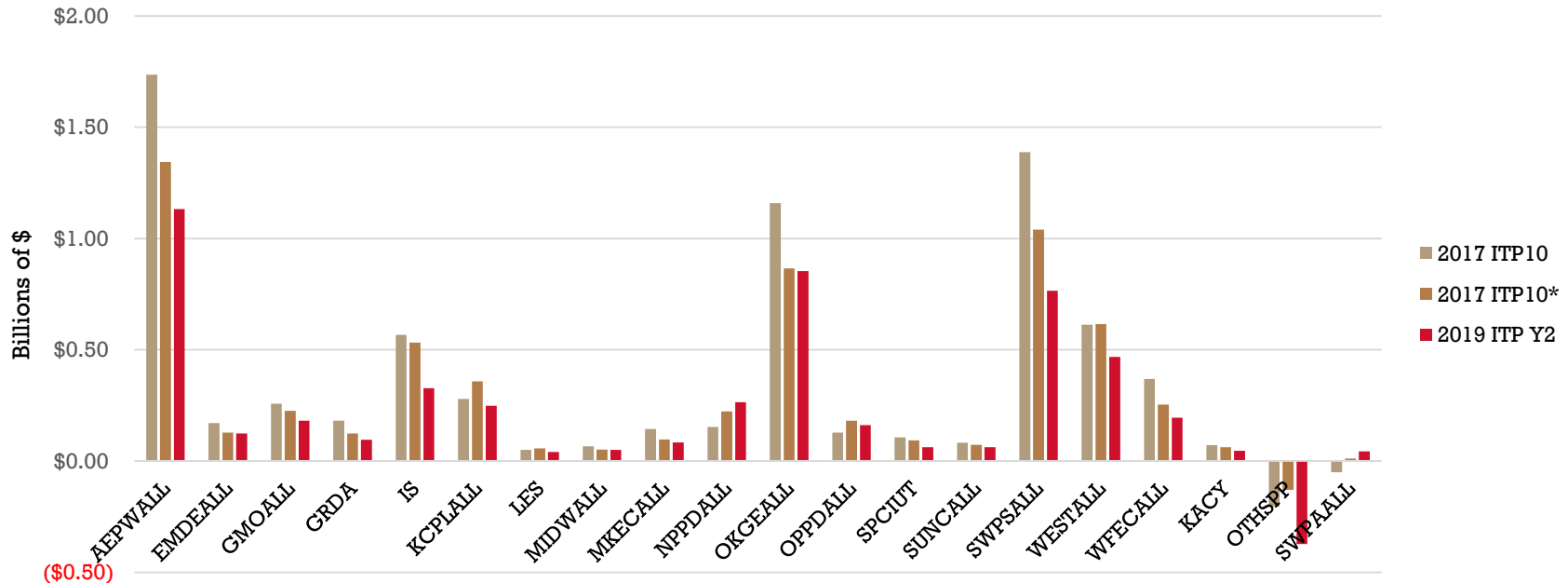
Adjusted Production Cost



- Results shown are comparing unconstrained model simulations
- The decrease in APC in the 2019 ITP models for all regions as shown above is expected due to:
 - Lower natural gas price
 - Lower load forecast
 - Utilizing ABB parameters for generation units
- Applying the lower natural gas forecast to the 2017 ITP10 model decreases APC across the translated regions, reducing the difference of APC with the 2019 ITP model.

Adjusted Production Cost by Zone

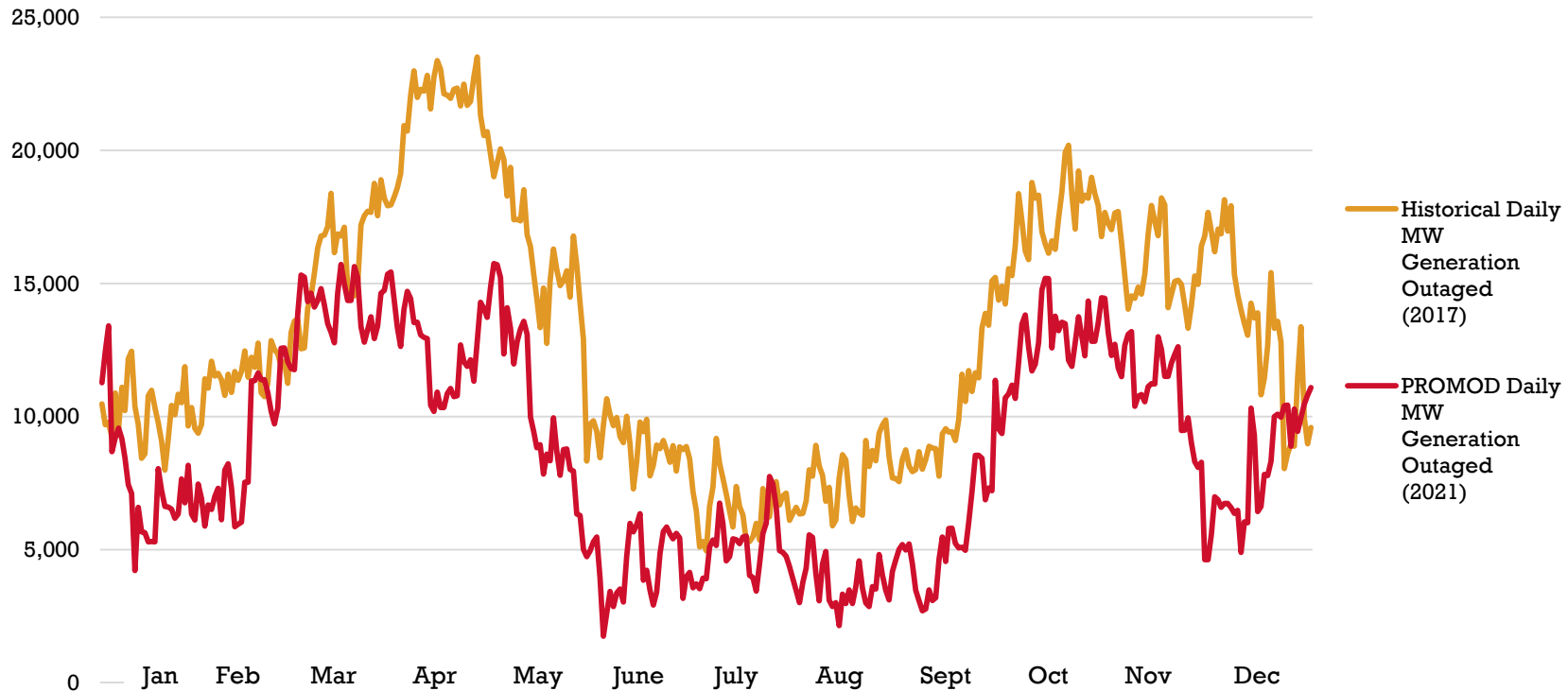
2017 ITP10 2020 F3 v. 2019 ITP Y2



- Results shown are comparing unconstrained model simulations
- “Other SPP” is negative due to the zone having sales and no purchases (all generation, no load).
- The decrease in APC in the 2019 ITP models for all SPP zones as shown above is expected due to:
 - Lower natural gas price
 - Lower load forecast
 - Utilizing ABB parameters for generation units
- Applying the lower natural gas forecast to the 2017 ITP10 model decreases APC across the translated regions, reducing the difference of APC with the 2019 ITP model.

Generator Outages

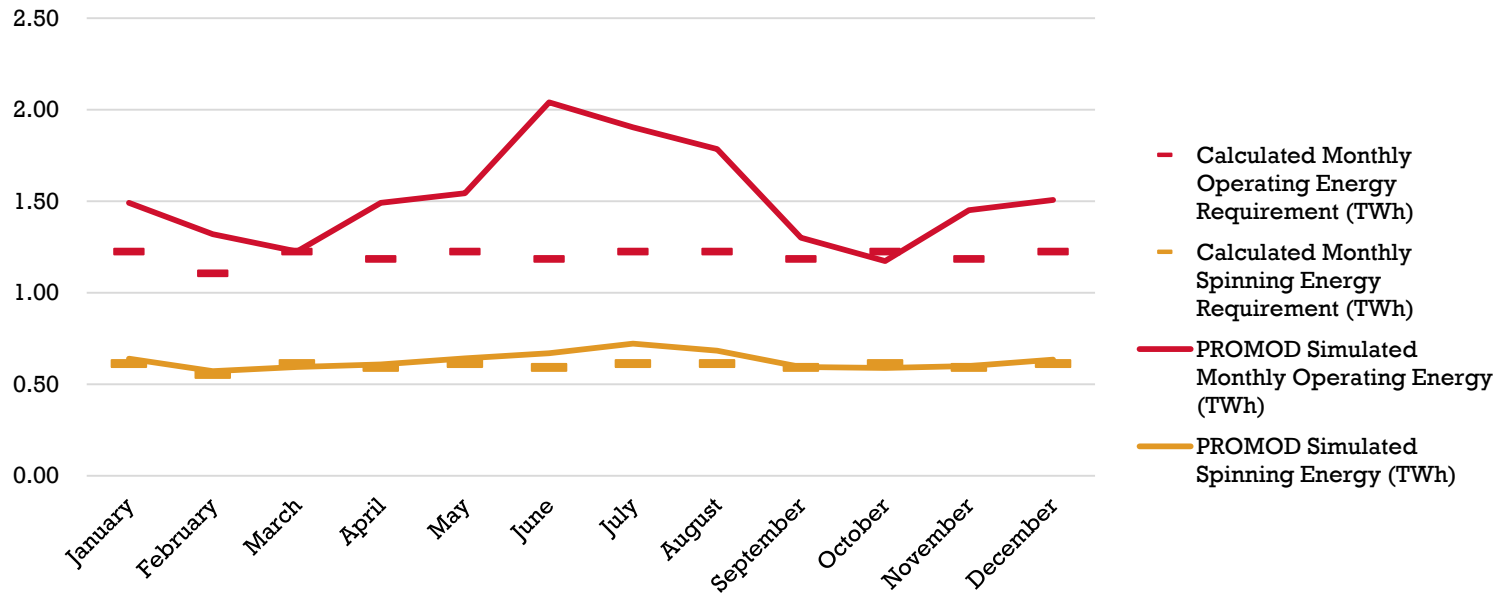
Historical Outages v. PROMOD Simulated Outages



- The 2017 Historical Outages are based on outage data from SPP Operations, and are generally higher in magnitude than historical outage data evaluated in previous study Benchmarking efforts. Operations data also includes additional outage types that are difficult to remove from the historical dataset.
- PROMOD simulated outages include automatic maintenance and forced outages.
- Although the magnitudes are different, the basic shape is similar between the two datasets, and the PROMOD simulated outages for the 2019 ITP Y2 model are comparable to the simulated outages for previous ITP studies.
- The distribution of outages by fuel type is consistent between SPP operations and the 2019 IPT Y2 PROMOD simulation.

Operating and Spinning Reserves

2019 ITP Y2 Operating and Spinning Reserves



- Results shown are Book of Flowgates event file simulations
- Monthly Reserve Calculations based on SPP Criteria:
 - Operating Reserve Requirement (GWh) = Sum of Capacity of Largest Unit and $\frac{1}{2}$ Capacity of 2nd Largest Unit)*Hours in the Month
 - Spinning Reserve Requirement (GWh) = Half of Operating Reserve Requirement*Hours in the Month
- The constraint violation file from the PROMOD output files does not show any spinning reserve violations for SPP.

Congestion

- SPP Staff is currently seeing some congestion in the 2019 ITP models that is representative of congestion in SPP Operations.
- SPP Staff will further evaluate congestion during and after the Constraint Assessment milestone.

Additional Notes

- SPP Staff will QA and continue to monitor model behavior during the Economic Model Build milestone.
- Any issues or anomalies will be brought to the appropriate working groups with resolutions, if applicable.

Recommendation

- SPP Staff recommends the Economic Model Benchmarking milestone be approved as complete for the 2019 ITP.