

Integrating Public Policy Phase 2: Reviewing Real Time Energy Market Simulation Results

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Market Issues Working Group

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Background- Phase 2 Presentations

Date	Working Group	Discussion points and links to materials
9-12-16	Budget & Priorities Working Group (BPWG)	Presentation of stakeholder feedback, proposed scope of the project
10-19-16	Market Issues Working Group (MIWG)	Presentation providing more detail on the scope and timeline of the project
11-22-16	Market Issues Working Group (MIWG)	Presentation updating project status -- consultant selection and goals of Phases 1 and 2
1-31-17	Market Issues Working Group (MIWG)	Integrating Public Policy Update (Phases 1 and 2)
2-16-17	Market Issues Working Group (MIWG)	Phase 2: Study Description and Assumptions Review
3-28-17	Market Issues Working Group (MIWG)	Phase 2: Study Description and Assumption Update
4-24-17	Market Issues Working Group (MIWG)	Phase 2: Preliminary DAM Results
6-21-17	Market Issues Working Group (MIWG)	Phase 2: Real-time Study Description and Assumptions
7-13-17	ICAP Working Group (ICAP WG)	The ICAP Market - Preliminary Findings (Phase 2)
8-22-17	ICAP Working Group (ICAP WG)	IPP Phase 2 Capacity Market Results and background information
8-25-17	Market Issues Working Group (MIWG)	IPP Phase 2: Simulation Progress

The study

- **Goal:**
 - Study the impacts of decarbonization goals on the current NYISO energy and capacity market rules.
- **Why:**
 - To help inform whether other market products or changes to the existing market structure will be necessary to meet the anticipated reliability needs (Phase 3).
- **How:**
 - Use the NYISO's market software in study mode.
 - Add sufficient renewable resources to meet the Clean Energy Standard ("CES") 50% renewable by 2030 goal.
- **The Caveat:**
 - This study is not a planning study. The question of underlying transmission upgrades to support CES is an important one but is not part of the scope of this work.
 - We will not be making any assumptions on generator retirements, new transmission etc.

Assumptions

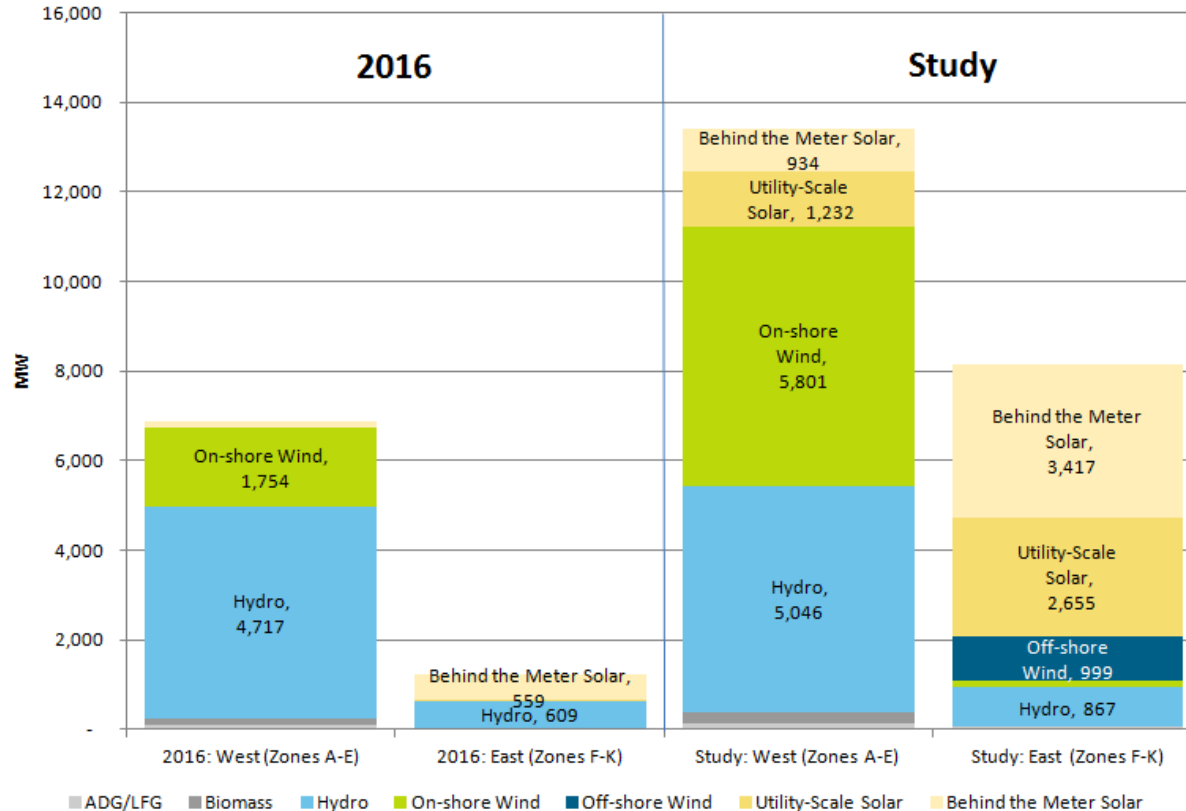
- The study focuses on four days in 2016: a summer high load day, a winter peak day and two shoulder days (one spring, one fall).
- How much incremental generation and where?
 - The primary source of projections for the quantity and location of qualified CES renewable generation is the [NYSDPS Final Supplemental Environmental Impact Statement](#) (“Final EIS”) in CASE 15-E-0302 using the “Blend Base Case.”
- How is the 24 hour profile determined?
 - DAM: Actual forecast data, where available, used to create the 24-hour generation shapes.
 - RT: Actual data from that day, where available, used to create 24-hour generation shapes.
 - Details can be found in the February 16 and March 28 presentations

Days Modeled

Study Day	Peak Load Forecast (MW)	Peak Hour	High-Low Temp. ALB/LGA	Gas Prices TNZ6/TZ6NY	Other
Tuesday, January 19, 2016	22,168	18:00	23-13/29-18	\$4.20/\$6.25	Winter peak
Tuesday, March 22, 2016	18,638	20:00	51-27/55-35	\$2.02/\$1.30	Indian Point 2 Refueling
Monday, July 25, 2016	31,401	16:00	89-68/91-81	\$2.91/\$2.83	Summer high load
Thursday, November 10, 2016	19,131	17:00	51-31/57-43	\$2.45/\$1.90	High wind

Note: Today's presentation covers preliminary results for March, July and November study days. Similar information will be provided for the January study day when it is available.

Today's renewables and study renewables



- ❖ The “study” case represents NYDPS Final Supplemental EIS installed megawatt (MW) projections.
- ❖ ADG/LFG = anaerobic digester/landfill gas generators.

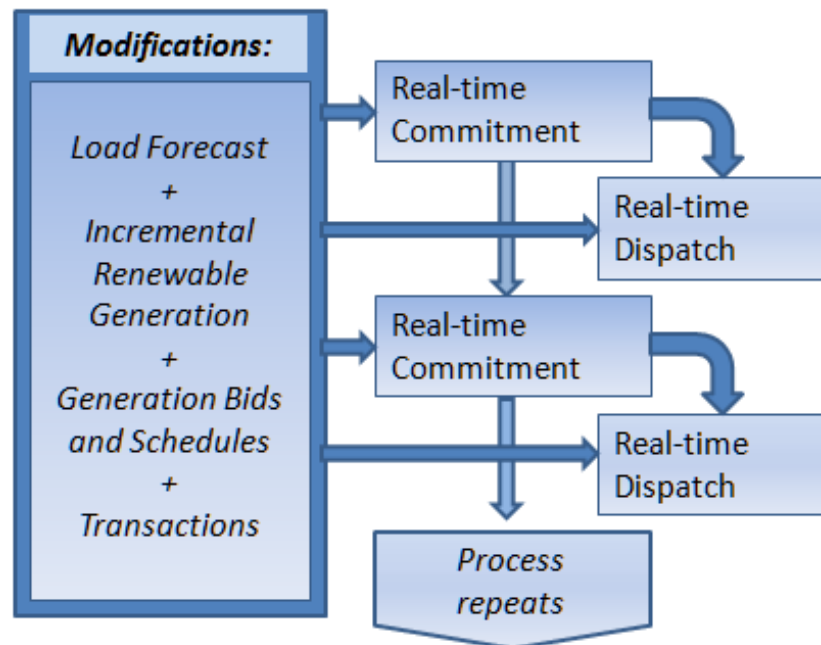


Since last presentation:

- **Re-ran DAM and RT simulations with updated assumptions:**
 - Reduced simulation virtual bid for incremental renewable resources from negative \$10 to negative \$47, which equals the sum of the 2016 Production Tax Credit plus the average NYSERDA Renewable Energy Credit
 - Simulated off-shore wind forecast error
 - To prevent correlation with on-shore wind forecast errors a different day's errors from existing wind facilities were applied to the study days
 - Updated selected resource bids based on preliminary pricing results
 - Bids from selected resources bidding based on opportunity costs were adjusted to account for different RT LBMPs (scaled by the peak hour ratio of preliminary study LBMP to production LBMP).
 - Selected resources bidding a higher RT Lower Operating Limit (LOL) than DAM LOL had their RT LOL in the study changed to their DAM LOL so their study DAM schedules were achievable within their RT operating range.

Real-Time Market Simulation Process

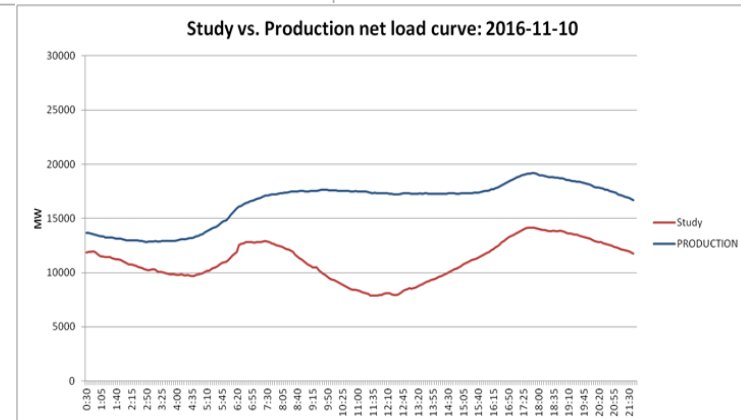
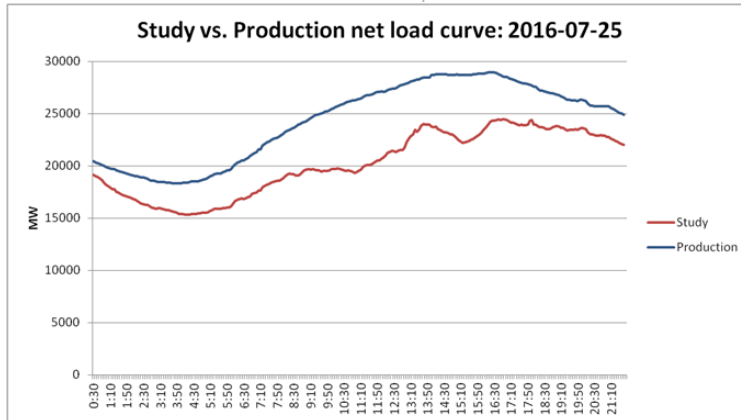
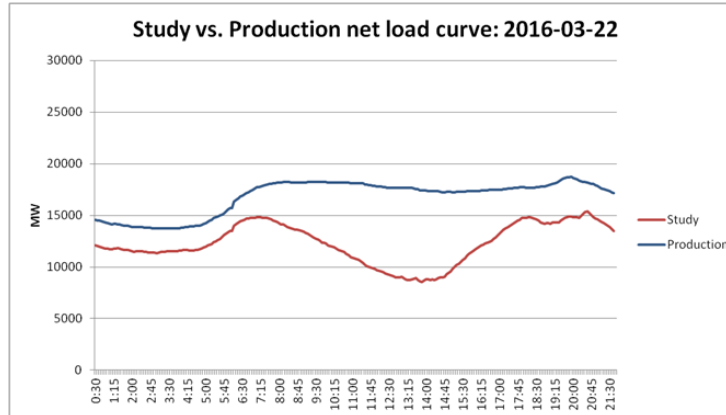
- Hourly commitments from DAM simulations passed to the real-time simulation
- Modifications are read into the solver for each RTC and RTD evaluation
 - Behind-the-meter solar modifies zonal load forecast
 - Incremental Renewable Generation
 - Commitment Schedules for existing Generation
 - Lost-opportunity cost bids modified for some resources
 - Fixed Transaction Schedules
- Note that the simulation covers hours 1 through 20 and part of hours 0 and 21 because other hours depend on the prior/next day's bids.



RT Net Load

Net Load = Load – Added Renewable
Resources

IPP vs. Production net load curve



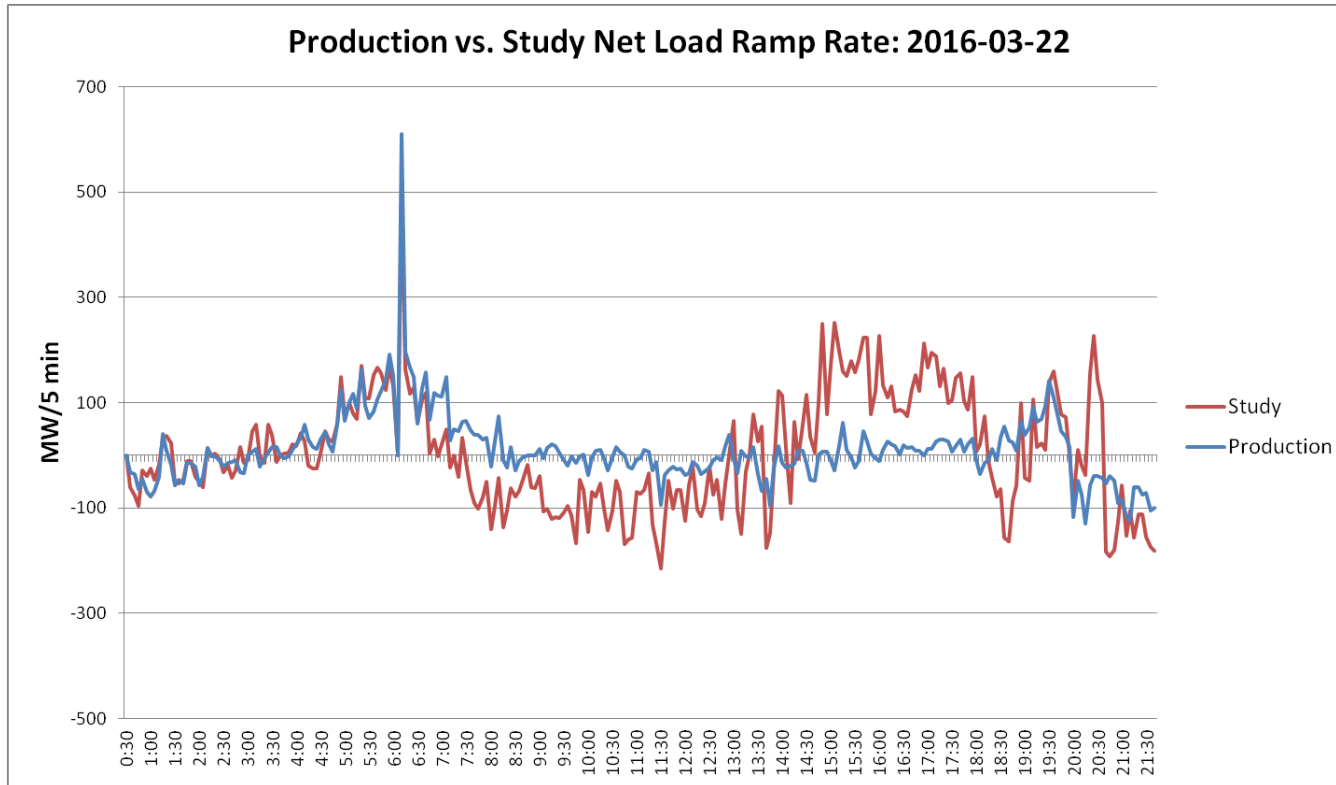
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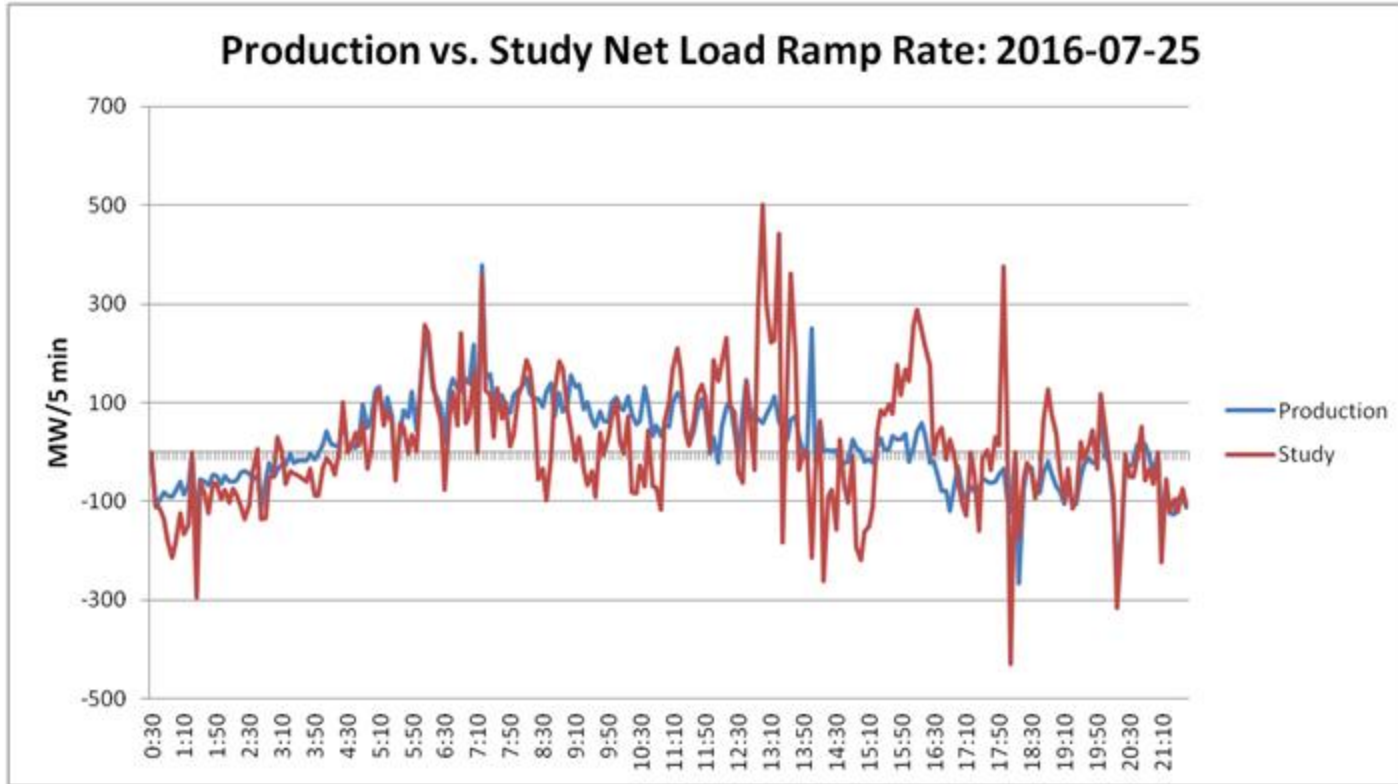
Net Load Ramp

Net Load ramp = the 5 minute change in
(load – added renewable resources)

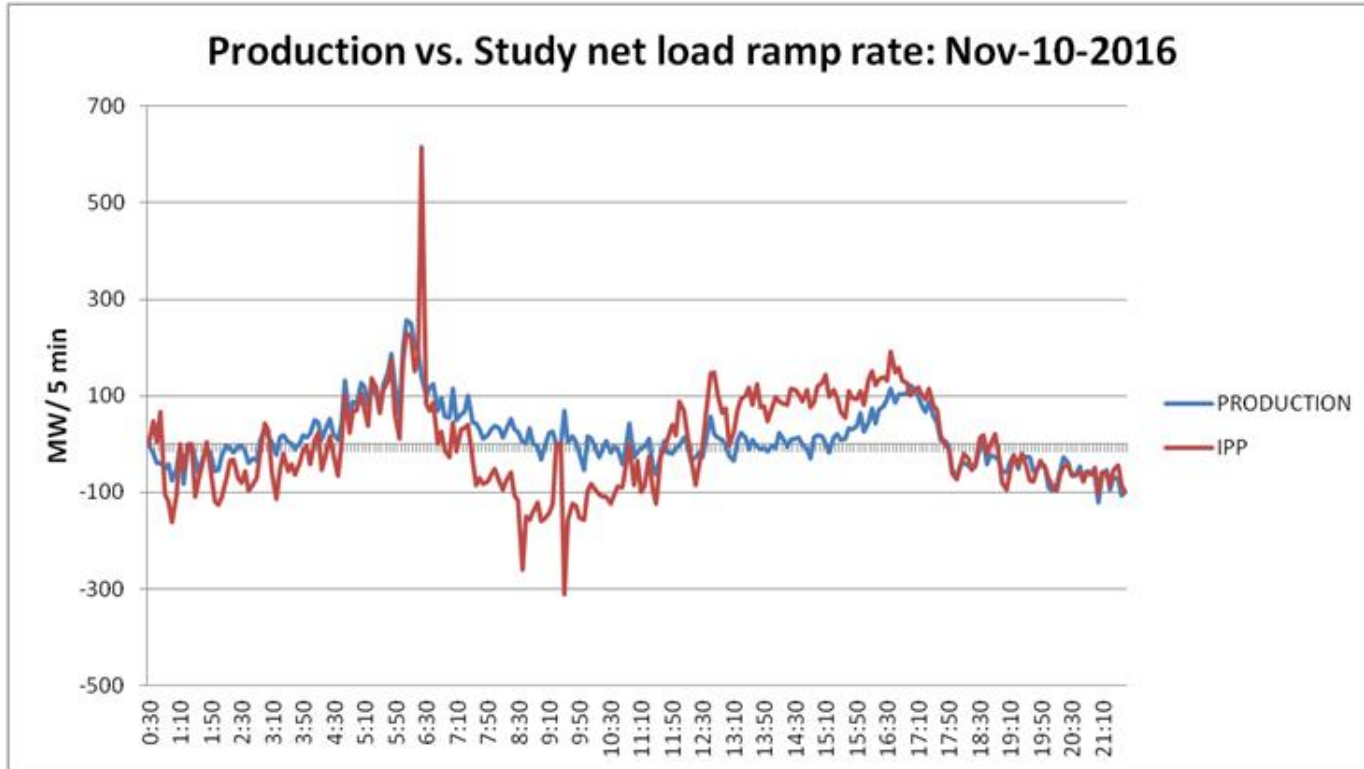
Net Load Ramp: March 22, 2016



Net Load Ramp: July 25, 2016

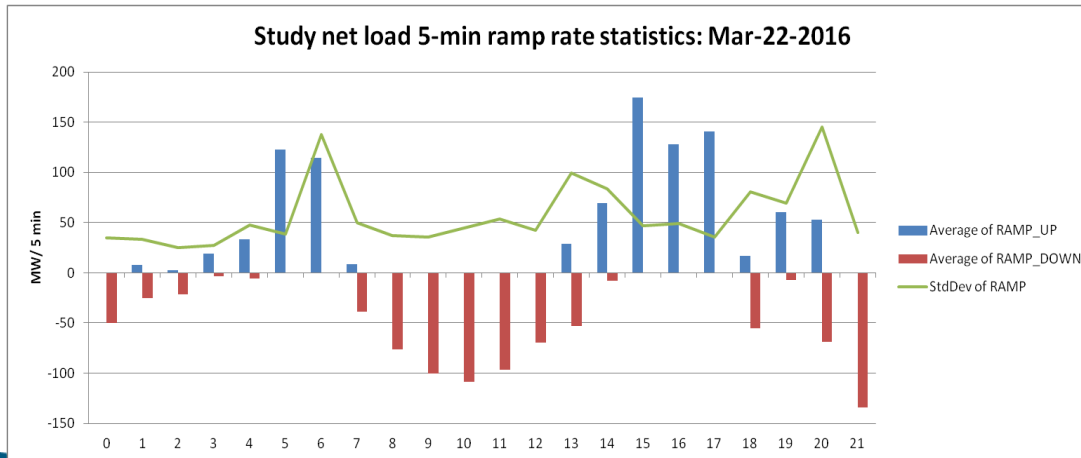
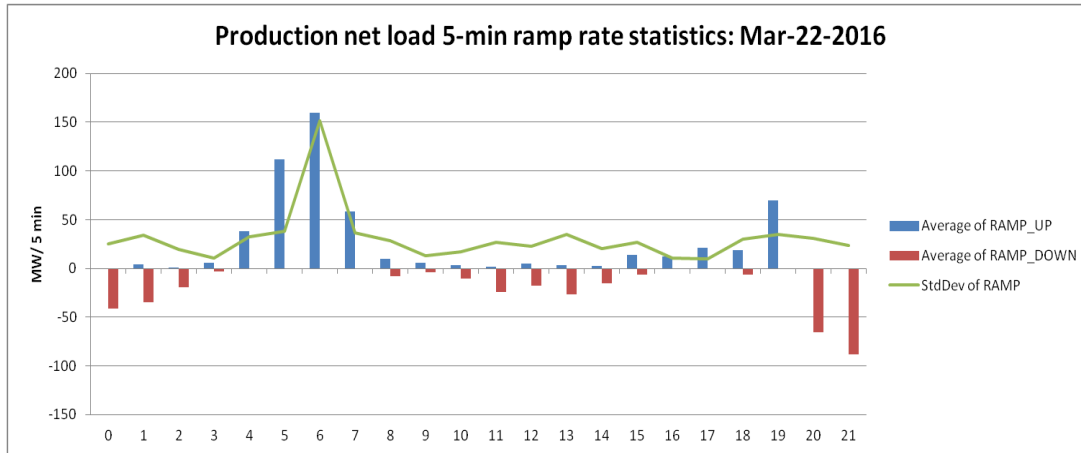


Net Load Ramp: November 10, 2016

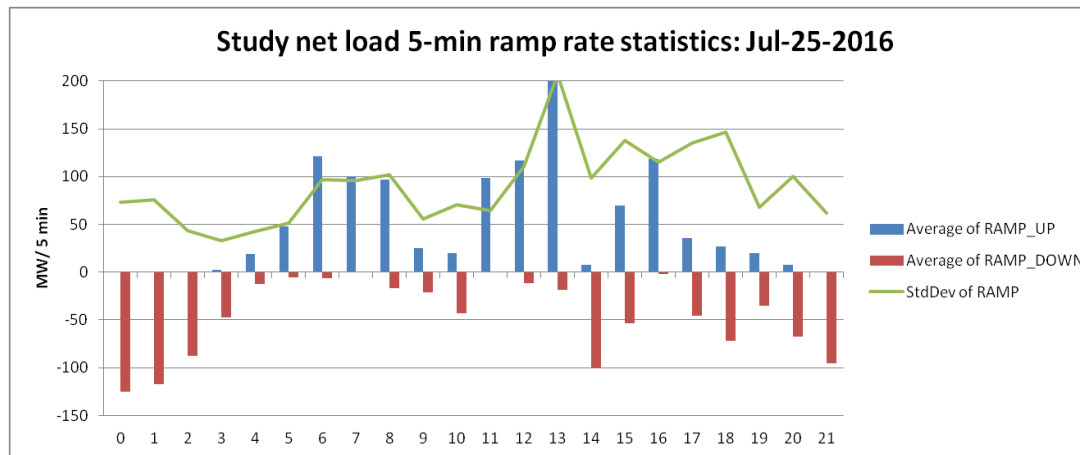
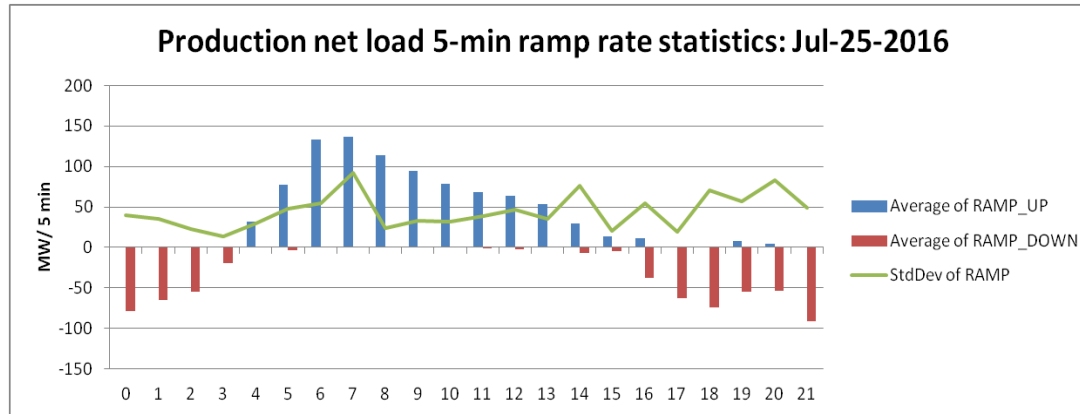


Net Load Descriptive Statistics

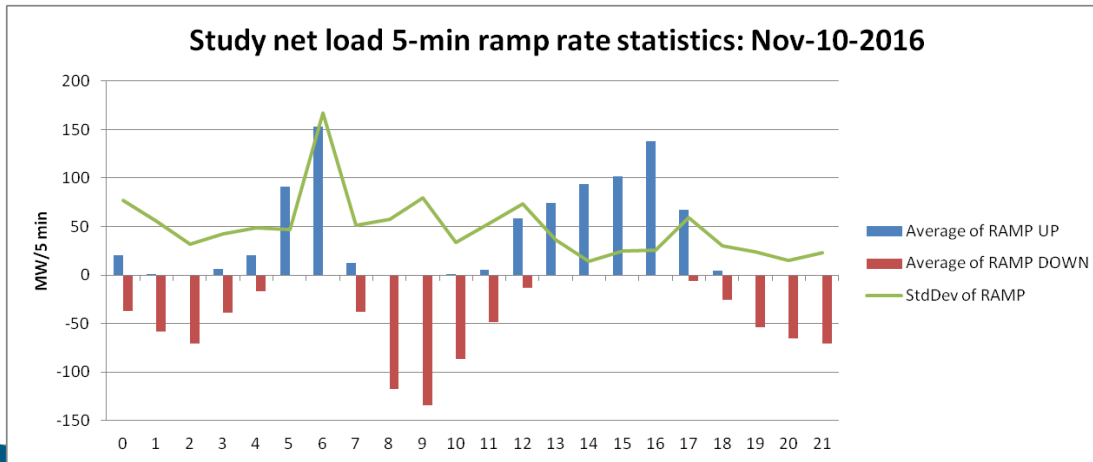
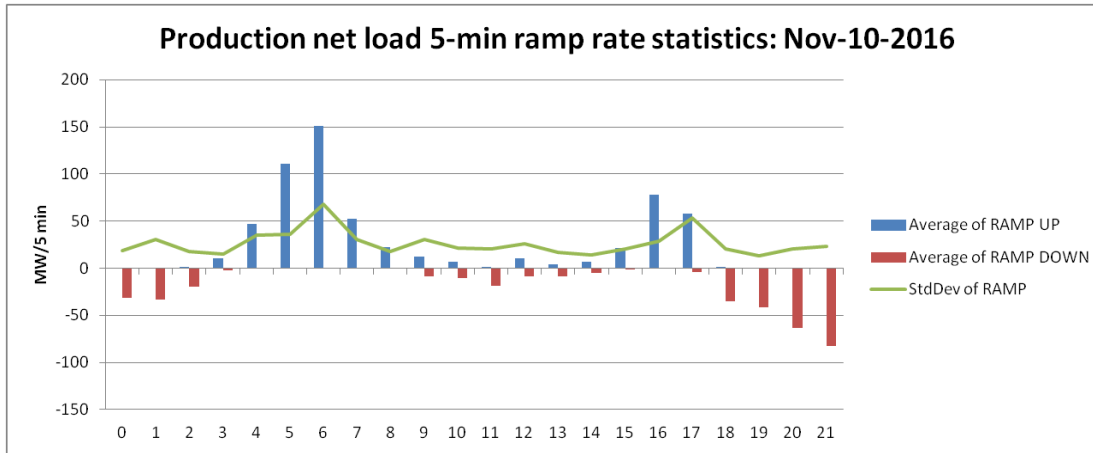
Net load ramp rate statistics: 2016-03-22



Net load ramp rate statistics: 2016-07-25



Net load ramp rate statistics: 2016-11-10

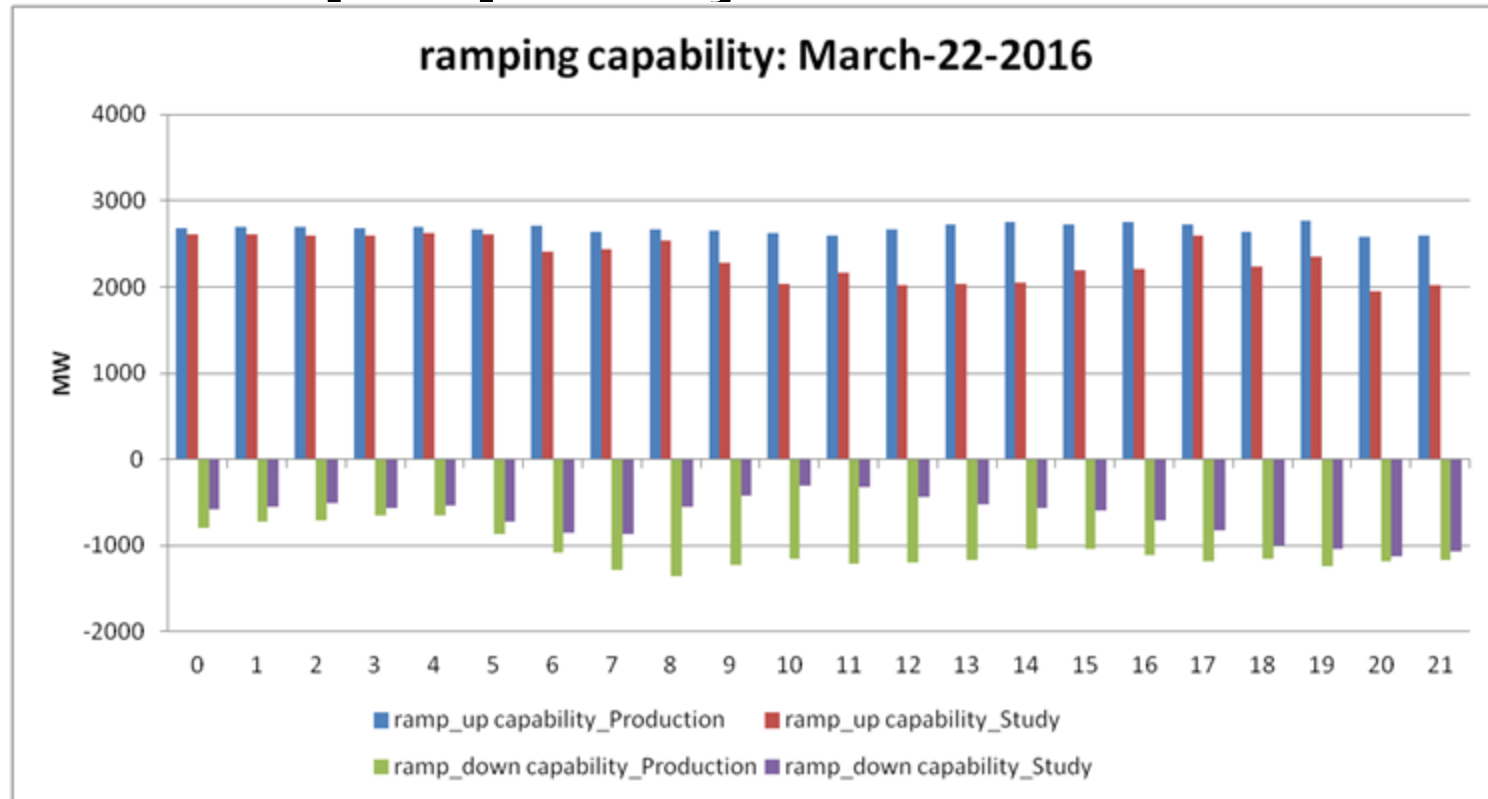


Ramp Capability

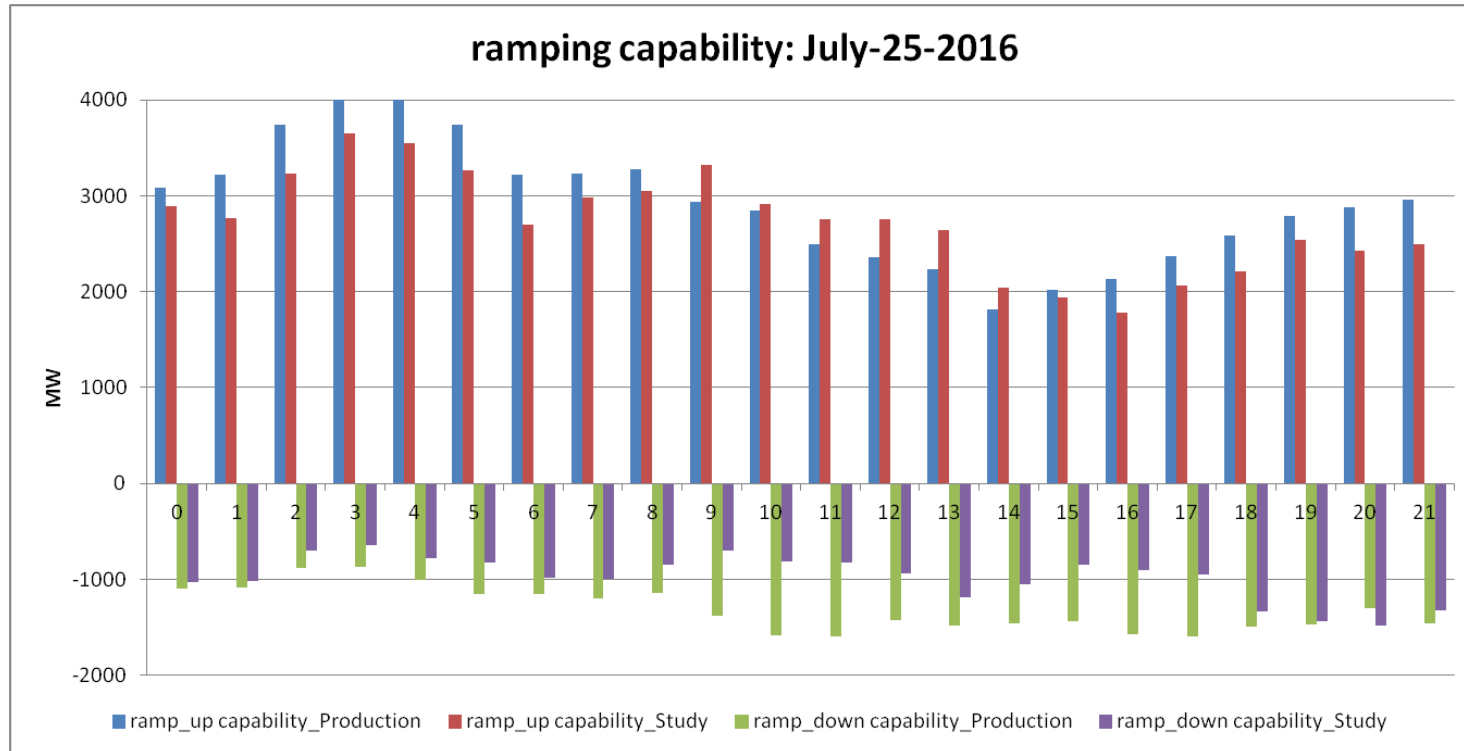
Ramp Capability

- This metric is intended to look at the available ramp in the next 5 minutes for existing generation (Note that this does not count the downward ramp that is available from renewable resources on dispatch)
- Definitions for the units:
 - system total ramp-up capability = sum (unit ramp-up capability)
 - system total ramp-down capability = sum (unit ramp-down capability)
 - unit ramp-up capability = min (UOL - schedule, 5*ramp rate/min) if the unit is on and unit ramp-up capability = 10 min quick start MW for units that are off.
 - unit ramp-down capability = min (schedule - LOL, 5*ramp rate/min) for units that are on and zero if off.

System ramp capability:2016-03-22



System ramp capability: 2016-07-25



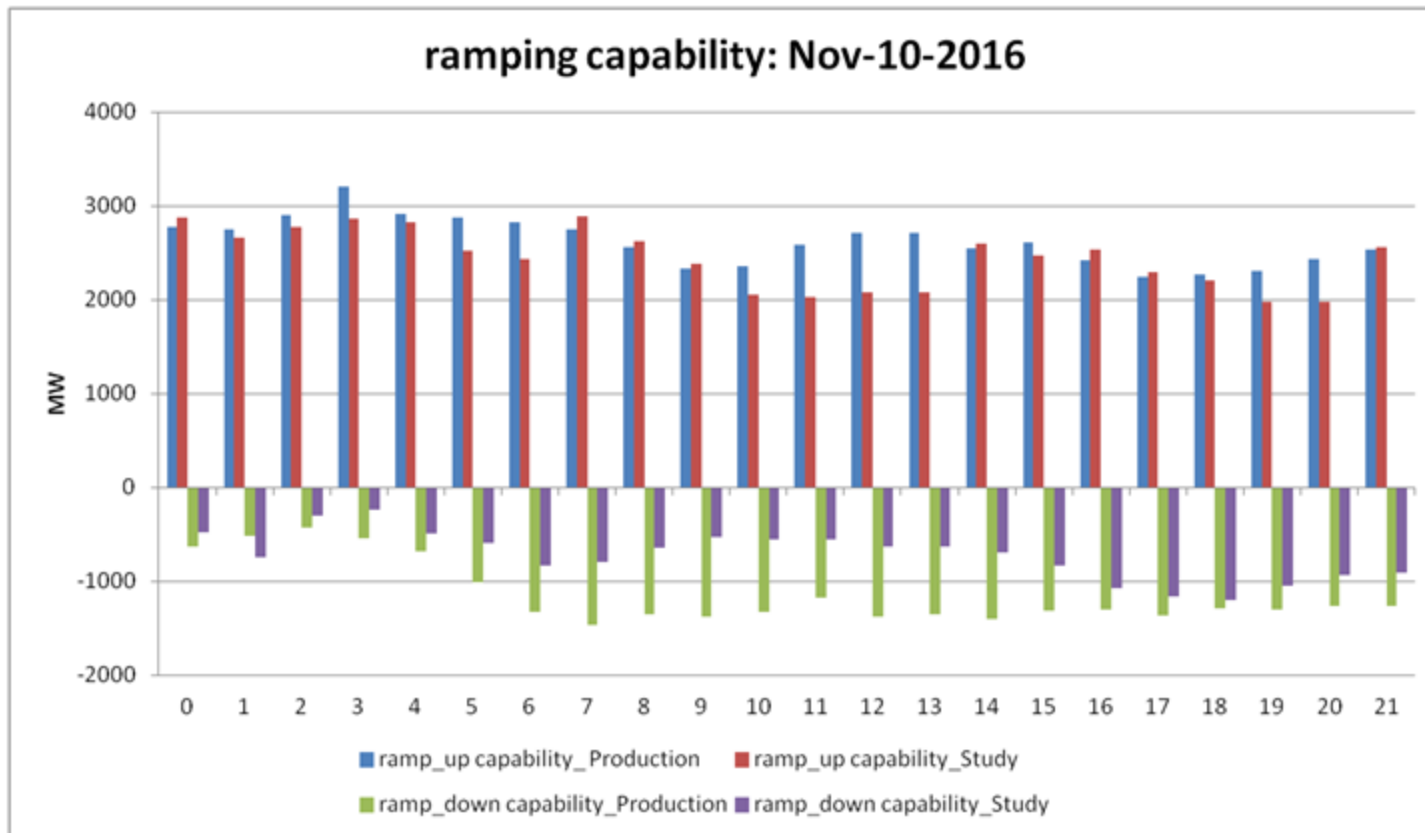
Slide updated 9/25

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System ramp capability: 2016-11-10



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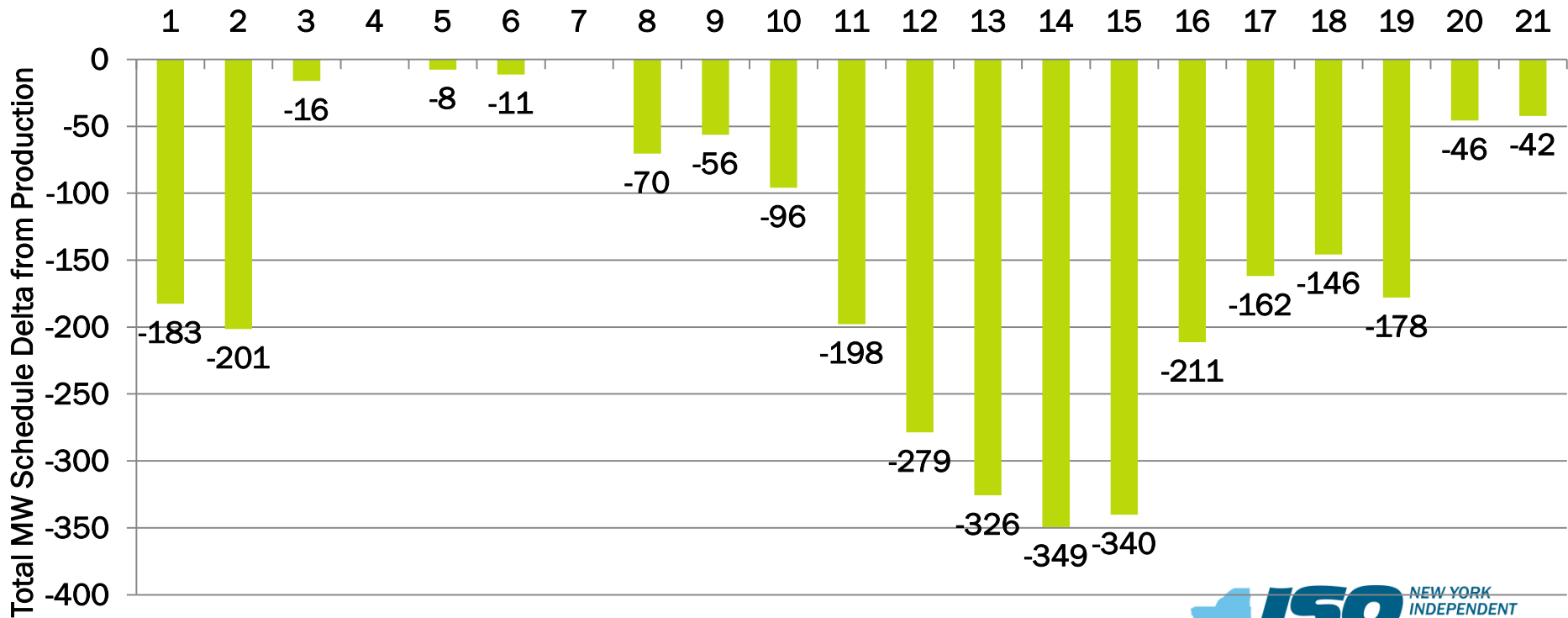
Changes in schedules from production

Resource Schedule Changes from Production

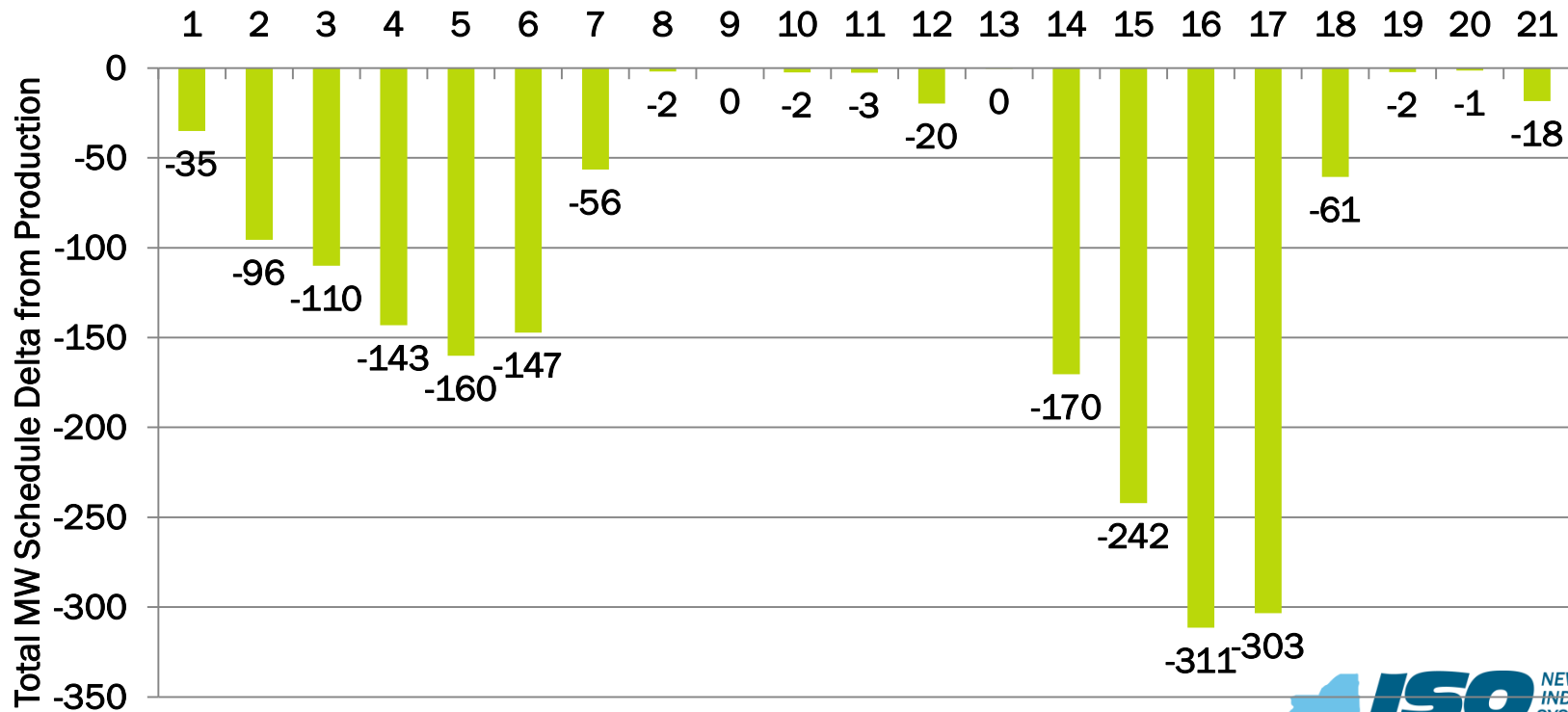
- In general, flexible resources currently connected to the grid were dispatched down, replaced by both the behind the meter resources and the renewables modeled as virtual supply
 - Units dispatched down include Conventional Hydro, Combined Cycle, Fossil Fuel Steam Turbine and existing wind resources.

RT wind curtailments of existing wind resources

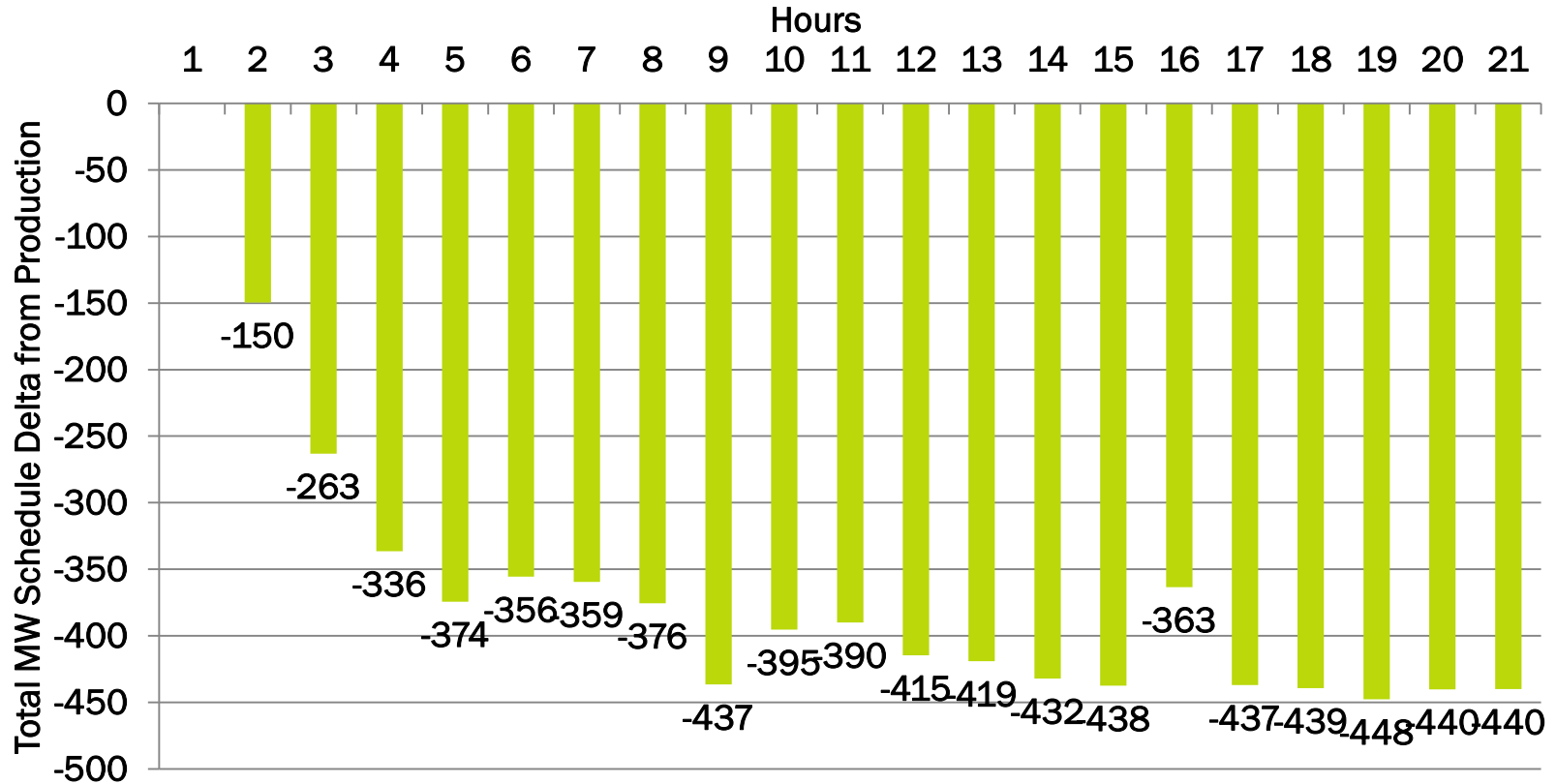
Wind Turbine Schedule MW Delta from Production - March Hours



Wind Turbine Schedule MW Delta from Production - July Hours



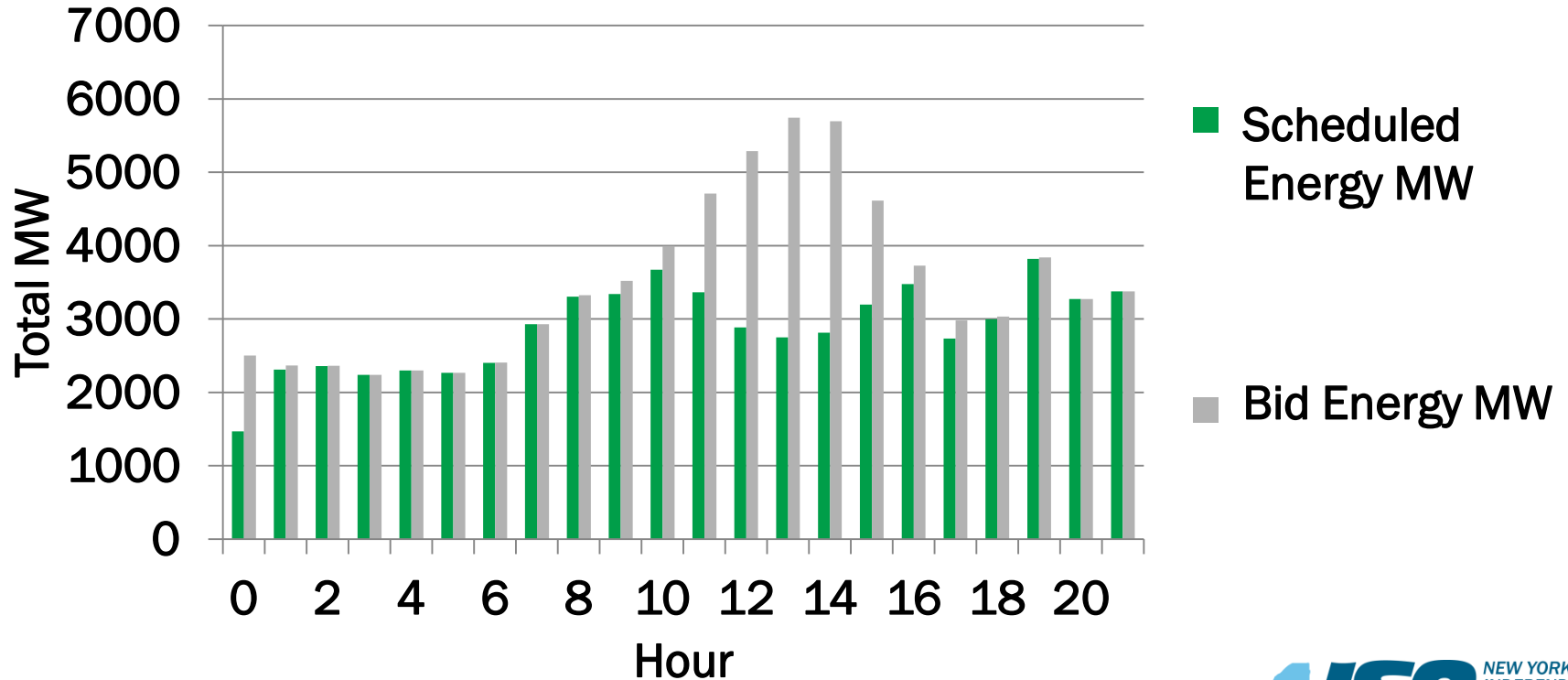
Wind Turbine Schedule MW Delta from Production - November



RT curtailments of added renewable resources

Virtual Bid MW compared to Scheduled MW

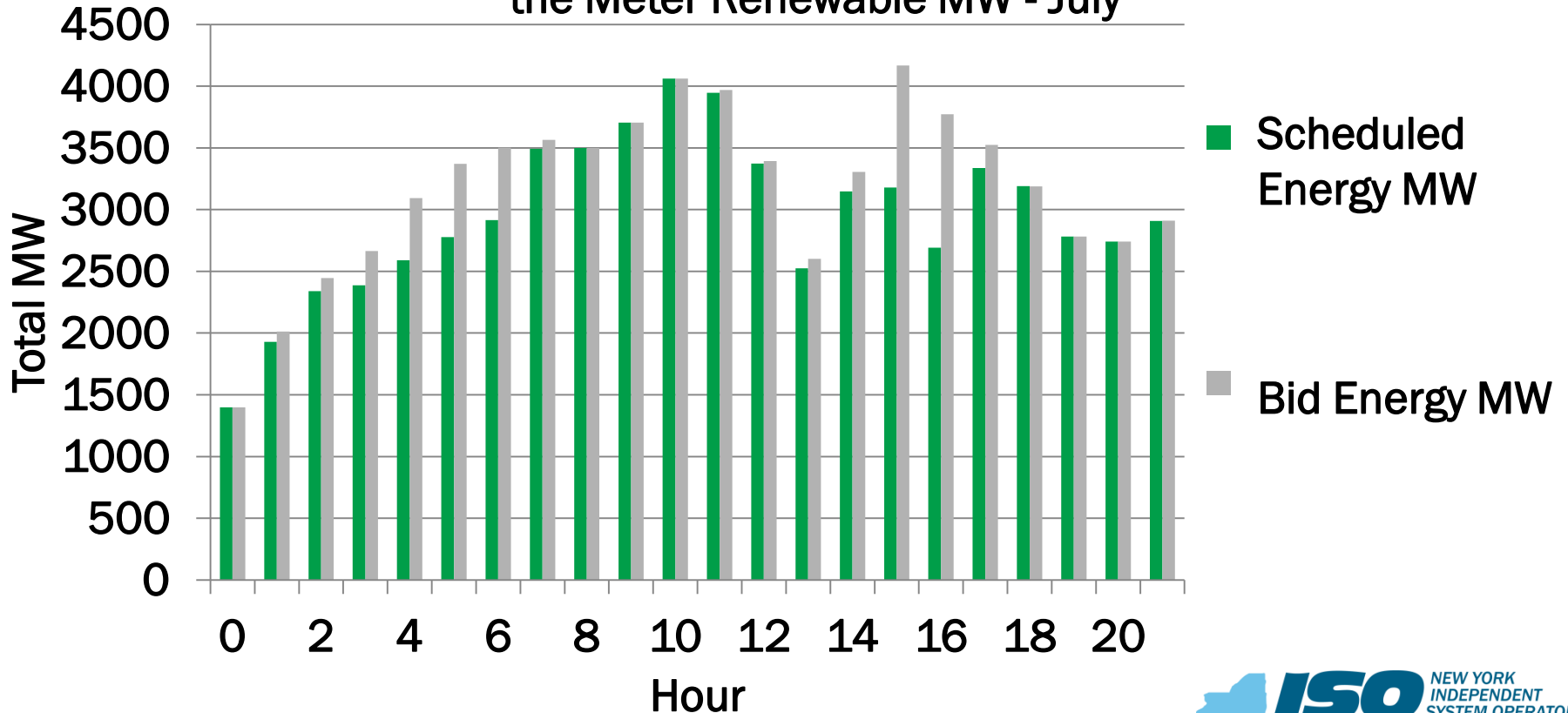
Real Time Hourly Average Bid MW Compared to Scheduled Front of the Meter Renewable MW - March



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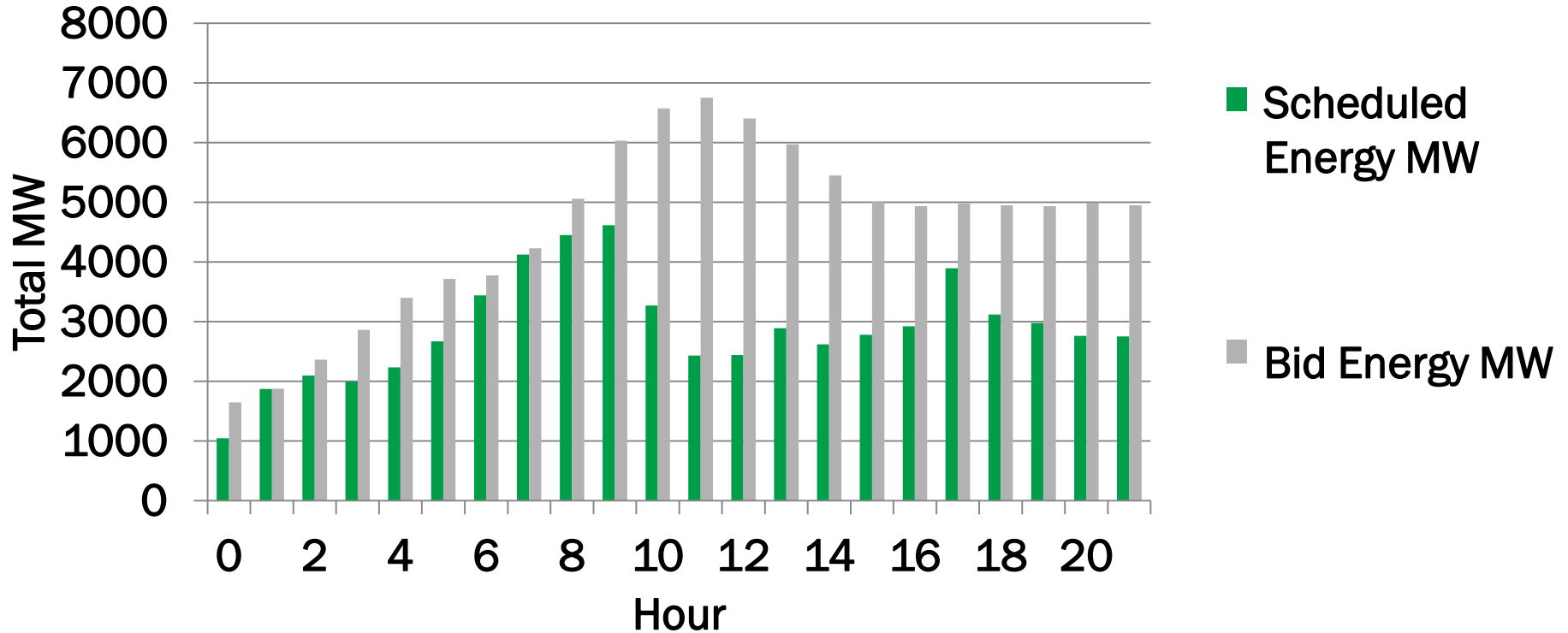
Real Time Hourly Average Bid MW Compared to Scheduled Front of the Meter Renewable MW - July



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Real Time Hourly Average Bid MW Compared to Scheduled Front of the Meter Renewable MW - November



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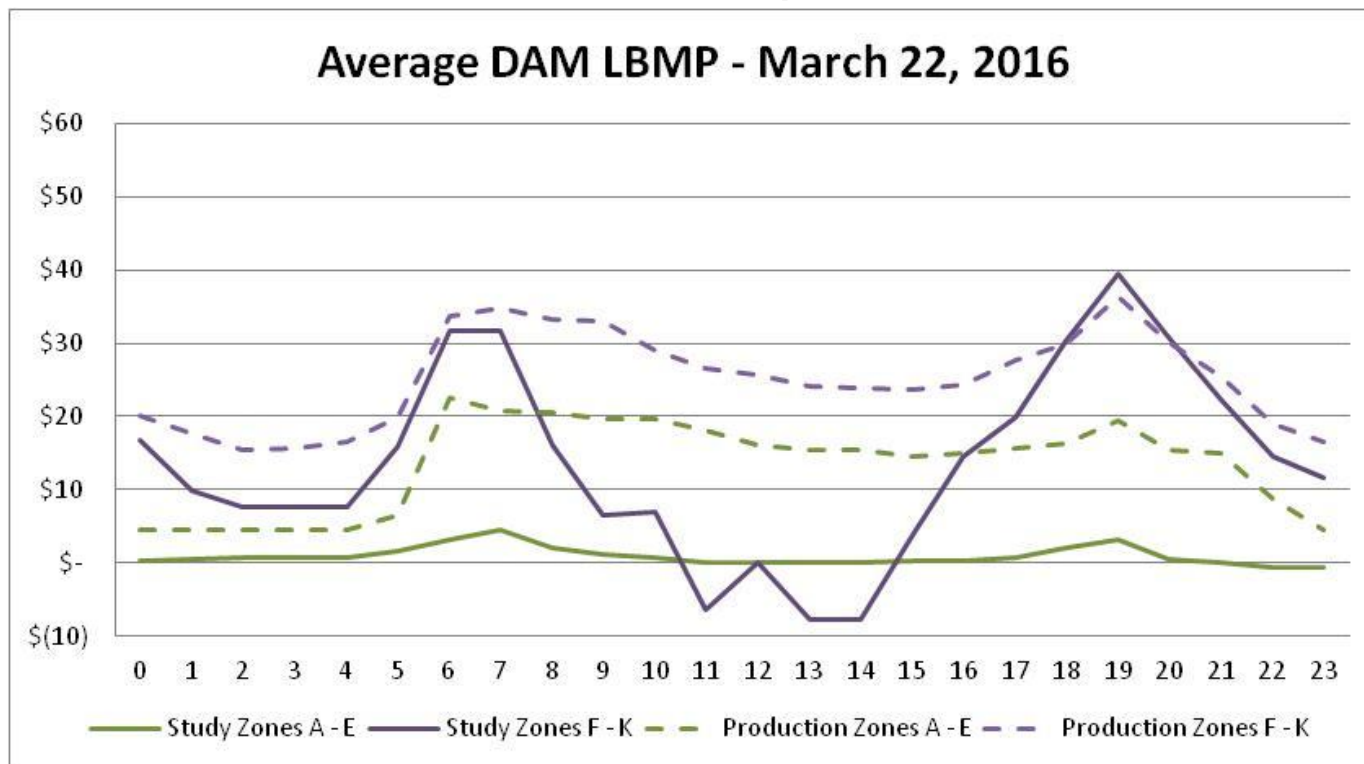
Total RT Renewable Capability not Scheduled

Curtailments of Existing Wind Generators plus Unscheduled Capability of Added Renewables

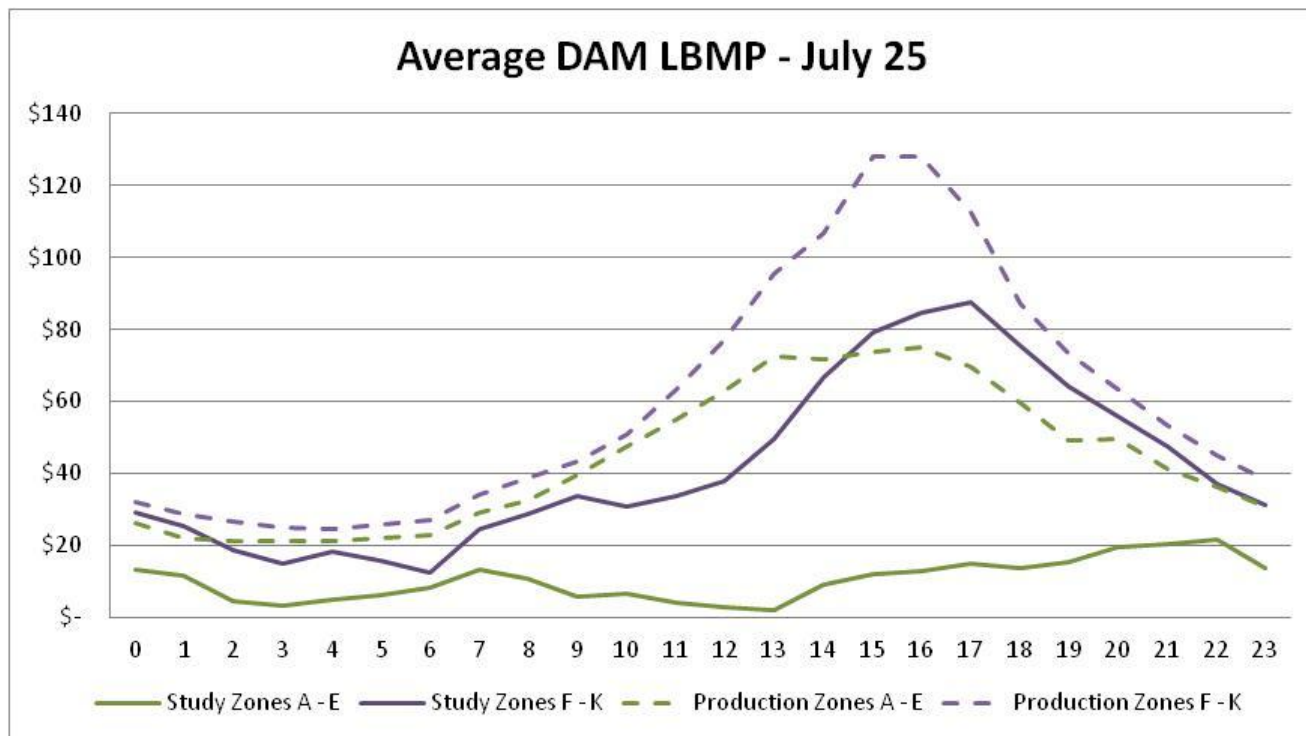
Hour	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
March	-1327	-240	-204	-17	0	-8	-17	0	-90	-238	-422	-1543	-2682	-3317	-3234	-1757	-462	-412	-183	-200	-46	-42
July	-1	-119	-200	-388	-646	-753	-735	-129	-1	0	-2	-24	-39	-78	-328	-1230	-1393	-490	-60	-2	-1	-21
November	-734	-8	-420	-1132	-1502	-1423	-691	-463	-988	-1854	-3698	-4712	-4379	-3504	-3262	-2664	-2378	-1523	-2270	-2408	-2669	-2637

Energy Prices: DAM

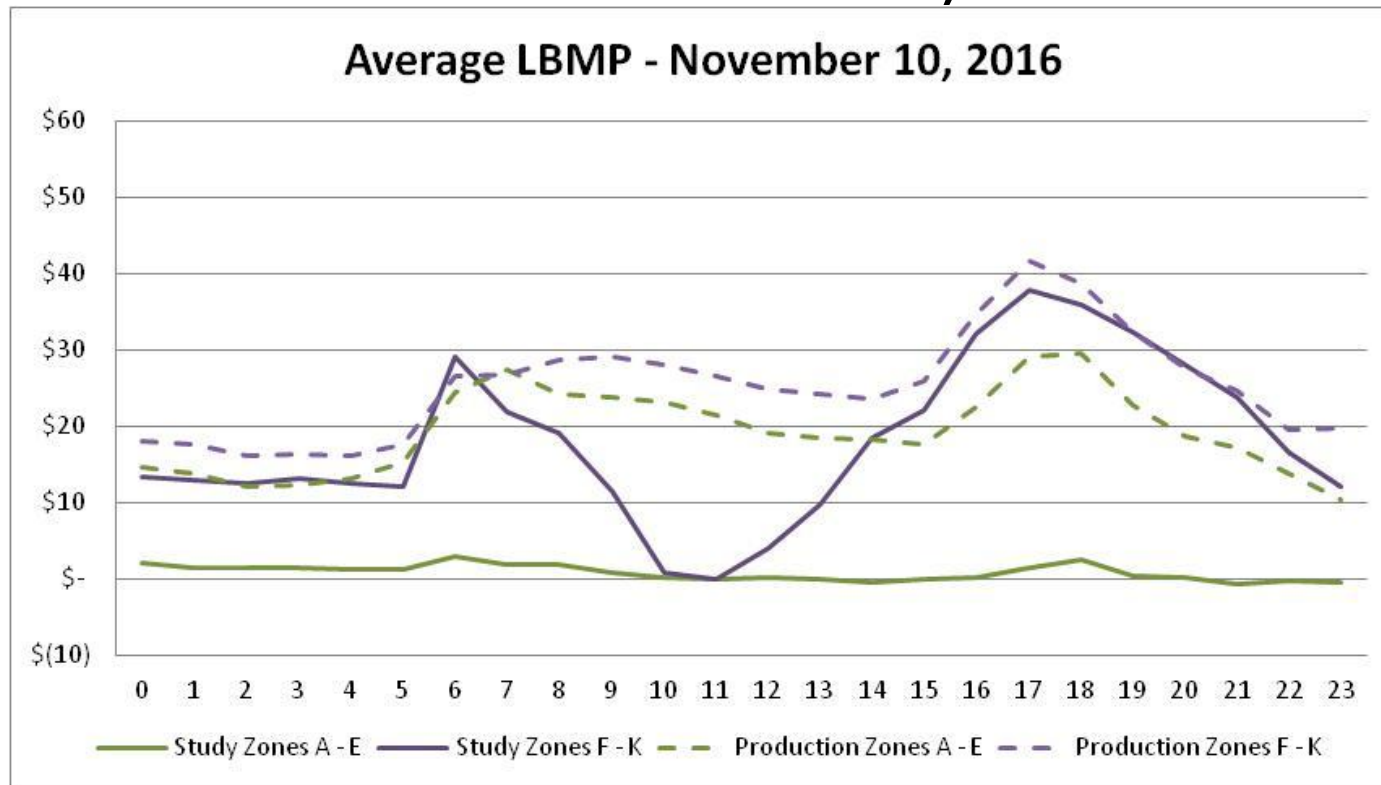
DAM Prices: March 22, 2016



DAM Prices: July 25, 2016

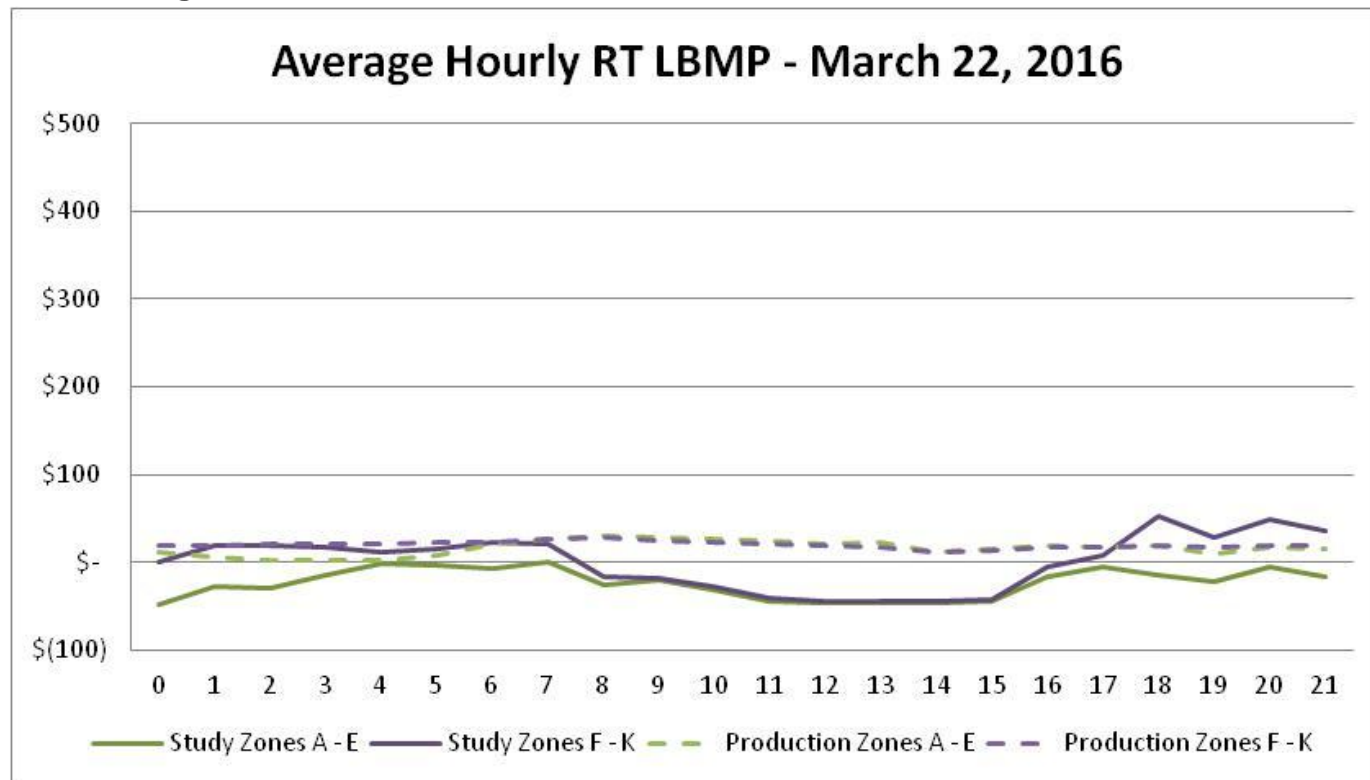


DAM Prices: November 10, 2016

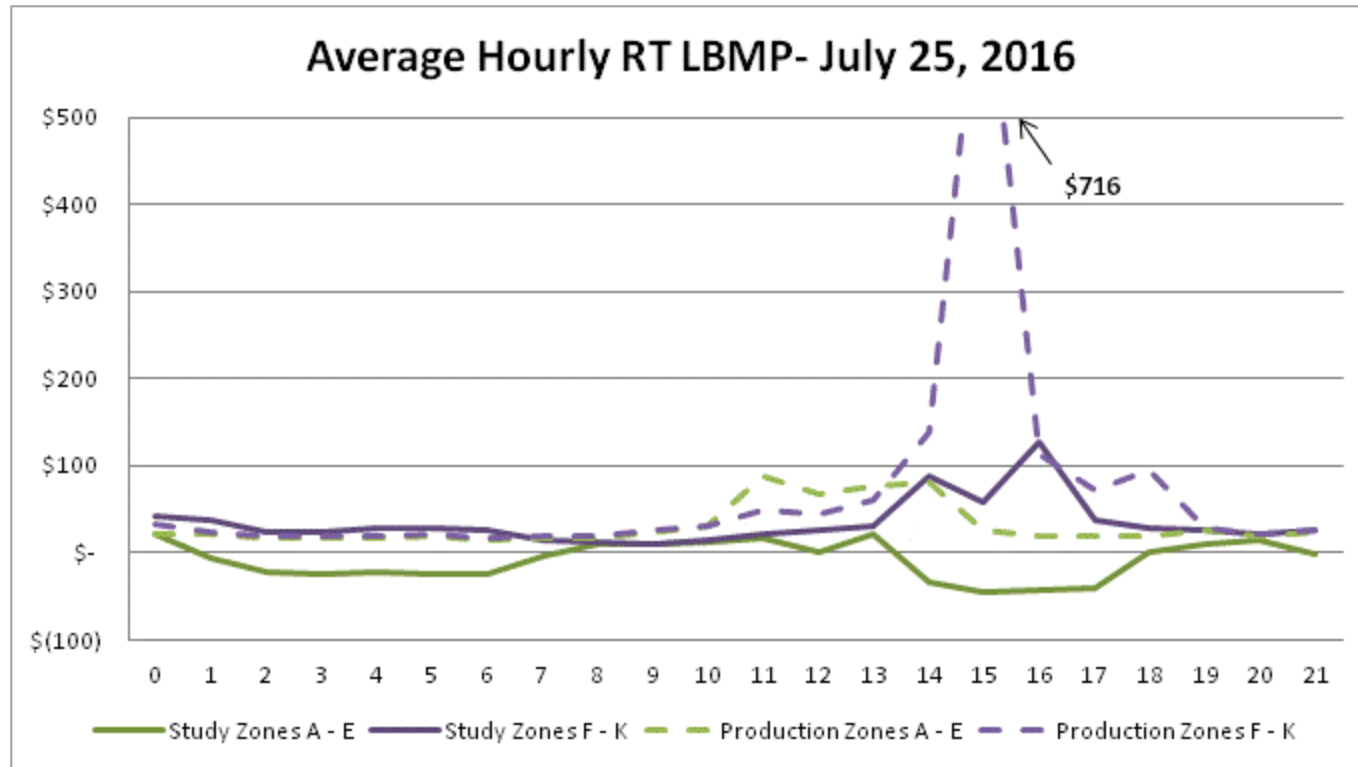


Energy Prices: RT Hourly Averages

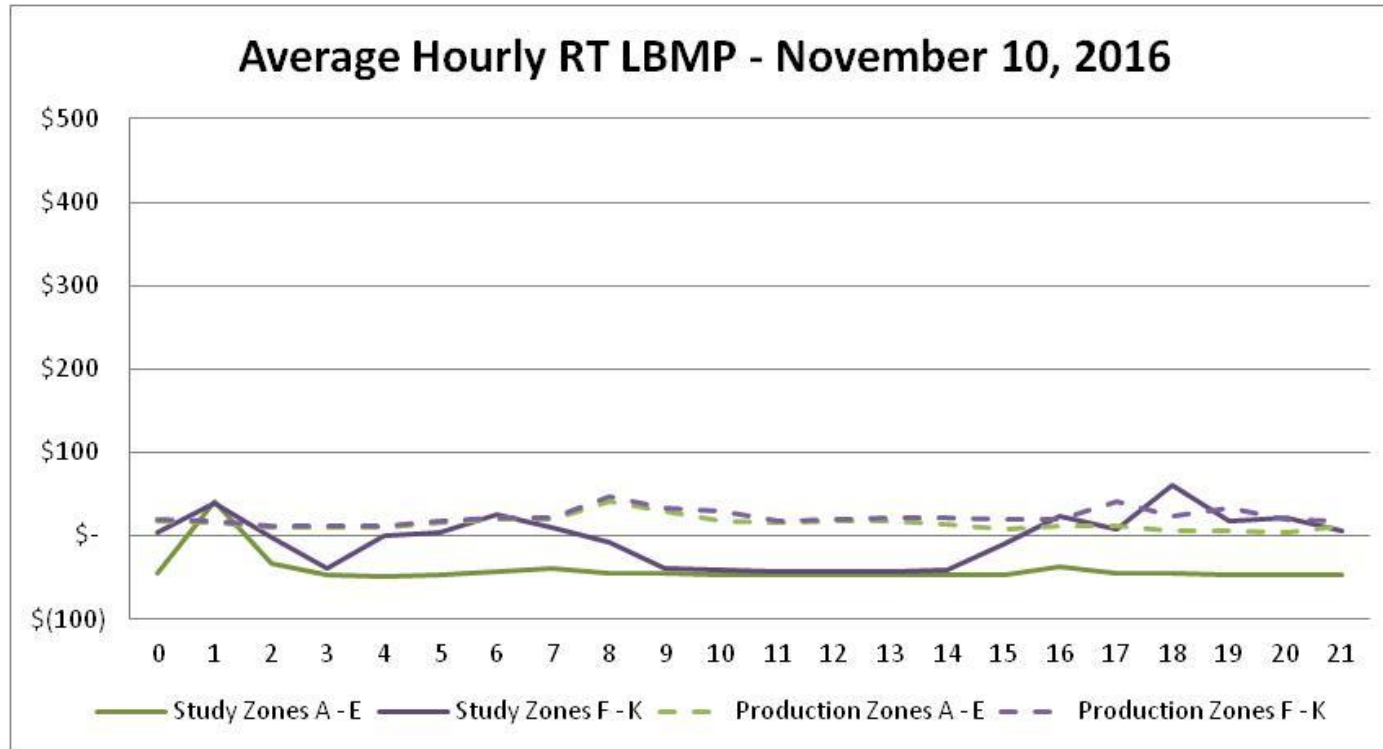
Hourly RTM Results: March 22, 2016



Hourly RTM Results: July 25, 2016

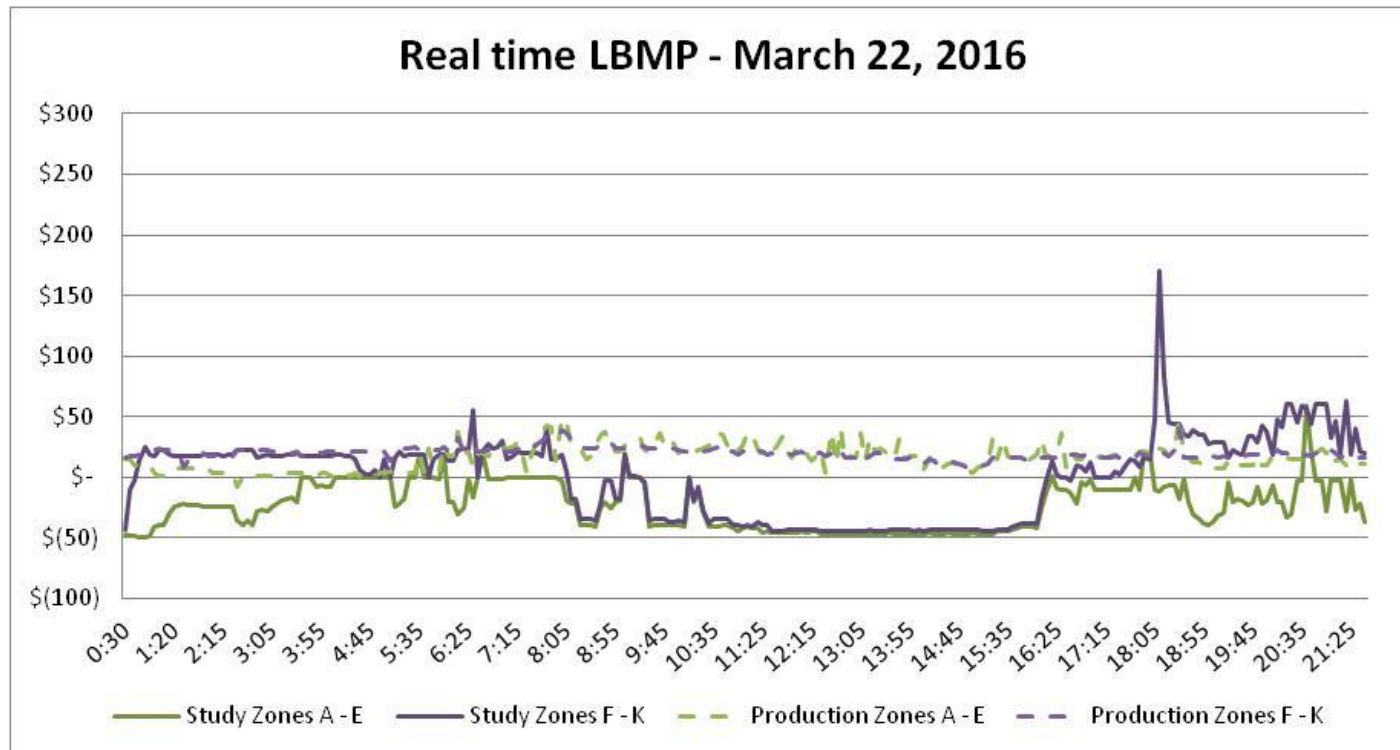


Hourly RTM Results: November 10, 2016



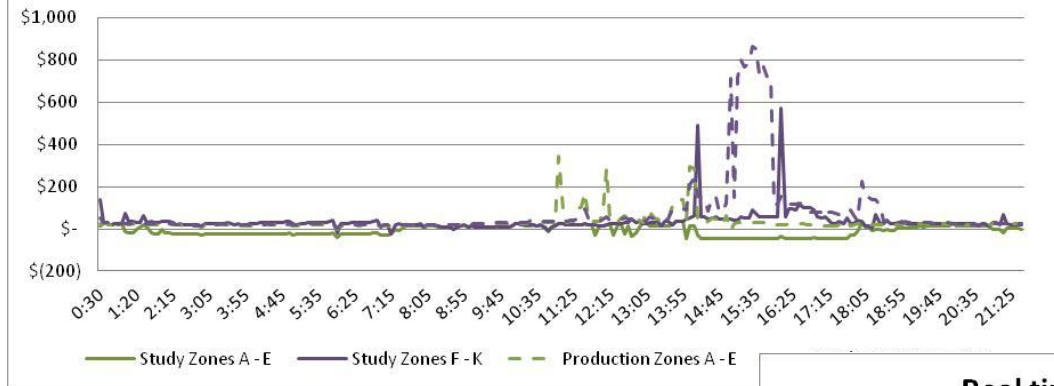
Energy Prices: RTD

RTD Prices: March 22, 2016

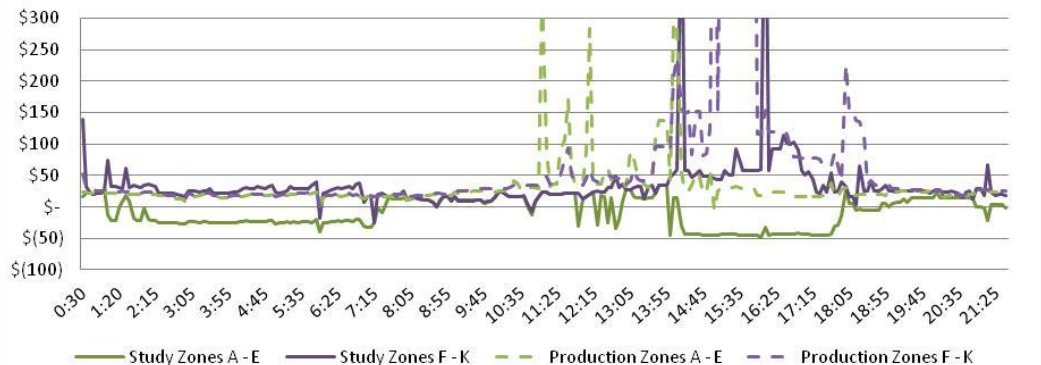


RTD Prices: July 25, 2016

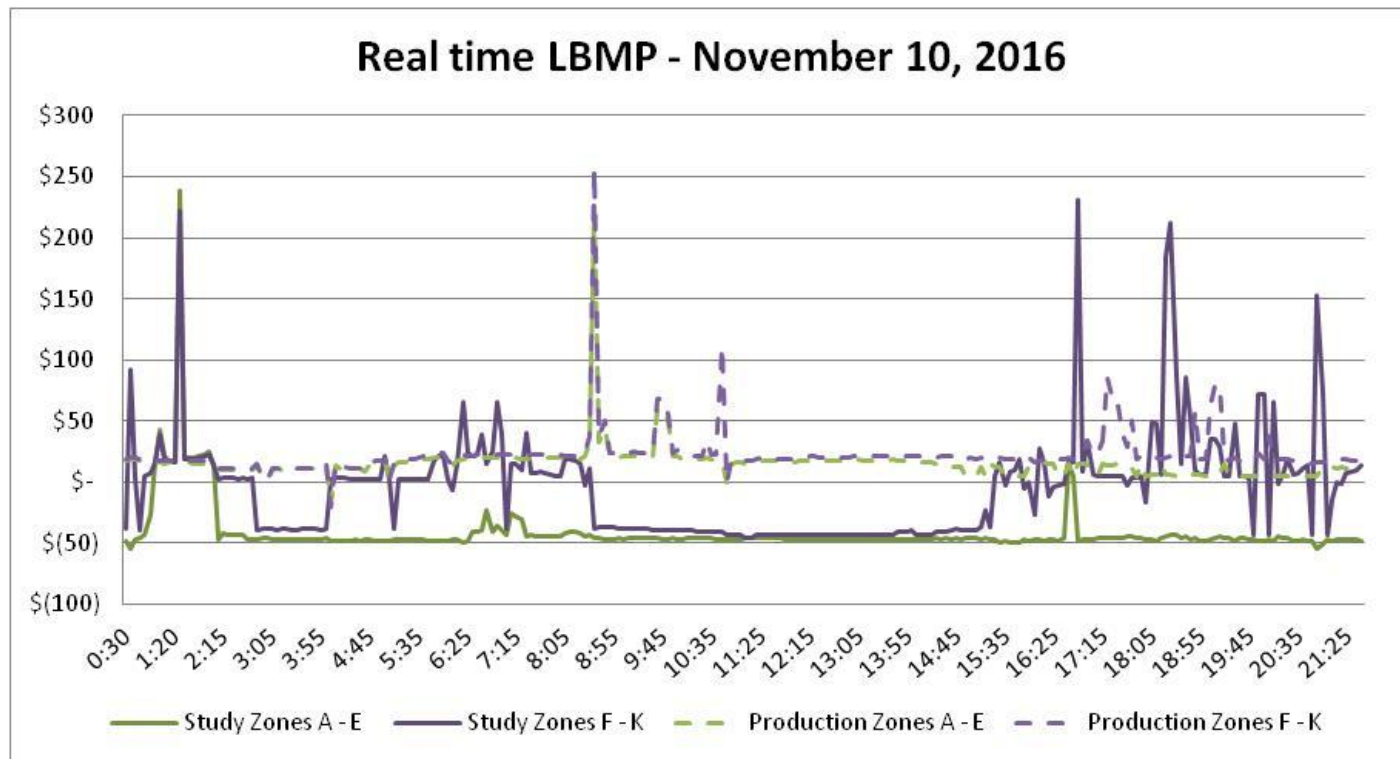
Real time LBMP - July 25, 2016 (Wide View)



Real time LBMP - July 25, 2016 (Narrow View)

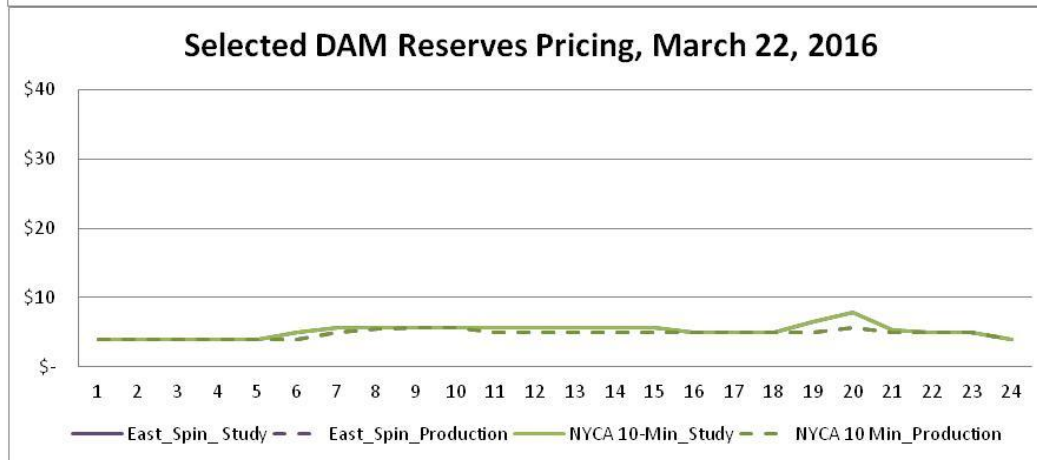
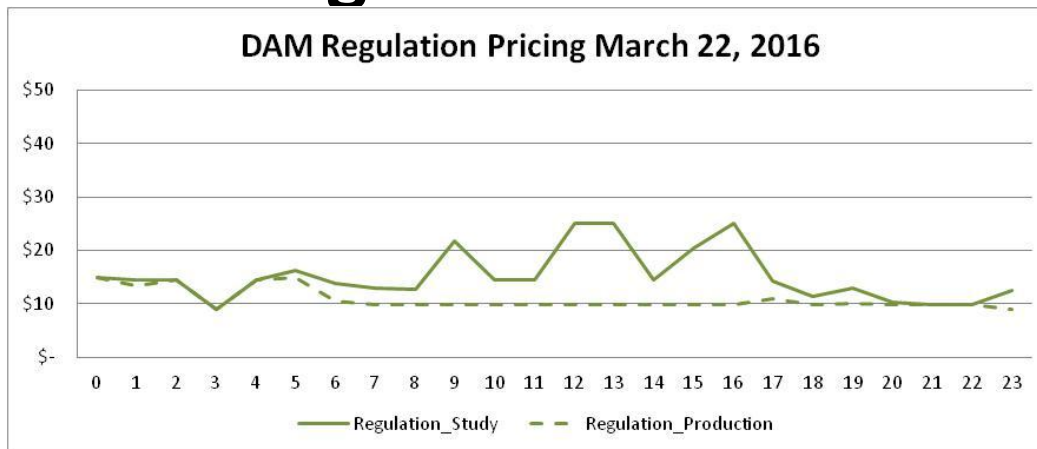


RTD Prices: November 10, 2016

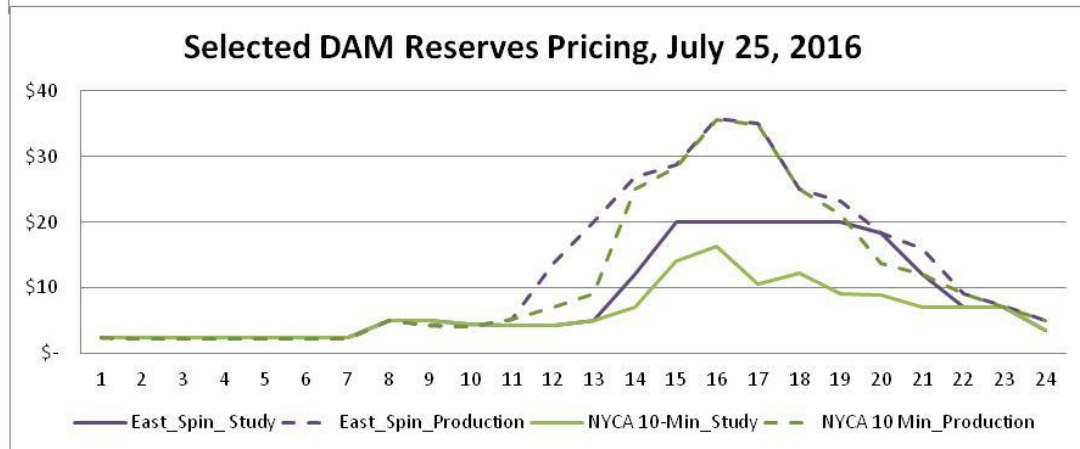
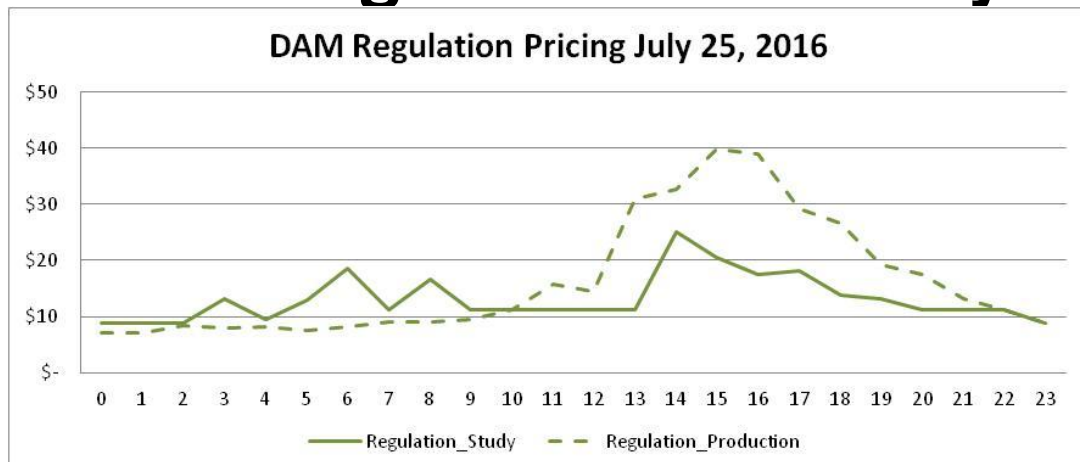


Regulation and Reserve Prices

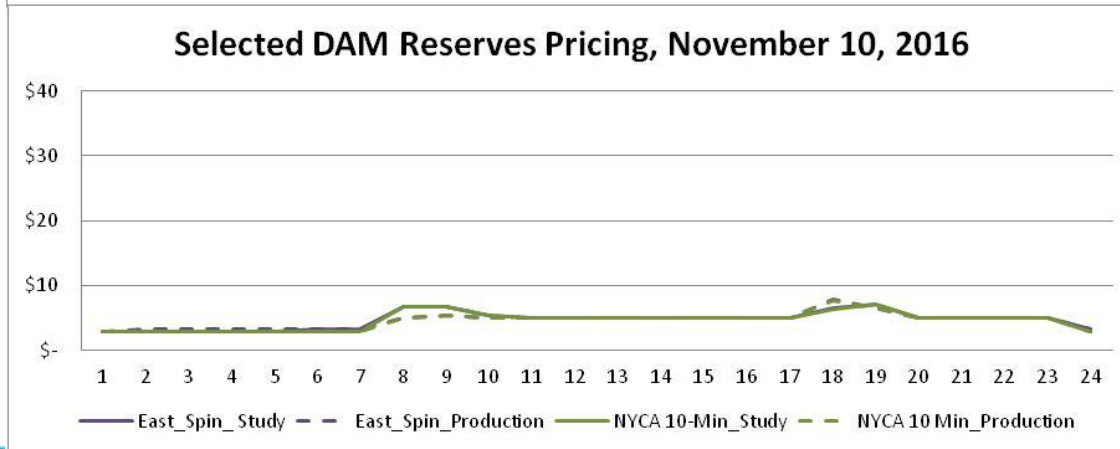
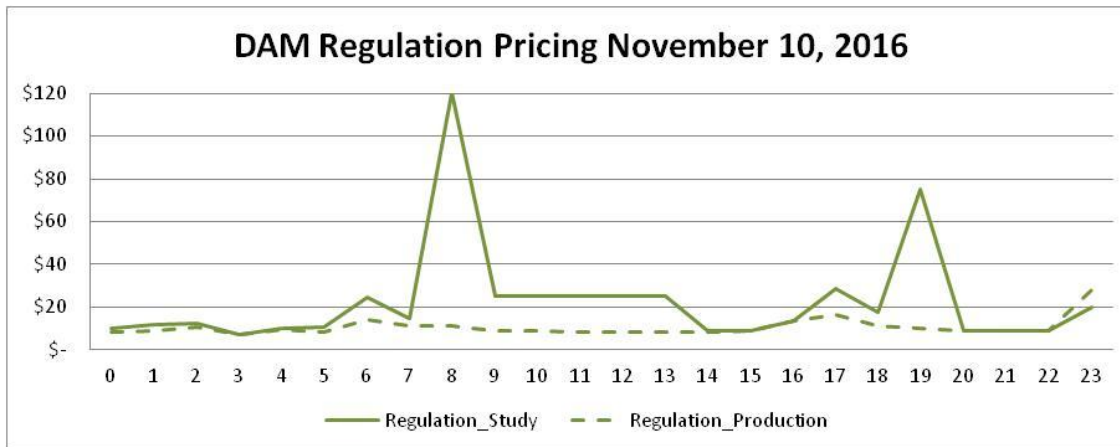
DAM Reserve and Regulation Prices: March 22



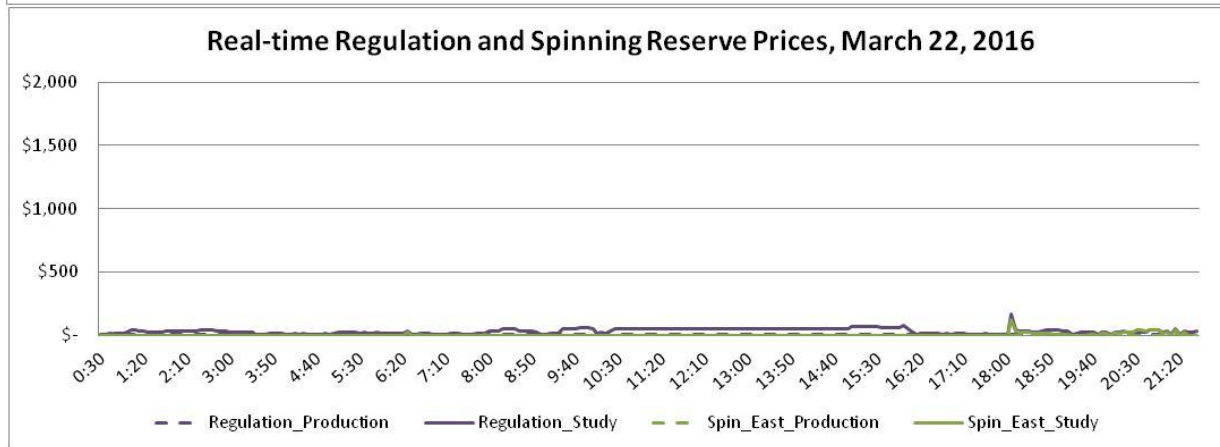
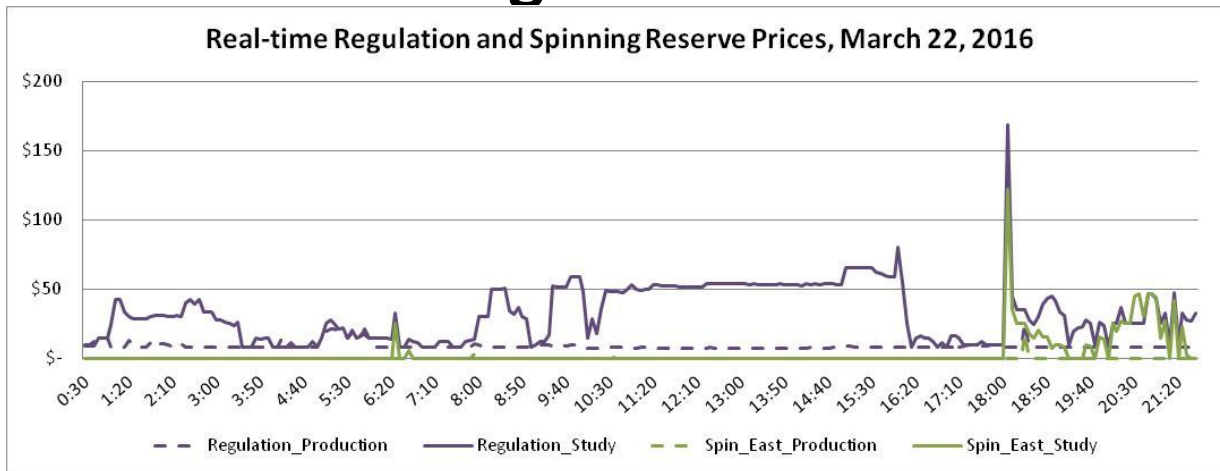
DAM Reserve and Regulation Prices: July 25



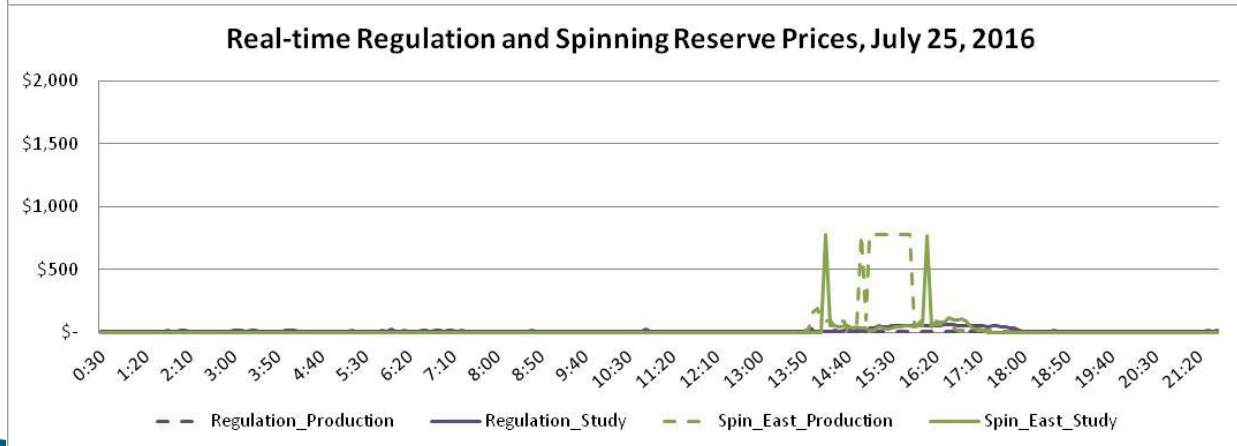
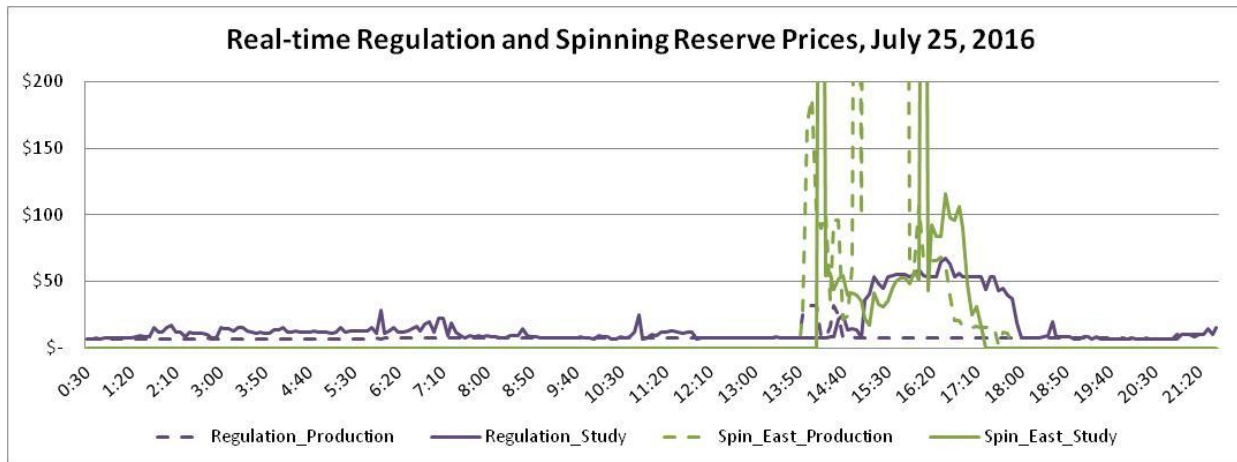
DAM Reserve and Regulation Prices: November 10



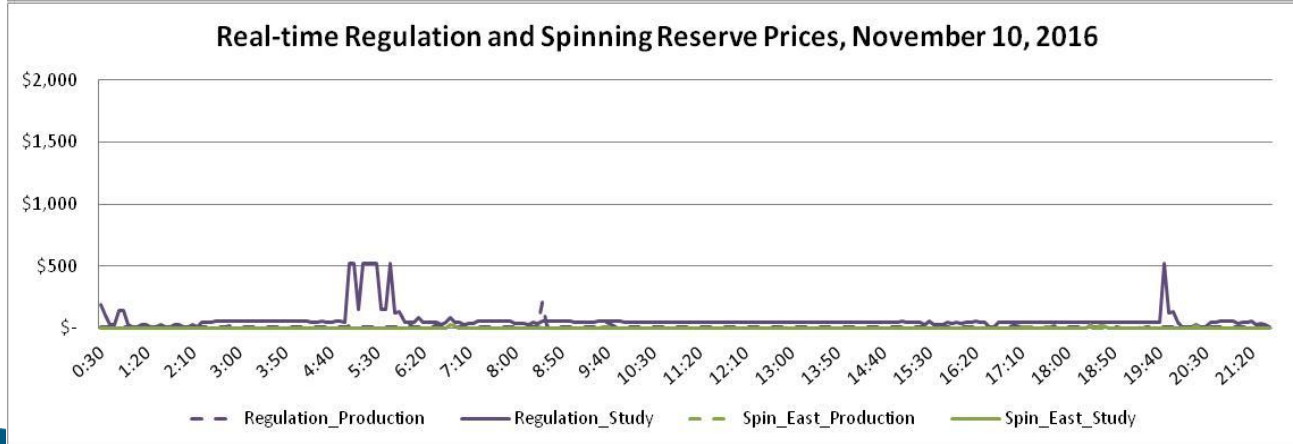
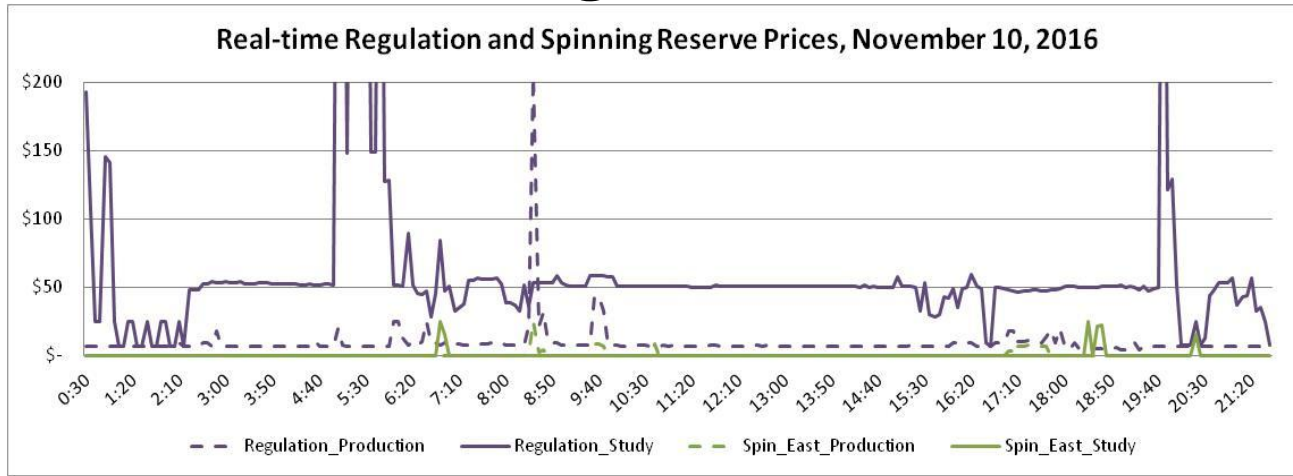
Real-time Reserve and Regulation Prices: March 22



Real-time Reserve and Regulation Prices: July 25



Real-time Reserve and Regulation Prices: November 10



Next Steps

Integrating Public Policy

Integrating Public Policy Project

The Brattle Group Work

PHASE 1: Incorporating the Cost of Carbon Study Study whether incorporating a state policy defined cost of carbon in the wholesale market would improve the overall efficiency of the NYISO energy and capacity markets

NYISO Work

PHASE 2: Market Impact Assessment Study the impacts of decarbonization goals on the current NYISO energy and capacity markets from the high penetration of low carbon or carbon-free resources

PHASE 3: Market Rule Assessment Study whether other market products or changes to the existing market structure will be necessary to meet the anticipated reliability needs

Next Steps

- Email additional feedback to:
IPP_feedback@nyiso.com
- Whitepaper
- Kickoff of Phase 3 – Market Rule Assessment
 - October 16th
 - Looking for stakeholders interested in presenting on what new market products/changes to existing market products should be considered.

Appendix: Assumptions

Modeling Assumptions

- **Bid pass & forecast pass**
 - New Behind The Meter (BTM) Solar resources are modeled as fixed load modifiers
 - New utility-scale renewables are modeled as virtual supply (with -\$47/MWh incremental bid in the bid pass)
 - Existing resources and existing virtuals are modeled as bid in production, except for resources bidding opportunity costs
- **External Transactions**
 - All interfaces but HQ are fixed at production cleared quantities. HQ is economically evaluated in the simulation.
- **Regulation, reserves**
 - Current production requirements
- **Resources bidding**
 - Bids from selected resources bidding based on opportunity costs were adjusted to account for different RT LBMPs (scaled by the peak hour ratio of preliminary study LBMP to production LBMP).
 - Selected resources bidding a higher RT Lower Operating Limits (LOL) than DAM LOL had their RT LOL in the study changed to their DAM LOL so their study DAM schedules were achievable within their RT operating range.

Modeling Assumptions (cont.)

- For wind, solar and hydro, both the installed capacity (MW) and the annual production (GWh) are needed to form the profiles
- Wind
 - On-shore wind profiles based on forecasts in DAM and metered performance in RT
 - Total MWs from EIS, Exhibit 4-1. Zonal distribution based on current NYISO Interconnection queue.
 - Day Ahead wind profiles from actual production forecasts for the study day.
 - Zone F profile based on Zone C.
 - Real-time wind profiles based on actuals
 - Total GWh in EIS requires a capacity factor 50% higher than historical average for wind generators in NYCA. To match GWhs to MWs installed profiles were scaled up MW-hour profiles, respecting upper operating limits, using the following scalar:
 - $MWh_{scaled} = (2 * MWh_{actual}) - (MWh_{actual} * (MWh_{actual} / MW_{nameplate}))$
 - Off-shore wind profiles are based on NREL data,
 - The error modeled in the DA forecast is based on the error from on-shore wind.
 - Total MWs for J and K based on EIS, Exhibit 5-20.
 - Daily profiles from NREL Wind Prospector, 2012 case
 - Site south of NYC chosen for Zone J, and a site chosen off the Eastern tip on Long Island for Zone K.
 - Hourly MWs scaled to annual GWh projection in the EIS
 - Profiles and forecasts are zonal

Modeling Assumptions (cont.)

■ Large-Scale Solar

- Using actual profiles for Jan 19, March 25 and November 10 for both the Day-Ahead and Real-Time Markets
 - Better simulates day-ahead bidding of utility-scale solar and virtual supply on a normal day
- Using “clear sky” zonal profiles in the DAM for July 25, and the actual, more variable, profiles in real time for that day
 - Better simulates day-ahead bidding of solar resources and virtual supply on a day with a weather front and thunderstorms moving across New York state
 - Hourly profile shape estimated with a 27% axis tilt, due south orientation.
- Profile shapes based on actual metered output provided by a vendor

■ Behind-the-meter Solar

- MWs scaled to Final EIS assumption of 5,000 GWh
- Profile shape based on actual metered output from vendor
- July 25 to uses a “clear sky” profile in the DAM
- Zonal distributions based on current zonal distributions provided by NYSERDA, net of existing BTM solar

Modeling Assumptions (cont.)

- **Run of River Hydro**
 - Zonal MWs based on Final EIS, Exhibit 5-24.
 - Profiles based on like-days
- **Anaerobic Digesters/LFG**
 - Zonal MWs from Final EIS, Exhibit 5-27.
 - Flat profiles based on average actuals
- **Biomass**
 - New Zonal MWs from Final EIS.
 - Profiles based on existing facilities

Modeling Assumptions (cont.)

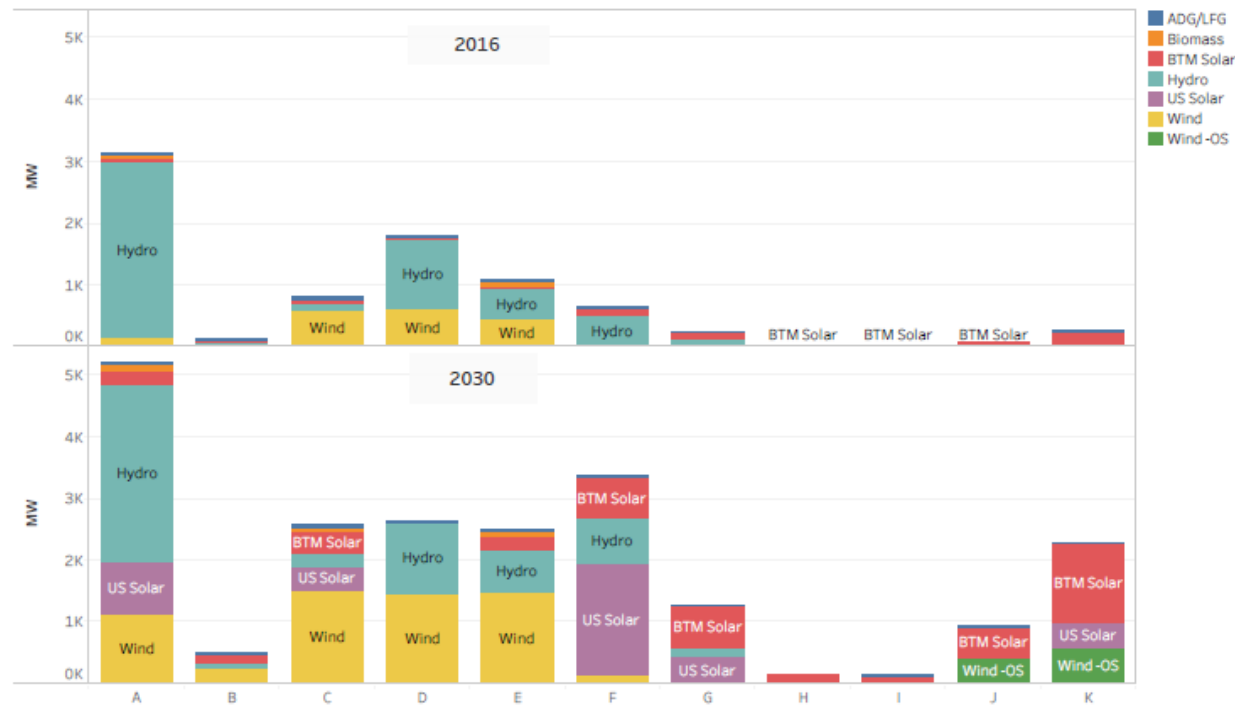
■ Transmission

- No topology changes in the system. System considered “as is”.

■ Real Time

- Incremental renewable generation added as zonal virtual supply (-\$47)
- Simulated DAM commitment overwrites real-time unit bid mode
 - Fast Start units re-evaluated using their RTM bids and non-fast-start units set to either “must run” or “unavailable” based on day-ahead commitment
 - Simulations are not linked to the prior day or the next day, therefore Real-time simulations can only calculate LBMPs from 00:30 to 21:40
- All resources are assumed to follow real-time commitment and dispatch perfectly

Distribution of Renewable Capacity



- “2030” case represents NYDPS Final Supplemental EIS installed megawatt (MW) projections.

Distribution of Renewable Capacity (cont.)

- Summary of Final EIS GWh used in Modeling Assumptions

Incremental Energy GWh in Assumptions from Final EIS 2030 Blend Case						
	Incremental		Existing		Total	
	GWH	MW	GWH	MW	GWH	MW
Land-based Wind	14,326	4,188	3,984	1,754	18,310	5,942
Utility-scale Solar	4,582	3,855	52	32	4,634	3,887
Hydro	2,720	587	26,704	6,727	29,424	7,314
Biomass/ADG	1,179	175	422	148	1,601	323
Offshore Wind	4,275	1,000	-	-	4,275	1,000
BTM Solar	5,000	4,350	811	712	5,811	5,062
Total	32,082	14,155	31,973	9,372	64,055	23,527

"Existing" here is based on 2016 Gold Book. Existing in Final EIS uses 2015 Gold Book