Day Ahead and Real Time Operations – A US ISO Point of View

Daniel Harless, SPP

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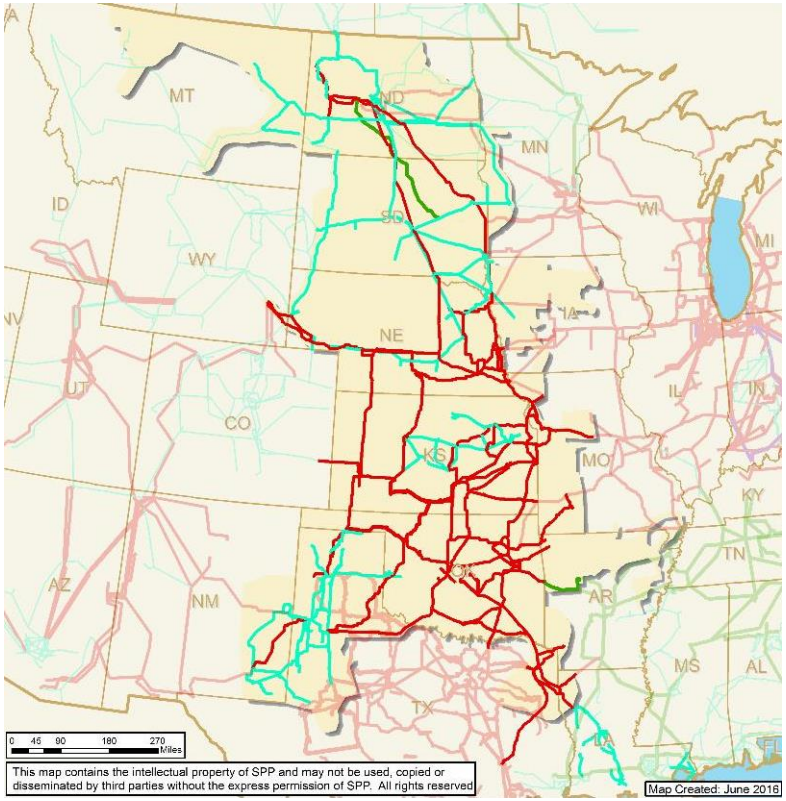
Overview

- SPP RTO Footprint
- Overview of processes that use Variable Energy Resources (VER) Forecasts in the SPP Market
- SPP Operations Market Timeline Overview
  - Study Timeline
  - Study Windows
  - Forecast Data Used for Each Study
- Current limitations and Possible Future Enhancements

SPP Operating Region



- Miles of service territory: 575,000
- Population served: 18M
- Generating Plants: 756
- Substations: 4,757
- Miles of transmission: 60, 944
  - 69 kV 13,532
  - 115 kV 14,269
  - 138 kV 9,117
  - 161 kV 5,647
  - 230 kV 7,608
  - 345 kV 10,772

Wind Energy in SPP

Maximum wind penetration:

Instantaneous: 63.96%
(4/30/18)

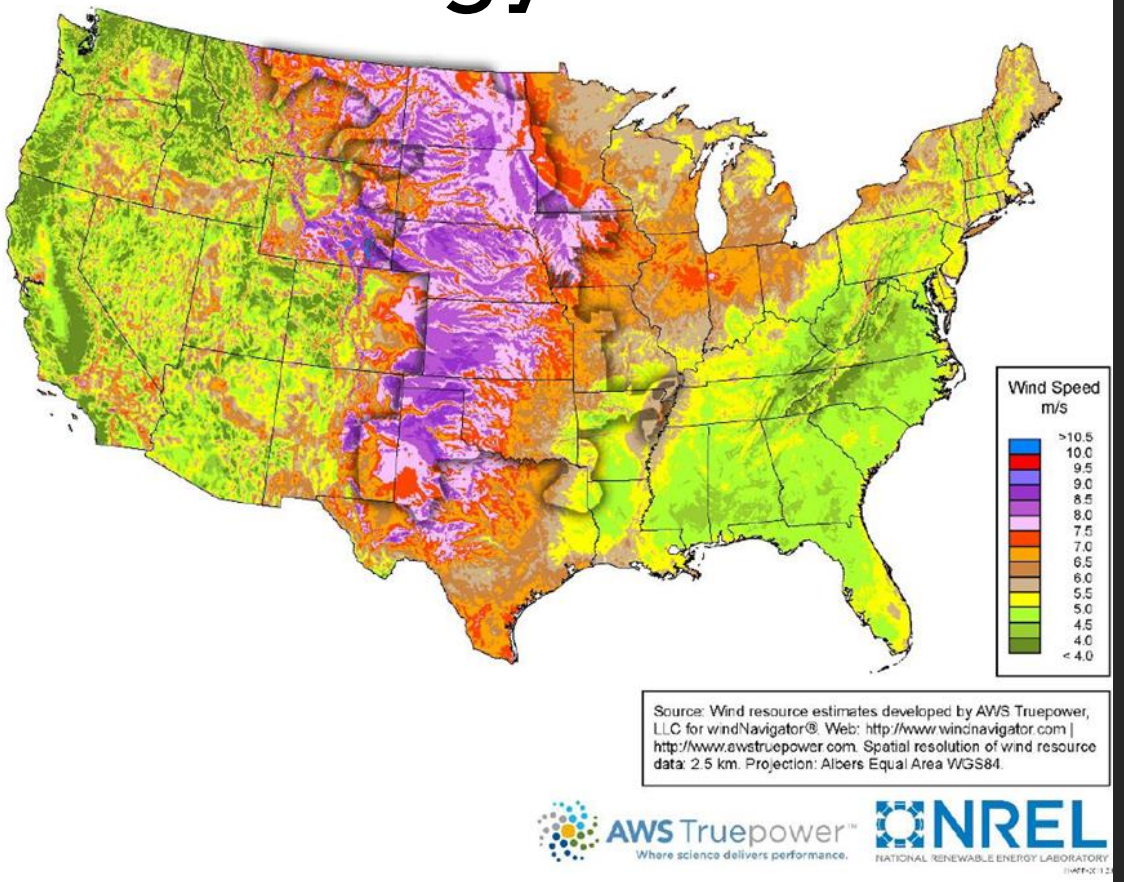
Hourly Average: 62.89%
(4/29/2018)

Daily Average: 54.1%
(4/29/2018)

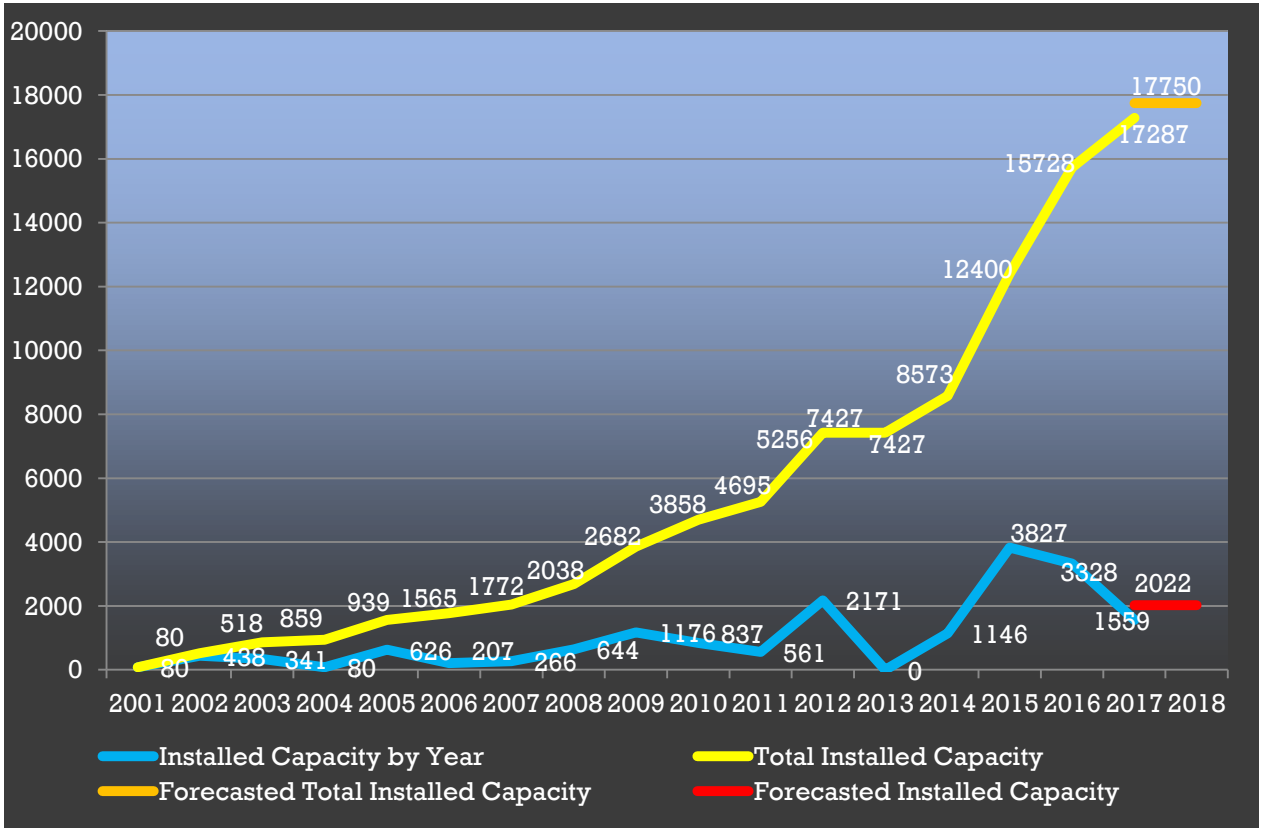
2018 up to May 8th:
>60%, 6 days
>50%, 40days

Max wind swing in a day:
>10 GW
(12.5 GW to 2 GW back to 12 GW)

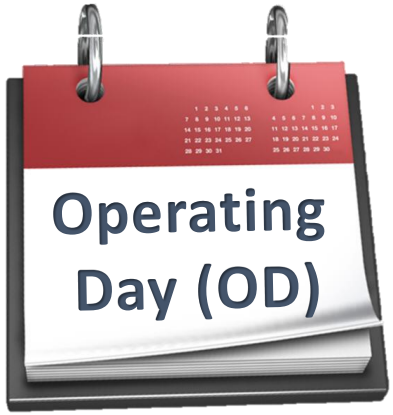
Max 1-hour ramp:
3,700 MW



Wind Capacity Installed by Year



SPP Operation Market Timeline



- Multi-Day Reliability Assessment (MDRA)
- Day-Ahead Market (DAMKT)
- Day-Ahead Reliability Unit Commitment (DARUC)
- Intra-Day Reliability Unit Commitment (IDRUC)
- Real-Time Balancing Market (RTBM)
- Short-Term Reliability Unit Commitment (STRUC)
- Pre Real-Time Balancing Market (Pre_RTBM)

Load Forecast Usage

- Study Forecast Types
  - **Short Term Forecast:**
    - Forecasts 5 minute intervals for the next 4 hours.
    - Receive updates every 5 minutes
  - **Mid Term Forecast:**
    - Forecasts one hour intervals for the next 10 days.
    - Receive updates every hour
- Studies that use the forecasts
  - MDRA – MTF
  - DARUC – MTF
  - IDRUC – MTF
  - STRUC – STF
  - Pre_RTBM – STF
  - RTBM– STF

VER Forecast Usage

- Study Forecast Types
  - **Short Term Forecast (STF):**
    - Forecasts 5 minute intervals for the next 4 hours.
    - Receive updates every 5 minutes
  - **Mid Term Forecast (MTF):**
    - Forecasts one hour intervals for the next 72 hours.
    - Receive updates every hour
  - **Long Term Forecast (LTF):**
    - Forecasts one hour intervals starting 48 hours in the future to 168 hours in the future.
    - Receive updates 8 times a day.
    - The availability is limited by the availability of weather forecast data.
- Studies that use the VER forecasts
  - MDRA – MTF and LTF if available
  - DARUC – MTF
  - IDRUC – MTF
  - STRUC – STF
  - Pre_RTBM – STF
  - RTBM– STF

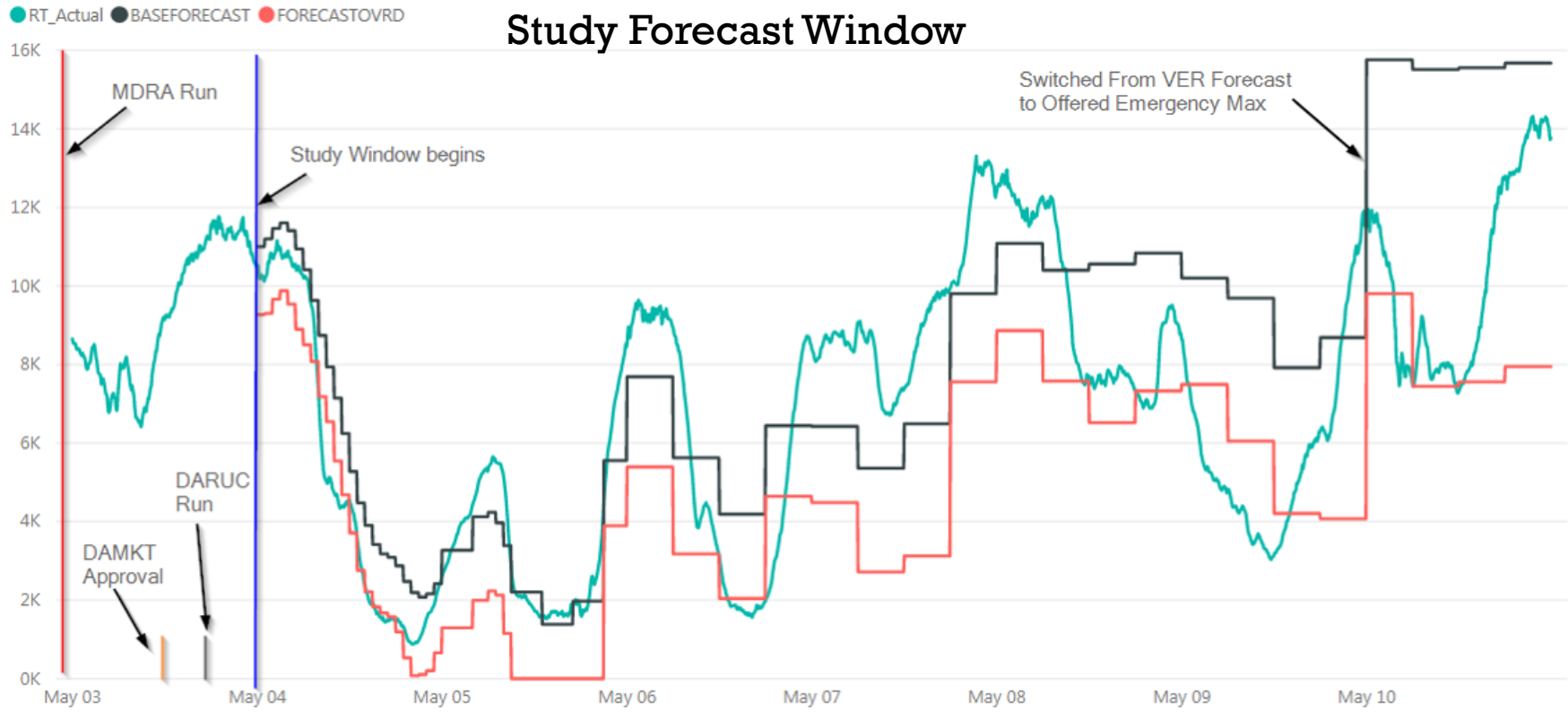
Other VER and Load Forecast Usage

- Regulation Requirements
  - Load Magnitude
  - Load Variability
  - VER Forecast Magnitude
  - VER Forecast Variability

- Possibly Contingency Reserve Requirements
  - Currently there is not a single contingent element that would cause a VER or a group of VERs to be the Most Single Severe Contingency (MSSC), but in the future this may become a reality.
  - In this case the forecast for that MSSC might be used to calculate the Contingency Reserve Requirement.

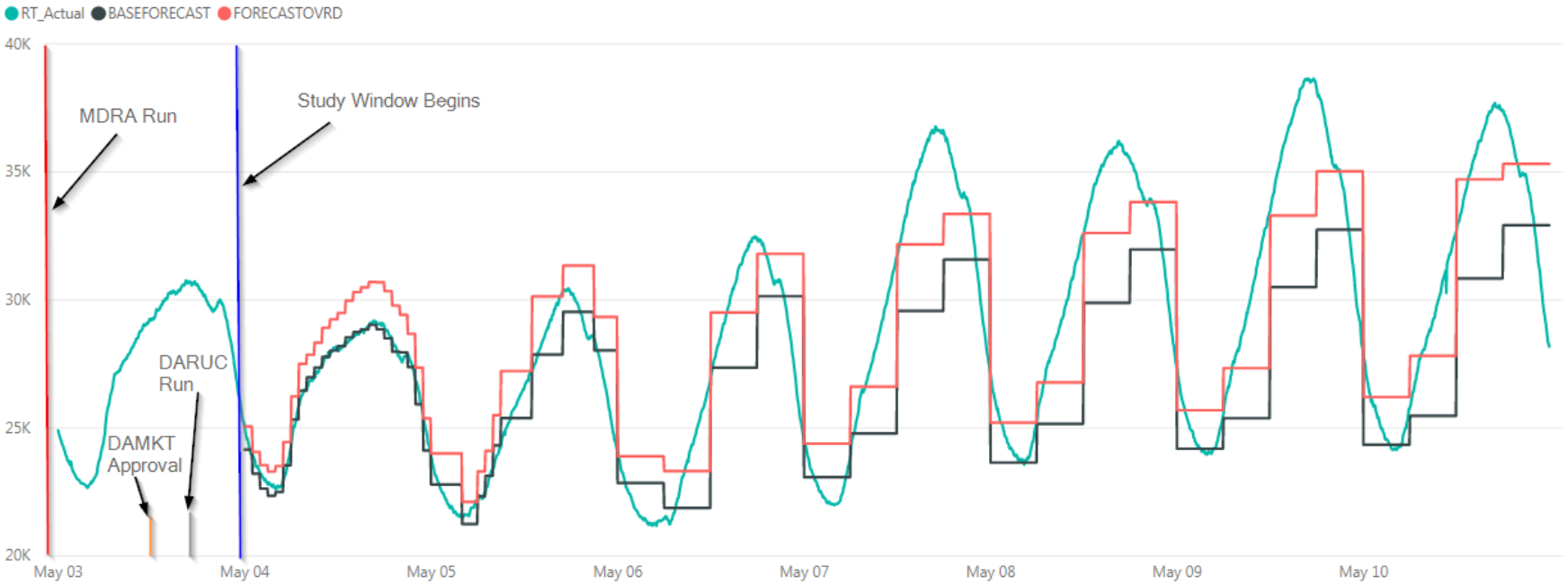
Multi-Day Reliability Assessment (MDRA)

- Primary function is to analyze the system to address capacity issues days in advance of the DAMKT and DARUC.
- Run around Midnight each day
- The study window is beginning the next morning and goes through 7 days.



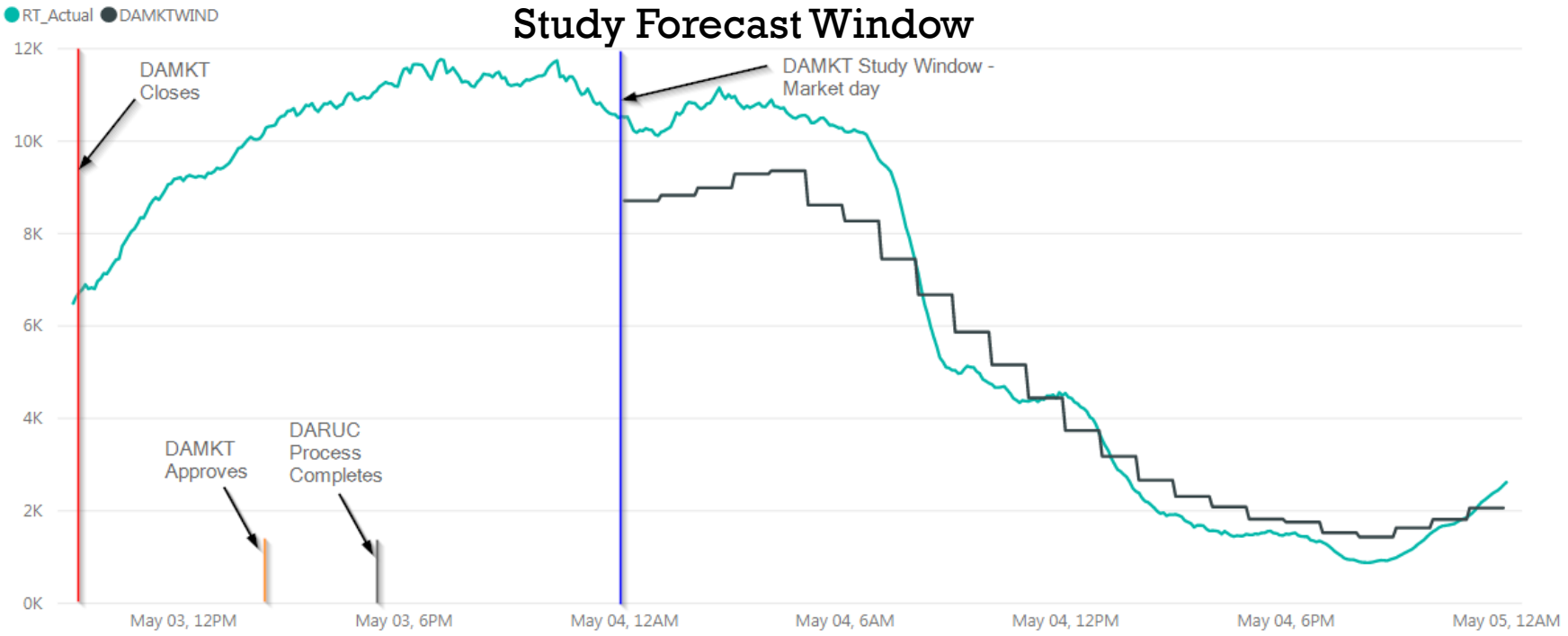
Multi-Day Reliability Assessment (MDRA)

Study Load Forecast Window



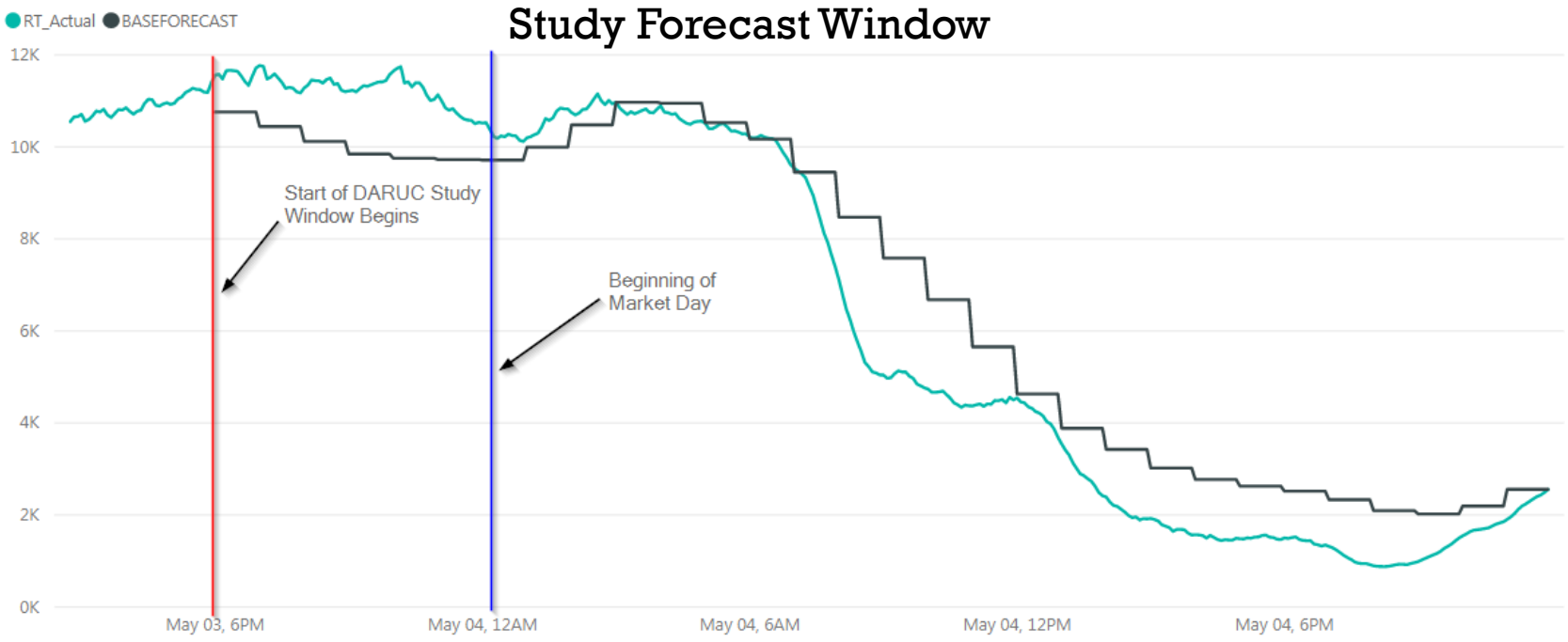
Day-Ahead Market (DAMKT)

- Financially binding market with the resource commitments being passed on to real-time.
- Closes at 9:30 a.m. and is approved at 2:00 p.m. each day.
- The study window is the next day.
- Forecasts are <u>not</u> used in the DAMKT. Bid in Load and VER capacity is used.



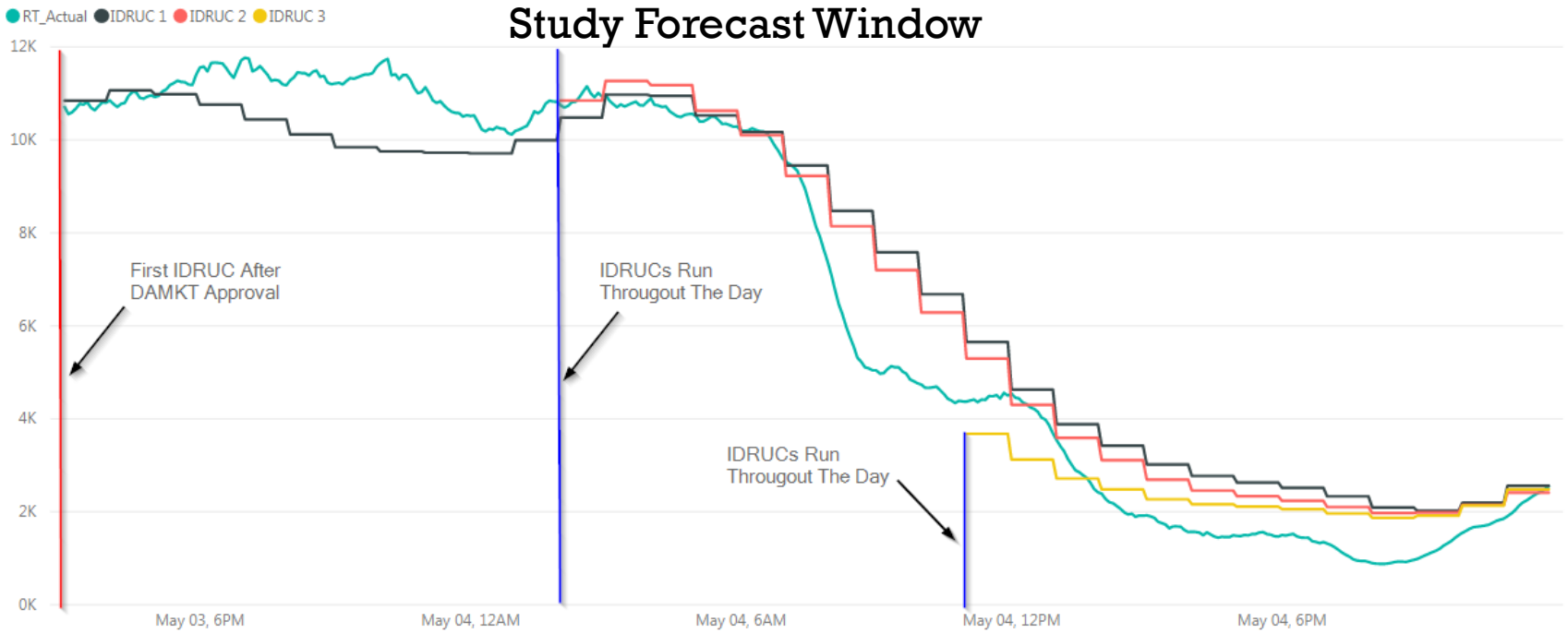
Day-Ahead Reliability Unit Commitment (DARUC)

- Primary function is to use the most recent VER and Load forecast to determine any extra commitments needed after DAMKT.
- Run between 14:45 and 17:15 with results of additional commitments communicated at 17:15.
- The study window is from 18:00 the current day through the next day.
- Does not de-commit units unless there is an energy surplus.



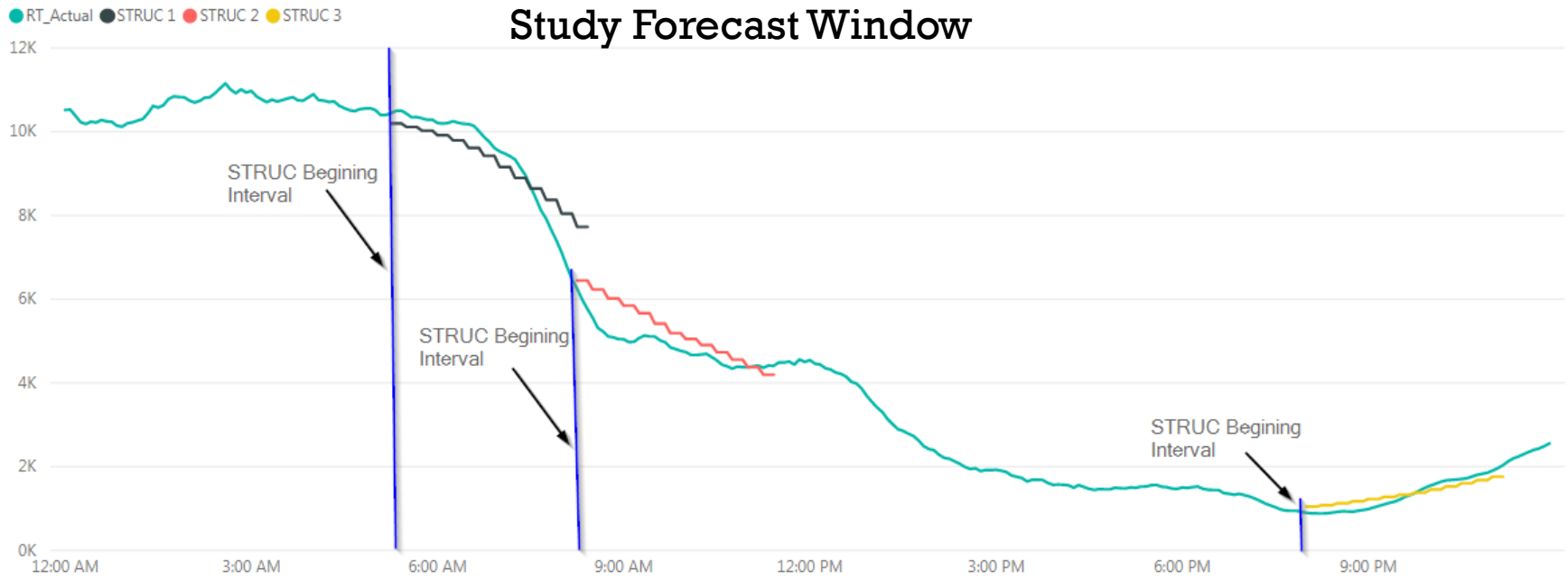
Intra-Day Reliability Unit Commitment (IDRUC)

- Primary function is to use the most recent VER and Load forecast to determine any extra commitments throughout the market day.
- Run at least every 4 hours, but typically every hour.
- The Study window is now to the rest of the day, except after the DAMKT approves.
- After the approval of the DAMKT it runs from now to the end of the next day.
- Does not de-commit units unless there is an energy surplus.



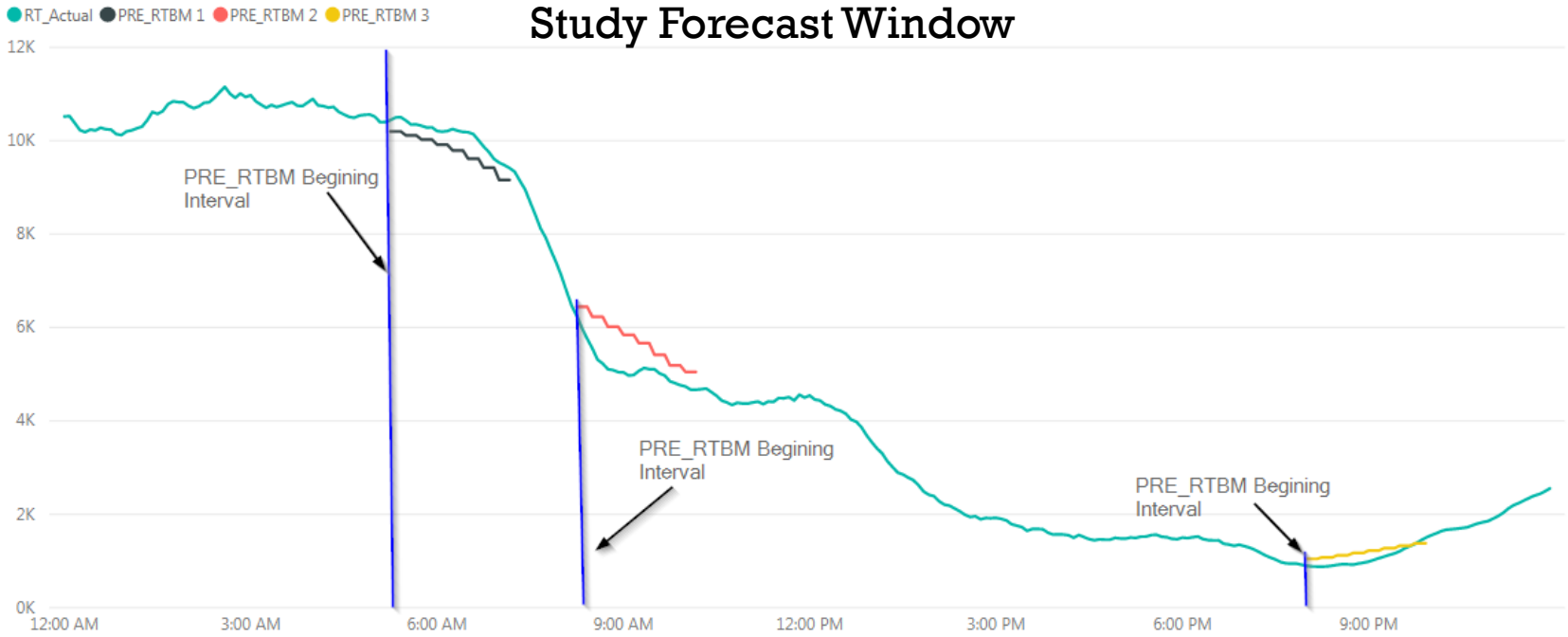
Short-Term Reliability Unit Commitment (STRUC)

- Primary function is to use near real-time forecasts to determine if minor adjustments to the operating plan are needed.
- Run every 15 minutes with 15 minute intervals.
- The Study window is now to through the next 3 hours.
- Must respect the current operating plan for the first two intervals and return everything to the operating plan at the end of the study.



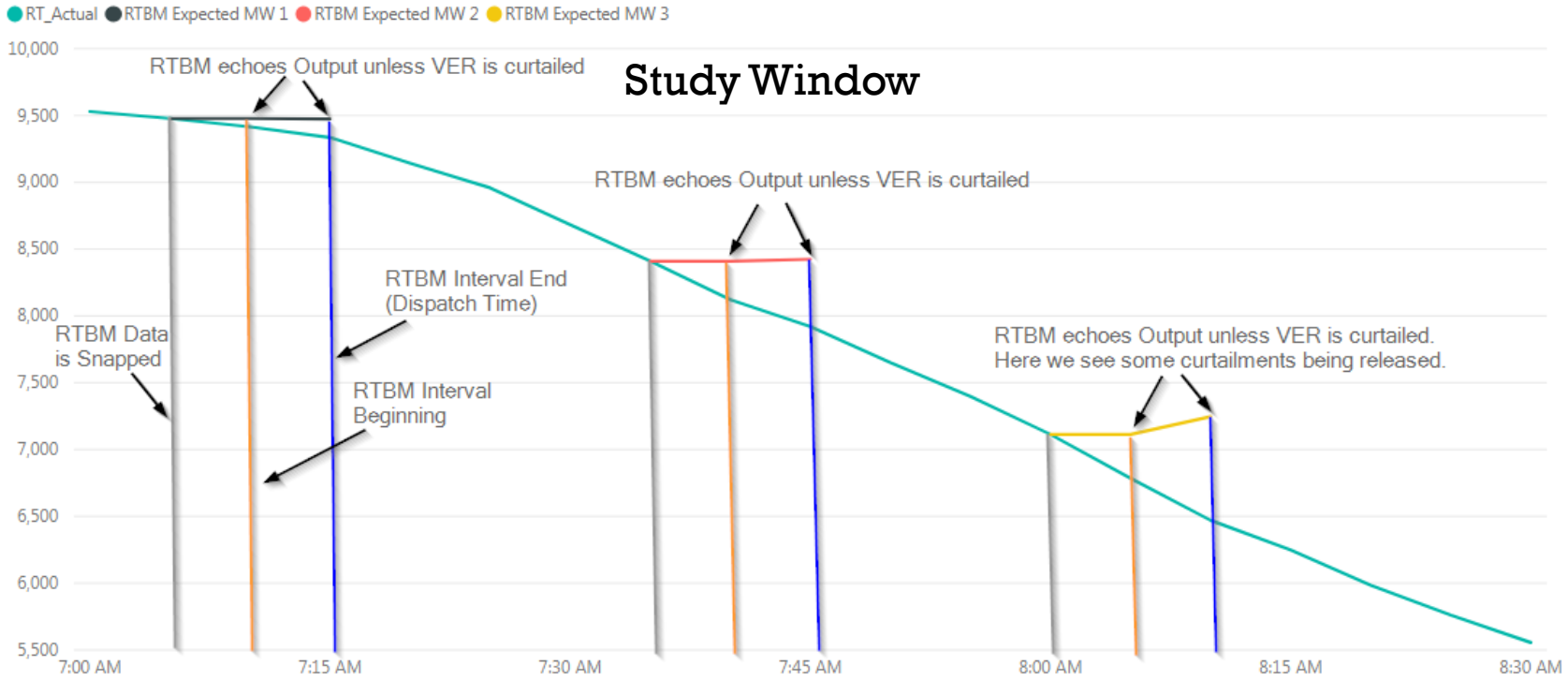
Pre Real-Time Balancing Market (PRE_RTBM)

- Primary function is to give the operators an idea of how the system looks over the next 2 hours with no additional commitments.
- Run every 15 minutes with 5 minute intervals for the first 3 intervals and then 15 minute intervals for the next 7 intervals.
- The Study window is now to through the next 2 hours.
- Does not commit or de-commit any resources. It dispatches the resources in the operating plan.



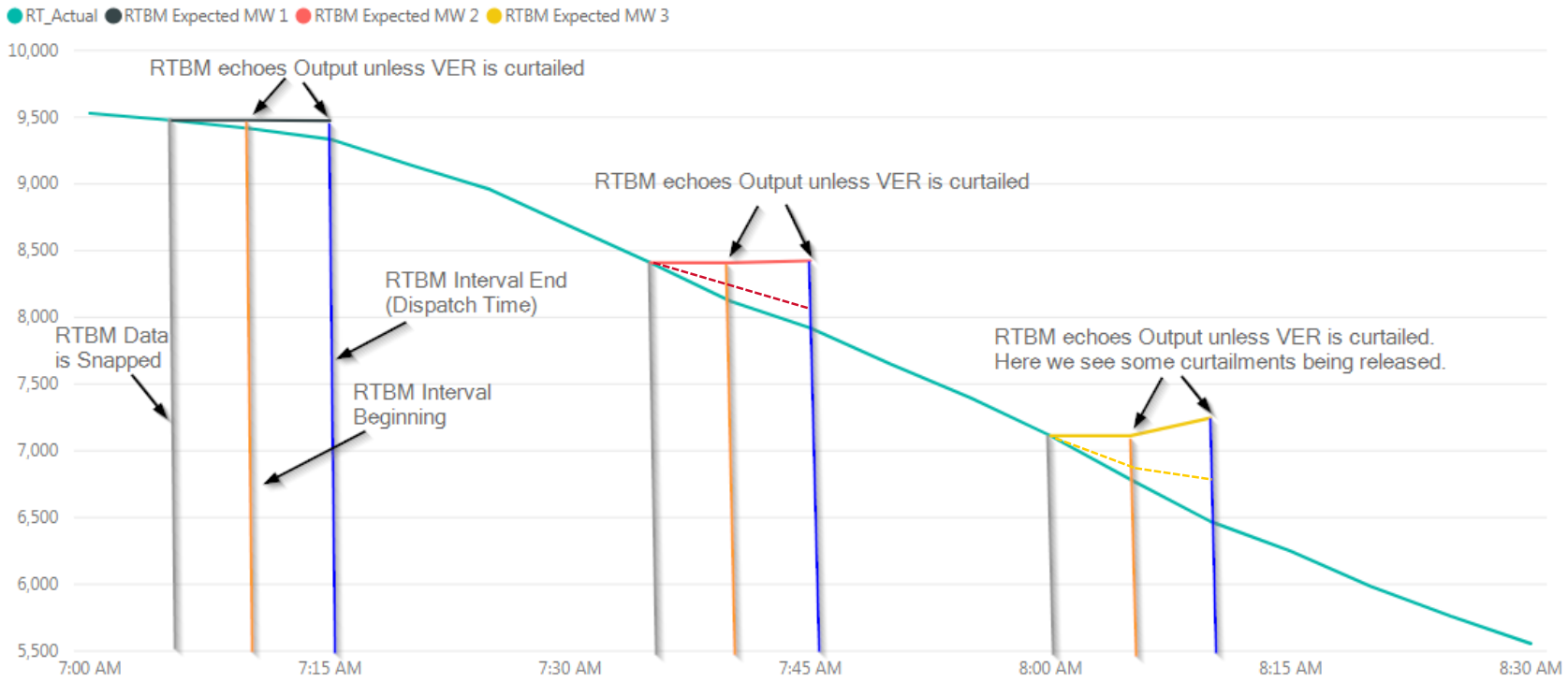
Real-Time Balancing Market (RTBM)

- RTBM's is the reliability dispatch and the real-time pricing study.
- Run every 5 minutes for one 5 minute interval.
- Does not commit or de-commit any resources. It dispatches the resources in the operating plan.
- Echoes VER output unless prices dictate they be curtailed. When the curtailment is released RTBM tries to dispatch the VER back to the Short-Term Forecast.



Current Limitations and Possible Enhancements

- Due to RTBM echoing the output of VERs deviations in the real-time dispatch to the real-time output can occur.
- One method being discussed to reduce this deviation is to profile the VER output from the last few intervals and project the VER dispatch.



Current Limitations and Possible Enhancements

- DVER Regulation Deployment
  - In our current market we allow qualified Dispatchable Variable Energy Resources (DVER) to provide regulation down.
  - Because our regulation deployments can vary widely in time we do not make our clearing engine aware of these deployments.
- Regulating DVER inefficiency
  - Since DVERs are echoed in RTBM any regulation down deployment looks like lowered capability.
  - This can cause a cycle of dispatch and regulation down deployments that drive the output of the DVER lower than intended.
- Enhancement
  - The DVER will send SPP their potential output limit for use for energy.
  - SPP will use the potential output limit as the basepoint for any regulation down deployment.

Questions ?