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Multi-Settlement Simulation of Stochastic Reserve Determination : Project Status Update

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Technical Conference on Increasing Market Efficiency through Improved Software

June 25, 2013

Outline

- Project Background
- Case study based on CAISO
- Results and insights into modeling
- Conclusions

This is a work in progress with increasing realism

Background

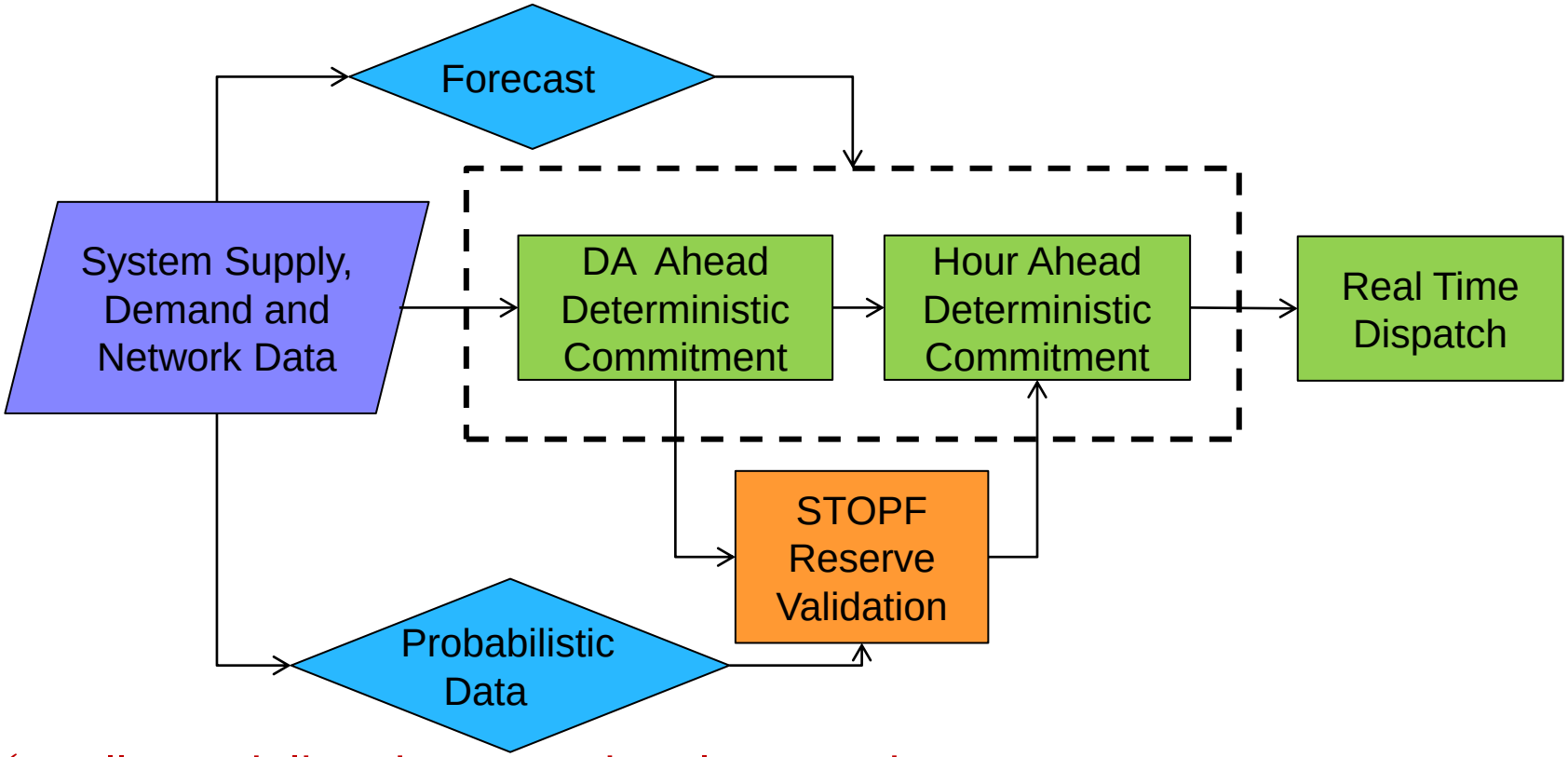
Traditional reserve procurement may not be efficient or sufficiently reliable under future system conditions

- We need methods to dynamically procure reserve in anticipation of dynamic system conditions
  - Wind ramping
  - Uncertain production and demand
- Stochastic modeling offers hope of accomplishing this
  - A drawback is a lack of transparency
- Use dynamic reserve requirements from an *off-line* calculation fed into current operating practice

This offers augmentation with minimum disruption

Concepts

- Dynamic Reserve Determination in a *Complete Stochastic Process*

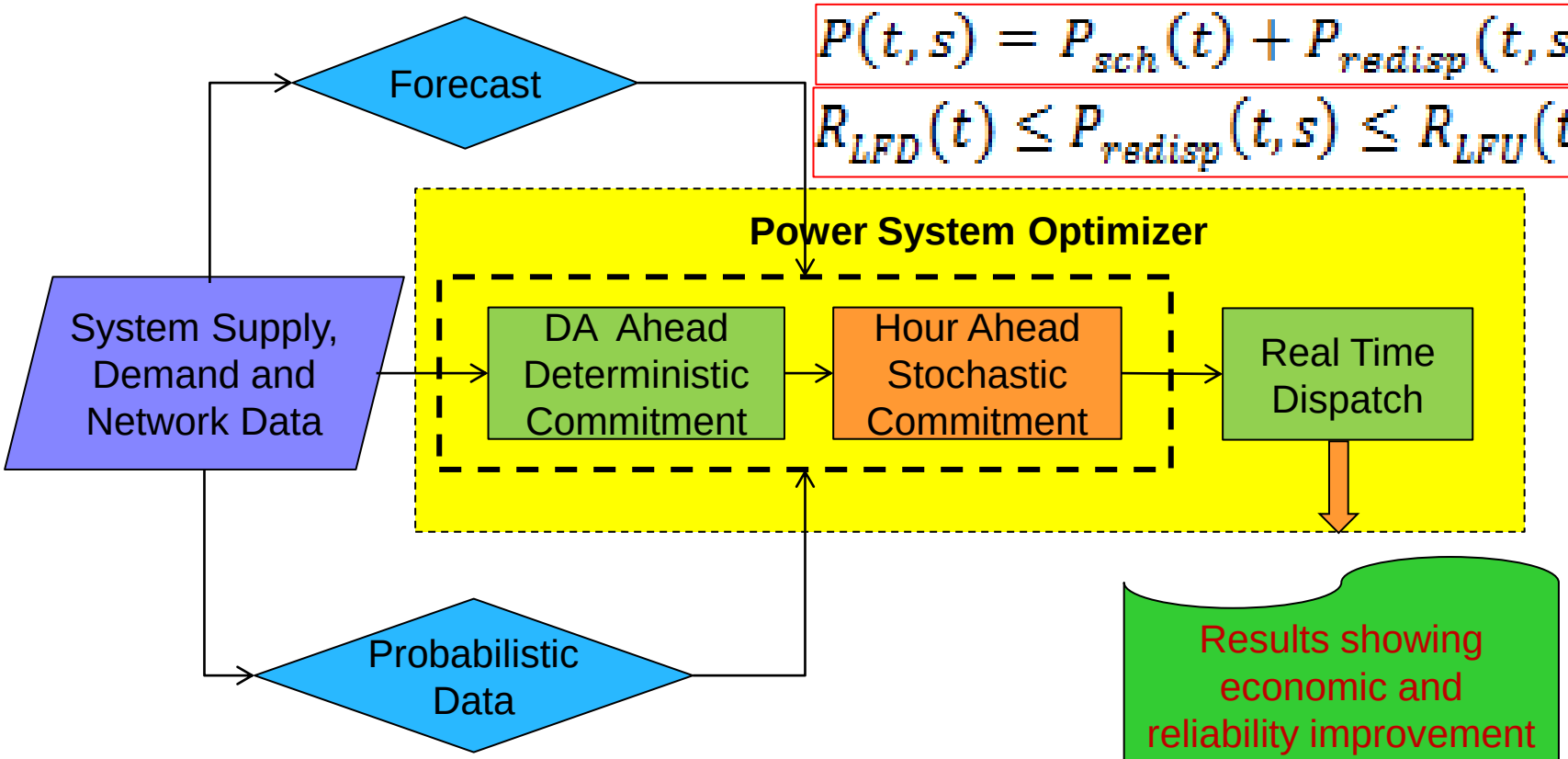


✓ Fully modeling the operational uncertainty

✓ Testing the ability to redispatch to meet the uncertainties

Concepts

- Dynamic Reserve Determination implementation in PSO



✓ Redispatch included in the HA market clearing

✓ Problem is solvable for a realistic system

CAISO case study

- Last year: showed overall concepts of multi-settlement approach
- This update: Larger more realistic system studied – CAISO
- Extended supply/demand model for the WECC region
- Handle multiple, varied forecast errors
  - Multiple wind locations
  - Multiple load centers with DR resources
- Challenges to manage data and benchmark output
  - Data from traditional tools may not be suitable for these new techniques
- Challenges to scale the algorithm
  - Utilize model decomposition with sampling?

New work in past year on larger more realistic test system

Main insight: stochastic modeling is practical

The Studied Case: Modified WECC Zonal Model

No. of Resources	No. of Dispatchable Resources	No. of Resources with Fixed Schedules	No. of Loads
1592	1466	126	39
No. of Resources in Commitment	No. of Resources Committed in DA	No. of Resource Committed in HA	No. of Areas
1112	877	235	27

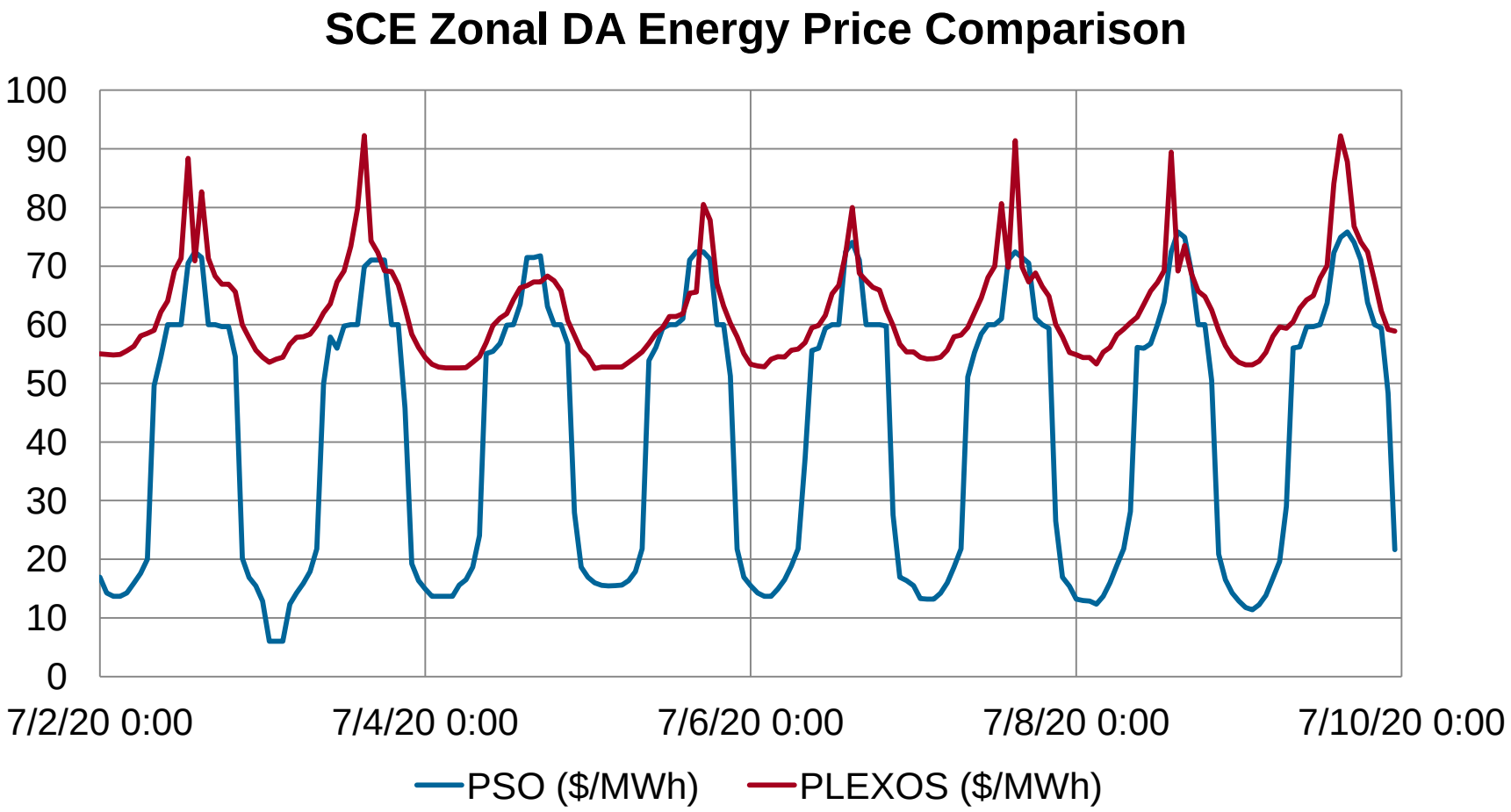
Simulation Setup and Performance: Total Runs per day = 1 DA + 96 HA + 288 RT

Sequence	No. of Intervals	Decision Horizon (minute)	Advisory Horizon (minute)	No. of Scenarios	Average Execution Time/Run (second) – Thinkpad T430, i7-3520M, 8GB Memory
DA	36	24*60	12*120	1	20
HA	10	1*15	9*15	10	50
RT	12	1*5	11*5	1	8

Preliminary Results

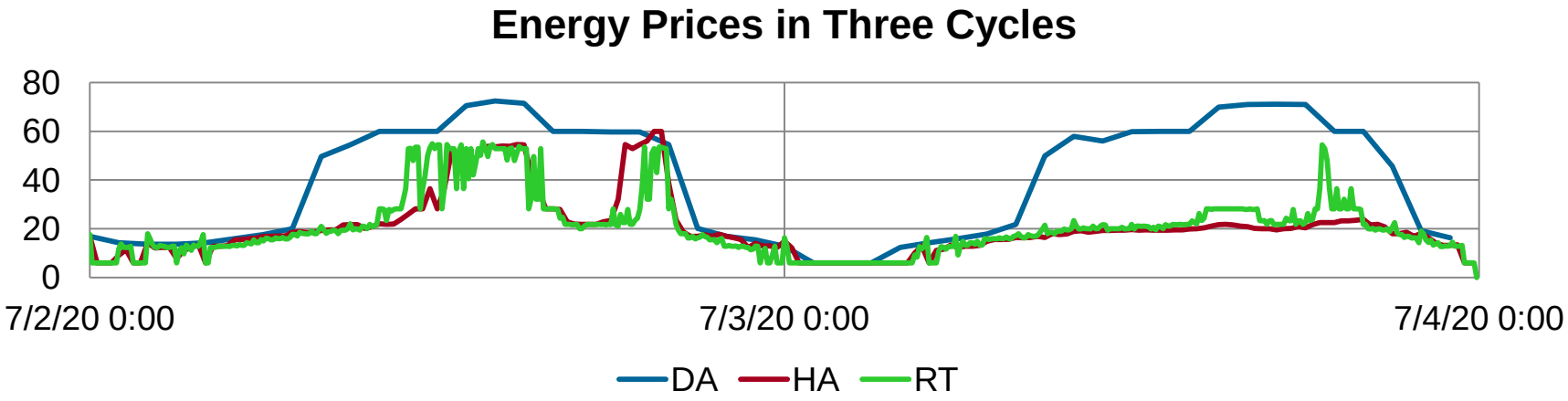
- Case Study July 1 to 10, 2020
  - Deterministic Case
    - Compare 33% Study
    - Energy prices, energy mix
    - Regulation and LF reserve prices
    - 3-cycle prices and dispatch
  - Stochastic Cases
    - Scenario creation

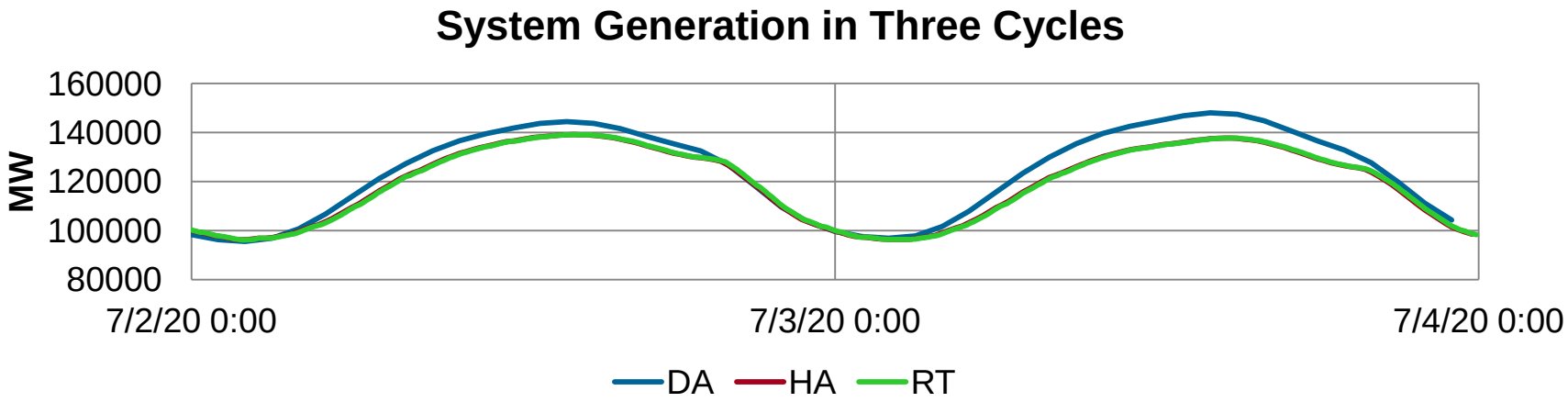
Preliminary Results



EPRI simulations have lower off-peak prices…

Preliminary Results

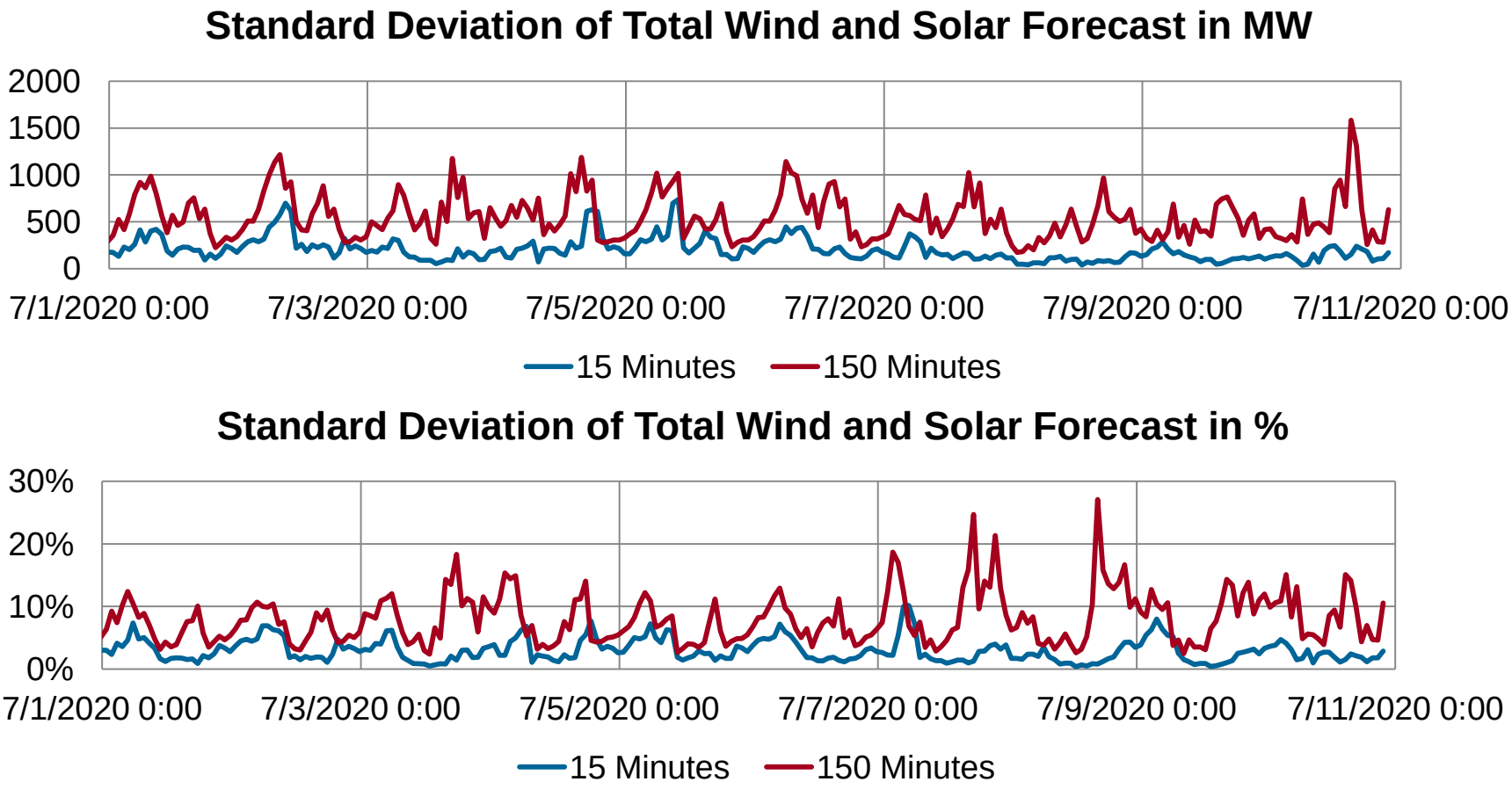




Hour ahead and real time prices are volatile.

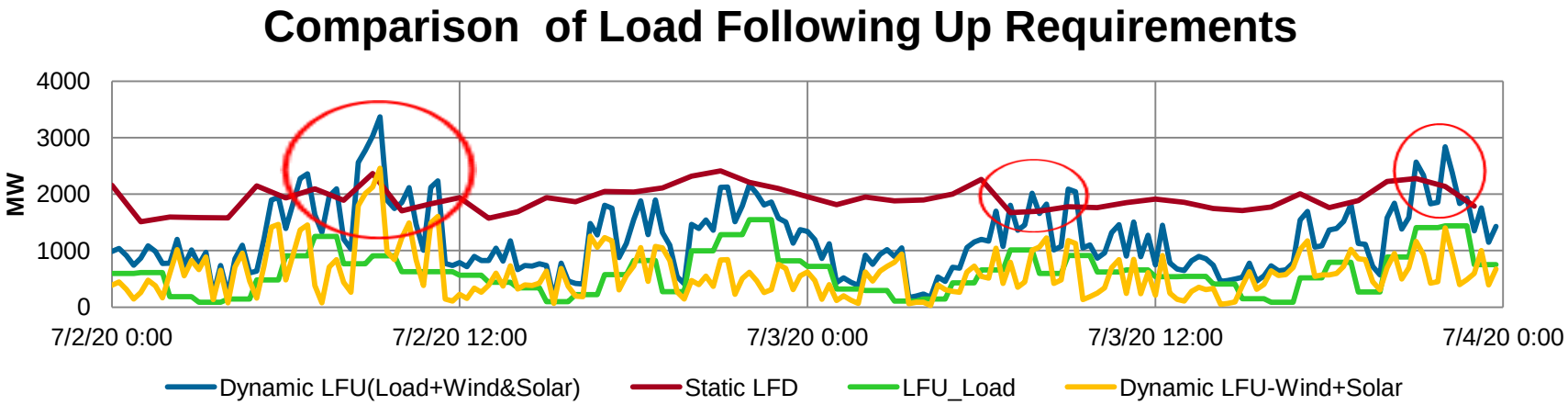
Real-time production is reduced from day ahead forecasts…

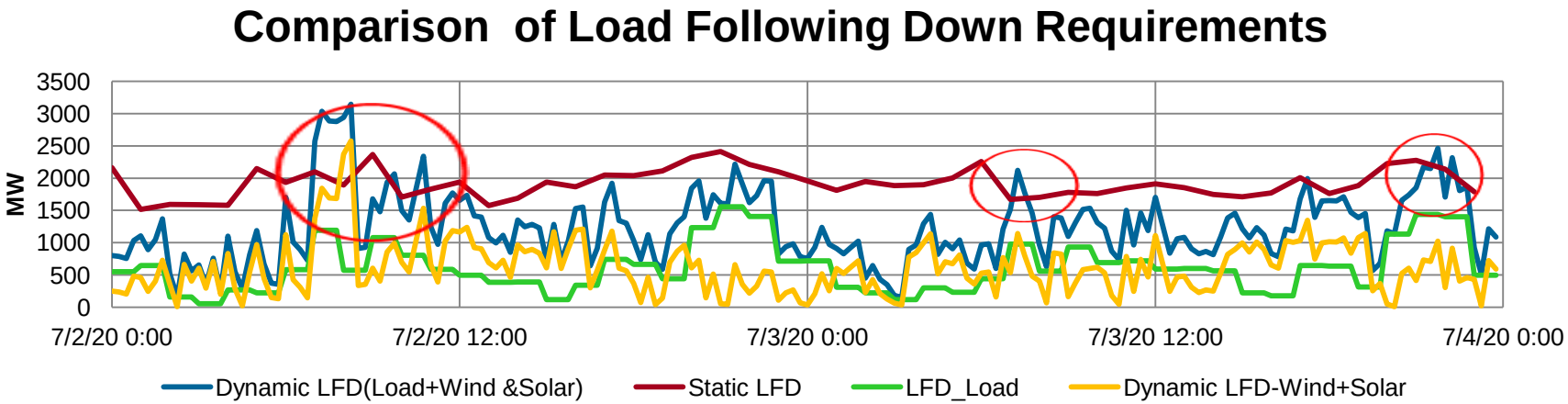
Preliminary Results – Input Analysis



Wind and solar forecasts are added together

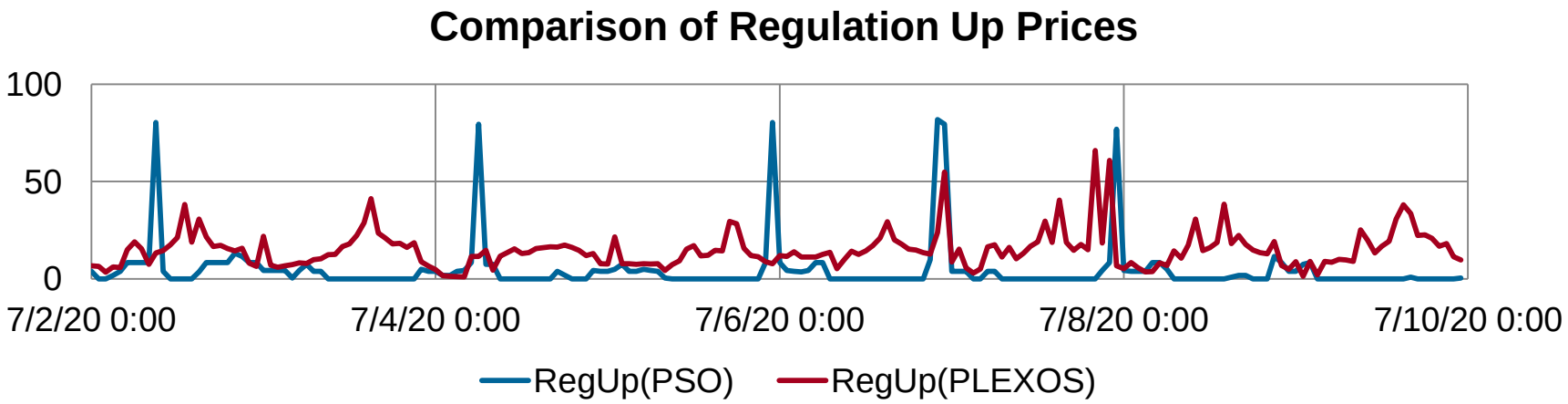
Preliminary Results – Output Analysis

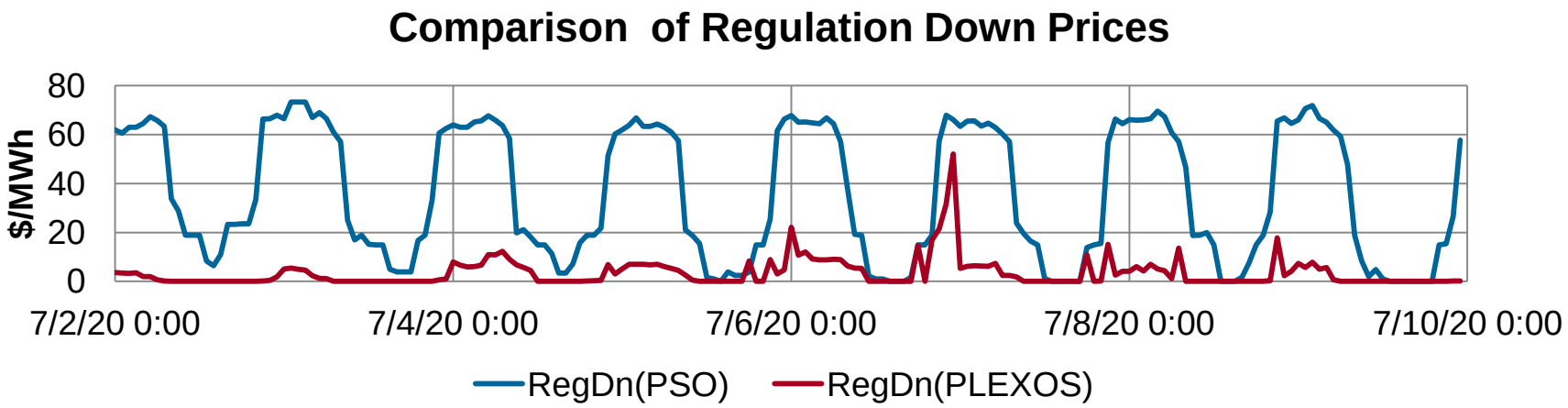




EPRI LFU (blue) sometimes exceeds 33% Study levels (red)

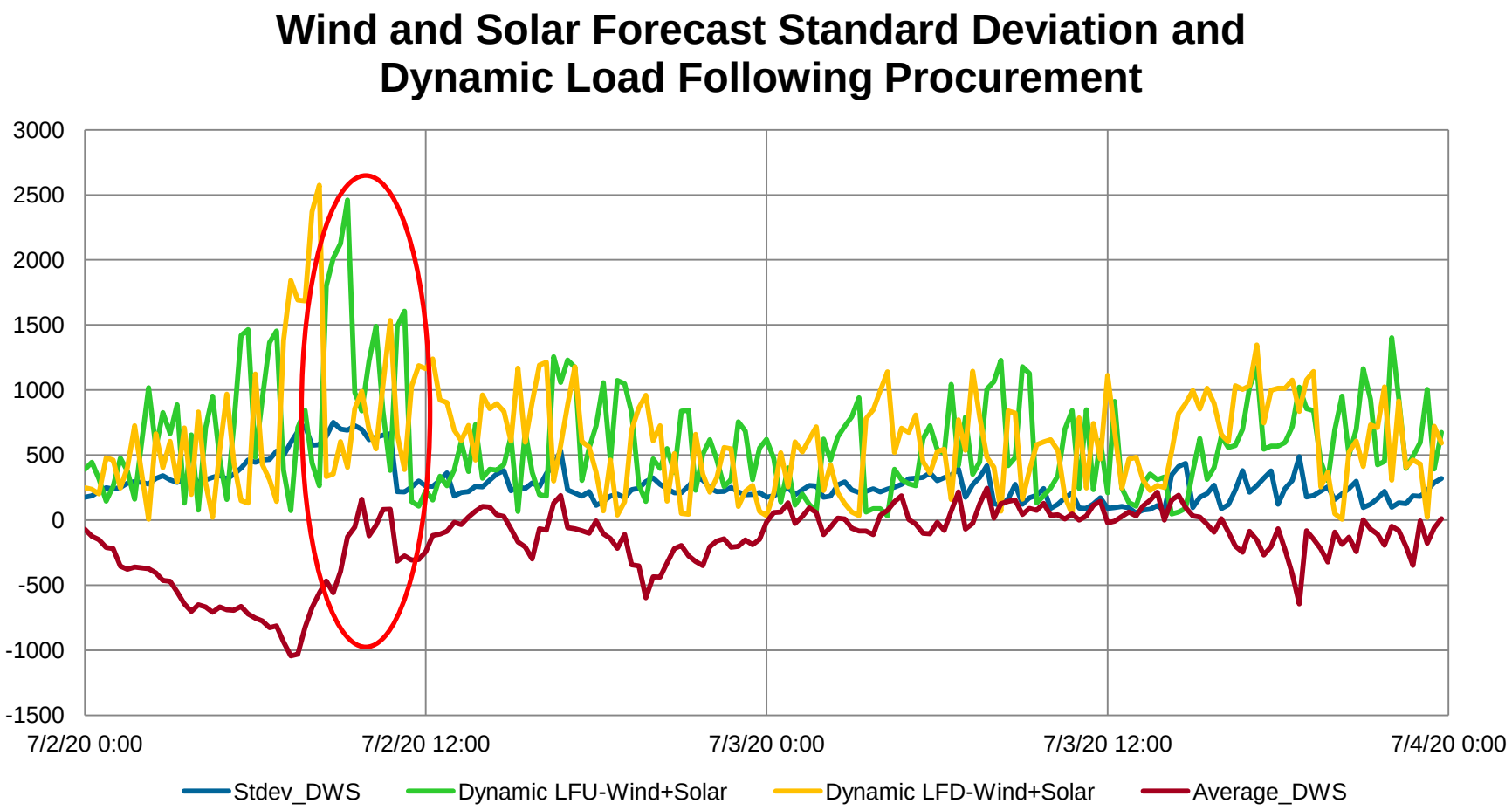
Preliminary Results – Output Analysis





EPRI Regulation prices are more volatile

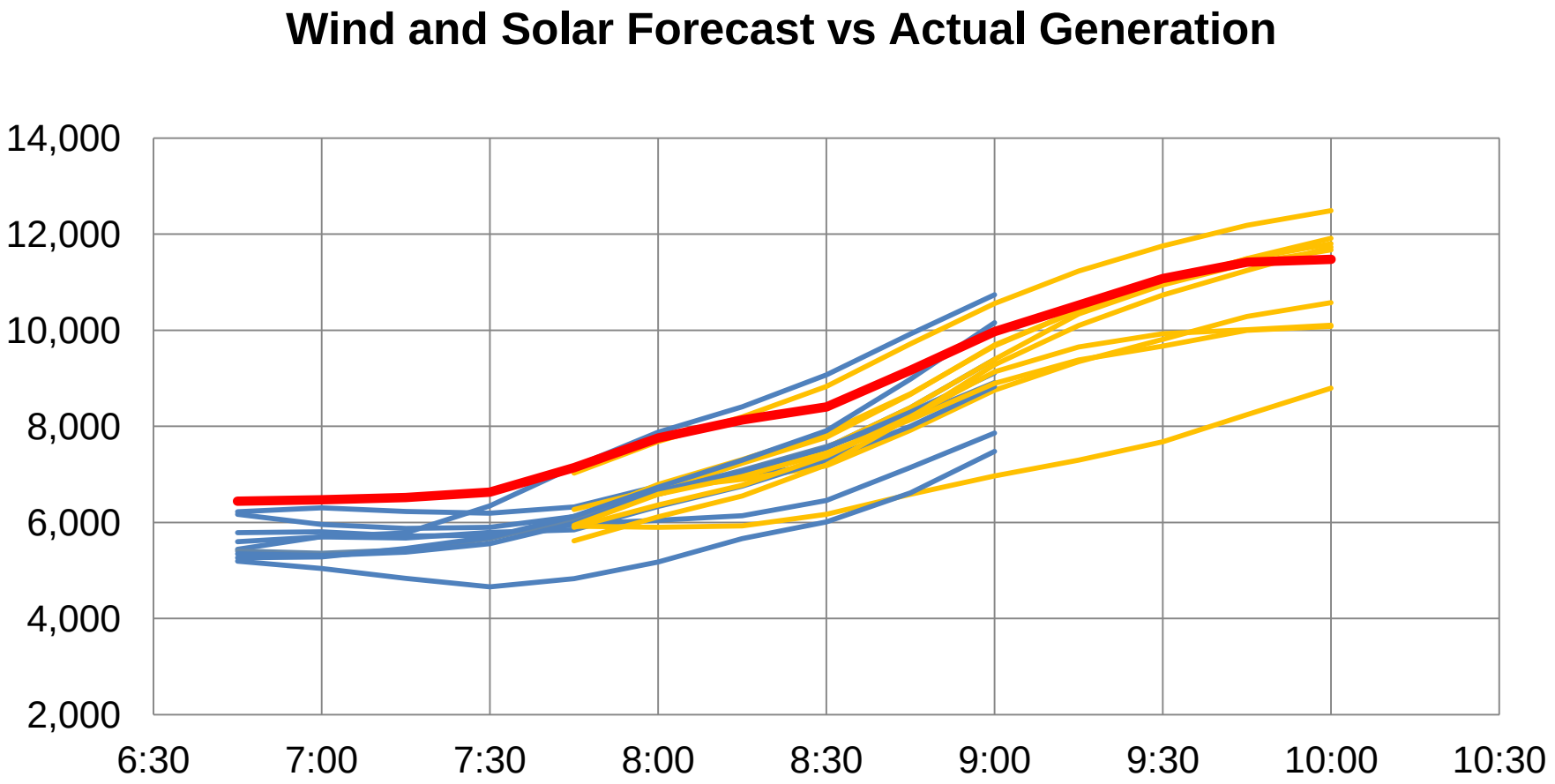
Preliminary Results – Output Analysis



Some correlation (0.34) between input uncertainty and LF requirement

The marked region has high LF procurement…

Preliminary Results – Output Analysis



… because the forecast is low compared to the actual.
We have yet to conduct Monte Carlo analysis.

Conclusions (1 of 3)

- Leveraged software improvements that allow dynamic procurement of both Load Following Up and Down within the same cycle
- Successfully exercised dynamic reserve procurement simulations on the large WECC planning network model for the California 2020 33% Renewable Integration Study.
  - 2-day rolling horizon of multi-cycle simulations,
  - 2000 generators, 46 zones, and 27 regions
  - 626 commitment and dispatch runs
  - Runtime ~*1 hour*
    - on Core I7 CPU

Conclusions (2 of 3)

- Data issues are not yet clarified
- Results are preliminary, but continue to prove the concept.
- Project team is advised by California ISO
  1. Ensure quality data in the model
  2. Benchmark with another tool
  3. Clarify differences

Conclusions (3 of 3)

- 33% Study <u>method may overestimate</u> the Load Following reserve requirement
- <u>Stochastic optimization *may be* practical and feasible</u> to adopt for *studying* renewable integration and *use* in the dynamic reserve determination application

Further work

- Perform the study also on a *small system* with well-maintained renewable data
- Perform a *benchmarking* study with another tool
- Reasonably capture *congestion* and reliability impacts
- Evaluate use of decomposition, parallel computing, and large-scale sampling with variance reduction techniques
- Leverage improved processes for representing and generating scenarios

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