



Real-Time Reserve Requirements Tool (R3T) Status Update for 5/30/13

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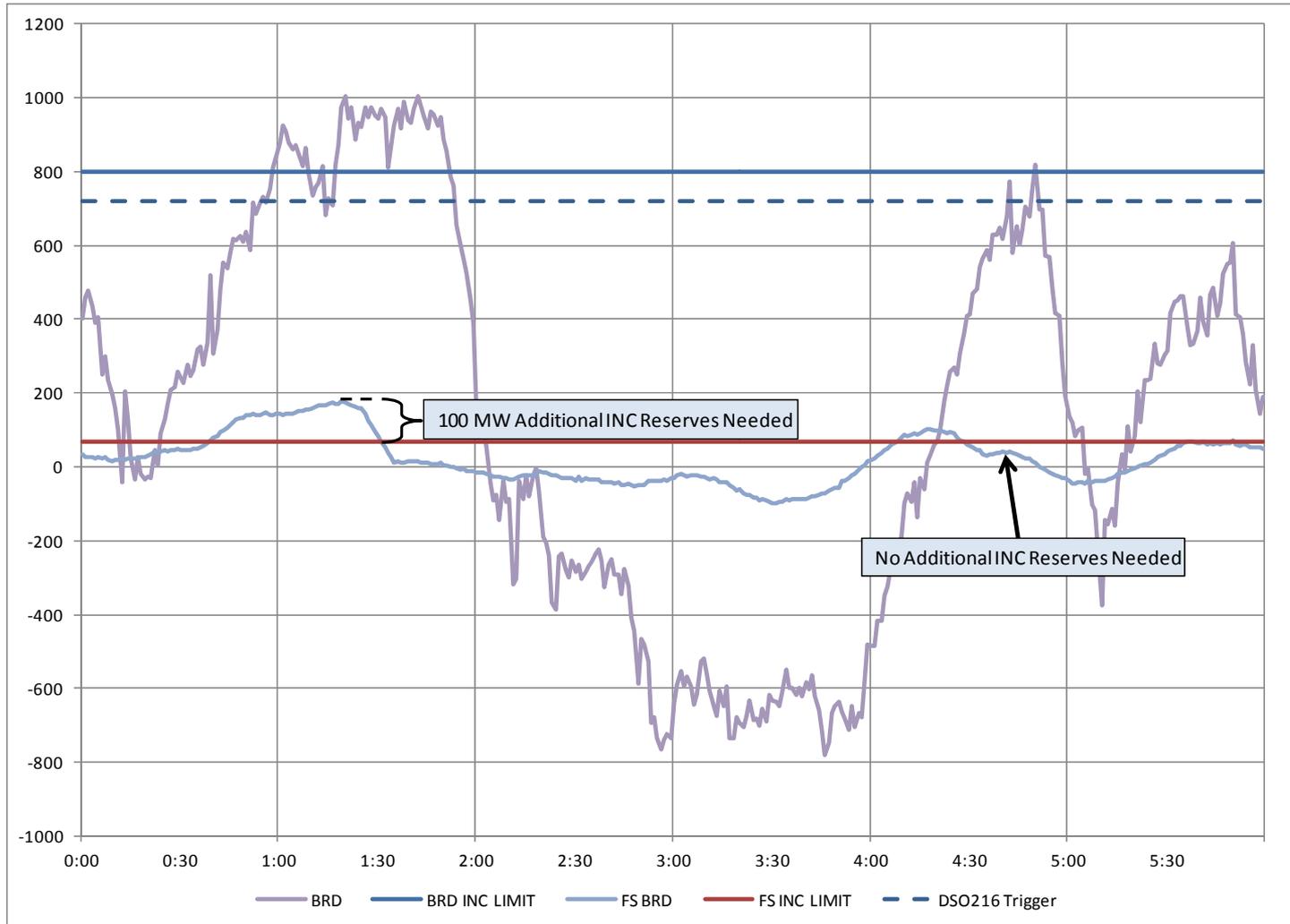


PRELIMINARY

Disclaimer

- The content of this presentation is to convey BPA's efforts to predict the balancing reserves needed on shortened time periods.
- It is not meant to imply that BPA will be able to acquire reserves within those shortened timeframes or that the market has the ability to provide the identified balancing reserves within the FY14-15 Rate Period.

R3T Problem



R3T Objectives

- The R3T will be developed for three objectives:
 1. Inform BPA of the additional reserves to purchase for Full Service Participants
 2. Confirm additional reserves purchased for Full Service participants is sufficient **X** hours ahead of the delivery hour
 3. Predict the likelihood of a DSO 216 curtailment event occurring during any given hour at **Y** hours ahead of time for BAA's use

R3T Update Outline

- R3T Milestones
- Buy versus Build Update
- R3T Options Update
- Cross-Walk Update
- R3T Decision
- R3T DSO 216 Predictor

R3T Milestones

MILESTONE	TIMELINE
Mock Up and Evaluate Options	DONE
Choose Option	DONE
Develop DSO 216 Predictor	IN PROGRESS
Develop Test & Production Systems	IN PROGRESS
Full Service Elections	July 2013
Test System Running	Summer 2013
Develop Displays	Summer 2013
Go Live	October 2013

R3T Buy versus Build

- BPA Wind Forecast RFP for FY14 has been sent out.
- RFP includes an “optional” product for Real-Time Reserve Forecasting or a “Buy” option for R3T.
- If proposals are accepted, BPA will likely run “Build” (in-house R3T option) and “Buy” (vendor option) to evaluate the performance of each.

R3T Options Update

- Previously-investigated algorithms:
 - Matrix algorithm (4 main variants)
 - Regression algorithm (4 main variants)
- Current algorithm:
 - Time Series (9 variants)
- Future algorithms:
 - Signal predictor: ARMA, ARMAX, Kalman Filter
 - Variance predictor: GARCH

R3T Options Update

- Delta between forecasts is a predictor
 - However, the wind front can be slower or faster than the forecast predicts – sometimes by as much as 8 hours in each direction.
 - Too wide of a window results in too much overbuying of reserves. Too narrow of a window results in missed events.
 - The optimal window that we have found is 4 hours in each direction.
- Delta within the same hour forecast is also a predictor
 - Example: If last hours' prediction was 500MW, and this hour's prediction was 1000MW, the delta is 500MW.
- Performance is similar for a window vs. intra-hour delta.

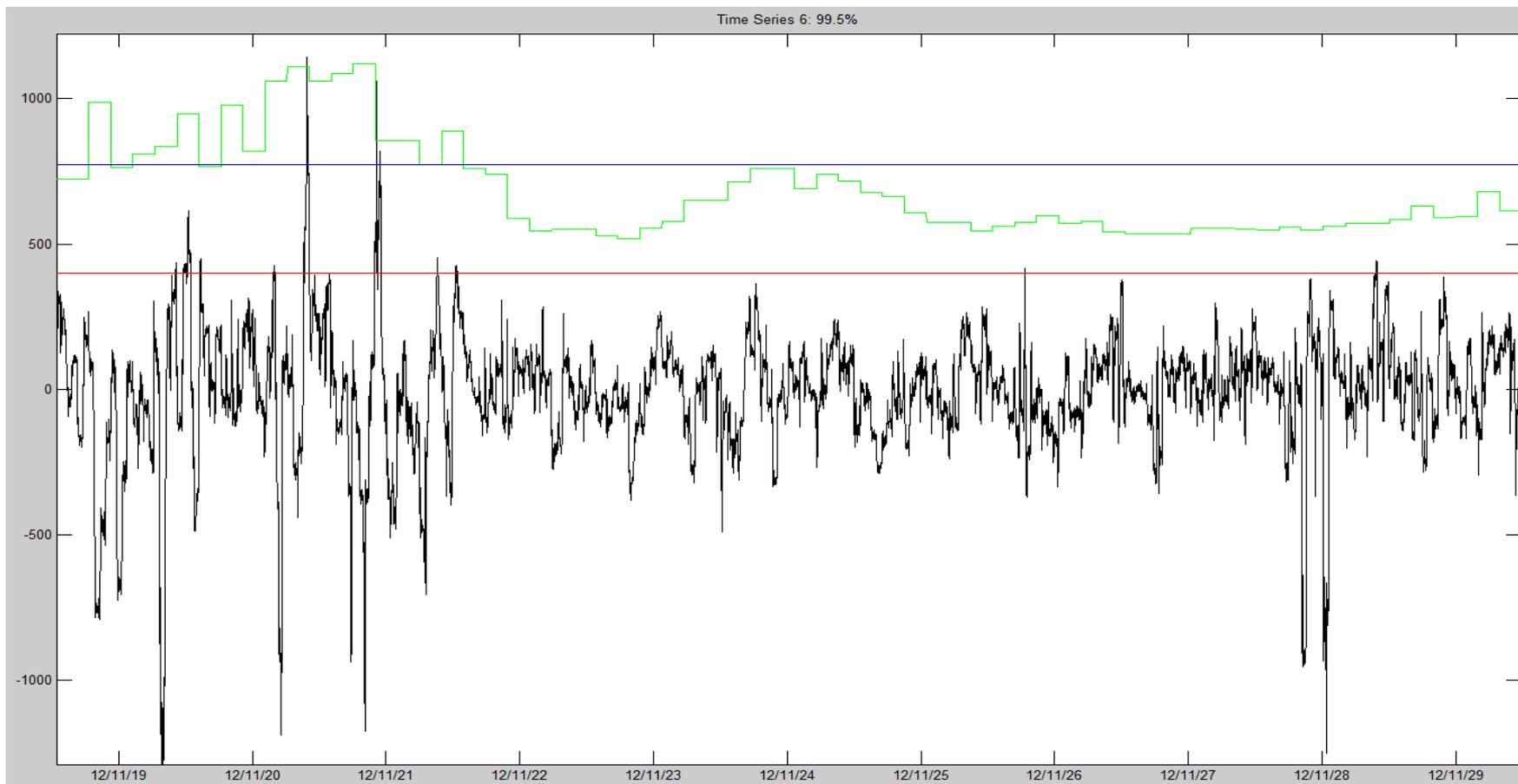
R3T Options Update

- **Time Series Algorithm (current)**
 - Pick the wind forecast for hours 64-72.
 - Find the maximum hourly change (delta)
 - ACE – 95th Percentile from Last Year
 - Load Error – 95th Percentile from Last Year

Reserve Level for the 68th hour out, set at 64 hours out:

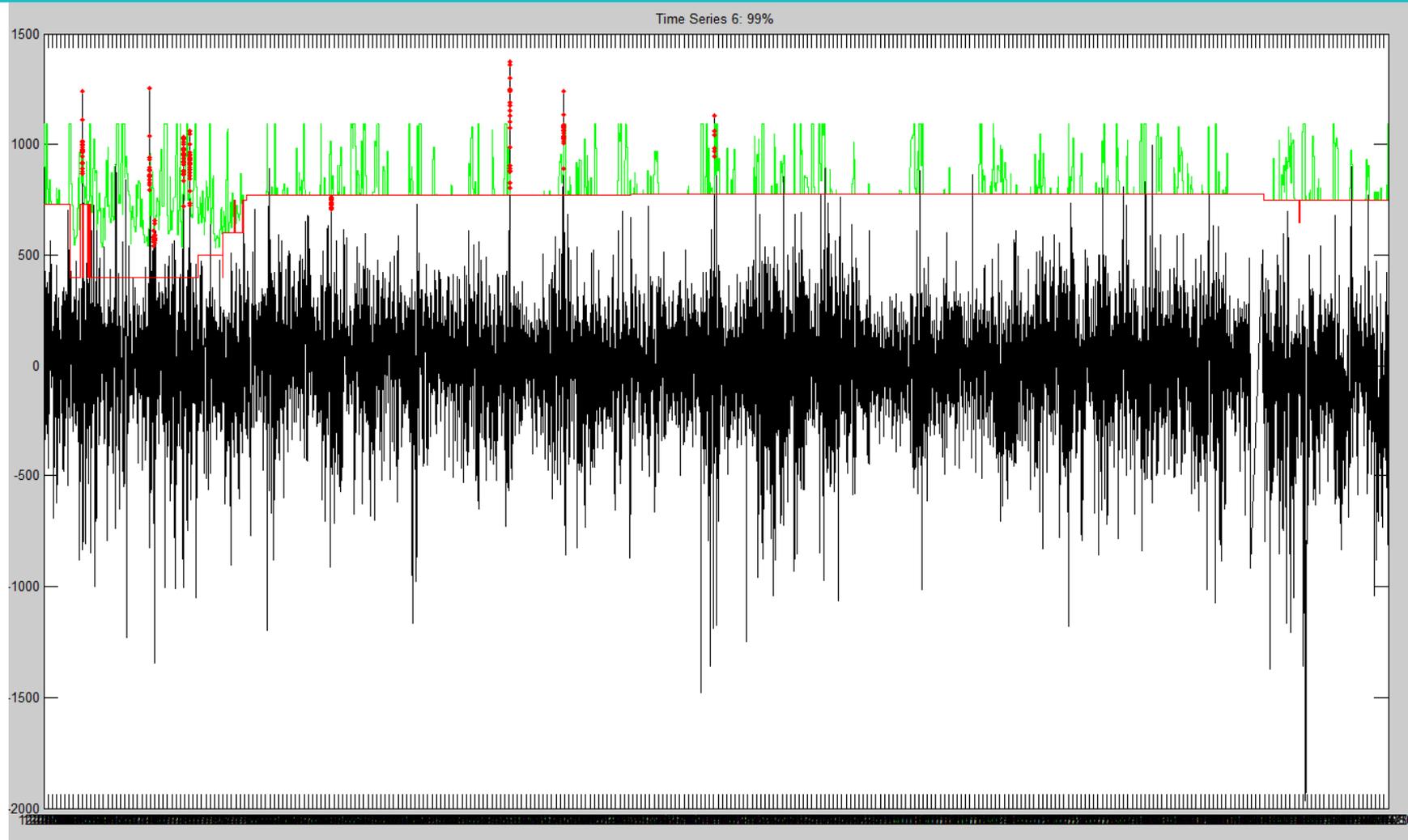
$$\text{Reserve} = \text{ACE} + \text{Load error} + \text{delta} * 2/3$$

R3T Options Update



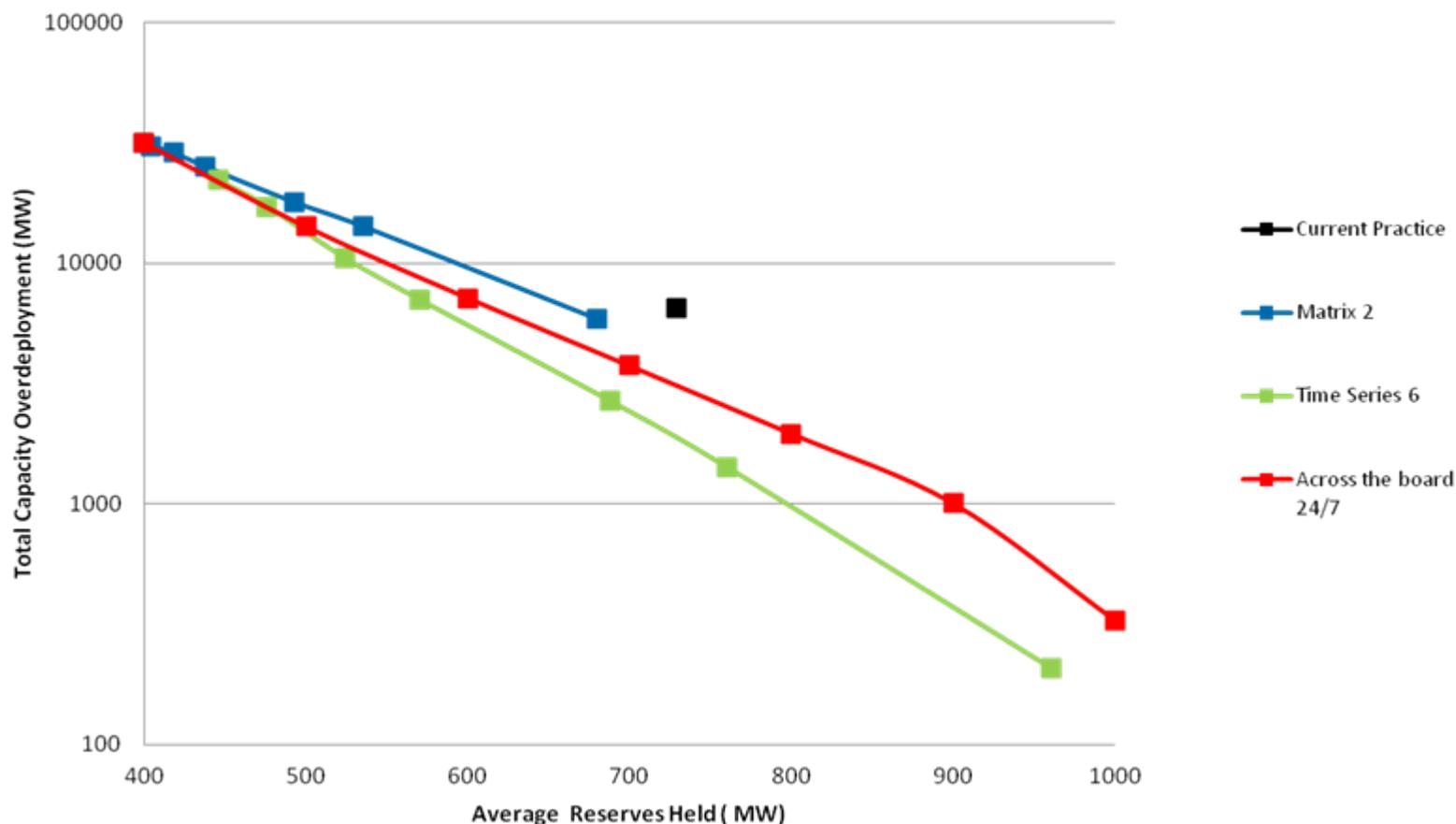
NOTE: 400 MW (red line) is a arbitrary reserve requirement used to benchmark the algorithm and not the reserves held by BPA.

R3T Options Update



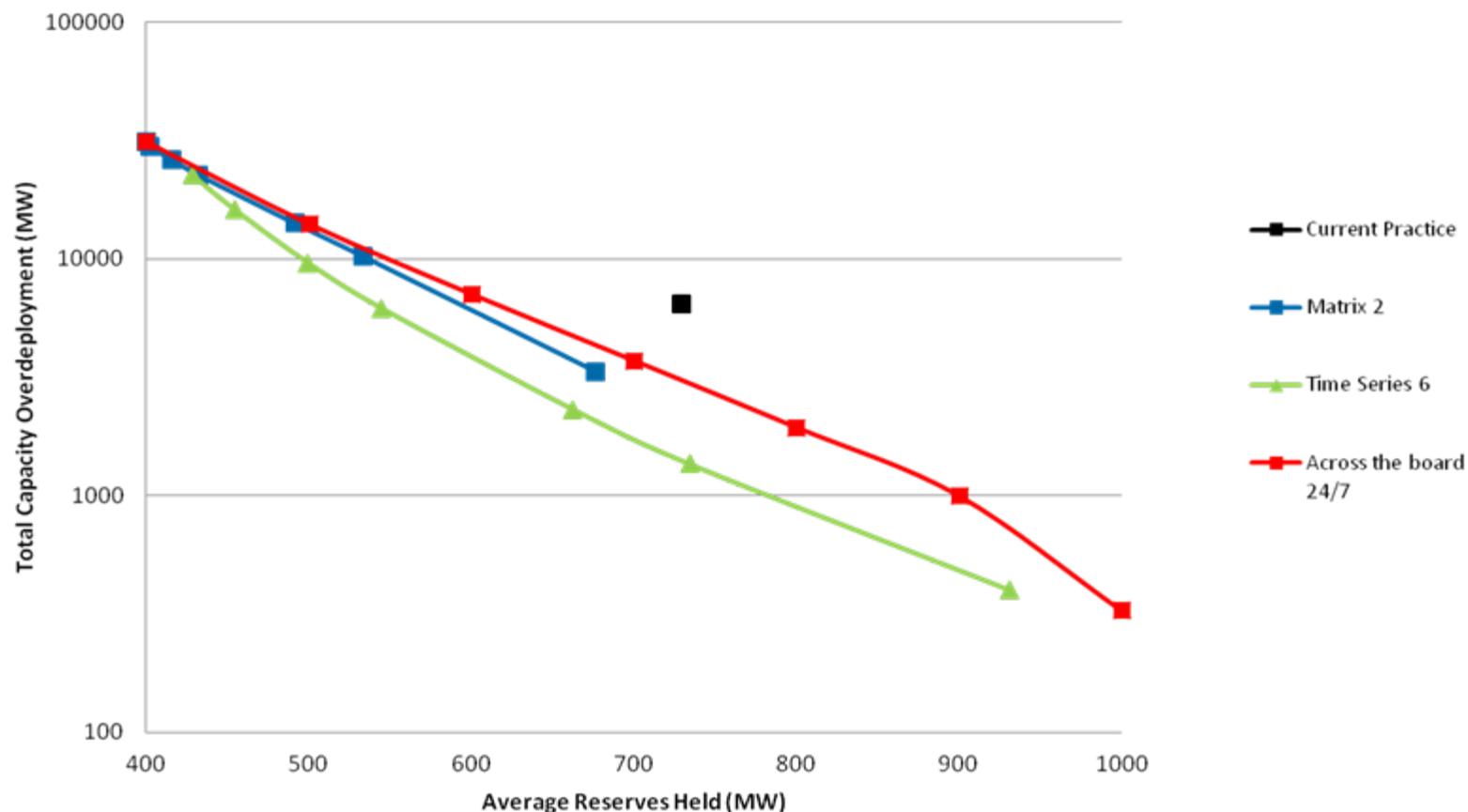
R3T Options Update

64 hours out benchmark of various methods. The closer to (0,0) the better.



R3T Options Update

4 hours out benchmark of various methods. The closer to (0,0) the better.



R3T Options Update

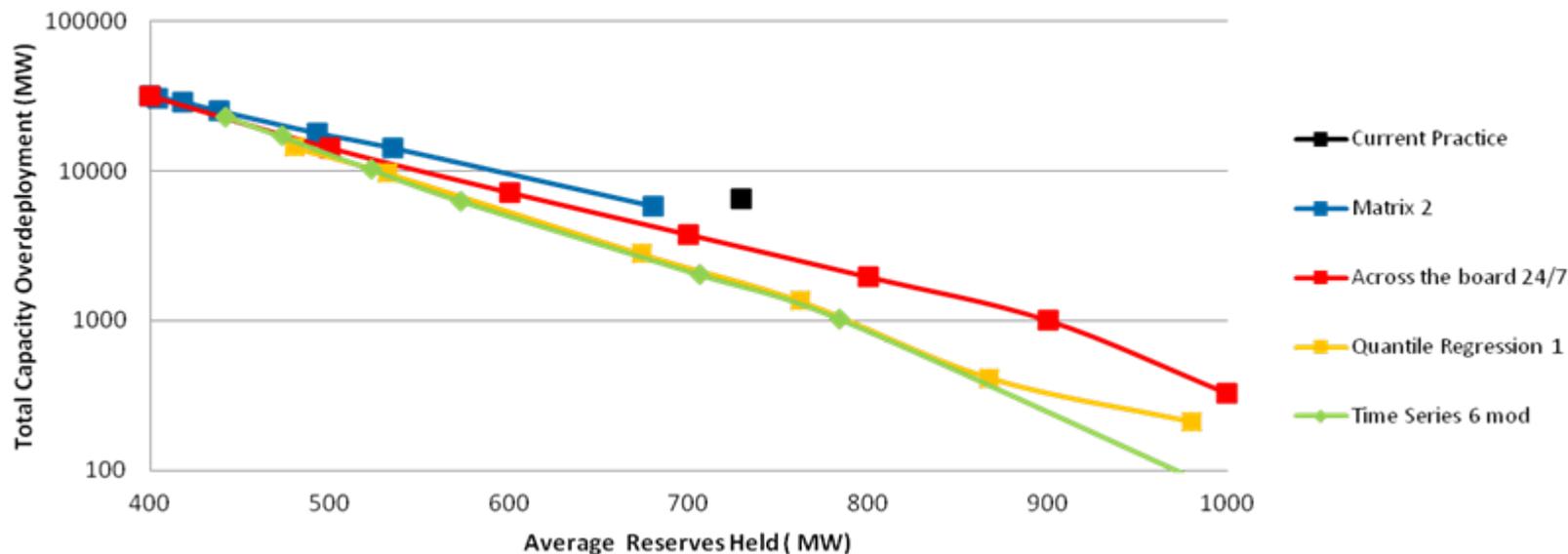
- **Other Options with investigations in progress**
 - ARMA-GARCH model
 - Quantile Regression

R3T Options Update

■ Quantile Regression Progress:

- Initial results seem to at least match the performance of the time series. May get better with tuning.

64 hours out benchmark of various methods. The closer to (0,0) the better.



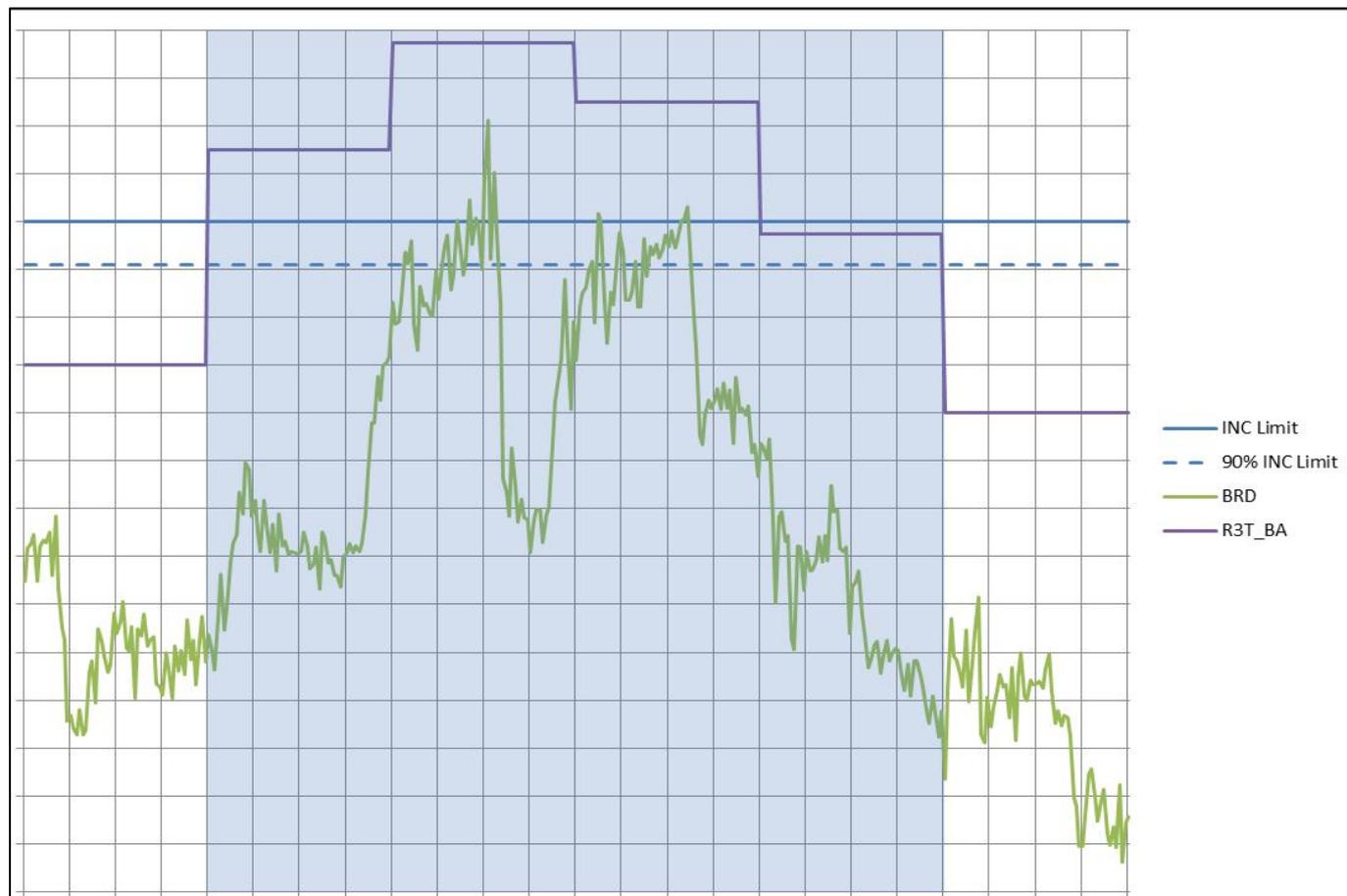
R3T Cross-Walk Update

■ Crosswalk algorithm

- Use the forecast of total reserves for the BA.
 - If the predicted reserves need for the BA exceeds the 90% of the INC reserves held for all Base Service, buy additional reserves for full-service participants. We will not buy DEC.
- Forecast the reserves needed for Full Service.
- Buy the difference between that Full Service Forecast and their Base Service reserve allocation.
- Elections are on July 1st for Full-Service participation.
 - We will work with those that elect service to give them a feel for the additional reserve required for Full Service.

R3T Cross-Walk Update

- The blue shaded area indicates when Full Service reserves need to be purchased.



NOTE: The graph above is for illustrative purposes and does not reflect actual output of R3T.

R3T Cross-Walk Update

- The dark blue shaded area indicates the amount of Full Service reserves that need to be purchased.



NOTE: The graph above is for illustrative purposes and does not reflect actual output of R3T.

R3T Options Choice

- We have chosen the Time Series Algorithm to implement on October 1st, 2013 for it's accuracy and simplicity
 - Time Series will be implemented on both the BAA and the Full Service participants using the cross-walk method laid out in this presentation.
- We will still explore additional options as time permits, but we be shifting focus onto development of the production systems.

R3T DSO216 Predictor

- Product of the real-time reserves algorithm
- First stab at an algorithm:
 - Given a certain reserve prediction, what are the odds that there will be an over-deployment event?
 - For instance, given a reserve prediction of 1100MW, if no additional reserves are bought, there will be a 30% likelihood of a DSO216 event.
- Real-Time Reserves + DSO216 Predictor
 - Two sides of the same coin
 - DSO216 Predictor tells you the likelihood of an event
 - Real-Time Reserves tells you how much reserves you need to buy

Real-Time Reserve Requirement Tool

Questions?