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2016 Economic Phase II Study

Regulation, Ramping, and Reserves Scenario Results Introduction

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Presentation Overview

- Background
- Helpful Definitions
- Next Steps
- Separate Presentation:
  - 2016 Economic Study Phase II: Regulation, Ramping, and Reserves – Scenario Results
    - Prof. Amro M. Farid, Thayer School of Engineering at Dartmouth

2016 Economic Study Scope Summary

The 2016 Economic Study request was addressed in two phases

- Phase I consisted of traditional economic study analyses
  - Production cost analyses and related metrics are summarized
  - Results were presented to the PAC at the end of 2016
  - Final report is posted on PAC website
- Phase II supplements the Phase I analyses by discussing several market and operational issues
  - Examine representative Forward Capacity Auction clearing prices for several scenarios (presented at the May 2017 PAC)
  - **Analyze intra-hour ramping, regulation, and reserve requirements (Methodology presented at the Sept 2017 PAC, results presented today)**
  - Assess natural gas system deliverability issues (presented at the May 2017 PAC)

BACKGROUND

Study Scenarios

Scenario	Retirements	Gross Demand	PV	Energy Efficiency	Wind	New NG Units	HQ and NB External Ties & Transfer Limits
1	½ in 2025 ½ in 2030	Based on 2016 CELT forecast	Based on 2016 CELT forecast	Based on 2016 CELT forecast	As needed to meet RPSs	NGCC	Based on historical profiles
2	½ in 2025 ½ in 2030	Based on 2016 CELT forecast	BTM based on 2016 CELT forecast; non-BTM same as wind	Based on 2016 CELT forecast	Used to satisfy net ICR	None	Based on historical profiles
3	½ in 2025 ½ in 2030	Based on 2016 CELT forecast	8,000 MW (2025) 12,000 MW (2030) BTM PV 4,000 (2025) 6,000 (2030) Utility PV 4,000 (2025) 6,000 (2030)	4,844 MW (2025) 7,009 MW (2030)	5,733 MW (2025) 7,283 MW (2030)	None	Based on historical profiles plus additional imports
4	No retirements beyond FCA #10	Based on 2016 CELT forecast	Based on 2016 CELT forecast	Based on 2016 forecast	Existing plus those with I.3.9 approval	NGCC	Based on historical profiles
5	½ in 2025 ½ in 2030	Based on 2016 CELT forecast	Based on 2016 CELT forecast	Based on 2016 CELT forecast	Existing plus those with I.3.9 approval	NGCC	Based on historical profiles
6	½ in 2025 ½ in 2030	Based on 2016 CELT forecast	Based on 2016 CELT forecast	Based on 2016 CELT forecast	Onshore wind: 2,509 MW (2025) 7,237 MW (2030) Offshore wind: 1,753 MW (2025) 5,553 MW (2030)	None	Based on historical profiles

Study Key Differences

- There were several key differences in the Phase I 2016 economic study and the Phase II operational study on regulation, ramping, and reserves, which reflects scenario weather for 2013
  - Required to get needed input data for wind and solar
    - Overall results will reflect the scenarios, but simulation results for specific days in the Phase I economic study will not match the same day in this study.
  - This study has an operational focus instead of an economic one
    - Modeled transmission interface constraints
    - Modeled historical average external tie-line flows as input schedules
  - This study did not model outages and maintenance
    - Added too much complexity to the model at this stage
    - Focus is on given a specified resource mix, what quantities of regulation, ramping, and reserves are needed and available on the system over the course of the year

Input Data Sources

- Load
  - Based on CELT 2016, 2013 historical 1 minute load data scaled so peak minute matches CELT forecasted peak for scenario year (2025/2030)
- Wind Resources
  - Based on 1 minute NREL wind toolkit data for 2013
- Solar PV Resources
  - Based on 30 minute NREL solar data for 2013, consultant upsampled data to 1 minute amounts
- Remaining Resources
  - Same as 2016 Phase I study data

What the Study Is and Is Not

- This study will show physical quantities of ramping, reserves, and regulation based on the scenarios
- This study will help inform stakeholders of the physical range of quantities that could be needed and available given the studied scenarios
- It will **NOT** indicate a requirement of these quantities going forward or address market issues

HELPFUL DEFINITIONS

Helpful Definitions

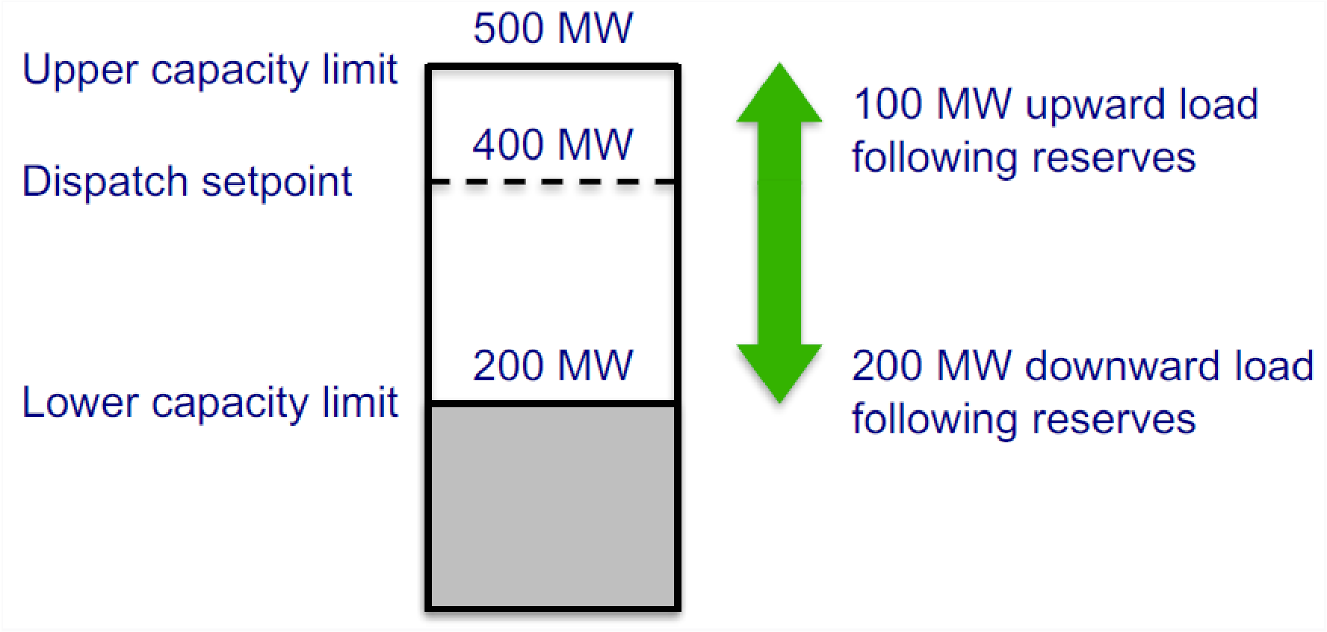
- **Semi-Dispatchable Resources:** Energy resources that can be dispatched downwards (i.e. curtailed) from their uncurtailed power injection value. In this study, wind, solar, run-of-river hydro, and tie-lines are assumed to be semi-dispatchable resources, similar to the Phase I Scenario Analysis study.
- **Must-Run Resources:** Energy resources that must run all the time at their maximum output. In this study, nuclear generation units (i.e. Seabrook, Millstone 2, and Millstone 3) are assumed to be must run resources.
- **Dispatchable Resources:** Energy resources that can be dispatched up and down from their current value of power injection. In this study, all other resources are assumed to be dispatchable within their range of minimum to maximum output.

Helpful Definitions, cont.

- **Load Profile:** The sum of gross load, charging load from electric vehicles, minus the savings from energy efficiency measures (i.e. “passive demand resources”) all in one minute increments.
- **Net Load Profile:** Load minus the unconstrained generation from semi-dispatchable resources (wind, solar, run-of-river hydro, and tie line imports) all in one minute increments.
- **Excess Generation:** Given the presence of must-run resources, excess generation at time steps where the net load is less than the power output from must-run resources.

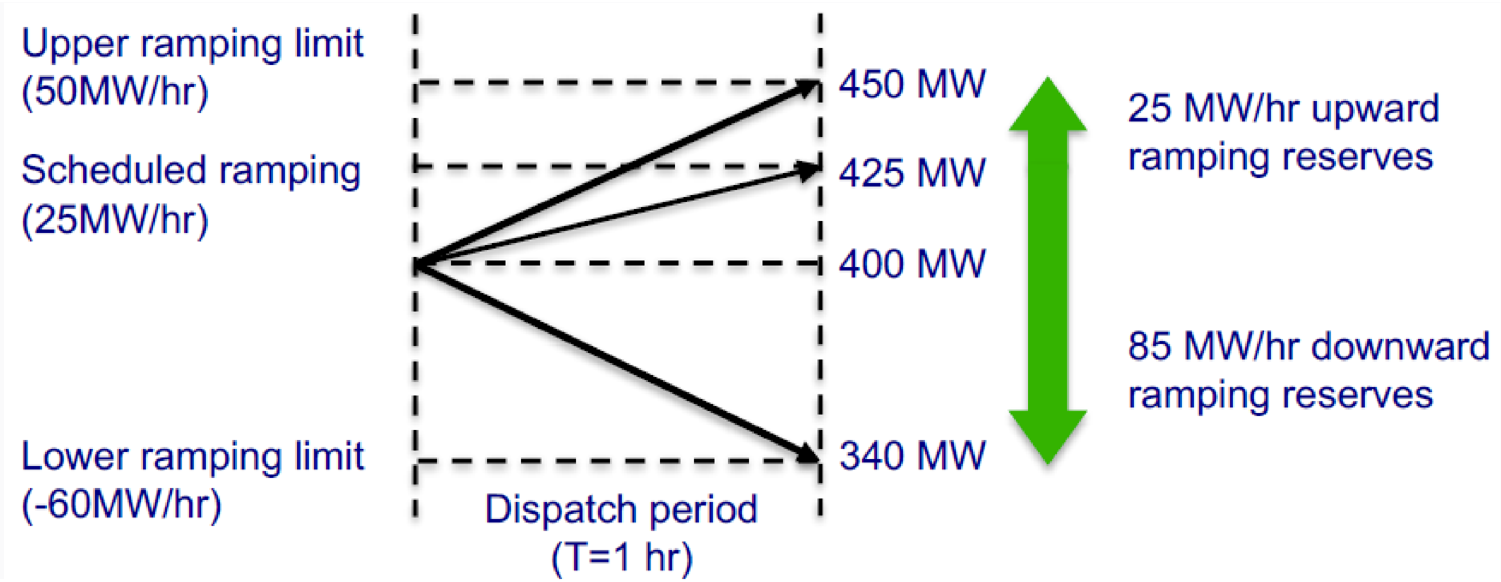
Helpful Definitions, cont.

- **Load Following Reserves (LFR):** The quantity of load following reserves is equal to the capacity of the aggregate generation fleet to move up or down (i.e. economic surplus)



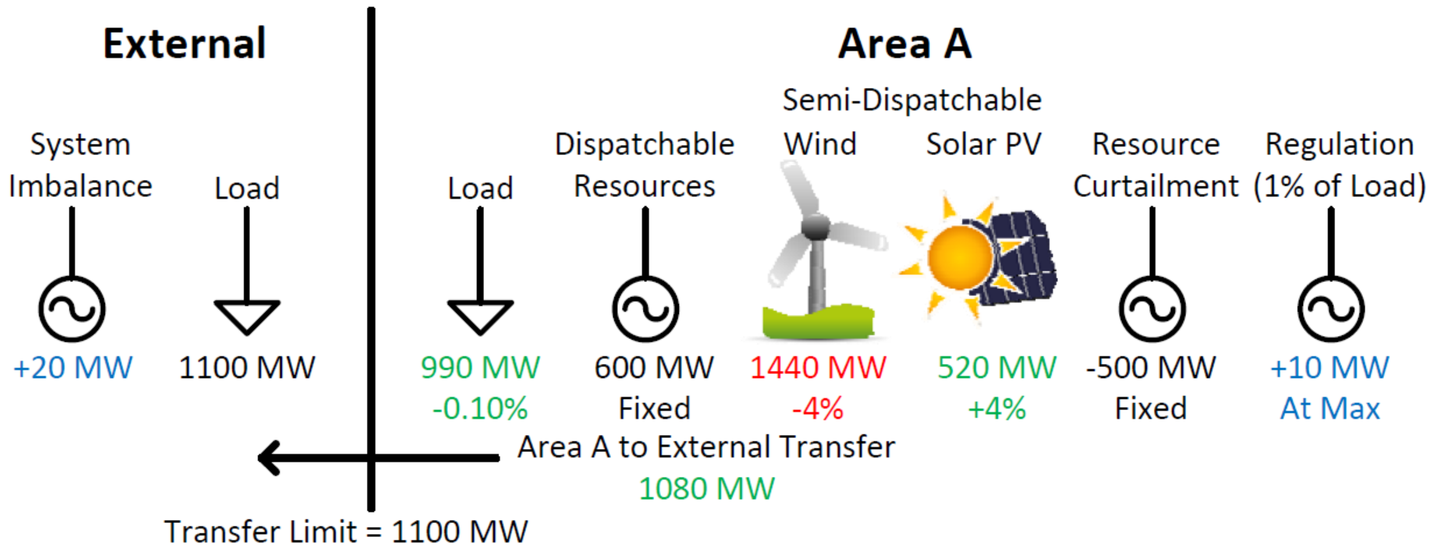
Helpful Definitions, cont.

- **Ramping Reserves (RampR):** The quantity of ramping reserves is equal to the ramping capability of the aggregate generation fleet to move up or down in time.



Helpful Definitions, cont.

- **Imbalance Profile:** The sum of all dispatchable energy resource power injections minus the net load profile as a function of time.



Area A Load/Gen Balance: Disp Res + Semi-Disp Res + Curtailment + Regulation = Load + Transfer

600 MW + (1440 MW + 520 MW) – 500 MW + 10 MW = 990 MW + 1080 MW

2070 MW = 2070 MW

NEXT STEPS

Schedule

- December 20, 2017 – Today's presentation on Scenario Results
- Q1 2018 – Final Report

Questions

A Request…

- The following presentation is a new concept not presented at PAC before and requires a detailed setup before the results
- The ISO and Dr. Farid welcome stakeholder input
- Dr. Farid’s presentation incudes an executive summary of some overall observations followed by detailed results that support those observations
- The presentation is divided into sections and indicates several points where questions should be asked.
  - Please hold questions until the detailed portion of the presentation by writing down any that come up during the executive summary and other detailed sections
  - This will help the flow of his presentation and allow many questions to be answered in subsequent slides

SCENARIO RESULTS PRESENTATION

2016 Economic Study Phase II – Regulation, Ramping, and Reserves

Scenario Results

Prof. Amro M. Farid, Thayer School of Engineering at Dartmouth