2012 Economic Study – ISO New England Summary of Requests

Planning Advisory Committee Meeting

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RESOURCE ADEQUACY

Background: Economic Studies

- "Attachment K" to the Tariff requires ISO New England to perform a wider planning assessment through an open stakeholder process
  - Stakeholder study requests due by April 1 - Completed
  - Stakeholder presentations before PAC by May 1 - Completed
  - ISO discussion of draft Scope of Work by June 1 - Today
  - There are no deadlines for completion of studies within the Tariff
- Not an introduction to a specific "Attachment N" Market Efficiency Transmission Upgrade (METU)

Background: Economic Studies

- Objectives of an “Attachment K” analysis
  - Economic studies provide forum for stakeholder discussions of alternative future system scenarios
    - Show potential effect of
      - Alternative resource mixes
      - Potential economic benefits of relieving transmission constraints
    - Results presented in the form of various metrics:
      - Production cost results
      - Load Serving Entity expenses
      - Congestion
      - Environmental emissions
      - Other metrics
    - Similar to “what-if” framework of Scenario Analysis

Attachment K Economic Studies to Date

- Completed
  - 2007 and 2008 Economic Studies
    - 2007: Ten year study of base system resource expansion. Included sensitivity analyses to fuel prices and demand resources
    - 2008: Various resource expansions were postulated and benefits of relieving transmission constraints was tested
  - 2009 Governors' Request - Year 2030 analysis of large-scale integration of renewable resources in the 20-year timeframe
  - 2010 NESCOE Request – Follow-up on the 2009 Governor's Request that focused on renewables and retirements
  - Interregional analysis of increased transfer limits conducted by the Joint ISO/RTO Planning Committee
  - 2011 Integration of Renewables with a focus on Western Maine

2012 ECONOMIC STUDY REQUESTS

Review of Requests

2012 Economic Study Request Details

- ISO received three Economic Study requests for 2012
  - Request submitted by CMP was withdrawn
  - Request submitted by Synapse Energy Economics on behalf of various stakeholders, requested a study focused on investigating electricity futures consisting of many renewable and low carbon alternatives.
  - Request submitted by the End Users Alliance to evaluate the forced retirements of base load resources

Synapse Energy Economics: Low Carbon Future

- Request focused on investigating a low carbon electricity future
  - Consisting of many renewable, and
  - Effect of state goals
- Study Year 2021
  - Key assumptions:
    - Retirement of all coal and oil resources.
    - These resources would be replaced by a mix that would include:
      - Energy Efficiency and
      - Other Renewable Portfolio Standards (RPS) Resources
        - » Solar,
        - » Geothermal,
        - » Wind, and
        - » Biomass

Synapse Energy Economics: Low Carbon Future

- Significant role envisioned for Renewable Portfolio Standards
  - Through the use of state mandated RPS goals and net metering
    - Distributed generation would be included
    - Assumed to meet the 2015 state RPS goals
  - Combined Heat and Power (CHP) plus geothermal (ground water heating and cooling) would be assumed to increase to levels envisioned under to state goals
  - Demand response via Smart Grid enhancements
    - Facilitate implementation of price-responsive demand
    - “Smart meters” to manage demand

End User Alliance: Retiring Base Load Resources

- Analyze the impacts of
  - The loss of one or more of New England's nuclear power plants
  - Investigate the impacts of these capacity reductions on various metrics.
    - Quantify energy pricing
    - Congestion
    - Tie line usage
    - Changes in fuel use
    - Environmental emissions

Metrics Requested to be Used

- From these studies, metrics would be developed to describe the results:
  - Production costs
  - Average LMPs
  - Load Serving Entity Energy Expense
  - Fuel consumption and
  - Emissions
    - SO2
    - NOx
    - SO2

Assumptions

- IREMM assumptions better described in the Appendix
  - 2012 AEO fuel forecast
  - 2012 peak and energy load forecast
  - Load shape based on 2006 historical
  - Resources from FCA #6
    - Energy Efficiency and Demand Response treated as supply side resource
    - Wind profiles based on New England Wind Integration Study (2006)
    - Photovoltaic profile based on Thompson Island (2006)
- These, and additional assumptions, to be discussed with PAC at a later date

PHASE I: DRAFT SCOPE OF WORK

Evaluating Incremental Changes in Resources

Process Overview

- Multi-step process
  - First: Establish a case for the year with FCA #6 resources
  - Second (part 1): Perform analysis of base case
    - Select types of resources to be used in sensitivity cases
    - Increase / decrease selected resources
    - Quantify change in all metrics for each sensitivity
  - Second (part 2): Repeat previous step with
    - All fossil steam units retired
    - Replaced with low carbon resources
  - Third: Evaluate specific cases with various mixes of resources
  - Fourth: Determine “capital investment supported by simulated energy revenues”

SECOND STEP (PART 1): INCREMENTAL / DECREMENTAL ANALYSIS

Evaluating Incremental Changes in Loads

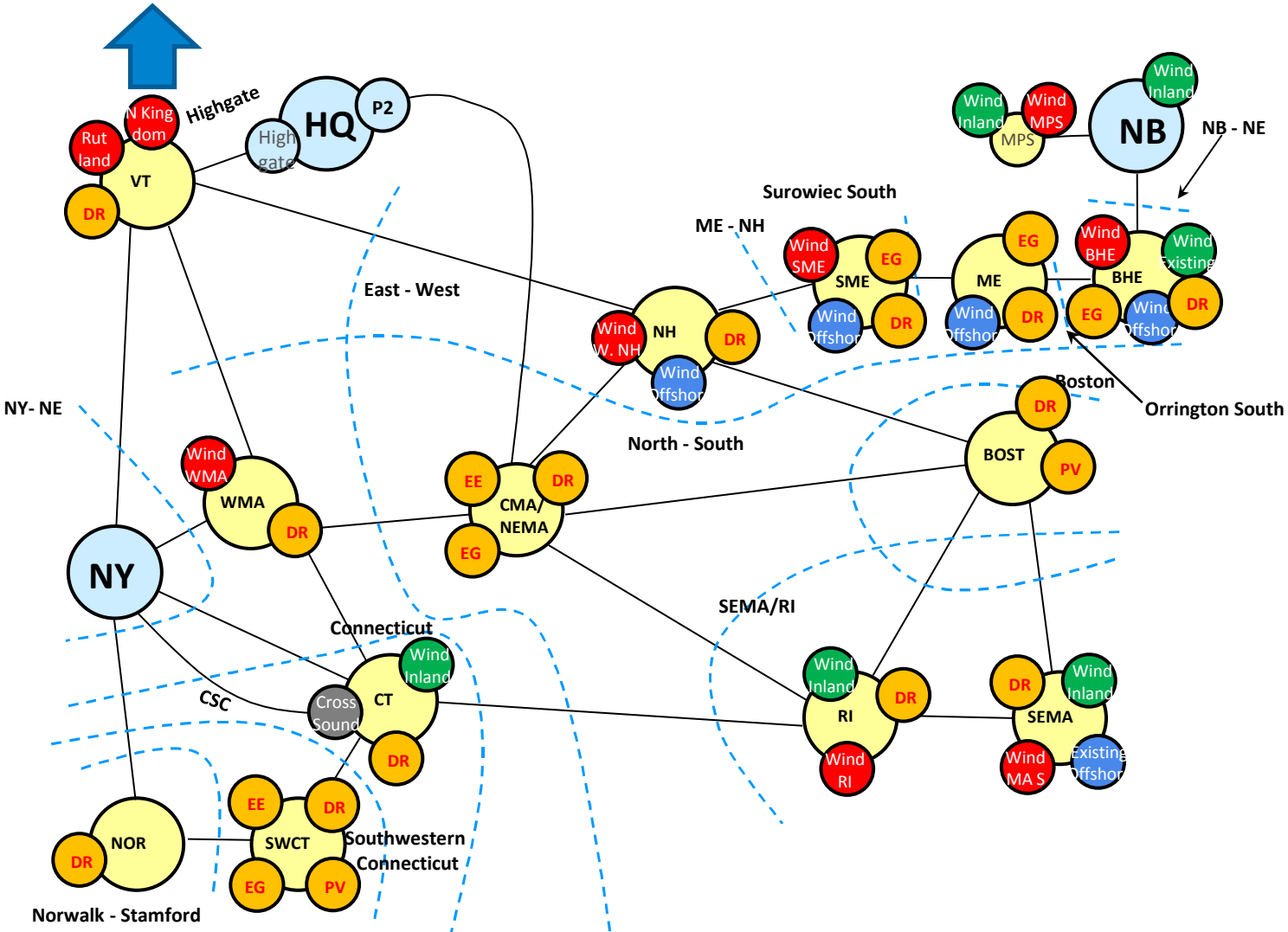
Proposed Scope of Work

- Develop process to accommodate both requests
  - Synapse Energy Economics
  - End-Users
- Use an incremental / decremental analysis
  - Discussed with the PAC on February 15, 2012
  - http://www.iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/mtrls/2012/feb152012/eco_study_requests.pdf
  - Develop representative load shapes to mimic a resource
    - Increase in load (equivalent to retirement)
    - Decreases in loads (equivalent to new-build)
    - Illustrates the best locations for resource retirements and additions
  - Show sensitivities to changes in load shape
    - Increase in base load (24 x 7) is equivalent to a base load retirement
    - Decrease in base load is equivalent to a base load addition
    - Increase in load with a wind profile is equivalent to a wind plant retirement
    - Decrease in load with a wind profile is equivalent to a wind plant addition
    - Other shapes can be used as proxies for other types of resource retirements and additions

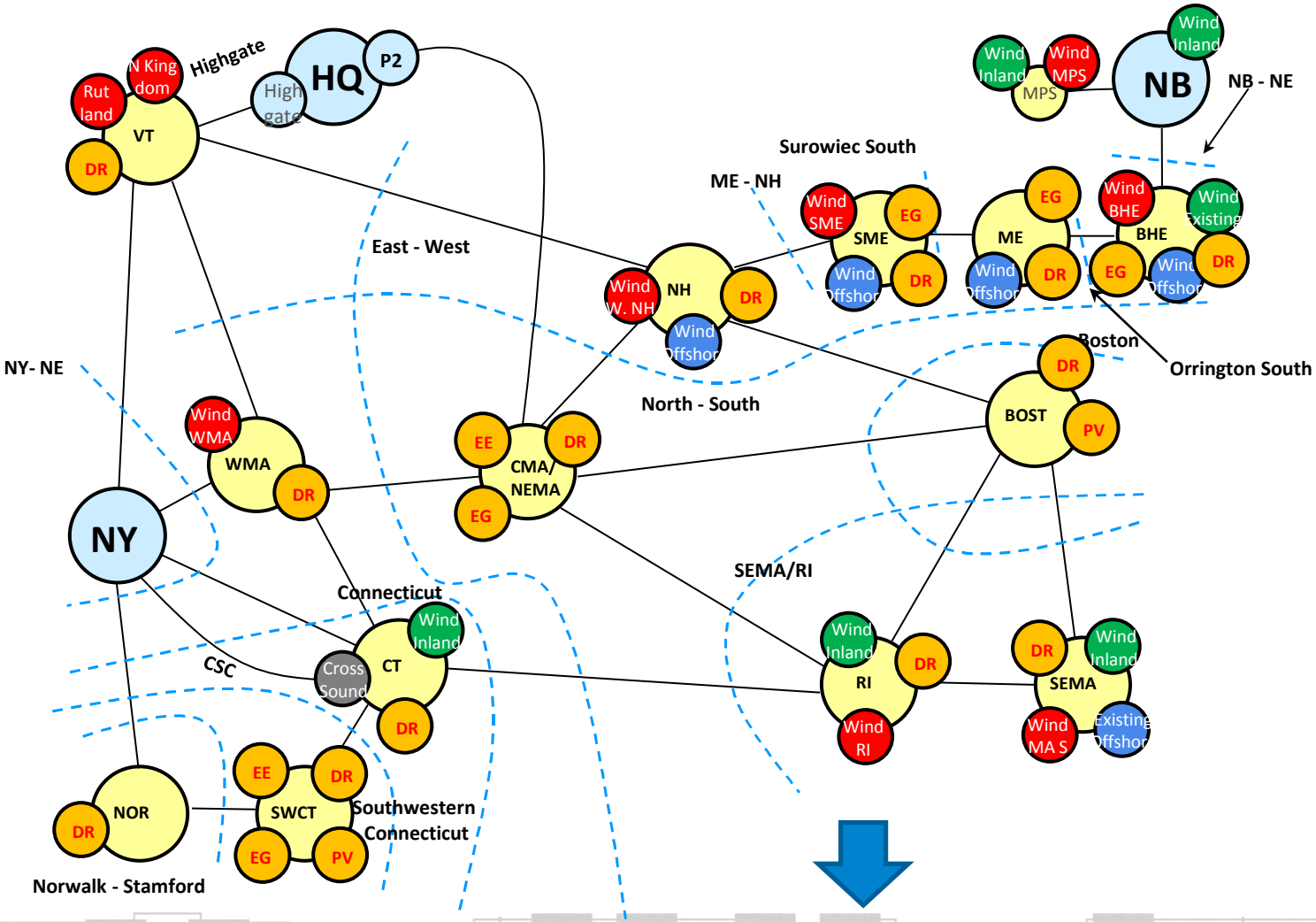
Phase I Approach

- "Incremental Curves" used to address scenario requests
  - Incremental Curves increase or decrease a key resource type
    - Observe resulting change in metrics
    - Increase / Decrease can be geographically sensitive
      - "New England wide" or
      - RSP zone level to investigate congestion
- Step-size of incremental change will be 300 MW
- Each incremental / decremental change will affect each metric
  - Re-dispatch of resources
  - Each defined interface has the potential to become constrained

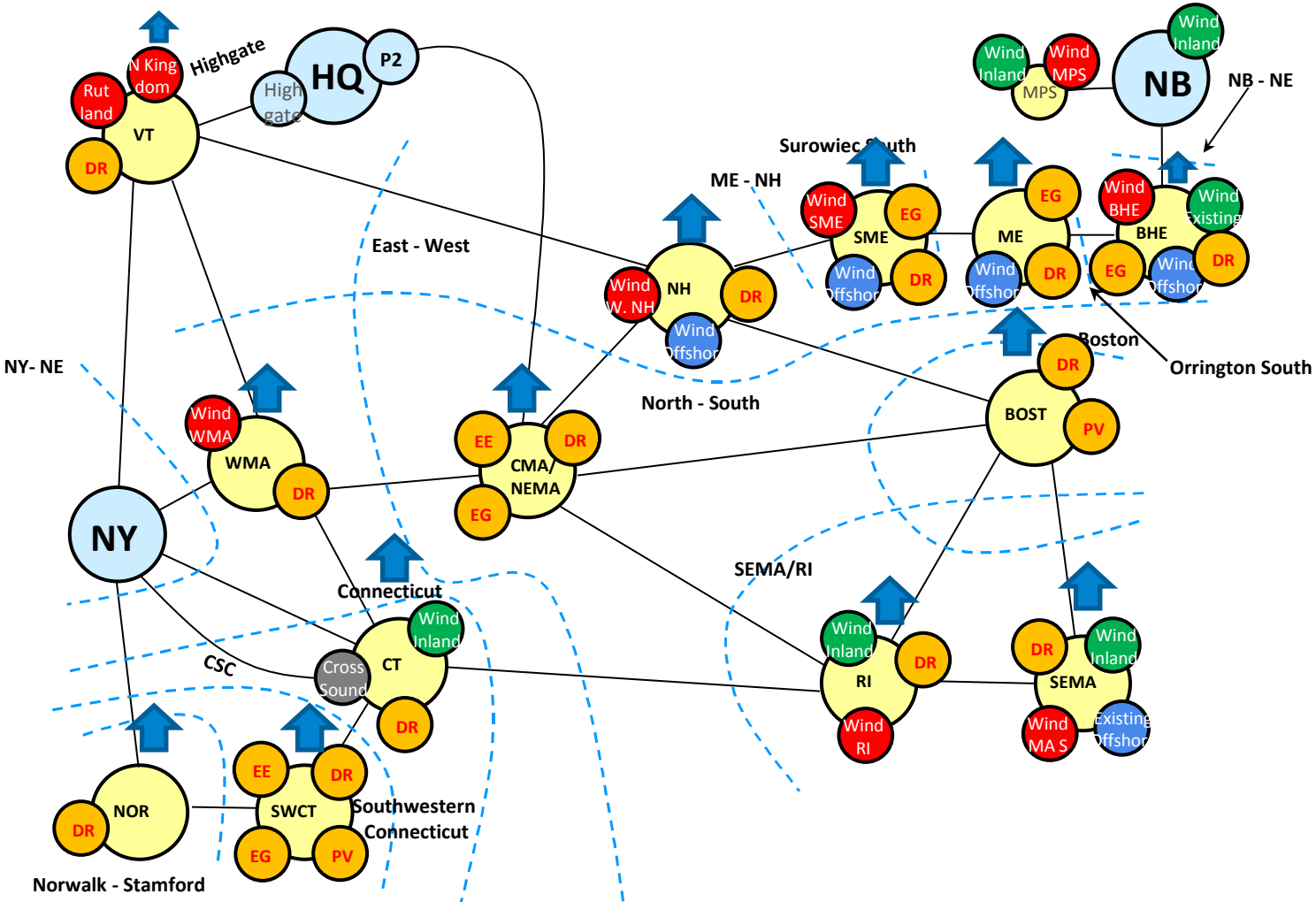
Increment Load in VT (Equivalent to Decrement in VT Resources)



Decrement Load in RI (Equivalent to Increment in RI Resources)



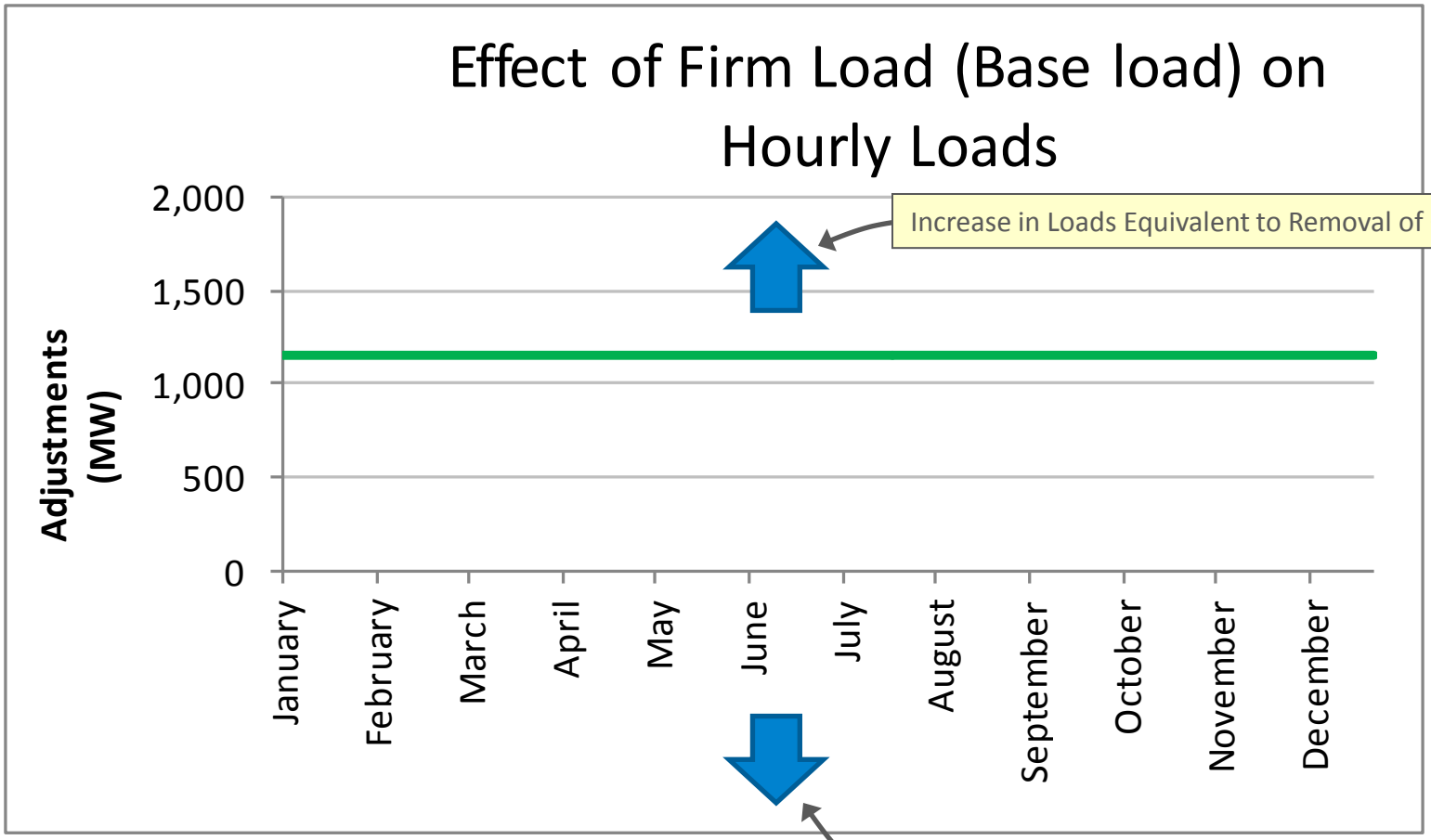
Increment Load Across New England (Equivalent to Decrement in Resources Across New England)



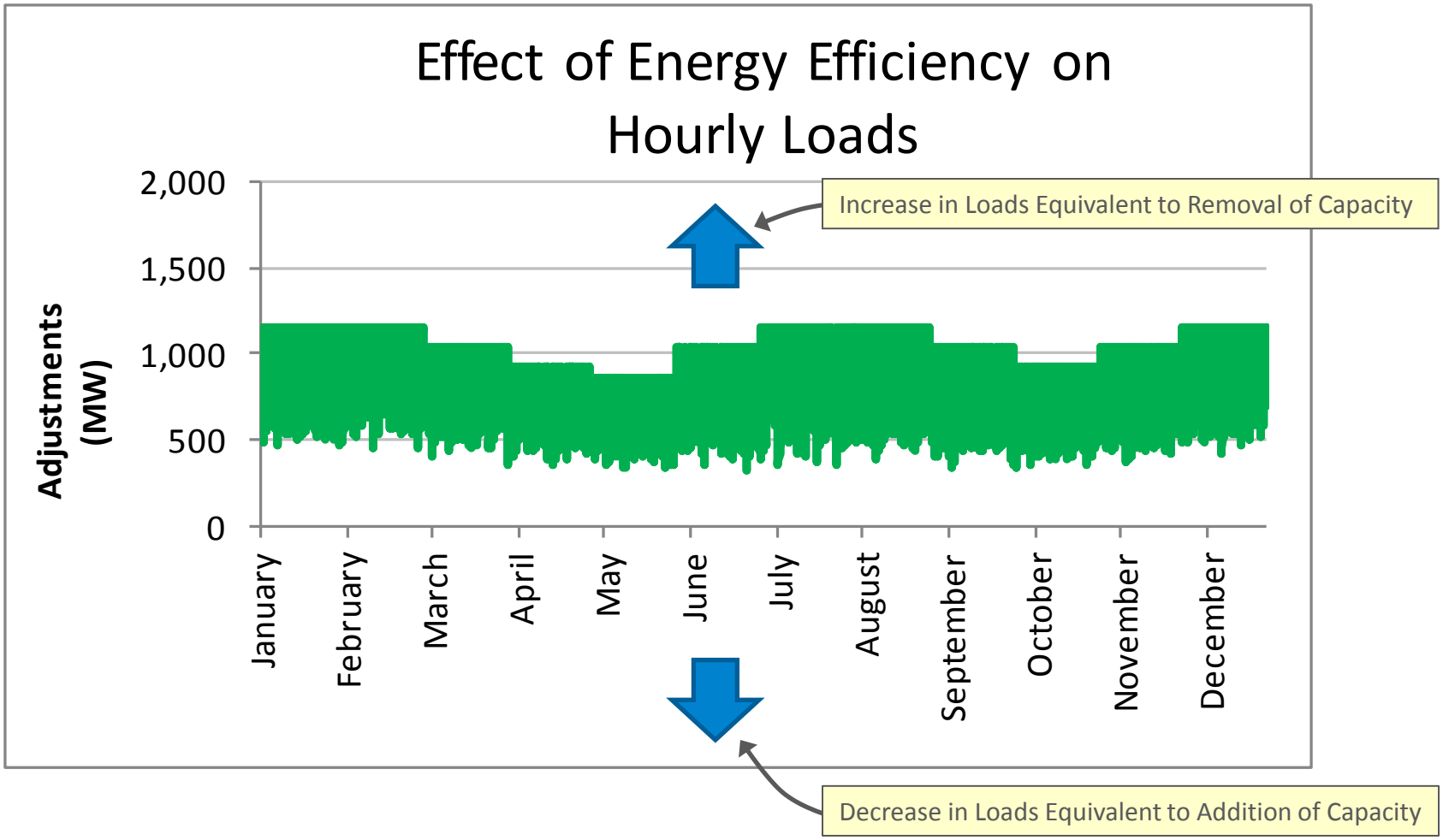
Framework: Parametric Analysis

- Effect of load / resource profile changes
  - Load shape can be used to reflect the characteristics of
    - Base load generating units
    - Intermediate generating units
    - Peaking generating units
    - Energy efficiency
    - Demand response
    - Wind
    - Photovoltaics
  - Load shape can reflect different technologies

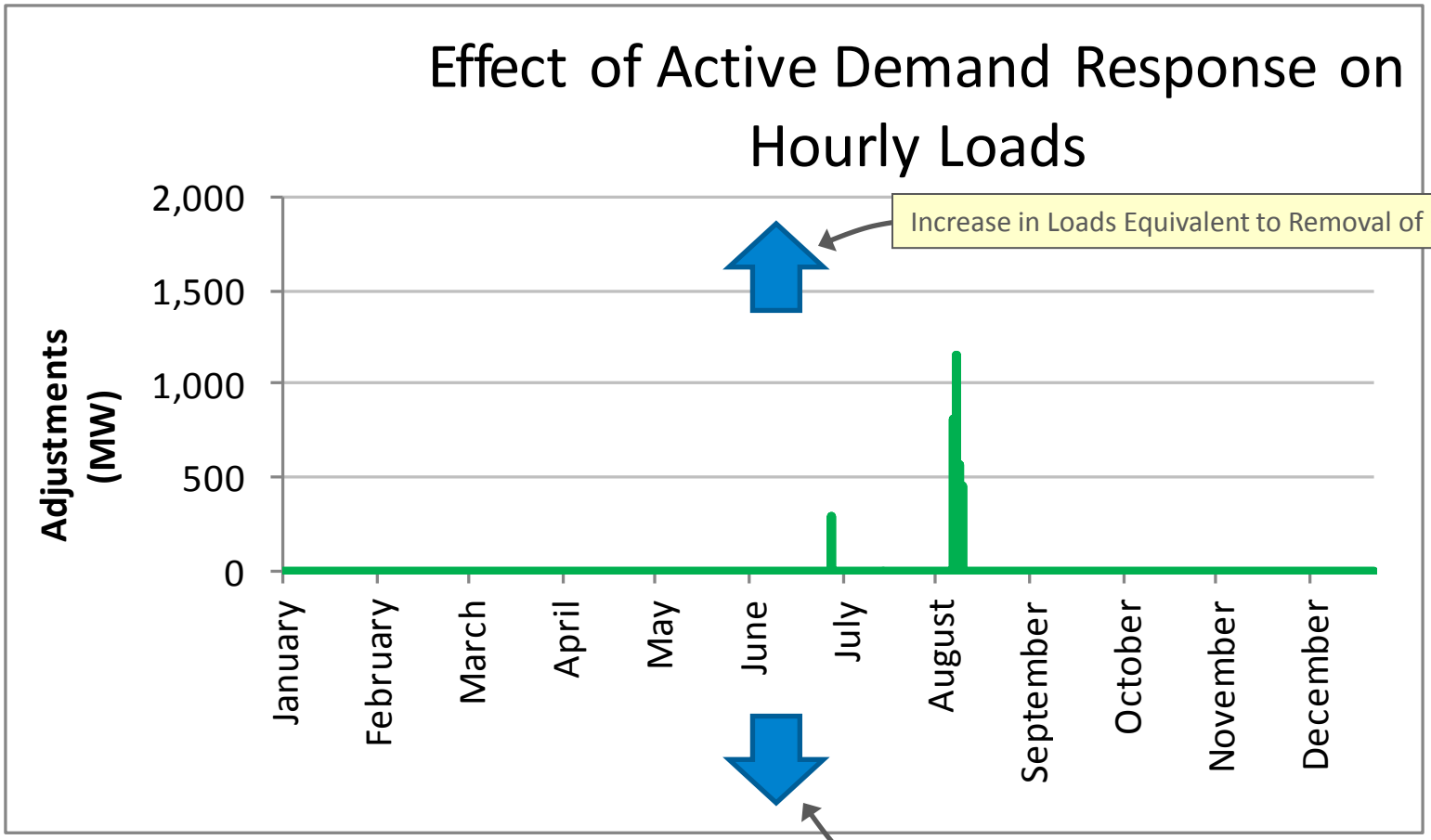
Changes in Firm Load (Equivalent to Base Load)



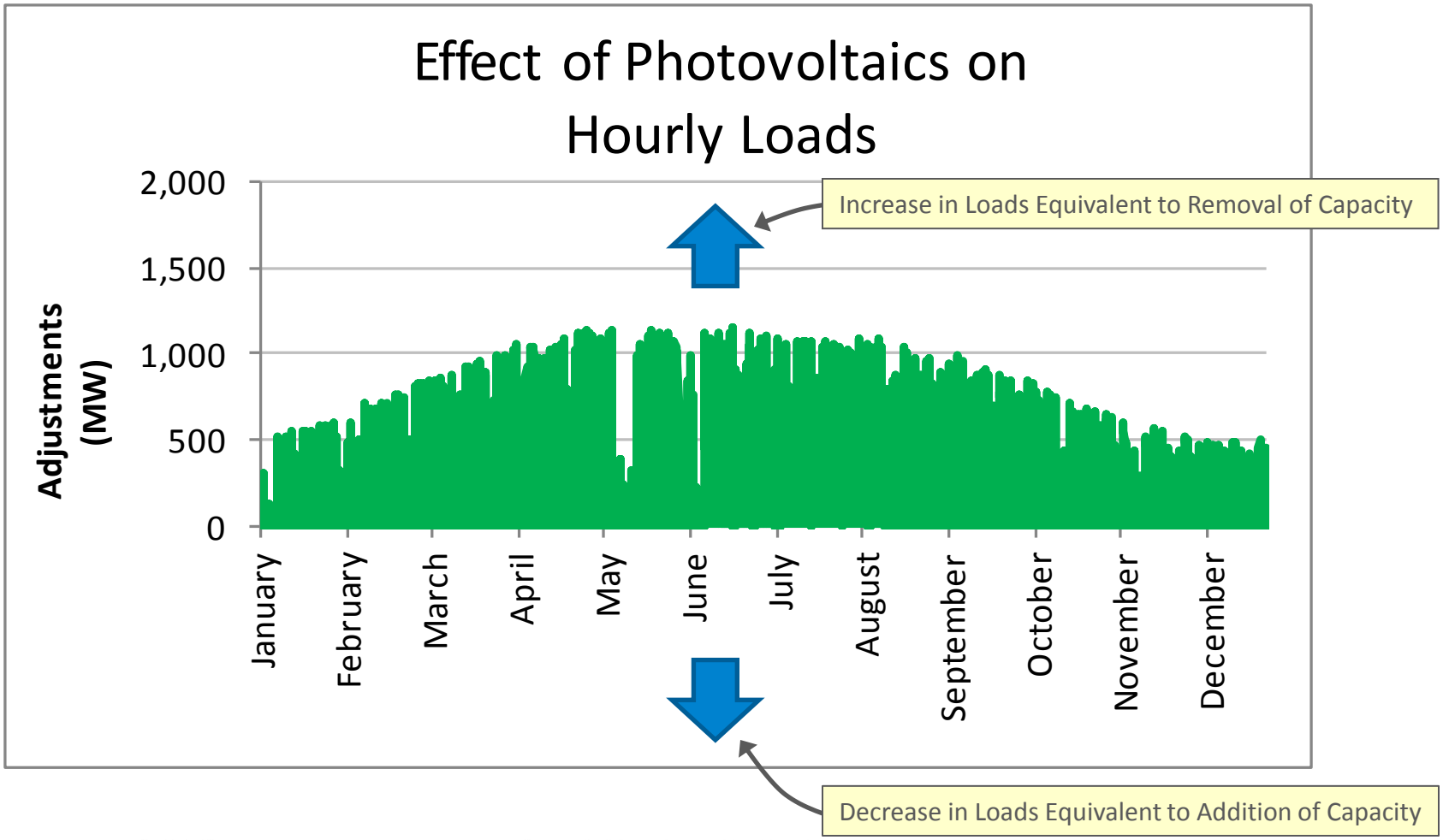
Increase / Decrease Energy Efficiency



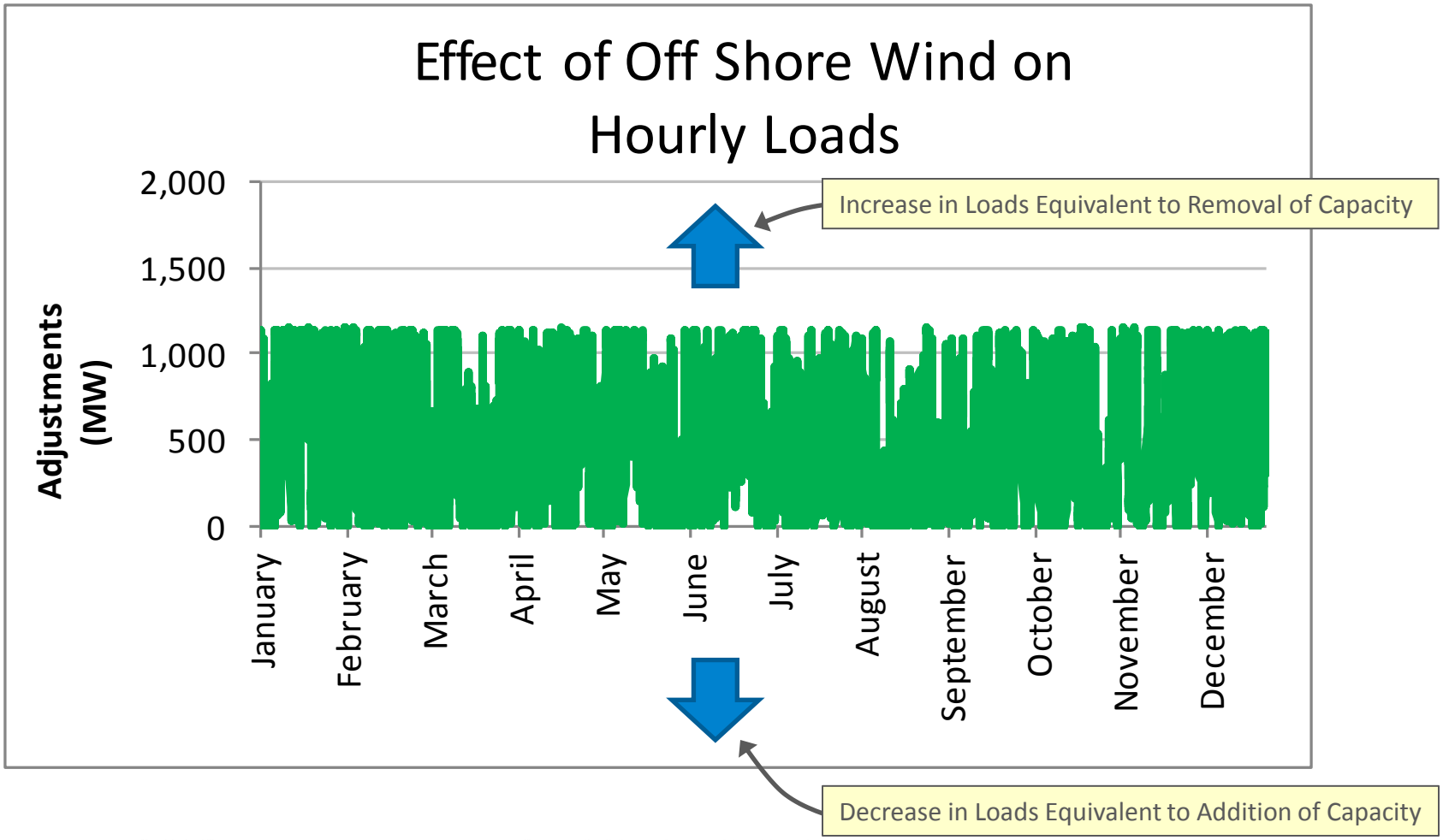
Increase / Decrease Active Demand Response (Also use for all Residual /Distillate Oil Units)



Increase / Decrease Photovoltaics



Increase / Decrease Off-Shore Wind



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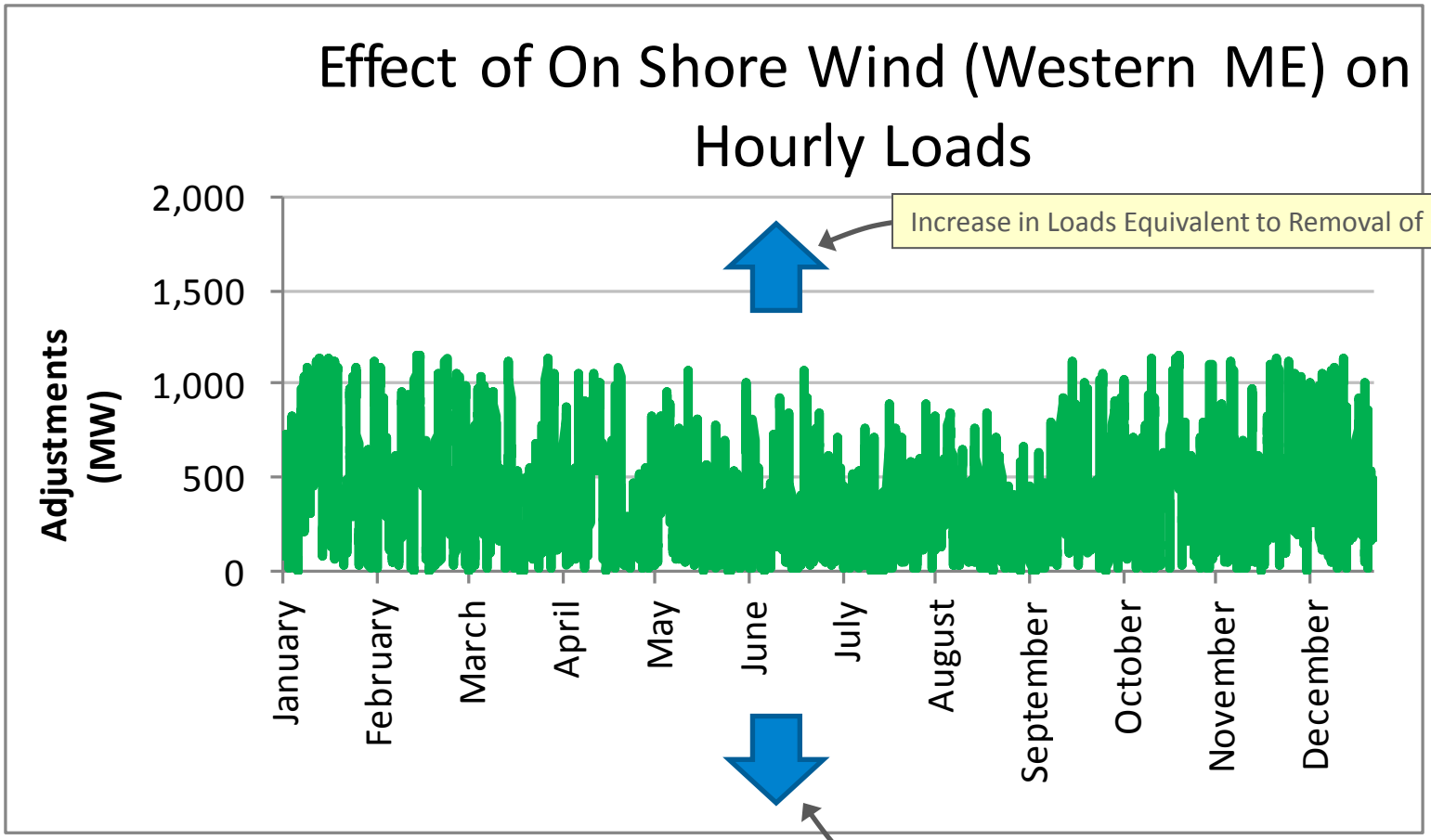
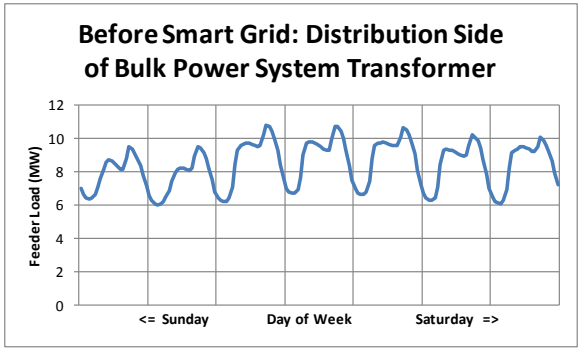
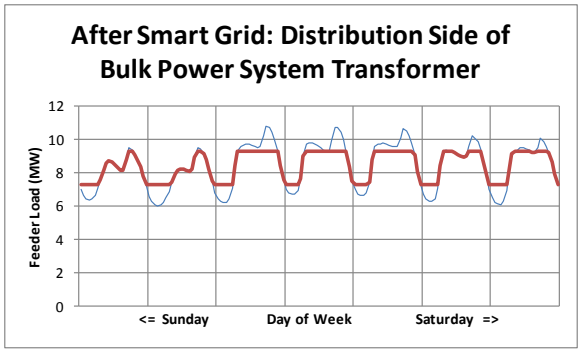
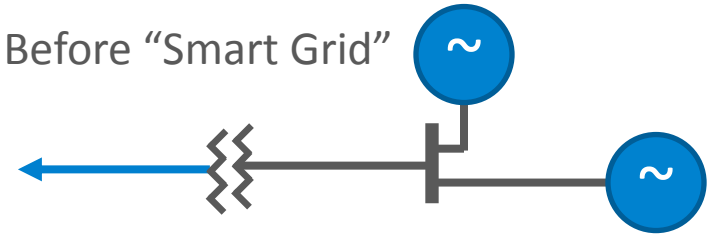


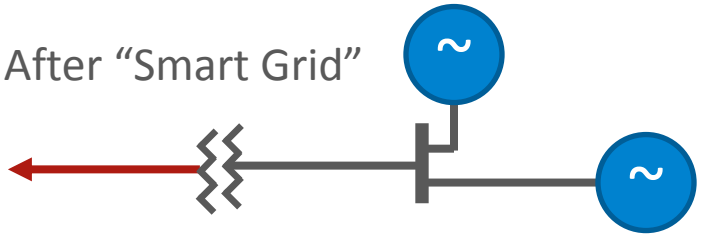
Effects of “Net Metering” and “Smart Grid”

- From a New England wide planning perspective, what change in load shape will result from Net Metering and/or Smart Grid?



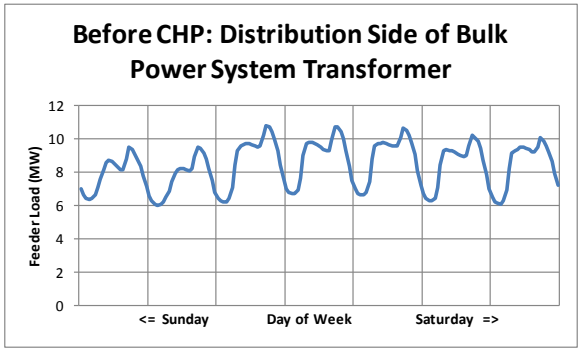


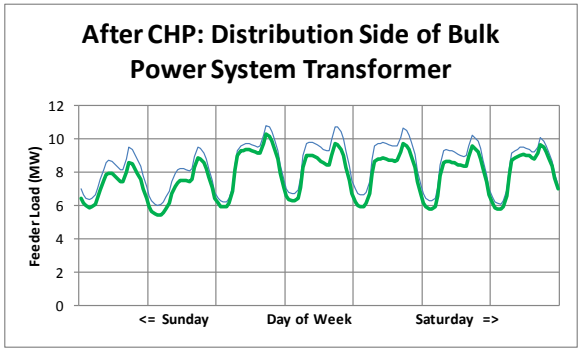


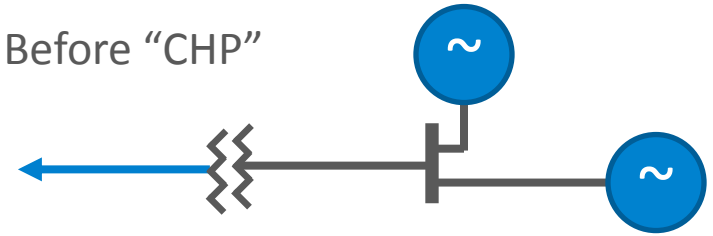


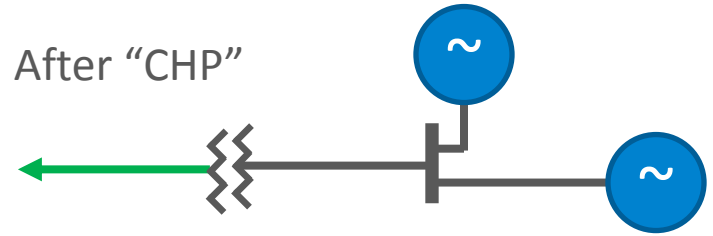
Effects of Combined Heat and Power (CHP)

- From a New England wide planning perspective, what change in load shape will result from Combined Heat and Power (CHP)?

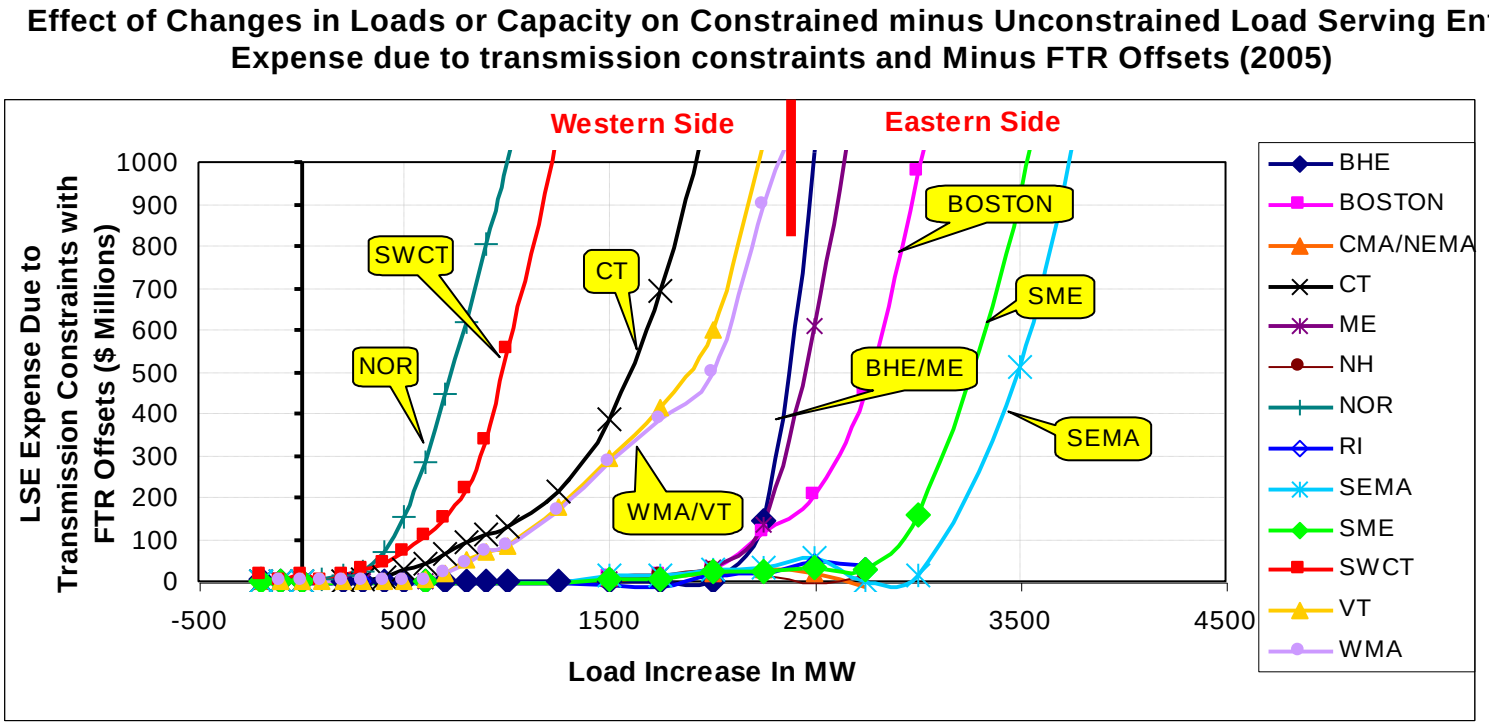






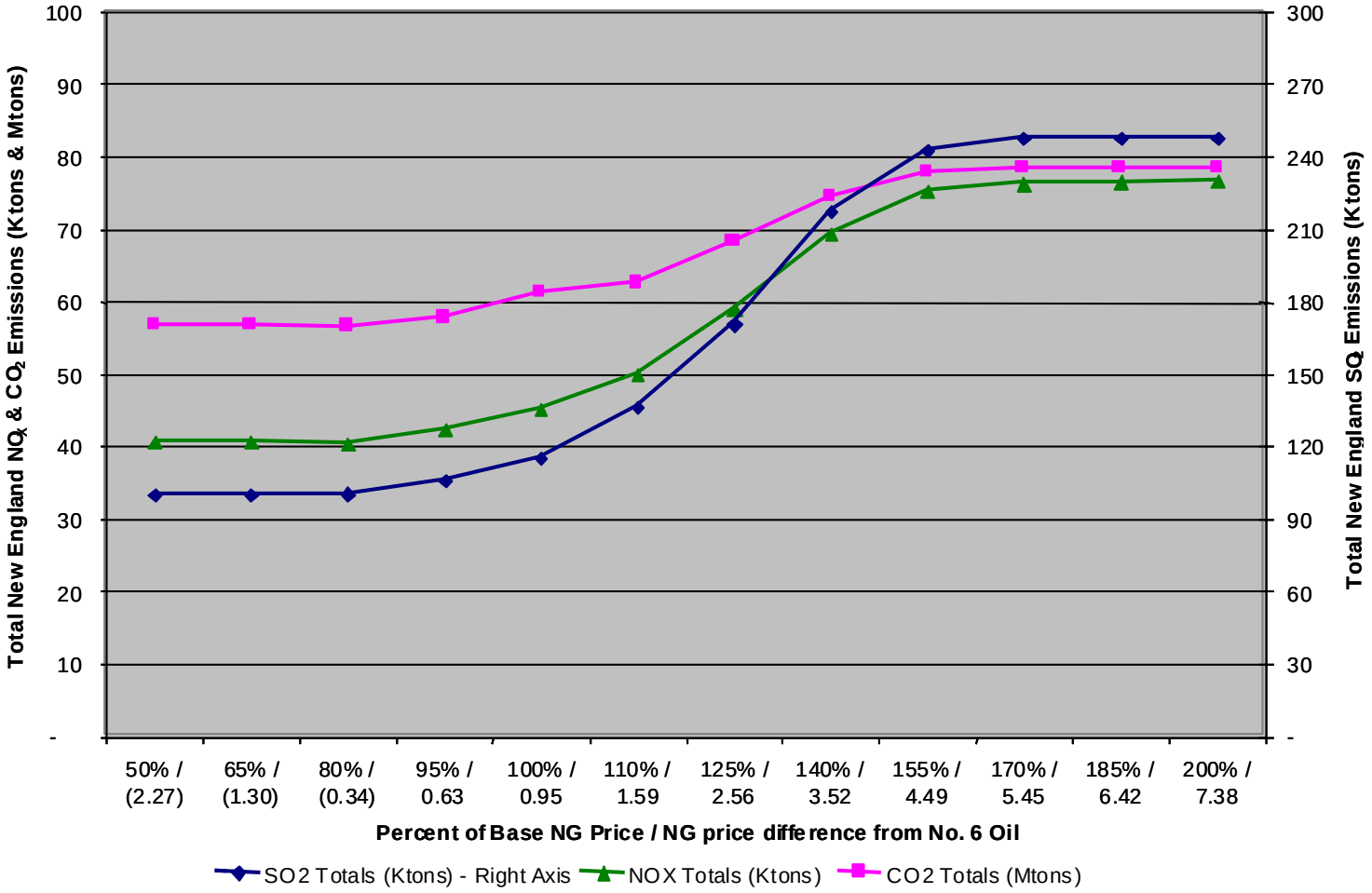


Load Serving Entity Expense Transmission Constraint Curves (Source: RTEP04 Figure 7.31)



Emission/Fuel Analysis Curves (Source: RTEP05 Figure A.4

Sensitivity of New England emissions to changes in natural gas prices



Effects of Load Increments / Decrements

- Will provide parametric information
  - Metrics can be quantified
  - Allows for evaluating combinations of changes
- Parametric effect captured in sensitivity values
  - For example load decrease of 300 MW and 600 MW results in changes to these metrics:
    - Load Change (GWh)
    - LSE Energy ($Million)
    - Production Cost ($Million)
    - SO2 (ktons)
    - NOx (ktons)
    - CO2 (Mtons)

Case	Change in Load with Firm (GWh)	Change in LSE Energy Expense ($Million)	Change in Production Cost ($Million)	Change in SO2 (ktons)	Change in NOx (ktons)	Change in CO2 (Mtons)
Base	0	0.0	0.0	0.0	0.0	0.00
300 Decrease	-2628	-56.9	-77.4	-1.1	-1.1	-1.48
600 Decrease	-5256	-136.5	-152.2	-4.8	-2.4	-2.90

Incremental Curves

- Benefits to this approach
  - Effects of incremental changes can be compared on comparable basis
  - Various combinations can be tested
- Limitations to this approach
  - Results for different parametric changes are not necessarily additive
    - Linear combinations of resources may not be additive
    - Combinations are valid for relatively “small” perturbations
    - Range of applicability may not always be known
    - Can be followed by scenarios
      - With specific combinations of resources
      - To verify differences

SECOND STEP (PART 2): TESTING THE PARAMETRIC ANALYSIS

Examples of Specific Combinations of Resources

Specific Scenarios

- Develop for a “Business As Usual” scenario
  - Expected system expansion
    - Defined by FCA #6
    - Natural gas dominates clearing prices
- Develop a retirement scenario
  - Replacement resources expansion based on
    - ISO interconnection queue
    - Behind the meter distributed generation
    - Low carbon resources
    - Renewable Portfolio Standards based resources

Evaluate Specific Scenarios – No Retirements

- 2021 Business As Usual (BAU) scenario
  - 2012 CELT load forecast with FCA #6 resources and Energy Efficiency forecast
  - No Retirements
- Meets Energy Efficiency goals
  - Same as BAU scenario except Energy Efficiency meets state goals
- Meets Renewable Portfolio Standards (RPS)
  - Same as BAU scenario where state RPS goals are met with Queue mix
- Meets both Energy Efficiency goals and RPS
  - Same as BAU scenario where Energy Efficiency meets state goals
  - Same as BAU scenario where state RPS goals are met with Queue mix
  - Relieve limiting transmission interfaces
- For sensitivity, assume RPS requirements double 2021

Evaluate Specific Scenarios – Fossil Retirements

- 2021 Retirement scenario ("RS")
  - 2012 CELT load forecast with FCA #6 Energy Efficiency
  - Retire Oil and Coal resource over 40 years old by 2021 (Example: Wyman 4 was installed in 1978 and will be 43 years old in 2021)
- Meets Energy Efficiency goals
  - Same as "RS" except Energy Efficiency meets state goals
- Meets Renewable Portfolio Standards (RPS)
  - Same as "RS" where state RPS goals are met
- Meets both Energy Efficiency goals and RPS
  - Same as "RS" where Energy Efficiency meets state goals
  - Same as "RS" where state RPS goals are met
- Relieve limiting transmission interfaces
- For sensitivity, assume RPS requirements double by 2021

THIRD STEP: CAPITAL COSTS

Typically, the Tradeoffs for Lower Energy Cost is Higher Capital Cost

Capital Investment Supported by Simulated Energy Revenues

- This analysis considers only net energy market revenues
  - Energy clearing prices
  - Less: resource production cost
  - Typically, referred to as “Contributions to Fixed Costs”
- Other revenue streams are possible, but not included
  - Forward Capacity Market (FCM) payments not included
  - Forward reserve market payments not included
  - Regulation market revenues
  - Other market revenues
  - Renewable Energy Credits (REC), Tax Incentives, etc.

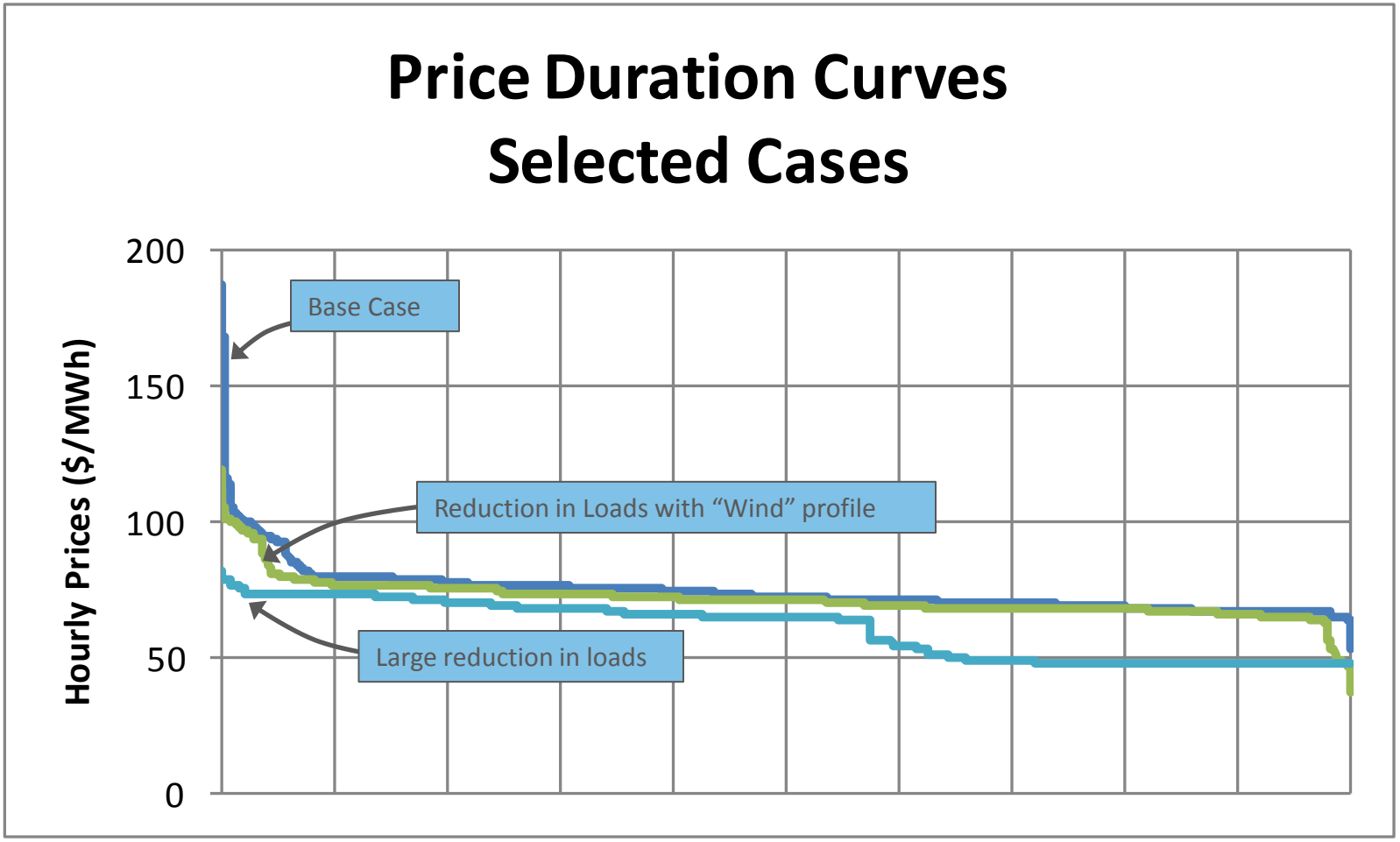
Capital Investment Supported by Simulated Energy Revenues

- As loads are reduced (or resources are added to the mix)
  - Downward pressure exerted on energy market clearing prices
  - Reduces energy market revenues
  - For some resources insufficient energy market revenues could result in retirement of existing resources
- The amount of energy revenues contributing to capital cost can be estimated
  - Assuming only net energy market revenues to support the resource
  - Assume range of capital investment

Supportable Investment for Technologies

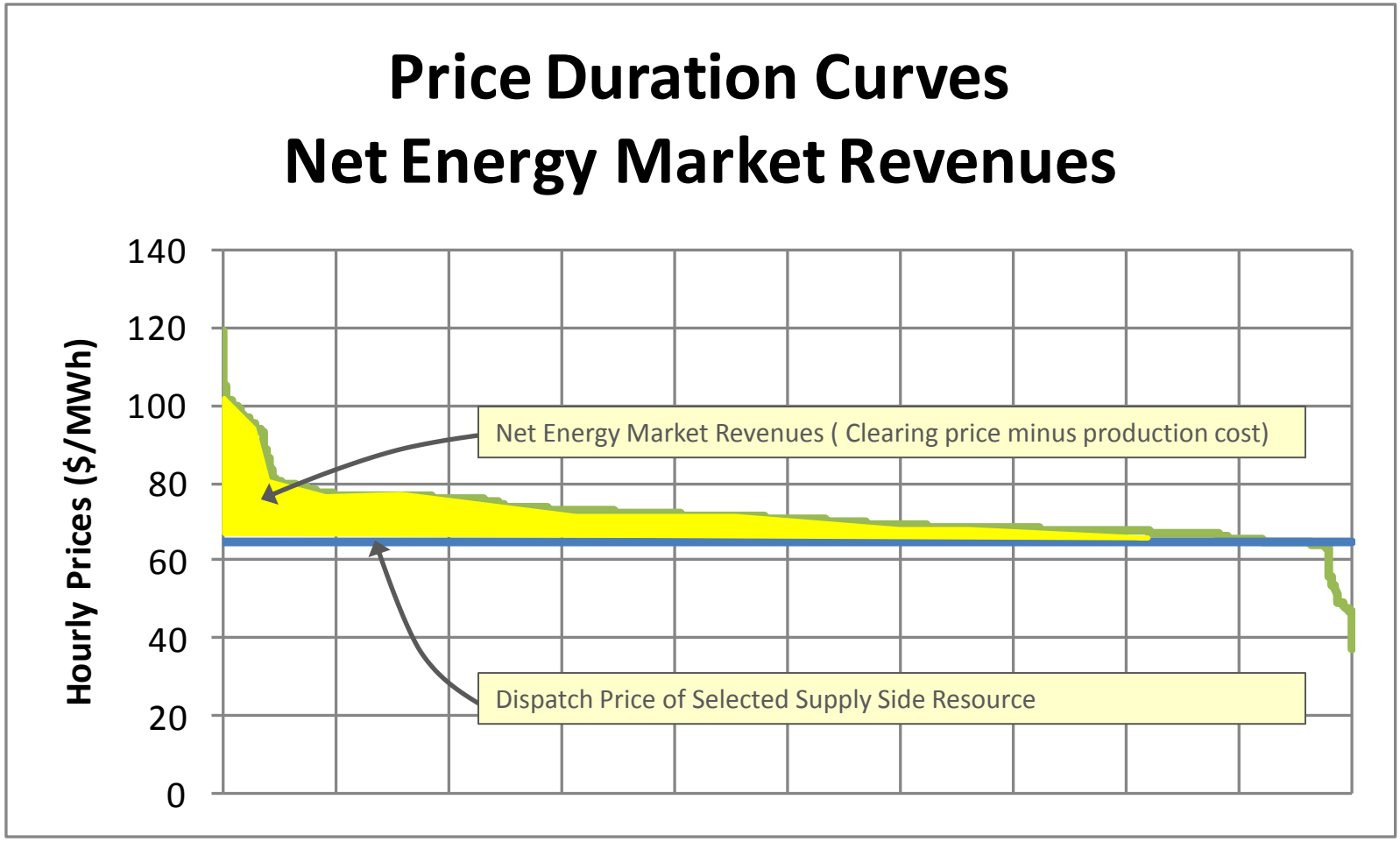
- Develop range of annual investment costs
  - "Higher capital cost"
  - "Lower capital cost"
- Investors anticipate annualized cash flow to recover costs related investment and these are called "Fixed Charge Rate" when expressed as a percentage
  - Higher range is probably 25 percent of capital investment (FCR)
  - Lower range is probably 15 percent of capital investment (FCR)
- Range of annualized cash flow can be calculated
  - Upper
    - "Higher capital cost"
    - Higher range at 25 percent fixed charge rate
  - Lower
    - "Lower capital cost"
    - Lower range at 15 percent fixed charge rate

Selected Price Duration Curves



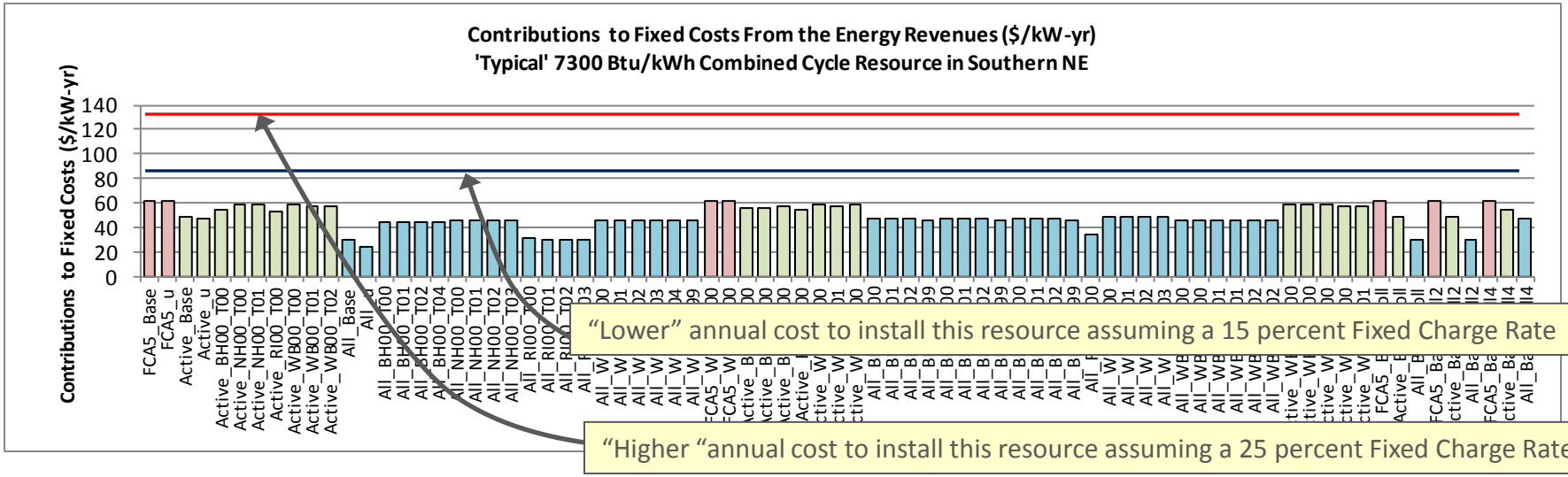
Net Energy Market Revenue Concept

(Based on the "Many MW of Wind" in New England case shown on prior slide)



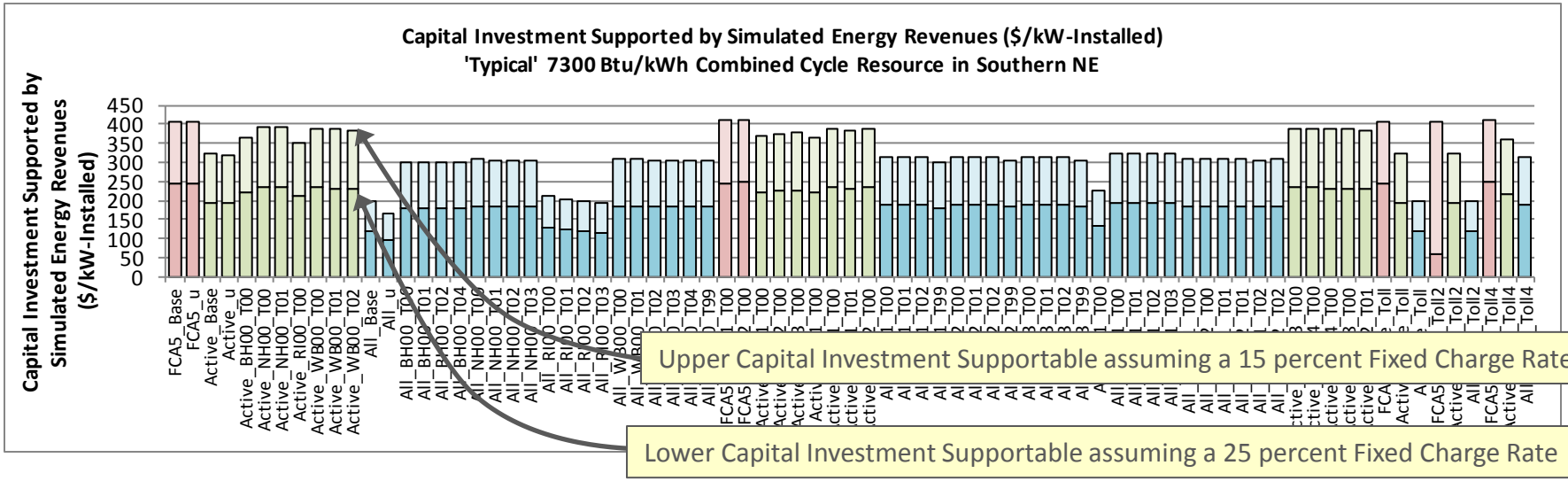
Simulated Annual Energy Revenues (Sample Illustration)

- Contributions to fixed costs is a frequently reported metric
  - Each scenario likely to have different energy prices and dispatch
  - Resulting net energy revenues from the energy market are different
  - Can be compared to a range of capital costs and fixed charge rates
    - Upper: Higher capital cost at 25 percent fixed charge rate
    - Lower: Lower capital cost at 15 percent fixed charge rate



Capital Investment Supported by Simulated Energy Revenues

- Simulated Annual Energy Revenues can be translated into "Capital Investment Supported by Simulated Energy Revenues"
- Can be converted by:
  - Upper Level established by dividing by 15 percent fixed charge rate
  - Lower Level established by dividing by 25 percent fixed charge rate



PHASE III: EVALUATION METRICS

Comparing Across Multiple Scenarios

Metrics

- Economic
  - Production Cost
  - LSE Energy Expense
  - Average LMP
  - Congestion
- Environmental
- Fuel consumption / energy by fuel type
- Revenues from the energy market

Fuel Consumption Metric

- Generation (GWh and percent) by fuel type
  - Wind and Demand Resources have no associated MBtus
  - Shows amount of energy assumed to be served by
    - Energy Efficiency
    - Active Demand Resources
    - Wind
    - Hydro / Pumped Storage
    - Coal
    - Nuclear
    - Gas
    - Net Imports

Summary

- Three Economic Study requests were received by the deadline for the 2012 Economic Planning Study process
- Proponents discussed study requests with the PAC
- The requests build upon analysis performed by the ISO over the past six years
  - Are targeted to strategic resource issues
  - Approach is a partial revisit of the 2007 Scenario Analysis
- PAC comments are being sought on this draft scope of work
- Additional discussions will be held with PAC on assumptions
  - Tentatively scheduled for June 19

Questions