2015 Economic Studies Common Assumptions Scope of Work - Draft

Planning Advisory Committee Meeting

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PROJECT MANAGER, ECONOMIC PLANNING

Outline

- Summary
- Stakeholder Input for 2015 Economic Studies
- Economic Study Metrics
- Economic Study Assumptions Affecting Energy Cost Results
- Assumptions
  - Demand
  - Development of the base network model
  - Resource modeling
  - Interchange modeling
  - Operating reserve
  - Fuel prices

Three 2015 Economic Study Requests

- Keene Rd. Interface (SunEdison)

http://www.iso-ne.com/static-assets/documents/2015/04/a6_sun_edison_presentation_economic_study_keene_rd.pdf

- Impact of Offshore Wind Deployment on New England's Wholesale Electricity Markets and Operations [Massachusetts Clean Energy Center]

http://www.iso-ne.com/static-assets/documents/2015/04/a6_cec_presentation_economic_study_offshore_wind.pdf

- Impact of Maine Upgrades Identified in ISO-NE's Strategic Transmission Analysis for Wind Integration [RENEW Northeast (RENEW)]

http://www.iso-ne.com/static-assets/documents/2015/04/a6_presentation_renew_strategic_transmission_analysis_wind_integration_economic_study_req.pdf

Summary

- The ISO will perform all three Economic Studies
  - The studies will be given priority by the ISO and Draft results to be presented to PAC by late 2015 or early 2016
  - Final reports completed after consultation with the PAC
- The studies will compare the performance of the future system with additional representative future system improvements
  - The study will not include detailed transmission planning analysis, such as new system impact studies
- The results ***may*** be used to inform the region on the need for future
  - Market Efficiency Transmission Upgrades in the Keene Road area
  - Public Policy Transmission Upgrades facilitating the integration of wind
    - Onshore wind resources in ME
    - Offshore wind resources in MA/RI

Stakeholder Input for 2015 Economic Studies

- The ISO is seeking input from the PAC today
  - High level scope of work
  - General study assumptions
- Later PAC input will be sought on
  - Overall study results and conclusions
  - Review of draft report
- Special economic study working groups ***may*** be formed to provide the ISO input on very detailed technical modeling and simulation methods not of interest to the general PAC audience
  - This has been done to support past Economic Studies
  - Past study groups required a very limited number of conference calls
  - May have different study working groups for each Economic Studies
- ***Alternatively or in addition to the economic study working group***
  - PAC presentations will be structured to discuss the general PAC economic study issues upfront
  - More technical discussions will be discussed with PAC members as a last meeting agenda item

Economic Study Metrics

- Production Costs
- Load Serving Entity Energy Expenses
- Congestion
- Interface Flow Duration Curves
- Generation Energy Production by Fuel Type
- Environmental Air Emissions by Electric Generator Type
- ***New***: Approximate cost estimates of representative transmission upgrades that can relieve congestion
  - Comparison of Annual Carrying Charges (assumed at 18%-22% of capital cost estimates) of transmission improvements with the production cost savings resulting from transmission improvements

Economic Study Assumptions Affecting Energy Cost Results

- Demand forecasts
- Energy Efficiency growth rates
- Renewable development and integration
- Types and locations of new resource development
- Potential retirements
  - Coal
  - Oil
  - Nuclear
- Fuel price
- Environmental emission allowance prices

Key Simulation Data

- Demand
- Transmission
  - Transmission Network
  - Internal Interface Limits
  - Phase Shifters
  - Line Monitoring
  - Contingencies
- Resources
  - Thermal Units
  - Hydro Units
  - Pumped Storage
  - Wind Units
  - Active Demand Resources, Energy Efficiency and Real-time Emergency Generators
  - Imports/Exports
  - Reserve Requirements

Questions

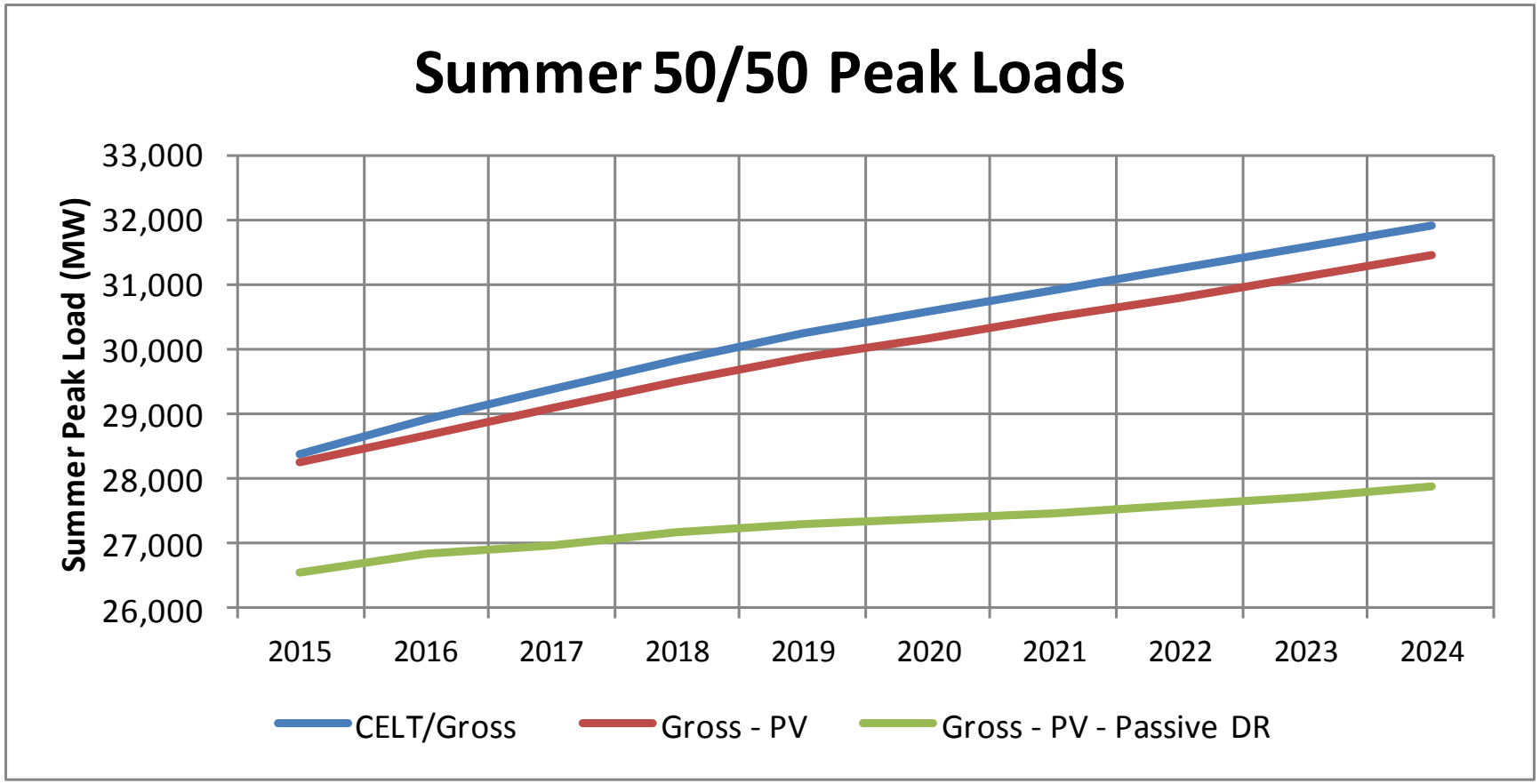
APPENDIX
SIMULATION METHODOLOGY

Development of Base Model

Overview of Assumptions – Consistent with 2015 CELT

- Demand
  - Net of Energy Efficiency (EE) and Photovoltaic (PV) – including forecasts
  - Active Demand Resources (DR) treated as supply
  - Hourly load profile based on 2006 weather (synchronized with wind data)
- Supply resources considered
  - Results from Forward Capacity Auction #9
  - Other Energy Only Resources
  - Wind in the each study are specified by the economic study request
    - Wind resource production modeled based on New England Wind Integration Study (NEWIS) data

50/50 Summer Peak Load Forecast
Effect of Behind-the-Meter PV and Passive DR



Network Modeling

- Modeling of Transmission Network
  - ISO-NE FERC 715 filling of summer case
  - Detailed modeling in ISO-NE region only
  - Representation for neighboring systems
    - Detailed network modeling not required for NY, NB and HQ
    - Tie-line flows modeled by dummy resources at external nodes
    - Base flows based on historical line flows

Network Modeling (cont)

- Modeling of Internal Interface Limits
  - The latest ISO-NE estimated internal interface limit values reflected
- Modeling of transmission line
  - All 230 kV and 345kV circuits ISO-NE region are monitored
    - Nearly 300 branches monitored
    - Includes transformers that step up to 230 kV and above
  - Generator step-up (GSU) transformers are excluded
    - Ensure a generating plant output is not limited by GSU modeling
- Monitoring of Transmission Line
  - 115 kV and above lines in areas of concern as appropriate
    - Maine for
      - Strategic Transmission Analysis – Wind Integration study
      - Keene Road study
    - SEMA / RI for off-shore wind study

Network Modeling (cont)

- Modeling of contingencies
  - Modeled same contingencies as defined in previous GridView cases
    - Based on 3 years of historical binding contingencies in Day-Ahead Market
    - 100 out of 160 frequently occurring identified and modeled
      - Full set of transmission planning contingences (OP-19) not modeled
    - Additional system contingencies identified by relevant needs assessments and solution studies

Thermal Units

- Points of interconnection for resources based on 2015 FERC 715 filing summer cases
- Existing thermal units
  - Simulation study production cost parameters: Heat rate curve, Start-up cost, No-load cost and etc.
  - Primary and secondary fuel definition are based on 2015 CELT
- Operational limits assumed same as previous economic study
  - Minimum up time, Minimum down time and Start up time
  - Ramp rate limits
- Energy limits: assume no energy limits
- Future thermal units
  - Generic
  - Production cost parameters based on: unit type, technology and rating

Thermal Units (Cont.)

- Combined Cycle Units
  - Individual machines from a combined cycle plant are modeled separately, connecting to different buses
- Outages
  - Thermal units derated to reflect the forced outages using Equivalent Forced Outage Rate (EFOR)
  - Planned maintenance schedule will be developed and held constant across cases

Hydro Units

- Hydro units modeled using
  - Hourly energy generation profiles
  - Used in previous economic studies
- Hydro units are assumed no maintenance outage

Pumped Storage Units

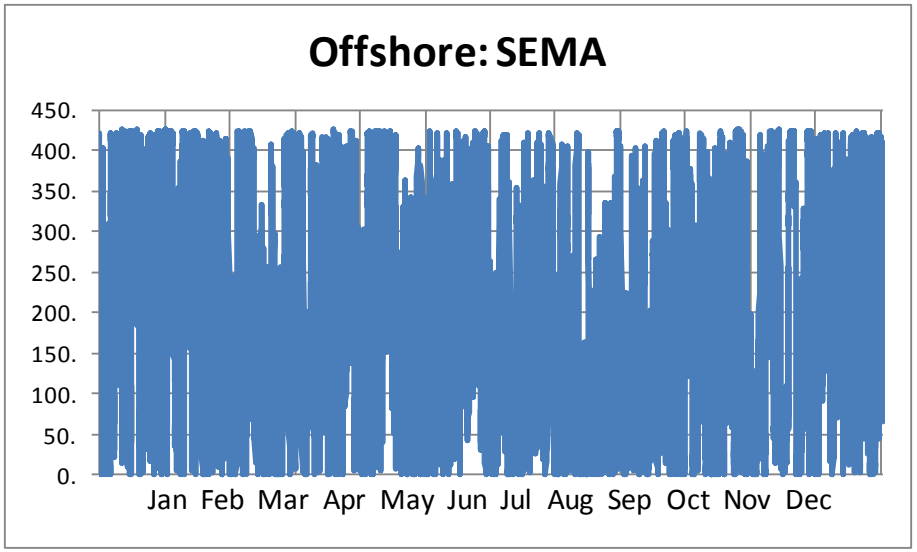
- Modeled in peak shaving mode
  - Pumping during off-peak hours
  - Generating during on-peak hours
- Pumped Storage physical parameters
  - Minimum pond size
  - Maximum pond size
  - Plant Capacity Factor
  - Based on assumptions used in previous studies

Wind Units

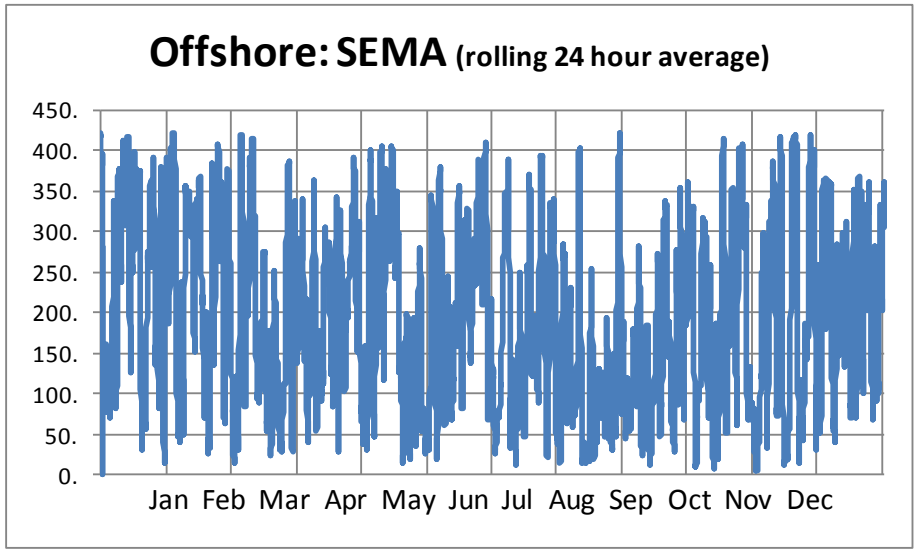
- Modeled as hourly resources,
  - Pre-defined using an hourly profile per RSP area
  - Same as used in previous economic studies
- Wind and hourly load profiles based on NEWIS data
  - ME-BHE (On-shore)
  - ME-CMP (On-shore)
  - NH (On-shore)
  - RI (Off-shore)
  - SEMA (Off-shore)
  - VT (On-shore)
  - WEMA (On-shore)
- Wind will be curtailed when transmission is constrained

Wind Profiles Based on NEWIS Profiles

Hourly Profile (to be used in the simulations)



Smoothed Hourly Profile (conceptual visualization)



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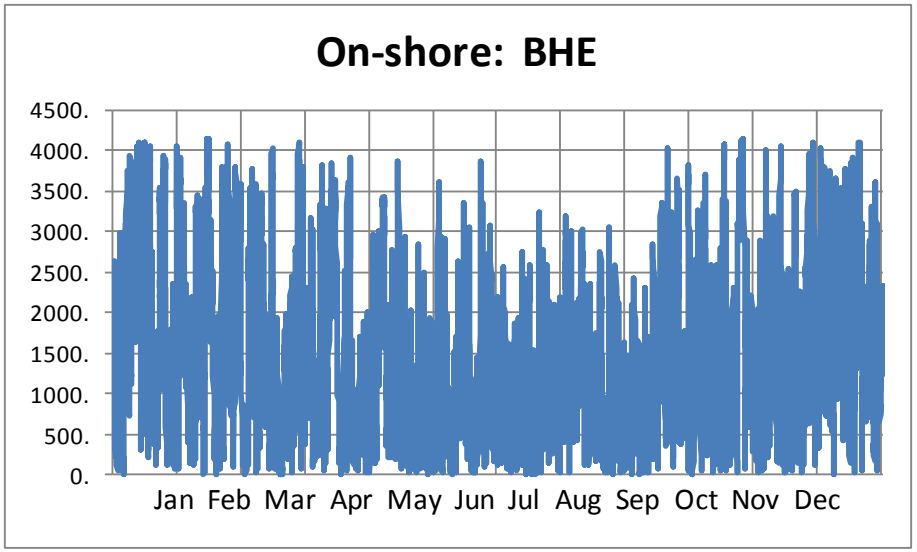

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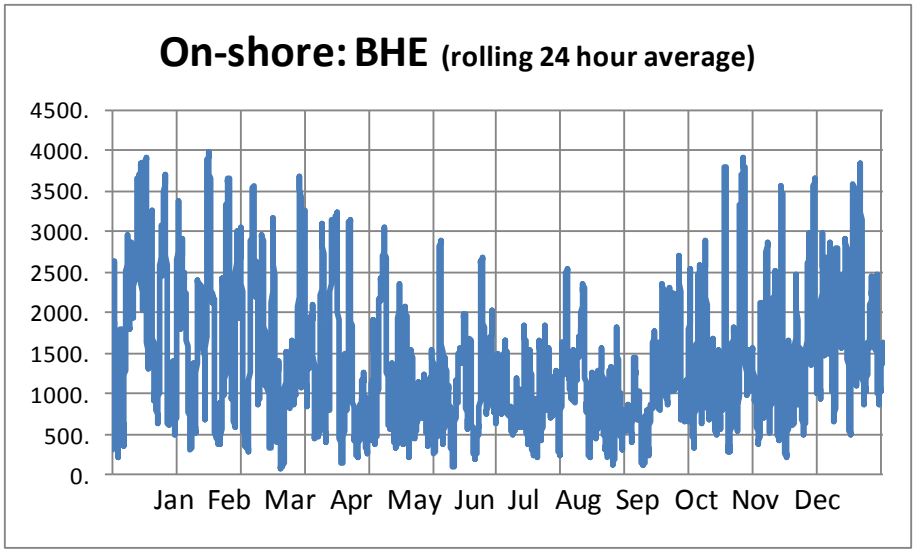


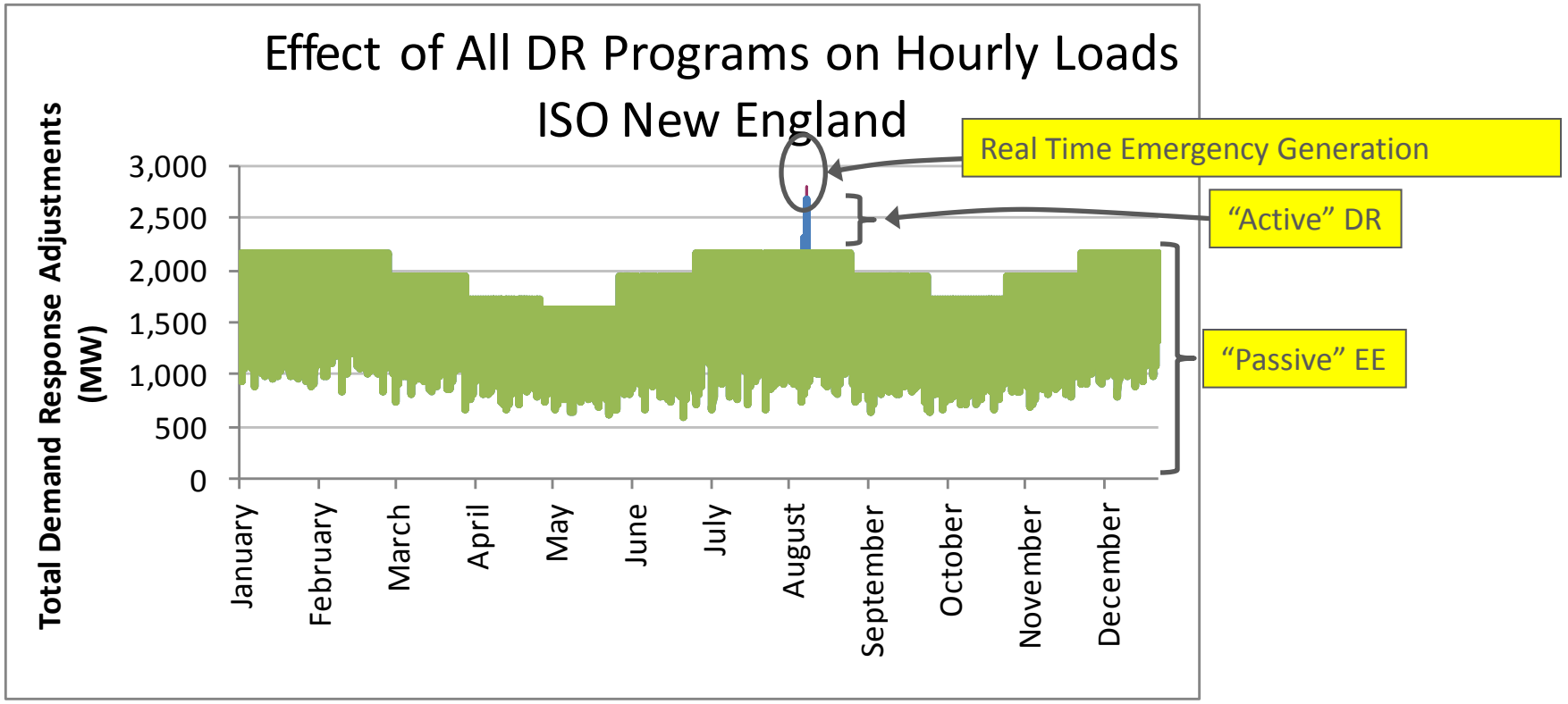
Photovoltaic

- Incorporating a time stamped, chronological solar PV profile
- National Renewable Energy Laboratory (NREL) has developed a simulated solar PV dataset based on 2006 weather
  - New England specific
  - Profiles by RSP area available
- Consistent with methodology used for wind profile
- Profiles to be developed consistent with the PV forecast discussed with the DGFWG

Demand Side Resources

- Active DR, EE and RTEG are modeled explicitly
  - Hourly profile for each category of demand side resource
  - FCA amounts used through capacity commitment periods
- Forecasts
  - The latest EE forecast through the year 2024 is reflected
  - Active DR and RTEG are held constant for years beyond capacity commitment period (same as other FCM resources)
- Modeled the same as previous economic studies

Load Modifiers (Base Case)
Energy Efficiency (EE), Active Demand Resources (DR) and Real-Time Emergency Generation (RTEG)

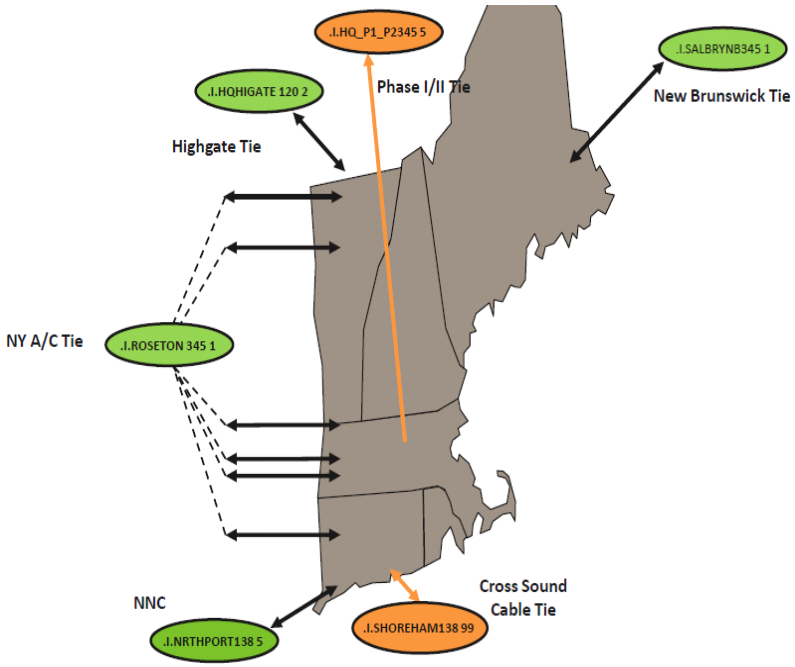


Imports and Exports

- Hourly imports and exports over the following external interconnections are modeled based on the average of 2012, 2013 and 2014 historical interchange values*
  - New York AC
  - NNC
  - Highgate
  - New Brunswick
  - Cross Sound Cable

*The same approach used in previous economic studies for representing import/export assumptions

ISO -NE External Interface

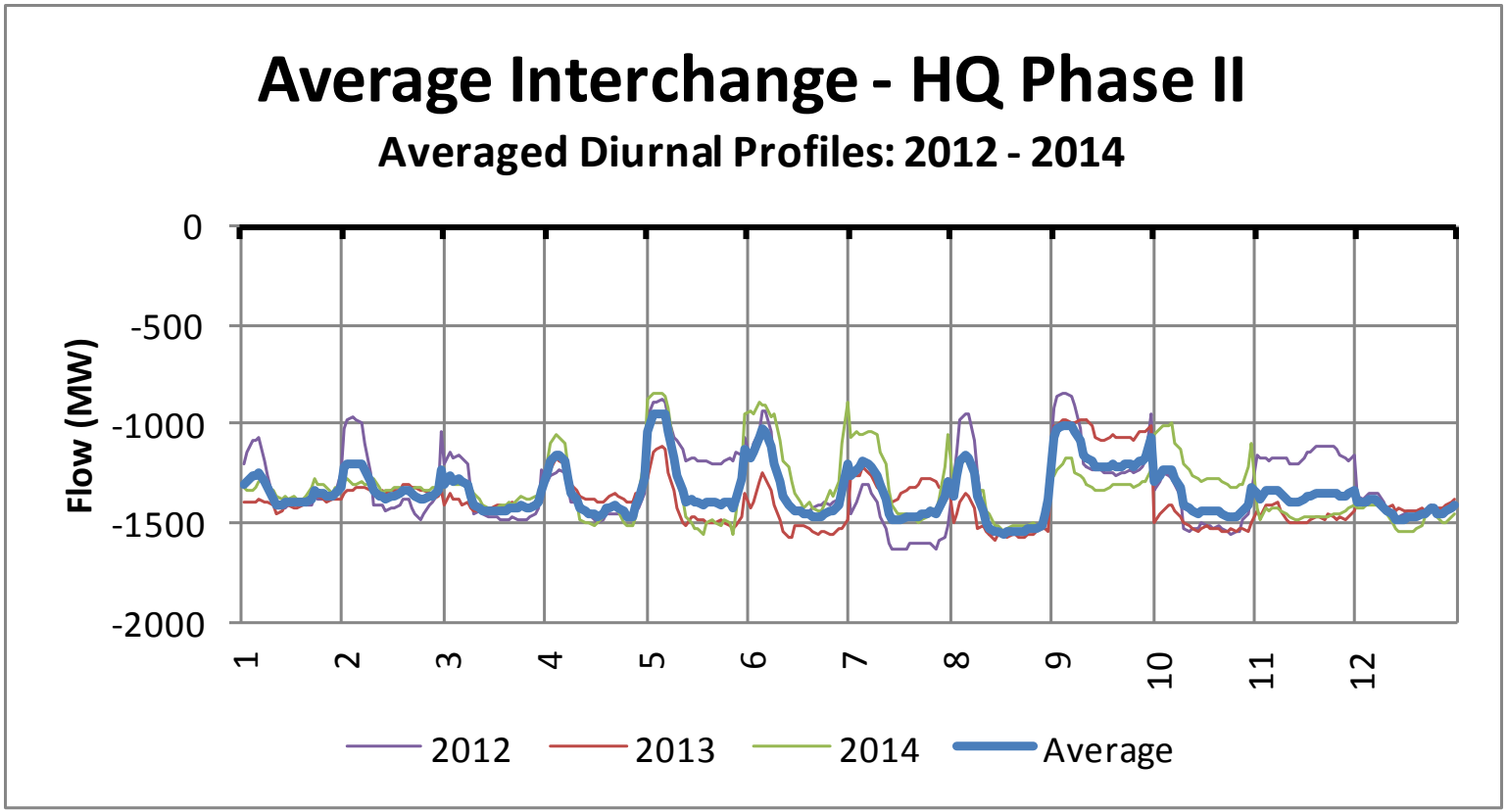


Modeling of Imports/Exports

Interchange Modeling

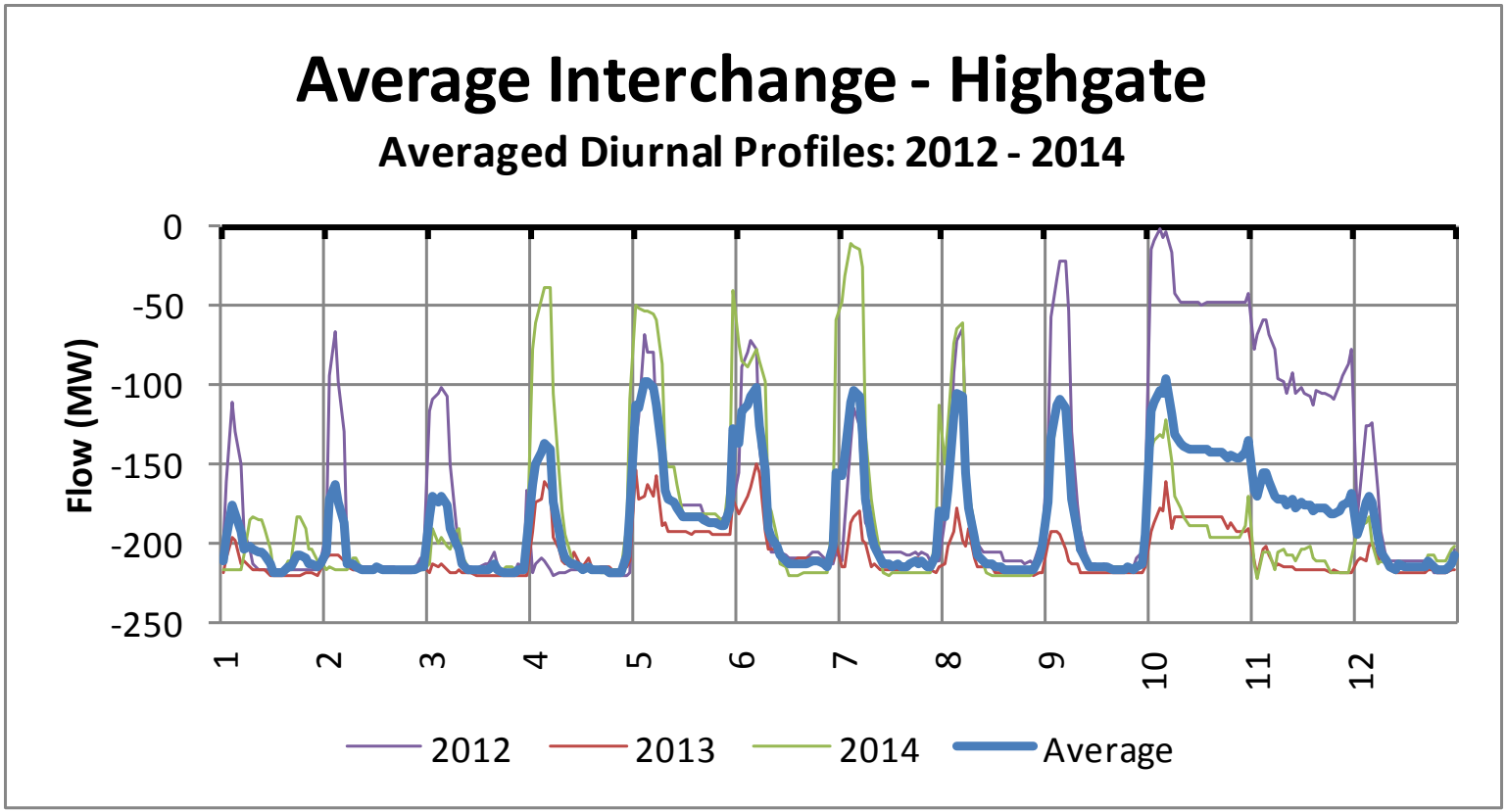
- Interchange with external areas will be based on:
  - Three year average
    - 2012
    - 2013
    - 2014
  - Monthly diurnal profiles
  - Five interchange profiles
    - HQ Phase II
    - HQ Highgate
    - Maritimes
    - New York interconnection AC
    - New York interconnection DC

Quebec to New England: Phase II



Note: negative values represent imports; positive values represent exports.

Quebec to New England: Highgate



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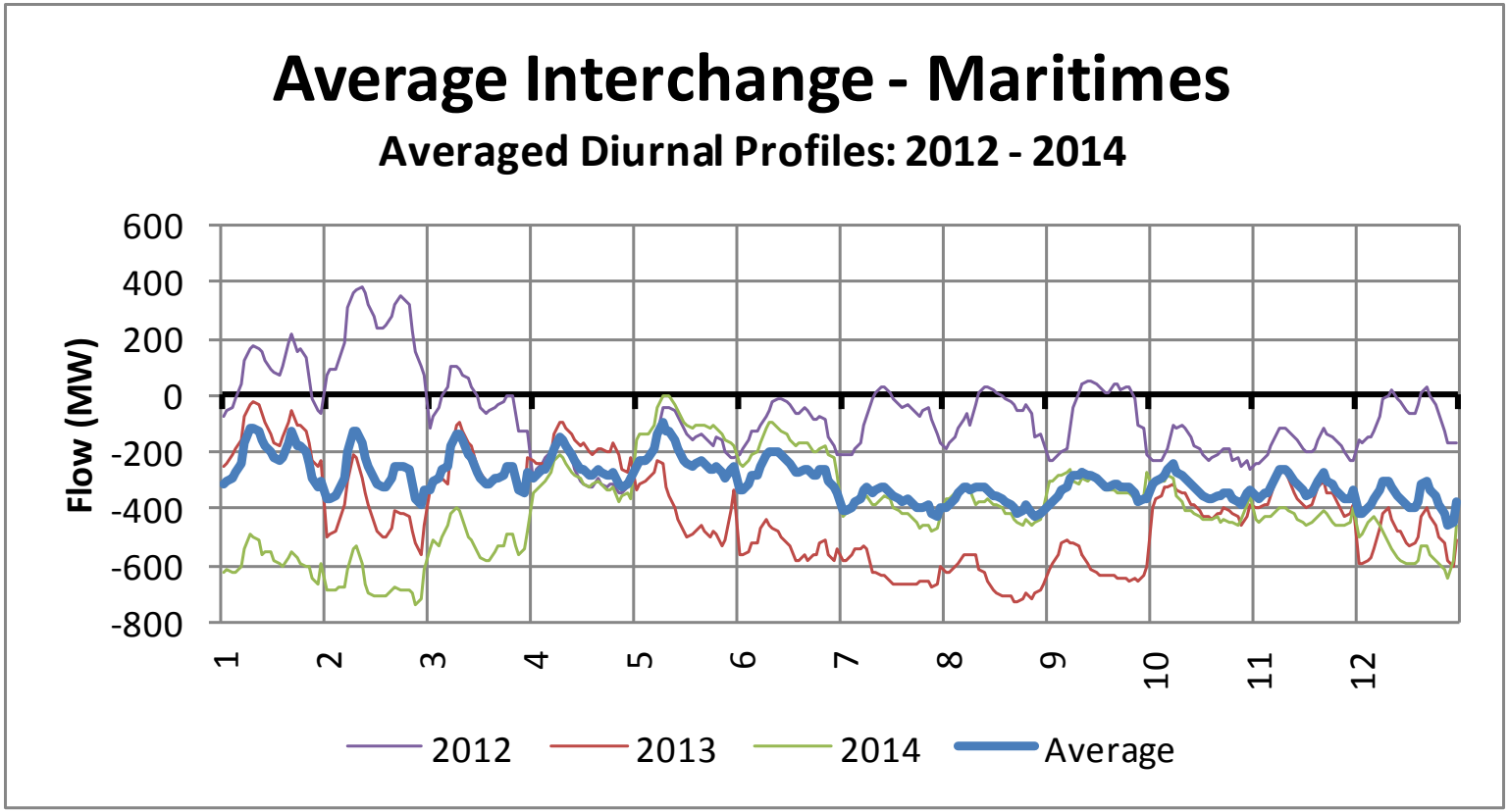
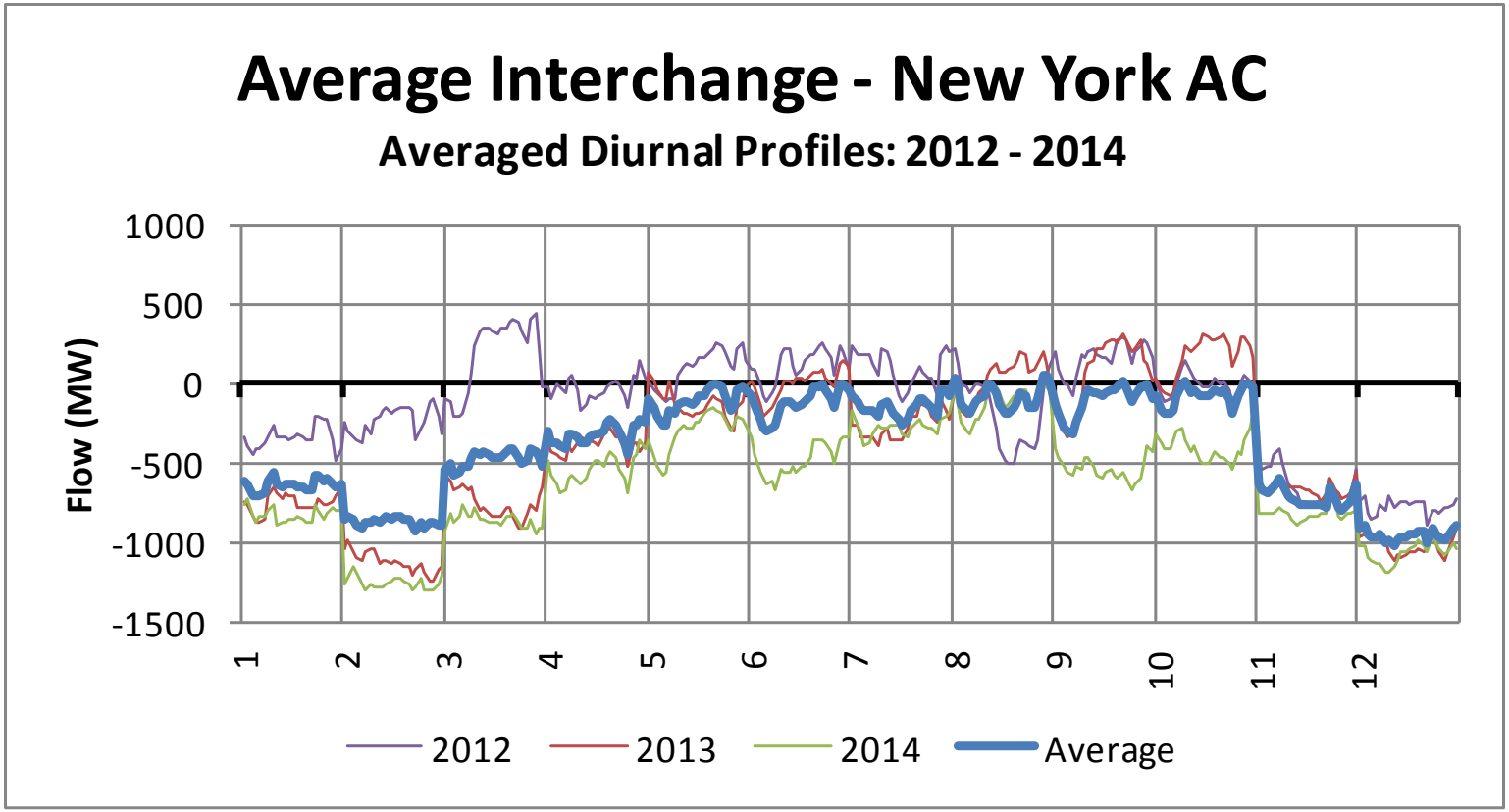
Maritimes to New England



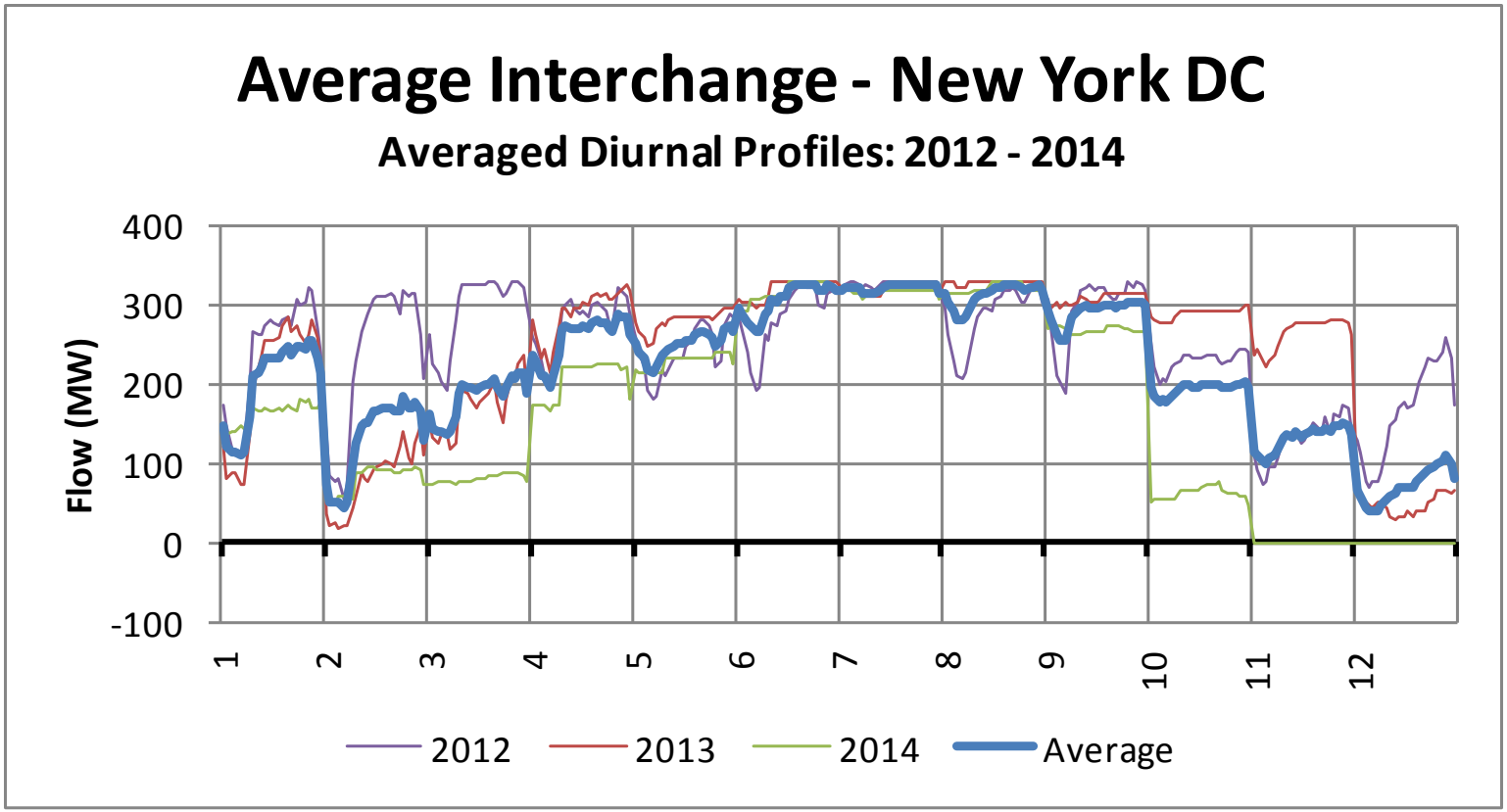
Note: negative values represent imports; positive values represent exports.

New England to New York - AC Interface



Note: negative values represent imports; positive values represent exports.

New England to New York - DC Interface



Note: negative values represent imports; positive values represent exports.

Modeling of Operating Reserves

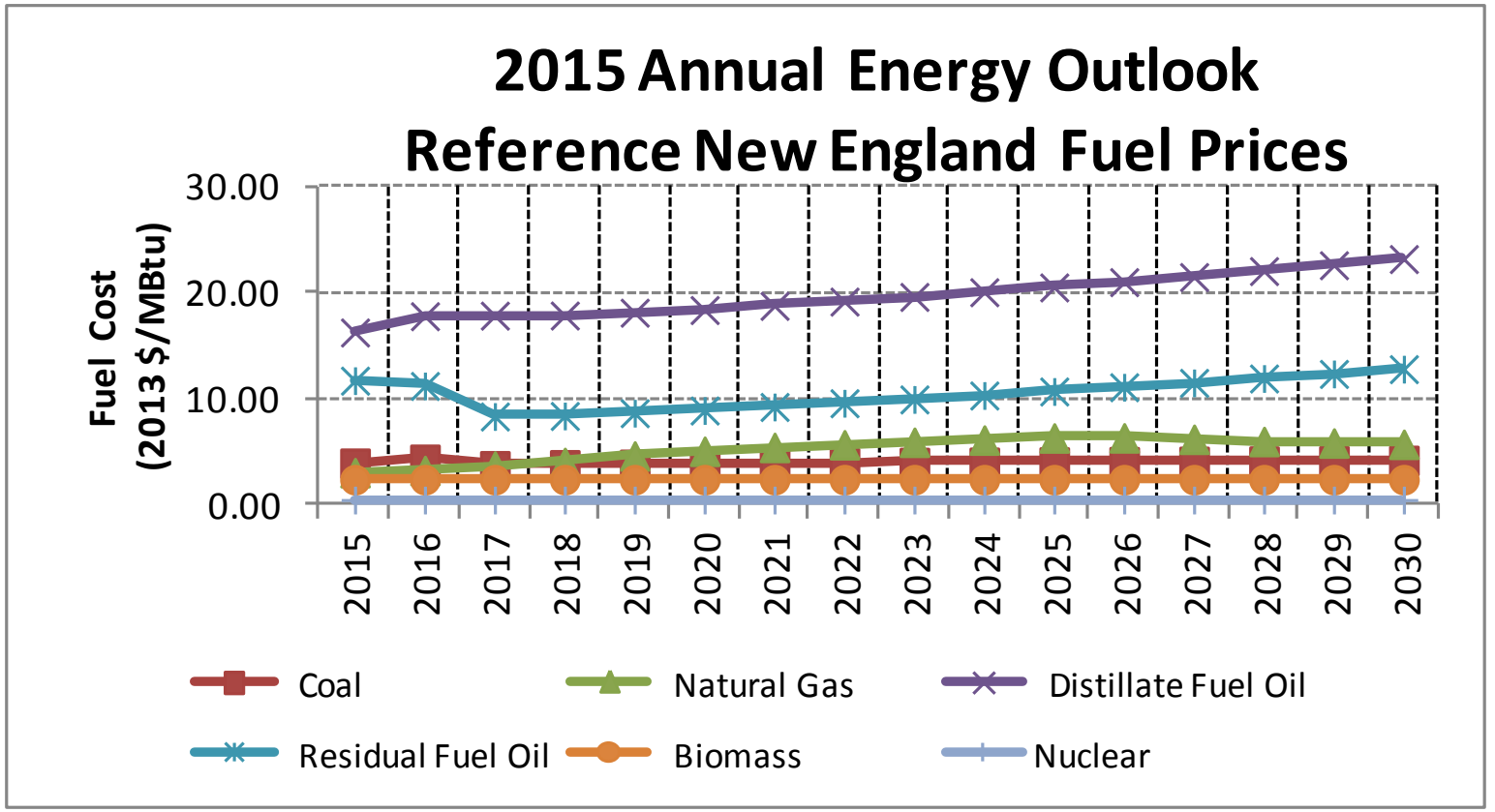
- Operating reserve requirement is determined in real time
  - Based on the first and second largest system contingencies
  - Resource profiles (hydro / wind / interchange etc) excluded
- Current operating reserve requirements
  - 125% of the first contingency in ten minutes split between
    - Ten-Minute spinning Reserve (TMSR) = 50%
    - Ten-Minute Non-Spinning Reserve (TMNSR) = 50%
  - Thirty-Minute Operation Reserve (TMOR) not modeled
    - Assumed to be adequate
    - Provided by hydro, pumped storage and quick-start resources
    - Reasonable assumption except, possibly, at times of peak loads

ISO-NE Reserve Requirement

Modeled	Not Modeled (assumed not a constraint)	
On-line: "Ten-Minute Spinning Reserve" (TMSR)	**Off-line: "Ten-Minute Non-Spinning Reserve" (TMSNR)**	**On-line or Off-line:"Thirty-Minute Operating Reserve" (TMOR)**
• Capability of on-line unit to provide increased energy within 10 minutes • Partially loaded on-line generator • Limited by ramp rate and Economic Maximum	• Capability of off-line resources to provide energy within 10 minutes • Off-line generation turbine, diesel or hydro generators • Load interruption – Dispatchable Asset Related Demand (DARD)	• Capability of resources to provide energy within 30 minutes • Can be either on-line or off-line resource • Generally the larger generation turbines • Load Interruption – DARD can also qualify

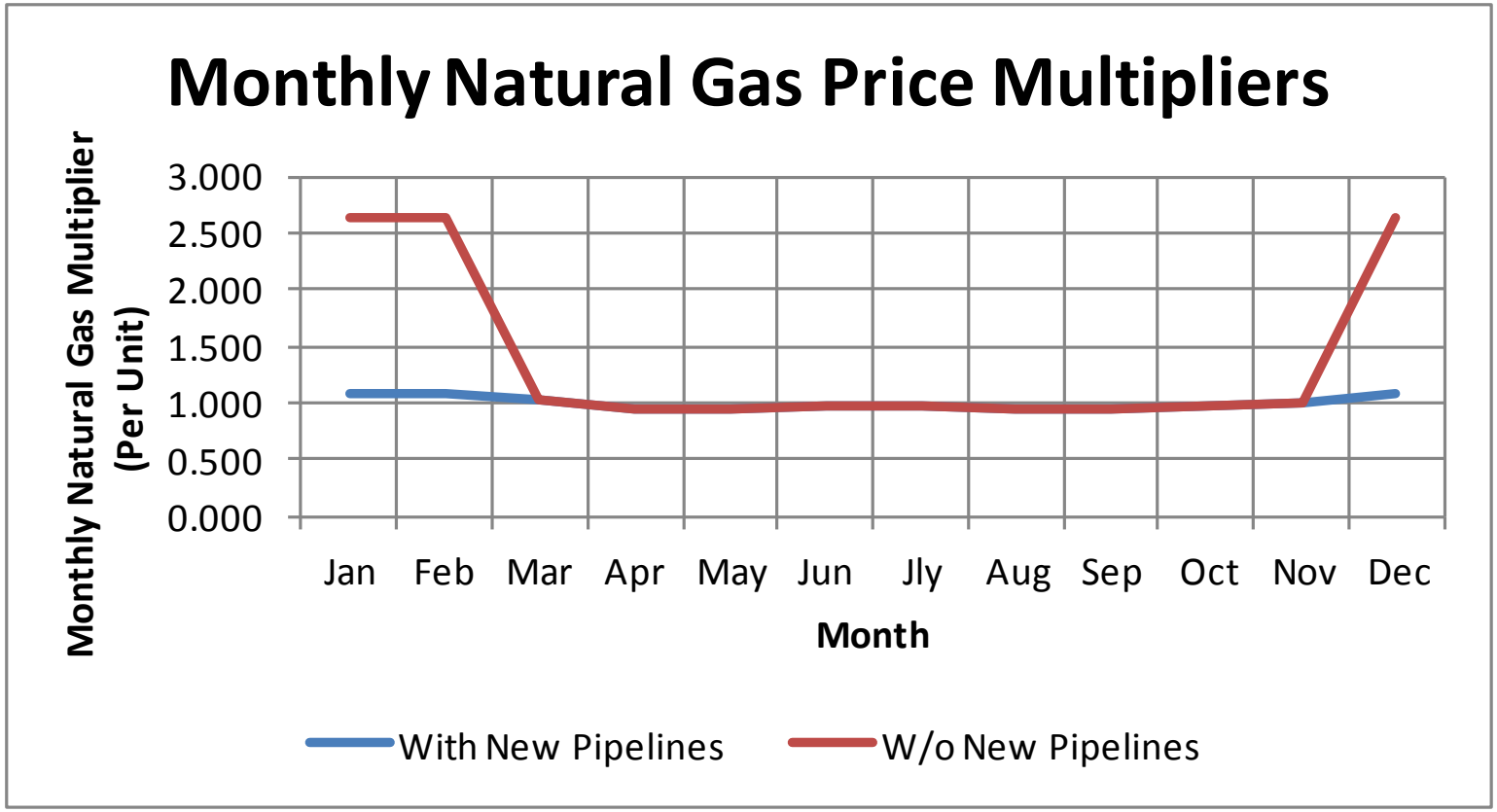
Reference: Introduction to Wholesale Electricity Markets (WEM 101) - Reserve Market Overview
http://www.iso-ne.com/support/training/courses/wem101/17_reserve_market_overview_likover.pdf

Fuel Price Forecast – EIA's 2015 AEO Base



Monthly Gas Price Profile

January, February and December gas prices equal residual oil in each year ($/MBtu)



Questions