

Natural Gas/Renewable Energy Dialogue: **Grid Integration Issues**

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Presentation Overview

- Overview of ISO New England, the New England power system, and wholesale markets
- Composition of the new capacity queue
- Wind integration and the NEWIS Study
 - Wind potential
 - Benefits and challenges
- Future direction and initiatives
- Questions

About ISO New England & Regional Grid

ISO New England

- Private not-for-profit
- Regulated by FERC
- Created in 1997
- Independent of companies doing business in the market
- Located In western Massachusetts



Regional Power Grid

- Population: 14 million
- 6.5 million residences/businesses
- > 350 generators
- > 5,000 demand assets
- > 8,000 miles high-voltage transmission
- 13 interconnections
- > 31,000 MW of total supply
- > 2,500 MW of demand resources
- All-time peak demand of 28,130 MW

ISO-NE's Major Responsibilities

Operate the Power System

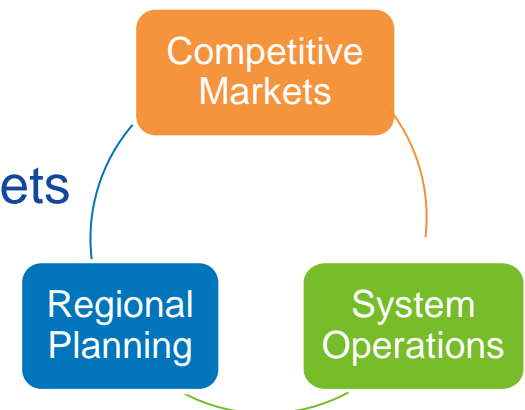
- Maintain minute-to-minute reliable operations of region's power grid
- Perform centralized dispatch of the lowest-priced resources
- Coordinate operations with neighboring systems

Power System Planning

- Administer generation and transmission interconnection requests
- Conduct transmission system need assessments
- Develop 10-year transmission plan to ensure a reliable and efficient power system

Administer Wholesale Electric Markets

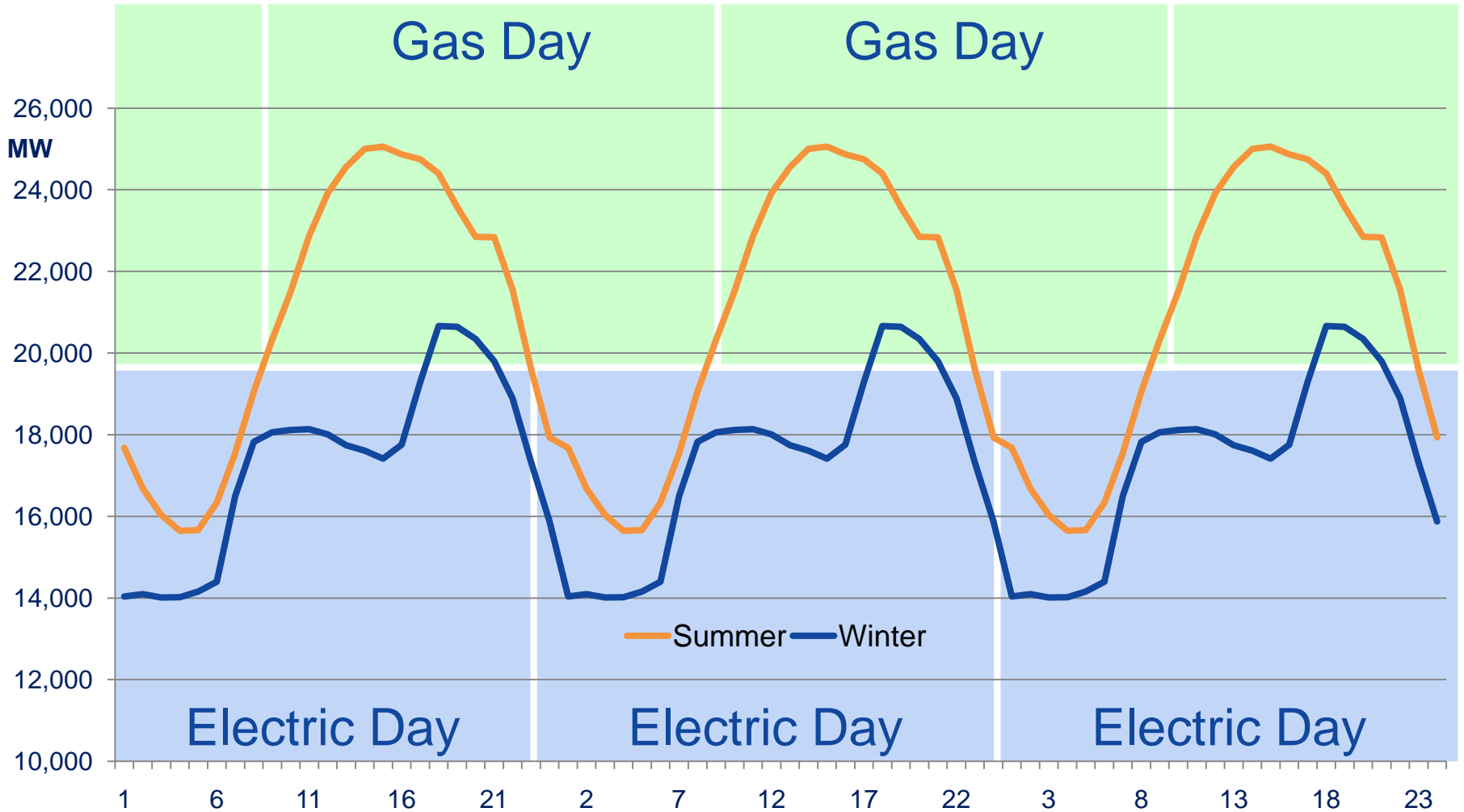
- Administer region's wholesale electricity markets
- Internal and external market monitoring



Wholesale Markets Administered by ISO-NE

- Core Product: Energy Market
 - Day-Ahead Financial and Real-Time Balancing
- Ancillary Services: Hourly and Long-Term Reliability
 - Regulation (second-to-second load following)
 - Reserve Markets (Forward and Real-Time Markets)
 - Forward Capacity Market (to ensure sufficient resources)
- Hedging Instruments: Financial Transmission Rights
- Open-Access Transmission Tariff
- Other Eastern ISOs (PJM, NYISO) operate similarly

Typical Energy Delivery Profiles

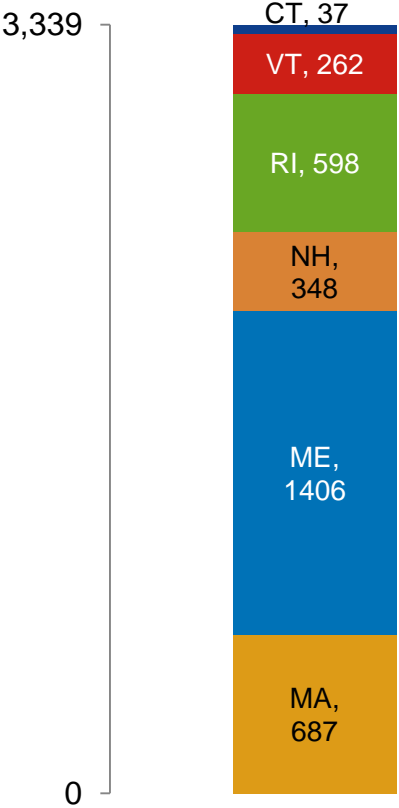


Hourly Reliability Products

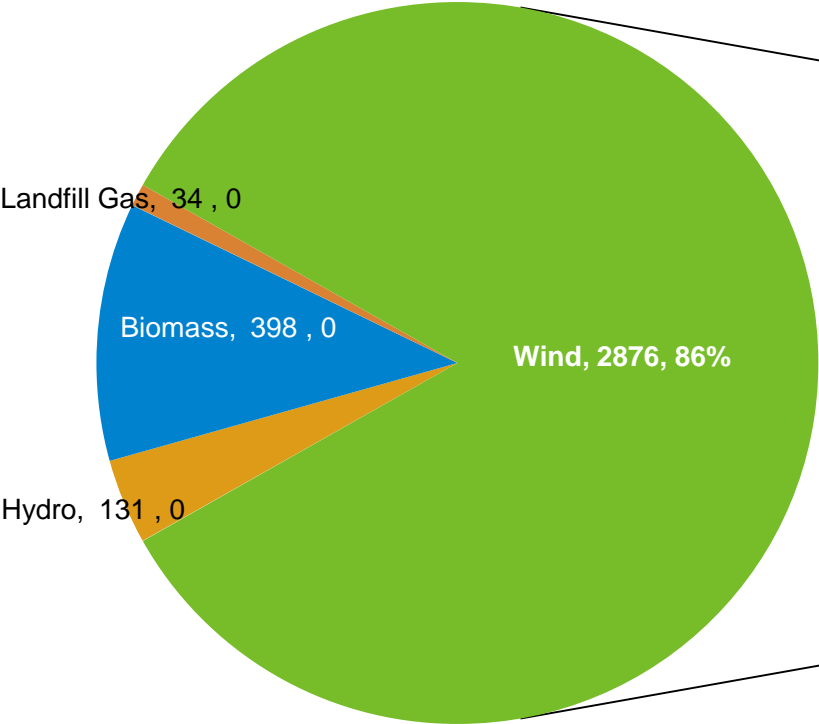
- ISO must ensure approximately 2,000 MW of available reserves each hour to respond to contingencies
- Forward Reserve Markets
 - Customer obligation to provide locational reserves secured through a seasonal auction
 - “Call option” on energy that requires specific daily offer above a threshold price to ensure accessibility to adequate reserves
- Regulation Market
 - Provides “minute-to-minute” balancing of load and generation
 - Providers compensated for “mileage” and lost opportunity
 - Alternative resources may participate (flywheel)

Policy Initiatives Have Led to Significant Renewable Capacity in Queue (April 2011 values)

By State (MW)



By Fuel (MW)



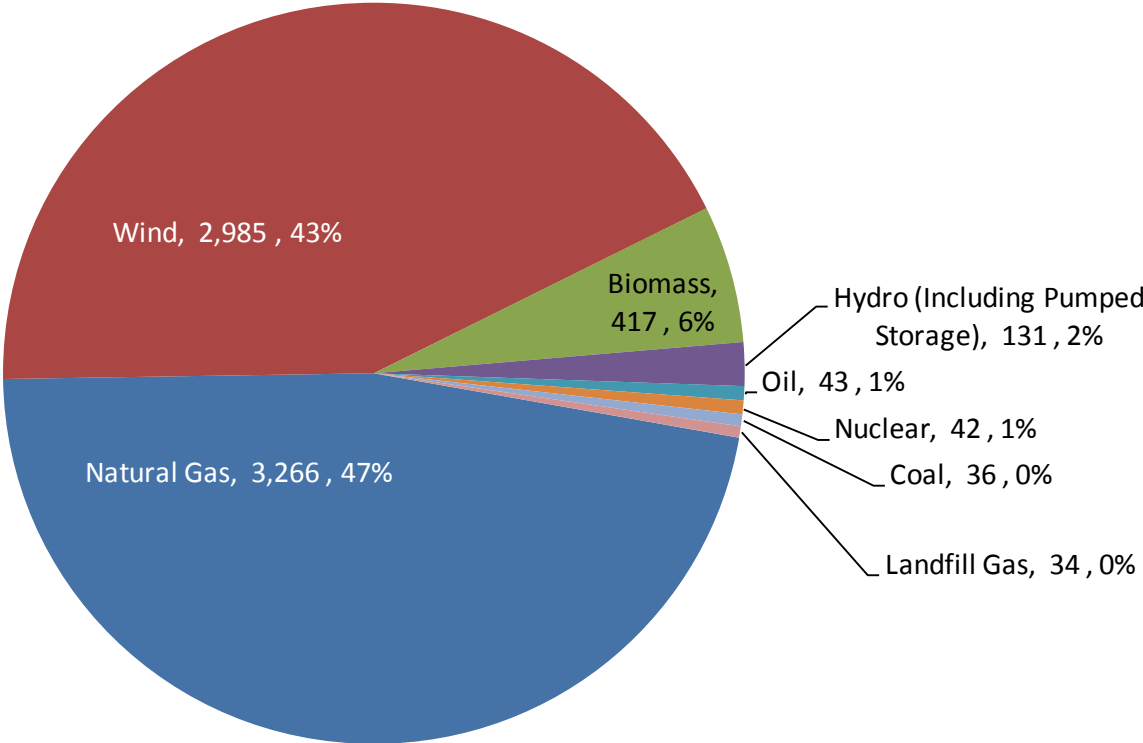
Wind Breakdown (MW)



* Nameplate ratings.

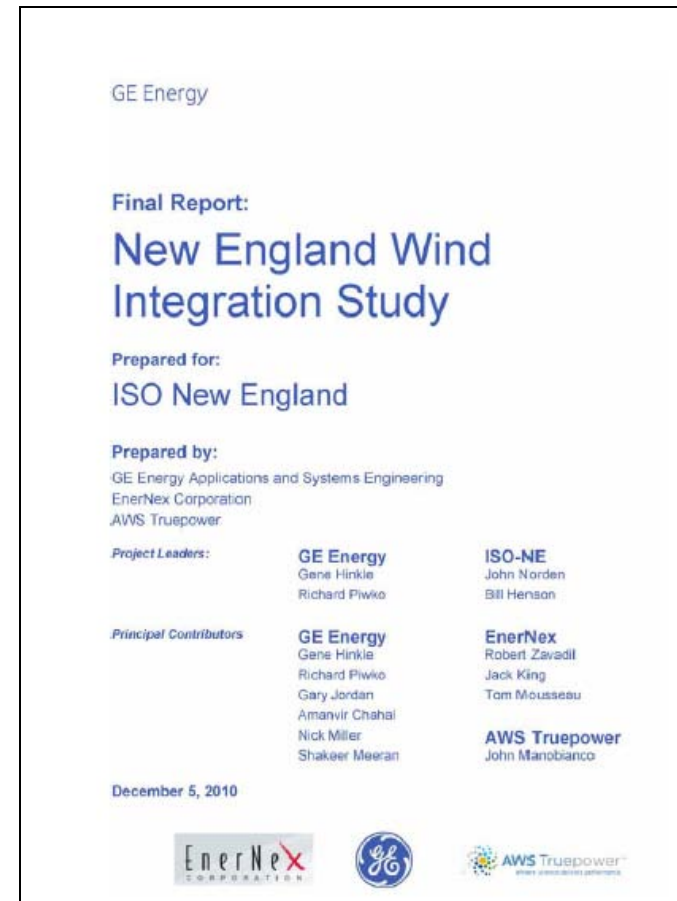
Future Capacity is Mostly Gas or Wind

May 2011 Capacity Additions Queue by Fuel Type



New England Wind Integration Study (NEWIS)

- Comprehensive, two-year wind integration study
 - Developed a detailed on- and off-shore New England wind model
- Snapshot of the year 2020 with hypothetical small, medium, and large wind power penetrations
- Highlights the operational impact of each wind development scenario on New England's power system
- Conducted by GE Energy Applications and Systems Engineering, with EnerNex and AWS Truepower



Major Findings of NEWIS



- Large-scale wind integration in New England is achievable
 - As much as 24%
 - When available to provide energy, wind resources could reduce fossil-fueled generation
- Large-scale wind integration will require:
 - Continued availability of existing and new supply- and demand-resources
 - Significant transmission upgrades

Major Findings of NEWIS (continued)

- Large-scale wind integration will require flexible resources
 - To manage variability
 - Increases in regulation and operating reserves
- Centralized wind power forecasting required for reliability
 - Accurate intra-day and day-ahead wind-power forecasts to ensure efficient unit commitment and market operation
 - Tools to forecast wind ramping so system operators can prepare for volatile wind situations by obtaining additional reserves or taking other steps
- The current natural gas fleet provides flexibility
 - Wind lowest during summer peak

Wind Provides Benefits and Challenges

- Benefits:
 - Wind energy improves fuel diversity
 - Can help meet environmental targets
 - Can dampen fuel cost uncertainty
- Challenges:
 - Higher capital costs
 - Siting issues
 - Variable Output
 - Cost of transmission investment
 - Operational concerns



Coordination: A Sampling of “Best Practices”

- As the region has expanded its dependence on natural gas, ISO-NE has increased coordination with the regional gas pipelines supplying its generators
 - Electric/Gas Operations Committee
 - Continues to evolve
- ISO-NE is having good success with a centralized, coordinated, and highly participatory stakeholder process for planning and evaluating the future electrical system
 - Planning Advisory Committee and the Regional System Plan
 - Inter-Area Planning Stakeholder Advisory Committee (IPSAC)
- Market participants, FERC, and ISO-NE have committed to and are realizing increased demand-side participation

Looking Forward...

- New challenges on the horizon:
 - Resource performance and flexibility
 - Increased reliance on natural gas-fired capacity
 - Retirement of generators
 - Integration of a greater level of variable resources
 - Greater alignment of system planning and wholesale market design
- Demand response initiatives
- Evolution of the capacity market (FCM)
- Regional dialogue on these challenges ongoing

