Review and Discussion of Suggested Scenarios

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Scenario Considerations

- **Expansion scenarios should highlight differences rather than "forecast reality"**
  - Inform policy makers
  - Help frame policy issues
  - Develop policy in other venues
- **Study results will include**
  - Reliability impacts
  - Production costs
  - Energy costs to consumers
  - Revenues to suppliers
  - Environmental emissions
    - NOx
    - SO2
    - CO2

Study Methodology

- **The power system is complicated**
  - Over 8,000 miles of high voltage transmission in New England
  - Over 350 generators
  - Resource expansion can occur anywhere
- **A simple model can highlight important results**

Study Methodology (continued)

- **A simplified model is needed for scenario analysis**
  - Choose a high load level to represent some distant year
  - Conduct production cost simulations
  - Clarify the results for different resource expansion scenarios
  - Assume no transmission restrictions and resources are deliverable to all load
    - Generation additions and demand side reductions could be located near load growth
    - Transmission system could expand as needed

Study Methodology (continued)

- **Provide separate generic estimate of $ per MW-mile for transmission expansion**
  - Provides rough transmission cost for remote placement of needed resources
- **Present natural gas pipeline information**
  - E.g. Need for expansion of fuel delivery
    - Pipeline
    - LNG

Long-term Resource Needs

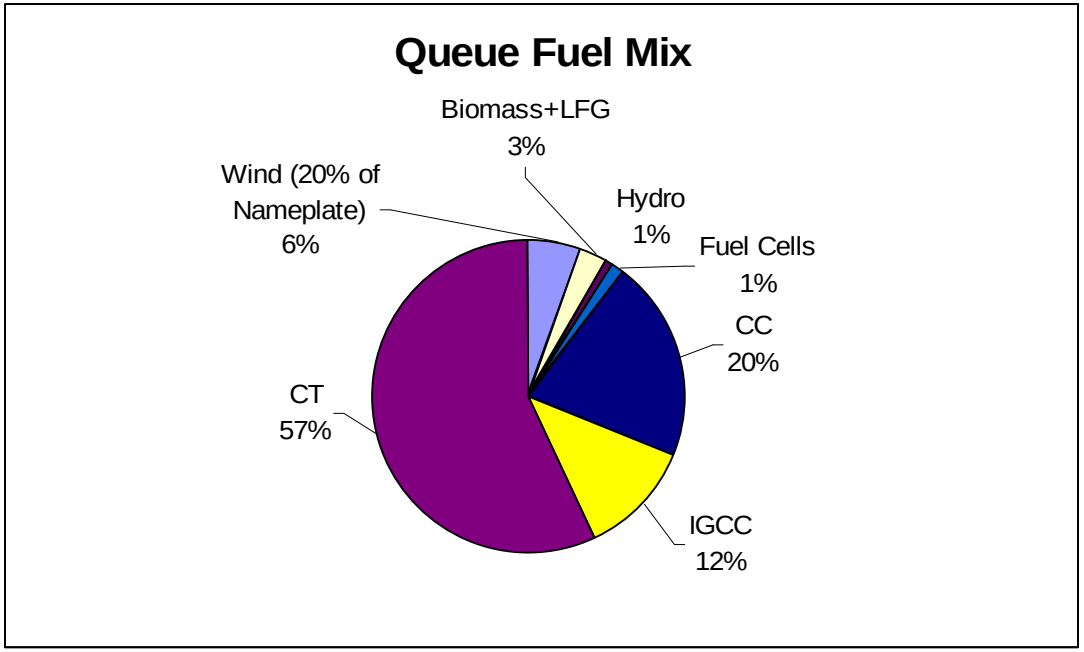
- **Study a long term (2020-2025) peak load level for scenarios**
  - Period beyond official ISO forecast
  - High load level provides
    - Long-term outlook
    - Requires enough capacity additions to show significant differences in scenarios
    - Provides opportunity to see impacts of significant demand-side resources
- **ISO suggests the study focus on 35,000 MW peak load level**
  - Peak to be met by combination of generation and demand-side resources
- **Long-term resource requirements**
  - RSP06 showed approximate resource need of 2,600 MW by 2012 growing to 4,300 MW by 2015
  - Total of about 8,000 MW new resources will be required to meet 35,000 MW peak load level

Resource Options
Considerations for Scenarios

- **RSP06 discusses various resource options**
- **Consider scenarios (in random order) that add:**
  - Resources with the same fuel mix as in the Queue
  - Significant additions of:
    - Nuclear
    - Clean coal
    - Natural gas
    - Renewable and energy efficiency resources
- **Significant difference in mix necessary to highlight impacts**
- **Issues will be discussed at future stakeholder meetings**

Queue Fuel Mix Considerations for Scenarios

- **Queue**
  - "Business as usual"
  - Representative mix of resources



Nuclear
Considerations for Scenarios

- **New nuclear technology**
  - Increase output of existing plants
  - Purchase from outside New England
  - Build within New England
- **No emissions**
- **Low energy production costs**
- **Licensing, siting and capital investment issues**
- **Spent fuel storage issue**

Clean Coal
Considerations for Scenarios

- **New coal technologies**
  - May be possible to sequester carbon emissions
- **Low energy production costs**
- **Siting issues**
- **Fuel transportation issues**

Natural Gas
Consideration for Scenarios

- **Recent resource of choice**
- **Low emissions**
- **Subject to high price volatility**
- **Dependent upon natural gas fuel availability**
  - Would likely require expansion of natural gas infrastructure
  - Reliability concern, especially without dual fuel capability

Renewables and Energy Efficiency Considerations for Scenarios

- **Driven by environmental regulations**
- **Demand Side Management**
  - Energy Efficiency
  - Demand Response
  - Use of true load response versus emergency generation
  - Short lead time
- **Wind**
  - Intermittent resource
  - Low capacity factor (assumed effective value is 20% of nameplate)
  - Power system limit on acceptable amount that can be added
  - Siting issues
- **Imports from Canada**
  - Over 6,000 MW of hydro expansion is being planned in Quebec and Labrador
  - Transmission upgrades will be required
  - Potential sales to markets other than New England

Five Scenarios – Straw Man

- **Five Scenarios are to be considered**
  - Each scenario should demonstrate impacts of all resource additions to meet (or reduce) 35,000 MW peak load and energy requirements for all hours

- **Addition of 8,000 MW total would be required**
  - Resources to include generation and demand side
- **Suggest:**
  - 2,600 MW common to all scenarios
    - Queue expansion with representative fuel mix
    - Captures “short term” expansion
  - 5,400 MW to represent different resource expansions

Assumptions – Straw Man

- **Assumptions**
  - 30,900 MW capacity assumed in RSP06
    - Assume the same fuel mix as currently exists
    - “No retirements” assumes maintenance and replacement in kind
  - Some resources are likely to reflect resources in the queue
    - 2,600 MW (out of 7,100 MW in Queue) with representative fuel mix for the units
  - Remaining resource additions to be reflected in scenarios
    - 5,400 MW to represent significant differences
      - Modest variation equals non-distinct results
      - Large variation equals distinct results
    - Demonstrates performance differences

Common Expansion for All Scenarios - 2,600 MW
(Based on Fuel Mix of Projects in the Queue)

Type	Additions in MW
Small Hydro	18
Wind (Qualified Capacity)	147
Biomass & Landfill Gas (LFG)	73
Fuel Cells	38
Peaking Combustion Turbines	1,484
Combined Cycle	530
Coal IGCC	310
Total	2600

Note: ISO forecast includes assumptions for energy efficiency.

Vary the Mix of the Additional 5,400 MW

- **Queue fuel mix**
- **Nuclear**
- **Clean Coal**
- **Natural Gas**
- **Renewables, Energy Efficiency and Imports**
  - Wind (assume 20% qualified capacity)
  - Imports of hydro from Canada
  - Increased DSM over the amount in the base ISO load forecast
    - 35,000 MW load level already includes over 1,500 MW of existing DSM programs

Resource Expansion (5,400 MW) Scenarios

Type	Queue Fuel Mix (MW)	Nuclear (MW)	Coal IGCC (MW)	NGCC (MW)	Renewables, Energy Efficiency & Imports (MW)
Increased Energy Efficiency					1,650
Small Hydro	37				100
Wind (Qualified Capacity)	305				550
Biomass+LFG	152				300
Fuel Cells	78				400
Peaking CTs	3,082				
Combined Cycle	1,101			5,400	
Coal IGCC	645		5,400		
Hydro Imports					2,400
Nuclear		5,400			

Stakeholder Comments and Discussion

- **Load level**
- **Common Expansion**
  - Amount and mix of resources
- **Five Scenarios**
  - Amount and mix of additional resources
- **Other comments**

Study Methods and Overview of Metrics

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Study Methods

Scenario Simulation Method

- **Use Inter-Regional Electric Market Model (IREMM)**
  - Used in RTEP and RSP analysis
  - Performs hourly system production simulation
  - Models generation unavailability as a unit derating
  - Models hydro, pumped hydro and wind as load reductions
  - Generator energy dispatch based on full load unit heat rates, fuel costs and emission allowance adders
  - Models emission rates and cost adders for SO2, NOX, and CO2

Scenario Modeling Assumptions

- **Use IREMM for a single bus production simulation of system, i.e ignore transmission constraints for costs and emissions**
- **Fuel forecast based on EIA**
- **RSP06 load duration curve for 2015**
- **Imports modeled to simulate supply cost curve**
- **Emission allowance adders to be reflected in dispatch**
  - Simulation of the full environmental emission allowance market isn't feasible for ISO
- **ISO to present more detailed information on IREMM simulation program and model assumptions at next meeting**
- **Stakeholders to provide input on study assumptions**

Suggested Sensitivity Analysis

- **Change relative fuel prices**
- **Different cost adders for emission allowances.**
- **Vary peak load level**
- **Vary energy use (system load factor)**
- **Others?**
  - Stakeholders to provide input

Overview of Metrics

Draft Metrics

- **Metrics are a means of comparing the results of scenario analyses**
- **Metrics can help identify issues**
  - Some metrics will be ISO simulation results
  - Others will be identified by stakeholders
- **Potential metrics**
  - Reliability
  - Cost
  - Environmental
  - Revenues to resource owners
  - Risk factors
  - Others? (Stakeholders to provide input)

Potential Metrics – Study Results

Reliability metrics

- Fuel Diversity
  - % capacity mix
  - Energy mix - Energy produced by units of different fuel types
  - Loss of Fuel source - Operable Capacity analysis to show shortfalls during peak summer and winter seasons and need for additional capacity, duel fuel, etc.
- **Not In Scope:** LOLE - # days in 10 years – LOLE is driven by too many assumptions and could produce misleading results

Potential Metrics – Study Results

Cost metrics

- Hours LMP set by gas/oil - hours per year
- Production cost - Total annual $ and average $/MWhr
- Transmission - $/MW-mile
- Cost to consumers - Total energy costs plus capacity cost in settlement agreement ($7.50/kW-mo).
- **Not In Scope:** Uplift – Uplift is dependent on assumed locational generation and transmission expansion
- **Not In Scope:** Economic development factors – Regional econometric models are beyond the scope and capability of ISO analysis.

Potential Metrics – Study Results

Environmental

- Environmental air emissions - Total annual tons of SO2, NOx, and CO2 emissions
- RGGI Compliance - Compare emissions with RGGI cap
- Ozone days - NOX emissions on 10 highest load days.
- RPS - Show percent of renewable energy production versus the total NE state RPS requirements

Potential Metrics – Study Results

Revenues for Expansion Resources

- Capacity - Use the FCM settlement number for capacity value, i.e. $7.50/kW-month
- Energy - Use simulation results for the total net energy revenues for the expansion units (energy savings for energy efficiency)
- **Not In Scope:** Capital cost estimates for expansion units - The cost of expansion units could vary greatly with site and is highly dependent on other unknown factors, such as financing, etc.

Potential Metrics – Stakeholder Input

- Likelihood of market supporting investment:
  - Assuming a carrying charge of 20%, the capacity plus net energy revenues could be multiplied by 5 to get the "justified market investment" per kW.

Draft Metrics – Stakeholder Input

Risk Factor:

- Propose stakeholder development of draft "risk index" of issues

- Difficulty siting
- Number of sites
- Size of sites
- Fuel cost
- Availability of technology
- Emissions
- Fuel delivery risk
- Ratings of units
- Others?

Stakeholder Input

- **Stakeholders to review potential metrics**
- **Suggest additions and deletions**
  - Submit to ISO who will provide a summary
- **Be prepared for further discussion at the next stakeholder meeting**