

Scenario Analysis Initiative: Study Methods and Overview of Metrics

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Metrics Working Group Meeting

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Agenda

- **Background (30 minutes to 1 hour)**
 - Review Scenario Analysis Goal, Process, and Proposed Scenarios
 - Study Methods and Assumptions
- **Proposed Metrics (3.5 hours)**
 - Definition of Metrics as quantitative measures
 - Reliability
 - Cost
 - Environmental
- **Format of ISO Study Output (30 Minutes)**

Metrics Working Group: Today's Goal

- **Understand Scope of Work and ISO capabilities**
- **Assist with determination of Metrics**
 - Only quantitative measures will be discussed
- **Suggest format of ISO study results to maximize compatibility with models that may be used by others**

Background

Scenario Analysis: What is it?

- An ISO sponsored stakeholder process to explore long range electric energy alternatives for meeting a New England load of 35,000 MW
- Will simulate a set of different fuel and technology based scenarios for one year
- Determine high level metrics for each scenario: reliability, transmission, economic, environmental impacts
- Use results to inform public policymakers of consequences of each scenario
- No judgment of best scenario will be made

Scenario Analysis Process

- **Stakeholder groups provide guidance to ISO on:**
 - Scope of work
 - Assumptions
 - Scenarios to be studied
 - Types of analyses
 - Results
 - Metrics
- **List of stakeholder groups:**
 - Plenary Stakeholder Group
 - Reviews the scope of work and study results
 - Technical Committees
 - Provide input on detailed assumptions and modeling
 - Transmission Owners Committee
 - Power Supply Planning Committee
 - Environmental Advisory Group
 - Demand Response Working Group
 - Others as may be required
 - Metrics Working Group

7 Proposed Scenarios

1. **Market Mix of Resources “Queue Mix”**
2. **Energy Efficiency (EE) and Demand Response (DR)**
 - Both EE and DR are considered resources
3. **Nuclear**
4. **Clean Coal (IGCC)**
5. **Natural Gas Combined Cycle**
6. **Renewable Resources**
7. **Imports: hydro and low emitting resources**

Scenario Expansions and Sensitivities

- Assume a base expansion of 2,600 MW common to all scenarios based on what's in the queue
- The remainder of 5,400 MW will be comprised solely of the fuel/technology type for a given scenario
 - Establishes boundary cases or bookends
- Sensitivity cases will test
 - Fuel prices
 - EE & DR replacement of new scenario based supply side resources
 - Retirements
 - CO₂ allowance prices
 - CO₂ sequestration
 - Increased imports

- Total for each scenario:

Base expansion	2,600 MW
Individual fuel/tech.	<u>5,400 MW</u>
Total new resources	8,000 MW

7 Scenarios, and Sensitivity Analyses

	A	B	C	D	E	F	G	H	I	J	K
	Common Assumptions	High Gas/Oil Fuel Prices	Low Gas/Oil Fuel Prices	Replace 3500 MW of the Scenario Technology with 1750 MW EE and 1750 MW of DR	Energy Efficiency - Replace 2700 MW of DR with 2700 MW of EE	Demand Response - Replace 2700 MW of EE with 2700 MW of DR	Retire 3500 MW and replace with Scenario Technology	High Carbon Allowance Prices	Low Carbon Allowance Prices	For coal: With Carbon Sequestration	Decreased imports of low-emission resources (- 7 TWh)
1	Mix of currently proposed resources – 5400 MW blend reflecting the fuel mix exhibited recently by the market (i.e., “the Queue”)	X	X	X	X		X	X	X		
2	Additional EE and DR with 2700 MW of DR and 2700 MW of EE	X	X	X	X	X	X	X	X		
3	Nuclear – 5400 MW	X	X	X	X		X	X	X		
4	Advanced clean coal – 5400 MW Without Carbon Sequestration	X	X	X	X		X	X	X	X	
5	Natural Gas (Combined Cycle) – 5400 MW	X	X	X	X		X	X	X		
6	Renewables – 5400 MW (including a combo of wind (on/off shore) hydro, biomass, landfill gas, CHP, fuel cells, PV.1/8 th each)	X	X	X	X		X	X	X		
7	Increased Imports of Hydro and/or other Low Emission Resources (30 TWh of imports)	X	X	X	X		X	X	X		X

Study Methods and Assumptions

Types of Analyses

- **Production Cost Simulation**
 - Provides total production costs for all resources
 - Calculates production costs for expansion resources
 - Determines energy costs to resources and consumers
 - Finds the gross energy revenues to resources
 - Shows air emissions for SO₂, NO_x, and CO₂
- **Operable Capability Analysis**
 - Evaluates need for fuel diversity
 - Uses methodology similar to RSP06
- **Conceptual Electrical Transmission Needs**
 - Develop costs of conceptual transmission needs
 - Determine representative \$/MW-mile for transmission expansion
- **Conceptual Electrical Distribution Needs**
 - Develop cost of conceptual distribution system infrastructure additions
- **Conceptual Expansion of Wholesale and Local Distribution Natural Gas Delivery Systems**

Scenario Production Cost Simulation

- **Use Inter-Regional Electric Market Model (IREMM)**
 - Needed for energy and air emission analysis
 - Used in RTEP and RSP analysis
 - Performs hourly system production simulation
 - Results can be presented in various timeframes
 - hourly, monthly, quarterly, seasonally, annually, etc.
 - Models generation unavailability as a unit derating
 - Models hydro, pumped hydro, wind, and PV as load reductions
 - Models Energy Efficiency and Demand Response as load modifiers
 - Generator energy dispatch (including DG) based on full load unit heat rates, fuel costs and emission allowance adders
 - Models emission rates and adders for SO₂, NO_x, and CO₂

Scenario Modeling: IREMM Assumptions

- **Use IREMM for a single bus production simulation of system**
 - Ignore transmission constraints for energy costs and emissions
- **Fuel forecast based on EIA**
 - Sensitivity cases to vary gas and oil prices
- **RSP06 8760 hourly load profile for 2015**
- **No imports modeled**
- **Emission allowance adders to be reflected in dispatch**
- **Wind model and PV**
 - Requires explicit assumption of on-shore and off-shore wind profile and capacity
- **Distributed Generation models**
 - Under development

Fuel Price Assumptions

EIA AEO 2006 Reference Price Forecast (2004 \$/MMBtu)

	Distillate Fuel	Residual Fuel	Natural Gas	Steam Coal
2015	9.02	5.72	5.21	1.4
2016	9.23	5.78	5.19	1.4
2017	9.23	5.83	5.23	1.39
2018	9.43	5.86	5.4	1.39
2019	9.48	5.9	5.54	1.39
<i>2020</i>	<i>9.62</i>	<i>6.02</i>	<i>5.53</i>	<i>1.39</i>
2021	9.67	6.06	5.66	1.4
2022	9.85	6.14	5.73	1.4
2023	9.92	6.27	5.79	1.41
2024	9.99	6.36	5.9	1.43
2025	10.05	6.43	6.02	1.44

Process for Review of Assumptions

- **ISO has discussed more detailed information on the IREMM simulation program and other study assumptions at Power Supply Planning Committee (PSPC) and Environmental Advisory Group (EAG) meetings**
- **Transmission Owners to work with ISO on developing cost estimates for**
 - Distribution infrastructure costs
 - Conceptual transmission expansion needs
 - Examine representative HVDC lines
 - Quebec/Labrador – New England
 - New York – New England
 - Within New England
- **Stakeholders to provide input on study assumptions and cost estimates for installation of supply side resources**

Proposed Metrics

Draft Quantitative 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
- **Metrics categories**
 - Reliability
 - Transmission
 - Environmental
 - Economic
 - Others? (Stakeholders to provide input)

Potential Quantitative 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 potential shortfalls during peak summer and winter seasons and need for additional capacity, dual fuel, etc.

Not In Scope: LOLE - # days in 10 years – LOLE is driven by too many assumptions and could produce misleading results.

Potential Quantitative Metrics: Environmental Emissions and Siting

- **Air Emissions**
 - Total units of fossil fuels consumed
 - Environmental air emissions - Total annual tons of SO₂, NO_x, and CO₂ emissions
 - RGGI Compliance - Compare emissions with RGGI cap
 - Ozone days - NO_x emissions on 10 highest load days.
- **Siting**
 - Number of required sites for each technology

Not In Scope: Cost projections for emission allowances – Simulation of the full environmental emission allowance market and the calculation of mercury emissions aren't feasible for ISO.

Economic Impacts

- **Discuss simulation results without making any judgments**
- **Generic costs to consumers**
 - Capacity
 - Energy
 - Transmission additions
 - Distribution additions
 - Others
- **Generic resource revenues and costs**
 - Capacity
 - Energy
 - Others
- **Renewable output and production of credits**
 - RPS - Show percent of renewable energy production versus the total NE state RPS requirements
 - Total number of renewable energy credits produced (RECs)

Potential Quantitative Metrics: Compare Revenues to Resource Costs

- **Contributions to fixed costs for new resource additions**
 - Capacity: Use the FCM settlement number for capacity value
 - \$4.50 - \$7.50 - \$12.00/kW-month
 - Energy: Use simulation results for:
 - The total energy produced by all expansion units (MWH by hour)
 - The total energy savings for new energy efficiency and demand response (MWH by hour)
 - The total gross energy revenues for the expansion units, energy efficiency and/or demand response (hourly MWH x hourly LMP)

Potential Quantitative Metrics: Revenues and Costs of Resources

- Revenues from energy and capacity markets
- Generic capacity and energy production costs for each technology

Not In Scope: Capital cost estimates for specific expansion units - The cost of expansion units could vary greatly with site and is highly dependent on other unknown factors, such as financing, etc. Therefore, an economic evaluation will not be conducted.

Potential Quantitative Metrics: Overview of Economic Issues

	System Costs – Calculating costs to produce and deliver electricity	Consumer Impacts – Calculating expenditures flowing through to consumers	Expansion Resource Costs and Revenues
Electric energy (kwh)	<ul style="list-style-type: none"> • Hours LMP set by gas/oil - hours per year • Production cost - Total annual \$ and average \$/MW/hr 	<ul style="list-style-type: none"> • Total expenditures on LMPs in wholesale system 	<ul style="list-style-type: none"> • Total revenues produced (e.g., LMPs)
Capacity (kW)	<ul style="list-style-type: none"> • Total annual capacity charges in FCM (@ \$ 4.50 - \$7.50/ - \$12.00 kW-mo) 	<ul style="list-style-type: none"> • Total expenditures on capacity payments in FCM ((@ \$ 4.50 - \$7.50/ - \$12.00 kW-mo) calculated ExPost 	<ul style="list-style-type: none"> • Total revenues produced (e.g., FCMs),
Delivery – electric	<ul style="list-style-type: none"> • Electric Transmission and Distribution Infrastructure Costs (using conceptual/generic \$/mw mile) 	<ul style="list-style-type: none"> • Potential additional transmission costs to consumers (using conceptual/generic \$/mw mile) 	<ul style="list-style-type: none"> • Conceptual delivery costs (where appropriate for a scenario)
Delivery – fuel supply	<ul style="list-style-type: none"> • Expansion costs for gas delivery (using conceptual/generic \$/pipeline mile) 	<ul style="list-style-type: none"> • Cost of LDC expansion 	<ul style="list-style-type: none"> • Fuel delivery costs and supply costs, given the output and profile of the technology
Other	<ul style="list-style-type: none"> • Units of fuel consumed by fuel type • Total \$ spent on fuel by fuel type 	<ul style="list-style-type: none"> • Already included in LMPs 	<ul style="list-style-type: none"> • Still in discussion on appropriate and useful way to characterize economic metrics for different technologies
Not in scope	<p>Uplift – Uplift is dependent on assumed locational generation and transmission expansion</p> <p>Economic development factors – Regional economic models are beyond the scope and capability of ISO analysis. However, ISO will provide the IREMM results in a format that can be used by others for this purpose.</p>	<p>Retail rate impacts – given the difficulties in making assumptions about full set of issues in retail ratemaking, the focus will be on costs in the wholesale system</p>	<p>Investment costs for any site-specific issues; use of generic cost profiles for each technology</p>

Stakeholder Input

- **Stakeholders to review potential metrics**
 - Provide input today
- **Suggest additions and deletions**
 - Provide input to ISO
 - ISO to summarize comments
- **Further discussions at the next Metrics WG if needed**
 - Tentatively scheduled for February 1
- **Limit metrics to quantitative results of studies within Scope of Work**

Format of ISO Study Output

Scenario Analysis Results

- **Can be used as input into other economic models, such as REMI**
- **IREMM results can be produced in spreadsheet format**
- **What information is desired to facilitate other non-ISO studies?**