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Energy Security Improvements Impact Analysis

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Agenda

- Future Cases – Preliminary Central Case Results
  - ~~Central Case Overview~~
  - ~~Net Revenues to Generators~~
  - Incentives for Energy Inventory
    - Fuel Oil Inventory
    - Forward LNG Contract
  - Production Costs
- Preliminary Scenario Analysis Results

Presentation will continue discussion of materials first posted for 9/4/2019 NEPOOL Markets Committee meeting

- These materials are generally unchanged from the 9/4/2019 materials
- Materials covered during the 9/4/2019 MC meeting have been moved to the appendix
- Several new slides have been added (these are identified)

New Slide

Topics to Be Covered Today

An Overview

- Incentives for energy inventory
  - Assess how ESI addresses identified problems – in particular, inadequate energy security creating risks that resources are unable to deliver energy in real-time (RT)
  - Analysis of ESI incentives for two actions resources can take to enhance their ability to deliver RT energy: increased energy inventory through fuel-oil refueling and forward contract with LNG terminals; *not an exhaustive list*
- Production costs
  - Assess changes in production costs with ESI rules (compared to current market rules)
  - Provides an measure of economic benefits and costs
  - We quantify some (but not all) economic benefits and costs
- Scenarios
  - New scenario presented: DA energy option strike price set at a higher level, 120% of expected peak/off-peak RT price (Central cases assumes strike price set at 100% of expected peak/off-peak RT price)
  - Preliminary analysis captures some, but not all economic and reliability impacts

New Slide

Incentives for Energy Inventory

Approach to Testing for Improvements in Energy Security

- ESI market design:
  - Identified problem: Misaligned (and thus inadequate) incentives for resources to take actions that enhance their ability to deliver energy in RT
    - Increased energy inventory is one, but not the only, way to enhance this ability
  - ESI design approach: Increase incentives to take such actions through the procurement of desired outputs – that is, options for this energy, as reflected in EIR, GCR and RER requirements
- Given this design, a key question is:
  - Will ESI increase *incentives* for resources to enhance their ability to deliver energy in RT (and thus improve energy security) relative to current market rules?
    - This question is addressed through analysis of ESI's *direct* effects on incentives to supply the desired outputs – in this case, inventoried energy that can back an energy option

New Slide

Incentives for Energy Inventory

Approach to Testing for Improvements in Energy Security

- While increasing incentives for the desired outputs, financial performance (e.g., net revenues) of particular resources may vary
  - Net revenue estimates account for how ESI impacts resource incentives to take actions to deliver energy in RT, but also consider broader changes to revenues stemming from actions taken by other resources and how this changes system dispatch and clearing prices for other market products (e.g., LMPs)
  - Changes in financial outcomes for particular resources (and resource types) does not directly inform whether energy security improvements for the system as whole are (cost-effectively) achieved

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Central Case – Incentives for Energy Inventory

ESI Incentives for Energy Inventory

Analysis of Incentives for Resources to Invest in Energy Inventory

- Among many objectives, the proposed ESI market rules are intended to improve generator incentives to secure energy inventory
- Our analysis compares the cost and benefits to individual resources that take steps to improve fuel security
  - We evaluate (1) inventory decisions by oil-fired resources and (2) forward LNG contracts by gas-only resources
  - Benefits reflect the direct incentives (revenues) created by ESI through *FER payments* and *DA energy options*
  - Costs reflect the costs of increases in energy inventory, such as contractual costs and holding costs

ESI Incentives for Energy Inventory

Analysis of Incentives for Resources to Invest in Energy Inventory

- Analysis considers two types of questions
- First, does ESI provide incremental incentives for more secure energy inventory compared to current market rules?
  - We find that ESI does create greater incentives for resources to procure incremental fuel as compared to current market rules
- Second, does ESI incent incremental action (i.e., additional fuel oil and forward LNG contracts) beyond energy inventories assumed under CMR?
  - We find that ESI does incent incremental actions, with certain exceptions
  - These exceptions reflect circumstances when incremental energy may provide relatively little benefit in terms of increased energy security or assumed level of incremental energy is too large to earn positive net returns

ESI Incentives for Energy Inventory

Direct Mechanisms by Which ESI Incents Action to Secure Energy Inventory

- Incremental energy inventory can earn additional FER payments by allowing resources to supplying additional energy
  - Incremental energy inventory may allow a resource to supply energy when it otherwise would not by relaxing a physical constraint on available energy inventory (e.g., incremental fuel oil inventory) or relaxing an economic constraint if energy inventory has lower opportunity costs (e.g., a forward LNG contract)
  - To the extent that incremental energy inventory allows a resource to supply incremental DA energy, the resource will earn incremental FER payments
- Incremental energy inventory lowers financial risk when offering DA energy options
  - Increases likelihood that DA energy options are awarded
  - Lowers cost (financial risk) when taking a DA energy option award
  - The incremental net revenues from lower financial risk are partially captured by the model

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Central Case – Incentives for Energy Inventory: Fuel Oil

Incremental Fuel Oil Incentives Relative to Current Market Rules

Direct Mechanisms by Which ESI Incents Action to Secure Energy Inventory

- The following tables quantify ESI incentives for oil-fired resources to hold incremental energy inventory
  - Tables quantify the direct incentives created by ESI to incent additional fuel inventory – these incentives are new to the market, incremental to incentives under current market rules
- Benefits quantified include:
  - "ESI FER Payments" – reflects all FER payments
  - "ESI DA Energy Option Revenue" – reflects risk premium component of all DA energy option awards
  - "Change in Holding Costs" – reflects difference in holding costs between CMR and ESI case; provided for context regarding the magnitude of costs of incremental fuel
    - Reminder: Fuel inventory levels differ between CMR and ESI
  - "Incremental Net Revenues" – sum of (1) FER Payments and (2) DA Energy Option Revenue net of (3) Change in Holding Costs

Incremental Fuel Oil Incentives Relative to Current Market Rules

Cost Effectiveness of Additional Fuel – Central Case, Frequent Stressed Conditions

Tank Size (Days of Fuel)	Number of Plants	Change In Holding Costs ($ / MW Capacity)	ESI FER Payments ($ / MW Capacity)	ESI DA Energy Option Revenue ($ / MW Capacity)	Change In Net Revenue ($ / MW Capacity)
0 - 1 Day	28	-$84.60	$667.82	$1,046.47	$1,629.68
1 - 3 Days	53	-$27.51	$3,338.42	$542.23	$3,853.15
3 - 7 Days	19	-$95.80	$9,722.26	$418.68	$10,045.15
7+ Days	24	-$1,744.04	$7,304.13	$756.58	$6,316.67

- Table shows net revenues, with plants grouped by tank size relative to plant capacity
- Compared to CMR, oil-fired resources have positive net incentives to maintain energy inventory
  - For all categories of plants, direct ESI incremental incentives (FER payments and DA energy options) exceed the additional fuel holding costs

Incremental Fuel Oil Incentives Relative to Current Market Rules

Cost Effectiveness of Additional Fuel – Central Case, Extended Stressed Conditions

Tank Size (Days of Fuel)	Number of Plants	Change In Holding Costs ($ / MW Capacity)	ESI FER Payments ($ / MW Capacity)	ESI DA Energy Option Revenue ($ / MW Capacity)	Change In Net Revenue ($ / MW Capacity)
0 - 1 Day	28	-$47.16	$314.29	$478.87	$746.00
1 - 3 Days	53	-$81.87	$1,136.65	$188.43	$1,243.21
3 - 7 Days	19	-$74.99	$3,168.92	$164.57	$3,258.49
7+ Days	24	-$2,264.14	$2,583.04	$172.50	$491.39

- Results are similar for the Extended Stressed Conditions Case

Incremental Fuel Oil Incentives Relative to Current Market Rules

Cost Effectiveness of Additional Fuel – Central Case, Infrequent Stressed Conditions

Tank Size (Days of Fuel)	Number of Plants	Change In Holding Costs ($ / MW Capacity)	ESI FER Payments ($ / MW Capacity)	ESI DA Energy Option Revenue ($ / MW Capacity)	Change In Net Revenue ($ / MW Capacity)
0 - 1 Day	28	-$47.16	$58.39	$8.63	$19.87
1 - 3 Days	53	-$79.45	$375.06	$11.23	$306.84
3 - 7 Days	19	-$56.81	$660.67	$25.92	$629.79
7+ Days	24	-$2,760.08	$369.60	$3.15	-$2,387.33

- In the Infrequent Stressed Conditions Case, all plants have increased incentives for energy inventory, except the plants with large tanks
  - For plants with large tanks, the additional holding costs of the assumed level of incremental fuel inventory exceeds the total ESI payments; result reflects specific assumptions about incremental fuel, which may not be optimal given expected plant utilization and other factors

Incremental Fuel Oil Incentives Relative to Current Market Rules

Are Incentives for Energy Inventory Greater than Current Market Rules?

- ESI unambiguously increases incentives for energy inventory
  - For any given level of energy inventory, ESI increases payments for holding energy inventory
    - FER payments
    - DA energy options (risk premium portion)
  - ESI provides incremental revenues in all cases, not only those with stressed conditions

Modified Slide

Incentives for Additional Energy Relative to Assumed Levels

Are ESI Incentives Sufficient to Incent Assumed Additional Energy Inventory?

- The prior analysis compared incentives for energy inventory with ESI relative to current market rules
  - Results show that ESI increases incentives for energy inventory
- Now, we analyze whether ESI provides incentives to increase energy inventory at the margin – that is, in excess of the specific levels of energy inventory assumed under CMR
  - This analysis is performed by comparing two cases with different assumptions about the quantity of energy inventory with ESI in place, and then comparing the incremental direct ESI revenues (from the added energy inventory) to the incremental cost of the added energy inventory – for example:

Change in FER Payments = FER Payments (ESI Fuel Assumptions) – FER Payments (CMR Fuel Assumptions)

    - Similar calculations are made for DA energy options (risk premiums) and fuel holding costs
  - This analysis provides a test of whether the incremental incentives from ESI are large or small relative to the incremental costs of the incremental fuel

Modified Slide

Incentives for Additional Energy Relative to Assumed Levels

Are ESI Incentives Sufficient to Incent Assumed Additional Energy Inventory?

- The following tables provide estimates of the components of the incremental revenues, costs and net revenues from the incremental energy inventory:
  - *Incremental* costs ("Change in Holding Costs") of additional energy inventory, based on end of season fuel oil holding costs
  - *Incremental* ESI revenues from additional energy inventory, including "Change in FER payments" and "Change in DA Energy Option Revenues" (risk premium portion only)
  - Results reflect comparison of two cases: one case assumes CMR fuel assumptions, while the other assumes ESI fuel assumptions
    - Under ESI, initial inventory based on Winter Program levels
    - Under CMR, initial inventory based on post-Winter Program levels with daily refill at 25% of ESI rate

Incentives for Additional Energy Relative to Assumed Levels

Are ESI Incentives Sufficient to Incent Assumed Additional Energy Inventory?

- Counterfactual tests may understate potential benefits
  - Each test assumes that *all* oil-fired resources have incremental fuel; this test does not reflect the marginal decision faced by each resource, in which the resource increases its energy inventory, but all other resources keep inventories fixed
  - This may reduce revenues for any given resource, as the counterfactual includes energy for all resources, which will tend to "compete" for FER payments and DA energy options

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ESI Incentives for Fuel Oil Inventory: Incremental Inventory Above Assumed Levels

Oil Unit Revenue Impacts – Central Case, Frequent Stressed Conditions

Tank Size (Days of Fuel)	Number of Plants	Change In Holding Costs ($ / MW Capacity)	Change In FER Payments ($ / MW Capacity)	Change In DA Energy Option Revenue ($ / MW Capacity)	Change In Net Revenue ($ / MW Capacity)
0 - 1 Day	28	-$69.54	$167.53	$182.13	$280.12
1 - 3 Days	53	-$39.78	$869.87	$52.98	$883.08
3 - 7 Days	19	-$122.34	$250.98	$82.89	$211.54
7+ Days	24	-$1,788.13	$626.79	$205.46	-$955.88

- At the margin (i.e., given assumed level of energy inventory in CMR), ESI creates positive incentives for incremental inventory relative to holding costs for all units, except those with the largest tanks
- Analysis does not account for changes in market prices (e.g., LMPs) caused by the incremental energy inventory; thus, in equilibrium, more or less energy inventory could be incented than the assumed level
  - Development of a model that solves for the equilibrium level of incremental energy inventory, conditional observable system conditions, is outside of project scope

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ESI Incentives for Fuel Oil Inventory: Incremental Inventory Above Assumed Levels

Oil Unit Revenue Impacts – Central Case, Extended Stressed Conditions

Tank Size (Days of Fuel)	Number of Plants	Change In Holding Costs ($ / MW Capacity)	Change In FER Payments ($ / MW Capacity)	Change In DA Energy Option Revenue ($ / MW Capacity)	Change In Net Revenue ($ / MW Capacity)
0 - 1 Day	28	-$47.16	$133.14	$309.90	$395.88
1 - 3 Days	53	-$78.45	$296.63	$88.40	$306.58
3 - 7 Days	19	-$92.03	$73.97	$34.61	$16.54
7+ Days	24	-$2,170.05	$127.04	$92.79	-$1,950.22

- Results similar to Frequent Stressed Conditions Case

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ESI Incentives for Fuel Oil Inventory: Incremental Inventory Above Assumed Levels

Oil Unit Revenue Impacts – Central Case, Infrequent Stressed Conditions

Tank Size (Days of Fuel)	Number of Plants	Change In Holding Costs ($ / MW Capacity)	Change In FER Payments ($ / MW Capacity)	Change In DA Energy Option Revenue ($ / MW Capacity)	Change In Net Revenue ($ / MW Capacity)
0 - 1 Day	28	-$47.16	$6.12	$0.10	-$8.80
1 - 3 Days	53	-$79.45	$31.10	$0.03	-$38.93
3 - 7 Days	19	-$56.81	-$1.07	$0.47	-$20.13
7+ Days	24	-$2,760.08	-$8.25	$0.04	-$1,942.14

ESI Incentives for Incremental Fuel Oil Inventory

Incentives for Resources with *Small to Medium Tank Sizes*

- For resources with small to medium tank sizes (relative to plant size):
  - Incentives for energy inventory are increased by ESI relative to current market rules
  - At the margin, resources earn positive returns to holding additional fuel when market conditions are constrained
    - Incremental revenues are negative when market conditions are less constrained (such as the Infrequent Stressed Conditions case), but smaller in magnitude than gains
  - Analysis does not undertake any optimization of fuel procurement strategy that might lower (holding) costs during less constrained winters and raise returns during more constrained winters
  - In sum, results demonstrate that there are positive incentives to holding incremental fuel inventory under ESI

Modified Slide

ESI Incentives for Incremental Fuel Oil Inventory

Incentives for Resources with *Large Tank Sizes*

- For resources with large tank sizes (relative to plant size)
  - Incentives for energy inventory are increased by ESI relative to current market rules
  - But, at the margin, resources with large tanks on average do not earn positive returns for holding additional incremental energy inventory, given assumed additional quantities of inventory
    - Does not suggest that some level of refueling would not earn positive returns, but that assumed level of refueling is too high for positive returns
    - More sophisticated (or lower magnitude) refueling logic might provide positive returns to increased energy inventory
    - There are declining marginal benefits to incremental inventory in terms of improved energy security for resources with large tanks
  - In sum, results demonstrate that there are positive incentives to holding incremental fuel inventory under ESI, but that marginal benefits may be lower for units with larger tanks that have more fuel already (compared to units with smaller tanks)

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Central Case – Incentives for Energy Inventory: Forward LNG Contract

Forward LNG Contract

Economics of Forward LNG Contract

- Forward LNG Contract
  - Bi-lateral contract between LNG terminal and market participant – no liquid market with price discovery
  - Willingness to reach agreement depends on the benefits and costs to each party
- Prior analysis (Chapter 2B)[1] identified multiple components affecting these benefits and costs:
  - LNG terminal costs (e.g., operational cost recovery)
  - Generator costs (e.g., credit, financial risk)
  - Market value of stored fuel (given anticipated price volatility)
  - Incremental ISO-NE revenues (e.g., given illiquidity in intraday NG market)

[1] https://www.iso-ne.com/static-assets/documents/2019/01/a2_analysis_group_calculation_of_rate_interim_compensation_treatment.pdf

Forward LNG Contract

Analysis of forward LNG Contract

- Our analysis is based on a specific forward contract, with 10 calls and strike price = $10 per MMBtu
  - Same contract assumed in Chapter 2B analysis
  - In practice, generators and terminals may enter into different contract structures, some of which may provide greater net benefits under ESI
- Analysis of ESI benefits for CC units reflects only FER payments
  - Model currently does not award GRC10 and GRC30 to individual CC units for their ramp capability; thus, our analysis may understate ESI revenues

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Modified Slide

ESI Incentives for Forward LNG Contract

Incremental ESI Revenues from FER Payments

Severity	FER Hours	FER Price [A]	FER MWh [B]	FER Payments ($) [A] = [B]*[C]	FER Payments ($/MW)
Frequent Stressed Conditions	240	$12.48	146,311	$1,825,941	$2,962
Extended Stressed Conditions	240	$8.88	146,311	$1,299,421	$2,108
Infrequent Stressed Conditions	0	NA	0	$0	$0

Note: [1] FER Hours is the number of incremental hours in which FER payments are awarded due to the forward LNG contract. The forward LNG contract assumes 10 call options for supply over a 24 hour day; thus, the forward contract supplies up to 240 hours of energy (10 calls x 24 hours/call = 240 hours).

- In Frequent and Stressed Conditions cases, all call options are exercised – price exceeds assumed (static) trigger threshold for exercising call options ($16 per MMBtu)
  - This trigger threshold is greater than the commodity price to avoid exercising calls when gains are small
- In Infrequent Stressed Conditions case, options are not exercised due to low NG prices
  - With more complex decision-making regarding when to exercise call options, contract would likely earn positive FER payments in some hours

Incremental Incentives Relative to Current Market Rules

Economics of Forward LNG Contract

- Our analysis shows that ESI will provide incremental incentives for gas-only plants to enter into a forward LNG contract relative to the incentives under current market rules
  - Incentives reflect both FER payments and DA energy option awards
  - FER payments increase the value of holding energy inventory by over $2,000 per MW in two of three cases
- The AG model captures some, but not all, of the potential gains to resources from incremental fuel inventory
  - Gains in the Infrequent Stressed Conditions Case could be higher with more sophisticated algorithms to exercise call options
  - Analysis captures gains from reduction in financial risk when NG price exceeds LNG price, but not when prices are low (NG price less than LNG price)
  - Analysis does not capture more general benefits of operational performance available to a contract holder, given illiquidity of intraday NG markets

Incentives for Additional Energy Relative to Assumed Levels

Costs (and Benefits) of Forward LNG Contract

- Under current market rules, there may be a gap between prices a generator and LNG terminal are willing to accept for a forward LNG contract
- Incremental ESI revenues may close whatever gap there is between an LNG terminal and generator to reaching agreement
  - Actual values will vary across plants and companies (given portfolio effects, risk preferences, etc.)
- Extent to which ESI incentivizes additional forward LNG contracting depends on the size of the gap between generator willingness to pay and LNG terminal willingness to sell
  - This gap is largely unobservable; our analysis aims to quantity the gap, recognizing heterogeneity in value of forward LNG contract among market participants

Incentives for Additional Energy Relative to Assumed Levels

Costs (and Benefits) of Forward LNG Contract

- Prior analysis found, for the assumed forward contract:
  - LNG terminal and generator costs are approximately $4,626 per MW
  - Incremental ISO-NE revenues are approximately $1,921 per MW
    - These incremental revenues are not fully accounted for given the nature of our production cost analysis
    - Our estimates reflect expected costs across multiple scenarios, and thus are not directly comparable to the case-specific results
  - Based on this analysis, gap in revenues is: $2,705 per MW
- Value of stored fuel will vary with market conditions
  - Forward LNG contract price terms (reservation prices) will vary with the NG market equilibrium, with prices increasing under tighter market conditions
  - ESI may shift the market equilibrium relative to CMR, but compensating changes in key elements of the underlying forward LNG contract would be expected

Incentives for Additional Energy Relative to Assumed Levels

Net Effect of ESI on Forward LNG Contract Incentives

- ESI introduces incremental incentives for energy inventory
  - Chapter 2B estimate of gap ($2,705 per MW) aimed to ensure program participation; in practice, gap may be lower for some resources
- Incremental ESI revenues fully exceeds gap with Frequent Stressed Conditions ($2,962 per MW) and most of the gap with Extended Stressed Conditions ($2,108 per MW)
- These results suggest that ESI would provide meaningful incentives to help close any gap between generators and LNG terminals to signing LNG contract

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Central Case – Production Costs

New Slide

Production Costs

Factors that May Affect Production Costs

- Analysis of production costs provides a means of assessing changes in economic efficiency
  - ESI introduces new products that may enhance efficiency, while also requiring the procurement of new reliability services, with associated costs
  - Thus, production cost changes may reflect the offsetting effects of enhancements to efficiency (which reduce costs) and new requirements/services (which increase costs)
- Analysis will quantity some elements of changes in production costs, but not all elements
  - In particular, analysis does not account for changes in certain markets outcomes, particularly changes in natural gas prices (costs) due to increased energy inventory
  - Thus, analysis may not fully capture all production cost changes, including the "misalignment problem" identified in the ISO-NE discussion paper

Production Costs

Model Production Costs and Fuel Holding Costs Quantified

- We quantity two aspects of production costs.
- First, we quantity the marginal costs of meeting energy market requirements, including load, operating reserves and DA energy options
  - Marginal costs include fuel and variable operations and maintenance (O&M) costs
  - Marginal costs are quantified within the production cost model, AG-EMM (Energy Market Model)
- Second, we quantity the incremental holding costs between cases
  - Holding costs reflect the opportunity cost of holding fuel in storage
  - Fuel oil holding costs reflect financial opportunity costs, price risk and liquidity constraints
  - LNG holding costs reflect financial opportunity costs and operational storage costs
- Other factors not quantified by the analysis are being assesses qualitatively

Production Costs

Production Costs, with and without ESI, Central Cases
All Oil-Fired Resources Store Incremental Fuel

	Total Model Production Costs[1] ($ Million)			Incremental Energy Inventory Costs[2] ($ Million)	Change in Total Production Costs ($ Million)
Scenario Name/Acronym	CMR	ESI	Change	ESI	
Frequent Stressed Conditions	$1,550.9	$1,513.5	($37.3)	$9.1	($28.3)
Extended Stressed Conditions	$995.6	$972.8	($22.9)	$11.8	($11.1)
Infrequent Stressed Conditions	$677.6	$677.0	($0.6)	$15.8	$15.2

Notes:
[1] Production Costs only do not include opportunity costs.
[2] Incremental energy inventory costs include LNG and oil holding costs for incremental fuel at the end of winter.

- Assumes energy inventory costs for all resources
- Production costs lower in 2 of 3 cases despite increased DA energy market requirements

Production Costs

Production Costs, with and without ESI, Central Cases
Large Oil-Fired Resources Do Not Store Incremental Fuel

	Total Model Production Costs[1] ($ Million)			Incremental Energy Inventory Costs[2] ($ Million)	Change in Total Production Costs ($ Million)
Scenario Name/Acronym	CMR	ESI	Change	ESI	
Frequent Stressed Conditions	$1,550.9	$1,513.5	($37.3)	$1.1	($36.2)
Extended Stressed Conditions	$995.6	$972.8	($22.9)	$1.0	($21.8)
Infrequent Stressed Conditions	$677.6	$677.0	($0.6)	$2.3	$1.7

Notes:
[1] Production Costs only do not include opportunity costs.
[2] Incremental energy inventory costs include LNG and oil holding costs for incremental fuel at the end of winter.

- Assumes energy inventory costs for all resources except resources with large fuel tanks (12 largest resources in terms of tank size, measured by days of fuel)
  - Assume these resources to not store fuel (or store less fuel) given incentives analysis
  - Likely does not meaningfully affect production costs
- Production costs lower in 2 of 3 cases, but limited losses in Infrequent Constraints Case – suggests that with more refined refueling assumptions, gains would be larger

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Preliminary Scenario Analysis Results

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Scenarios Presented

Scenario Name	Scenario Description
Central Case	"Central Case" Current Market Rules (CMR) and Energy Security Improvements (ESI) assumptions, updated but largely as presented at July 30 Markets Committee Meeting. - RER Requirement updated to 1,200 MW; Refinement of Risk Premium methodology.
ESI Products - RER Plus	"Central Case", plus an additional 50% hourly RER requirement (1,800 MW total).
ESI Products - No EIR/RER	"Central Case", without EIR or RER products.
Supply Shocks	Unexpected real-time outages, experienced during coldest portion of historic base winter.
Shock HQ 1 Day	Shock of 1,364 MW is modeled in real-time market, but not expected in day-ahead market. - High Severity: Based on January 3, 2014 (average temp 11.64 °F); - Medium Severity: Based on January 1, 2018 (average temp 2.72 °F); - Low Severity: Based on December 16, 2016 (average temp 4.77 °F).
Shock HQ 5 Days	Shock of 1,364 MW is modeled Day 1 in real-time market, but not expected in Day 1 day-ahead market. Resource is expected out day-ahead in remaining days (Days 2-5). - High Severity: Based on January 21-25, 2014 (average temp 12.83 °F); - Medium Severity: Based on December 28, 2017 - January 1, 2018 (average temp 5.68 °F); - Low Severity: Based on January 6-10, 2017 (average temp 19.07 °F).
High Load	Load is increased by 5%, with no other modeling changes.
DA Load Adjusted for EIR (50%)	Day-ahead cleared load and EIR requirement adjusted such that EIR requirement is zero in 50% of hours. The load adjustment is the fixed quantity needed to shift up DA supply such that the EIR requirement is zero in 50% of the hours.
Resource Mix - Oil Retirements	Changes in retirements and replacements to future-year resource mix. For all scenarios: - ~1,500 MW at-risk resources and an additional ~1,000 MW of oil resources retired.
Renewable Replacement	3,824 MW nameplate (1,300 MW derated) of new offshore wind added; 1,200 MW of new hydro imports added.
Gas Replacement	2,500 MW of new natural gas CC resources added, none with dual-fuel capability.
Gas / Dual Fuel Replacement	2,500 MW of new natural gas CC resources added, 50% with dual-fuel capability.
High LNG Supply	Assume additional LNG availability of 0.4 Bcf/day to both ESI and CMR cases (all winter severities). Under ESI, assume an incremental 0.4 Bcf/day available for LNG forward contracts, for a total of 0.52 Bcf/day available for forward contracts.
Strike x 1.2	Strike Price increased to 120% of "Central Case" Value

Scenarios Presented

Set of Scenarios Presented Today

- The scenarios evaluated seeks to be responsive to the set of stakeholder requests we have received to date
- To the extent possible, additional scenarios requested by stakeholders will be evaluated in future analysis
- Assumptions regarding how ESI impacts oil and LNG arrangements remain unchanged in scenario analysis unless explicitly stated otherwise
- Results are preliminary, and we continue to evaluate results to develop more insight into expected ESI impacts

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Scenarios - Summary Results

Frequent Stressed Conditions

Summary of Modeled ESI Impacts by Scenario

	Prices ($/MWh)			Customer Payment ($ Million)		
Scenario Name/Acronym	Change in DA LMP (ESI - CMR)	Average FER Price	Average Option Price (GCR, RER)	Change in Energy and Ancillary Services (+ FER in ESI) (ESI - CMR)	Energy Options (DA Cost net of RT Settlement)	Change in Total Customer Payments
Frequent Stressed Conditions - Central Case						
Central Case	($6.31)	$10.38	$22.10	$119	$11	$131
Frequent Stressed Conditions - August Scenarios						
ESI Products - RER Plus	($6.15)	$10.46	$22.05	$127	$13	$140
ESI Products - No EIR/RER	($7.21)	NA	$22.28	($235)	$9	($227)
Shock HQ 1 Day	($6.44)	$10.39	$22.10	$115	$11	$126
Shock HQ 5 Days	($30.32)	$10.42	$22.39	($633)	$13	($619)
High Load	($10.83)	$10.46	$22.34	($33)	$13	($20)
DA Load Adjusted for EIR (50%)	($4.86)	$10.70	$21.99	$160	$10	$170
Oil Retirements; Renewable Replacement	($2.39)	$9.95	$21.27	$233	$3	$236
Oil Retirements; Gas Replacement	($10.74)	$10.42	$22.92	($41)	$17	($24)
Oil Retirements; Gas / Dual Fuel Replacement	($15.35)	$10.41	$22.61	($175)	$15	($161)
High LNG Supply	($6.30)	$10.31	$22.08	$113	$11	$123
Frequent Stressed Conditions - September Scenarios						
Strike x 1.2	($6.86)	$6.03	$12.88	($35)	$4	($30)

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Scenarios - Summary Results

Extended Stressed Conditions

Summary of Modeled ESI Impacts by Scenario

Scenario Name/Acronym	Prices ($/MWh)			Customer Payment ($ Million)		
	Change in DA LMP (ESI - CMR)	Average FER Price	Average Option Price (GCR, RER)	Change in Energy and Ancillary Services (+ FER in ESI) (ESI - CMR)	Energy Options (DA Cost net of RT Settlement)	Change in Total Customer Payments
Extended Stressed Conditions - Central Case						
Central Case	($10.80)	$6.48	$13.29	($141)	$16	($125)
Extended Stressed Conditions - August Scenarios						
ESI Products - RER Plus	($10.75)	$6.50	$13.36	($139)	$19	($120)
ESI Products - No EIR/RER	($11.34)	NA	$12.95	($361)	$8	($353)
Shock HQ 1 Day	($13.21)	$6.49	$13.31	($219)	$16	($203)
Shock HQ 5 Days	($13.21)	$6.49	$13.31	($219)	$16	($203)
High Load	($27.44)	$6.51	$13.56	($690)	$18	($672)
DA Load Adjusted for EIR (50%)	($8.52)	$5.90	$13.24	($89)	$15	($74)
Oil Retirements; Renewable Replacement	($2.23)	$6.11	$12.67	$120	$10	$130
Oil Retirements; Gas Replacement	($85.83)	$6.48	$13.79	($2,445)	$19	($2,426)
Oil Retirements; Gas / Dual Fuel Replacement	($58.54)	$6.47	$13.61	($1,634)	$18	($1,617)
High LNG Supply	($8.75)	$6.28	$13.01	($82)	$13	($69)
Extended Stressed Conditions - September Scenarios						
Strike x 1.2	($10.94)	$3.70	$7.69	($233)	$8	($225)

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Scenarios - Summary Results

Infrequent Stressed Conditions

Summary of Modeled ESI Impacts by Scenario

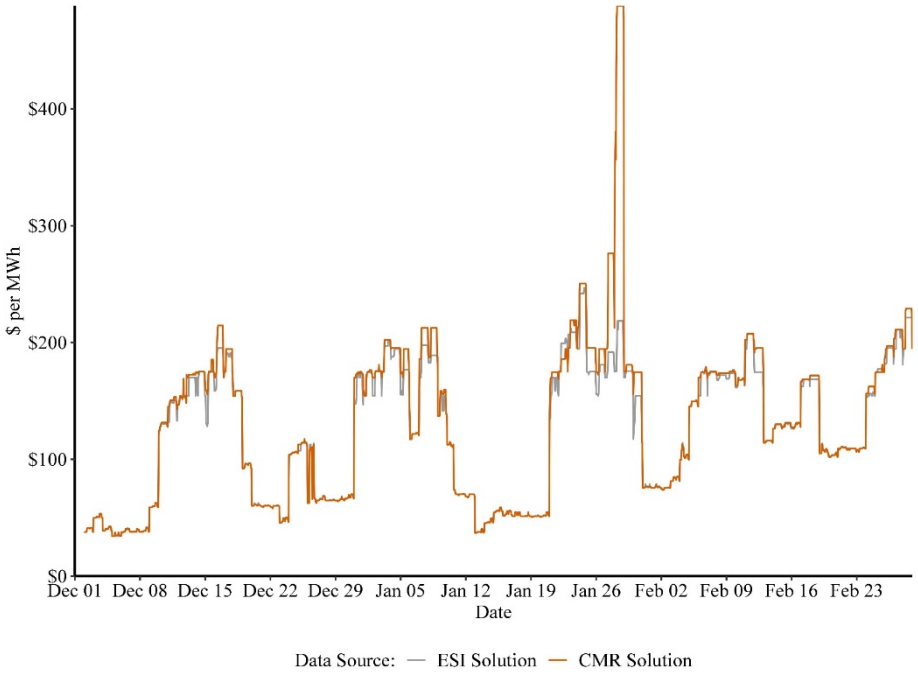
	Prices ($/MWh)			Customer Payment ($ Million)		
Scenario Name/Acronym	Change in DA LMP (ESI - CMR)	Average FER Price	Average Option Price (GCR, RER)	Change in Energy and Ancillary Services (+ FER in ESI) (ESI - CMR)	Energy Options (DA Cost net of RT Settlement)	Change in Total Customer Payments
Infrequent Stressed Conditions - Central Case						
Central Case	($0.14)	$3.65	$7.30	$108	$23	$130
Infrequent Stressed Conditions - August Scenarios						
ESI Products - RER Plus	($0.13)	$3.65	$7.29	$108	$26	$135
ESI Products - No EIR/RER	($0.17)	NA	$7.34	($5)	$15	$10
Shock HQ 1 Day	($0.13)	$3.65	$7.30	$108	$23	$131
Shock HQ 5 Days	($0.18)	$3.65	$7.31	$106	$23	$129
High Load	($0.28)	$3.66	$7.32	$108	$23	$131
DA Load Adjusted for EIR (50%)	($0.01)	$3.22	$7.29	$95	$22	$117
Oil Retirements; Renewable Replacement	$0.04	$3.63	$7.24	$113	$22	$135
Oil Retirements; Gas Replacement	($0.26)	$3.63	$7.26	$103	$23	$126
Oil Retirements; Gas / Dual Fuel Replacement	($0.11)	$3.63	$7.26	$108	$23	$130
High LNG Supply	$0.05	$3.65	$7.30	$114	$23	$136
Infrequent Stressed Conditions - September Scenarios						
Strike x 1.2	($0.16)	$1.99	$4.23	$56	$15	$71

Scenarios - Prices

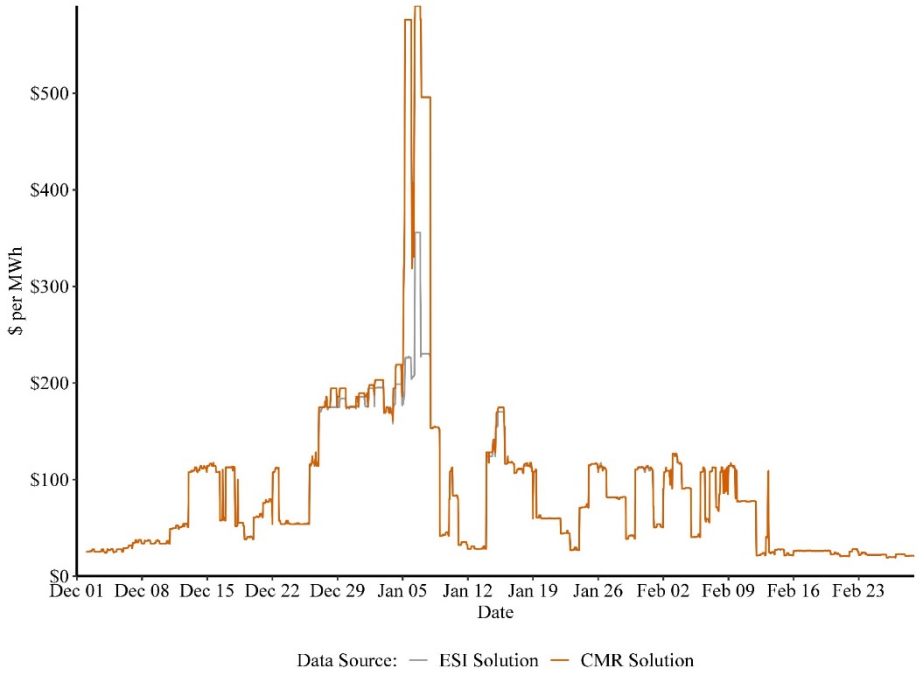
DA LMPs – 120% Strike Price

DA LMPs, 120% Strike Price, CMR vs ESI ($ per MWh)

Frequent Stressed Conditions



Extended Stressed Conditions



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Modified Slide

Scenarios – Total Payments

120% Strike Price

Total Payments, 120% Strike Price, CMR vs ESI ($ per MWh)

		Frequent Stressed Conditions			Extended Stressed Conditions			Infrequent Stressed Conditions		
		Payments ($Million)			Payments ($Million)			Payments ($Million)		
Product / Payment		**CMR**	**ESI**	**Difference**	**CMR**	**ESI**	**Difference**	**CMR**	**ESI**	**Difference**
Energy and RT Operating Reserves	[A]	$4,427	$4,203	-$224 (-5.1%)	$3,128	$2,779	-$349 (-11.2%)	$1,821	$1,816	-$5 (-0.3%)
DA Energy Option										
DA Option Payment			$111			$66			$36	
EIR			$13			$6			$3	
RER			$31			$20			$11	
GCR10			$46			$29			$15	
GCR30			$21			$11			$7	
RT Option Settlement			-$107			-$58			-$21	
Net DA Ancillary	[B]		$4			$8			$15	
FER Payments	[C]		$190			$116			$61	
Total Payments	[A+B+C]	$4,427	$4,397	-$30 (-0.7%)	$3,128	$2,903	-$225 (-7.2%)	$1,821	$1,892	$71 (3.9%)

Modified Slide

Scenarios – Total Payments

120% Strike Price

- Analysis of 120% Strike Price Scenario does not capture all expected market changes – for example:
  - The scenario assumes the same level of energy inventory as the Central Case, although the increase in DA energy option strike price could affect the additional levels of energy inventory incented by ESI; estimating such effects is outside the scope of the current analysis
    - Such changes in energy inventory could affect economic outcomes, for example, increasing LMPs if there were a reduction in inventoried energy
  - The scenario assumes that FER payments occur with the same frequency
    - As discussed previously, LSEs have an incentive to lower the frequency of FER payments and can do so by increasing demand offers in DA markets
    - The incentive to reduce the frequency of FER payments decreases when the FER price is lower (all else equal)
    - Thus, reducing the FER price would be expected to increase the frequency of FER payments and thus increase total payments (all else equal); estimating such effects is outside the scope of the current analysis

Operational / Reliability Impacts

Impacts Vary Across Scenarios

- Reliability impacts vary across scenarios in terms of the level of impact, and the impact of ESI (relative to CMR)
  - Impacts are greatest in the Frequent Stressed Conditions Case, although impacts are observed in all cases, including the Infrequent Stressed Conditions Case

- For scenario with higher DA energy option strike price (i.e., “Strike x 1.2”):
  - Our analysis shows limited changes in reliability impacts compared to the Central Case
  - However, our analysis does not quantify the change incentives to secure energy inventory due to the lower risk associated with a DA energy option with a higher strike price
  - Such changes in energy inventory would be expected to affect reliability outcomes, but these are not captured in our analysis

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Operational / Reliability Metrics

Multiple Metrics to Capture Different Aspects of Energy Security

Change in Reliability Metric with ESI compared to CMR
Frequent Stressed Conditions

Scenario Name/Acronym	Operating Reserve Shortages (Hours)	NG Physically Binding (Hours)	Uncovered NG Peakers: NG Physically or Economically Binding (Hours)	Natural Gas Used in Generation When NG Economically Binding (MMBtu)	Daily Available Oil Generation Minimum (MWh)
Frequent Stressed Conditions - Central Case					
Central Case	0	(43)	(72)	(2,690,653)	31,134
Frequent Stressed Conditions - August Scenarios					
ESI Products - RER Plus	0	(37)	(68)	(2,687,268)	31,134
ESI Products - No EIR/RER	0	(37)	(64)	(2,613,230)	31,134
Shock HQ 1 Day	0	(42)	(64)	(2,675,548)	30,759
Shock HQ 5 Days	0	(58)	(94)	(2,831,887)	31,681
High Load	0	(52)	(69)	(2,712,209)	36,795
DA Load Adjusted for EIR (50%)	0	(42)	(77)	(2,912,293)	28,018
Oil Retirements; Renewable Replacement	0	(4)	(6)	(773,310)	13,666
Oil Retirements; Gas Replacement	0	(42)	(39)	(2,181,279)	17,853
Oil Retirements; Gas / Dual Fuel Replacement	0	(67)	(54)	(3,110,186)	23,938
High LNG Supply	0	(17)	(24)	(5,346,168)	17,294
Frequent Stressed Conditions - September Scenarios					
Strike x 1.2	0	(42)	(72)	(2,749,095)	30,918

Operational / Reliability Metrics

Multiple Metrics to Capture Different Aspects of Energy Security

Change in Reliability Metric with ESI compared to CMR, Extended Stressed Conditions

Scenario Name/Acronym	Operating Reserve Shortages (Hours)	NG Physically Binding (Hours)	Uncovered NG Peakers: NG Physically or Economically Binding (Hours)	Natural Gas Used in Generation When NG Economically Binding (MMBtu)	Daily Available Oil Generation Minimum (MWh)
Extended Stressed Conditions - Central Case					
Central Case	0	16	14	(827,322)	34,594
Extended Stressed Conditions - August Scenarios					
ESI Products - RER Plus	0	15	13	(827,322)	34,594
ESI Products - No EIR/RER	0	16	14	(827,322)	34,594
Shock HQ 1 Day	0	12	9	(790,125)	38,633
Shock HQ 5 Days	0	12	9	(790,125)	38,633
High Load	0	8	(8)	(827,409)	33,796
DA Load Adjusted for EIR (50%)	0	11	8	(844,477)	33,606
Oil Retirements; Renewable Replacement	0	(16)	2	(483,505)	13,741
Oil Retirements; Gas Replacement	0	(4)	(30)	(1,132,786)	19,539
Oil Retirements; Gas / Dual Fuel Replacement	0	5	(23)	(1,000,221)	17,715
High LNG Supply	0	(20)	(8)	(3,279,617)	32,101
Extended Stressed Conditions - September Scenarios					
Strike x 1.2	0	16	13	(827,322)	34,594

Operational / Reliability Metrics

Multiple Metrics to Capture Different Aspects of Energy Security

Change in Reliability Metric with ESI compared to CMR
Infrequent Stressed Conditions

Scenario Name/Acronym	Operating Reserve Shortages (Hours)	NG Physically Binding (Hours)	Uncovered NG Peakers: NG Physically or Economically Binding (Hours)	Natural Gas Used in Generation When NG Economically Binding (MMBtu)	Daily Available Oil Generation Minimum (MWh)
Infrequent Stressed Conditions - Central Case					
Central Case	0	(4)	(4)	0	5,651
Infrequent Stressed Conditions - August Scenarios					
ESI Products - RER Plus	0	(4)	(4)	0	5,651
ESI Products - No EIR/RER	0	(4)	(4)	0	5,651
Shock HQ 1 Day	0	(4)	(4)	0	6,071
Shock HQ 5 Days	0	(10)	(10)	0	7,695
High Load	0	0	0	0	9,905
DA Load Adjusted for EIR (50%)	0	(4)	(4)	0	5,651
Oil Retirements; Renewable Replacement	0	3	3	0	10,083
Oil Retirements; Gas Replacement	0	(4)	(4)	0	6,566
Oil Retirements; Gas / Dual Fuel Replacement	0	0	0	0	6,795
High LNG Supply	0	11	11	0	13,078
Infrequent Stressed Conditions - September Scenarios					
Strike x 1.2	0	(4)	(4)	0	5,651

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Appendix

RER Price Upper Bound

Maximum single-hour RER price in Central Cases

Maximum RER Price, Central Cases ($ per MWh)

Scenario Name	Maxmimum RER Price
Central Case - Frequent Stressed Conditions	$69.75
Central Case - Extended Stressed Conditions	$67.90
Central Case - Infrequent Stressed Conditions	$41.21

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Operational / Reliability Metrics

Reliability Metrics, with ESI, Frequent Stressed Conditions Case

Scenario Name/Acronym	Operating Reserve Shortages (Hours)	NG Physically Binding (Hours)	Uncovered NG Peakers: NG Physically or Economically Binding (Hours)	Natural Gas Used in Generation When NG Economically Binding (MMBtu)	Daily Available Oil Generation Minimum (MWh)
Frequent Stressed Conditions - Central Case					
Central Case	0	192	217	7,797,048	208,975
Frequent Stressed Conditions - August Scenarios					
ESI Products - RER Plus	0	198	221	7,800,433	208,975
ESI Products - No EIR/RER	0	198	225	7,874,471	208,975
Shock HQ 1 Day	0	210	239	7,906,929	208,738
Shock HQ 5 Days	0	197	231	7,968,763	209,381
High Load	0	290	340	10,894,746	207,071
DA Load Adjusted for EIR (50%)	0	191	209	7,323,898	208,277
Oil Retirements; Renewable Replacement	0	61	67	1,939,247	200,843
Oil Retirements; Gas Replacement	0	302	387	11,933,919	184,565
Oil Retirements; Gas / Dual Fuel Replacement	0	254	330	8,925,308	191,180
High LNG Supply	0	34	49	6,285,779	206,959
Frequent Stressed Conditions - September Scenarios					
Strike x 1.2	0	193	217	7,738,606	208,758

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Operational / Reliability Metrics

Reliability Metrics, with CMR, Frequent Stressed Conditions Case

Scenario Name/Acronym	Operating Reserve Shortages (Hours)	NG Physically Binding (Hours)	Uncovered NG Peakers: NG Physically or Economically Binding (Hours)	Natural Gas Used in Generation When NG Economically Binding (MMBtu)	Daily Available Oil Generation Minimum (MWh)
Frequent Stressed Conditions - Central Case					
Central Case	0	235	289	10,487,701	177,840
Frequent Stressed Conditions - August Scenarios					
ESI Products - RER Plus	0	235	289	10,487,701	177,840
ESI Products - No EIR/RER	0	235	289	10,487,701	177,840
Shock HQ 1 Day	0	252	303	10,582,477	177,979
Shock HQ 5 Days	0	255	325	10,800,650	177,701
High Load	0	342	409	13,606,955	170,276
DA Load Adjusted for EIR (50%)	0	233	286	10,236,192	180,259
Oil Retirements; Renewable Replacement	0	65	73	2,712,557	187,177
Oil Retirements; Gas Replacement	0	344	426	14,115,198	166,712
Oil Retirements; Gas / Dual Fuel Replacement	0	321	384	12,035,494	167,242
High LNG Supply	0	51	73	11,631,947	189,665
Frequent Stressed Conditions - September Scenarios					
Strike x 1.2	0	235	289	10,487,701	177,840

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Operational / Reliability Metrics

Reliability Metrics, with ESI, Extended Stressed Conditions Case

Scenario Name/Acronym	Operating Reserve Shortages (Hours)	NG Physically Binding (Hours)	Uncovered NG Peakers: NG Physically or Economically Binding (Hours)	Natural Gas Used in Generation When NG Economically Binding (MMBtu)	Daily Available Oil Generation Minimum (MWh)
Extended Stressed Conditions - Central Case					
Central Case	0	485	424	1,681,552	226,665
Extended Stressed Conditions - August Scenarios					
ESI Products - RER Plus	0	484	423	1,681,552	226,665
ESI Products - No EIR/RER	0	485	424	1,681,552	226,665
Shock HQ 1 Day	0	477	404	1,732,942	225,164
Shock HQ 5 Days	0	477	404	1,732,942	225,164
High Load	0	553	477	1,982,209	224,621
DA Load Adjusted for EIR (50%)	0	478	421	1,670,860	224,835
Oil Retirements; Renewable Replacement	0	112	122	388,425	209,535
Oil Retirements; Gas Replacement	0	538	450	1,881,246	185,003
Oil Retirements; Gas / Dual Fuel Replacement	0	548	469	1,829,587	190,964
High LNG Supply	0	163	153	999,832	235,040
Extended Stressed Conditions - September Scenarios					
Strike x 1.2	0	485	423	1,681,552	226,665

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Operational / Reliability Metrics

Reliability Metrics, with CMR, Extended Stressed Conditions Case

Scenario Name/Acronym	Operating Reserve Shortages (Hours)	NG Physically Binding (Hours)	Uncovered NG Peakers: NG Physically or Economically Binding (Hours)	Natural Gas Used in Generation When NG Economically Binding (MMBtu)	Daily Available Oil Generation Minimum (MWh)
Extended Stressed Conditions - Central Case					
Central Case	0	469	410	2,508,874	192,071
Extended Stressed Conditions - August Scenarios					
ESI Products - RER Plus	0	469	410	2,508,874	192,071
ESI Products - No EIR/RER	0	469	410	2,508,874	192,071
Shock HQ 1 Day	0	465	395	2,523,067	186,531
Shock HQ 5 Days	0	465	395	2,523,067	186,531
High Load	0	545	485	2,809,618	190,825
DA Load Adjusted for EIR (50%)	0	467	413	2,515,336	191,229
Oil Retirements; Renewable Replacement	0	128	120	871,929	195,794
Oil Retirements; Gas Replacement	0	542	480	3,014,031	165,464
Oil Retirements; Gas / Dual Fuel Replacement	0	543	492	2,829,808	173,250
High LNG Supply	0	183	161	4,279,449	202,940
Extended Stressed Conditions - September Scenarios					
Strike x 1.2	0	469	410	2,508,874	192,071

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Operational / Reliability Metrics

Reliability Metrics, with ESI, Infrequent Stressed Conditions Case

Scenario Name/Acronym	Operating Reserve Shortages (Hours)	NG Physically Binding (Hours)	Uncovered NG Peakers: NG Physically or Economically Binding (Hours)	Natural Gas Used in Generation When NG Economically Binding (MMBtu)	Daily Available Oil Generation Minimum (MWh)
Infrequent Stressed Conditions - Central Case					
Central Case	0	350	350	0	247,147
Infrequent Stressed Conditions - August Scenarios					
ESI Products - RER Plus	0	350	350	0	247,147
ESI Products - No EIR/RER	0	350	350	0	247,147
Shock HQ 1 Day	0	350	350	0	246,622
Shock HQ 5 Days	0	357	357	0	244,897
High Load	0	425	425	0	244,124
DA Load Adjusted for EIR (50%)	0	350	350	0	247,147
Oil Retirements; Renewable Replacement	0	134	134	0	219,275
Oil Retirements; Gas Replacement	0	385	385	0	207,469
Oil Retirements; Gas / Dual Fuel Replacement	0	393	393	0	215,117
High LNG Supply	0	166	166	0	258,149
Infrequent Stressed Conditions - September Scenarios					
Strike x 1.2	0	350	350	0	247,147

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Operational / Reliability Metrics

Reliability Metrics, with CMR, Infrequent Stressed Conditions Case

Scenario Name/Acronym	Operating Reserve Shortages (Hours)	NG Physically Binding (Hours)	Uncovered NG Peakers: NG Physically or Economically Binding (Hours)	Natural Gas Used in Generation When NG Economically Binding (MMBtu)	Daily Available Oil Generation Minimum (MWh)
Infrequent Stressed Conditions - Central Case					
Central Case	0	354	354	0	241,496
Infrequent Stressed Conditions - August Scenarios					
ESI Products - RER Plus	0	354	354	0	241,496
ESI Products - No EIR/RER	0	354	354	0	241,496
Shock HQ 1 Day	0	354	354	0	240,550
Shock HQ 5 Days	0	367	367	0	237,202
High Load	0	425	425	0	234,220
DA Load Adjusted for EIR (50%)	0	354	354	0	241,496
Oil Retirements; Renewable Replacement	0	131	131	0	209,192
Oil Retirements; Gas Replacement	0	389	389	0	200,903
Oil Retirements; Gas / Dual Fuel Replacement	0	393	393	0	208,322
High LNG Supply	0	155	155	0	245,071
Infrequent Stressed Conditions - September Scenarios					
Strike x 1.2	0	354	354	0	241,496

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Discussed at 9/4/2019
NEPOOL MC Meeting

Central Case Overview

Discussed at 9/4/2019 NEPOOL MC Meeting

ESI Impacts

Fundamentals of Impact Approach

- Impacts are measured as the difference between two cases:
  - ***Current Market Rules ("CMR") Case***, reflecting current market rules and market responses
  - ***ESI Case***, reflecting ESI proposed rules and expected market responses
- Analysis will consider different levels of stressed conditions in a future winter, 2025/26:
  - ***Frequent Stressed Conditions*** based on 2013/2014
    - Multiple, shorter periods with fuel system constraints (e.g., multiple, shorter cold-snaps)
  - ***Extended Stressed Conditions*** based on 2017/2018
    - One extended period with fuel system constraints (e.g., one extended cold-snap)
  - ***Infrequent Stressed Conditions*** based on 2016/2017
- Results are *preliminary,* but provide reasonable estimates of impacts for the cases evaluated

Discussed at 9/4/2019 NEPOOL MC Meeting

Central Case

Underlying Assumptions

- Current fleet (FCA 13 resources, with all approved retirements through FCA 13)
  - Mystic 8 and 9 out
- DOMAC out
  - Repsol in operation, with full supply available on all days to electricity suppliers
  - Under ESI, forward LNG contracts (~610 MW) for capacity not contracted by LDCs to meet design day requirements
- Fuel oil: initial inventory and refilling
  - Under ESI, initial inventory based on Winter Program levels
  - Under CMR, initial inventory based on post-Winter Program levels with daily refill at 25% of ESI rate

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Central Case

Total Customer Payments

Total Payments by Case ($ Million)

		Frequent Stressed Conditions			Extended Stressed Conditions			Infrequent Stressed Conditions		
		Payments ($Million)			Payments ($Million)			Payments ($Million)		
Product / Payment		**CMR**	**ESI**	**Difference**	**CMR**	**ESI**	**Difference**	**CMR**	**ESI**	**Difference**
Energy and RT Operating Reserves	[A]	$4,427	$4,220	-$207 (-4.7%)	$3,128	$2,784	-$344 (-11.0%)	$1,821	$1,816	-$4 (-0.2%)
DA Energy Option										
DA Option Payment			$191			$114			$63	
EIR			$23			$11			$6	
RER			$54			$35			$18	
GCR10			$79			$50			$26	
GCR30			$36			$19			$12	
RT Option Settlement			-$180			-$98			-$40	
Net DA Ancillary	[B]		$11			$16			$23	
FER Payments	[C]		$327			$203			$112	
Total Payments	[A+B+C]	$4,427	$4,558	$131 (3.0%)	$3,128	$3,003	-$125 (-4.0%)	$1,821	$1,951	$130 (7.2%)

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Discussed at 9/4/2019
NEPOOL MC Meeting

Central Case – Net Revenues to Generators

Discussed at 9/4/2019 NEPOOL MC Meeting

Net Revenues

Impact on Energy Market Net Revenues Reflects Multiple Factors

- The proposed ESI market rules will impact net revenues earned by generators in the New England energy markets
  - Changes to net revenues may impact offers and clearing prices in the Forward Capacity Market; such impacts are not quantified in our analysis
- Estimated impacts vary:
  - *Across resource types*, depending on each resource's energy and DA energy option offers (relative to other resources), quantity of energy inventory, fuel flexibility, etc.
  - *Across cases,* depending on market conditions in each case
- Some caution should be exercised in over-interpretation of results as they reflect specific cases and the model may not fully capture all factors affecting plant-level economics

Discussed at 9/4/2019 NEPOOL MC Meeting

Net Revenues

Impact on Energy Market Net Revenues Reflects Multiple Factors

- Changes in net revenue are quantified within the production cost model, AG-EMM (Energy Market Model), reflecting multiple factors:
  - Changes in payments for energy, including changes in LMPs and FER payments
  - Changes in quantity of energy sold
  - Award and settlement of DA energy options
  - Changes in energy inventory costs

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Net Revenues

Discussed at 9/4/2019 NEPOOL MC Meeting

Average Net Revenues by Resource Type, Winter Season, Frequent Stressed Conditions ($ per MW)

	Net Revenue ($/MW)			
Resource Type:	**CMR [A]**	**ESI [B]**	**Change [C] = [B] - [A]**	**Percent Change [D] = [C]/[A]**
Dual Fuel - CC	$43,656	$50,142	$6,486	14.86%
Dual Fuel - GT	$25,290	$24,772	($518)	-2.05%
Gas Only - CC	$2,890	$6,987	$4,097	141.79%
Gas Only - GT	$0	($1,399)	($1,399)	0.00%
Gas with LNG under ESI	$16,453	$29,646	$13,193	80.19%
Oil Only - Steam	$16,159	$14,128	($2,031)	-12.57%
Oil Only - Non-steam	$5,536	$691	($4,845)	-87.52%
Coal	$169,927	$177,387	$7,460	4.39%
Biomass/Refuse	$249,095	$256,751	$7,656	3.07%
Fuel Cell	$152,600	$159,270	$6,670	4.37%
Hydro	$99,316	$102,336	$3,020	3.04%
Nuclear	$277,619	$286,558	$8,939	3.22%
Solar	$12,851	$12,161	($690)	-5.37%
Wind	$95,899	$94,722	($1,177)	-1.23%
Offshore Wind	$141,751	$147,264	$5,513	3.89%

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Net Revenues

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Average Net Revenues by Resource Type, Winter Season, Extended Stressed Conditions ($ per MW)

	Net Revenue ($/MW)			
Resource Type:	**CMR [A]**	**ESI [B]**	**Change [C] = [B] - [A]**	**Percent Change [D] = [C]/[A]**
Dual Fuel - CC	$29,017	$26,907	($2,110)	-7.27%
Dual Fuel - GT	$21,498	$15,564	($5,934)	-27.60%
Gas Only - CC	$7,741	$12,143	$4,402	56.86%
Gas Only - GT	$0	$340	$340	0.00%
Gas with LNG under ESI	$41,998	$44,469	$2,471	5.88%
Oil Only - Steam	$21,303	$6,937	($14,366)	-67.44%
Oil Only - Non-steam	$12,239	$1,648	($10,590)	-86.53%
Coal	$104,382	$95,168	($9,214)	-8.83%
Biomass/Refuse	$174,308	$166,805	($7,503)	-4.30%
Fuel Cell	$92,946	$83,599	($9,347)	-10.06%
Hydro	$73,178	$72,356	($822)	-1.12%
Nuclear	$194,168	$187,800	($6,368)	-3.28%
Solar	$10,220	$9,842	($378)	-3.70%
Wind	$69,117	$65,528	($3,589)	-5.19%
Offshore Wind	$106,256	$99,185	($7,071)	-6.65%

Net Revenues

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Average Net Revenues by Resource Type, Winter Season, Infrequent Stressed Conditions ($ per MW)

	Net Revenue ($/MW)			
Resource Type:	**CMR [A]**	**ESI [B]**	**Change [C] = [B] - [A]**	**Percent Change [D] = [C]/[A]**
Dual Fuel - CC	$7,760	$11,599	$3,839	49.47%
Dual Fuel - GT	$6,406	$7,322	$916	14.30%
Gas Only - CC	$8,178	$11,715	$3,537	43.25%
Gas Only - GT	$0	$875	$875	0.00%
Gas with LNG under ESI	$29,946	$15,336	($14,610)	-48.79%
Oil Only - Steam	$379	($3,130)	($3,508)	-926.70%
Oil Only - Non-steam	$3	($63)	($66)	-2,548.73%
Coal	$35,978	$40,656	$4,678	13.00%
Biomass/Refuse	$103,237	$109,615	$6,378	6.18%
Fuel Cell	$29,247	$32,965	$3,718	12.71%
Hydro	$40,564	$44,455	$3,891	9.59%
Nuclear	$118,043	$125,144	$7,101	6.02%
Solar	$7,996	$7,978	($17)	-0.22%
Wind	$39,673	$40,186	$512	1.29%
Offshore Wind	$61,725	$65,494	$3,769	6.11%

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Net Revenues

Frequent Stressed Conditions Case

Average Net Revenues, Selected Resources, Winter Season, Frequent Stressed Conditions

		Gas Resources with LNG Contracts in ESI ($/MW)	Oil Only Steam Resources ($/MW)	Oil Only Non-steam Resources ($/MW)	Dual Fuel Gas CC Resources ($/MW)	Dual Fuel Gas GT Resources ($/MW)
CMR						
Settlement Revenues	[A]	$181,139	$86,462	$24,586	$144,096	$93,997
Production Costs	[B]	$164,686	$70,304	$19,050	$100,440	$68,707
Net Revenues	[C] = [A] - [B]	$16,453	$16,159	$5,536	$43,656	$25,290
ESI						
Settlement Revenues	[D]	$200,363	$85,768	$14,373	$153,766	$91,484
Production Costs	[E]	$149,046	$69,536	$13,567	$103,549	$66,535
Incremental Oil Holding Costs	[F]		$2,104	$115	$75	$177
LNG Contract Costs	[G]	$21,671				
Net Revenues	[H] = [D] - ([E]+[F]+[G])	$29,646	$14,128	$691	$50,142	$24,772
Incremental ESI Net Revenues	[H] - [C]	$13,193	($2,031)	($4,845)	$6,486	($518)

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Net Revenues

Many Factors Account for Impact Differences Across Resource Types

- Results on prior slides show that net revenue impacts vary across resources
- Many factors drive these differences, some of which may not capture long-run, expected impact; thus, caution should be taken in over-interpretation of results; *for example*:
  - Changes in net EAS revenues
    - Less efficient units (e.g., some oil-fired units) tend to be disproportionately impacted by the reduction in LMPs during high priced hours; FER payments may not offset the reduction in LMPs in these hours; these results reflect the particular assumptions made regarding incremental fuel inventory, which tends to lower LMPs, all else equal
  - DA energy option net payments
    - Net payments may be sensitive to calculation of risk-premiums for particular resource types
    - Peaking resources with Claim10 and Claim30 capability can earn higher DA energy option revenues, because fewer resources are eligible for these products, which causes prices to be higher (particularly in tight market conditions)
  - Frequency of operation
    - Current analysis may not fully capture real-time price volatility; thus, expected net revenues may be understated for peaking units

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Net Revenues

Net Revenue Impacts Vary Across Resource Types

- In many cases, estimated impacts are modest
  - For example, in the Frequent Stressed Conditions case, oil-only non-steam units earn $4,845 per MW less under ESI, which translates to $0.40 per kW-month across a 12-month period
- However, as we will see, incentives to individual resources under ESI encourage incremental fuel procurement

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