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Energy Security Improvements Impact Analysis

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Agenda

- Update to Central Case Results
- Winter Scenario Analysis Results
- Non-Winter Scenario Analysis Results
- Appendices
  - Updated Central Case Results

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Status and Progress to Date

Several changes in assumptions

- We appreciate the feedback provided by stakeholders, as it has helped inform many of the model's assumptions
- We have received many requests for additional results, analysis, and scenarios; we have worked diligently to be as responsive as possible, although time constraints have affected our ability to respond to all requests
- Our work continues and all results remain preliminary
  - We will do our best to respond to outstanding requests in the report
- Today we present results for:
  - Winter Central Case – updated results
  - Winter Scenarios – additional cases
  - Non-Winter Scenarios – two cases

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Brief Update to Central Case Results

Update to Central Case Results

Refinements to assumptions

- Results reflect limited changes in assumptions relative to those presented at the prior January MC meeting
  - Hourly strike price inputs used in all cases
  - Last barge refueling date extended from Feb 1 to Feb 14
- Changes result in minor decreases in total payments in Frequent and Infrequent cases
- Other results are similar to those reported on January 14th, and the full set of tables is provided in the Appendix
- Appendix also includes new requested table of DA energy option shortages

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Total Customer Payments

Central Cases

Total Payments by Case ($ Million)

		Payments ($Million)											
		Frequent Stressed Conditions				Extended Stressed Conditions				Infrequent Stressed Conditions			
Product / Payment		**CMR**	**ESI**	**Difference**		**CMR**	**ESI**	**Difference**		**CMR**	**ESI**	**Difference**	
Energy and RT Operating Reserves	[A]	$4,101	$3,917	-$184	-4.5%	$2,730	$2,516	-$214	-7.8%	$1,749	$1,707	-$42	-2.4%
DA Energy Option													
DA Option Payment			$208				$114				$46		
EIR			$0				$1				$1		
RER			$66				$37				$15		
GCR10			$94				$51				$20		
GCR30			$47				$25				$10		
RT Option Settlement			-$142				-$81				-$31		
Net DA Ancillary	[B]		$66				$33				$15		
FER Payments	[C]		$250				$119				$62		
Total Payments	[A+B+C]	$4,101	$4,233	$132	3.2%	$2,730	$2,668	-$62	-2.3%	$1,749	$1,784	$35	2.0%

- ESI increases total customer payments in some Cases (Frequent, Infrequent) and decreases it in others (Extended)
  - Payments increase due to FER payments plus net cost of new DA energy options
  - These higher payments are partially or more than fully offset by reduced energy (LMP) costs caused, largely, by the incremental energy inventory under ESI

Qualitative Findings Remain Consistent with Previous Results

Summary of Results

- ESI procures new ancillary services day-ahead to improve system reliability, increasing the supply of energy inventory and reducing stress of fuel supply systems
- ESI would cause DA markets to clear energy supply levels closer to the ISO forecast load
- ESI may cause shifts in energy use through more efficient use of energy inventory that can lower production costs
  - For example, shifts in energy supply from resources with stored energy inventories to those with just-in-time fuel supply

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Winter Scenario Analysis Results

Scenarios Presented

Set of Scenarios Presented Today

- The Scenarios evaluated seek to be responsive to the set of stakeholder requests we have received to date
- All Scenarios have been updated to new Central Case with hourly-varying strike price
- Many of these Scenarios were presented in December
- Today, we focus on new Scenarios in which fuel assumptions reflect a market response:
  - Behavioral responses to ESI incentives (e.g., with ESI design changes)
  - Aggregate market response to changes in resources and infrastructure (e.g., with oil and nuclear retirements)
- Other Scenarios with no market response are provided in the appendix

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Scenarios Presented: Fuel Assumptions Differ from Central Case

Scenario Name	Scenario Description
Central Case	"Central Case" Current Market Rules (CMR) and Energy Security Improvements (ESI) assumptions
ESI Design	
No EIR/RER	"Central Case" with no RER nor EIR requirement. Under ESI, there is incremental fuel relative to amounts assumed under CMR.
No RER	"Central Case" with no RER requirement. Under ESI, incremental fuel (i.e., relative to CMR) is assumed to be one-half of the incremental fuel amounts assumed in the Central Case.
Alternative Resources & Demand	
Resource Mix	Changes in retirements and replacements to future-year resource mix. For all scenarios: ~1,500 MW at-risk resources retired.
Oil Retirements	For oil retirement scenarios: an additional ~1,000 MW of oil resources retired.
Oil Retirements; Gas Replacement	2,500 MW of new natural gas CC resources, none with dual-fuel capability, and 0.3 Bcf/day of additional NG supply
Oil Retirements; Gas / Dual Fuel Replacement	2,500 MW of new natural gas CC resources, 50% with dual-fuel capability, and 0.3 Bcf/day of additional NG supply
Nuclear Retirements	For nuclear retirement scenarios: an additional ~3,500 MW of nuclear resources retired.
Nuclear Retirements; Gas Replacement	5,000 MW of new natural gas CC resources, none with dual-fuel capability and 0.7 Bcf/day of additional NG supply
Nuclear Retirements; Gas / Dual Fuel Replacement	5,000 MW of new natural gas CC resources, 50% with dual-fuel capability, and 0.7 Bcf/day of additional NG supply

Scenarios Presented: Fuel Assumptions Differ from Central Case

Key Takeaways and Caveats

- Impacts vary across cases
  - When excluding particular products from ESI (i.e., No EIR and No EIR/RER Scenarios), payments are lower in most Scenarios
    - Elimination of EIR or EIR/RER would reduce incentives for incremental energy inventory and would result in a less reliable system
    - Differences in incremental fuel to capture differences in incentives are assumed, not the result of economic analysis
    - Impact is accounted for in some Scenarios (No EIR, No EIR/RER), but not others (Strike price + $10, in the Appendix)
  - ESI with retired resources leads to varied impacts
    - Higher payments in Frequent Case, and lower payments in Extended case
    - Specific impacts depend on market response assumptions

Scenarios - Customer Payment and Price Impacts

Impacts Vary Across Cases and Scenarios

- ESI's impact on consumer costs varies across scenarios and Cases
  - Range from reduction of $311 million to increase of $530 million
    - (Ranges reflect results across all scenarios, including those in appendix)
  - Impact is complex, reflecting multiple factors, including:
    - Changes in and nature of change in market tightness (e.g., High Load, 1- and 5-day Supply Shocks, More/Less LNG supply)
    - Changes in costs (e.g., higher risk premiums)
    - ESI design (e.g., higher RER quantity)
- LMPs decrease due to increased energy inventory incented by ESI and increased DA energy supply (at lower LMPs)
- FER prices range from $1.38 to $18.73 per MWh
- DA energy option prices vary across Cases, but relatively similar across Scenarios within Cases

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Scenarios - Summary Results

Frequent Stressed Case

Scenario Name/Acronym	Weighted Average 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
Frequent Stressed Conditions - Central Case						
Central Case	($5.51)	$7.75	$27.14	$66	$66	$132
ESI Design Scenarios						
No EIR/RER	$0.06	NA	$22.46	$3	$21	$24
No RER	($4.36)	$5.63	$22.92	$35	$25	$59
Alternative Resources & Demand Scenarios						
Oil Retirements; Gas Replacement	($5.64)	$18.73	$33.78	$410	$120	$530
Oil Retirements; Gas / Dual Fuel Replacement	($7.30)	$8.75	$28.78	$37	$77	$113
Nuclear Retirements; Gas Replacement	($5.10)	$9.28	$29.50	$120	$79	$199
Nuclear Retirements; Gas / Dual Fuel Replacement	($4.04)	$9.52	$28.13	$166	$73	$239

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Scenarios - Summary Results

Extended Stressed Case

Scenario Name/Acronym	Weighted Average 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	($6.45)	$3.73	$14.68	($95)	$33	($62)
ESI Design Scenarios						
No EIR/RER	$0.21	NA	$11.43	$7	$7	$14
No RER	($5.83)	$2.28	$11.30	($122)	$6	($117)
Alternative Resources & Demand Scenarios						
Oil Retirements; Gas Replacement	($8.98)	$4.49	$15.85	($159)	$41	($118)
Oil Retirements; Gas / Dual Fuel Replacement	($10.30)	$4.51	$15.74	($199)	$40	($159)
Nuclear Retirements; Gas Replacement	($8.32)	$14.88	$20.38	$191	$81	$272
Nuclear Retirements; Gas / Dual Fuel Replacement	($9.09)	$4.28	$15.08	($170)	$35	($135)

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Scenarios - Summary Results

Infrequent Stressed Case

	Weighted Average 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	($1.21)	$1.96	$5.78	$20	$15	$35
ESI Design Scenarios						
No EIR/RER	($0.00)	NA	$5.01	($0)	$7	$6
No RER	($1.05)	$1.76	$5.04	$19	$7	$26
Alternative Resources & Demand Scenarios						
Oil Retirements; Gas Replacement	($1.04)	$1.80	$5.75	$20	$15	$35
Oil Retirements; Gas / Dual Fuel Replacement	($1.15)	$1.78	$5.72	$16	$14	$30
Nuclear Retirements; Gas Replacement	($1.16)	$1.95	$5.77	$21	$15	$36
Nuclear Retirements; Gas / Dual Fuel Replacement	($1.73)	$1.99	$5.73	$5	$14	$19

Scenarios – Operational and Reliability Outcomes

Impacts Vary Across Cases and Scenarios

- Across scenarios, ESI causes positive operational improvements through incremental fuel supply and substitution of resources with just-in-time energy supply for inventoried energy
  - Fewer operating reserve shortages during 5-day supply contingency ("Shock HQ 5 Days") in Frequent Case
  - Use of natural gas when prices are high (i.e., NG supply is tight) decreases under all scenarios, illustrating how ESI reduces stress on fuel systems
  - System-wide quantity of fuel oil inventory generally higher under ESI
  - Depletion of oil inventory during periods of high demand (i.e., "cold snaps") reduced under ESI

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Operational / Reliability Metrics

Multiple Metrics to Capture Different Aspects of Energy Security

Change in Reliability Metrics with ESI compared to CMR, Frequent Stressed Conditions

	System Reliability (Change)				
Scenario Name/Acronym	Operating Reserve Shortages (Hours)	NG Used in Generation when NG Supply is Tight (MMBtu)	Daily Available Oil Generation Minimum (MWh)	Daily Available Oil Generation Average (MWh)	Daily Available Oil Generation Largest Four Day Decline (MWh)
Frequent Stressed Conditions - Central Case					
Central Case	0	(2,900,051)	24,487	15,204	(15,815)
ESI Design Scenarios					
No EIR/RER	0	3,314	68	(80)	920
No RER	0	(2,448,623)	20,954	11,281	(4,907)
Alternative Resources & Demand Scenarios					
Oil Retirements; Gas Replacement	0	(6,395,750)	26,098	10,679	(2,301)
Oil Retirements; Gas / Dual Fuel Replacement	0	(6,275,122)	16,245	13,935	(8,465)
Nuclear Retirements; Gas Replacement	0	(12,302,402)	10,131	9,566	(4,088)
Nuclear Retirements; Gas / Dual Fuel Replacement	0	(12,852,218)	32,986	13,687	(15,229)

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Operational / Reliability Metrics

Multiple Metrics to Capture Different Aspects of Energy Security

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

	System Reliability (Change)				
Scenario Name/Acronym	Operating Reserve Shortages (Hours)	NG Used in Generation when NG Supply is Tight (MMBtu)	Daily Available Oil Generation Minimum (MWh)	Daily Available Oil Generation Average (MWh)	Daily Available Oil Generation Largest Four Day Decline (MWh)
Extended Stressed Conditions - Central Case					
Central Case	0	(943,020)	32,663	14,017	(2,886)
ESI Design Scenarios					
No EIR/RER	0	0	0	45	0
No RER	0	(860,078)	35,039	11,597	(3,604)
Alternative Resources & Demand Scenarios					
Oil Retirements; Gas Replacement	0	(3,484,459)	10,230	13,081	1,928
Oil Retirements; Gas / Dual Fuel Replacement	0	(3,498,224)	12,101	15,003	(3,416)
Nuclear Retirements; Gas Replacement	0	(7,662,552)	20,129	12,803	(10,965)
Nuclear Retirements; Gas / Dual Fuel Replacement	0	(7,277,589)	12,911	16,731	2,328

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Operational / Reliability Metrics

Multiple Metrics to Capture Different Aspects of Energy Security

Change in Reliability Metrics with ESI compared to CMR, Infrequent Stressed Conditions

	System Reliability (Change)				
Scenario Name/Acronym	Operating Reserve Shortages (Hours)	NG Used in Generation when NG Supply is Tight (MMBtu)	Daily Available Oil Generation Minimum (MWh)	Daily Available Oil Generation Average (MWh)	Daily Available Oil Generation Largest Four Day Decline (MWh)
Infrequent Stressed Conditions - Central Case					
Central Case	0	NA	6,753	11,656	2,045
ESI Design Scenarios					
No EIR/RER	0	NA	0	0	0
No RER	0	NA	5,896	6,609	(2,199)
Alternative Resources & Demand Scenarios					
Oil Retirements; Gas Replacement	0	NA	10,830	12,482	3,207
Oil Retirements; Gas / Dual Fuel Replacement	0	NA	30,811	14,288	(16,800)
Nuclear Retirements; Gas Replacement	0	NA	7,201	11,064	6,007
Nuclear Retirements; Gas / Dual Fuel Replacement	0	NA	35,900	16,738	(22,323)

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Non-Winter Scenario Analysis

ESI Impacts in Non-Winter Months

Fundamentals of Impact Approach

- Framework for analysis of ESI during non-winter months is largely the same as the analysis for winter months
- Analysis considers different levels of stressed conditions in a future non-winter, 2026:
  - ***Moderate Conditions*** based on 2017 (March through November)
    - Moderate or typical non-winter market conditions
  - ***Severe Conditions*** based on 2018 (March through November)
    - More severe non-winter market conditions

Non-Winter Central Case – Assumptions

Data and assumptions generally consistent with winter analysis

- Demand escalated in manner consistent with winter approach (reflecting ISO forecasts for 2026)
- Variable renewable profiles consistent with historical output, grown to anticipated future renewable supplies
- Fuel supply (natural gas and fuel oil) not materially binding on market outcomes in these Cases
- No market responses to ESI incentives
- DA energy option offer prices adjusted for non-winter market conditions (with limited intra-day fuel price risk)

Non-Winter Central Case – Assumptions

Updates to Assumptions

- As the model assumes no market responses to ESI incentives and model does not have intertemporal constraints, it does not quantify ESI reliability benefits in non-winter months
  - In practice, we expect that the procurement of the additional reliability services under ESI could improve system reliability in cases where an increased supply of energy in real-time mitigated potential adverse reliability outcomes
- Non-Winter results are qualitatively the same as those presented on January 15th
  - Results differ due to hourly strike price and other model updates

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Non-Winter Results: Payments and Prices

Payments and Prices

Key Takeaways

- ESI increases total customer payments in non-winter months for the Cases considered
  - Consistent with procurement of additional reliability services
  - Reflects assumption of no market responses to ESI incentives

- Change in LMPs and total payments to energy is relatively small
  - In Moderate Case, total change in payments – accounting for change in LMP and new FER payments – is approximately ~ $0.59 per MWh
  - In Severe Case, total change in payments is approximately ~ $0.90 per MWh

Total Customer Payments

Central Case

Total Payments by Case ($ Million)

		Moderate Summer Conditions				Severe Summer Conditions			
Product / Payment		**CMR**	**ESI**	**Difference**		**CMR**	**ESI**	**Difference**	
Energy and RT Operating Reserves	[A]	$2,473	$2,455	-$18	-0.7%	$2,697	$2,672	-$25	-0.9%
DA Energy Option									
DA Option Payment			$152				$186		
EIR			$0				$0		
RER			$51				$62		
GCR10			$68				$83		
GCR30			$34				$41		
RT Option Settlement			-$113				-$139		
Net DA Ancillary	[B]		$39				$47		
FER Payments	[C]		$69				$104		
Total Payments	[A+B+C]	$2,473	$2,564	$91	3.7%	$2,697	$2,824	$126	4.7%

- Customers payments under ESI increase by
  - $91 million (3.7%) in the Moderate Case
  - $126 million (4.7%) in the Severe Case
- Increases due to new FER payments and net cost of ESI AS products

LMPs

Central Case

Average Day-Ahead and Real-Time LMPs by Case ($ per MWh)

	CMR		ESI		Difference	
Severity	Day-Ahead [A]	Real-Time [B]	Day-Ahead [C]	Real-Time [D]	Day-Ahead [E] = [C] - [A]	Real-Time [F] = [D] - [B]
Moderate Summer Conditions	$27.37	$27.59	$27.14	$27.59	($0.23)	$0.00
Severe Summer Conditions	$29.41	$29.78	$29.14	$29.78	($0.27)	$0.00

Note: [1] Prices are the unweighted average across hours.

- With ESI, DA LMPs lower than under current market rules
  - Market clears more DA energy
  - LMPs "set" at demand offers, which are lower when clearing a greater quantity of supply
- No change in RT LMPs, as energy inventories and fuel use decisions unchanged by ESI given lack of tightness in energy supplies

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Payments to Day-Ahead Energy

Central Case

Weighted Average DA Energy Payments to Generators, CMR vs ESI ($ per MWh)

	CMR	ESI				Change	
Case	Day-Ahead LMP [A]	Day-Ahead LMP [B]	FER [C]	Day-Ahead LMP + FER [D]=[B]+[C]	Real-Time LMP [E]	Day-Ahead LMP [B]-[A]	Day-Ahead LMP + FER [D]-[A]
Moderate Summer Conditions	$27.90	$27.71	$0.78	$28.49	$28.35	($0.19)	$0.59
Severe Summer Conditions	$29.81	$29.58	$1.13	$30.72	$30.65	($0.23)	$0.90

Note: [1] Prices are weighted by hourly quantity of generation.

- DA energy is compensated with both LMPs and FER payments
  - Average FER payment (column [C]) is the weighted average across all DA energy
- Total compensation to DA energy increases under ESI (compared to CMR) reflecting combined impact to LMPs and new FER payments
  - FER payments (more than) offset decrease in LMPs

Day-Ahead Option Prices

Central Case

Weighted Average DA Energy Option Clearing Prices ($ per MWh)

Case	Zero EIR Price (% of hours)	Zero EIR Quantity (% of hours)	EIR	GCR10	GCR30	RER
Moderate Summer Conditions	57%	98%	$13.53	$6.40	$6.38	$6.38
Severe Summer Conditions	61%	97%	$31.84	$7.85	$7.82	$7.82

Note: [1] Prices are weighted by hourly quantity of each ESI product.

- Weighted average hourly prices for EIR, GCR10, GCR30, and RER are:
  - As with winter Cases, RER and GCR average prices are relatively similar, although this masks significant hour-to-hour variation in each
  - EIR price is higher because prices are typically highest in hours when EIR quantity is large

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Non-Winter Results: Energy Supply

Energy Supply

Key Takeaways

- ESI increases cleared DA energy, with cleared amount closer to the ISO forecast

- Under ESI, DA energy supply generally increases for all resource types, with certain exceptions
  - Largest increases for CC units (dual fuel and gas-only)
  - DA energy options supplied largely by pumped storage, GT's (dual fuel, oil-only and gas-only), hydro, and CC's (dual fuel and gas-only)

Changes in DA Energy With ESI

Difference in Cleared DA Energy by Resource Type, CMR vs ESI, Central Cases

	CMR	ESI		Difference	Real-Time Comparison	
Severity	Day-Ahead Energy [A]	Day-Ahead Energy [B]	Cleared EIR [C]	Day-Ahead Energy [D] = [B] - [A]	Real-Time Demand	Energy + EIR [E] = [B] + [C]
Moderate Summer Conditions	87,970,357	89,590,855	7,125	1,620,498	88,287,439	89,597,980
Severe Summer Conditions	90,175,883	91,534,059	11,054	1,358,175	90,053,188	91,545,113

- With ESI, total cleared DA energy increases (compared to CMR) due to cost savings of substituting DA energy for EIR
  - EIR is small, as energy is substituted for EIR

Total Non-Winter Generation Mix

Energy and DA Options by Resource Type, CMR vs ESI, Moderate Summer Conditions

Resource Type	Nameplate Capacity (MW)	DA CMR Energy (MWh)	DA ESI Energy (MWh)	DA Energy Options (MWh)	Change in DA Energy (MWh)
Active Demand Response	267	11	33	0	22
Battery Storage	458	(15,109)	(15,109)	0	0
Biomass/Refuse	830	4,249,546	4,260,566	0	11,019
Coal	531	167,617	177,569	24,431	9,952
Dual Fuel - CC	5,884	16,409,650	17,267,679	1,130,816	858,029
Dual Fuel - GT	1,237	777,989	776,390	4,203,524	(1,599)
Fuel Cell	21	4,929	5,572	0	644
Gas - CC	7,411	21,220,038	21,874,624	1,476,007	654,586
Gas - GT	364	10,993	7,435	1,270,882	(3,558)
Hydro	1,987	4,464,248	4,464,248	3,093,115	0
Imports	2,850	15,011,434	15,059,883	0	48,449
Nuclear	3,344	19,488,822	19,528,602	0	39,780
Offshore Wind	800	2,398,673	2,398,673	0	0
Oil Only - Steam	3,698	114	2,719	2,719	2,605
Oil Only - Non-steam	2,114	0	0	5,022,405	0
Pumped Storage	1,778	(660,116)	(660,116)	7,542,569	0
Solar	1,671	1,968,609	1,968,609	0	0
Wind	1,401	2,472,822	2,472,822	0	0

Total Non-Winter Generation Mix

Energy and DA Options by Resource Type, CMR vs ESI, Severe Summer Conditions

Resource Type	Nameplate Capacity (MW)	DA CMR Energy (MWh)	DA ESI Energy (MWh)	DA Energy Options (MWh)	Change in DA Energy (MWh)
Active Demand Response	267	51	169	0	118
Battery Storage	458	(15,109)	(15,109)	0	0
Biomass/Refuse	830	4,295,501	4,297,550	0	2,050
Coal	531	252,245	273,204	39,558	20,958
Dual Fuel - CC	5,884	17,699,486	18,101,491	1,183,431	402,006
Dual Fuel - GT	1,237	792,172	797,257	4,155,403	5,086
Fuel Cell	21	6,460	7,509	0	1,049
Gas - CC	7,411	22,111,781	22,999,838	1,426,980	888,057
Gas - GT	364	25,141	28,354	1,256,449	3,212
Hydro	1,987	4,085,436	4,085,436	3,299,392	0
Imports	2,850	15,346,463	15,358,400	0	11,937
Nuclear	3,344	19,523,479	19,529,181	0	5,703
Offshore Wind	800	2,398,596	2,398,596	0	0
Oil Only - Steam	3,698	1,418	18,189	18,189	16,771
Oil Only - Non-steam	2,114	0	69	2,932,378	69
Pumped Storage	1,778	(660,116)	(660,116)	9,457,666	0
Solar	1,671	1,863,549	1,863,549	0	0
Wind	1,401	2,448,824	2,448,824	0	0

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Non-Winter Results: Net Revenues

Net Revenues and Production Costs

Key Takeaways

- Given assumption that there is no change in fuel availability or other response to ESI, total production costs are unchanged between CMR and ESI cases
- Net revenues generally increase by resource type, on average
  - Net revenues reflect multiple factors, including changes to LMPs, new FER payments and ESI awards for DA energy options

Net Revenues

Average Net Revenues by Resource Type, Non-Winter Season, Moderate Summer Conditions ($ per MW)

	Net Revenue ($/MW)		
Resource Type:	**CMR [A]**	**ESI [B]**	**Change [C] = [B] - [A]**
Dual Fuel - CC	$7,914	$9,958	$2,044
Dual Fuel - GT	$6,782	$12,867	$6,085
Gas Only - CC	$8,265	$10,381	$2,116
Gas Only - GT	$562	$6,985	$6,423
Oil Only - Steam	$23	$49	$27
Oil Only - Non-steam	$353	$2,649	$2,295
Coal	$5,353	$6,358	$1,005
Biomass/Refuse	$134,779	$137,249	$2,469
Fuel Cell	$3,463	$3,644	$182
Hydro	$67,892	$71,648	$3,756
Nuclear	$158,399	$161,190	$2,792
Solar	$31,080	$31,485	$405
Wind	$49,772	$50,597	$825
Offshore Wind	$81,640	$82,852	$1,212

Net Revenues

Average Net Revenues by Resource Type, Non-Winter Season, Severe Summer Conditions ($ per MW)

	Net Revenue ($/MW)		
Resource Type:	**CMR [A]**	**ESI [B]**	**Change [C] = [B] - [A]**
Dual Fuel - CC	$9,872	$13,209	$3,337
Dual Fuel - GT	$8,380	$16,052	$7,672
Gas Only - CC	$10,264	$13,599	$3,335
Gas Only - GT	$1,382	$9,126	$7,744
Oil Only - Steam	$192	$248	$56
Oil Only - Non-steam	$606	$12	($594)
Coal	$9,411	$9,434	$22
Biomass/Refuse	$145,754	$149,260	$3,506
Fuel Cell	$6,964	$7,491	$526
Hydro	$69,230	$74,287	$5,057
Nuclear	$170,861	$174,842	$3,981
Solar	$32,442	$33,305	$863
Wind	$53,491	$54,577	$1,087
Offshore Wind	$88,152	$89,841	$1,689

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Net Revenues

Average Net Revenues, Selected Resources, Non-Winter Season, Moderate Summer Conditions

		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]	$50	$353	$79,512	$18,086
Production Costs	[B]	$27	$0	$71,598	$11,304
Net Revenues	[C] = [A] - [B]	$23	$353	$7,914	$6,782
ESI					
Settlement Revenues	[D]	$76	$2,649	$81,556	$24,171
Production Costs	[E]	$27	$0	$71,598	$11,304
Incremental Oil Holding Costs	[F]	$0	$0	$0	$0
LNG Contract Costs	[G]				
Net Revenues	[H] = [D] - ([E]+[F]+[G])	$49	$2,649	$9,958	$12,867
Incremental ESI Net Revenues	[H] - [C]	$27	$2,295	$2,044	$6,085

Note: Net revenues account for settlement revenues, production costs, and incremental oil holding costs.

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Net Revenues

Average Net Revenues, Selected Resources, Non-Winter Season, Severe Summer Conditions

		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]	$508	$606	$88,931	$21,372
Production Costs	[B]	$316	$0	$79,059	$12,991
Net Revenues	[C] = [A] - [B]	$192	$606	$9,872	$8,380
ESI					
Settlement Revenues	[D]	$564	$12	$92,268	$29,044
Production Costs	[E]	$316	$0	$79,059	$12,991
Incremental Oil Holding Costs	[F]	$0	$0	$0	$0
LNG Contract Costs	[G]				
Net Revenues	[H] = [D] - ([E]+[F]+[G])	$248	$12	$13,209	$16,052
Incremental ESI Net Revenues	[H] - [C]	$56	($594)	$3,337	$7,672

Note: Net revenues account for settlement revenues, production costs, and incremental oil holding costs.

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Non-Winter Results: Scenarios

Non-Winter Scenarios

Scenarios Presented Today

- Analysis Group has additionally run one additional winter scenario, a No RER case
- Compared to the Central Case, without RER:
  - FER prices are lower (by ~ $0.25 per MWh)
  - ESI prices are lower
  - Total payments are reduced by $43 and $70 million (for Moderate and Severe Cases, respective)
- The analysis does not quantify non-winter month reliability benefits
  - But, the additional reliability services under ESI could improve system reliability in cases where an increased supply of energy in real-time mitigated potential adverse reliability outcomes

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Non-Winter Scenarios - Summary Results

LMPs & Payments

	Weighted Average 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
Moderate Conditions - Central Case						
Central Case	($0.19)	$0.78	$6.39	$51	$39	$91
Moderate Conditions - ESI Design Scenario						
No RER	($0.22)	$0.59	$5.67	$31	$16	$48
Severe Conditions - Central Case						
Central Case	($0.23)	$1.13	$7.83	$79	$47	$126
Severe Conditions - ESI Design Scenario						
No RER	($0.26)	$0.82	$6.21	$47	$8	$56

Next Steps

Current plan for providing stakeholders with findings

- February
  - Draft Report

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Appendix

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Update to Central Case Results: Payments and Prices

Payments and Prices

Key Takeaways

- ESI's impact on total customer payments is ambiguous
  - Increased payments in 2 of 3 Cases
  - Depends on level of additional energy inventory incented by ESI

Total Customer Payments

Central Cases

Total Payments by Case ($ Million)

		Payments ($Million)											
		Frequent Stressed Conditions				Extended Stressed Conditions				Infrequent Stressed Conditions			
Product / Payment		**CMR**	**ESI**	**Difference**		**CMR**	**ESI**	**Difference**		**CMR**	**ESI**	**Difference**	
Energy and RT Operating Reserves	[A]	$4,101	$3,917	-$184	-4.5%	$2,730	$2,516	-$214	-7.8%	$1,749	$1,707	-$42	-2.4%
DA Energy Option													
DA Option Payment			$208				$114				$46		
EIR			$0				$1				$1		
RER			$66				$37				$15		
GCR10			$94				$51				$20		
GCR30			$47				$25				$10		
RT Option Settlement			-$142				-$81				-$31		
Net DA Ancillary	[B]		$66				$33				$15		
FER Payments	[C]		$250				$119				$62		
Total Payments	[A+B+C]	$4,101	$4,233	$132	3.2%	$2,730	$2,668	-$62	-2.3%	$1,749	$1,784	$35	2.0%

- Total customer payments increases in some Cases (Frequent, Infrequent) and decreases in others (Extended)
  - Payments increase due to FER payments plus net cost of new DA energy options
  - These higher payments are partially or more than fully offset by reduced energy (LMP) costs caused, partly, by the incremental energy inventory under ESI

LMPs

Central Cases

Average Day-Ahead and Real-Time LMPs by Case ($ per MWh)

	CMR		ESI		Difference	
Severity	Day-Ahead [A]	Real-Time [B]	Day-Ahead [C]	Real-Time [D]	Day-Ahead [E] = [C] - [A]	Real-Time [F] = [D] - [B]
Frequent Stressed Conditions	$125.05	$123.88	$119.50	$119.45	($5.55)	($4.43)
Extended Stressed Conditions	$81.60	$79.02	$75.56	$76.33	($6.04)	($2.69)
Infrequent Stressed Conditions	$53.88	$54.61	$52.61	$54.40	($1.27)	($0.21)

Note: [1] Prices are the unweighted average across hours.

- With ESI, LMPs generally decline compared to current market rules
  - Reductions range from $0.21 to $6.04 per MWh, driven by incremental energy supplies and other factors
- DA and RT prices are generally aligned, consistent with arbitrage between DA and RT markets, which will continue to promote efficient pricing in DA markets under ESI

Payments to Day-Ahead Energy

Central Case

Weighted Average DA Energy Payments to Generators, CMR vs ESI ($ per MWh)

	CMR	ESI				Change	
Case	Day-Ahead LMP [A]	Day-Ahead LMP [B]	FER [C]	Day-Ahead LMP+ FER [D]=[B]+[C]	Real-Time LMP [E]	Day-Ahead LMP [B]-[A]	Day-Ahead LMP + FER [D]-[A]
Frequent Stressed Conditions	$127.40	$121.89	$7.75	$129.64	$121.60	($5.51)	$2.25
Extended Stressed Conditions	$85.15	$78.70	$3.73	$82.43	$79.72	($6.45)	($2.72)
Infrequent Stressed Conditions	$54.97	$53.76	$1.96	$55.72	$55.86	($1.21)	$0.75

Note: [1] Prices are weighted by hourly quantity of generation.

- DA energy is compensated with both LMPs and FER payments
  - Average FER payment (column [C]) is the weighted average across all DA energy
- Average compensation (per MWh) to DA energy increases under ESI (compared to CMR) in two of three Cases (Frequent and Infrequent)
  - In Extended Case, LMPs reductions exceed FER payments, on average
- FER payments for DA energy increases the return to holding energy inventory, all else equal

Day-Ahead Option Prices

Weighted Average DA Energy Option Clearing Prices ($ per MWh)

Case	Zero EIR Price (% of hours)	Zero EIR Quantity (% of hours)	EIR/FER	GCR10	GCR30	RER
Frequent Stressed Conditions	27%	96%	$70.09	$27.17	$27.17	$27.11
Extended Stressed Conditions	53%	93%	$49.70	$14.72	$14.67	$14.67
Infrequent Stressed Conditions	42%	84%	$8.52	$5.80	$5.78	$5.78

Note: [1] Prices are weighted by hourly quantity of each ESI product.

- Weighted average hourly prices for EIR, GCR10, GCR30, and RER vary across cases, but relatively little within Cases, similar to prior results
  - The weighted average price paid for EIR is generally higher because prices are typically highest in hours when EIR quantity is large
- EIR quantity zero in large fraction of hours, as market clearing substitutes energy for EIR to lower costs

Reliability Metrics - Day-Ahead Option Shortages

DA Energy Option Product Shortages with ESI (Number of Hours)

Case	GCR10 Shortages (Hours)	GCR30 Shortages (Hours)	RER Shortages (Hours)	EIR Shortages (Hours)
Frequent Stressed Conditions	0	0	62	0
Extended Stressed Conditions	0	0	25	0
Infrequent Stressed Conditions	0	0	0	0

- RER shortages occur under Frequent and Extended Cases, but not in Infrequent Case
  - RER prices are capped at penalty factor of $100 per MWh

Incremental Fuel Oil Incentives Relative to Current Market Rules

Summary of Changes in Results

- Compared to CMR, net incentives to maintain energy inventory increase for all types of oil-fired resources
- Updated results – with revised categories – are in the appendix
- As in prior analyses:
  - In the Frequent and Extended Cases, new FER payments and DA energy options (for ESI AS products) exceed incremental holding costs
  - In the Infrequent Case, plants with dual fuel capabilities continue to receive positive returns for holding incremental energy inventory, while oil-only, incur negative returns, as these units infrequently supply energy and DA energy options
  - Incremental energy inventory may not be beneficial under all market conditions, particularly when market conditions (including weather conditions) provide sufficient supplies of energy inventory

Incremental Fuel Oil Incentives Relative to Current Market Rules

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

Technology Type	Number of Units	Change in Holding Costs ($ / MW)	ESI FER Payments ($ / MW)	ESI DA Energy Option Revenue ($ / MW)	Change in Net Revenue ($ / MW)
Dual Fuel, Combined Cycle (CC)	17	-$14.15	$5,434.77	$144.62	$5,565.25
Dual Fuel, Peaker (GT/CT/IC)	14	-$118.48	$5,870.30	$2,238.41	$7,990.23
Oil Only, Non-steam (NST)	70	-$134.19	$1,782.78	$1,018.99	$2,667.58
Oil Only, Steam (ST)	13	-$1,257.23	$6,199.94	$618.52	$5,561.23

- Compared to CMR, net incentives to maintain energy inventory increase for all types of oil-fired resources
- In the Frequent Case, new FER payments and DA energy options (for ESI AS products) exceed incremental holding costs

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Incremental Fuel Oil Incentives Relative to Current Market Rules

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

Technology Type	Number of Units	Change in Holding Costs ($ / MW)	ESI FER Payments ($ / MW)	ESI DA Energy Option Revenue ($ / MW)	Change in Net Revenue ($ / MW)
Dual Fuel, Combined Cycle (CC)	17	-$111.58	$2,225.58	$64.66	$2,178.66
Dual Fuel, Peaker (GT/CT/IC)	14	-$124.74	$1,940.07	$1,223.23	$3,038.55
Oil Only, Non-steam (NST)	70	-$87.78	$724.17	$562.79	$1,199.19
Oil Only, Steam (ST)	13	-$1,292.41	$2,912.84	$113.81	$1,734.24

- Results are similar for the Extended Case as the Frequent Case

Incremental Fuel Oil Incentives Relative to Current Market Rules

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

Technology Type	Number of Units	Change in Holding Costs ($ / MW)	ESI FER Payments ($ / MW)	ESI DA Energy Option Revenue ($ / MW)	Change in Net Revenue ($ / MW)
Dual Fuel, Combined Cycle (CC)	17	-$254.25	$793.66	$12.62	$552.02
Dual Fuel, Peaker (GT/CT/IC)	14	-$434.83	$153.07	$438.14	$156.38
Oil Only, Non-steam (NST)	70	-$83.98	$7.67	$0.00	-$76.30
Oil Only, Steam (ST)	13	-$1,315.39	$96.84	$3.58	-$1,214.97

- In the Infrequent Case, plants with dual fuel capabilities continue to receive positive returns for holding incremental energy inventory
  - For oil-only plants, additional holding costs of the assumed level of incremental fuel inventory exceeds the total FER and ESI DA AS payments; under infrequent stressed conditions, these units infrequently supply energy and DA energy options
- Incremental energy inventory may not always be beneficial, particularly when market conditions provide sufficient supplies of energy inventory

Incremental LNG Contract Incentives Relative to Current Market Rules

Summary of Changes in Results

- Compared to CMR, net incentives to enter into a forward LNG contracts are increased under ESI
- Incremental revenues associated with signing an LNG contract are greater under ESI because of additional revenues from FER payments and award of DA energy options

FER Revenues to Generators with LNG Contracts under ESI

	ESI FER Revenues				
Severity	FER Hours	FER Price [A]	FER MWh [B]	**FER Payments ($) [C] = [A]*[B]**	**FER Payments ($/MW)**
Frequent Stressed Conditions	240	$8.70	146,311	$1,272,608	$2,065
Extended Stressed Conditions	240	$6.41	146,311	$937,613	$1,521
Infrequent Stressed Conditions	0	NA	0	$0	$0

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Update to Central Case Results: Energy Supply

Changes in DA Energy With ESI

Difference in Cleared DA Energy by Resource Type, CMR vs ESI, Central Cases

	CMR	ESI		Difference	Real-Time Comparison	
Severity	Day-Ahead Energy [A]	Day-Ahead Energy [B]	Cleared EIR [C]	Day-Ahead Energy [D] = [B] - [A]	Real-Time Demand	Energy + EIR [E] = [B] + [C]
Frequent Stressed Conditions	31,188,025	32,215,664	6,256	1,027,639	32,155,711	32,221,920
Extended Stressed Conditions	31,503,187	31,942,916	25,860	439,729	31,840,458	31,968,776
Infrequent Stressed Conditions	31,047,336	31,635,091	82,640	587,755	31,525,206	31,717,731

- With ESI, total cleared DA energy increases (compared to CMR)
  - Adjustment due to cost savings of substituting DA energy for EIR, which does not incur a cost under CMR
  - This substitution leads EIR to be relatively small in most cases
- With ESI, cleared DA energy quantities are more similar to system real-time demand than under current market rules

Energy Supply

DA Energy and Energy Option Mix

- With ESI, the mix of energy supply shifts
  - Under ESI, DA energy supply generally increases for all resource types, with certain exceptions
    - Increase in DA energy greatest for dual-fuel and gas-only
    - Oil-fired steam supply increases across Cases, as well
  - DA energy options supplied largely by pumped storage, GT's (dual fuel, oil-only and gas-only), hydro and CC's (dual fuel and gas-only)
  - Some substitution from DA energy to DA energy options (particularly, oil-fired GT's)

Total Winter Generation Mix

Energy and DA Options by Resource Type, CMR vs ESI, Frequent Stressed Conditions

Resource Type	Nameplate Capacity (MW)	DA CMR Energy (MWh)	DA ESI Energy (MWh)	DA Energy Options (MWh)	Change in DA Energy (MWh)
Active Demand Response	285	18,559	18,898	0	339
Battery Storage	458	(4,945)	(4,945)	0	0
Biomass/Refuse	849	1,601,428	1,601,548	0	120
Coal	535	957,230	965,073	10,922	7,844
Dual Fuel - CC	6,392	5,887,192	6,224,546	421,283	337,355
Dual Fuel - GT	1,435	697,219	737,326	1,289,815	40,108
Fuel Cell	21	35,109	35,125	0	17
Gas - CC	7,583	3,131,703	3,467,718	419,553	336,014
Gas - GT	404	669	723	287,110	54
Hydro	1,987	1,251,996	1,251,996	790,887	0
Imports	2,850	6,096,019	6,099,678	0	3,659
Nuclear	3,344	7,184,403	7,184,403	0	0
Offshore Wind	800	879,483	879,483	0	0
Oil Only - Steam	3,792	1,290,766	1,560,335	226,824	269,569
Oil Only - Non-steam	2,511	194,309	169,811	1,967,690	(24,498)
Pumped Storage	1,778	(216,038)	(216,038)	2,251,837	0
Solar	1,671	152,197	152,197	0	0
Wind	1,401	992,964	992,964	0	0

Total Winter Generation Mix

Energy and DA Options by Resource Type, CMR vs ESI, Extended Stressed Conditions

Resource Type	Nameplate Capacity (MW)	DA CMR Energy (MWh)	DA ESI Energy (MWh)	DA Energy Options (MWh)	Change in DA Energy (MWh)
Active Demand Response	285	23,846	12,045	0	(11,801)
Battery Storage	458	(4,945)	(4,945)	0	0
Biomass/Refuse	849	1,581,343	1,577,807	0	(3,536)
Coal	535	646,721	652,099	9,077	5,377
Dual Fuel - CC	6,392	5,416,572	5,616,118	403,029	199,546
Dual Fuel - GT	1,435	470,553	494,728	1,423,053	24,175
Fuel Cell	21	23,202	23,318	0	117
Gas - CC	7,583	4,729,551	4,935,505	272,464	205,954
Gas - GT	404	0	0	310,416	0
Hydro	1,987	1,526,266	1,526,266	1,123,614	0
Imports	2,850	5,929,432	5,931,749	0	2,317
Nuclear	3,344	7,184,403	7,184,403	0	0
Offshore Wind	800	879,483	879,483	0	0
Oil Only - Steam	3,792	619,222	640,474	37,499	21,252
Oil Only - Non-steam	2,511	116,800	66,541	1,129,945	(50,259)
Pumped Storage	1,778	(216,038)	(216,038)	3,080,047	0
Solar	1,671	245,603	245,603	0	0
Wind	1,401	1,083,132	1,083,132	0	0

Total Winter Generation Mix

Energy and DA Options by Resource Type, CMR vs ESI, Infrequent Stressed Conditions

Resource Type	Nameplate Capacity (MW)	DA CMR Energy (MWh)	DA ESI Energy (MWh)	DA Energy Options (MWh)	Change in DA Energy (MWh)
Active Demand Response	285	4,246	4,380	0	134
Battery Storage	458	(4,945)	(4,945)	0	0
Biomass/Refuse	849	1,559,242	1,559,856	0	614
Coal	535	549,273	558,755	16,164	9,483
Dual Fuel - CC	6,392	5,170,503	5,440,892	362,594	270,389
Dual Fuel - GT	1,435	362,534	362,690	1,526,710	156
Fuel Cell	21	12,645	13,166	0	521
Gas - CC	7,583	5,543,212	5,833,034	297,594	289,822
Gas - GT	404	74	74	394,715	(0)
Hydro	1,987	1,421,185	1,421,185	1,137,865	0
Imports	2,850	5,850,967	5,856,812	0	5,845
Nuclear	3,344	7,184,403	7,184,403	0	0
Offshore Wind	800	931,752	931,752	0	0
Oil Only - Steam	3,792	51,739	61,430	2,422	9,691
Oil Only - Non-steam	2,511	2,553	3,617	1,310,903	1,065
Pumped Storage	1,778	(216,038)	(216,038)	2,809,637	0
Solar	1,671	289,960	289,960	0	0
Wind	1,401	1,017,230	1,017,230	0	0

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Update to Central Case Results: Net Revenues and Production Costs

Net Revenues and Production Costs

Key Takeaways

- Total production costs are reduced in Cases where the incremental fuel ESI incents is used to displace generation from higher cost, less efficient units
  - Change in production costs may be understated, as distribution of incremental energy inventory across resources may not reflect optimal allocation
- Changes in net revenues vary across Cases and resource types, on average
  - Net revenues reflect multiple factors, including changes to LMPs, new FER payments and ESI awards for DA energy options
  - Changes sensitive to amount of incremental energy inventory incented by ESI across all resources

Production Costs

Production Costs, with and without ESI, Central Cases

Case	Total Model Production Costs [1] ($ Million) CMR	ESI	Change	Incremental Energy Inventory Costs with ESI [2] ($ Million)	Change in Total Production Costs ($ Million)
Frequent Stressed Conditions	$1,415.1	$1,374.3	($40.8)	$5.3	($35.5)
Extended Stressed Conditions	$939.5	$914.5	($25.0)	$5.7	($19.3)
Infrequent Stressed Conditions	$657.2	$656.3	($0.9)	$8.5	$7.5

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.

- Production costs lower in 2 of 3 cases despite increased DA energy market requirements

Net Revenues

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]**
Dual Fuel - CC	$38,260	$42,189	$3,929
Dual Fuel - GT	$19,548	$30,007	$10,459
Gas Only - CC	$2,231	$3,292	$1,060
Gas Only - GT	$188	$6,146	$5,957
Oil Only - Steam	$10,174	$14,832	$4,659
Oil Only - Non-steam	$2,435	$8,708	$6,273
Coal	$161,951	$165,447	$3,496
Biomass/Refuse	$229,680	$232,967	$3,287
Fuel Cell	$144,742	$147,843	$3,101
Hydro	$95,745	$100,151	$4,405
Nuclear	$268,661	$272,289	$3,627
Solar	$12,222	$12,241	$19
Wind	$94,529	$95,725	$1,196
Offshore Wind	$138,457	$139,932	$1,475

Net Revenues

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]**
Dual Fuel - CC	$20,343	$18,426	($1,917)
Dual Fuel - GT	$13,555	$17,254	$3,699
Gas Only - CC	$6,257	$6,757	$501
Gas Only - GT	$0	$3,301	$3,301
Oil Only - Steam	$9,748	$5,553	($4,195)
Oil Only - Non-steam	$3,964	$2,603	($1,361)
Coal	$87,783	$82,771	($5,012)
Biomass/Refuse	$148,791	$143,468	($5,324)
Fuel Cell	$76,588	$71,509	($5,080)
Hydro	$66,814	$67,407	$594
Nuclear	$175,308	$169,772	($5,537)
Solar	$9,944	$9,662	($282)
Wind	$68,604	$65,169	($3,435)
Offshore Wind	$93,357	$89,939	($3,418)

Net Revenues

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]**
Dual Fuel - CC	$6,594	$7,110	$516
Dual Fuel - GT	$6,070	$7,730	$1,660
Gas Only - CC	$7,702	$8,358	$657
Gas Only - GT	$21	$1,595	$1,574
Oil Only - Steam	$310	($971)	($1,281)
Oil Only - Non-steam	$1	$776	$774
Coal	$34,234	$35,192	$958
Biomass/Refuse	$96,287	$97,460	$1,173
Fuel Cell	$27,541	$28,029	$489
Hydro	$39,673	$41,189	$1,516
Nuclear	$115,752	$117,120	$1,368
Solar	$7,707	$7,761	$54
Wind	$38,893	$39,312	$418
Offshore Wind	$60,976	$61,704	$728

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Net Revenues

Frequent Stressed Conditions Case

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

		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]	$65,444	$17,302	$135,328	$86,708
Production Costs	[B]	$55,270	$14,867	$97,068	$67,160
Net Revenues	[C] = [A] - [B]	$10,174	$2,435	$38,260	$19,548
ESI					
Settlement Revenues	[D]	$68,618	$18,411	$142,694	$95,491
Production Costs	[E]	$52,528	$9,596	$100,496	$65,375
Incremental Oil Holding Costs	[F]	$1,257	$107	$9	$109
LNG Contract Costs	[G]				
Net Revenues	[H] = [D] - ([E]+[F]+[G])	$14,832	$8,708	$42,189	$30,007
Incremental ESI Net Revenues	[H] - [C]	$4,659	$6,273	$3,929	$10,459

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Net Revenues

Extended Stressed Conditions Case

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

		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]	$37,501	$11,244	$81,960	$42,186
Production Costs	[B]	$27,754	$7,280	$61,616	$28,631
Net Revenues	[C] = [A] - [B]	$9,748	$3,964	$20,343	$13,555
ESI					
Settlement Revenues	[D]	$29,966	$6,533	$81,500	$44,598
Production Costs	[E]	$23,121	$3,860	$63,000	$27,229
Incremental Oil Holding Costs	[F]	$1,292	$70	$74	$115
LNG Contract Costs	[G]				
Net Revenues	[H] = [D] - ([E]+[F]+[G])	$5,553	$2,603	$18,426	$17,254
Incremental ESI Net Revenues	[H] - [C]	($4,195)	($1,361)	($1,917)	$3,699

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Net Revenues

Infrequent Stressed Conditions Case

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

		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]	$2,897	$301	$51,344	$15,559
Production Costs	[B]	$2,588	$300	$44,750	$9,489
Net Revenues	[C] = [A] - [B]	$310	$1	$6,594	$6,070
ESI					
Settlement Revenues	[D]	$2,540	$1,044	$52,183	$16,961
Production Costs	[E]	$2,196	$202	$44,905	$8,831
Incremental Oil Holding Costs	[F]	$1,315	$67	$169	$400
LNG Contract Costs	[G]				
Net Revenues	[H] = [D] - ([E]+[F]+[G])	($971)	$776	$7,110	$7,730
Incremental ESI Net Revenues	[H] - [C]	($1,281)	$774	$516	$1,660

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Update to Central Case Results: Operational and Reliability Outcomes

Operational / Reliability Metrics

Multiple Metrics to Capture Different Aspects of Energy Security

- ***Operating reserve shortages***. Hours of 10- or 30-minute operating reserve shortage
- ***Natural gas consumption when natural gas supply is tight***. Change in natural gas consumption during periods when NG supply is tight, as reflected by high prices (> $16 / MMBtu), net of NG from forward LNG contracts
- ***Minimum daily deliverable energy from oil-fired units.*** Minimum daily quantity of energy (MWh) available from oil-only and dual-fuel resources given actual fuel inventory
- ***Average daily deliverable energy from oil-fired units.*** Average daily quantity of energy (MWh) available from oil-only and dual-fuel resources given actual fuel inventory
- **Maximum 4-day drop in energy inventory.** Largest drop in energy inventory over a 4-day period.

Operational / Reliability Metrics

Multiple Metrics to Capture Different Aspects of Energy Security

Change in Reliability Metric with ESI compared to CMR
Central Cases

Case	Operating Reserve Shortages (Hours)	Natural Gas Used in Generation When NG Economically Binding (MMBtu)	Daily Available Oil Generation Minimum (MWh)	Daily Available Oil Generation Average (MWh)	Daily Available Oil Generation Largest Four Day Decline (MWh)
Frequent Stressed Conditions	0	(2,900,051)	24,487	15,204	(15,815)
Extended Stressed Conditions	0	(943,020)	32,663	14,017	(2,886)
Infrequent Stressed Conditions	0	0	6,753	11,656	2,045

- Consistent with prior results, ESI generally relaxes energy physical and economic constraints
  - Reduced reliance on NG supply when supplies are constrained (prices are high)
  - Increased energy inventory
  - Reduced draw-down on energy inventory during periods of need

System Operations and Reliability

Key Takeaways

- ESI generally expected to improve system operations and reliability
  - Increased energy inventory reduces risk of operational events
  - Reduced reliance and stress on fixed fuel (natural gas) delivery systems
  - Compensation for DA energy option helps to preserve energy inventory, while shifting energy supply to resources with just-in-time fuel supplies (i.e., natural gas)
    - Magnitude of this effect will tend to increase as system conditions become more stressed

Update to Winter Scenario Analysis Results

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Additional Winter Scenarios: Fuel Assumptions Same as Central Case

Scenario Name	Scenario Description
Central Case	"Central Case" Current Market Rules (CMR) and Energy Security Improvements (ESI) assumptions
ESI Design	
RER Plus	"Central Case" with RER requirement set to 150% of Central Case level (1,800 MW).
Strike Plus $10	"Central Case" with DA energy option strike price = Central Case strike price + $10 in all hours; adjustment affects all calculations, incuding risk premia.
Risk Premium x1.25	"Central Case" with DA energy option offers calculating using risk premia set at 125% of Central Case levels.
Alternative Resources & Demand	
Supply Shocks	Unexpected real-time outages, experienced during coldest portion of historic winter.
Shock HQ 1 Day	Supply shock (outage) fo 1,364 MW is modeled in real-time market, but not modeled in day-ahead market. - Frequent Stressed Conditions: on January 3, 2014 (average temperature 11.64 F); - Extended Stressed Conditions: on January 1, 2018 (average temperature 2.72 F); - Infrequent Stressed Conditions: on December 6, 2016 (average temperature 4.77 F).
Shock HQ 5 Days	Supply shock of 1,364 MW is modeled in Day-1 real-time market, but not expected in Day 1 day-ahead market. Resource is expected out day-ahead in remaining days (Days 2-5). - Frequent Stressed Conditions: on January 21-25, 2014 (average temperature 12.83 F); - Extended Stressed Conditions: on December 28, 2017 - January 1 2018 (average temperature 5.68 F); - Infrequent Stressed Conditions: on January 6-10, 2016 (average temperature 19.07 F).
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.
Low LNG Supply	Assume reduced LNG availability of 0.12 Bcf/day in both ESI and CMR cases for all winter severities (corresponding to LNG forward contract).
High Load	Load is increased by 5%, with no other modeling changes.
Resource Mix	Changes in retirements and replacements to future-year resource mix. For all scenarios: ~1,500 MW at-risk resources retired.
Oil Retirements	For oil retirement scenarios: an additional ~1,000 MW of oil resources retired.
Oil Retirements; Renewable Replacement	3,824 MW nameplate (1,400 MW derated) of new offshore wind, 1,200 MW of new hydro imports, and 0.3 Bcf/day of additional LNG capacity added.
Nuclear Retirements	For nuclear retirement scenarios: an additional ~3,500 MW of nuclear resources retired.
Nuclear Retirements; Renewable Replacement	8,824 MW nameplate (3,000 MW derated) of new offshore wind, 5,333 MW nameplate (800 MW derated) of new onshore wind, 1,200 MW of new hydro imports, and 0.6 Bcf/day of additional LNG capacity added.
No Incremental Oil under ESI	
No Incremental Oil under ESI	"Central Case" CMR and ESI assumptions, but CMR oil inventory levels assumed for ESI.

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Winter Scenarios - Payments and Prices

Frequent Stressed Case

	Weighted Average 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	($5.51)	$7.75	$27.14	$66	$66	$132
ESI Design Scenarios						
RER Plus	($5.39)	$9.52	$30.82	$127	$106	$233
Strike Plus $10	($5.43)	$7.77	$23.05	$69	$62	$131
Risk Premium x1.25	($5.32)	$7.77	$32.50	$72	$108	$180
Alternative Resources & Demand Scenarios						
Shock HQ 1 Day	($5.42)	$7.70	$27.14	$61	$66	$127
Shock HQ 5 Days	($19.37)	$20.54	$33.35	($25)	$116	$91
High LNG Supply	($9.00)	$6.13	$24.75	($98)	$48	($50)
Low LNG Supply	($6.84)	$9.42	$29.25	$78	$78	$156
High Load	($23.89)	$12.22	$31.19	($403)	$93	($311)
Oil Retirements; Renewable Replacement	($4.82)	$5.64	$23.89	$41	$43	$84
Nuclear Retirements; Renewable Replacement	($5.25)	$6.62	$26.21	$96	$62	$157
No Incremental Oil under ESI						
No Incremental Oil under ESI	($1.17)	$10.94	$30.06	$308	$85	$394

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Winter Scenarios - Payments and Prices

Extended Stressed Case

	Weighted Average 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
Extended Stressed Conditions - Central Case						
Central Case	($6.45)	$3.73	$14.68	($95)	$33	($62)
ESI Design Scenarios						
RER Plus	($6.29)	$4.47	$16.39	($66)	$53	($13)
Strike Plus $10	($6.53)	$3.46	$10.61	($106)	$26	($80)
Risk Premium x1.25	($6.40)	$3.81	$17.84	($91)	$58	($33)
Alternative Resources & Demand Scenarios						
Shock HQ 1 Day	($7.12)	$4.19	$15.37	($102)	$39	($64)
Shock HQ 5 Days	($7.12)	$4.19	$15.37	($102)	$39	($64)
High LNG Supply	($5.97)	$2.33	$13.13	($126)	$21	($104)
Low LNG Supply	($7.21)	$5.79	$16.40	($54)	$45	($9)
High Load	($14.00)	$5.68	$16.55	($292)	$46	($246)
Oil Retirements; Renewable Replacement	($4.09)	$2.19	$13.04	($54)	$21	($34)
Nuclear Retirements; Renewable Replacement	($2.69)	$2.01	$13.33	$12	$23	$35
No Incremental Oil under ESI						
No Incremental Oil under ESI	($2.57)	$7.93	$17.54	$165	$60	$225

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Winter Scenarios - Payments and Prices

Infrequent Stressed Case

	Weighted Average 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	($1.21)	$1.96	$5.78	$20	$15	$35
ESI Design Scenarios						
RER Plus	($1.55)	$2.50	$6.84	$26	$27	$53
Strike Plus $10	($0.87)	$1.38	$2.71	$15	$7	$22
Risk Premium x1.25	($1.31)	$2.14	$7.16	$22	$26	$48
Alternative Resources & Demand Scenarios						
Shock HQ 1 Day	($1.26)	$1.97	$5.79	$19	$15	$34
Shock HQ 5 Days	($1.29)	$2.08	$5.92	$21	$16	$37
High LNG Supply	($0.76)	$1.58	$5.73	$22	$14	$36
Low LNG Supply	($1.51)	$2.09	$5.82	$15	$15	$30
High Load	($1.45)	$2.18	$5.85	$21	$15	$37
Oil Retirements; Renewable Replacement	($1.28)	$1.45	$5.69	$18	$14	$32
Nuclear Retirements; Renewable Replacement	($1.74)	$1.72	$5.80	$27	$15	$42
No Incremental Oil under ESI						
No Incremental Oil under ESI	($1.04)	$1.96	$5.81	$26	$15	$41

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Winter Scenarios - Operational / Reliability Metrics

Frequent Stressed Conditions

Scenario Name/Acronym	System Reliability (Change)				
	Operating Reserve Shortages (Hours)	NG Used in Generation when NG Supply is Tight (MMBtu)	Daily Available Oil Generation Minimum (MWh)	Daily Available Oil Generation Average (MWh)	Daily Available Oil Generation Largest Four Day Decline (MWh)
Frequent Stressed Conditions - Central Case					
Central Case	0	(2,900,051)	24,487	15,204	(15,815)
ESI Design Scenarios					
RER Plus	0	(2,899,847)	23,931	15,187	(16,286)
Strike Plus $10	0	(2,899,363)	24,512	15,239	(15,815)
Risk Premium x1.25	0	(2,900,241)	24,539	14,886	(15,815)
Alternative Resources & Demand Scenarios					
Shock HQ 1 Day	0	(2,860,874)	24,539	15,342	(14,091)
Shock HQ 5 Days	(3)	(2,980,534)	28,026	15,904	(14,745)
High LNG Supply	0	(5,097,543)	14,821	17,475	(34,694)
Low LNG Supply	0	(1,909,443)	29,003	16,925	(15,066)
High Load	0	(3,680,051)	14,078	18,418	(23,414)
Oil Retirements; Renewable Replacement	0	(1,086,838)	20,942	14,490	(1,589)
Nuclear Retirements; Renewable Replacement	0	(903,635)	22,586	15,213	(11,278)
No Incremental Oil under ESI					
No Incremental Oil under ESI	0	(1,326,266)	645	(1,185)	(2,183)

Winter Scenarios - Operational / Reliability Metrics

Extended Stressed Conditions

Scenario Name/Acronym	System Reliability (Change)				
	Operating Reserve Shortages (Hours)	NG Used in Generation when NG Supply is Tight (MMBtu)	Daily Available Oil Generation Minimum (MWh)	Daily Available Oil Generation Average (MWh)	Daily Available Oil Generation Largest Four Day Decline (MWh)
Extended Stressed Conditions - Central Case					
Central Case	0	(943,020)	32,663	14,017	(2,886)
ESI Design Scenarios					
RER Plus	0	(938,207)	32,517	14,002	(2,886)
Strike Plus $10	0	(943,020)	32,663	14,017	(2,886)
Risk Premium x1.25	0	(943,020)	32,663	14,022	(2,886)
Alternative Resources & Demand Scenarios					
Shock HQ 1 Day	0	(1,009,333)	28,426	15,371	(6,721)
Shock HQ 5 Days	0	(1,009,333)	28,426	15,371	(6,721)
High LNG Supply	0	(3,440,918)	40,214	15,327	(26)
Low LNG Supply	0	(78,902)	26,394	15,541	(8,810)
High Load	0	(851,854)	25,828	15,984	(3,746)
Oil Retirements; Renewable Replacement	0	(625,636)	11,128	11,078	(538)
Nuclear Retirements; Renewable Replacement	0	(332,387)	28,510	12,340	(6,551)
No Incremental Oil under ESI					
No Incremental Oil under ESI	0	(739,566)	3,017	(85)	(247)

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Winter Scenarios - Operational / Reliability Metrics

Infrequent Stressed Conditions

	System Reliability (Change)				
Scenario Name/Acronym	Operating Reserve Shortages (Hours)	NG Used in Generation when NG Supply is Tight (MMBtu)	Daily Available Oil Generation Minimum (MWh)	Daily Available Oil Generation Average (MWh)	Daily Available Oil Generation Largest Four Day Decline (MWh)
Infrequent Stressed Conditions - Central Case					
Central Case	0	NA	6,753	11,656	2,045
ESI Design Scenarios					
RER Plus	0	NA	6,753	11,656	2,045
Strike Plus $10	0	NA	6,753	11,656	2,045
Risk Premium x1.25	0	NA	6,753	11,656	2,045
Alternative Resources & Demand Scenarios					
Shock HQ 1 Day	0	NA	7,237	12,184	3,501
Shock HQ 5 Days	0	NA	6,569	12,068	2,228
High LNG Supply	0	NA	14,294	10,452	(4,307)
Low LNG Supply	0	NA	22,417	13,526	(8,470)
High Load	0	NA	14,520	12,955	96
Oil Retirements; Renewable Replacement	0	NA	14,728	12,037	(6,001)
Nuclear Retirements; Renewable Replacement	0	NA	8,562	11,244	5,129
No Incremental Oil under ESI					
No Incremental Oil under ESI	0	NA	0	0	0

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Winter Scenarios - Operational / Reliability Metrics

Frequent Stressed Conditions

Scenario Name/Acronym	System Reliability (Change)			
	GCR 10 Shortages (Hours)	GCR 30 Shortages (Hours)	RER Shortages (Hours)	EIR Shortages (Hours)
Frequent Stressed Conditions - Central Case				
Central Case	0	0	62	0
ESI Design Scenarios				
RER Plus	0	0	97	0
Strike Plus $10	0	0	63	0
Risk Premium x1.25	0	0	62	0
Alternative Resources & Demand Scenarios				
Shock HQ 1 Day	0	0	63	0
Shock HQ 5 Days	0	23	95	0
High LNG Supply	0	0	31	0
Low LNG Supply	0	0	122	0
High Load	0	0	141	0
Oil Retirements; Renewable Replacement	0	0	2	0
Nuclear Retirements; Renewable Replacement	0	1	33	0
No Incremental Oil under ESI				
No Incremental Oil under ESI	0	0	113	0

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Winter Scenarios - Operational / Reliability Metrics

Extended Stressed Conditions

Scenario Name/Acronym	System Reliability (Change)			
	GCR 10 Shortages (Hours)	GCR 30 Shortages (Hours)	RER Shortages (Hours)	EIR Shortages (Hours)
Extended Stressed Conditions - Central Case				
Central Case	0	0	25	0
ESI Design Scenarios				
RER Plus	0	0	44	0
Strike Plus $10	0	0	22	0
Risk Premium x1.25	0	0	26	0
Alternative Resources & Demand Scenarios				
Shock HQ 1 Day	0	0	31	0
Shock HQ 5 Days	0	0	31	0
High LNG Supply	0	0	0	0
Low LNG Supply	0	0	59	0
High Load	0	0	55	0
Oil Retirements; Renewable Replacement	0	0	0	0
Nuclear Retirements; Renewable Replacement	0	0	4	0
No Incremental Oil under ESI				
No Incremental Oil under ESI	0	0	62	0

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Winter Scenarios - Operational / Reliability Metrics

Infrequent Stressed Conditions

Scenario Name/Acronym	System Reliability (Change)			
	GCR 10 Shortages (Hours)	GCR 30 Shortages (Hours)	RER Shortages (Hours)	EIR Shortages (Hours)
Infrequent Stressed Conditions - Central Case				
Central Case	0	0	0	0
ESI Design Scenarios				
RER Plus	0	0	0	0
Strike Plus $10	0	0	0	0
Risk Premium x1.25	0	0	0	0
Alternative Resources & Demand Scenarios				
Shock HQ 1 Day	0	0	0	0
Shock HQ 5 Days	0	0	0	0
High LNG Supply	0	0	0	0
Low LNG Supply	0	0	0	0
High Load	0	0	0	0
Oil Retirements; Renewable Replacement	0	0	0	0
Nuclear Retirements; Renewable Replacement	0	0	0	0
No Incremental Oil under ESI				
No Incremental Oil under ESI	0	0	0	0

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