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Energy Security Improvements Impact Analysis

Todd Schatzki
Principal

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Agenda

- New DA Energy Option Offers – Risk Premium
- ESI and CMR Case Future Results

New DA Energy Option Offers – Risk Premium

Offers for Proposed ESI Products

Approach Based on Financial Risks of DA Energy Options

- Approach to DA Energy Option offers was discussed at July 8, 2018 Markets Committee meeting
- To recap, market participant offers for ESI products will reflect two components:
  - First component captures the *expected* cost *of settling the option* against RT LMPs (***expected "closeout costs***")
  - Second component captures financial risk faced by market participants when taking the option position (i.e., a ***risk premium***)
- First component (expected closeout costs) was discussed at July 8 MC meeting – will not discuss further today
- Second component (risk premium) will be discussed today
- Analysis of unrecovered cost of actions taken to secure energy inventory will be based on comparison of these costs to change in net revenues associated with taking each action

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Offers for Proposed ESI Products

Resource offers

- ESI offer prices reflect costs of settlement plus a risk premium – mathematically:

$$ESI\ AS\ Offer = Expected\ Cost\ of\ Settlement + Risk\ Premium$$

$$= E[Max(LMP - K, 0)] + RP(MC_{inv}, K, \sigma_{LMP})$$

  - Here, the risk premium depends on many factors that affect the riskiness of the option position, including:
    - Expected marginal production costs (*MC*) given resource's fuel inventory (accounting for inventory surety)
    - *K*, the option strike price
    - LMP volatility (σ_{LMP})

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Financial Risk from DA Energy Options

Financial Risk Lower with Physical Inventoried Energy

- Effectiveness of the hedge on option settlement risk depends on the expected marginal costs (MC) of supplying energy underlying the option position
  - A resource with no inventory faces very high MC as it either buys fuel at spot or cannot get fuel on intraday market
  - A resource with inventory, but high MC, has a only partial (or no) hedge
  - A resource with inventory, but low MC, has a more effective hedge and lower risk as the likelihood that resource supplies in RT is greater
- Implications
  - Incentives to sell ESI energy option are greatest for those resources that can supply inventoried energy with lowest MC
  - Creates incentives to secure energy in advance to mitigate closeout cost risk
  - Incentives are aligned (even if there is no physical requirement)

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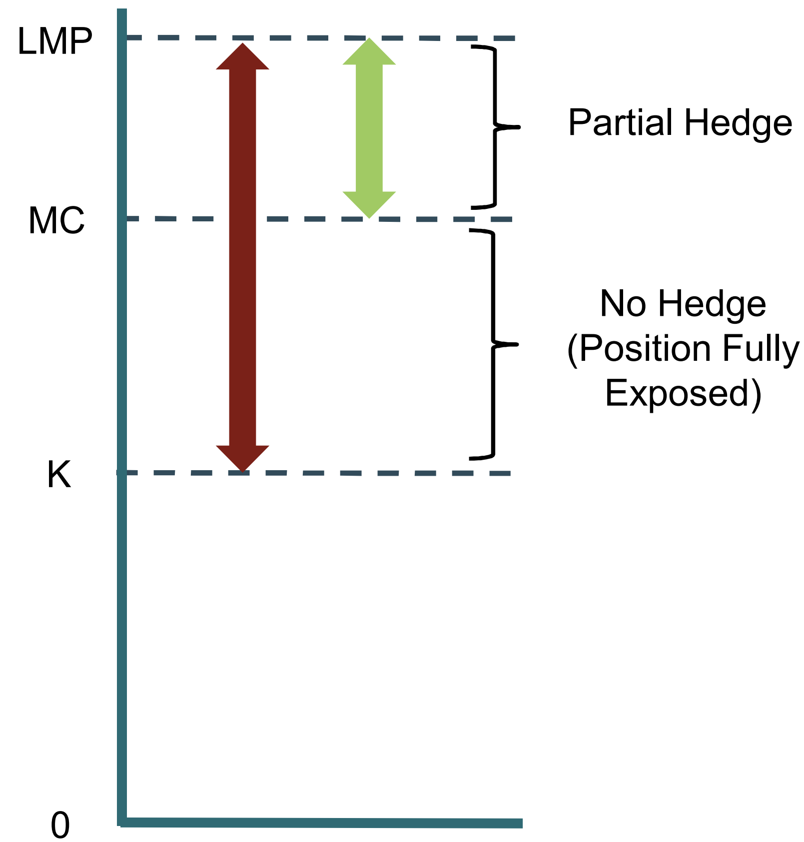
Financial Risk from DA Energy Options

Risk Premium Depends on Exposure Created by Option Position

For each unit, net position reflects energy and ESI positions:

- Energy:
  - Earn Max (0, LMP – MC)
- ESI:
  - Pay Max (0, LMP – K)

- Thus, the degree to which an ESI position creates exposed risk varies with marginal cost of supply
  - As MC decreases, exposure decreases
  - As MC increases, exposure increases



Approach to Estimating ESI Offer Risk Premium

Estimation of Risk Premium

- Estimates of option risk premium build off the observation that the same risk preferences underlying risk premiums for forward positions (e.g., a DA energy position) underlie risk premiums for DA energy options
  - Prior research estimates risk premiums for forward positions on the order of 1 to 2 percent, particularly during more volatile winter periods (e.g., Jacobs, Li and Pirrong, 2017)
  - While forward risk premiums can be observed, in practice, DA energy option risk premiums cannot
- DA energy option risk premium estimates reflect risk preferences revealed in forward risk premiums, making appropriate adjustments to account for:
  - Relative sizes of forward energy price to DA energy option price
  - Relative size of the risk, as measured by the standard deviation of the (negative) returns

Approach to Estimating ESI Risk Premium

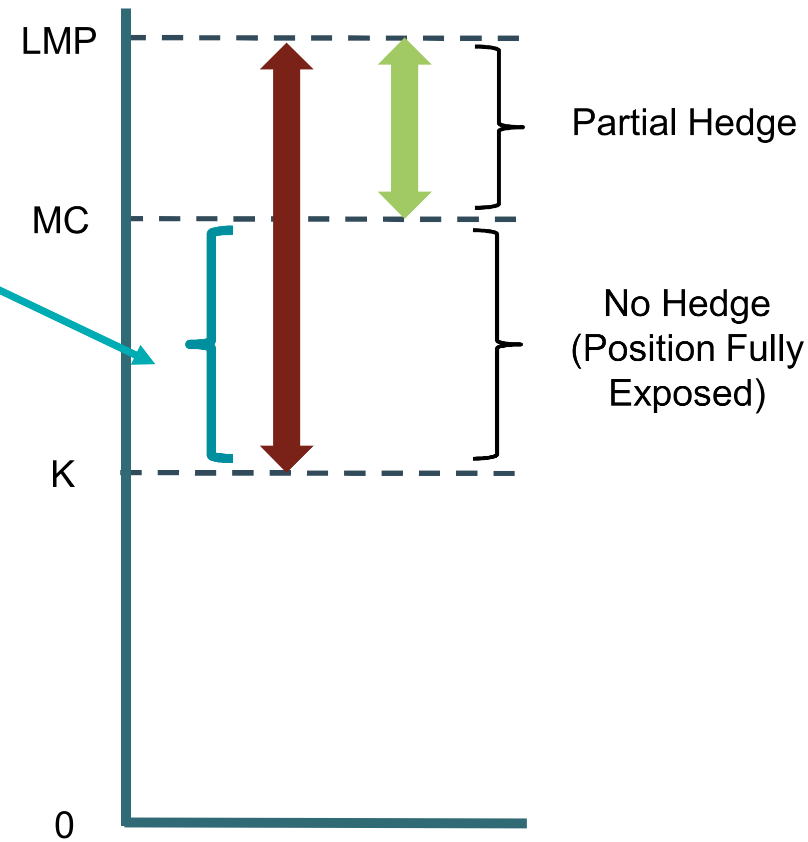
Risk Premium Depends on Exposure Created by Option Position

Risk premium is resource-specific, depending on the resource's marginal costs relative to *K* in each hour

Difference in risk based on observed differences in variability of returns on positions as MC varies

Details in to be provided in subsequent materials

Analysis is *preliminary*



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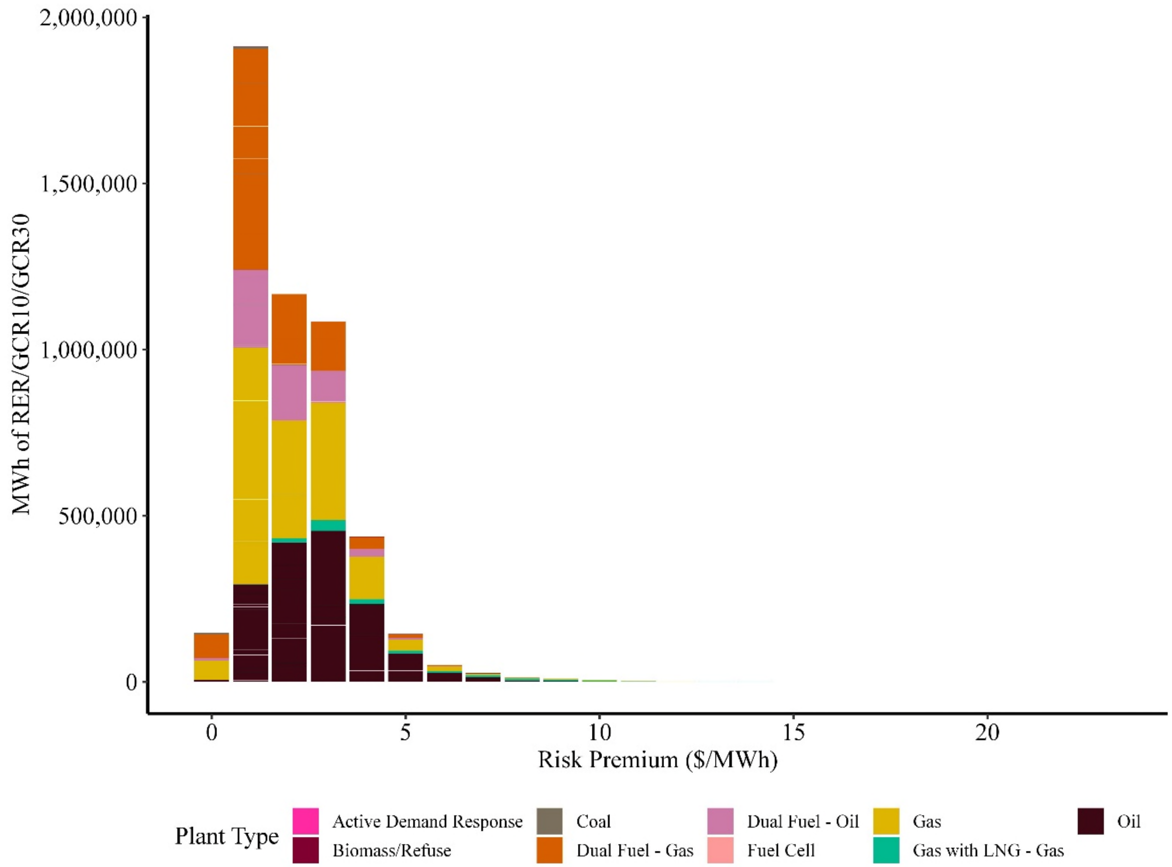
Risk Premium

Estimated Risk Premiums – High Future Case, Cleared



Note:
[1] "Gas with LNG – [fuel]" refers to Gas units with an LNG contract, running the specified fuel type.

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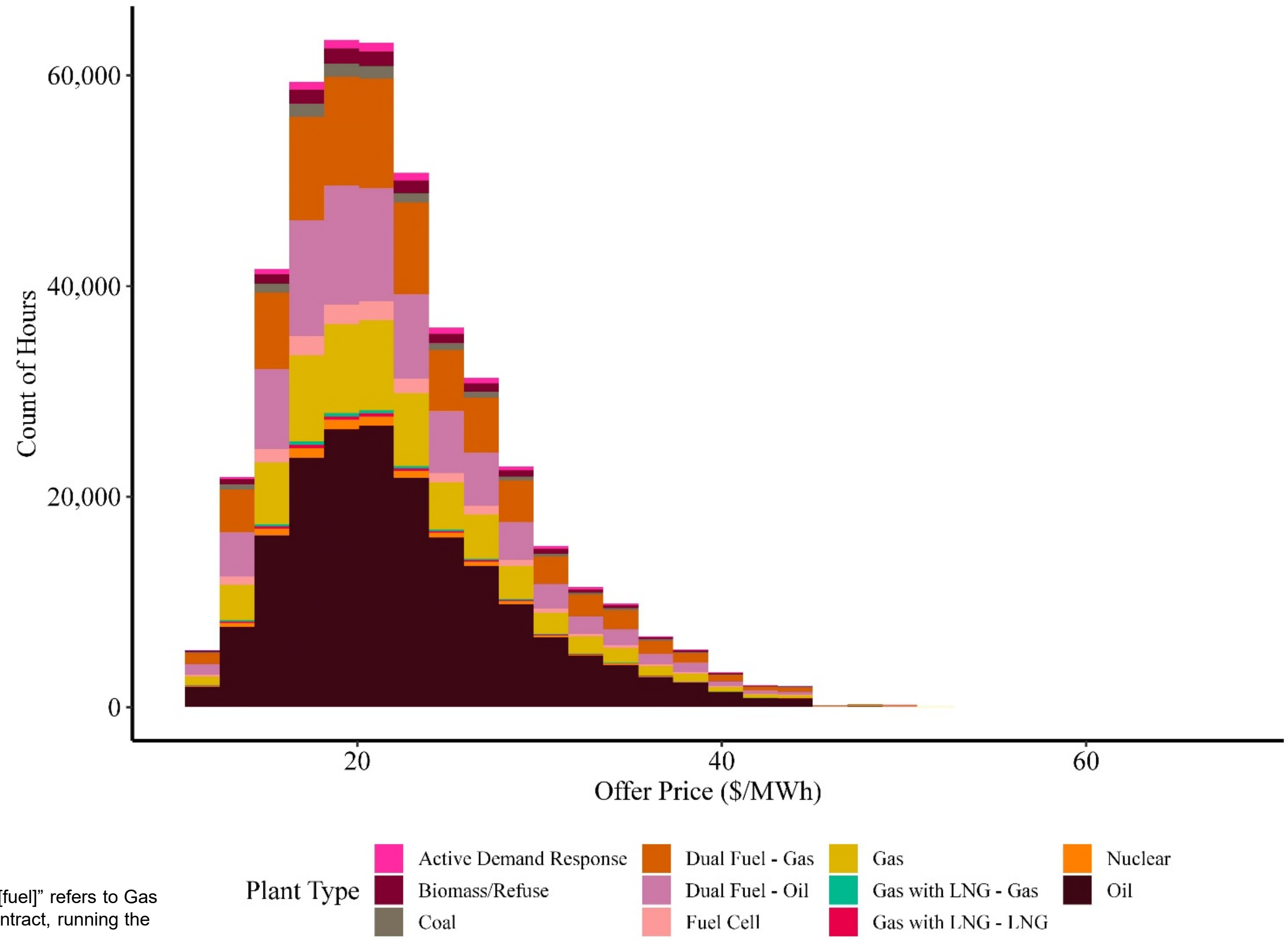
DA Energy Option Offers

Estimated DA Energy Option Offers – High Future Case



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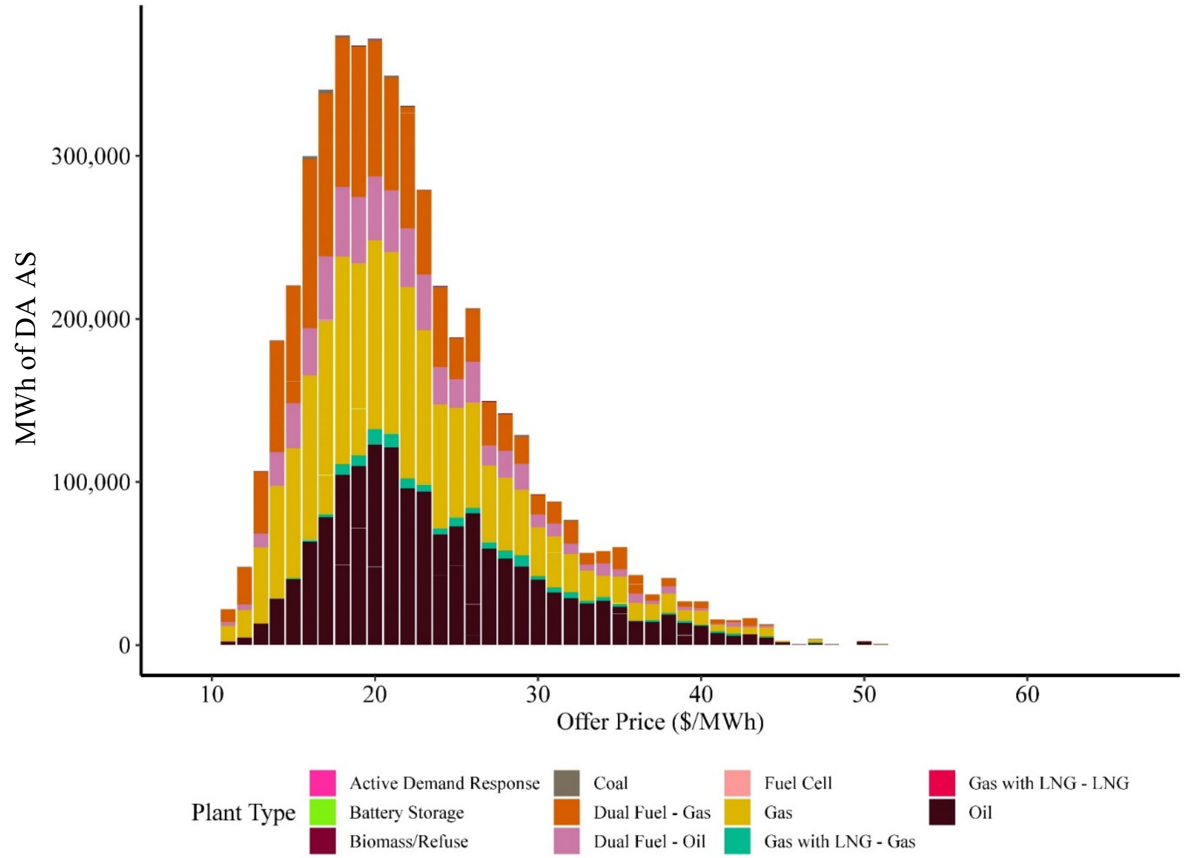
DA Energy Option Offers

Estimated DA Energy Option Cleared Prices – High Future Case



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[1] "Gas with LNG – [fuel]" refers to Gas units with an LNG contract, running the specified fuel type.

Future Cases – Preliminary Results

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 winter severity in a future year, 2025/26:
  - Low 2016/2017
  - Moderate 2017/2018
  - High 2013/2014
- Modeling approach does not capture all market features (congestion; commitment/start-up and min-load costs; full EIS calculations, etc.)
- Results are *preliminary* – some ESI elements and some assumptions are still being refined – and some analysis is not complete
- Although preliminary, results provide reasonable estimates of impacts for the cases evaluated

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Market Impacts

Changes in Market Clearing Prices

- The model analyzes prices (LMPs) on an hourly level for the DA and RT markets
- Changes in DA and RT LMPs potentially reflects many factors, including:
  - Incremental energy inventory available to meet DA and RT energy demand
  - Substitution in resource-level awards between energy and DA energy options
  - Changes in opportunity costs given changes in resource-level energy inventory
- The following figures illustrate LMP impacts – in general, we see:
  - Overall reduction in LMPs in the DA and RT markets
  - Reduction in peak DA and RT prices
  - Both increases and decreases in hourly DA and RT prices compared to CMR
  - Forecast Energy Requirement (FER) payments to DA energy not included, thus do not reflect full ESI impact

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Average Hourly LMPs: CMR vs ESI

Future Cases

Case	Mean LMP - CMR		Mean LMP - ESI Base		Mean ESI Impact	
	Day-Ahead [A]	Real-Time [B]	Day-Ahead [C]	Real-Time [D]	Day-Ahead [E] = [C] - [A]	Real-Time F = [D] - [B]
High Case	$130.53	$131.70	$123.38	$123.83	$-7.15	$-7.87
Medium Case	$92.63	$84.08	$82.87	$78.70	$-9.76	$-5.38
Low Case	$55.47	$55.48	$55.33	$55.38	$-0.14	$-0.10

- Average LMPs generally lower with ESI, with difference varying across winter cases
- Does not include FER payments to DA energy, which are discussed in subsequent slides

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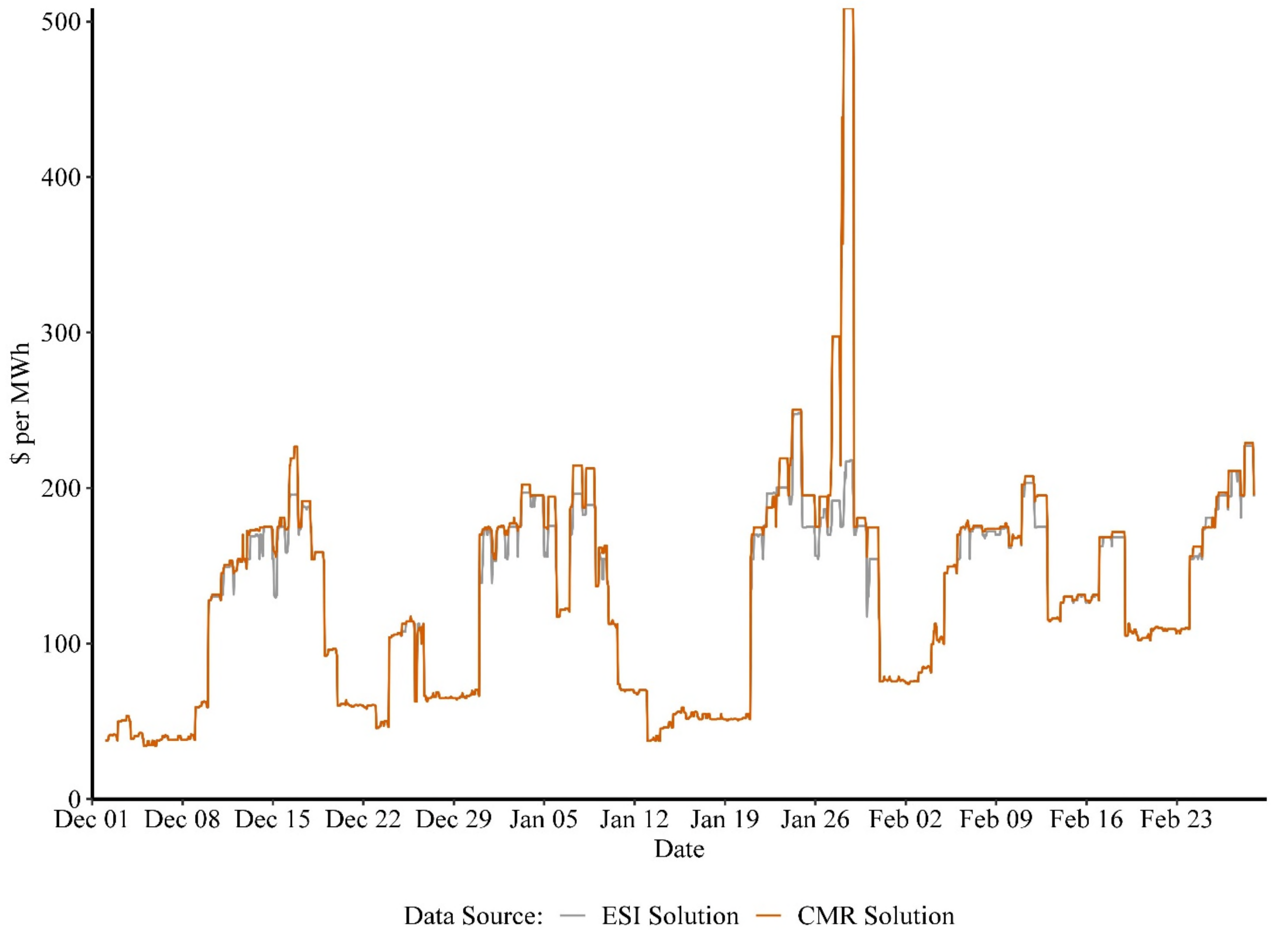
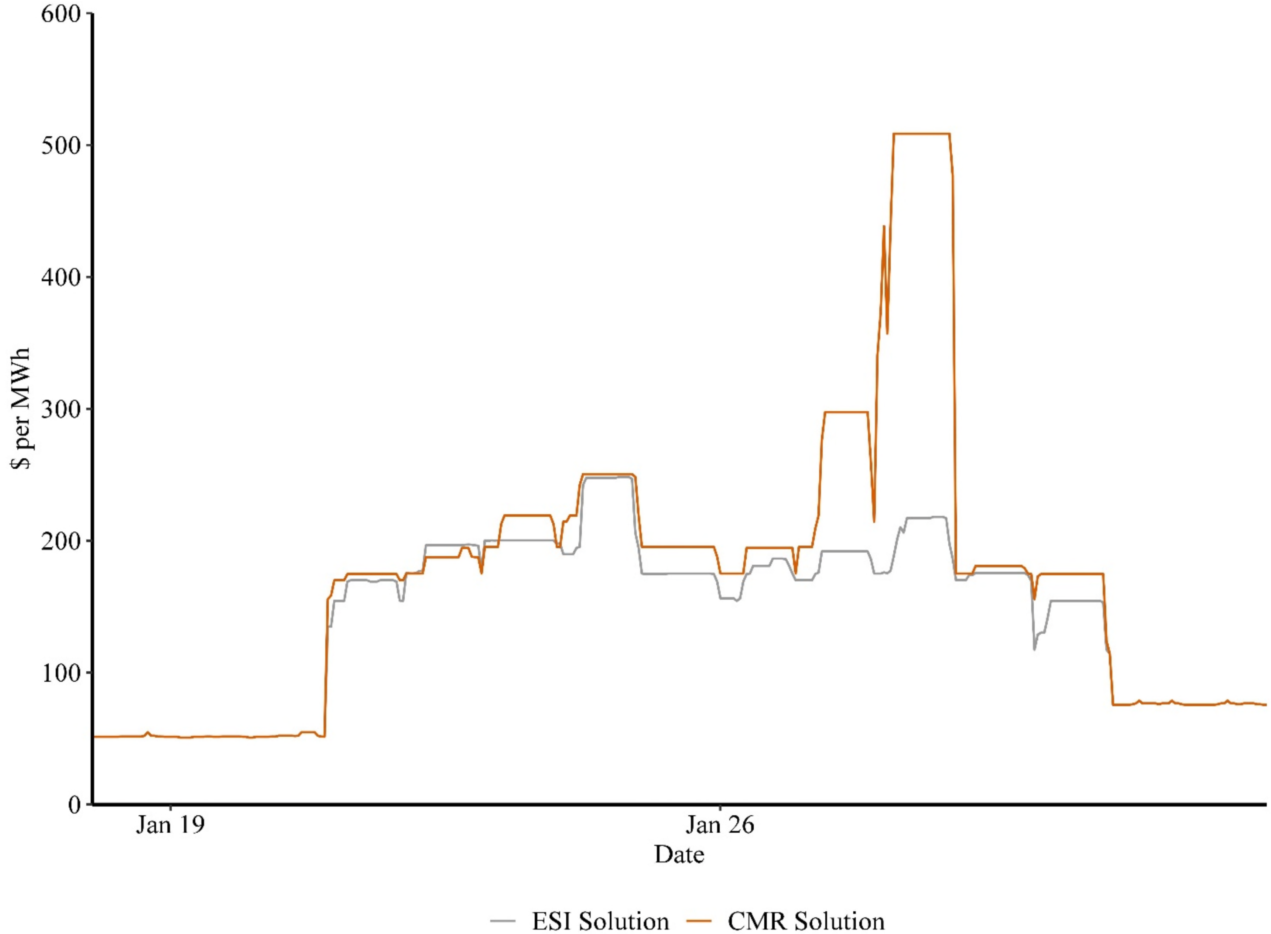
Hourly Day-Ahead LMP

High Future Case



Hourly Day-Ahead LMP

High Future Case



Clearing Prices – DA Energy Options

Future Cases

	Mean Hourly Day-Ahead Clearing Prices ($/MWh)			
Case	**EIR**	**GCR10**	**GCR30**	**RER**
Low Case	$ 6.62	$ 7.74	$ 7.72	$ 7.60
Medium Case	$ 10.30	$ 14.49	$ 14.48	$ 14.00
High Case	$ 19.42	$ 24.00	$ 24.00	$ 21.93

- Average hourly prices for RER, GCR10 and GCR30 relatively similar, although this masks significant hourly variation
- EIR price lower because price is zero in many hours when actual load is greater than forecast load

Customer Payments

Changes in Net Customer Payments

- The model analyzes energy market payments by customers from DA and RT markets
- Payments reflect:
  - Two-part settlement for DA and RT energy
  - Payment of DA energy option products
  - Settlement of DA energy options against RT LMPs
  - Analysis includes a preliminary estimate of FER payments to generators
- Model does not consider any changes in Forward Capacity Market payments

Total Customer Payments – Forecast Energy Requirement

- Analysis includes calculation of FER payment
- FER payment is a payment to generation to capture the "missing" opportunity cost for resources supplying energy that could supply EIR
  - Resources supplying energy provide two services, energy and reduction of EIR
- Estimated FER payments:
  - *All DA physical clear energy* receives the LMP plus the EIR
  - In equilibrium, assume FER payments made in 50% of hours, as market responses drive day-ahead energy toward forecast energy (i.e., implicitly assumes EIR price = $0 in half of hours)

Case	FER Payments	
Low Case	$	119.09
Medium Case	$	208.12
High Case	$	342.97

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Total Customer Payments – ESI Products Only

Future Cases

	Settlement Payments ($Million)							
	Day-Ahead Energy Options							
Case	EIR	GCR10	GCR30	RER	Total Options	FER	Option Cost	Total
Low Case	$ 6.71	$ 27.88	$ 36.58	$ 21.92	$ 93.10	$ 119.09	$ (54.31)	$ 157.87
Medium Case	$ 10.85	$ 54.32	$ 70.14	$ 40.38	$ 175.69	$ 208.12	$ (140.65)	$ 243.17
High Case	$ 23.33	$ 84.23	$ 103.59	$ 63.24	$ 274.39	$ 342.97	$ (235.22)	$ 382.15

- Payments reflect total DA payments for all four ESI products
- Option cost reflects closeout cost for all four ESI products against the RT LMP
- Total reflects the net position across all ESI products and payments

Total Customer Payments – CMR vs ESI

High Future Case

Product		Settlements ($Million) CMR	Settlements ($Million) ESI	Difference
Energy and Real-Time Reserves	[A]	$ 4,475.82	$ 4,211.41	-5.9%
Day-Ahead Ancillary Services				
EIR			$ 23.33	
RER			$ 63.24	
GCR10			$ 84.23	
GCR30			$ 103.59	
Option Cost			$ (235.22)	
Net Day-Ahead Ancillary	[B]		$ 39.18	
FER	[C]		$ 342.97	
Total Payments	[A+B+C]	$ 4,475.82	$ 4,593.56	2.6%

- In this case, reduction in energy payments is more than offset by ESI costs, including net cost of DA energy options and FER payments
  - Across cases, the net impact is sensitive to the offsetting effects of changes in LMPs and FER payments

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Total Customer Payments – CMR vs ESI

Medium and Low Future Cases

Medium Future Case

Product		Settlements ($Million) CMR	ESI	Difference
Energy and Real-Time Reserves	[A]	$ 3,185.88	$ 2,828.27	-11.2%
Day-Ahead Ancillary Services				
EIR			$ 10.85	
RER			$ 40.38	
GCR10			$ 54.32	
GCR30			$ 70.14	
Option Cost			$ (140.65)	
Net Day-Ahead Ancillary	[B]		$ 35.04	
FER	[C]		$ 208.12	
Total Payments	[A+B+C]	$ 3,185.88	$ 3,071.44	-3.6%

Low Future Case

Product		Settlements ($Million) CMR	ESI	Difference
Energy and Real-Time Reserves	[A]	$ 1,827.19	$ 1,822.69	-0.2%
Day-Ahead Ancillary Services				
EIR			$ 6.71	
RER			$ 21.92	
GCR10			$ 27.88	
GCR30			$ 36.58	
Option Cost			$ (54.31)	
Net Day-Ahead Ancillary	[B]		$ 38.78	
FER	[C]		$ 119.09	
Total Payments	[A+B+C]	$ 1,827.19	$ 1,980.57	8.4%

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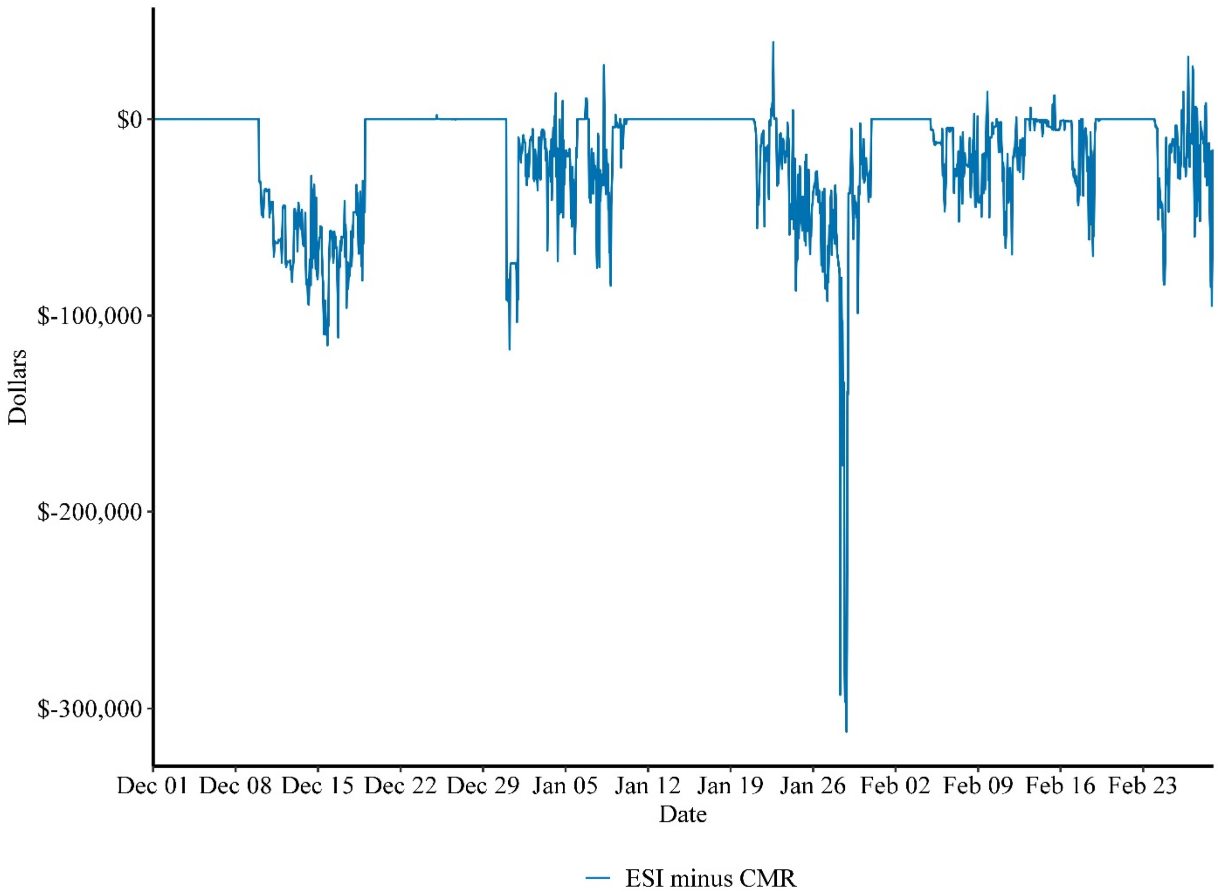
Resource Outcomes

Changes in Production Costs and Energy Mix

- The model analyzes changes in production outcomes, including production costs and energy mix
- Production costs generally decline, although costs increase in some hours due to economic posturing
- Resource use shifts given changes in energy inventory and other substitutions resulting from ESI

Hourly Change in Real Time Production Costs

High Future Case



Total Winter Generation

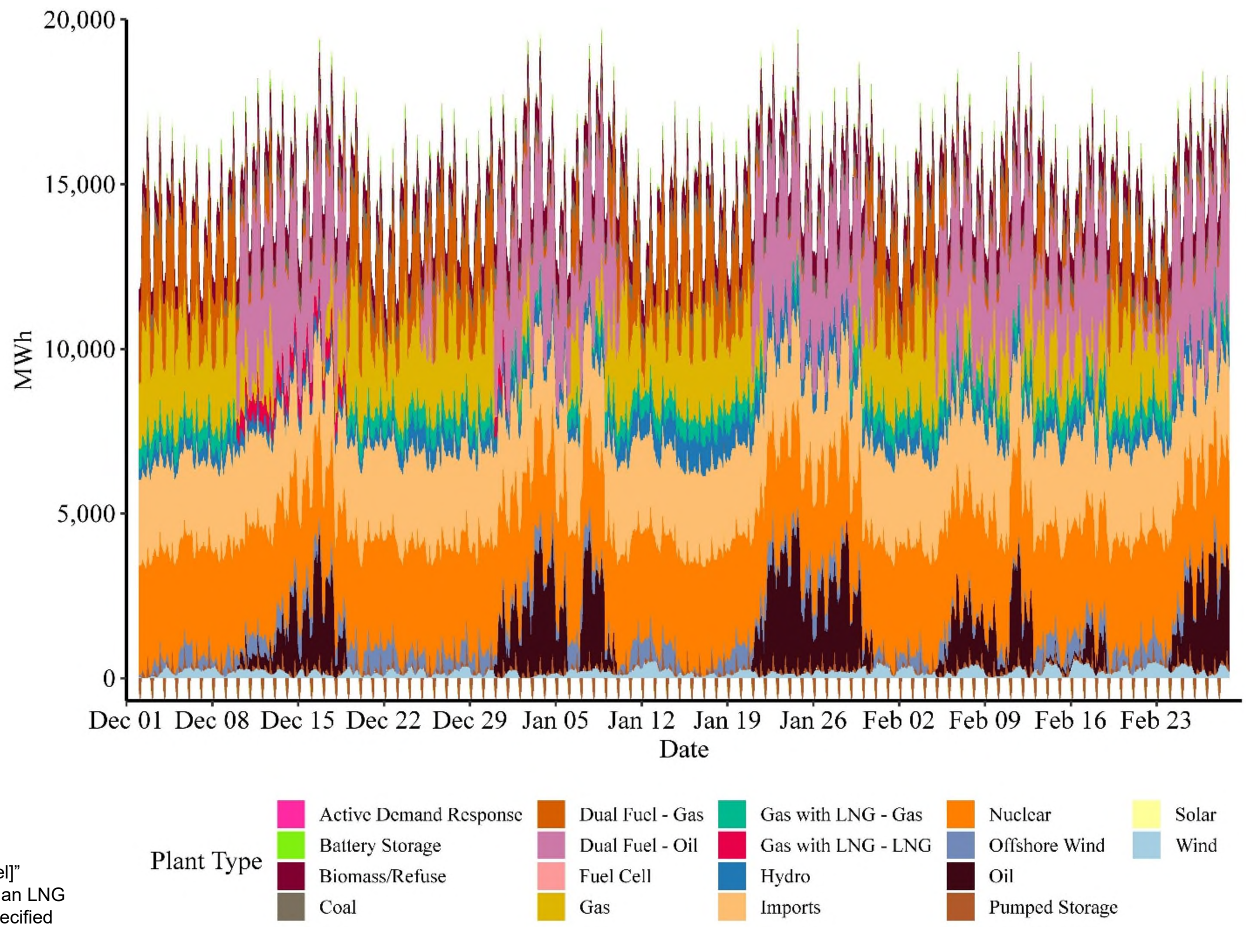
High Future Case – Day Ahead

Plant Type	DA ESI Generation (MWh) [A]	DA CMR Generation (MWh) [B]	Change in DA Generation (MWh) [A] - [B]	% Change in DA Generation (MWh) [A] vs [B]
Active Demand Response	15,037	15,292	-255	-1.67%
Battery Storage	-20,009	-20,009	0	0%
Biomass/Refuse	1,520,239	1,521,669	-1,430	-0.09%
Coal	953,280	953,280	0	0%
Dual-Fuel	7,099,736	6,894,798	204,938	2.97%
Fuel Cell	34,814	34,814	0	0%
Gas	3,301,592	4,533,442	-1,231,850	-27.17%
Gas with LNG	1,093,155	0	1,093,155	100%
Hydro	1,241,219	1,241,219	0	0%
Imports	6,032,748	6,032,748	0	0%
Nuclear	7,104,576	7,104,576	0	0%
Offshore Wind	867,965	867,965	0	0%
Oil	1,825,290	1,889,848	-64,558	-3.42%
Pumped Storage	-29,552	-29,552	0	0%
Solar	0	0	0	0%
Wind	419,629	419,629	0	0%

Note:
[1] "Gas with LNG" refers to Gas units with an LNG contract.

Hourly Winter Day-Ahead Energy Positions

High Future Case – ESI



Note:
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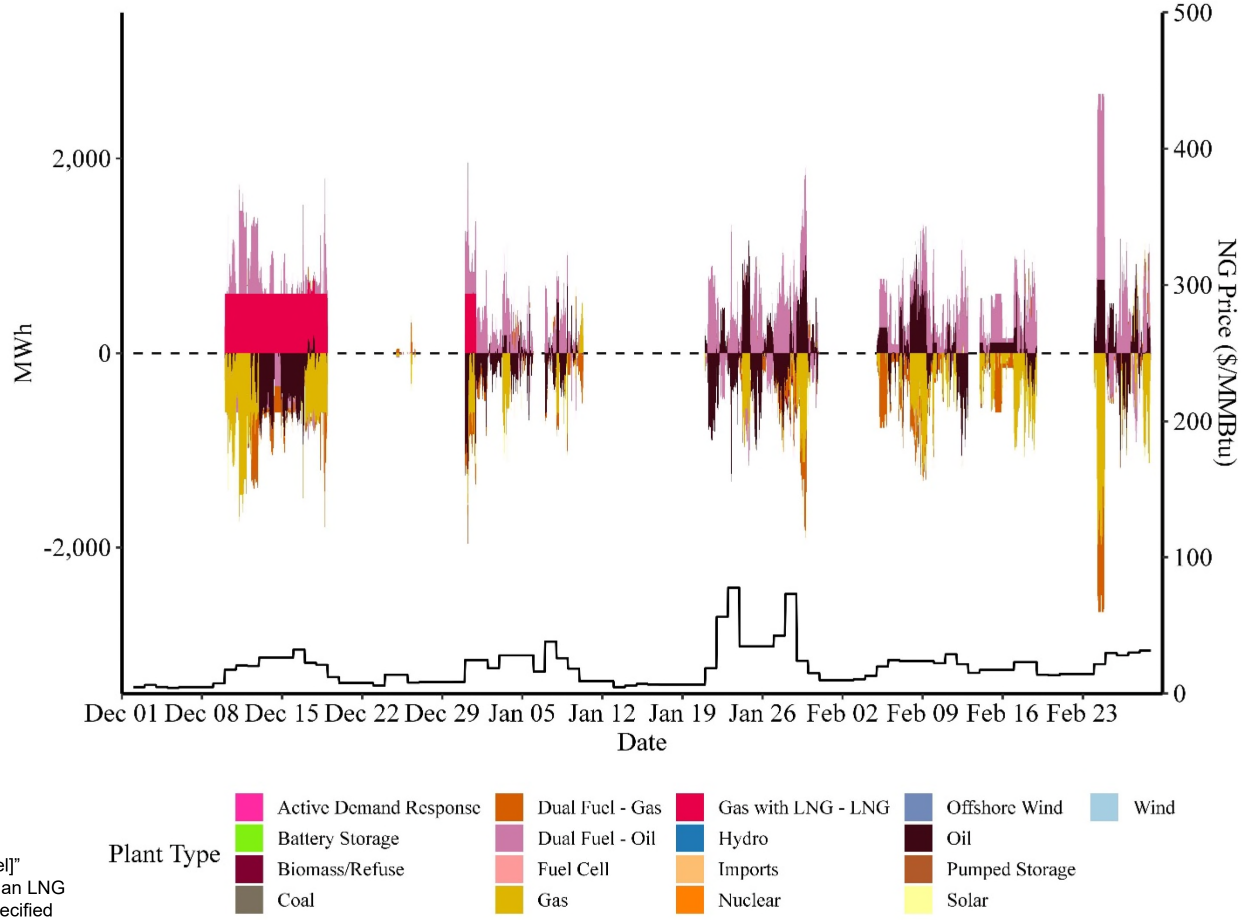
Hourly Winter Day-Ahead Energy Positions

High Future Case – ESI vs CMR



Note:
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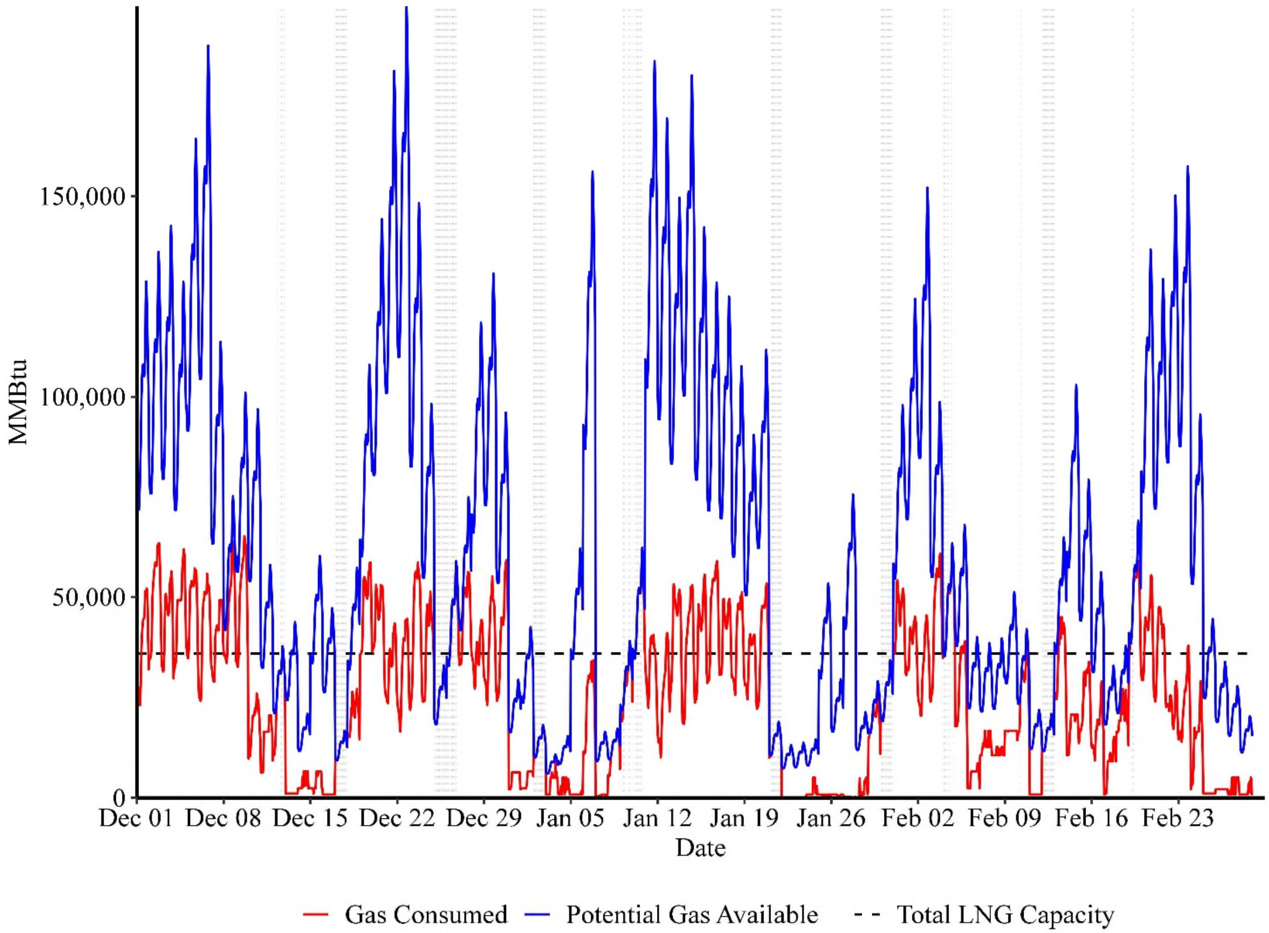
Operational Constraints

System Constraints

- The analysis provides a variety of potential metrics for evaluating energy security
  - Gas system constraints – measure how frequently gas supply available to the electricity sector is fully utilized
  - Fuel oil inventory
  - Operating reserve shortages

Hourly Winter Gas Availability and Consumption

High Future Case – CMR



Grey cross-hatch represents periods when NG supply is fully utilized

Note:
[1] Hourly total LNG capacity is set to 35,957.8 MMBtu; this quantity is obtained by converting 0.833 Bcf/day from Canaport into MMBtu/hour.

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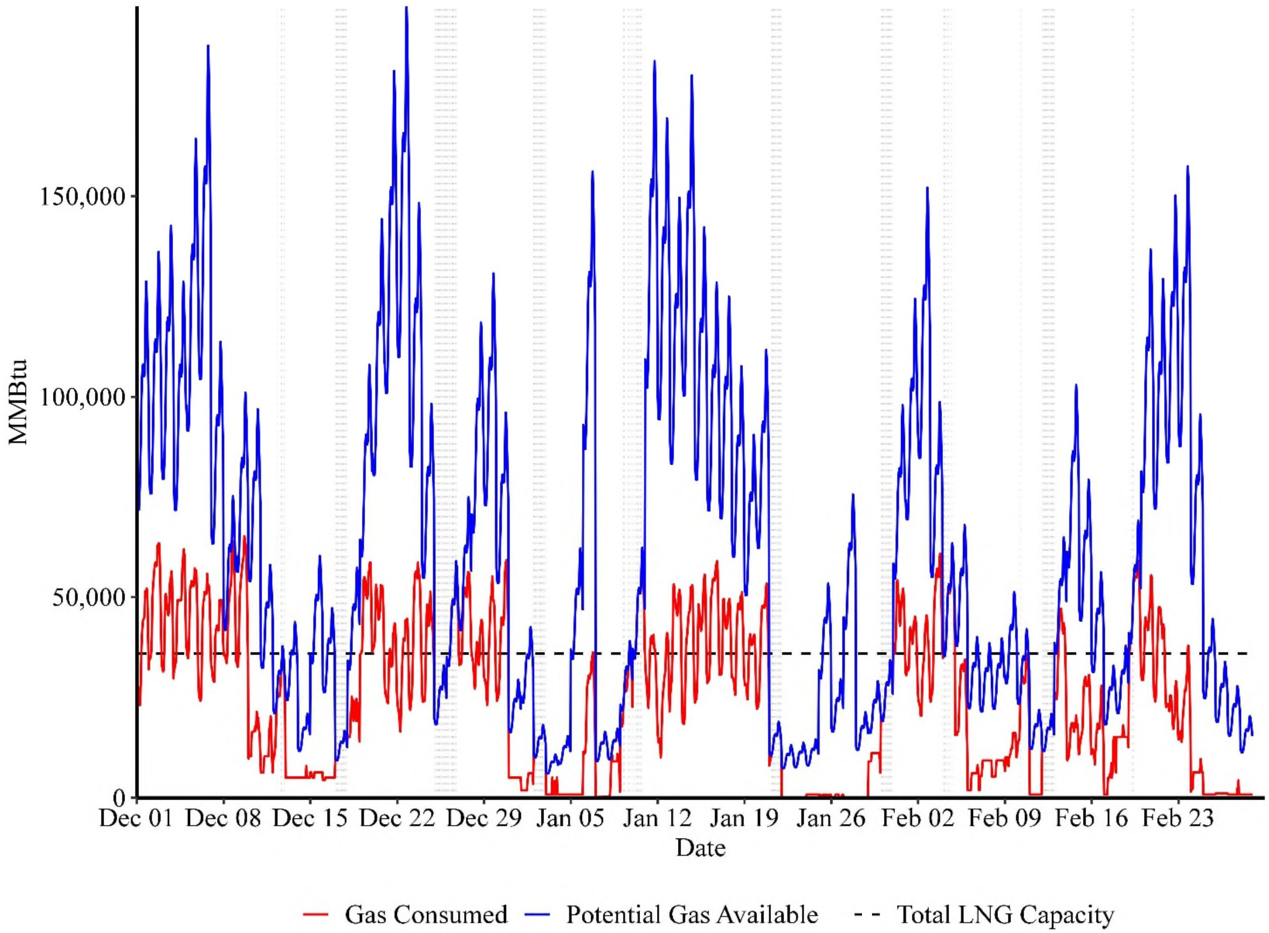
Hourly Winter Gas Availability and Consumption

High Future Case – ESI



Note:
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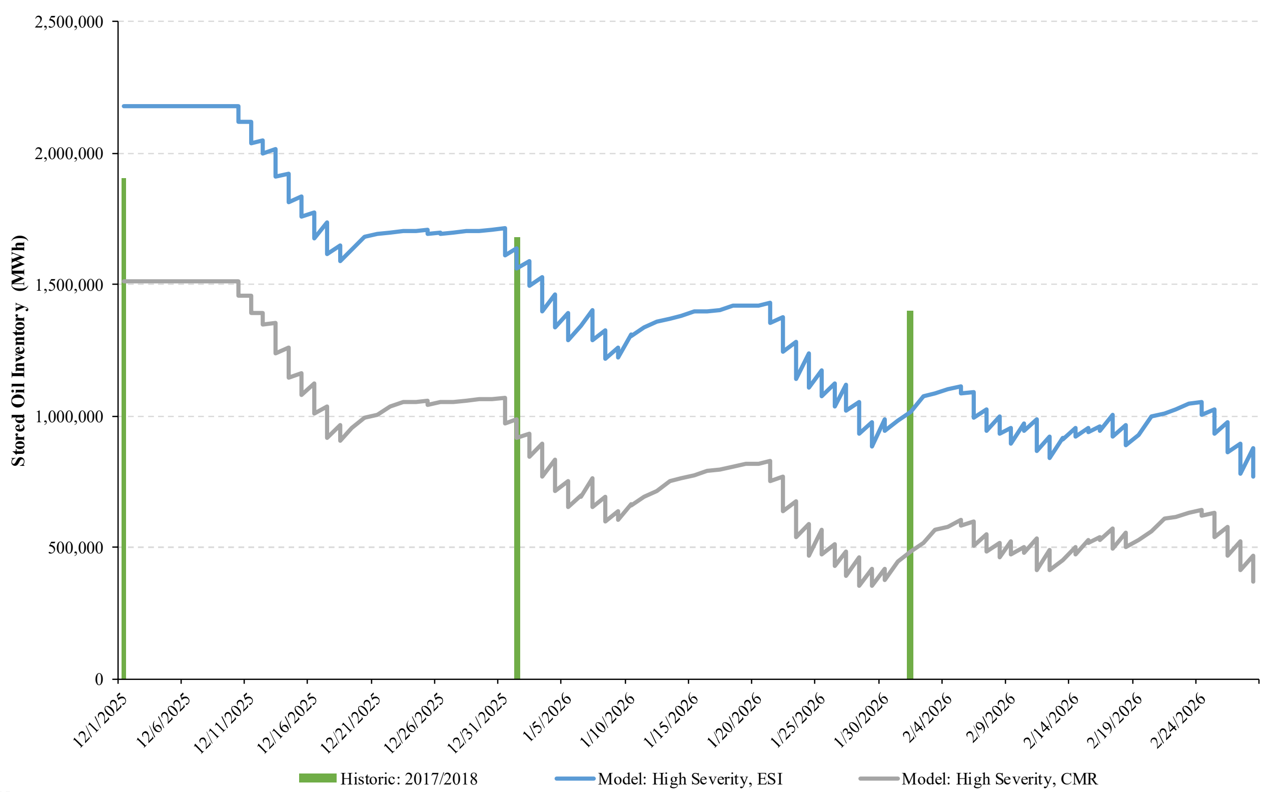
Hourly Winter Fuel Oil Inventory

High Future Case – Model vs 2018/19 Reported Inventory



Notes:

[1] Oil inventories are shown for all resources that refuel via truck or barge. Oil resources that refuel via pipeline storage are excluded.

[2] Historic data displayed as provided from ISO-NE fuel surveys.

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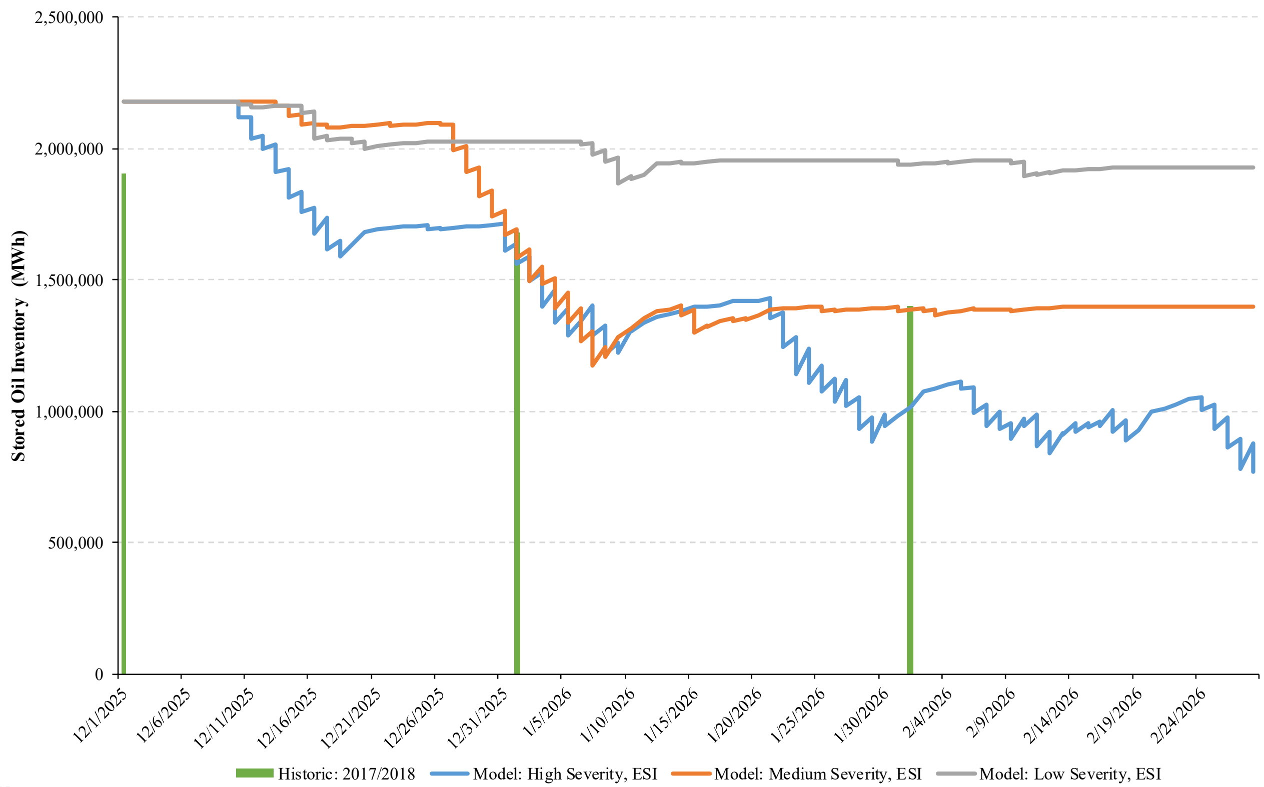
Hourly Winter Fuel Oil Inventory

ESI vs 2017/18 Reported Inventory



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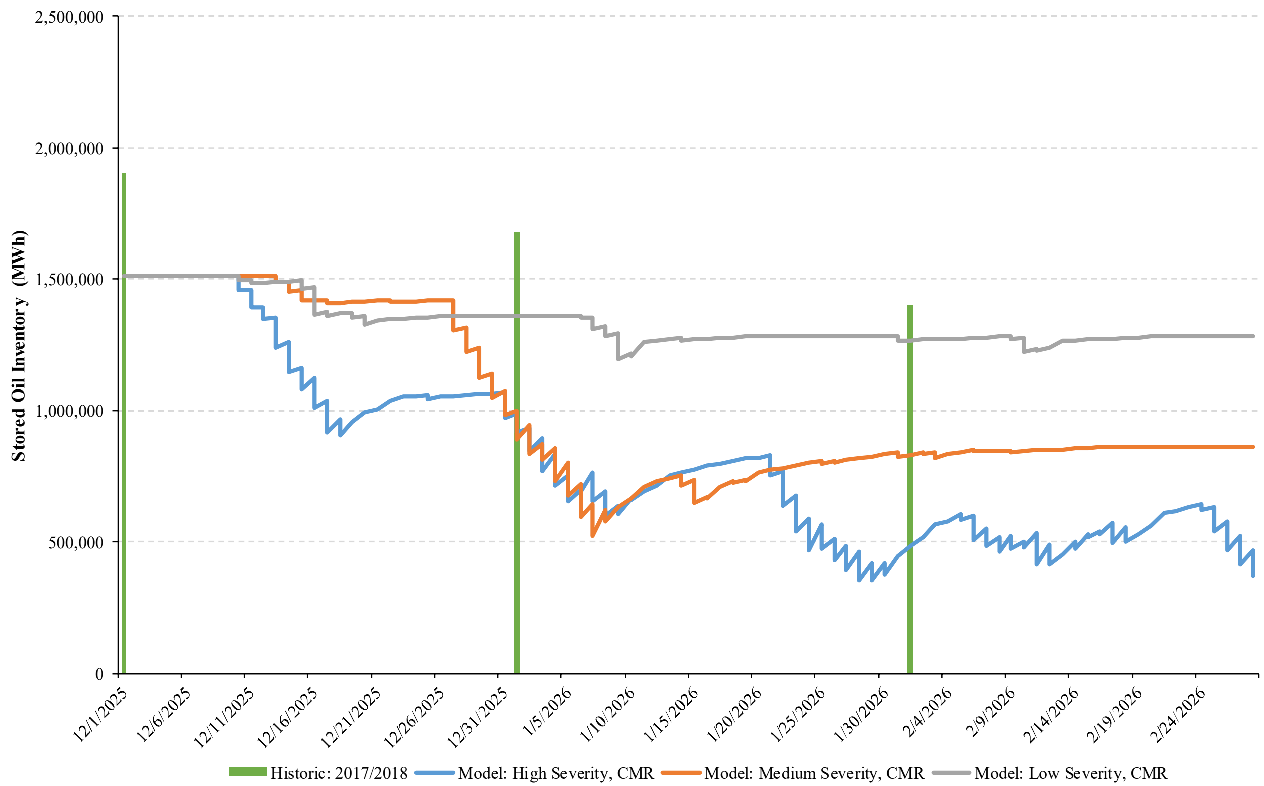
Hourly Winter Fuel Oil Inventory

CMR vs 2017/18 Reported Inventory



Notes:
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[2] Historic data displayed as provided from ISO-NE fuel surveys.

Next Steps

A Range of Scenarios Will be Evaluated

- August
  - Further analysis of impacts
  - Preliminary scenario results
  - Respond to stakeholder feedback from July results
- September
  - Draft Report (summarizing presented material)
- October
  - Filing

Contact

Todd Schatzki
Principal
617-425-8250
todd.Schatzki@analysisgroup.com