Capacity Market Impacts and Implications of Alternative Resource Expansion Scenarios

An Element of the ISO New England 2016 Economic Analysis

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May 17, 2017

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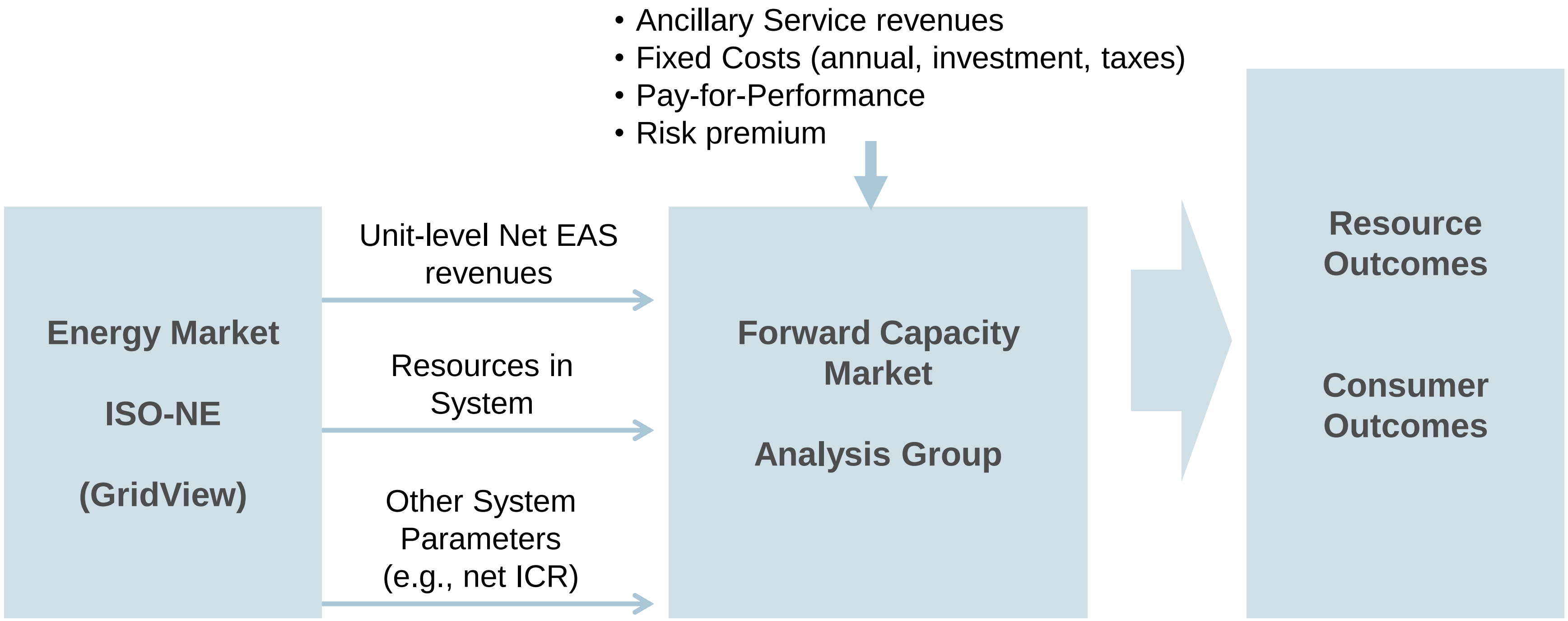
Assignment, Study Purpose and Policy Background

- Analysis Group was asked to assess outcomes in the ISO New England ("ISO-NE") Forward Capacity Market ("FCM") under alternative "Scenarios" evaluated as a part of the 2016 Economic Analysis.
- Our study is designed to complement and be consistent with ISO-NE's analysis of outcomes in the ISO-NE energy markets under each of these Scenarios.
- The study assumes current FCM rules, and does not contemplate outcomes under alternative rules, including modifications that might emerge from the Integrating Markets and Public Policy ("IMAPP") process.



NEPOOL's Six Base Scenarios

Our analysis considers the six scenarios identified by stakeholders for analysis in the 2016 Economic Analysis, summarized below. Scenarios differ largely in terms of (1) fossil resource retirements; (2) new resources used to fill a gap in resource adequacy; and (3) "clean" resources added to the system, defined to include wind, solar, battery storage, imports (hydro) and energy efficiency.

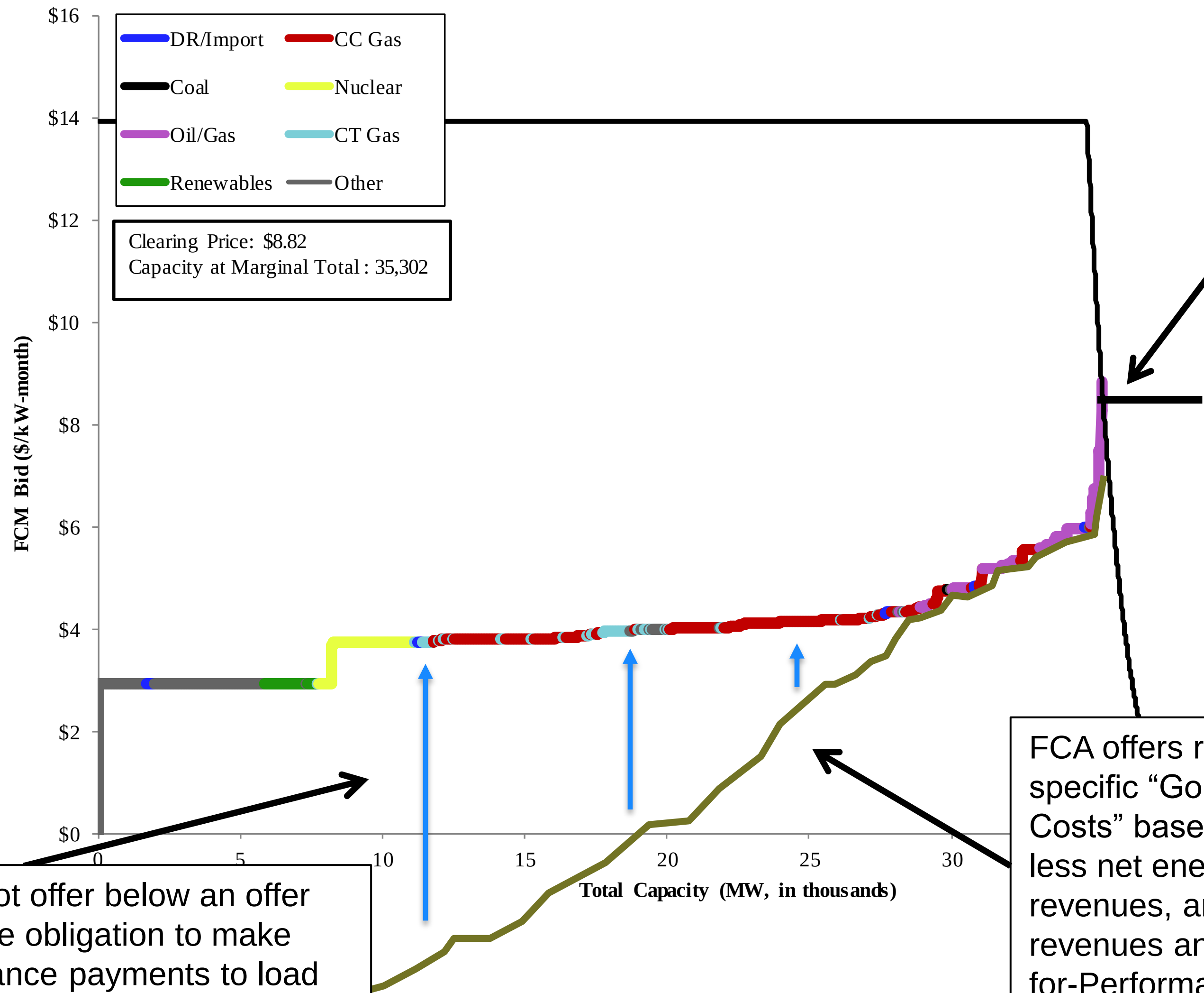
1. **RPS + Gas:** Meet Renewable Portfolio Standards ("RPS") with new renewable resources (wind) and additional natural gas (combined cycle) units for resource adequacy.
2. **ISO Queue**: Meet RPS and resource adequacy with new renewable resources (wind).
3. **Renewables Plus**: Meet RPS with new renewable resources (wind), with additional renewable resources (on- and off-shore wind), energy efficiency, photovoltaics ("PV") (behind-the-meter), battery storage, and imports (hydropower).
4. **No Retirements (beyond FCA #10)**: Meet RPS with resources under development and Alternative Compliance Payments ("ACP") for shortfalls; add natural gas units for resource adequacy.
5. **Gas + ACPs**: Meet RPS with resources under development and ACP; add natural gas units for resource adequacy.
6. **RPS + Geodiverse Renewables**: Scenario 2 with a more geographically balanced mix of on- and off-shore wind and solar PV.

All Scenarios – except Scenario 4 – assume the retirement of fossil-fired resources.

Scenarios Under Analysis

Scenario	Retire Oldest Oil/Coal	Gross Load	PV	EE	Wind	New NG Units	HQ and NB External Ties
1	½ in 2025 ½ in 2030	Based on 2016 Forecast	Based on 2016 Forecast	Based on 2016 Forecast	As needed to meet RPS and counted towards NICR	NGCC to meet NICR	Based on Historical Profiles
2	½ in 2025 ½ in 2030	Based on 2016 Forecast	Queue additions scaled up by same factor as wind	Based on 2016 Forecast	Queue additions scaled up to satisfy NICR	None	Based on Historical Profiles
3	½ in 2025 ½ in 2030	Based on 2016 Forecast	Provided by Stakeholders	Provided by Stakeholders	Provided by Stakeholders	None	Based on Historical Profiles plus additional Imports
4	None	Based on 2016 Forecast	Based on 2016 Forecast	Based on 2016 Forecast	Existing plus I.3.9	None	Based on Historical Profiles
5	½ in 2025 ½ in 2030	Based on 2016 Forecast	Based on 2016 Forecast	Based on 2016 Forecast	Existing plus I.3.9	NGCC to replace retirements and meet NICR	Based on Historical Profiles
6	½ in 2025 ½ in 2030	Based on 2016 Forecast	Provided by Stakeholders	Based on 2016 Forecast	Provided by Stakeholders	None	Based on Historical Profiles

Illustrative ISO-NE FCM Supply and Demand Curve



New Gas-Fired Supply (Combustion Turbine) (at Net CONE = $8.70)

Analysis does not consider additional new entry unless there are insufficient resources to clear demand

FCA offers reflect unit-specific “Going Forward Costs” based on fixed costs less net energy market revenues, ancillary service revenues and expected Pay-for-Performance revenues

Resources will not offer below an offer floor reflecting the obligation to make Pay-for-Performance payments to load that can otherwise be avoided by foregoing the Capacity Supply Obligation

Key Drivers of Market Outcomes

FCM outcomes depend on several key drivers:

- Increased resource supply
  - Entry of new "clean" policy-supported renewable resources, which generally offer only a fraction of nameplate capacity into the Forward Capacity Auction ("FCA")
  - Entry of other policy-supported resources, such as hydro imports and battery storage, which are assumed to offer capacity into the FCA at full nameplate value
- Decreased resource supply
  - Assumed retirements, which may occur due to low market prices, particularly in the FCM, or other (exogenous) factors, such as the need for one-time capital investment
- Changes in resource "going forward" costs, particularly net energy market revenues
  - Assumptions regarding relatively low Going Forward Costs ("GFC") for existing fleet is confirmed by recent auction outcomes
- Reduced demand, i.e., net Installed Capacity Requirement ("ICR")
  - Diminished peak load growth, due to, among other things, energy efficiency, behind-the-meter-PV, and demand-response programs.
- Minimum Offer Price Rule ("MOPR") offer mitigation, including the scope of resources subject to mitigation and the renewable technology exemption

ISO-NE FCM 2016 Economic Analysis Scenario Outcomes

	2025 (Unconstrained)					
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Net CONE	$8.70	$8.70	$8.70	$8.70	$8.70	$8.70
Clearing Price ($/kW-Month)	$8.82	$8.99	$4.82	$6.20	$8.74	$9.04
Cleared Capacity @ Marginal Total (MW, thousands)	**35,302**	**35,299**	**35,627**	**35,665**	**35,302**	**35,302**
Total FCM Payments ($, millions)	**$3,736**	**$3,808**	**$2,061**	**$2,653**	**$3,702**	**$3,830**
Average FCM Payments ($ per MWh)	$24.57	$25.06	$12.77	$17.53	$24.35	$25.20
Capacity Above ICR	0	-3	823	363	0	0
Not Cleared Capacity (MW, thousands)	0	0	5,010	891	0	0
Total Energy Revenue ($, millions)	$8,659	$8,325	$7,688	$8,737	$8,819	$8,382

	2030 (Unconstrained)					
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Net CONE	$9.61	$9.61	$9.61	$9.61	$9.61	$9.61
Clearing Price ($/kW-Month)	$9.61	$9.75	$4.68	$7.04	$9.61	$9.84
Cleared Capacity @ Marginal Total (MW, thousands)	**36,919**	**36,916**	**37,439**	**37,332**	**36,920**	**36,920**
Total FCM Payments ($, millions)	**$4,257**	**$4,319**	**$2,103**	**$3,154**	**$4,257**	**$4,360**
Average FCM Payments ($ per MWh)	$26.67	$27.18	$11.98	$19.75	$26.68	$27.43
Capacity Above ICR	0	-3	1,166	413	1	1
Not Cleared Capacity (MW, thousands)	0	0	5,989	331	0	0
Total Energy Revenue ($, millions)	$11,262	$7,444	$8,051	$11,453	$11,362	$6,992

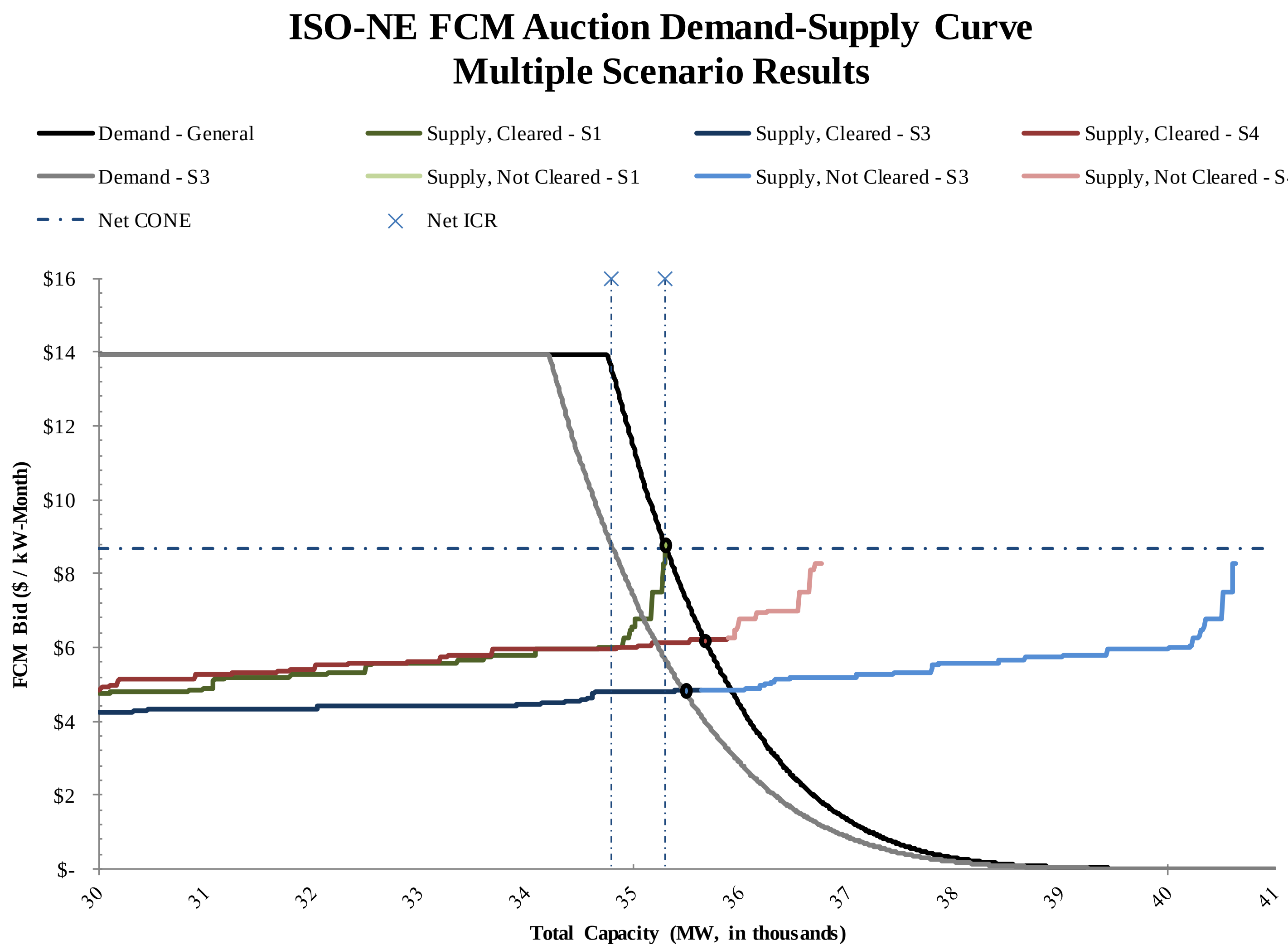
Note: Results are reported in nominal dollars (e.g., 2025 results are in $2025).

Overview of Results

Across the scenarios, market equilibrium outcomes can be grouped into three general categories:

- ***Retirements with Entry to Meet Net ICR*** (Scenarios 1, 2, 5, and 6)
  - Highest FCA prices, slightly above net CONE (clears at existing resource offer)
  - Capacity Supply Obligation ("CSO") quantities roughly equal to net ICR, with all resources clearing
- ***No Retirements and No Major New Resources beyond FCA 10*** (Scenario 4)
  - Lower FCA prices
  - CSO quantities slightly in excess of net ICR (~ 400 to 600 MW)
  - ~ 300 to 800 MW does not clear the FCA
- ***Retirements with Substantial New Clean and Distributed Resources*** (Scenario 3)
  - Lowest FCA prices
  - Largest quantity of CSO's in excess of net ICR (~ 800 to 1,166 MW)
  - Largest quantity of resources that do not clear the FCA (~5,000 to 6,000 MW)

- Market equilibrium for each of these cases is illustrated in the figure on the following slide.


ISO-NE FCM Auction Demand-Supply Curve
Multiple Scenario Results
Demand - General
Supply, Cleared - S1
Supply, Cleared - S3
Supply, Cleared - S4
Demand - S3
Supply, Not Cleared - S1
Supply, Not Cleared - S3
Supply, Not Cleared - S4
Net CONE
Net ICR
$16
$14
$12
$10
$8
$6
$4
$2
$-
FCM Bid ($ / kW-Month)
30
31
32
33
34
35
36
37
38
39
40
41
Total Capacity (MW, in thousands)

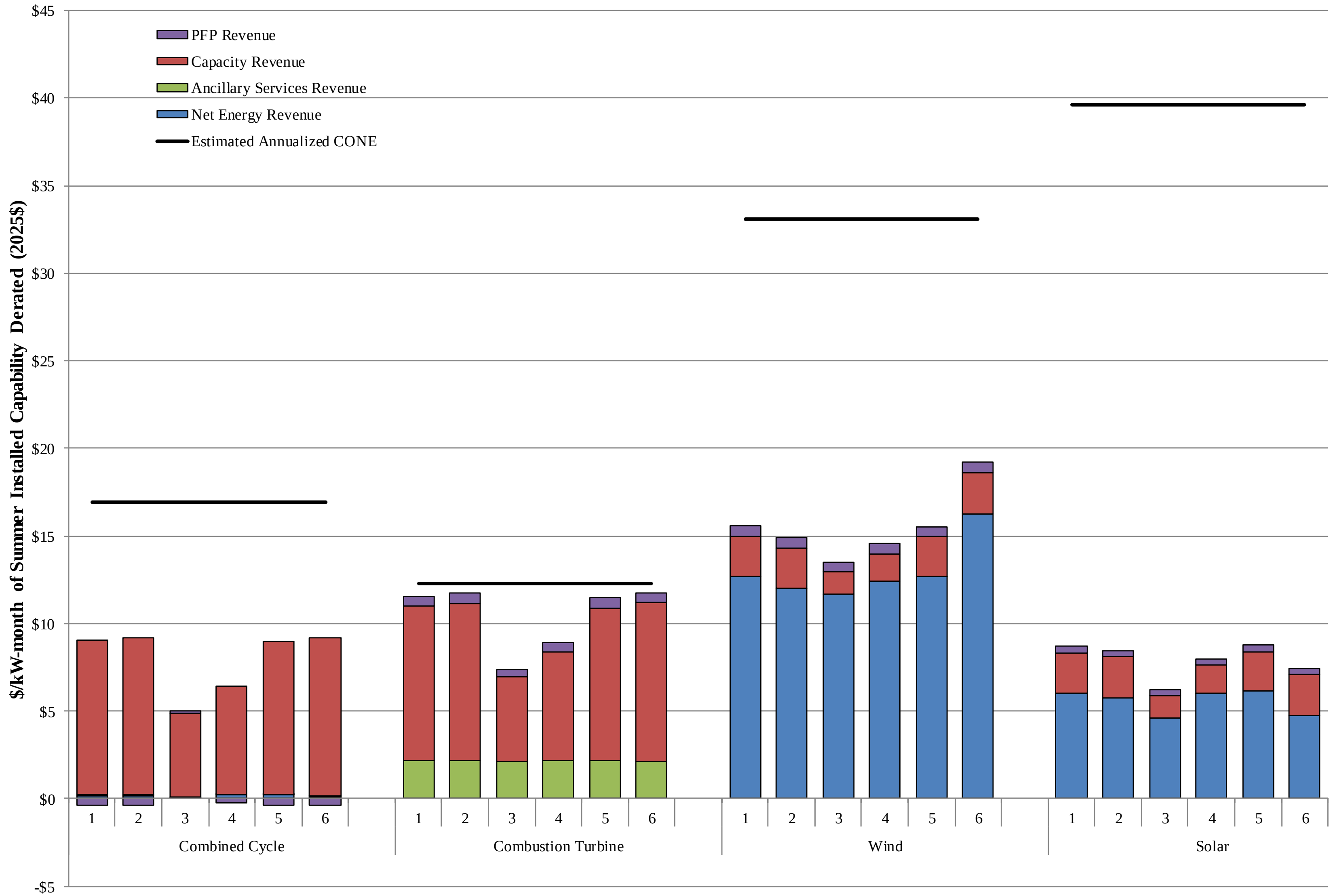
Implications of Resource Assumptions for FCA Outcomes

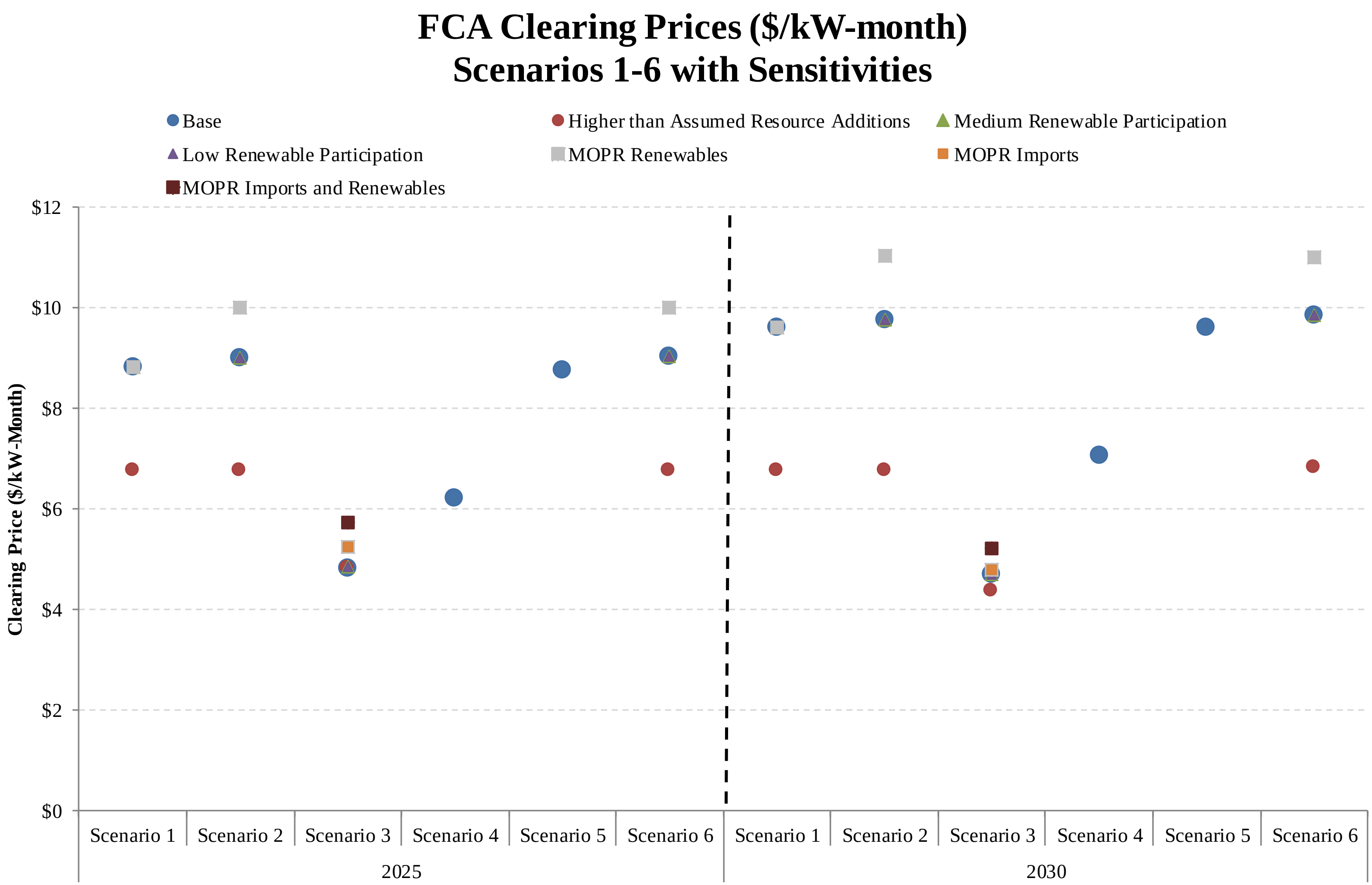
- Absent retirements, there is limited need for new resources (Scenario 4).
  - With low-load growth, growth in behind-the-meter resources and limited growth in new capacity, growth in demand is insufficient to drive the need for new resources.
- Retirements, such as assumed retirements of 2,457 MW by 2025 and 4,668 MW by 2030, can drive the need for new capacity to maintain resource adequacy.
  - While the type of capacity added – renewables only, gas-only or a mix of the two – does affect energy market outcomes (see ISO-NE results), there is relatively little impact on FCA outcomes (in Scenarios 1, 2, 5, and 6). However, reliance on renewables to fill gaps in resource adequacy would require additional sources of revenues given the higher cost of new entry for these resources.
- Substantial expansion of clean resources (i.e., Scenario 3) would lower FCA prices, crowding out existing resources.
  - These impacts would depend on what portion of new renewables actually participate in the FCM and the extent of MOPR offer mitigation. However, at the high levels of resource additions assumed in Scenario 3, market outcomes are fairly insensitive to these changes.

Implications of Expanded Renewable Resource Supplies

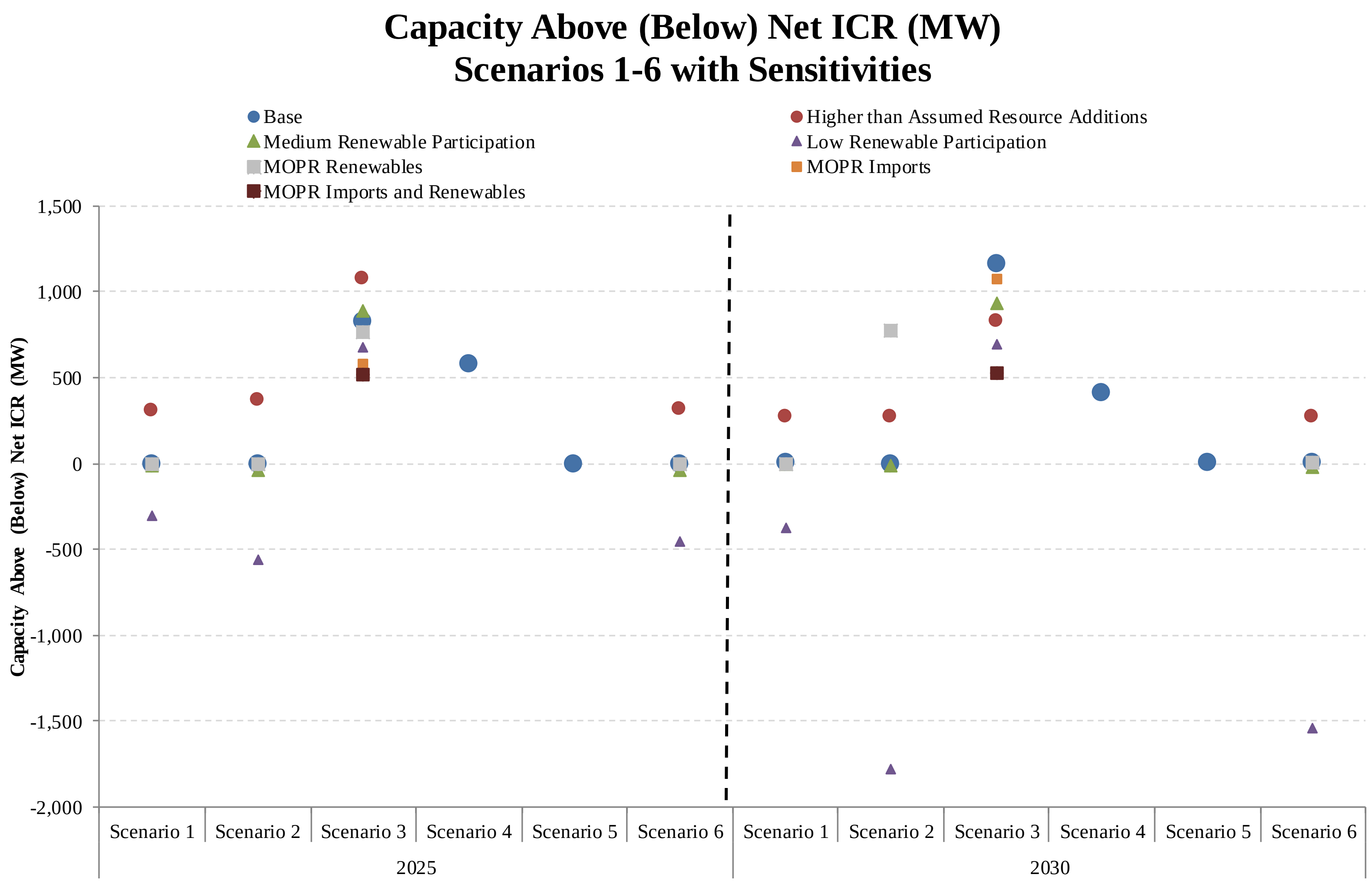
- Scenarios with expanded clean resources (i.e., Scenario 3), lead to lower FCA prices and energy market prices (as shown in ISO-NE analysis).
  - Scenarios with larger quantities of renewable additions (Scenarios 2, 3, and 6) would require additional revenue streams outside the ISO-NE markets. Total ISO payments (FCM and energy market) included in the table on page 7 do not include these payments. Moreover, these payments do not reflect social costs (partial or total) under the various Scenarios.
  - Substantial quantities of existing resources "exit" the market in some form, including assumed retirements and "non-economic" resources that do not clear the FCA.
  - In principle, MOPR offer mitigation would attenuate decreases in FCA prices from new renewable resources (receiving out-of-market revenues). In practice, its impact would be limited by the renewable technology exemption and the behind-the-meter policies that are outside the scope of the MOPR.
  - As the quantity of new clean resources added to the system increases, the cost (per MWh or MW) of supporting clean resources increases. The gap in revenue requirement (for new entry) needs to be filled by other sources because of decreases in revenues from both the FCM and energy markets. See the following slide.

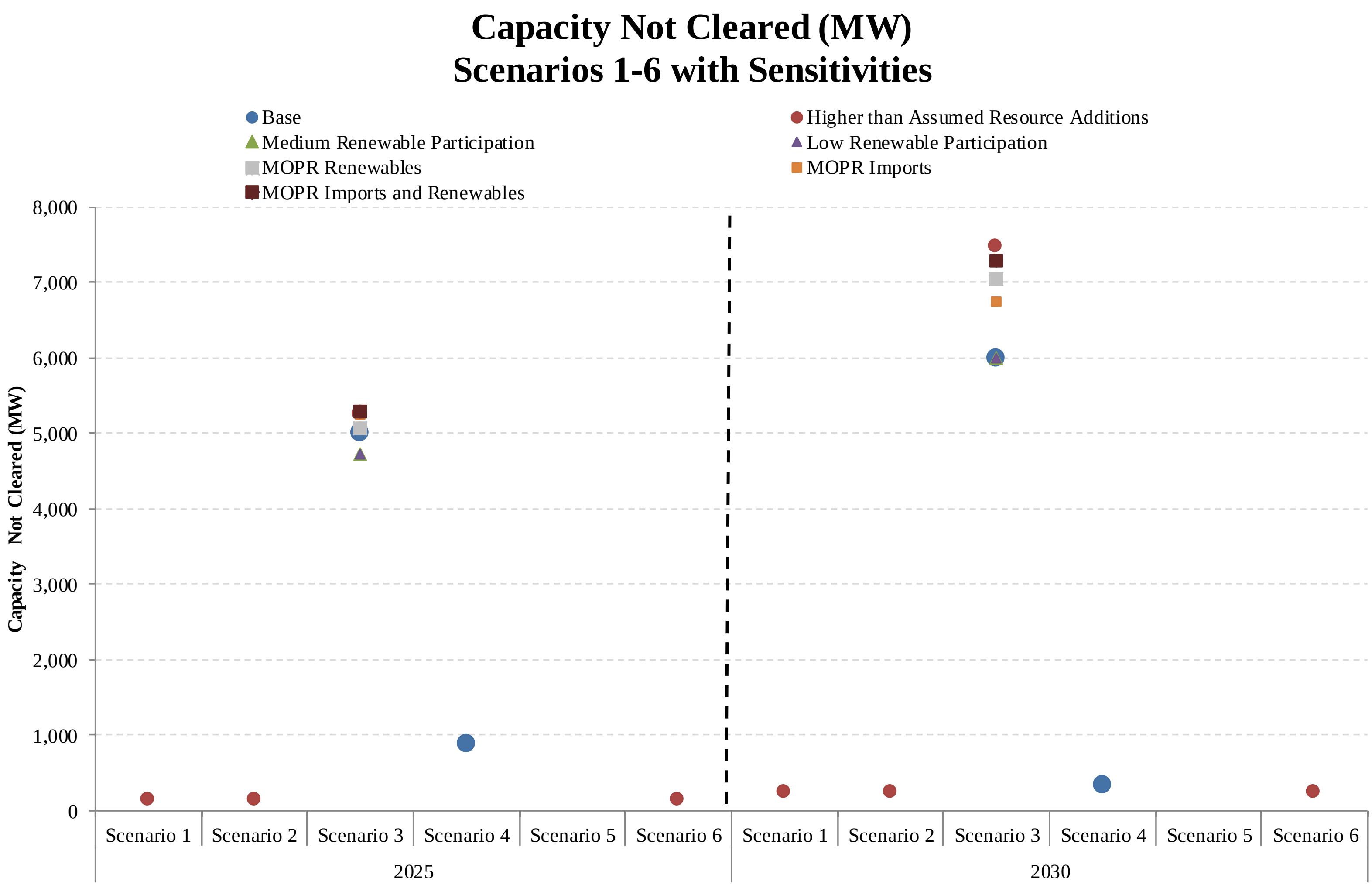
Gross Revenue Breakdown by Resources Type, 2025 Unconstrained





Note: All values are reported nominally.


Capacity Above (Below) Net ICR (MW)
Scenarios 1-6 with Sensitivities
Base
Higher than Assumed Resource Additions
Medium Renewable Participation
Low Renewable Participation
MOPR Renewables
MOPR Imports
MOPR Imports and Renewables
Capacity Above (Below) Net ICR (MW)
1,500
1,000
500
0
-500
-1,000
-1,500
-2,000
Scenario 1
Scenario 2
Scenario 3
Scenario 4
Scenario 5
Scenario 6
2025
2030


Capacity Not Cleared (MW)
Scenarios 1-6 with Sensitivities
Base
Higher than Assumed Resource Additions
Medium Renewable Participation
Low Renewable Participation
MOPR Renewables
MOPR Imports
MOPR Imports and Renewables
Capacity Not Cleared (MW)
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Scenario 1
Scenario 2
Scenario 3
Scenario 4
Scenario 5
Scenario 6
2025
2030

Considerations

- Scenarios reflect the specific assumptions adopted by stakeholders. These are not market forecasts, and are not necessarily "equilibrium" outcomes.
- Analysis suggests that all Scenarios (and Sensitivities) represent potential FCA outcomes that are part of long-run market equilibria that my involve outcomes that vary across sequential auctions given the timing of new resource entry (in- and out-of-market). That is, given factors such as low load growth and entry driven by many factors, FCA prices below the cost of new entry for some period of time may be part of a long-run equilibrium.
  - The analysis does not explore pricing dynamics given the timing of new resource entry, whether through market price signals or state policies. For example, the episodic entry of resources driven by factors other than signals from the ISO markets may have implications for pricing dynamics over time, which could, in turn, have implications for resource offers, retirement decisions, and new market-based entry, including the net Cost of New Entry ("CONE"). These drives could lead to more complex market dynamics, such as "bi-modal" market outcomes, with low market prices followed by high auction prices when new entry is required.
  - Some Scenario assumptions may not result in internally consistent market outcomes. In particular, some scenarios assume the retirement of fossil resources, although FCA prices may be sufficiently high to support continued economic operation of these resources, although other drivers, such as one-time capital requirements, could lead to retirement.
- Results are driven, in part, by the shape of our estimated offer curve. We find that the region's offer curve has a "hockey stick" shape, with a dwindling supply of existing resources offering supply at or above the prices clearing in recent auctions (e.g., $5.30 per kW-Month in FCA11).

Overview of Report

- The **Background and Assignment** section (pages 14 to 18) provides background information about the study.
- The **Data, Methods and Model** section (pages 19 to 33) provides an overview of Analysis Group's FCM model, the methods and data sources used to estimate individual resource FCA offers, specific assumptions about resources in each Scenario, and illustrations of how the market clears supply against the FCM demand curve. Details on methods and data are provided in an appendix.
- The **Results** section (pages 34 to 66) summarizes the findings of our analysis. It starts by providing a high-level overview of the key drivers affecting FCM outcomes across scenarios. It then summarizes the results of each Scenario, including prices, quantities of resources that clear (and do not clear) the FCA, and total payments. We consider the implications of FCM and energy market for both the revenues needed by new resources to support new entry, as well as the implications for total (customer) payments.
- The **Sensitivity Analysis** section (pages 67 to 89) analyzes the sensitivity of base case results to key assumptions, including the quantity of new resource additions, the quantity of new renewable resources that offer supply into the FCA, and the mitigation of offers under the MOPR.

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Assignment, Study Purpose and Policy Background

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- Our study is designed to complement and be consistent with ISO-NE's analysis of outcomes in the ISO-NE energy markets under each of these Scenarios.
  - We model FCM outcomes, which are not part of the ISO-NE analysis. Thus, our study helps provide a fuller picture of the market impacts associated with each Scenario.
  - Our study's assumptions and methodology are designed to be internally consistent with the ISO-NE study. We make the same assumptions about available resources in each Scenario, calculate resource offers using estimates of net energy market revenues from ISO-NE's analysis, and rely on common assumptions for other model parameters, such as net Installed Capacity Requirements ("ICR"). By tailoring our study's assumptions to those of the ISO-NE analysis, together, the Analysis Group and ISO studies provide an internally consistent characterization of the market outcomes under the different Scenarios that are analyzed.

NEPOOL's Six Base Scenarios

Our analysis considers the six scenarios identified by stakeholders for analysis in the 2016 Economic Analysis, summarized below. Scenarios differ largely in terms of (1) fossil resource retirements; (2) new resources used to fill a gap in resource adequacy; and (3) "clean" resources added to the system, defined to include wind, solar, battery storage, imports (hydro) and energy efficiency.

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Scenarios Under Analysis

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6	½ in 2025 ½ in 2030	Based on 2016 Forecast	Provided by Stakeholders	Based on 2016 Forecast	Provided by Stakeholders	None	Based on Historical Profiles

Retire oldest oil and coal units in 2025 and remaining units in 2030.

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Assignment, Study Purpose and Policy Background

- The six Scenarios reflect different assumptions about the future path of resource development and retirement in the New England region. Each scenario complies with existing state Renewable Portfolio Standards (“RPS”) through new resources or Alternative Compliance Payments. Otherwise, the analysis does not make assumptions about the particular policies. Further, no assumptions are made about region-wide solutions to achieving certain state policy goals that might emerge from NEPOOL’s Integrating Markets and Public Policy ("IMAPP") process.
- ISO-NE analyzes energy market outcomes both with transmission constraints (“constrained”) and without transmission constraints (“unconstrained”). The constrained case reflects the projected transmission interface limits without any transmission expansion between 2025 or 2030. Unless otherwise noted, unconstrained case results are reported because these findings are less sensitive to assumptions about the location of new resources. However, results under both assumptions are reported in the appendix.
- The Scenarios evaluated consider a range of possible future resource outcomes.
  - At one end, Scenario 3 considers a suite of resources including on- and off-shore wind, behind-the-meter and utility-scale solar, storage, imports supported by new transmission, and demand-side programs.
  - At the other end, Scenario 4 assumes no retirements of fossil resources, and Alternative Compliance Payments to comply with state RPS regulations.
  - Other Scenarios consider mixes of these two extremes, with a focus on different degrees of renewable resource development.

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Other Study Considerations

- Our analysis allows for a detailed consideration of potential differences in capacity market outcomes under scenarios defined by different assumptions about new resource developments and retirements. While our analysis estimates capacity market outcomes under each Scenario, our focus is not on the levels of these outcomes (i.e., the market-clearing prices and quantities), but on the differences in outcomes between scenarios, the primary drivers of these differences, and the implications of these differences.
  - This study should not be seen as a forecast or prediction of future capacity market outcomes, including clearing prices, under any of the scenarios.
- The current analysis considers a “snapshot” of market outcomes in 2025 and 2030. When evaluating outcomes in each these years, we consider the types of market dynamics that would have led to these equilibrium resource outcomes, consider the types of market adjustments or responses that would likely result from these outcomes, and identify potential inconsistencies between Scenario assumptions and resulting model outcomes.
  - Many factors will affect resource entry and exit in the short-term. These include developer and operator expectations of future market demand, supply, and potential revenues.

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Model Overview

FCM Model – Model Structure

- The FCM Model simulates FCA outcomes. Market outcomes reflect the market-clearing price and quantity given a supply curve comprising offers from existing and new resources at their net GFC and the administratively-determined FCM Demand Curve.
- The model incorporates the option to mitigate offers based on the MOPR.
  - Mitigated offers are based on Offer Review Trigger Price ("ORTP") values.
  - The current renewable exemption (200 derated MW per auction) is assumed to remain in effect.
  - All new resources are potentially subject to the MOPR, although behind-the-meter PV, which reduces Net ICR, effectively bypasses the MOPR.
  - Base Case assumes no MOPR offer mitigation. Instead, offer mitigation is evaluated through sensitivity analysis.
- The FCM Demand Curve is based on the current demand curve construct, adjusted to anticipated future market conditions, and forecast net ICR in 2025 and 2030, consistent with ISO-NE's analysis of capacity additions needed to maintain resource adequacy.

Model Overview

FCM Model – Model Structure

- The analysis is performed for two years: compliance year 2025/2026 (FCA 16) to correspond to ISO-NE's analysis of energy market outcomes in 2025; and compliance year 2030/2031 (FCA 21) to correspond to energy market outcomes in 2030.
- Market-clearing in the FCM Model follows the same rules as the descending clock auction
  - All units are assumed to enter prorated offers such that the market exactly clears at the marginal unit
  - If the market is short, two outcomes are reported (1) the price and quantity if no new resources clear; this outcome reflects the quantity of supply available and the price at the vertical intercept with the demand curve, and (2) the price and quantity assuming that new resources enter at net CONE.
- When evaluating outcomes in each year, the assumed supply of resources includes all resources that are currently in the ISO-NE system and Scenario-specific assumptions about new resources, but excludes retired resources, based on Scenario-specific assumptions.

Model Overview

FCM Model – Model Structure

- The model identifies resources that do not clear the FCA, but does not draw conclusions about whether these resources retire, moth-ball or continue to operate as energy-only resources.
  - However, the logic of the FCM is that resources with higher offers that do not clear have positive going forward costs of operation that, presumably, cannot be sustained indefinitely. From this perspective, our model results can be viewed as providing FCA outcomes in which resources that do not clear the FCM may exit the system. Under this assumption, the retired resources under each Scenario would reflect both the Scenario-specific retired resources and the resources that do not clear the FCA. However, our analysis does not provide any insight into the timing of when resource retirement would occur over the intervening years between the auctions modelled.
  - The model assumes that all assumed resource additions enter the market before the auctions being modeled (i.e., FCA 16 and FCA 21). Thus, resource additions are assumed to bid into the FCA as existing resources, not “new” resources in FCA 16 or FCA 21. This implicitly assumes that entry of the assumed additional resources was supported by clearing prices in prior FCM auctions or by other revenues sources outside the ISO markets. However, we do not make any explicit assumptions about these prior auction outcomes or the source of other revenues.

Supply or Offer Curve

- The supply curve comprises offers from individual resources. Each resource's offer reflects several components. First we estimate the net GFC, reflecting net EAS market revenues, net Pay-for-Performance ("PFP") revenues, operational fixed costs, incremental capital costs, taxes and a risk premium – that is:

Net GFC = Fixed Costs + Annualized Capital Costs + Taxes

- Net EAS Revenues - Expected Net PFP Revenues

- The "avoidable" costs of plant operation generally include the **fixed costs** of plant operation, **on-going capital investment** to maintain plant operation, and **taxes**.
- **Net EAS revenues** reflect **net energy market revenues** from the ISO-NE analysis and estimates of ancillary service revenues.
  - **Ancillary service revenues** reflect resource-specific operating reserves revenues, based on an analysis of actual revenues earned by resources over the period 2012 to 2016. Resource-specific revenue estimates reflect Forward Reserve Market ("FRM") outcomes (including resource assigned to meet FRM obligations), real-time reserve market outcomes, and appropriate adjustments to FCM revenues.
  - Estimates of ancillary service revenues do not consider any changes to ancillary service requirements (and markets) that might be necessary to maintain reliability requirements with higher renewable quantities.
- The data and approach to estimating each of these costs is summarized on the following slide.

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Supply Curve Components

Component	Data Source(s)	Brief Detail
Net Energy Revenues	ISO-NE GridView Output	Modeled by ISO-NE, reflecting energy revenues net of variable and fuel costs
Ancillary Revenues	ISO-NE Historical Data	Analysis of unit-specific forward and real-time operating reserve prices and supply from 2012 to 2016 Does not consider any changes in ancillary service requirements
Fixed Costs	SNL Financial; ABB Ventyx	Detailed review of annual fixed costs modeled by SNL and Ventyx for individual units and by technology type
Investment Costs	SNL Financial	Analysis of annual investment costs for plants by technology type (2010 to 2015), excl. major investment
Taxes	Public Tax Rates and Property Assessments	Based on review of financial materials for 76 units of various capacity sizes and technology types
PFP Adjustment	ISO-NE Historical Data	Analysis of unit historical performance during reserve shortages
Risk Premium	ISO-NE Pre-Determined Formulas	Based on ISO-NE projected scarcity hours and other parameters

Additional details are available in the technical appendix

Supply or Offer Curve

- **Expected Net PFP Revenues** are based on an estimate of the difference between expected PFP revenues and expected PFP payments (to load), which depends on the unit's output (performance) during reserve shortages. This adjustment can be positive or negative.
  - For each unit, expected PFP revenues reflect the unit's actual performance during past reserve shortages and expected PFP costs reflect load conditions (i.e., the "balancing ratio") during past reserve shortages.
- The PFP rules also create a "minimum" price any resource will offer into the FCA.
  - Under the PFP rules, a rational bidding strategy includes an offer floor, reflecting expected PFP payments to load that the resource is obligated to pay when it accepts a CSO. Because PFP revenues can be earned without a CSO, any offer below this minimum offer will be less profitable (in expectation) than simply forgoing the CSO (i.e., FCA revenues are less than expected PFP payments to load).
  - Additional details can be found in Schatzki, Todd and Hibbard, Paul, "Assessment of the Impact of ISO-NE's Proposed Forward Capacity Market Performance Incentives", 2013.
- Resource offers are allowed to include a **Risk Premium**, reflecting, for example, the risk greater than expected reserve deficiency hours.
- **Figure 1a** illustrates the impact of the PFP rules in creating an offer floor while **Figure 1b** provides further information on the important features of the shape of the supply curve.

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Figure 1a
ISO-NE FCM Auction Demand-Supply Curve, By Type
Scenario 1 Unconstrained 2025 - Base Case

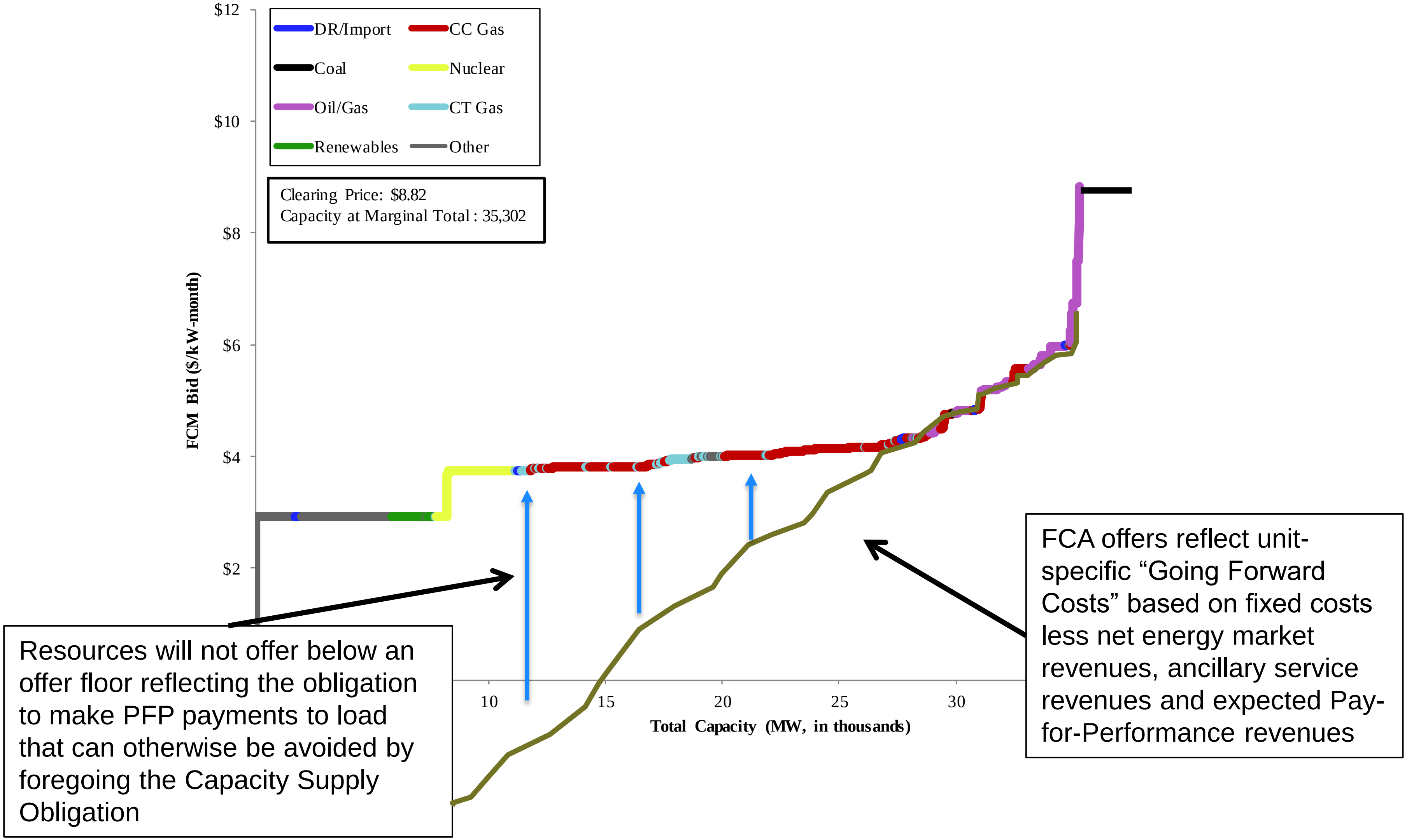
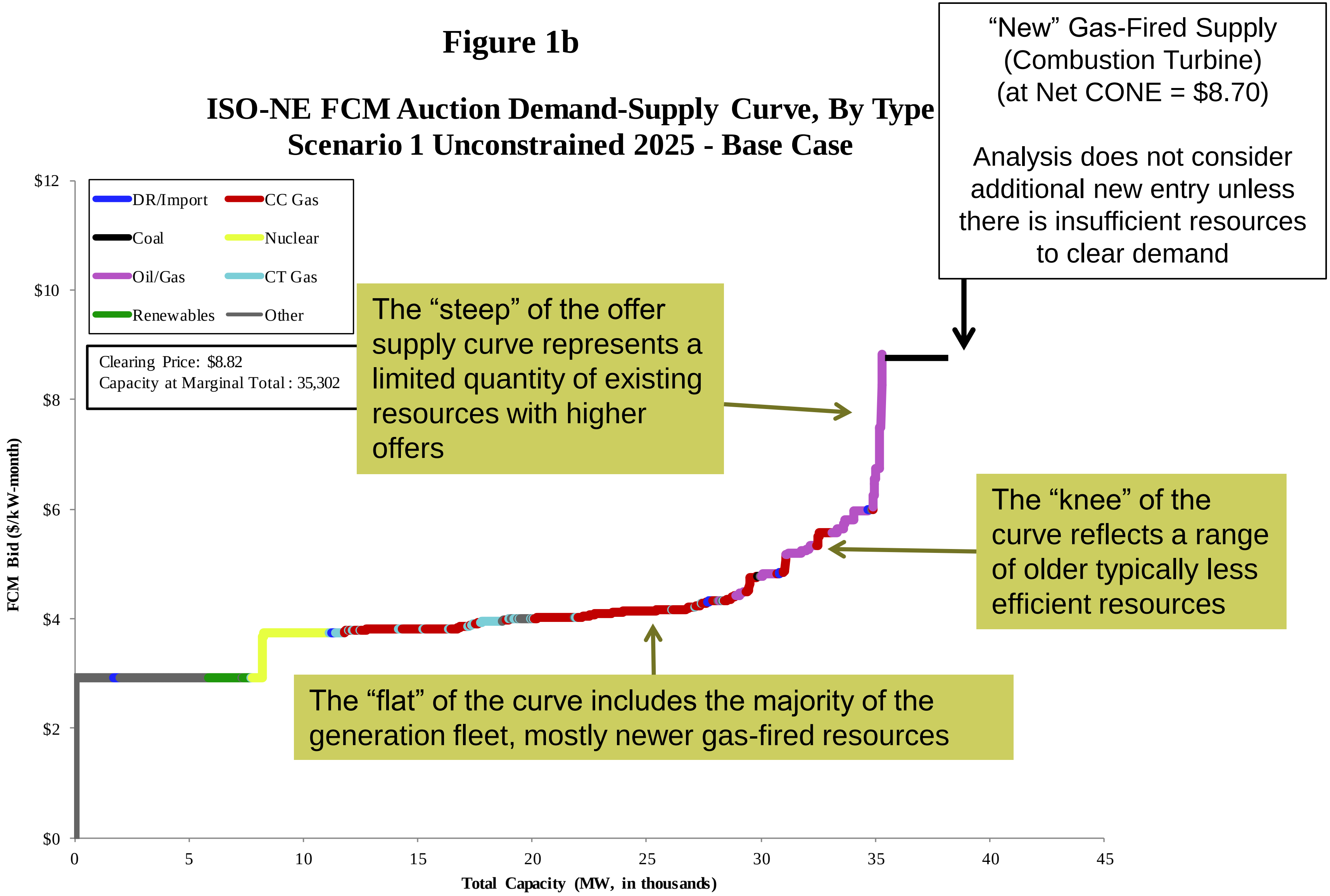


Figure 1b


ISO-NE FCM Auction Demand-Supply Curve, By Type
Scenario 1 Unconstrained 2025 - Base Case
DR/Import
CC Gas
Coal
Nuclear
Oil/Gas
CT Gas
Renewables
Other
Clearing Price: $8.82
Capacity at Marginal Total : 35,302
FCM Bid ($/kW-month)
$12
$10
$8
$6
$4
$2
$0
0
5
10
15
20
25
30
35
40
45
Total Capacity (MW, in thousands)
"New" Gas-Fired Supply (Combustion Turbine) (at Net CONE = $8.70)
Analysis does not consider additional new entry unless there is insufficient resources to clear demand
The "steep" of the offer supply curve represents a limited quantity of existing resources with higher offers
The "knee" of the curve reflects a range of older typically less efficient resources
The "flat" of the curve includes the majority of the generation fleet, mostly newer gas-fired resources

Demand Curve

- The FCM clears the supply of resource offers against an administratively determined demand curve. The FCM Model uses a demand curve reflecting current rules for future FCA's.
  - Starting in FCM 10, the FCA used a sloped demand curve, under which cleared capacity is greater than net ICR when prices clear below the net Cost of New Entry ("CONE"), and cleared capacity is less than net ICR when prices clear above net CONE.
  - Most recently, for FCA 11, the FCM has adopted a non-linear demand curve reflecting the Marginal Reliability Impact ("MRI") of capacity. To construct demand curves for future years, the current MRI curve, and associated demand curve, was translated into a future year through a horizontal shift in the curve.*
- The model evaluated for the 2016 Economic Analysis includes one zone for ISO-NE.
  - Sub-regional zones (import or export constrained) were not evaluated because of the substantial uncertainty about the future geographic configuration of transmission constraints, if any, that forms the basis for determining capacity zones. Because of this uncertainty, it would unduly speculative to adopt particular zonal configurations for these future periods and any resulting conclusions would be suspect.
- **Figure 2** illustrates the demand curve evaluated within the FCM model.

* While the demand curve in future years may reflect both a demand curve shift and rotation, a shift was chosen because of uncertainty about the extent of any appropriate (counterclockwise) rotation.

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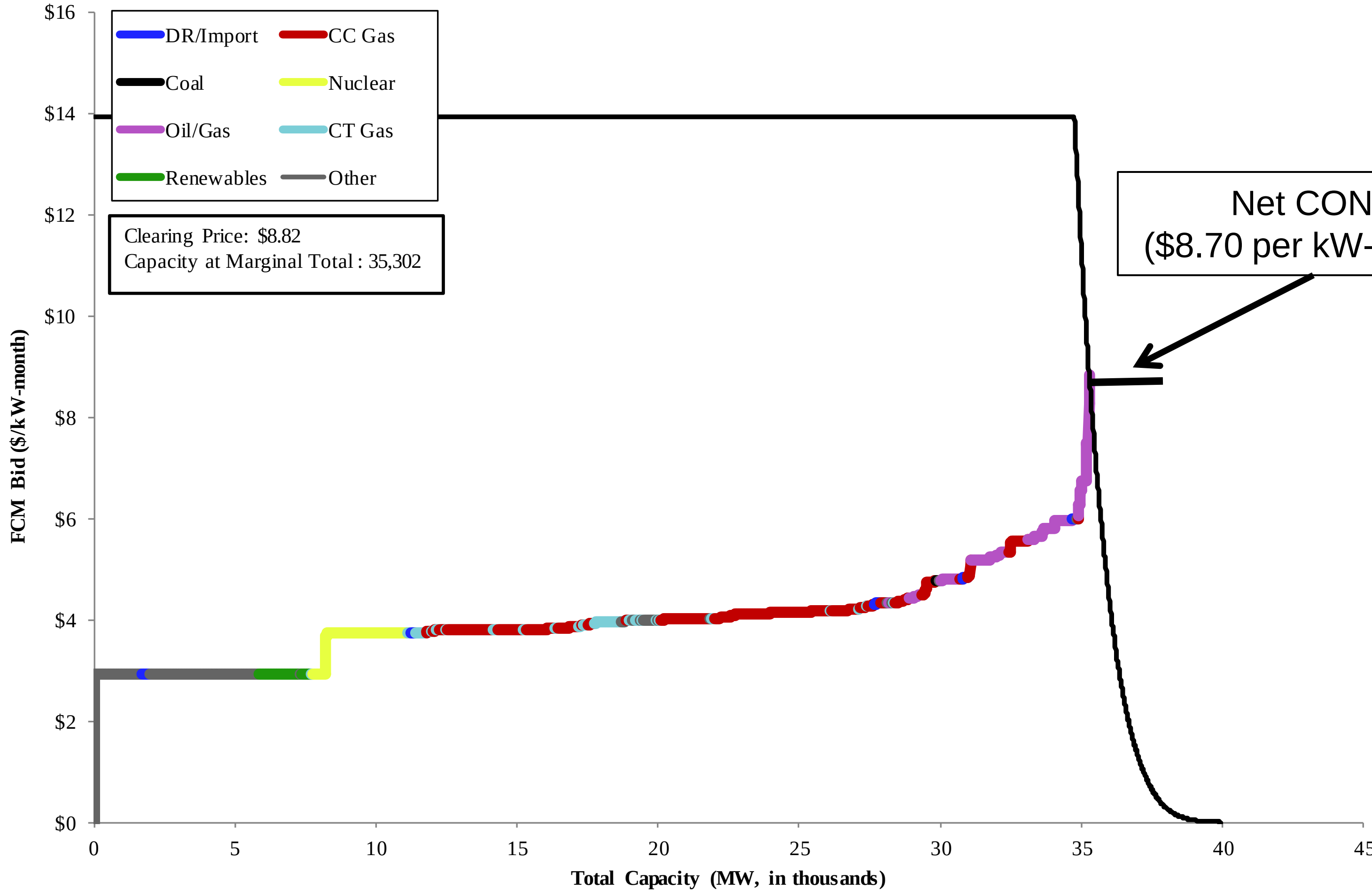
Figure 2
ISO-NE FCM Auction Demand-Supply Curve, By Type
Scenario 1 Unconstrained 2025 - Base Case



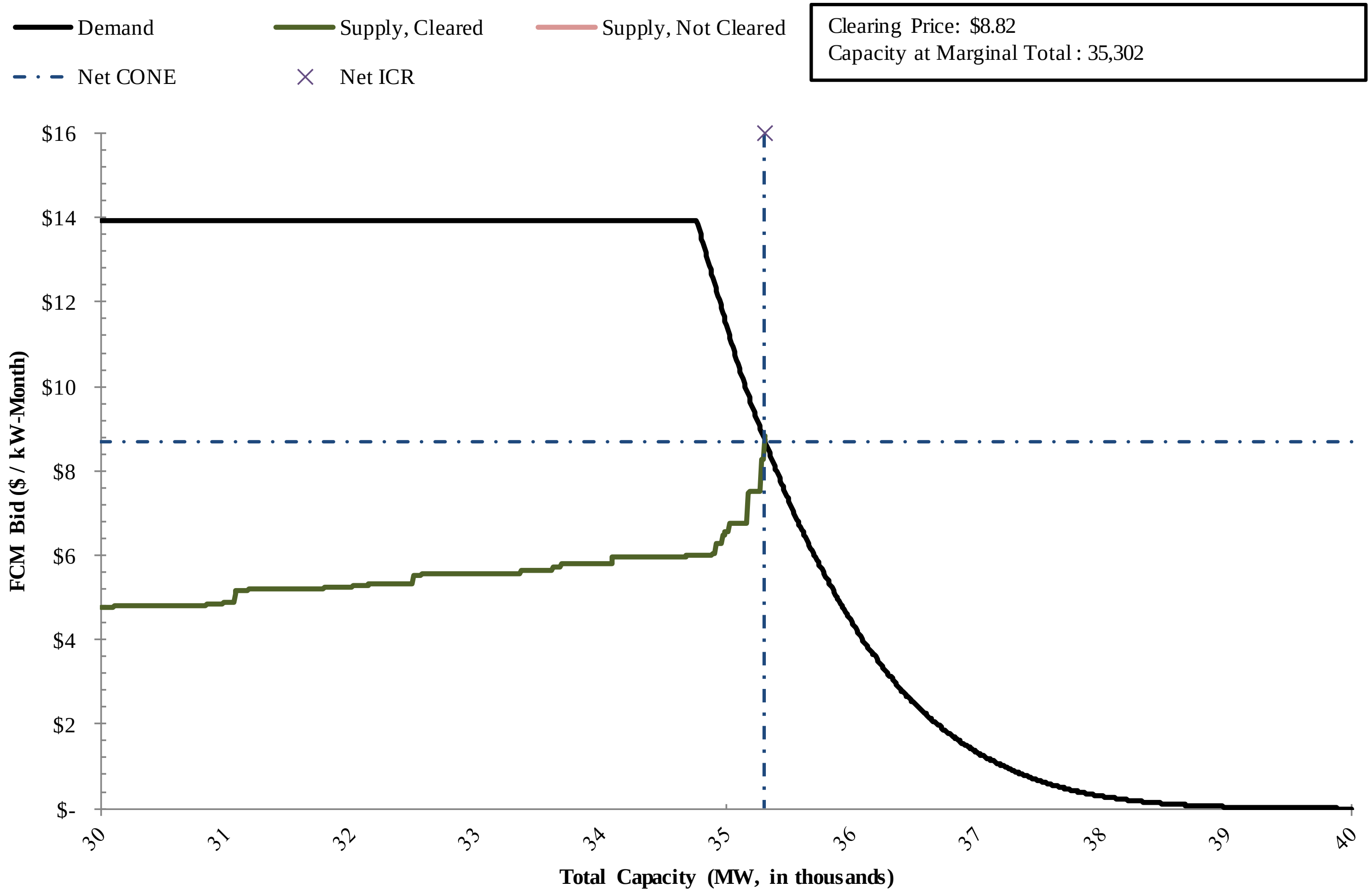
Illustrative Examples of Auction Clearing

The FCM Model – Example Auction

- As an illustration of the model, **Figure 3** shows the supply and demand curve for Scenario 1.
  - Supply bids into the market place based on their GFC, the calculated risk premium and the PFP offer floor.
  - Clearing price and quantity are calculated based on the auction results. When there is a tie between offers from multiple resources, tied offers are cleared on a pro-rated basis and the market clears exactly at the intersection of the supply and demand curves.
- In Scenario 1, illustrated in **Figure 3**, the marginal unit crosses the demand curve near net CONE and net ICR.

Figure 3

ISO-NE FCM Auction Demand-Supply Curve
Scenario 1 Unconstrained 2025 - Base Case



Resources Offering Into the FCM

- Our analysis builds off ISO-NE's energy market analysis. In our base case, we assume that the same universe of resources is available to participate in the FCM as is assumed in ISO-NE's production cost analysis. As shown in **Table 1**, these resources include:
  - Resources available as of FCM 10 and certain resources in the interconnection queue, with the exception of certain resources that are assumed to retire in all scenarios except Scenario 4;
  - New renewable resource additions needed to comply with current state RPS (Scenarios 1, 2, 3 and 6) (with alternative compliance payments in lieu of new resources in Scenarios 4 and 5);
  - Additional new "clean" resources, including imports and battery storage, beyond those needed for RPS compliance reflecting expanded "clean energy" state policies (Scenario 3); and
  - New gas-fired resources needed to maintain resource adequacy, including new renewable resources (Scenario 2) and new gas-fired resources (Scenario 1 and 4).
- For each scenario, ISO-NE compared the resource levels after assumed retirements and new resource additions against a resource adequacy criteria, assumed to be the net Installed Capacity Requirement ("ICR"), to determine whether new resources would be needed to maintain resource adequacy.
  - In many scenarios, assumptions regarding retirements and new resource development were such that there were sufficient (if not excess) resources relative to net ICR.
  - In other scenarios, these assumptions were such that there was an insufficient quantity of resources relative to net ICR, such that new resources would be required to meet net ICR. In these scenarios, new resources of a specified technology consistent with the scenario were added. These resource additions are summarized in **Table 2.**

Resources Offering Into the FCM

Table 1
Summary of Resources in the ISO-NE System in 2025 and 2030 (FCM Eligible Capacity)

Category	2025 S1	2025 S2	2025 S3	2025 S4	2025 S5	2025 S6	2030 S1	2030 S2	2030 S3	2030 S4	2030 S5	2030 S6
FCA 10 Cleared Renewables (non solar)	487	487	487	487	487	487	487	487	487	487	487	487
FCA 10 Cleared Solar & Solar added in S6	62	62	62	62	62	443	62	62	62	62	62	1,673
Forecasted EE & ADR w/o RTEG	4,163	4,163	5,663	4,163	4,163	4,163	5,058	5,058	8,328	5,058	5,058	5,058
FCA 10 Cleared Nuclear	3,347	3,347	3,347	3,347	3,347	3,347	3,347	3,347	3,347	3,347	3,347	3,347
FCA 10 Cleared Hydro	3,116	3,116	3,116	3,116	3,116	3,116	3,116	3,116	3,116	3,116	3,116	3,116
Citizen Block Load	30	30	30	30	30	30	30	30	30	30	30	30
Imports	1,006	1,006	2,506	1,006	1,006	1,006	1,006	1,006	3,006	1,006	1,006	1,006
Existing Wind (FCM + I.3.9) & Wind Added in S2 & S6	366	1,511	1,457	366	366	1,129	366	5,199	1,900	366	366	3,588
Gas after Retirement	16,582	16,582	16,582	16,676	16,582	16,582	16,011	16,011	16,011	16,676	16,011	16,011
Oil after Retirement	4,509	4,509	4,509	6,109	4,509	4,509	2,114	2,114	2,114	6,109	2,114	2,114
Coal after Retirement	0	0	0	917	0	0	0	0	0	917	0	0
Total Existing Resource after Retirement	33,668	34,813	37,759	36,279	33,668	34,812	31,597	36,430	38,401	37,174	31,597	36,430
Utility Scale Batery Storage	0	0	1,200	0	0	0	0	0	2,500	0	0	0
Capacity Added to Meet RPS	488	0	0	0	0	0	687	0	0	0	0	0
Total Existing Resource plus Storage and RPS Renewables	34,156	34,813	38,959	36,279	33,668	34,812	32,284	36,430	40,901	37,174	31,597	36,430
Net NICR	35,302	35,302	34,804	35,302	35,302	35,302	36,919	36,919	36,273	36,919	36,919	36,919
NGCC Capacity Added to Replace Retirement and to Meet NICRc	656	0	0	0	1,144	0	4,146	0	0	0	4,833	0
Wood	489	489	489	489	489	489	489	489	489	489	489	489
Total Capacity Modeled	35,302	35,302	39,448	36,768	35,302	35,301	36,919	36,919	41,390	37,663	36,919	36,919

Source: ISO-NE.

Assumed Retirements

- Assumed retirements are reported in **Table 2**. These resource retirements include:
  - All coal resources,
  - Roughly 25 percent of existing oil resources in 2025, and an additional 40 percent in 2030, and
  - Small quantities of additional resources

Table 2

Retirements by Plant Type
Scenarios 1-6

	2025 Retired Summer Capacity (MW)						2030 Retired Summer Capacity (MW)					
Plant Type	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**	**Scenario 5**	**Scenario 6**	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**	**Scenario 5**	**Scenario 6**
Coal	856	856	856	0	856	856	856	856	856	0	856	856
Oil/Gas Steam	1,600	1,600	1,600	0	1,600	1,600	3,805	3,805	3,805	0	3,805	3,805
Combustion Turbine	0	0	0	0	0	0	7	7	7	0	7	7
Total	**2,457**	**2,457**	**2,457**	**0**	**2,457**	**2,457**	**4,668**	**4,668**	**4,668**	**0**	**4,668**	**4,668**

Note:
[1] The capacity shown represents implied retirements derived by comparing the units modeled across all scenarios to the units modeled in an individual scenario.

Source:
[1] ISO New England GridView Output.

Agenda

Executive Summary

Background and Assignment

Data, Methods and Model

Results

Sensitivity Analysis

Appendix

Key Economic Drivers of Differences in Scenario Outcomes

- The FCM is designed to ensure that there are sufficient revenues (the "missing money") in the ISO-NE markets to maintain resource adequacy in the long-run. In principle, many different factors affect capacity market outcomes. The Demand Curve will reflect the growth in peak loads, policies aimed at demand response (and energy efficiency), and the growth in distributed (behind-the-meter) technologies. The Supply (Offer) Curve will reflect the net revenues earned in the region's energy and ancillary service markets, the (fixed) cost of operating plants, and the entry and exit of resources from the region's fleet.
- The Scenario analysis, and Sensitivity analysis that follows in the next section, is designed to capture many potential drivers of FCM outcomes:
  - **Demand Curve**: Across Scenarios, the demand curve (and net ICR) remains fixed, with the exception of Scenario 3, which assumes a lower net ICR due to increased behind-the-meter generation.
  - **Net Energy Market Revenues:** Across Scenarios, net energy market revenues vary depending on the Scenario-specific mix of resources assumed to operate in ISO-NE's simulations.
  - **Resources in the Supply Curve:** Scenarios vary the specific resources included in the supply curve through assumptions about new resources that are developed and retirements.

Impacts of Shifts in Supply on FCM Outcomes

- Changes in resource mix would affect net EAS outcomes.
  - For example, increased renewable participation or imports in wholesale markets may be expected to lower net EAS revenues, which, in turn, would increase net GFC and offers. This change is illustrated in **Figure 4.**
  - **Figure 4** illustrates a uniform shift in offers, although, in practice, resource net EAS revenues would not be uniformly impacted by an increase in renewable resources (and, in fact, many resources with high net GFC may earn limited net EAS revenues and thus could see limited impact).
  - In principle, a reduction in net EAS revenues could also increase the net CONE for the reference technology, which would shift the demand curve higher. The combined effect of a shift the supply curve and change in net CONE is illustrated in **Figure 5**. However, because net CONE is based on a combustion turbine, which relies less heavily on energy market revenues, this effect may be relatively small going-forward. The current analysis and sensitivities do not consider shifts in the demand curve.
- Changes in the resource mix would also affect the quantity of resources offering into the FCM.
  - As shown in **Figure 6**, an increase in the quantity of infra-marginal resources would shift the supply curve out (to the right), resulting in market-clearing at a different marginal unit with a lower offer; this, in turn, would lower FCA prices, all else equal.
  - In the long-run, with entry driven by FCM prices, new entry would occur when there was sufficient retirement of excess capacity for prices to rise to the cost of new entry. With entry driven by other sources of revenues (e.g., state policies), new entry will continue to push prices downward, resulting in a further depression of FCM prices (as illustrated by the green line in **Figure 6**).

Figure 4

Illustrative Cumulative Effects: Reduction in net EAS revenues and increase in GFC

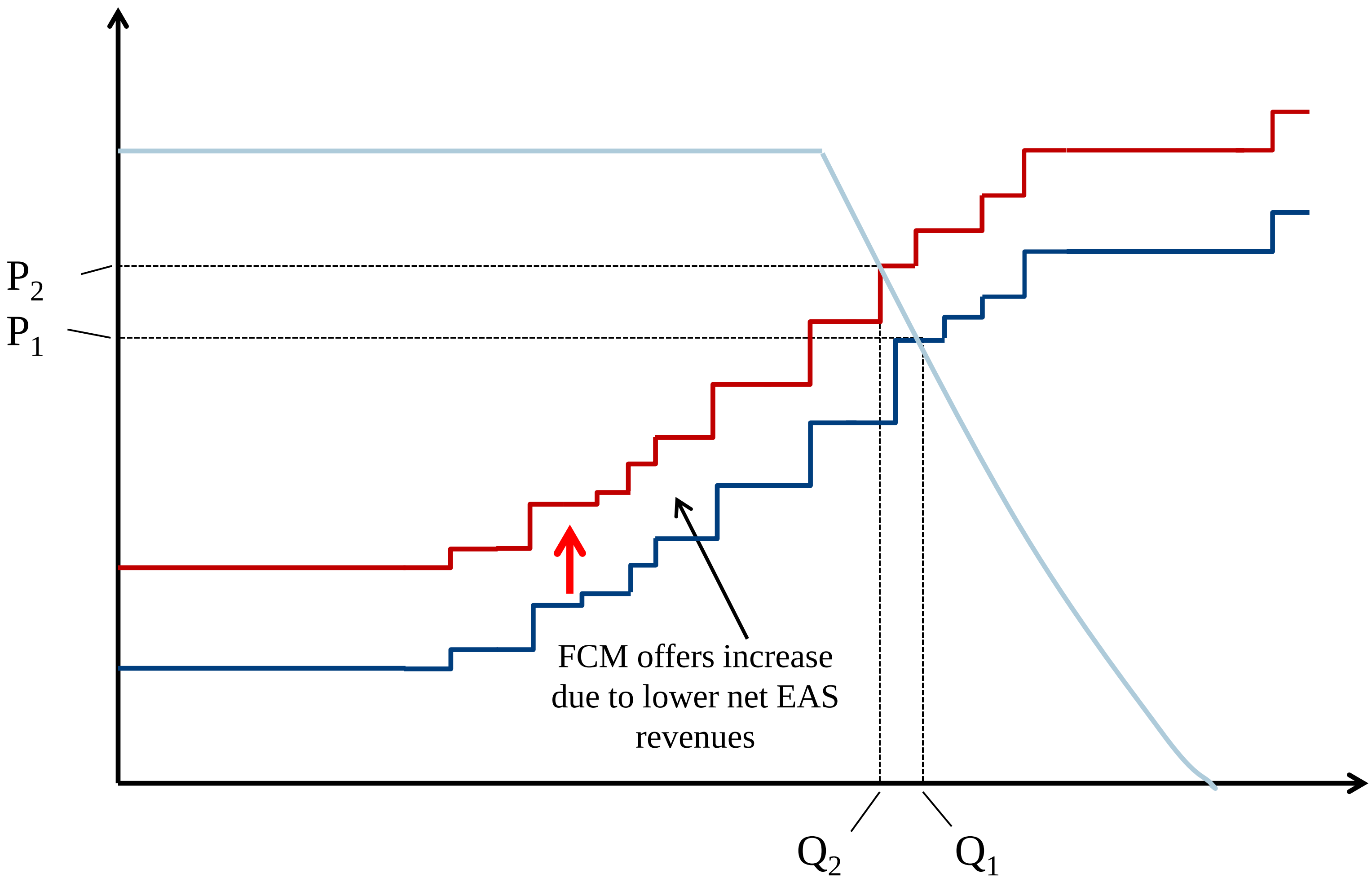


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Figure 5

Illustrative Cumulative Effects: Reduction in net EAS revenues and increase in GFC

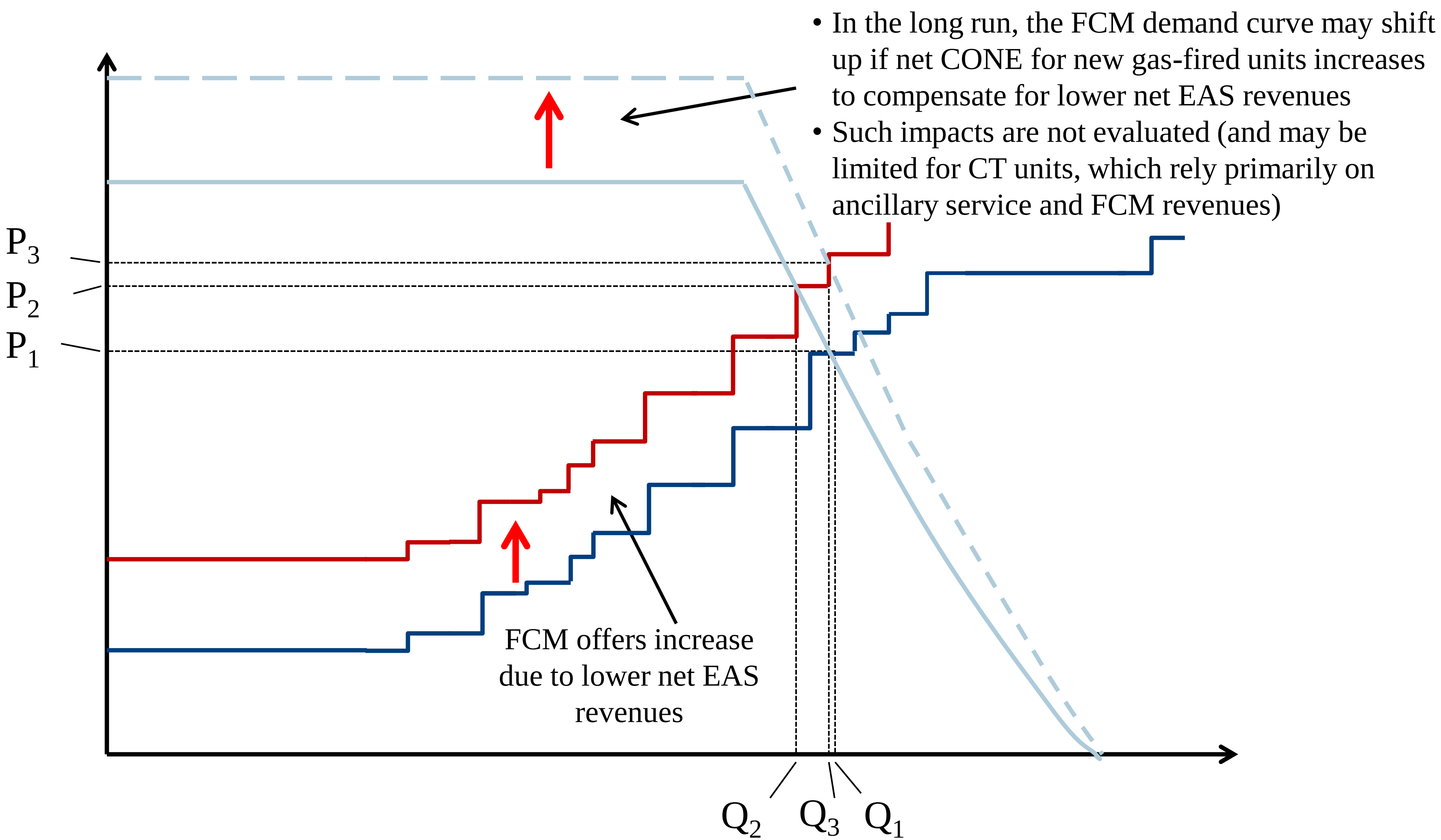
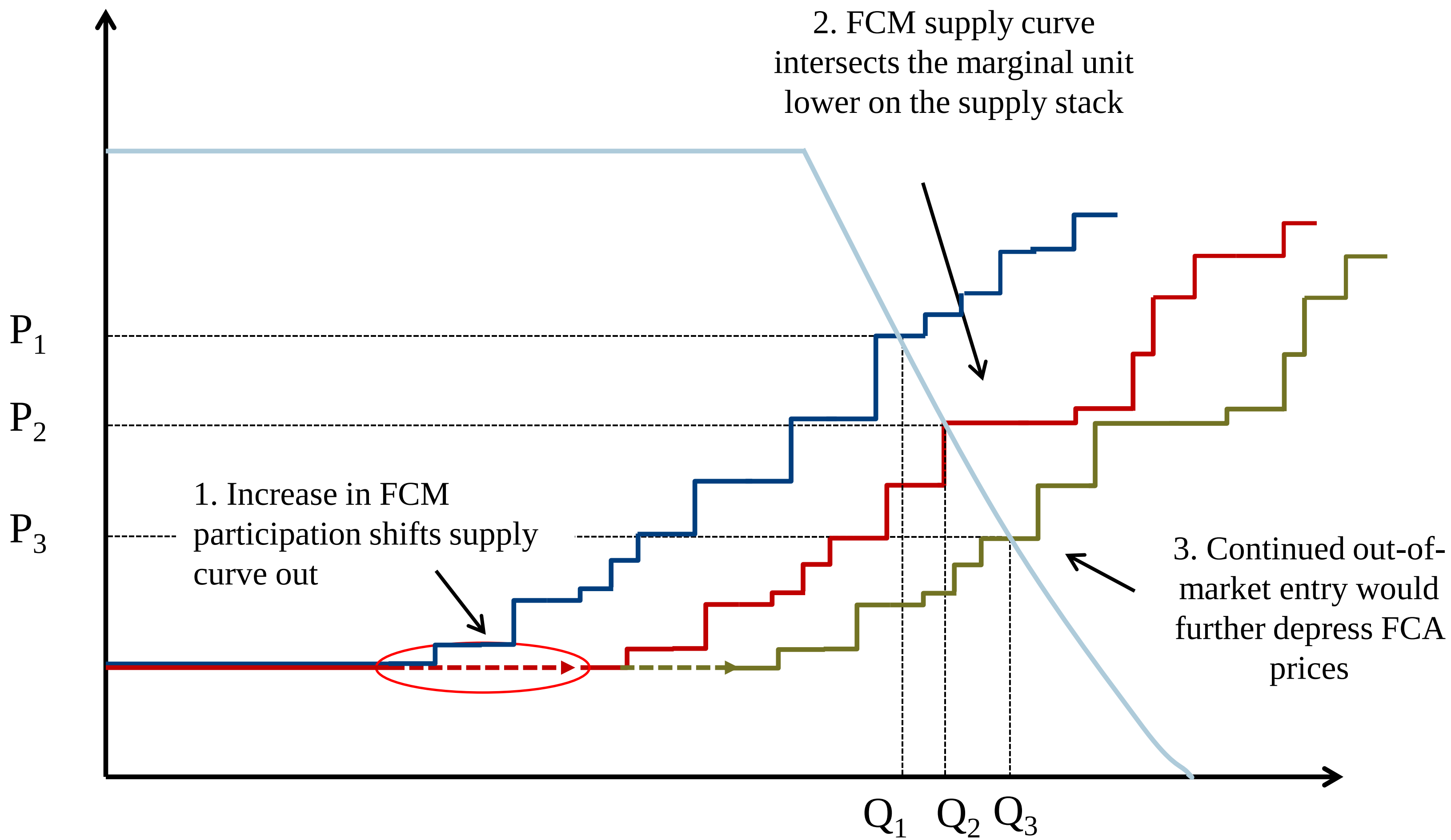


Figure 6

Illustrative Cumulative Effects: Increase in Capacity Market Participation



Summary of Scenario Outcomes

- **Table 3** reports key market outcomes for each scenario, including market clearing FCA prices and quantities, total FCM payments, average FCM payment per MWh, and clearing amounts relative to net ICR.
- **Figure 7** compares FCA prices across Scenarios, including results based on the constrained and unconstrained analysis of energy markets are reported.
  - As we find that results do not differ meaningfully between these scenarios, we focus on the unconstrained scenarios given that its results do not depends on future assumptions regarding the location of transmission congestion within the ISO-NE system. Further information on the results of the constrained cases are provided in the appendices.
- Across the scenarios, market equilibrium outcomes can be grouped into three general categories:
  - ***Retirements with Entry to Meet Net ICR.*** Market outcomes with higher FCA prices, slightly above net CONE, and Capacity Supply Obligation (CSO) quantities roughly equal to net ICR (Scenarios 1, 2, 5, and 6)
  - ***No Retirements and No Meaningful New Resources.*** Market outcomes with intermediate FCA prices and CSO quantities slightly in excess of net ICR (Scenario 4)
  - ***Retirements with Substantial New Clean Resources.*** Equilibrium outcomes with lower FCA prices, larger quantities of capacity in excess of net ICR and larger quantities of resources that do not clear the FCA (Scenario 3)

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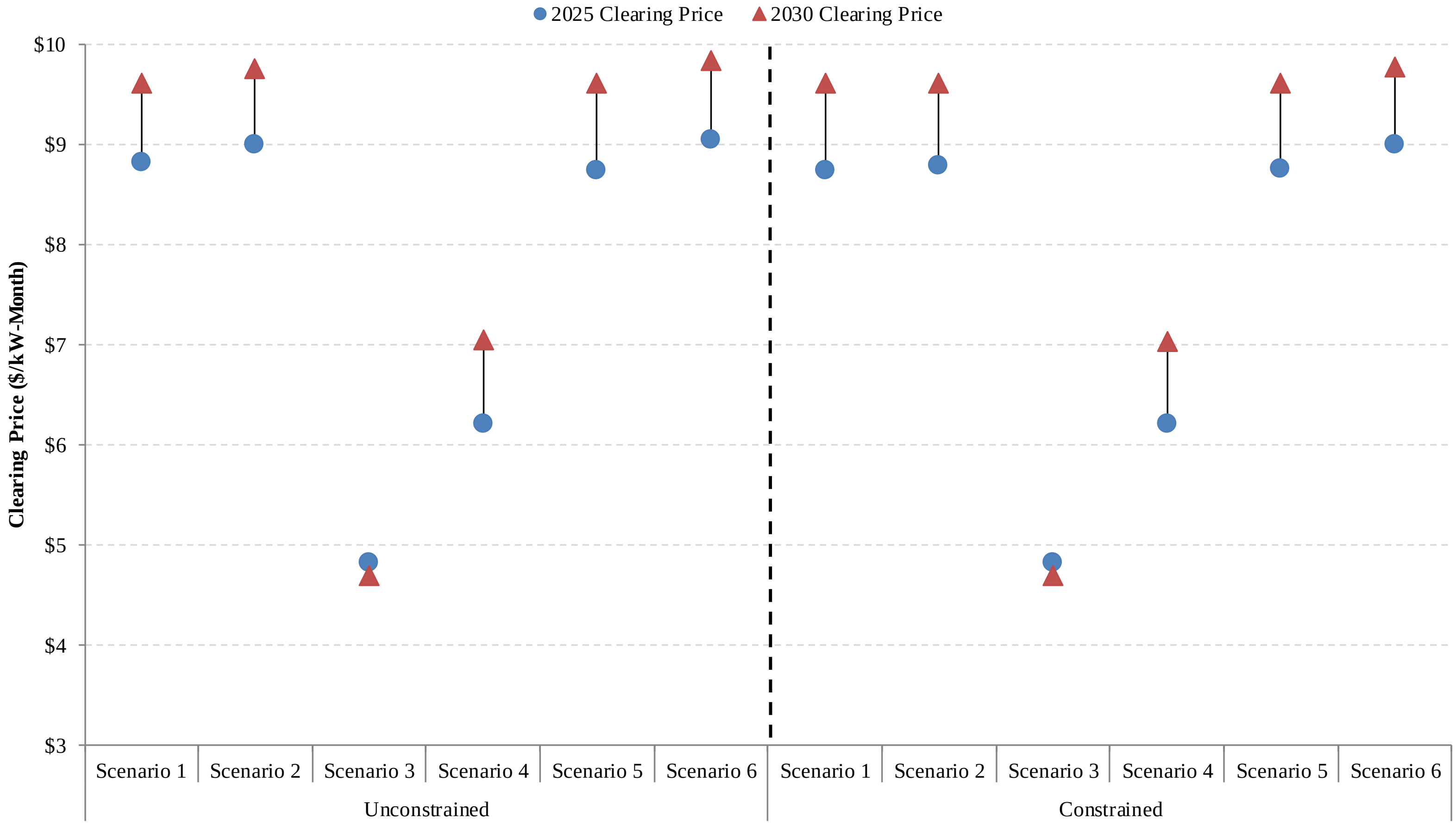
Table 3
ISO-NE FCM Bidding Model
Results Table

	2025 (Unconstrained)					
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Net CONE	$8.70	$8.70	$8.70	$8.70	$8.70	$8.70
Clearing Price ($/kW-Month)	$8.82	$8.99	$4.82	$6.20	$8.74	$9.04
Cleared Capacity @ Marginal Total (MW, thousands)	**35,302**	**35,299**	**35,627**	**35,665**	**35,302**	**35,302**
Total FCM Payments ($, millions)	**$3,736**	**$3,808**	**$2,061**	**$2,653**	**$3,702**	**$3,830**
Average FCM Payments ($ per MWh)	$24.57	$25.06	$12.77	$17.53	$24.35	$25.20
Capacity Above ICR	0	-3	823	363	0	0
Not Cleared Capacity (MW, thousands)	0	0	5,010	891	0	0
Total Energy Revenue ($, millions)	$8,659	$8,325	$7,688	$8,737	$8,819	$8,382

	2030 (Unconstrained)					
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Net CONE	$9.61	$9.61	$9.61	$9.61	$9.61	$9.61
Clearing Price ($/kW-Month)	$9.61	$9.75	$4.68	$7.04	$9.61	$9.84
Cleared Capacity @ Marginal Total (MW, thousands)	**36,919**	**36,916**	**37,439**	**37,332**	**36,920**	**36,920**
Total FCM Payments ($, millions)	**$4,257**	**$4,319**	**$2,103**	**$3,154**	**$4,257**	**$4,360**
Average FCM Payments ($ per MWh)	$26.67	$27.18	$11.98	$19.75	$26.68	$27.43
Capacity Above ICR	0	-3	1,166	413	1	1
Not Cleared Capacity (MW, thousands)	0	0	5,989	331	0	0
Total Energy Revenue ($, millions)	$11,262	$7,444	$8,051	$11,453	$11,362	$6,992

Note: Results are reported in nominal dollars (e.g., 2025 results are in $2025).

Figure 7
FCA Clearing Prices ($/kW-month)
Scenarios 1-6



Note: Results are reported in nominal dollars (e.g., 2025 results are in $2025).

Scenarios with Retirements and Sufficient New Entry to Meet Net ICR

Four of the six scenarios (Scenarios 1, 2, 5, and 6) are driven by the assumption that the resource deficit created through the retirement of existing resources is filled by a sufficient quantity of new resources to exactly meet net ICR.

- **Figure 8** illustrates the market equilibrium for Scenario 1, which is representative of these Scenarios.
- In these Scenarios, FCA prices range from $8.82 to $9.04 per kW-month in 2025, and $9.61 to $9.64 per kW-month in 2030.
- In these Scenarios, there is no excess capacity and no capacity that does not clear the market.
- These outcomes are sensitive to the offers of marginal resources reflecting their GFC. We estimate that there is a small quantity of resources with offers in the “steep” part of the supply curve, slightly above net CONE.

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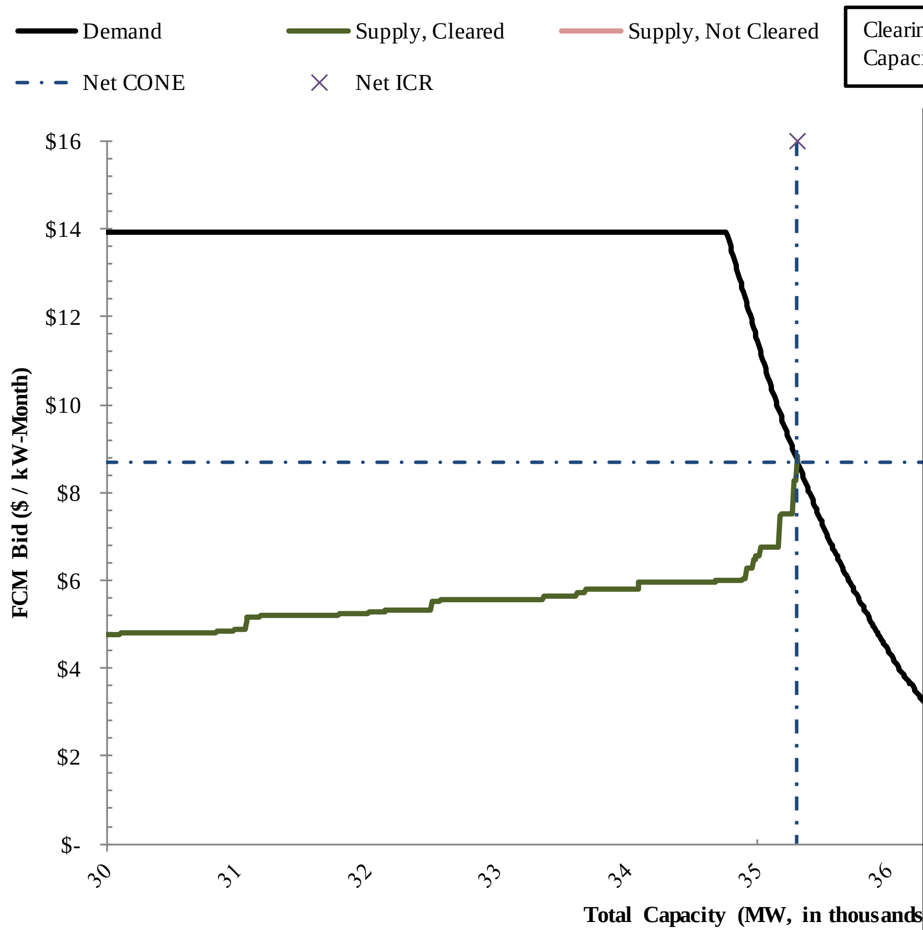
Figure 8

ISO-NE FCM Auction Demand-Supply Curve
Scenario 1 Unconstrained 2025 - Base Case



In the base case, demand clears at existing resources in all Scenarios. In Scenarios 1, 2, 5 and 6, the market clearing resources have high offers, near to net CONE.

But, FCA outcomes in these Scenarios are not sensitive to this assumption.

- If offers from these resources were lower, the market would still clear at prices near to net CONE. Resources in these Scenarios are limited to net ICR. As a result, the supply curve would be below the demand curve if offers were all less than net CONE. If the supply of offers is insufficient to clear demand, the model provides results assuming (1) new entry, with the model clearing at net CONE, and (2) no new entry, with the model clearing at the vertical intercept with demand.

Potential inconsistency between high FCA prices and assumed retirements

- The relatively high FCA prices in Scenarios 1, 2, 5 and 6 are potentially inconsistent with the quantity of existing fossil resources assumed to retire for economic reasons (2,457 MW by 2025, and 4,668 by 2030). To date, the resources that are assumed to retire continue to participate in the ISO-NE markets despite lower and declining FCA prices in recent auctions (e.g., $5.30 per kW-month in FCA 11, and $7.03 per kW-month in FCA 10). Several possible explanations could reconcile the assumed retirements with current pricing, such as the possibility that older fossil resources can only sustain operations at weaker pricing for short periods, but not indefinitely, or that each facility requires large capital upgrades that cannot be economically justified at some point over the study period.
- If actual retirements were lower, fewer new resources would be required to maintain resource adequacy. If retirements were substantially lower, this could affect market outcomes (e.g., Scenario 4)
- For comparison, since FCA 6, 2,215 MW of resources have retired from participation the ISO-NE markets. **Table 4** identifies these units. Including Pilgrim Nuclear Power Plant and Brayton Point, which did not clear in FCA 10, 4,485 MW of resources have or plan to retire, since FCA 6.

Table 4

Power Plants Retired in ISO New England FCA 6 Through 2016 by Generation Type

Generation Type	Capacity (MW)
Oil/Gas Steam	1,117
Nuclear	563
Coal	302
Miscellaneous	90
Combustion Turbine	44
Wood	45
Combined Cycle	34
Hydro	20
Total	**2,215**

Notes:

[1] FCA 6 was held on May 1, 2012.

[2] This table only includes units that have retired. It does not include units with a retirement date scheduled such as Pilgrim Nuclear Power Plant and Brayton Point which combined account for 2,270 MW.

Source:

[1] SNL Financial.

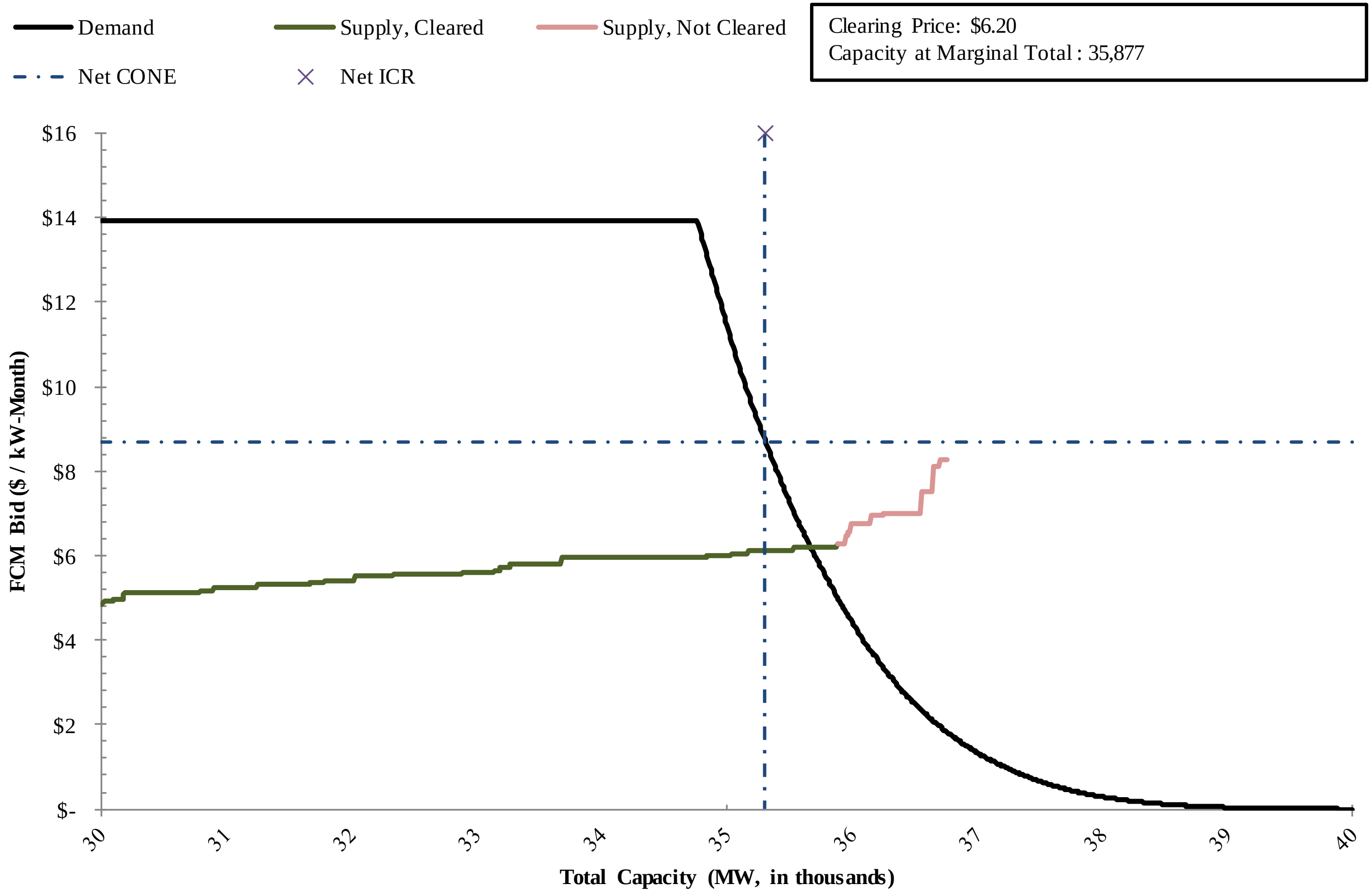
Scenarios with No Retirements and No Meaningful New Resources

Scenario 4 represents an intermediate scenario with lower prices than Scenarios 1, 2, 5 and 6.

- **Figure 9** illustrates the market equilibrium for Scenario 4.
- FCA prices are $6.20 per kW-month in 2025 and $7.04 per kW-month in 2030, which is about $2.55 to $2.85 per kW-month lower than Scenarios 1, 2, 5 and 6.
- In contrast to Scenarios 1,2, 5, and 6, which assumed fossil retirements in the face of strong pricing, Scenario 4 assumes no resource retirements. In this scenario, there is a modest excess supply of resources given the relative pace of new resource entry (energy efficiency and renewables) and underlying load growth (as reflected in net ICR). Given the excess quantity of resources, clearing prices are lower and some resources (891 MW in 2025 and 331 MW in 2030) do not clear the market.
- Market-clearing occurs at the lower part of the “steep” part of the curve. At this point, changes in supply will tend to have an asymmetric effect on FCA price – the increases in supply will tend to have a smaller impact on FCA prices relative to those from decreases in supply.

Figure 9

ISO-NE FCM Auction Demand-Supply Curve
Scenario 4 Unconstrained 2025 - Base Case



Scenarios with Retirements with Substantial New Clean Resources

- Scenario 3 represents the scenario with the lowest FCA prices.
  - **Figure 10** illustrates the market equilibrium for Scenario 3.
  - FCA prices are $4.82 per kW-month in 2025 and $4.68 per kW-month in 2030, which is about $3.90 to $5.16 per kW-month lower than Scenarios 1, 2, 5 and 6.
  - In Scenario 3, existing fossil resources are assumed to retire, but new resources of various types enter the market and net ICR grows at a slower pace than other Scenarios due to the offsetting impact of behind-the-meter photovoltaics. As a result of the combined effect of these changes, the total quantity of resources that offer into the FCM in excess of net ICR is greater than in Scenario 4 (5,010 MW versus 891 MW). Given this excess supply, clearing prices are lower and some resources (5,010 MW in 2025 and 5,989 in 2030) do not clear the market.
  - Market-clearing occurs at the "flat" part of the curve, where FCA prices are very insensitive to shifts in the offer curve.

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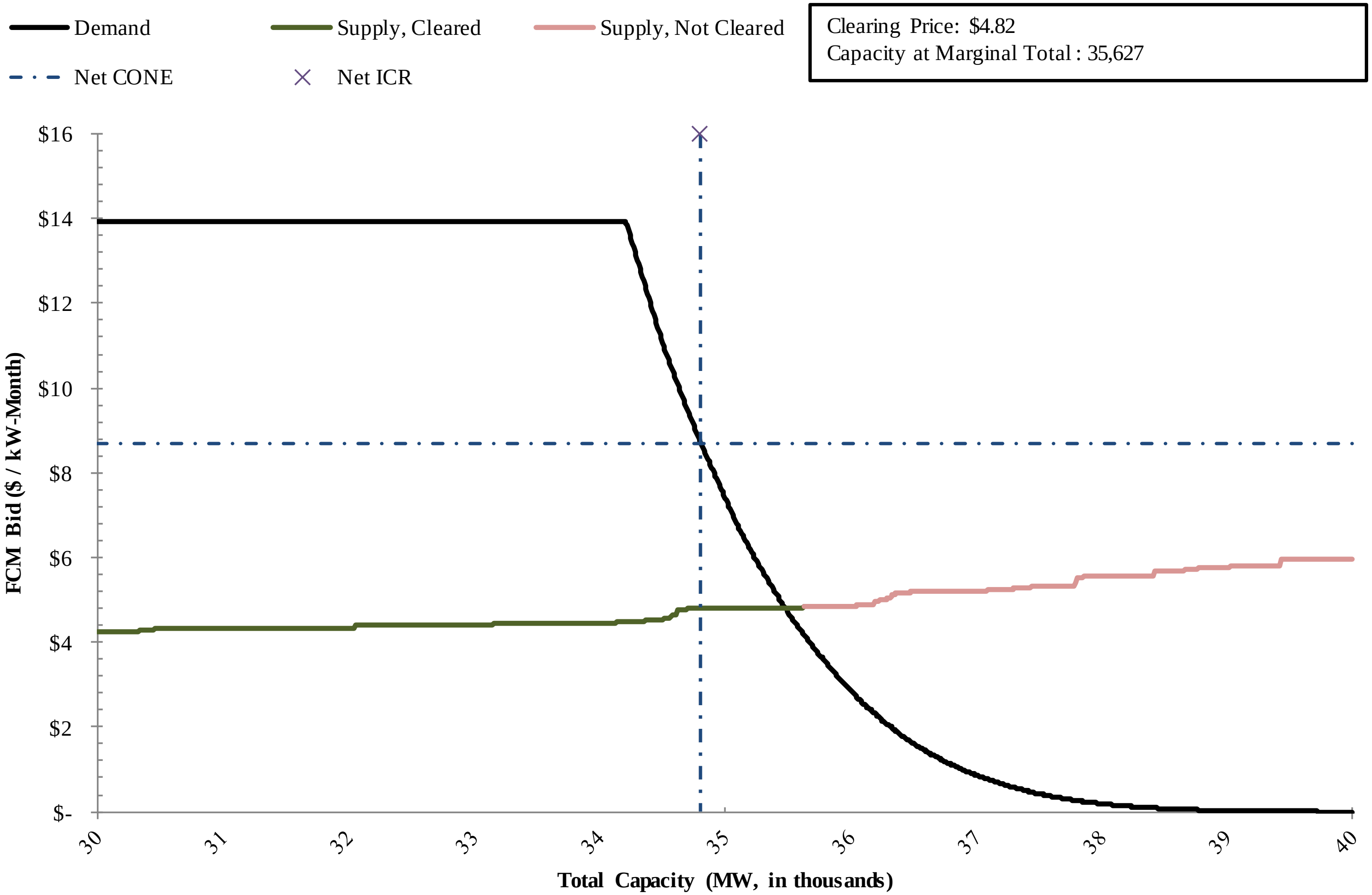
Figure 10

ISO-NE FCM Auction Demand-Supply Curve
Scenario 3 Unconstrained 2025 - Base Case



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Total Payments – FCM

- With the change in prices and quantities, total FCM payments vary across scenarios.
  - In Scenario 1, 2, 5 and 6, total FCM payments range from $3.7 to $3.8 billion in 2025 and $4.3 to $4.4 billion in 2030.
  - In Scenario 4, total FCM payments are $2.7 billion in 2025 and $3.1 billion in 2030, a reduction of approximately 27 to 30 percent relative to Scenario 1, 2, 5 and 6.
  - Scenario 3 payments are lower still – $2.1 billion in both 2025 and 2030, a reduction of approximately 43 to 52 percent relative to Scenario 1, 2, 5 and 6.
- FCM payments are also reported relative to energy consumption (in MWh) – that is, in dollar per MWh terms. These figures provide a means of comparing differences in capacity market outcomes to outcomes in the EAS markets, as reflected in LMPs.
  - In Scenario 1, 2, 5 and 6 total FCM payments range from $24 to $27 per MWh between 2025 and 2030.
  - Scenario 4 has FCM payments of $18 and $20 per MWh (for 2025 and 2030, respectively) and Scenario 3 has FCM payments of $13 and $12 per MWh (for 2025 and 2030, respectively).

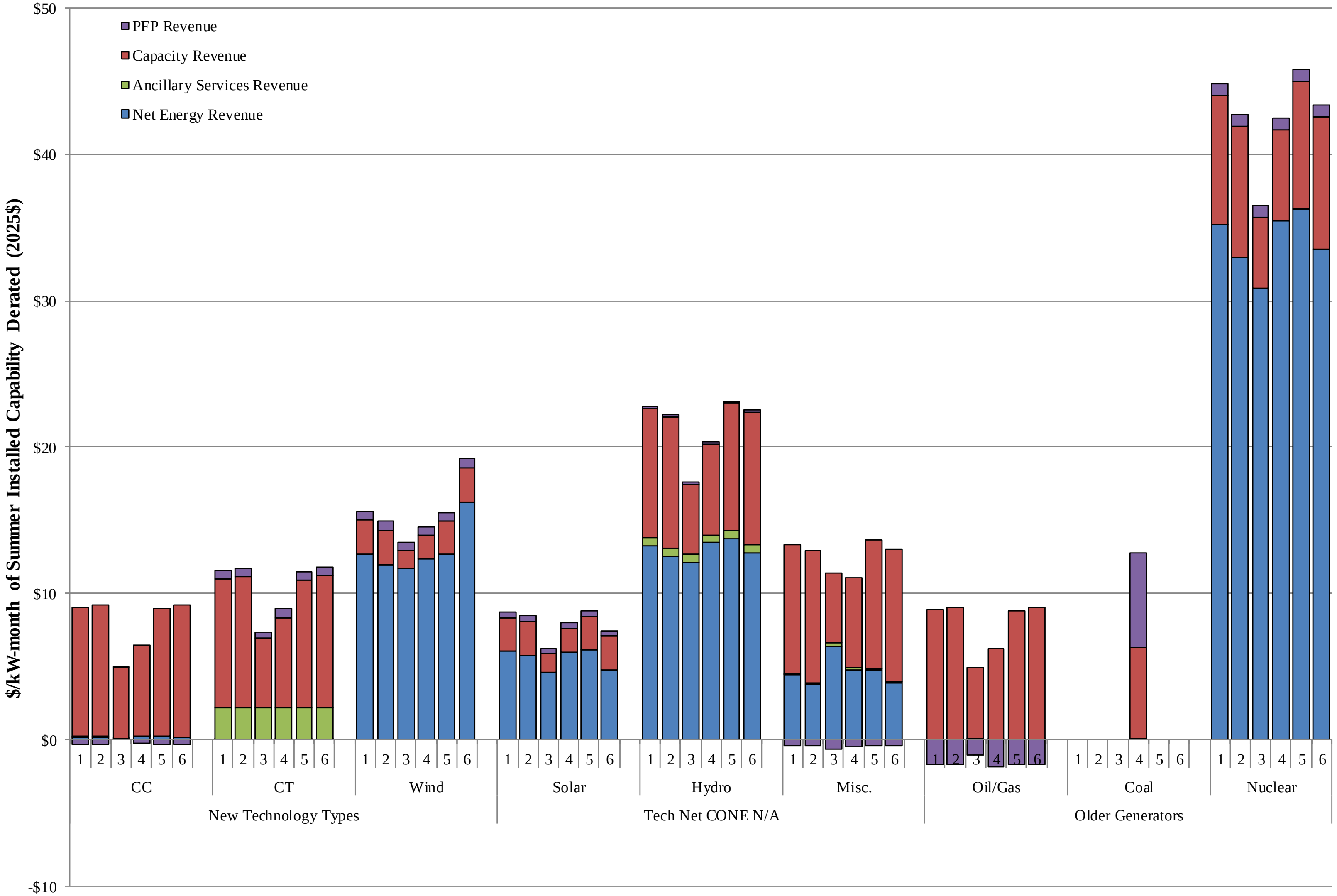
Total Payments – FCM, Energy Markets, Other Sources

- Total payments in ISO-NE markets ranges from $9.7 to $15.6 billion (excluding ancillary service payments)
  - Costs are lowest in Scenario 3, and highest in the Scenarios requiring new entry to meet net ICR (Scenarios 1, 2, 5 and 6)
  - These total payments do not include the costs associated with measures taken to support non-gas-fired resources, including state policies. These costs would be incremental to payments associated with the ISO-NE markets, with an incidence that reflects the particular states undertaking these policies.
- The estimated payments in Table 5 *do not* reflect social costs, but only the costs to consumers.
  - Estimates of social costs were developed by ISO-NE, based on the U.S. Energy Administration Agency's cost of developing new resources. The difference in outcomes reflects transfers from producers to consumers.

Resource Revenue Outcomes

- **Figure 11** shows average revenues per kW month by resource type across the six scenarios. The estimates reflect averages over all resources of each type. Actual revenues for individual resources will vary given heterogeneity in resource characteristics, such as heat rates, variable costs, and start/no-load costs.
- Revenues reflect four components:
  - **Net energy market revenues** per kW vary across resources. Resources operating at high capacity factors with low fuel costs, such as nuclear facilities, earn the highest net revenues. Gas-fired resources – combustion turbines and combined-cycle resources, earn low net energy revenues.
    - For some resources, such as gas-fired CC's, net energy market revenues are particularly thin. This outcome reflects both current market conditions, in which there is a large amount of combined-cycle capacity with very similar operating characteristics, and modeling approach, which tends to result in less energy price volatility than is experienced under actual market conditions. For other resources, such as nuclear and renewables, with no or low variables costs, net EAS revenues are less sensitive to these factors.
  - **Ancillary services revenues** are an important revenue source for combustion turbines and storage resources, but less important for other resources.
  - **Expected net PFP revenues** reflect the positive or negative net revenues, given expected from PFP payments to load and expected PFP revenues given actual performance
  - **Capacity market revenues** are equal across resources on a capacity (per kW) basis.
- Net revenues reflect the sum of the column values. When PFP net revenues are negative, total net revenues would reflect the top of the (colored) columns net of the expected PFP revenues.

Figure 11
Gross Revenue Breakdown by Resources Type, 2025 Unconstrained



Resource Revenue Outcomes Relative to Entry Costs

- **Figure 12** compares revenues from the ISO-NE markets against an estimate of the (gross) cost of new entry for various technologies. Values are derived from the most recent Net CONE/ ORTP Study.
- Under Scenarios 1, 2, 5 and 6, the ISO-NE EAS markets and the FCM provide sufficient revenues to support the new entry of the new gas-fired combustion turbine resources that are assumed to enter in these Scenarios.
- Revenues from the ISO-NE markets are insufficient to financially support the development of all other new resources assumed to enter the market in each scenario.
  - In Scenarios 3 and 4, revenues are insufficient to support new gas-fired combustion turbines.
  - Revenues are not sufficient for new gas-fired combined-cycle resources in any Scenarios.
  - "Clean" resources, including renewables, off-shore wind, imports, battery storage and behind-the-meter solar, would require financial support through state policies, including state RPS. Our analysis does not make assumptions about the policies that would be adopted to achieve the clean resources assumed to be developed in each scenario.
- Additional revenues needed to support the entry of clean resources varies across Scenarios.
  - Needed revenues increase with the expansion of clean resources, as these resources reduce prices in both the energy and capacity markets. Despite the de-rating of capacity, reductions in FCM revenues are greater than reductions in net EAS revenues (assuming that the resource receives these revenues streams at all, given the potential for offer mitigation under the MOPR).
- **Figure 13 and 14** compare revenue streams and costs for several key technologies for Scenario 1 and Scenario 3.

Figure 12
Gross Revenue Breakdown by Resources Type, 2025 Unconstrained

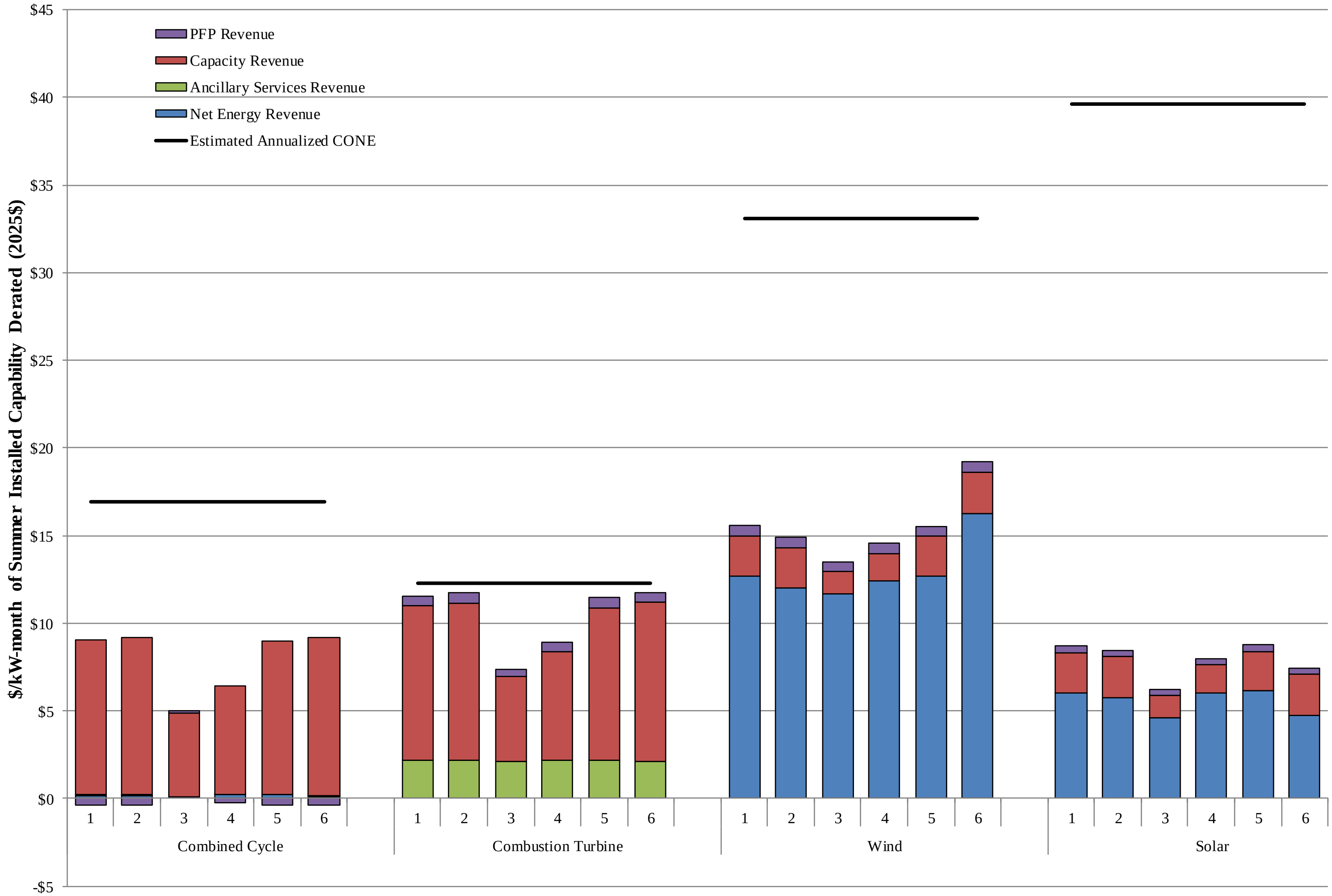


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Figure 13

Average Revenue and Costs: Scenario 1, 2025 Unconstrained Select Unit Types

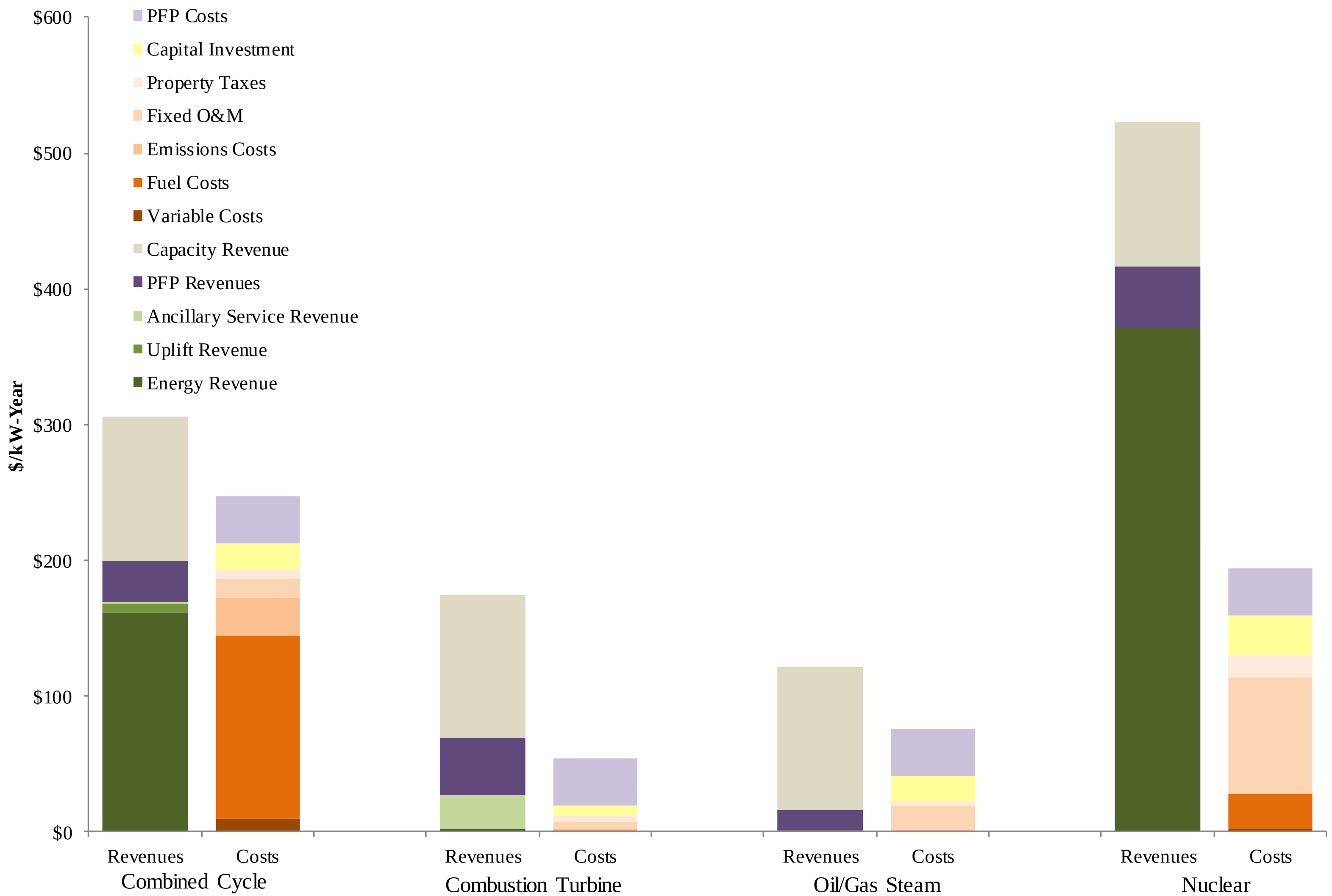
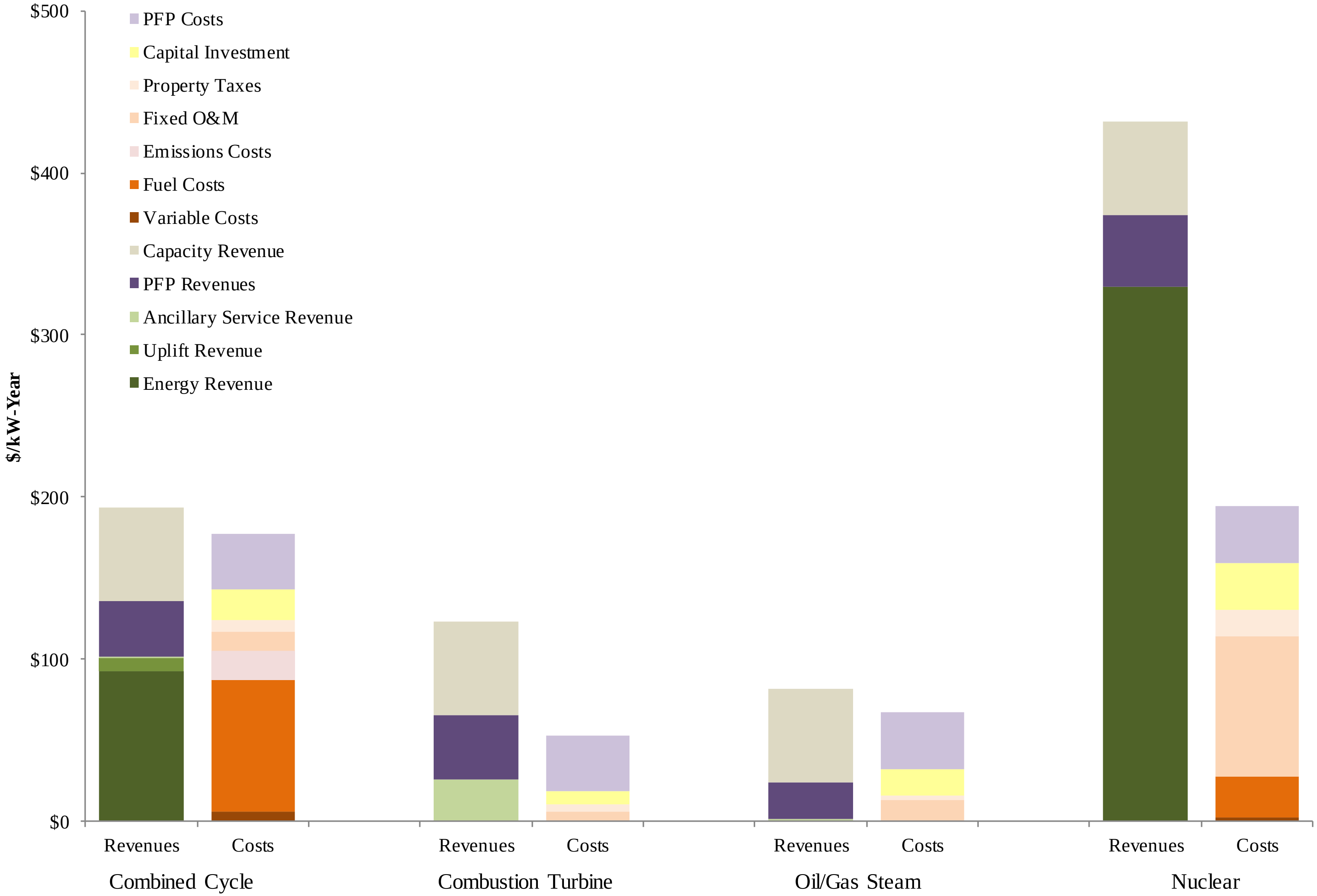


Figure 14

Average Revenue and Costs: Scenario 3, 2025 Unconstrained Select Unit Types



Market Clearing Resources

- **Figures 15 to 18** illustrates the resources that clear in FCM, and those that do not.
  - **Figure 15 and 17** illustrate the resources that clear the FCA by resource type in 2025 and 2030.
  - **Figure 16 and 18** illustrate the resources that do not clear the FCA by resource type in 2025 and 2030.
  - Tables in the appendices provide numerical results that correspond to these figures.
- The figures illustrate the substantial shifts in the composition of resources in the ISO-NE system across Scenarios. Comparison of Scenarios 3 and 4 illustrate the breadth of resource shifts arising under the alternative Scenarios.
- Scenario 3 represents a shift in resource mix from fossil to “clean” resources.
  - Between assumed retirements and resources that do not clear the FCA, there is a substantial reduction in existing resources, particularly fossil resources.
    - Oil steam resources that offer into the auction largely do not clear: in 2025, 2,513 of 2,965 MW of offered supply does not clear, and all offered capacity in 2030 (4,249 MW) does not clear. Thus, given assumed retirements, all oil resources in the system are not economic by 2030.
    - A large quantity of gas-fired combined cycle resources also fails to clear the market. In 2025, 5,010 MW of capacity does not clear, and in 2030, 5,989 MW of capacity does not clear.
    - In addition, 604 MW of import and demand response (DR) capacity does not clear in both 2025 and 2030.

Market Clearing Resources

- Scenario 4 represents the smallest change in resource mix relative to the current system.
  - In total, 894 MW of capacity does not clear in 2025, and only 331 MW of capacity does not clear in 2030. The reduction in the quantity of capacity that does not clear in 2030, relative to 2025, occurs largely because assumed growth in certain resources (energy efficiency and behind-the-meter photovoltaics) exceeds growth in net ICR.
  - In 2025, resources that do not clear the FCA include 492 MW of coal resources, 201 MW of imports and DR, 122 MW of combined cycle, and 75 MW of other resources.
  - In 2030, resources that do not clear the FCA include 197 MW of coal resources, 101 MW of imports and DR, and 34 MW of other resources.
- In all other scenarios, the quantity of total resources equals net ICR by construction, given the assumption that new capacity is added such that total capacity exactly equals net ICR. As a result, all resources clear the FCA.

Figure 15
2025 Unconstrained Scenarios 1-6
Cleared Capacity
by Technology and Fuel Type

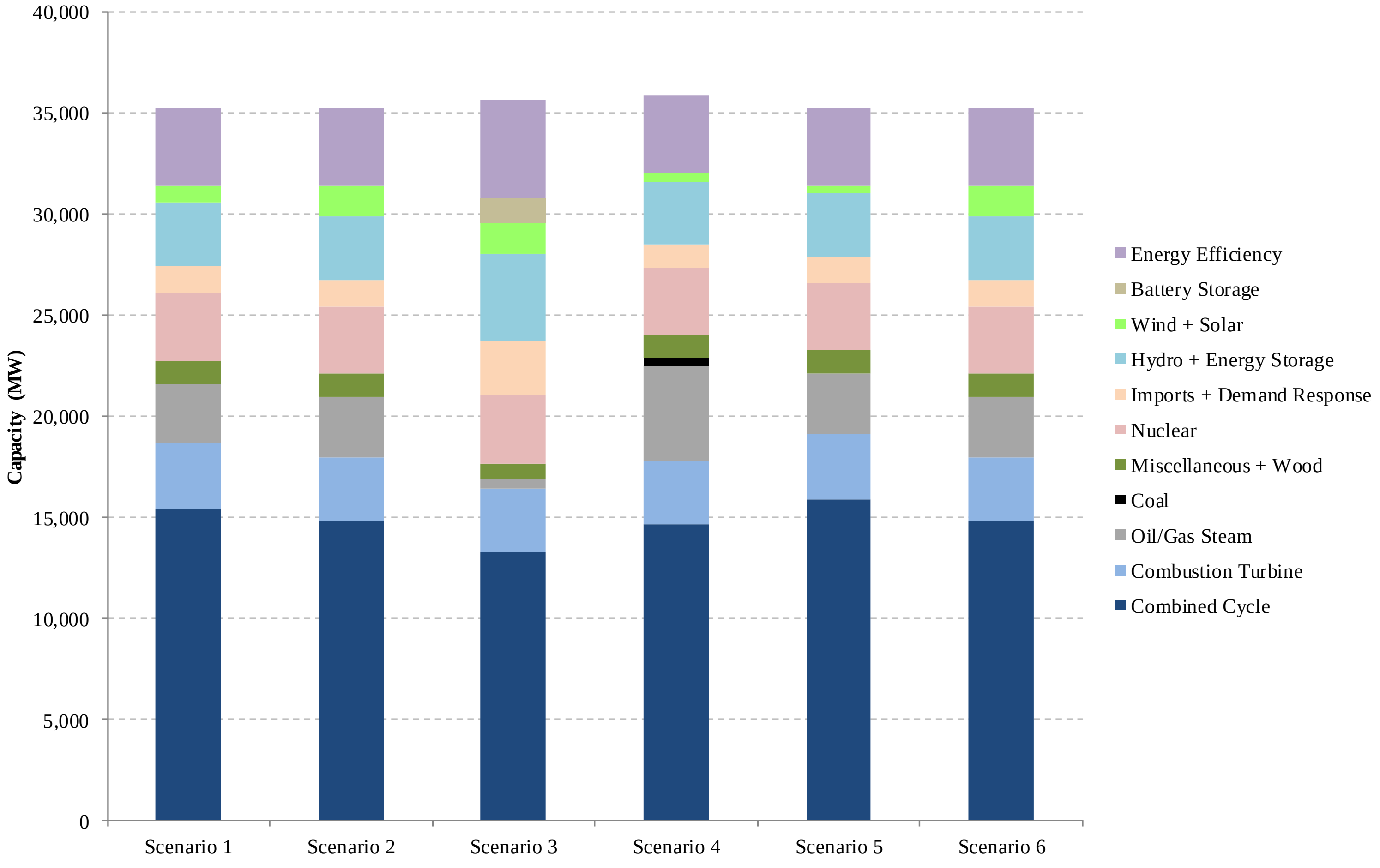


Figure 16
2025 Unconstrained Scenarios 1-6
Uncleared Capacity
by Technology and Fuel Type

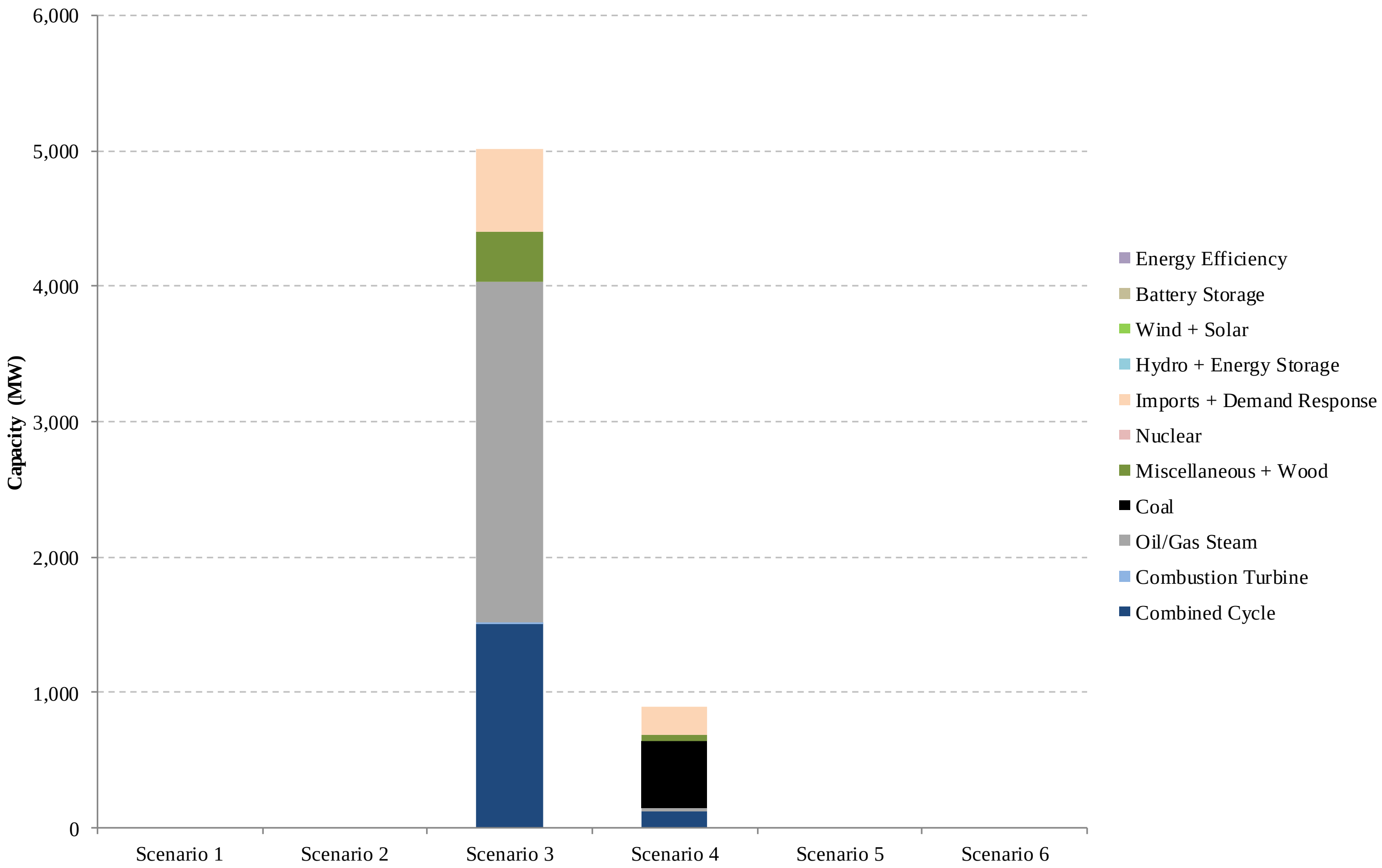


Figure 17
2030 Unconstrained Scenarios 1-6
Cleared Capacity
by Technology and Fuel Type

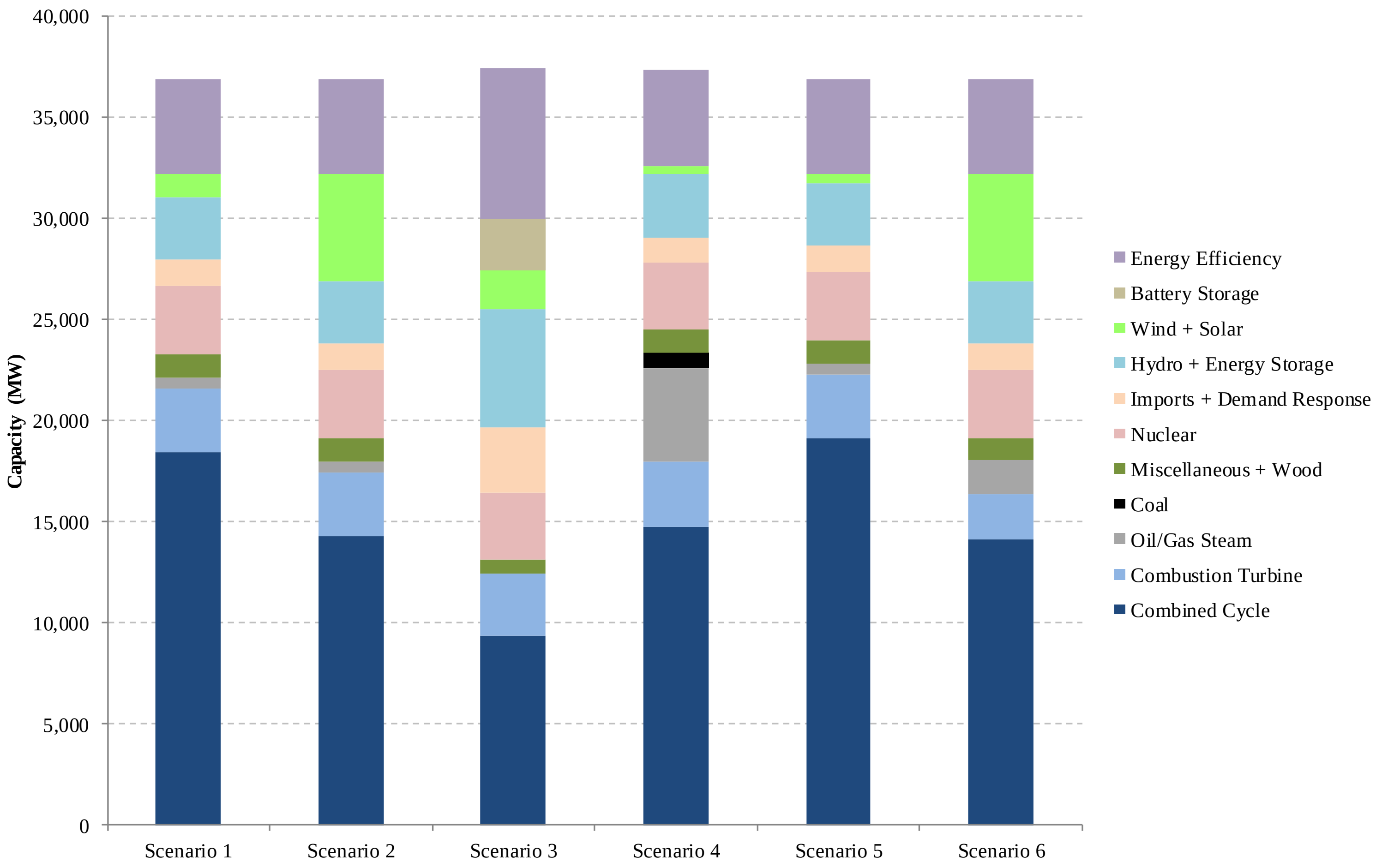
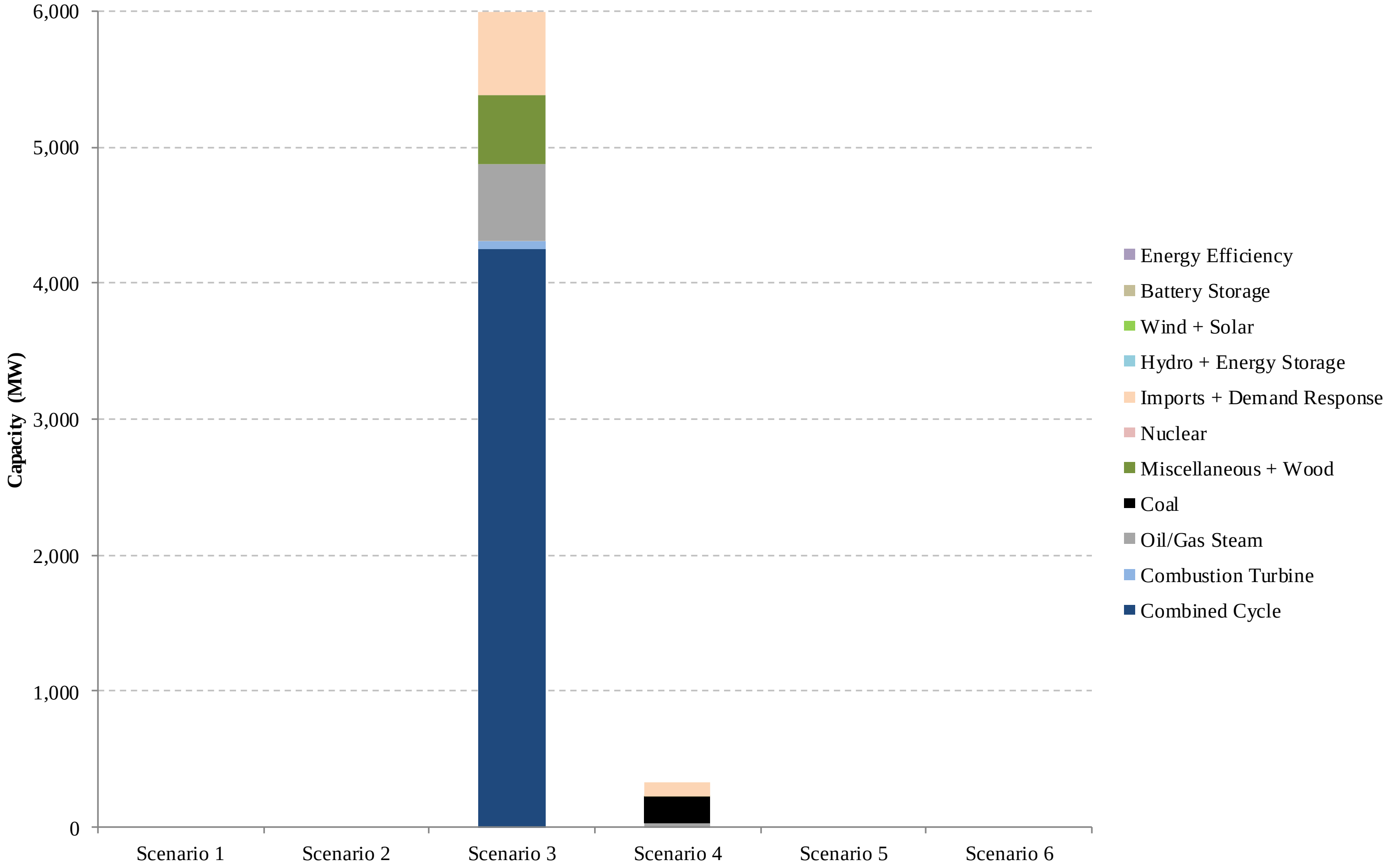


Figure 18

2030 Unconstrained Scenarios 1-6 Uncleared Capacity by Technology and Fuel Type



Agenda

Executive Summary

Background and Assignment

Data, Methods and Model

Results

Sensitivity Analysis

Appendix

Overview of Sensitivity Analyses

- We analyze the sensitivity of the Scenario outcomes to several key drivers of market outcomes.
- In particular, we consider the following six Sensitivity analyses addressing both the *Market Participation* of assumed resources and the *Market Mitigation* of future resources.
  - Market Participation
    - ***Sensitivity 1***: Higher than assumed additional resources (to meet resource adequacy)
    - ***Sensitivity 2 and 3***: Lower than expected renewable participation rates
  - Market Mitigation
    - ***Sensitivity 4 to 6***: Minimum Offer Price Rule (MOPR) offer mitigation
- These sensitivities are considered for all Scenarios, when relevant.
- We do not test the sensitivity of results to expectations about the number of reserve shortage hours, but note that expectations of a larger number of hours could affect offers, particularly for Scenarios when prices clear at lower prices.
  - The appendix includes results assuming 12 reserve shortages hours, instead of 8.48 hours, as is assumed in the base case.
- **Table 5** shows the changes in resource assumptions made in each of the Sensitivity analyses

Table 5

Sensitivity Capacity Summary 2025 (MW)
Affected Resource Quantities, Differences from Base Case

Market Participation		**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**	**Scenario 5**	**Scenario 6**
1. Higher than Assumed Resource Additions	Increase Capacity	500	500	500	500	500	500
2. "Low" Renewable Participation	Decrease Capacity	304	555	420	0	0	221
3. "Medium" Renewable Participation	Decrease Capacity	152	278	210	0	0	111
Market Mitigation							
4. MOPR Renewables	Mitigated Offers	0	570	1,718	0	0	0
5. MOPR Imports	Mitigated Offers	0	0	1,500	0	0	0
6. MOPR Imports and Renewables	Mitigated Offers	0	570	3,218	0	0	0

Sensitivity Capacity Summary 2030 (MW)
Affected Resource Quantities, Differences from Base Case

Market Participation		**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**	**Scenario 5**	**Scenario 6**
1. Higher than Assumed Resource Additions	Increase Capacity	500	500	500	500	500	500
2. "Low" Renewable Participation	Decrease Capacity	380	1,777	475	0	0	836
3. "Medium" Renewable Participation	Decrease Capacity	190	889	238	0	0	418
Market Mitigation							
4. MOPR Renewables	Mitigated Offers	0	3,258	2,500	0	0	3,310
5. MOPR Imports	Mitigated Offers	0	0	1,500	0	0	0
6. MOPR Imports and Renewables	Mitigated Offers	0	3,258	4,000	0	0	3,301

Sensitivity 1: Higher than assumed resource additions

- In ISO-NE's economic analysis, the quantity of new resource additions is calculated as the gap between total system resources and net ICR, after accounting for assumed retirements (see **Table 1**).
- In this Sensitivity, we assume a larger quantity of new resources than in the base case. The analysis assumes that approximately 500 MW of additional capacity compared to the base case.
  - This Sensitivity is evaluated to illustrate the sensitivity of FCM outcomes, particularly given the "lumpy" nature of new gas-fired capacity additions. This sensitivity only focuses on changes in the FCA outcomes, and does not consider potential changes in energy market revenues that might occur due to changes in LMPs from a change in resources in the ISO-NE fleet. From the standpoint of understanding the sensitivity of FCM results, such changes are of second order in magnitude and do not warrant additional energy market analysis.

Larger Resource Additions Results

Table 6 reports market outcomes under the Higher Resource Additions sensitivity.

- **Figure 21** illustrates the impact of a greater quantity of resource additions on Scenario 1. The resource additions increases the supply of resources that participate in the FCA, which shifts the supply curve to the right. With additional supply, the market clears at a unit with a lower offer, resulting in a lower FCA price. The quantity cleared increases given the slope of the demand curve, and some resources fail to clear the FCM.
- The reduction in FCA prices tend to be large in Scenarios 1, 2 and 6, because the base case clears at the end of the current offer curve, near net CONE. In these scenarios, FCA prices reflect clearing lower on the steep part of the supply curve, resulting in larger reductions in FCA prices.
  - In 2025 and 2030, FCA prices decline to around $6.75 to $6.80 per kW-month across all three of these sensitivities from prices that were from $8.8 to over $9.8 per kW-month in the base case.
- While **Figure 19** illustrates a large change in price arising from greater resource additions, the incremental impacts from further resource additions would be smaller because of the declining slope (steepness) of the supply curve as supply clears on the “knee” of the curve.
- FCA price impacts are smaller in Scenarios that already clear further down the supply curve (due to an excess supply of resources). For example, in Scenario 3, there is a minimal FCA price decline ($0.5 per kW-month) given the limited variation in offers among resources in the flat portion of the supply curve.

Table 6
FCM Sensitivity Analysis

Results Table - Higher Resource Additions

	2025 (Unconstrained)			
	Scenario 1	Scenario 2	Scenario 3	Scenario 6
Net CONE	$8.70	$8.70	$8.70	$8.70
Clearing Price ($/kW-Month)	$6.75	$6.75	$4.81	$6.75
Cleared Capacity @ Marginal Total (MW, thousands)	**35,611**	**35,665**	**35,475**	**35,612**
Total FCM Payments ($, millions)	**$2,885**	**$2,889**	**$2,048**	**$2,885**
Average FCM Payments ($ per MWh)	$18.97	$19.01	$12.84	$18.98
Capacity Above ICR	309	363	671	310
Not Cleared Capacity (MW, thousands)	134	134	5,254	134
Total Energy Revenue ($, millions)	$8,659	$8,325	$7,688	$8,382

	2030 (Unconstrained)			
	Scenario 1	Scenario 2	Scenario 3	Scenario 6
Net CONE	$9.61	$9.61	$8.70	$9.61
Clearing Price ($/kW-Month)	$6.75	$6.75	$4.35	$6.80
Cleared Capacity @ Marginal Total (MW, thousands)	**37,190**	**37,186**	**36,855**	**37,186**
Total FCM Payments ($, millions)	**$3,012**	**$3,012**	**$1,924**	**$3,034**
Average FCM Payments ($ per MWh)	$18.88	$18.95	$11.03	$19.09
Capacity Above ICR	271	267	582	267
Not Cleared Capacity (MW, thousands)	229	229	7,482	234
Total Energy Revenue ($, millions)	$11,262	$7,444	$8,051	$6,992

Note: Results are reported in nominal dollars (e.g., 2025 results are in $2025).

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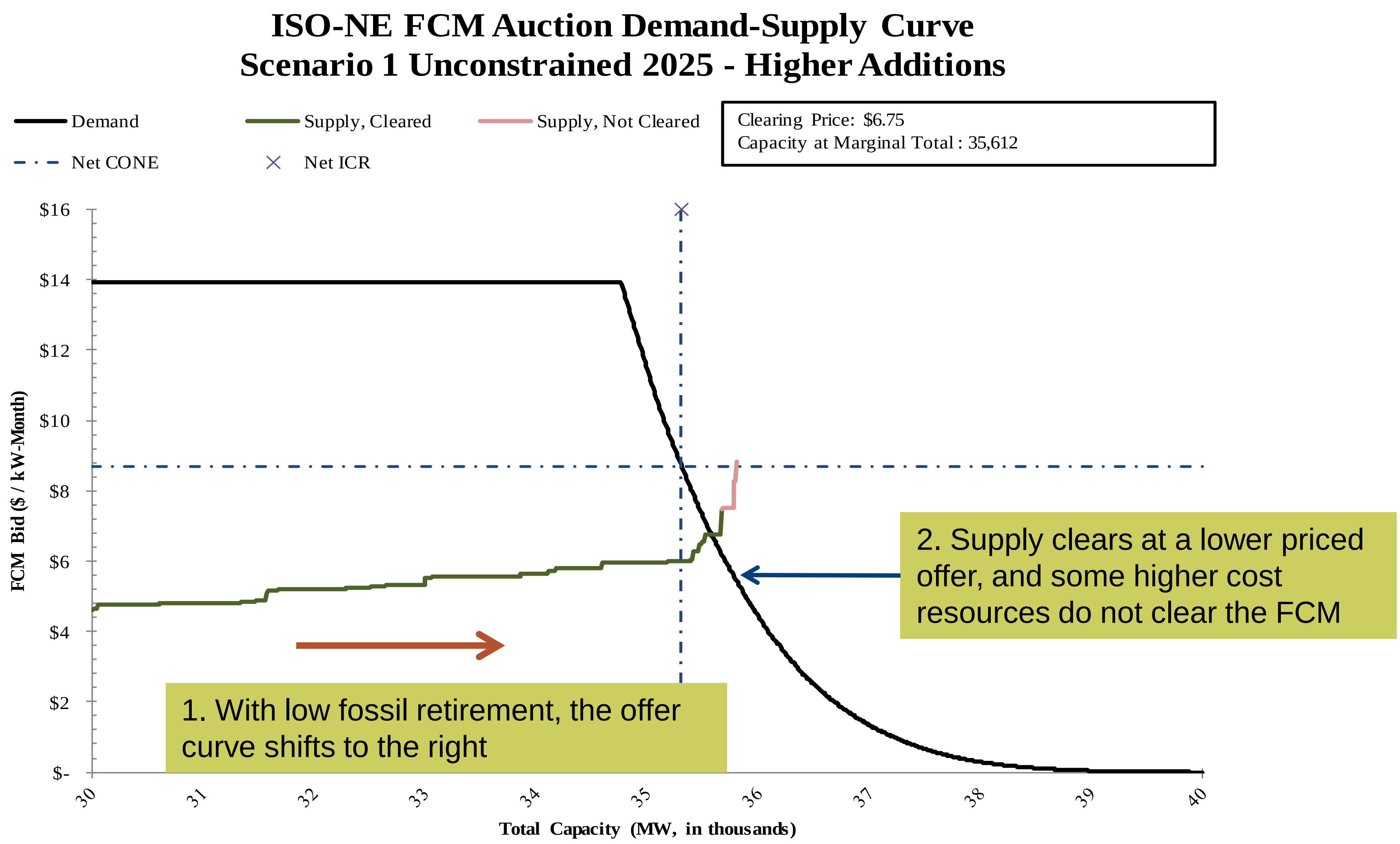
Figure 19 – Illustrative Case for High Resource Additions



Sensitivities 2 and 3: Renewable Capacity Participation in FCA

- There are many factors that affect the quantity of renewable nameplate capacity that actually participates in the FCM market. These factors include:
  - *Derates*. Many renewable resources supply capacity intermittently, contingent on weather conditions. As a result, only a fraction of nameplate capacity is eligible to participate in the FCM.
  - *Other Factors.* Other factors may reduce the ability or likelihood that some renewable resources offer into the FCA, including interconnection and PFP risks.
- At present, the quantity of intermittent renewable resources that clears the FCM relative to the nameplate capacity of these resources in the system (their "participation rate") is approximately 16 percent. An appendix table provides further details.
- Sensitivity Assumptions:
  - **Renewable Participation.** In the ISO-NE economic analysis, the renewable FCM participation rate for incremental resources is assumed to be 26% for on-shore wind and 40% for utility-scale solar.
    - Medium Participation assumes participation rates of 21% for on-shore wind and 30% for solar
    - Low Participation assumes participation rates of 16% for on-shore wind and 20% for solar
  - **Other Resources**. No changes are made to assumption about resource retirements or additional gas-fired resource entry.

Reduced Renewable Participation Results

- **Table 7** reports the FCA outcomes under the Low Renewable Participation sensitivity. Results for Medium Renewable Participation are very similar, and thus not reported.
  - **Figure 20** illustrates the impact of the lowest participation levels on Scenario 1. With the reduction in in renewable resource supply, the total aggregate resource supply is insufficient to clear demand. In the short-run, the market would clear at a higher price, the vertical intercept of the demand curve. In the long-run, either new (gas-fired or renewable) resources would be needed to fill the gap, or fewer fossil resources may retire given the higher FCA prices.
  - **Figure 21** illustrates the impact of the lowest participation levels on Scenario 3. In this case, although the lower renewable participation rate reduces the quantity of renewables offering into the FCA by 420 MW, there is little impact on the FCA clearing price. This outcome occurs because the market clears in the base case so far onto the flat part of the curve that the shift in the supply curve from the reduction in renewable resources has little effect on the marginal offer, and thus on the clearing price.
  - The difference in outcomes under these two sensitivities illustrates that the sensitivity of FCA market outcomes varies depending on market and policy circumstances.

Table 7
FCM Sensitivity Analysis

Results Table - Low Renewable Participation

	2025 (Unconstrained)			
	Scenario 1	Scenario 2	Scenario 3	Scenario 6
Net CONE	$8.70	$8.70	$8.70	$8.70
Clearing Price ($/kW-Month)	$8.82	$8.99	$4.83	$9.04
Cleared Capacity @ Marginal Total (MW, thousands)	**34,998**	**34,744**	**35,484**	**34,848**
Market Short Flag	Short	Short	-	Short
Quantity of New Gas in Short Situations	2,500	2,500	-	2,500
Total FCM Payments ($, millions)	**$3,704**	**$3,748**	**$2,057**	**$3,780**
Average FCM Payments ($ per MWh)	$24.56	$25.04	$12.75	$25.17
Capacity Above ICR	-304	-558	680	-454
Not Cleared Capacity (MW, thousands)	0	0	4,733	0
Total Energy Revenue ($, millions)	$8,659	$8,325	$7,688	$8,382

	2030 (Unconstrained)			
	Scenario 1	Scenario 2	Scenario 3	Scenario 6
Net CONE	$9.61	$9.61	$9.61	$9.61
Clearing Price ($/kW-Month)	$9.61	$9.75	$4.68	$9.84
Cleared Capacity @ Marginal Total (MW, thousands)	**36,539**	**35,138**	**36,964**	**35,379**
Market Short Flag	Short	Short	-	Short
Quantity of New Gas in Short Situations	2,500	2,500	-	2,500
Total FCM Payments ($, millions)	**$4,213**	**$4,111**	**$2,076**	**$4,177**
Average FCM Payments ($ per MWh)	$26.67	$27.17	$11.82	$27.41
Capacity Above ICR	-380	-1,781	691	-1,540
Not Cleared Capacity (MW, thousands)	0	0	5,989	0
Total Energy Revenue ($, millions)	$11,262	$7,444	$8,051	$6,992

Note: Results are reported in nominal dollars (e.g., 2025 results are in $2025).

Figure 20 – Illustrative Case for Low Renewable Participation

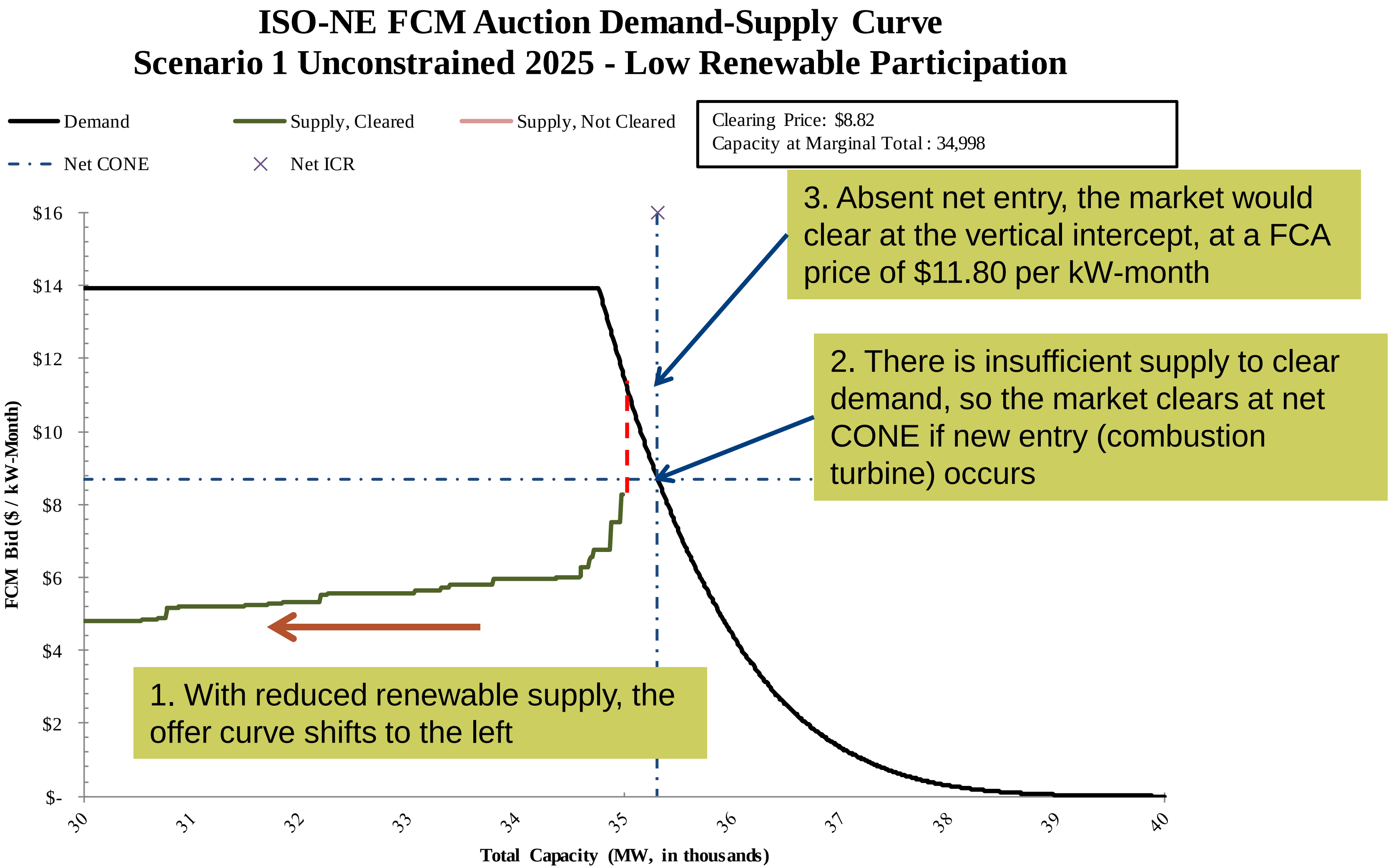


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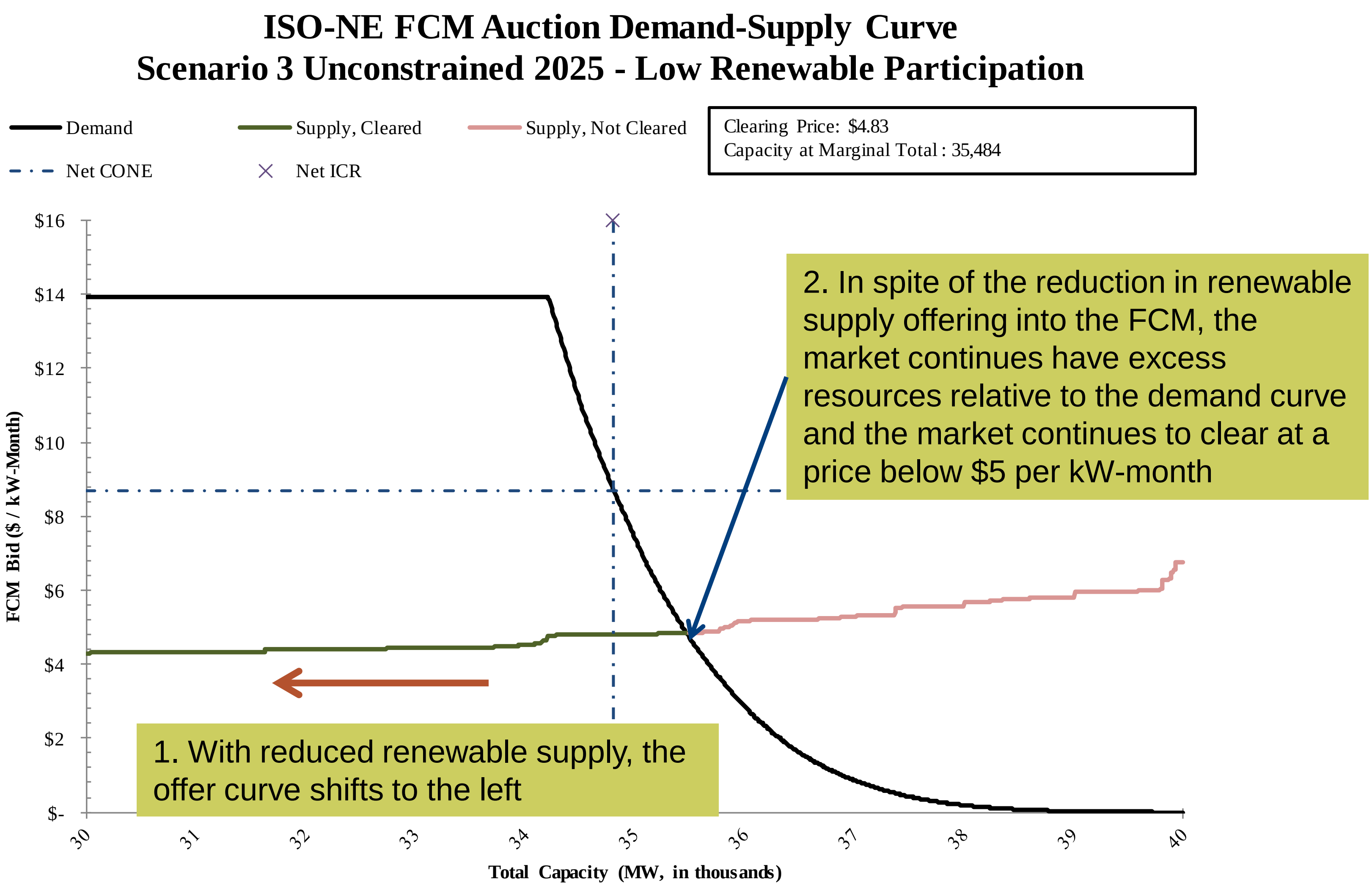
Figure 21 – Illustrative Case for Low Renewable Participation



Sensitivity 4-6: Minimum Offer Price Rule (MOPR)

- The ISO-NE FCM has a MOPR designed to ensure that FCM offers for resources that receive Out of Market ("OOM") revenues to support entry are mitigated to competitive market offers. The MOPR is designed to remedy price distortions in the FCM created when new resources enter with the support of OOM revenues. **Figure 22** illustrates the impact of resources receiving OOM revenues on FCM market outcomes, including the reduction in prices below competitive levels.
- Under the MOPR, the Internal Market Monitor ("IMM") may mitigate offers receiving OOM revenues so that they reflect the net cost of new entry given the type of technology and particular project's circumstances. If the change in offer due to IMM mitigation is sufficiently large, the resource may not clear the FCM. **Figure 23** illustrates this outcome.
- In principle, new entry supported by OOM revenues may also reduce energy market revenues independent of the direct impacts on capacity market outcomes. Such reductions in energy market revenues would, in turn, increase resource offers, due to the reduction in net EAS revenues. **Figure 4** provides an illustration of how a shift in net EAS revenues may affect market-clearing quantities and prices (for example, compare P_{SR} and P_{M}). Offers from existing resources do shift given the resource- and Scenario-specific net EAS revenues as estimated by the ISO-NE GridView analysis.
- Application of the MOPR to resources supported by state policies has been somewhat controversial, and modifications to the MOPR have been proposed in various venues, including the IMAPP process. For the purposes of this study, we assume that the current MOPR remains in effect.

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Figure 22
Impact of Out-of-Market Resource Offer on FCM Market Outcomes

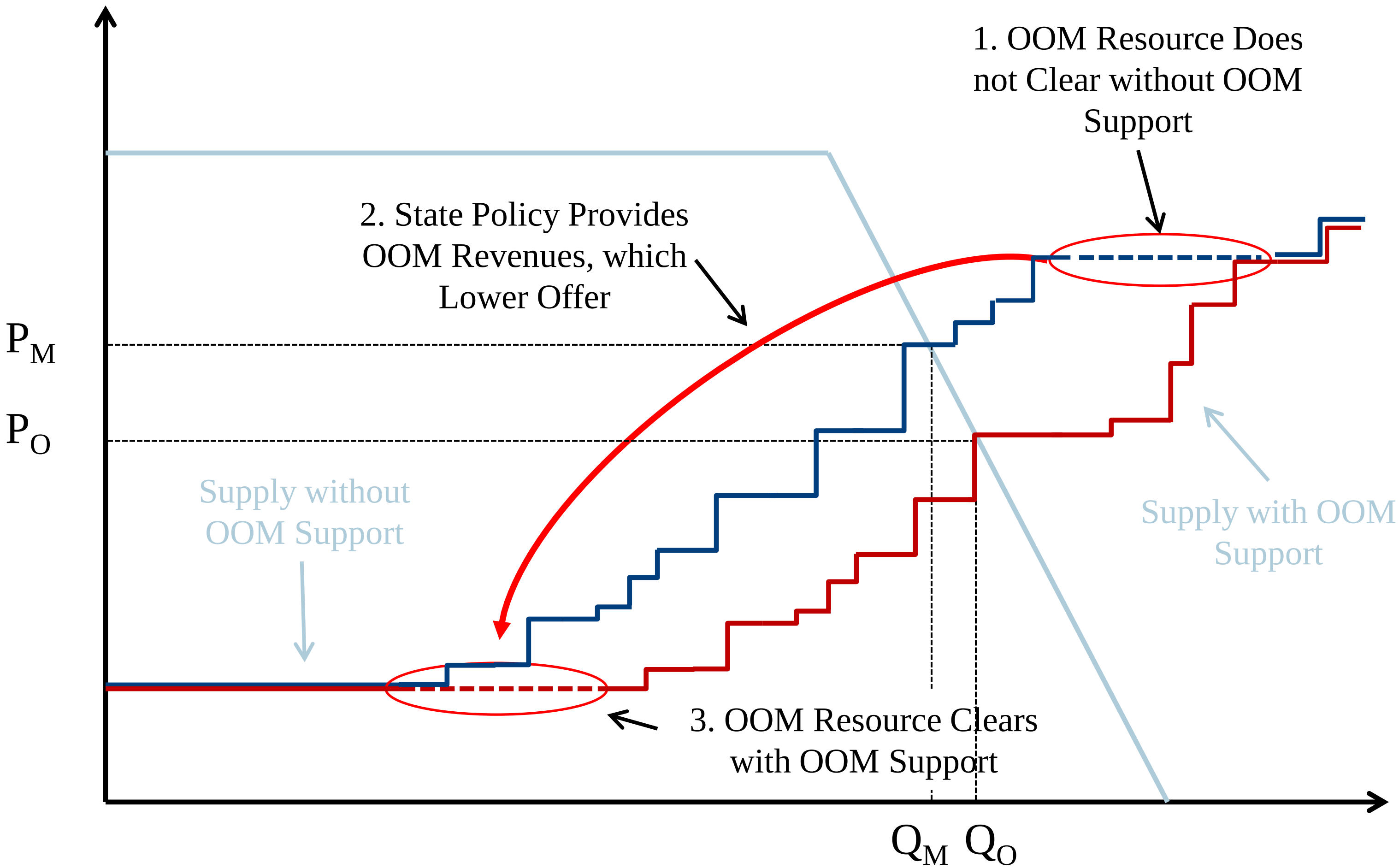
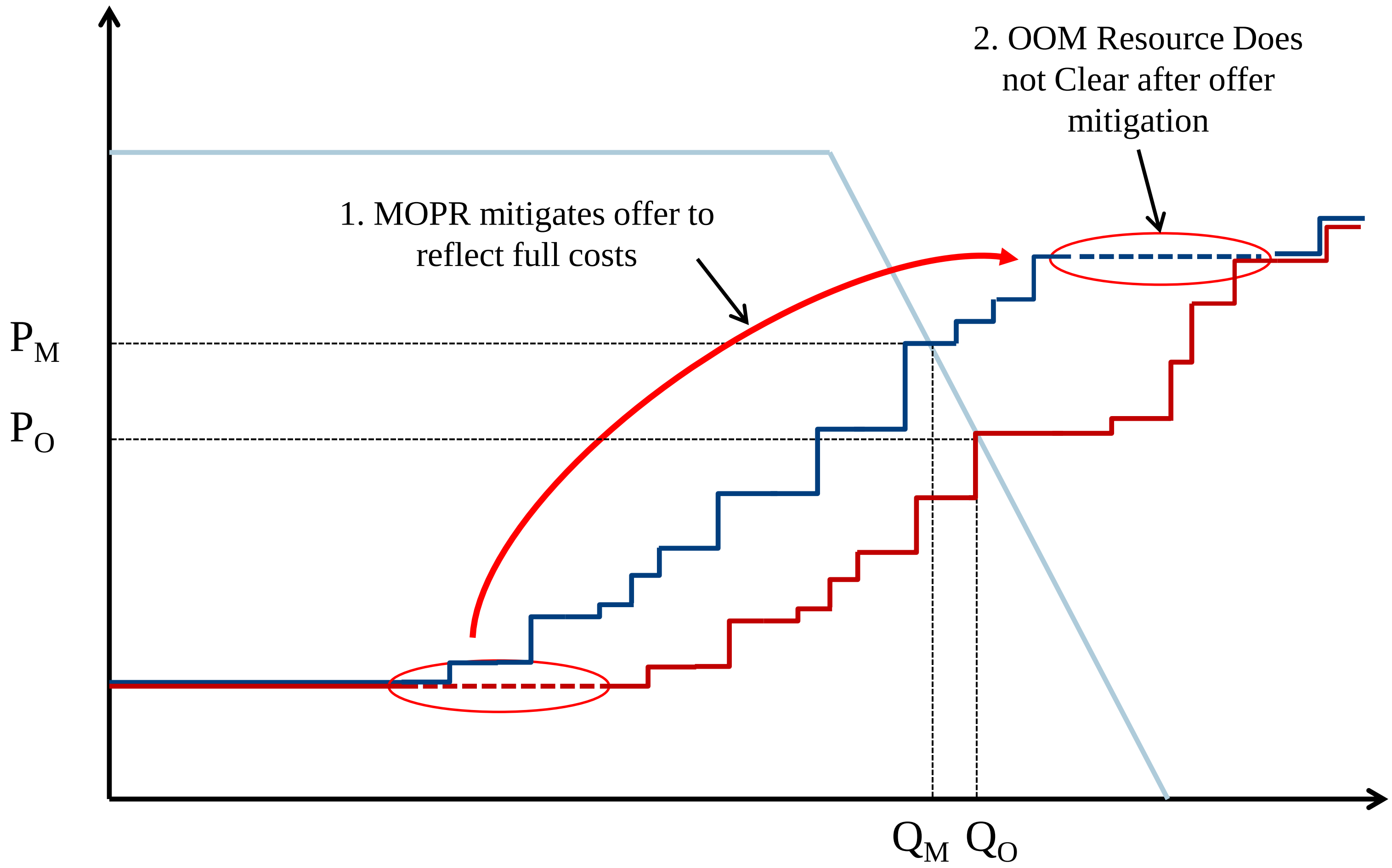


Figure 23
Implementation of MOPR on Out-of-Market Resource Offer



MOPR Sensitivity Analyses: Assumptions

- The MOPR sensitivities consider several possible MOPR outcomes:
  - Sensitivity 4: MOPR Applied to New Renewables and Battery Storage Only
  - Sensitivity 5: MOPR Applied to New Imports Only
  - Sensitivity 6: MOPR Applied to New Renewables, Battery Storage and Imports
- **Figures 24 and 25** illustrate total quantity of renewable capacity and battery storage that is potentially subject to offer mitigation under the MOPR.
  - When assessing the quantity of capacity that is subject to the MOPR, we account for the renewable technology exemption. Under this exemption, up to 200 MW of renewable technology capacity can offer with an exemption from offer mitigation. This exemption can be carried over for up to two auctions. We assume 200 MW of existing banked MOPR exemption capacity, plus four auctions of additional exemptions at 200 MW each for 1,000 MW total exemption in 2025.
  - Given the renewable technology exemption, the quantity of resources subject to the MOPR is limited those resource above the exemption line in **Figures 24 and 25**. Thus, for example, all new renewable resources in Scenario 1 fall within the exemption, resulting in no offer mitigation.
  - Our Sensitivity analyses assume that all non-gas-fired new capacity is out-of-market – i.e., these resources would rely on “out-of-market” resources to support offers that would clear in the FCA.
- When applying offer mitigation, we do not identify the particular resource offers that are mitigated and those that receive exemptions. Mitigations apply to infra-marginal resources and are set to a generic bid cost assumed to be above base case clearing prices across all scenarios (e.g., $10/kW-month).

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Figure 24

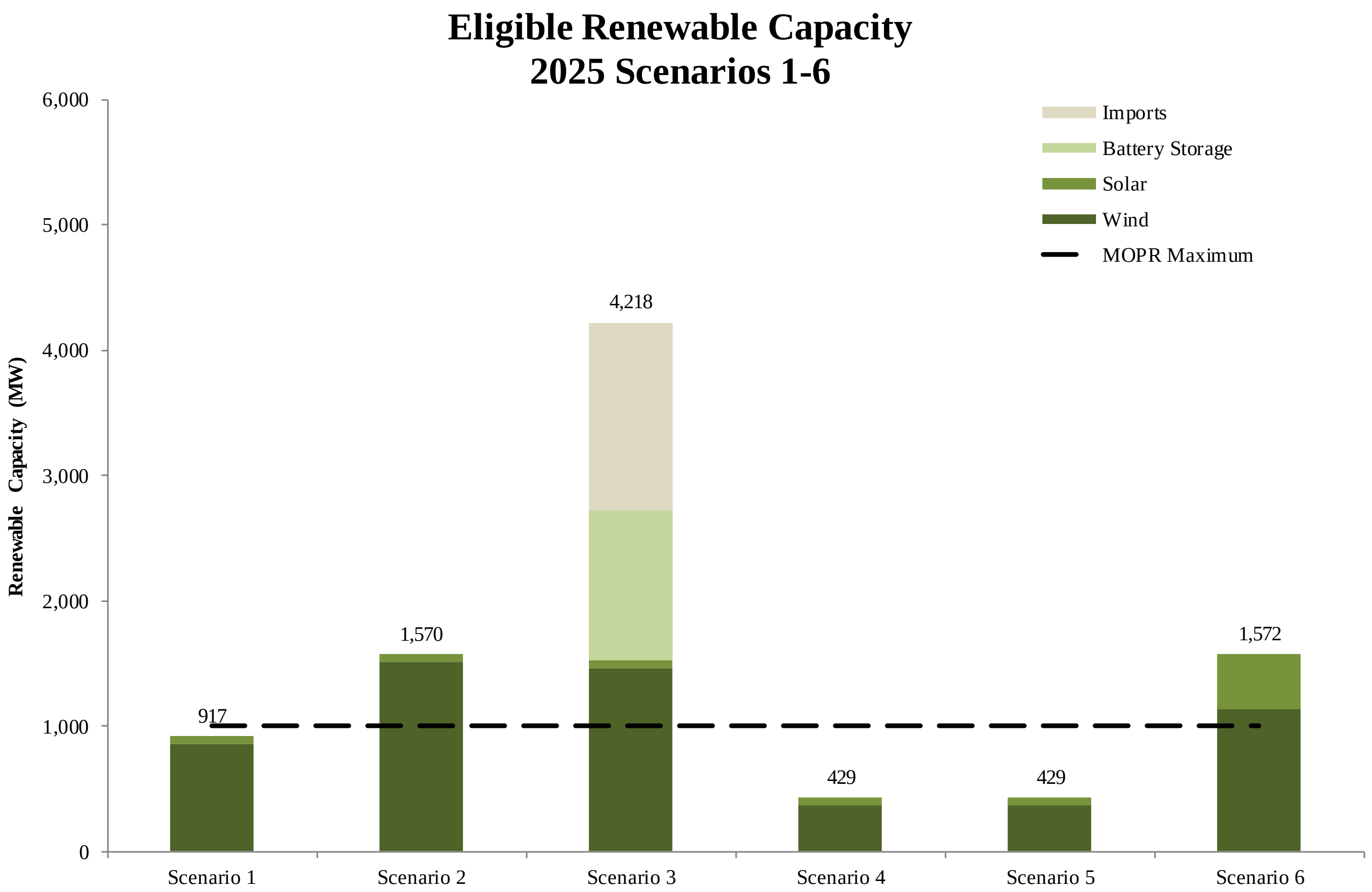
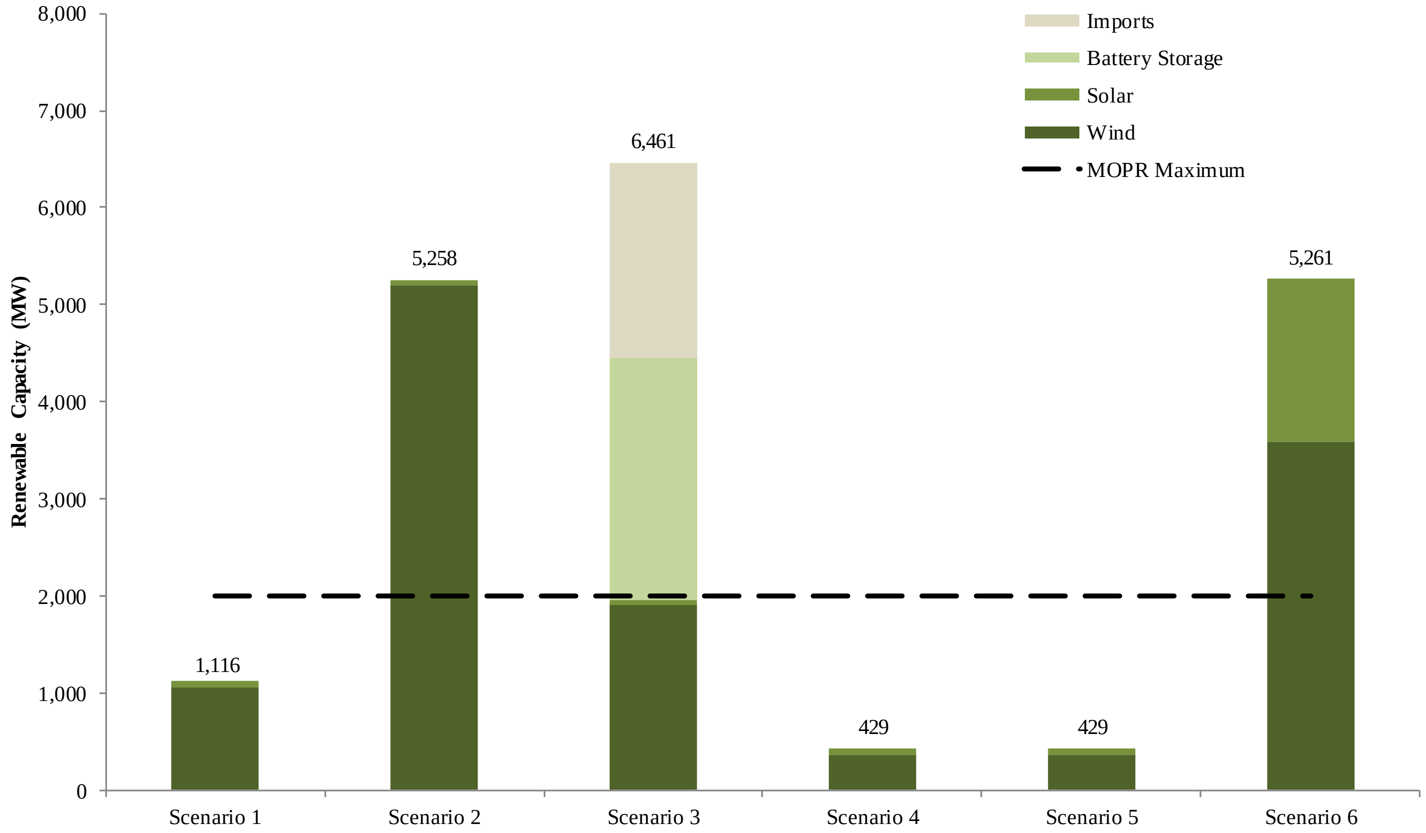


Figure 25

**Eligible Renewable Capacity
2030 Scenarios 1-6**



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MOPR Offer Mitigation Results

- In these sensitivity analyses, we assume that all offers from certain resources that enter the market through some form of out-of-market revenue. These resource types include wind, solar, battery storage and new imports, but do not include energy efficiency and demand response. The quantity of offers that are mitigated is net of the renewable technology exemption.
- **Table 8** reports results that reflect offer mitigation under the MOPR, with three levels of mitigation considered for Scenario 3.
- **Figure 26** illustrates the impact of MOPR offer mitigation on Scenario 2. In this case, the shift in mitigated offers leaves the market short of supply of existing resources. Market-clearing could occur through the entry of new gas-fired CC resources, clearing at the mitigated renewable offers, or through a reduction in retirements or clearing with the supply short of demand. The analysis reports outcomes in which the market clears at the assumed mitigated offer of $10 per kW-month, above net CONE.
- **Figure 27** illustrates the impact of MOPR offer mitigation on Scenario 3 when mitigation applies to both renewables and import capacity. In this case, approximately 3,200 MW of renewable and import resource offers are mitigated in 2025. Even after this substantial offer mitigation, the change in market outcomes is modest due to the combination of the lower net ICR from expanded behind-the-meter resources and the renewable technology exemption (1,000 MW in 2025 and 2,000 MW in 2030), large quantities of resources fail to clear the market – over 5,000 MW in 2025, and 7,000 MW of supply in 2030. FCA prices decrease from $5.73 to $5.20 per kW-month, an decrease of $0.53 per kW-month. Thus, in the Scenario with the most aggressive expansion of “clean” energy resources, MOPR offer mitigation does not lead to a price level that would be sufficient to sustain new entry.

Table 8
FCM Sensitivity Analysis

Results Table - MOPR Renewables

	2025 (Unconstrained)				MOPR Imports: Imports Only	MOPR Imports: Imports + Renewables
	Scenario 1	Scenario 2	Scenario 3	Scenario 6	Scenario 3	Scenario 3
Net CONE	$8.70	$8.70	$8.70	$8.70	$8.70	$8.70
Clearing Price ($/kW-Month)	$8.82	$10.00	$5.25	$10.00	$5.23	$5.73
Cleared Capacity @ Marginal Total (MW, thousands)	**35,302**	**35,299**	**35,572**	**35,302**	**35,385**	**35,275**
Total FCM Payments ($, millions)	**$3,736**	**$4,236**	**$2,241**	**$4,236**	**$2,221**	**$2,426**
Average FCM Payments ($ per MWh)	$24.57	$27.88	$14.02	$27.88	$13.77	$15.19
Capacity Above ICR	0	-3	768	0	581	471
Not Cleared Capacity (MW, thousands)	0	0	5,065	0	5,250	5,290
Total Energy Revenue ($, millions)	$8,659	$8,325	$7,688	$8,382	$7,688	$7,688

	2030 (Unconstrained)				MOPR Imports: Imports Only	MOPR Imports: Imports + Renewables
	Scenario 1	Scenario 2	Scenario 3	Scenario 6	Scenario 3	Scenario 3
Net CONE	$9.61	$9.61	$9.61	$9.61	$9.61	$9.61
Clearing Price ($/kW-Month)	$9.61	$11.04	$4.77	$11.04	$4.77	$5.20
Cleared Capacity @ Marginal Total (MW, thousands)	**36,919**	**36,916**	**37,046**	**36,920**	**37,344**	**36,798**
Total FCM Payments ($, millions)	**$4,257**	**$4,891**	**$2,120**	**$4,891**	**$2,138**	**$2,296**
Average FCM Payments ($ per MWh)	$26.67	$30.77	$12.28	$30.77	$12.17	$13.29
Capacity Above ICR	0	-3	773	1	1,071	525
Not Cleared Capacity (MW, thousands)	0	0	7,040	0	6,742	7,288
Total Energy Revenue ($, millions)	$11,262	$7,444	$8,051	$6,992	$8,051	$8,051

Note: Results are reported in nominal dollars (e.g., 2025 results are in $2025).

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Figure 26 – Illustrative Case for MOPR

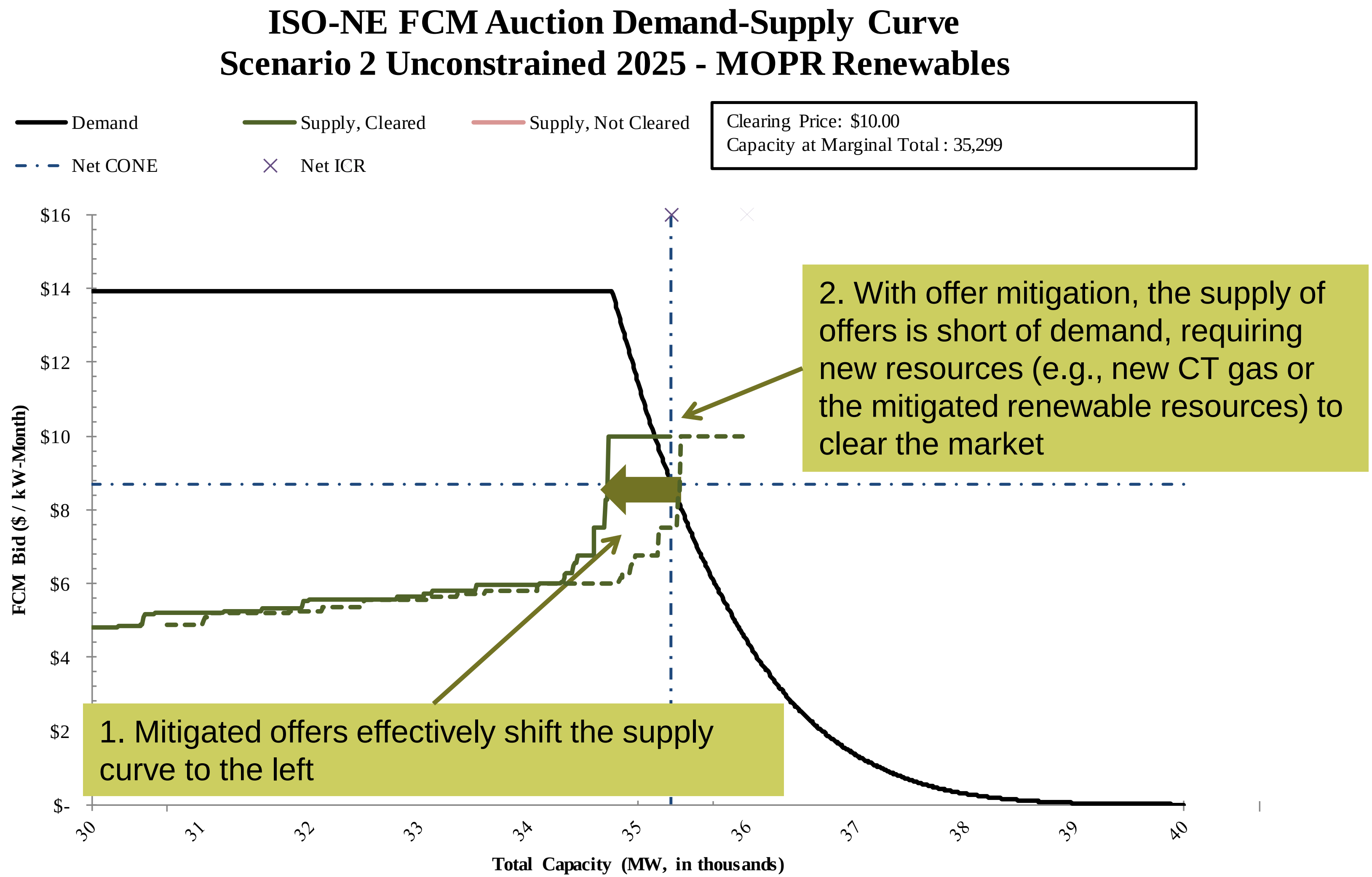

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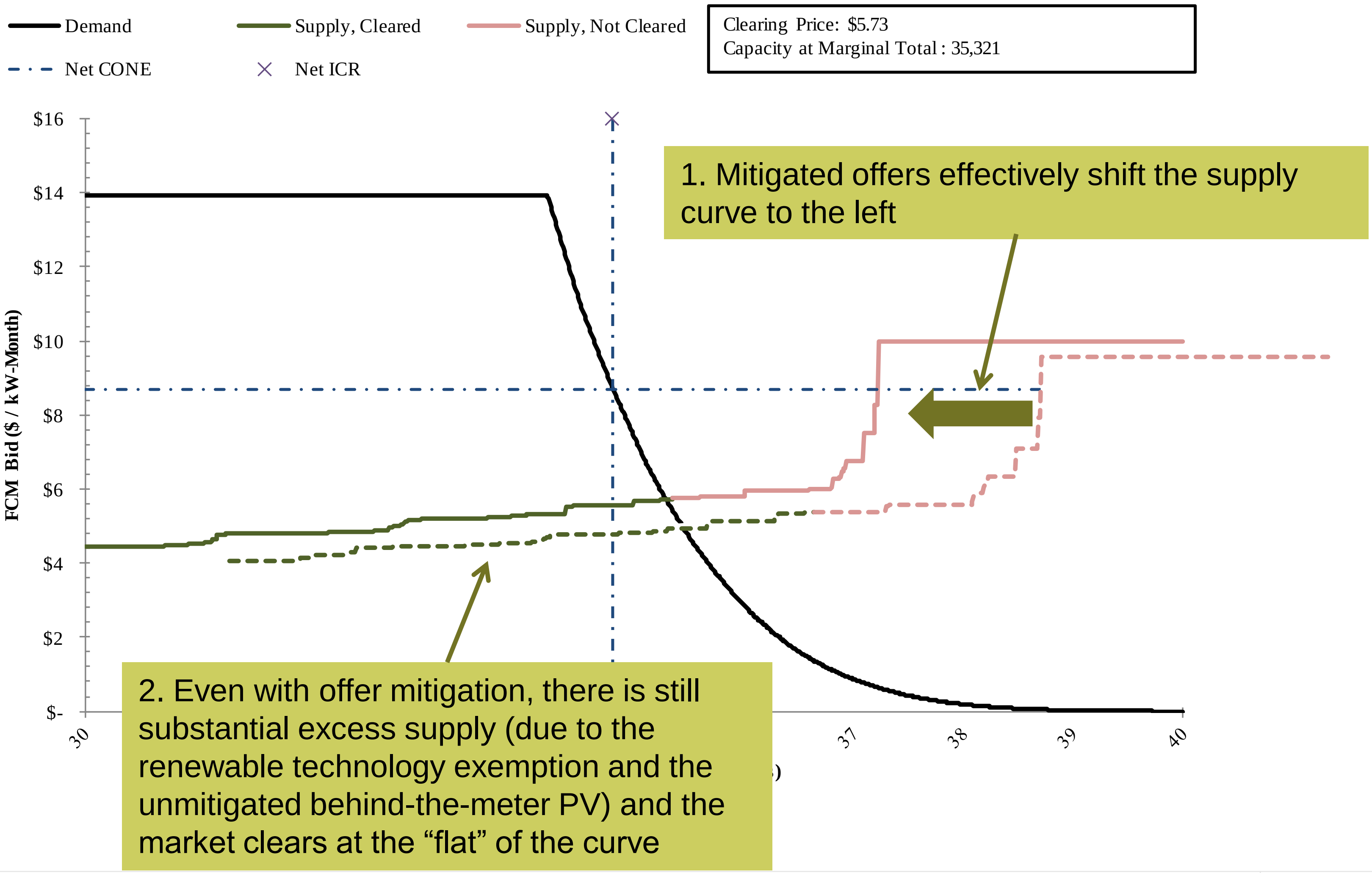
Figure 27 – Illustrative Case for MOPR

ISO-NE FCM Auction Demand-Supply Curve
Scenario 3 Unconstrained 2025 - MOPR Imports and Renewables

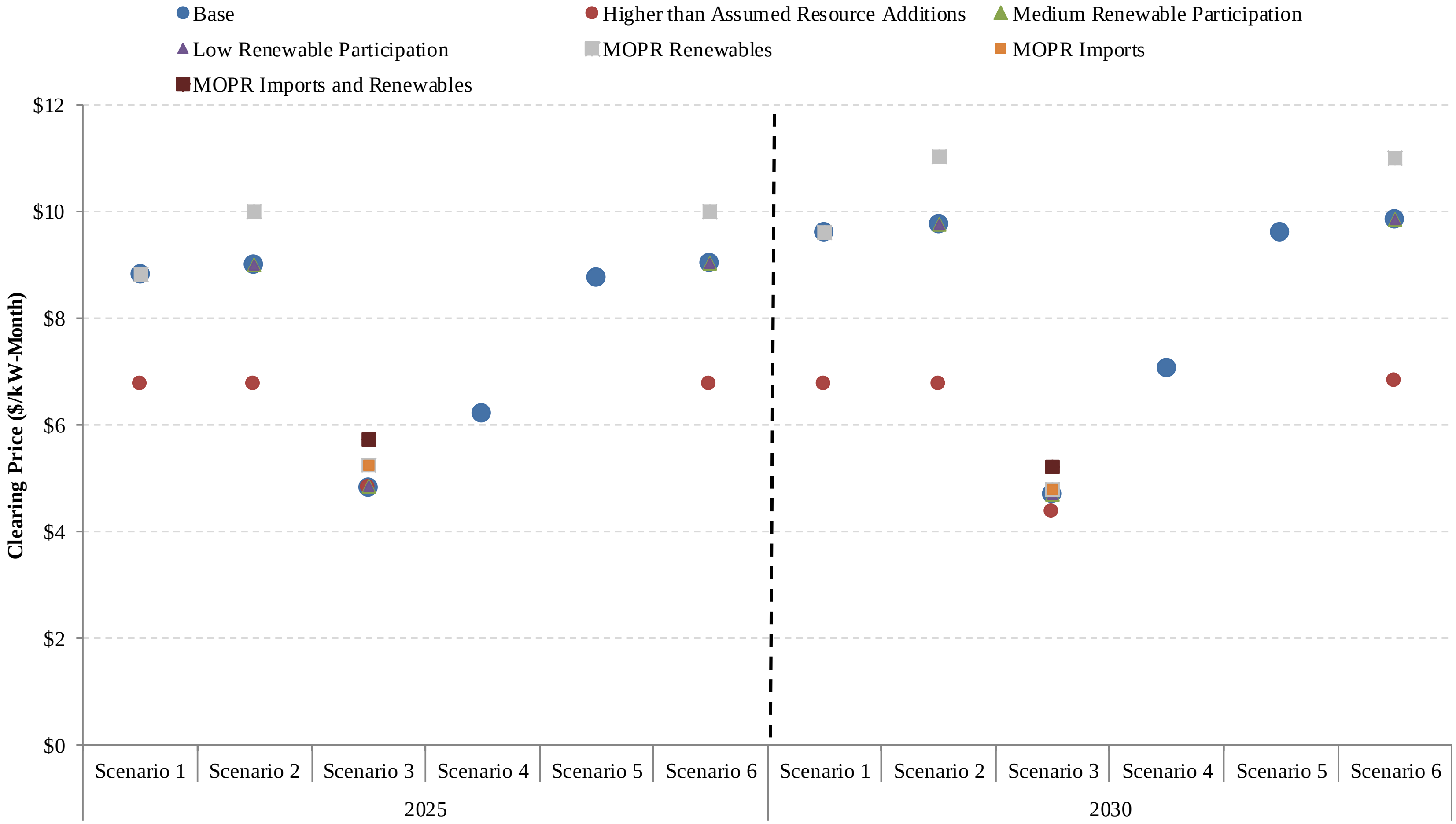


Sensitivity Analysis: Implications

- Several important themes emerge from these sensitivities, which are summarized graphically in Figures 29 to 31:
  - The impact of changes in assumptions regarding retirements, renewable participation and MOPR mitigation is Scenario-specific and depends on the FCM outcomes in the base case and the location on the supply curve where supply clears demand.
  - Results are driven, in part, by the shape of our estimated offer curve. We find that the region's offer curve has a "hockey stick" shape, with a dwindling supply of resources offering supply at or above the prices clearing in recent auctions (e.g., $5.30 per kW-Month in FCA11).
  - The non-linear "hockey-stick" shape of the offer supply curve affects the sensitivity of market outcomes to changes in assumptions. When the market clears higher on the supply curve, price and quantity are more sensitive to changes in assumptions. By contrast, when there is an excess of resources, price and quantity is less sensitive to changes in assumptions.
  - For some Sensitivities that might be expected to show meaningful price changes, particularly the mitigation of resource offers under the MOPR, price changes are relatively small because market-clearing occurs far down on the supply curve.
  - When supply is tighter and existing (higher cost) fossil resources remain in the market, the market continues to clear at higher prices. To the extent that existing (higher cost) fossil resources exit the market, the steepness of the supply curve could increase, which in turn could increase FCM price volatility.

Figure 28

FCA Clearing Prices ($/kW-month)
Scenarios 1-6 with Sensitivities



Note: Results are reported in nominal dollars (e.g., 2025 results are in $2025).

Figure 29

Capacity Above (Below) Net ICR (MW)
Scenarios 1-6 with Sensitivities

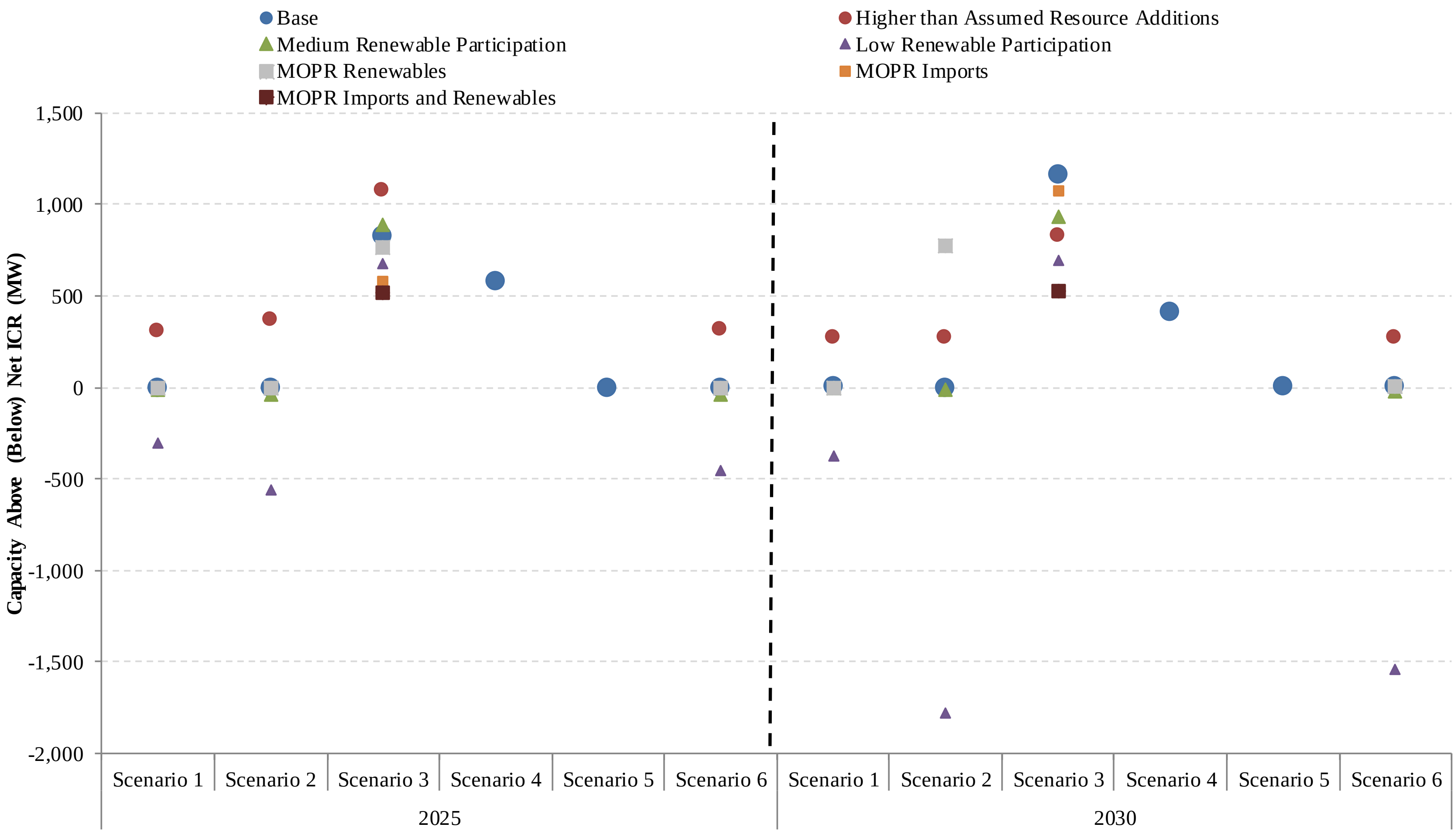
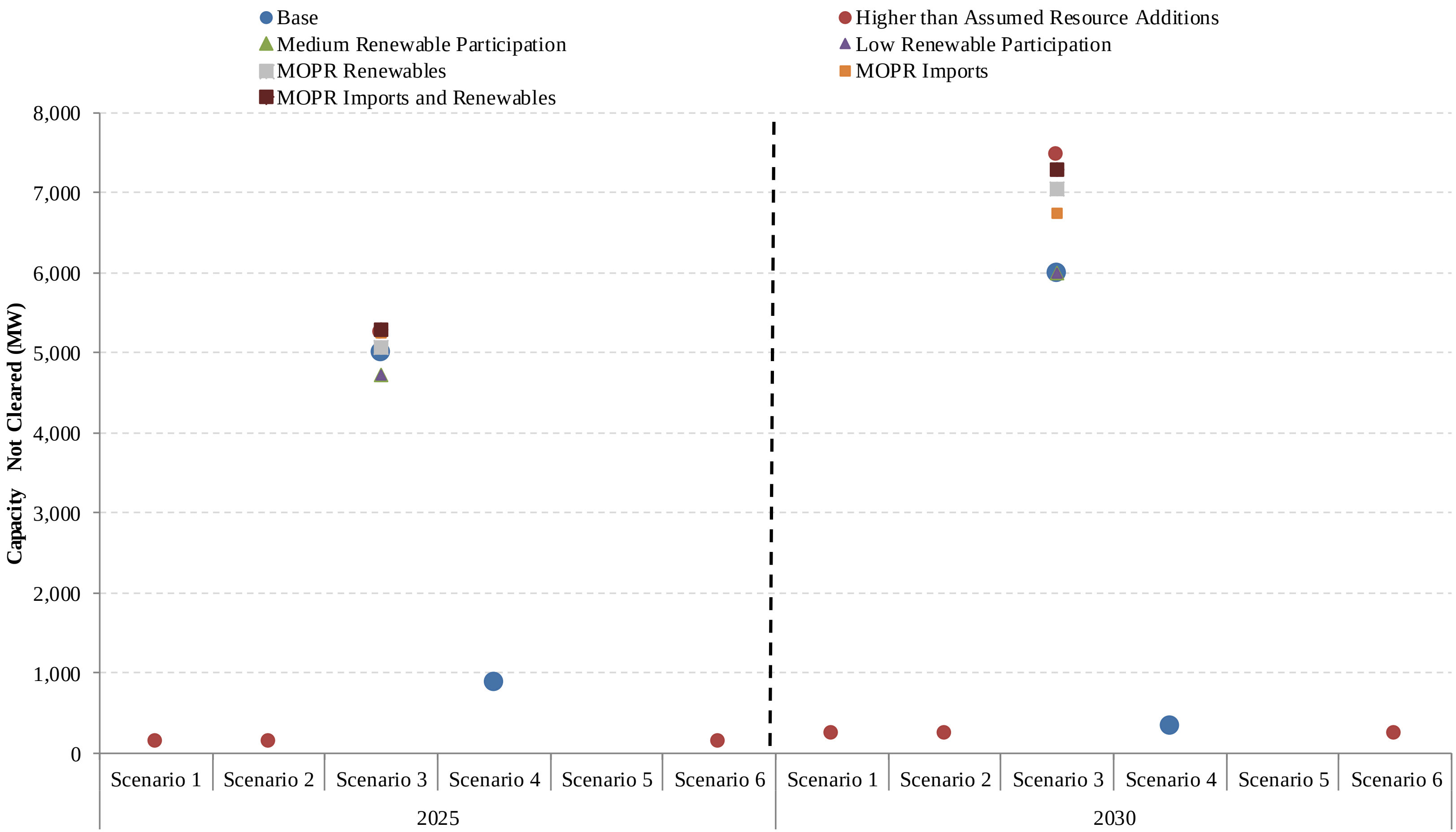


Figure 30

Capacity Not Cleared (MW)
Scenarios 1-6 with Sensitivities



Agenda

Executive Summary

Background and Assignment

Data, Methods and Model

Results

Sensitivity Analysis

Appendix

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INPUTS	2025	2030
Demand Curve Settings		
Net CONE Inflated	$8.70	$9.61
Net ICR	35,302	36,919
Net ICR (Scenario 3)	34,804	36,273
FCA Ceiling Price ($/kW-m)	$13.92	$15.37
Inflation		
Infl. Rate (Costs)	2.0%	2.0%
Infl. Rate (NEAS)	2.0%	2.0%
Cost Year	2025	2030
Supply Curve		
Fixed Cost Scenario	Average	Average
Tax Scenario	Actual	Actual
Risk Factor & Performance Incentive		
Performance Payment Rate [PPR] ($/MWh)	$5,455	$5,455
Total Scarcity Hours (H)	8.48	8.48
Balancing Ratio (Br)	75.4%	75.4%
Risk Cost	0.25	0.25
Probability of Significant Decrease in Capacity (%)	7.0%	7.0%
De-Rate		
Solar	40%	40%
Hydro	100%	100%
Onshore Wind	26%	26%
Offshore Wind	30%	30%

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Power Plants Retired or with Announced Retirement Dates in ISO New England Since FCA 6

Power Plant	In-Service Date	Retirement Date	Generation Technology	Plant Type	Nameplate Capacity (MW)
Retired					
Vermont Yankee	Nov-72	Dec-14	Nuclear	Nuclear	563
Salem Harbor 4	Dec-72	May-14	Steam Turbine	Oil/Gas Steam	476
Norwalk Harbor Generating Station	Jun-60	Jun-13	Steam Turbine	Oil/Gas Steam	326
Salem Harbor 1-3	Aug-58	May-14	Steam Turbine	Coal	166
Bridgeport Harbor 2	Aug-61	Jan-14	Steam Turbine	Oil/Gas Steam	163
Mount Tom	Nov-60	Oct-14	Steam Turbine	Coal	136
Millinocket Mill	Jul-57	Dec-13	Steam Turbine	Oil/Gas Steam	86
Lowell CC	Sep-88	Sep-13	Combined Cycle	Combined Cycle	34
Worcester Energy Company Inc.	Mar-89	Dec-13	Steam Turbine	Wood	26
Maine Energy Recovery	Jun-87	Dec-12	Steam Turbine	Miscellaneous	22
Cabot-Holyoke	Aug-55	Mar-13	Steam Turbine	Oil/Gas Steam	20
Sprague Paperboard	Oct-62	Aug-14	Steam Turbine	Oil/Gas Steam	20
Ridgewood Providence Power	Jan-90	May-13	Internal Combustion	Miscellaneous	20
New Boston CT	Sep-66	Oct-16	Gas Turbine	Combustion Turbine	19
Eastern Paper - Lincoln Mill	Jan-57	Jun-13	Steam Turbine	Oil/Gas Steam	18
Norwalk Harbor Generating Station CT	Oct-66	Jun-13	Gas Turbine	Combustion Turbine	16
Greenville Steam Company	Jan-88	Sep-15	Steam Turbine	Wood	16
Wallingford Resource Recovery Facility	Oct-88	Apr-15	Steam Turbine	Miscellaneous	11
Brayton Point IC	Mar-67	Jun-13	Internal Combustion	Miscellaneous	11
Old Town CT	Dec-02	Dec-13	Gas Turbine	Combustion Turbine	10
Veazie	Jul-33	Jul-13	Hydraulic Turbine	Hydro	8
Medway IC	Jul-60	Mar-15	Internal Combustion	Miscellaneous	8
Great Works Hydro	Jan-10	Nov-12	Hydraulic Turbine	Hydro	8
Bar Harbor	Nov-61	May-14	Internal Combustion	Miscellaneous	4
Gilman Mill Steam	Feb-82	Jan-14	Steam Turbine	Wood	4
Old Town Division	Jul-56	Dec-13	Steam Turbine	Oil/Gas Steam	3
Pfizer Groton Plant	Jan-48	Jun-15	Steam Turbine	Oil/Gas Steam	3
Proctor	Aug-05	Jan-14	Run of River	Hydro	2
Four Hills/Nashua Landfill (Suncook Facility)	Apr-96	Aug-14	Internal Combustion	Miscellaneous	2
Fall River Electric	Jul-00	May-12	Internal Combustion	Miscellaneous	2
Harris Energy & Realty Corporation	Jan-82	Nov-12	Hydraulic Turbine	Hydro	2
Clark University	Jun-81	May-12	Internal Combustion	Miscellaneous	2
Connecticut Valley Hospital Plant		Mar-13	Steam Turbine	Oil/Gas Steam	2
Portsmouth Wind	Mar-09	Jan-16	Wind Turbine	Miscellaneous	2
Dunbarton Energy Partners LP	Aug-88	Jun-12	Internal Combustion	Miscellaneous	1
CJTS Energy Center	Nov-01	Apr-13	Fuel Cell	Miscellaneous	1
Block Island	Aug-93	Jun-12	Internal Combustion	Miscellaneous	1
Beacon Power Flywheel Storage System 1	Nov-08	Mar-15	Other	Miscellaneous	1
Kraft Foods Atlantic Gelatin IC	Feb-78	Aug-12	Internal Combustion	Miscellaneous	1
South Norwalk	May-90	Nov-14	Internal Combustion	Miscellaneous	1
Kraft Foods Atlantic Gelatin	Sep-88	Aug-12	Steam Turbine	Oil/Gas Steam	1
Framingham State University IC Project	Jun-74	Dec-15	Internal Combustion	Miscellaneous	0
Retired Total					**2,215**
Planned Retirements					
Brayton Point 1-3	Aug-63	May-17	Steam Turbine	Coal	1,125
Pilgrim Nuclear Power Station	Dec-72	May-19	Nuclear	Nuclear	670
Brayton Point 4	Dec-74	Jun-17	Steam Turbine	Oil/Gas Steam	476
Planned Retirments Total					**2,270**
Total					**4,485**

Note: FCA 6 was held on May 1, 2012. **Source:** SNL Financial.

Ratio of Wind Capacity Clearing the FCM to Operating Capacity (MW)

	2010	2011	2012	2013	2014	2015
[A] FCM Cleared Wind Capacity	10	89	93	118	152	167
[B] Operating Capacity Wind	311	506	821	824	836	1,028
[C] = [A] / [B] *% of Operating Capacity*	*3.3%*	*17.5%*	*11.4%*	*14.4%*	*18.1%*	*16.3%*

Source: Analysis Group calculations; ISO-NE.

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ISO New England GridView Retirements
Unconstrained Scenarios 1-6

Unit	Plant Type	2025 Retired Summer Capacity (MW)	2030 Retired Summer Capacity (MW)
BRIDGEPORT HARBOR3_3	Coal	358	358
MERRIMACK 2_2	Coal	299	299
MERRIMACK 1_1	Coal	108	108
SCHILLER 6_6	Coal	46	46
SCHILLER 4_4	Coal	46	46
YARMOUTH 4_4	Oil/Gas Steam		557
CANAL 1_1	Oil/Gas Steam	540	540
CANAL 2_2	Oil/Gas Steam		513
NEW HAVEN HARBOR_1	Oil/Gas Steam		419
NEWINGTON 1_1	Oil/Gas Steam		382
MIDDLETOWN 4_4	Oil/Gas Steam		333
MONTVILLE 6_6	Oil/Gas Steam	332	332
MIDDLETOWN 3_3	Oil/Gas Steam	223	223
YARMOUTH 3_3	Oil/Gas Steam	113	113
MIDDLETOWN 2_2	Oil/Gas Steam	110	110
MONTVILLE 5_5	Oil/Gas Steam	79	79
YARMOUTH 2_2	Oil/Gas Steam	51	51
YARMOUTH 1_1	Oil/Gas Steam	50	50
WEST SPRINGFIELD 3_3	Oil/Gas Steam	103	103
MYSTIC JET_J	Combustion Turbine		7

Note:
[1] The capacity shown represents implied retirements derived by comparing the units modeled across all scenarios to the units modeled in an individual scenario.

Net EAS Revenues

Net Energy Revenues

- Energy revenues and costs were calculated and provided by ISO-NE via GridView production modeling.
- Outputs include revenues, uplift, and variable costs broken into fuel costs, emission costs, etc.
- Net energy revenues was calculated as energy revenues plus uplift, minus all costs associated with energy production.

Ancillary Services Revenues

- Ancillary services revenues were calculated for both Locational Forward Reserves (LFRM) and Real-Time Reserves (RTR).
- ISO-NE provided Analysis Group with RTR prices. LFRM prices were gathered from the web.
- ISO-NE provided Analysis Group with 5-minute settlement data including the MW of ancillary service provided by each unit.
- Analysis Group calculated the average yearly historic ancillary services revenue for each unit as the price of the ancillary product times the quantity of the product produced, evaluated over capacity years 2012-2016. Ancillary services were not assigned a cost.
- For new units and units where data was missing, Analysis Group assigned the unit an average revenues amount based on the technology and fuel type.

Pay for Performance Adjustment

Unit Historical Performance and Balancing Ratio

- Analysis Group calculated average unit performance during shortage events and an average balancing ratio during shortages by evaluating unit performance during historic RCPF events.
- ISO-NE provided Analysis Group with 5-minute settlement data, including the MW of energy and ancillary services provided by each unit, and with a dataset of historical RCPF events and associated balancing ratios.
- Analysis Group downloaded CSO and qualified capacity information for each unit from the ISO-NE website based on auction results in FCA4, FCA5, FCA6, and FCA7.
- The units historical performance was calculated as the sum of all output in an hour divided by the qualified capacity. The balancing ratio was calculated as the time-weighted average balancing ratio over historical RCPF events.
- For new units and units where data was missing, Analysis Group assigned the unit an average performance based on the technology and fuel type.

Expected Future Payment Rate and Scarcity Hours

- The performance payment rate (PPR) modeled is $5,455/MWh for both FCA 16 and FCA 21. We do not consider any changes to the PPR the might occur in future years.
- Analysis Group calculated a historic mean of 8.48 scarcity hours per year, over FCA4 through FCA7. This value was used as an estimate of future reserve shortage hours.

Fixed Costs and Investment Costs

Unit Fixed Costs

- Analysis Group downloaded from SNL Financial and Ventyx the estimated unit-level fixed costs for each plant in New England. Both SNL Financial and Ventyx use actual data and proprietary models to calculate an estimate of fixed costs.
- Analysis Group reviewed the estimation methodologies of both SNL and Ventyx and compared the estimated fixed costs for each unit across sources to ensure that estimates seemed reasonable. For the majority of units, Analysis Group applied the average fixed cost across the two data sources. Adjustments were made in situations where the technology or fuel type associated with the unit were reported differently across SNL and Ventyx, as in some cases those differences would interact with the proprietary modeling techniques to provide unreasonable estimates.
- Generic GridView units were assigned the average fixed cost for the matching technology type and fuel types. For new fossil plants, only newer units (post 1990) were averaged.

Annualized Investment Costs

- Annualized investment costs were calculated by examining and analyzing "Gross Capital Expenditure" data provided by SNL Financial in 2010-2015 from 1,231 power plants in the United States.
- By examining the yearly gross capital expenditures, Analysis Group developed estimates of capital expenditures in New England by comparing units to those with similar technology and fuel types. Further adjustments were applied to remove outliers and ensure the assumed costs were consistent with prior New England auctions.

Taxes and Risk Premiums

Unit Taxes

- Analysis Group collected information on a wide variety of New England plants over tax years 2013-2016, including 42 units with capacity greater than 100 MW and 34 units smaller than 100 MW. Two methods of finding a tax amount were used:
  - Available: The property tax value was in a newspaper, town report, or company publication (33 units).
  - Estimated: The assessed value of the plant was available in a town database, and using the town's property tax rate a tax was calculated (43 units).
- The GDP Implicit Price Deflator was used to standardize property tax in $2015.

Calculated Risk Premiums

- Analysis Group calculated risk premiums using the equations listed in the "Risk Tab" of the ISO-NE De-List Bid Generation workbook (as determined pursuant to MR1 Section III.13.1.2.3.2.1.4). These include:
  - Risk of Greater than Expected Number of Capacity Scarcity Conditions;
  - Risk of Worse than Expected Availability during Capacity Scarcity Condition Hours;
  - Risk of the Resource Experiencing a Significant Decrease in Capacity; and
  - A Stop Loss Limit.

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Detailed Scenario Outputs, Unconstrained Case (page 1)

OUTPUTS - Unconstrained	2025						2030					
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Clearing Price ($/kW-Month)	**$8.82**	**$8.99**	**$4.82**	**$6.20**	**$8.74**	**$9.04**	**$9.61**	**$9.75**	**$4.68**	**$7.04**	**$9.61**	**$9.84**
Total Cost ($, millions)	**$3,736**	**$3,808**	**$2,061**	**$2,669**	**$3,702**	**$3,830**	**$4,257**	**$4,319**	**$2,103**	**$3,154**	**$4,257**	**$4,360**
Cleared												
Capacity @ Marginal Total (MW, thousands)	**35,302**	**35,299**	**35,627**	**35,877**	**35,302**	**35,302**	**36,919**	**36,916**	**37,439**	**37,332**	**36,920**	**36,920**
Combined Cycle	15,437	14,781	13,272	14,650	15,925	14,781	18,427	14,282	9,375	14,772	19,115	14,110
Combustion Turbine	3,198	3,198	3,189	3,193	3,197	3,198	3,128	3,128	3,067	3,193	3,128	2,275
Oil/Gas Steam	2,964	2,964	452	4,645	2,964	2,964	569	568	-	4,645	568	1,668
Coal	-	-	-	425	-	-	-	-	-	720	-	-
Wood	489	489	489	489	489	489	489	489	460	489	489	489
Miscellaneous	665	665	289	615	665	665	664	664	186	658	664	589
Nuclear	3,347	3,347	3,347	3,347	3,347	3,347	3,347	3,347	3,347	3,347	3,347	3,347
Imports + Demand Response	1,325	1,325	2,722	1,124	1,325	1,325	1,325	1,325	3,222	1,225	1,325	1,325
Conventional Hydroelectric	1,411	1,422	1,396	1,398	1,398	1,409	1,391	1,431	1,520	1,403	1,403	1,431
Wind	855	1,508	1,457	367	367	1,130	1,054	5,196	1,900	367	367	3,589
Solar	62	62	62	62	62	443	62	62	62	62	62	1,673
Pumped + Energy Storage	1,705	1,694	2,909	1,718	1,718	1,707	1,725	1,685	4,293	1,713	1,713	1,685
Pumped Storage	-	-	28	28	28	28	28	28	-	-	-	28
Energy Storage	1,705	1,694	2,881	1,690	1,690	1,679	1,698	1,656	4,293	1,713	1,713	1,656
Battery Storage	-	-	1,200	-	-	-	-	-	2,500	-	-	-
Energy Efficiency	3,844	3,844	4,844	3,844	3,844	3,844	4,739	4,739	7,509	4,739	4,739	4,739

Detailed Scenario Outputs, Unconstrained Case (page 2)

OUTPUTS - Unconstrained	2025						2030					
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Not Cleared												
Capacity (MW, thousands)	**0**	**0**	**5,010**	**891**	**0**	**0**	**0**	**0**	**5,989**	**331**	**0**	**0**
Combined Cycle	-	-	1,509	122	-	-	-	-	4,249	-	-	-
Combustion Turbine	-	-	8	-	-	-	-	-	61	-	-	-
Oil/Gas Steam	-	-	2,513	27	-	-	-	-	568	27	-	-
Coal	-	-	-	492	-	-	-	-	-	197	-	-
Wood	-	-	-	-	-	-	-	-	29	-	-	-
Miscellaneous	-	-	377	49	-	-	-	-	478	7	-	-
Nuclear	-	-	-	-	-	-	-	-	-	-	-	-
Imports + Demand Response	-	-	604	201	-	-	-	-	604	101	-	-
Conventional Hydroelectric	-	-	-	-	-	-	-	-	-	-	-	-
Wind	-	-	-	-	-	-	-	-	-	-	-	-
Solar	-	-	-	-	-	-	-	-	-	-	-	-
Pumped + Energy Storage	-	-	-	-	-	-	-	-	-	-	-	-
Battery Storage	-	-	-	-	-	-	-	-	-	-	-	-
Retired												
Capacity (MW, thousands)	**2,456**	**2,456**	**2,456**	**0**	**2,456**	**2,456**	**4,668**	**4,668**	**4,668**	**0**	**4,668**	**4,661**
Combined Cycle	-	-	-	-	-	-	-	-	-	-	-	-
Combustion Turbine	-	-	-	-	-	-	7	7	7	-	7	-
Oil/Gas Steam	1,600	1,600	1,600	-	1,600	1,600	3,805	3,805	3,805	-	3,805	3,805
Coal	856	856	856	-	856	856	856	856	856	-	856	856
Wood	-	-	-	-	-	-	-	-	-	-	-	-
Miscellaneous	-	-	-	-	-	-	-	-	-	-	-	-
Nuclear	-	-	-	-	-	-	-	-	-	-	-	-
Imports + Demand Response	-	-	-	-	-	-	-	-	-	-	-	-
Conventional Hydroelectric	-	-	-	-	-	-	-	-	-	-	-	-
Wind	-	-	-	-	-	-	-	-	-	-	-	-
Solar	-	-	-	-	-	-	-	-	-	-	-	-
Pumped + Energy Storage	-	-	-	-	-	-	-	-	-	-	-	-
Battery Storage	-	-	-	-	-	-	-	-	-	-	-	-

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Detailed Scenario Outputs, Constrained Case (page 1)

OUTPUTS - Constrained

2025

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Clearing Price ($/kW-Month)	**$9.55**	**$9.59**	**$4.93**	**$6.25**	**$9.56**	**$9.80**
Total Cost ($, millions)	**$4,042**	**$4,059**	**$2,098**	**$2,679**	**$4,046**	**$4,148**
Cleared						
Capacity @ Marginal Total (MW, thousands)	**35,272**	**35,269**	**35,465**	**35,715**	**35,272**	**35,271**
Combined Cycle	15,437	14,781	13,295	14,650	15,925	14,781
Combustion Turbine	3,198	3,198	3,198	3,193	3,197	3,198
Oil/Gas Steam	2,964	2,964	452	4,645	2,964	2,964
Coal	-	-	-	425	-	-
Wood	489	489	470	489	489	489
Miscellaneous	635	635	316	587	635	635
Nuclear	3,347	3,347	3,347	3,347	3,347	3,347
Imports + Demand Response	1,325	1,325	2,521	990	1,325	1,325
Conventional Hydroelectric	1,411	1,422	1,396	1,398	1,398	1,409
Wind	855	1,508	1,457	367	367	1,129
Solar	62	62	62	62	62	443
Pumped + Energy Storage	1,705	1,694	2,909	1,718	1,718	1,707
Battery Storage	-	-	1,200	-	-	-
Energy Efficiency	3,844	3,844	4,844	3,844	3,844	3,844

2030

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Clearing Price ($/kW-Month)	**$10.10**	**$10.15**	**$4.73**	**$7.05**	**$10.06**	**$10.57**
Total Cost ($, millions)	**$4,471**	**$4,493**	**$2,122**	**$3,150**	**$4,453**	**$4,679**
Cleared						
Capacity @ Marginal Total (MW, thousands)	**36,889**	**36,886**	**37,379**	**37,235**	**36,890**	**36,889**
Combined Cycle	18,427	14,282	9,604	14,772	19,115	14,110
Combustion Turbine	3,128	3,128	3,076	3,193	3,128	2,275
Oil/Gas Steam	569	568	-	4,645	568	1,668
Coal	-	-	-	720	-	-
Wood	489	489	445	489	489	489
Miscellaneous	634	634	104	628	634	559
Nuclear	3,347	3,347	3,347	3,347	3,347	3,347
Imports + Demand Response	1,325	1,325	3,021	1,158	1,325	1,325
Conventional Hydroelectric	1,391	1,431	1,520	1,403	1,403	1,431
Wind	1,054	5,196	1,900	367	367	3,588
Solar	62	62	62	62	62	1,673
Pumped + Energy Storage	1,725	1,685	4,293	1,713	1,713	1,685
Battery Storage	-	-	2,500	-	-	-
Energy Efficiency	4,739	4,739	7,509	4,739	4,739	4,739

Detailed Scenario Outputs, Constrained Case (page 2)

OUTPUTS - Constrained

	2025						2030					
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Not Cleared												
Capacity (MW, thousands)	**0**	**0**	**5,030**	**891**	**0**	**0**	**0**	**0**	**6,004**	**331**	**0**	**0**
Combined Cycle	-	-	1,509	122	-	-	-	-	4,249	-	-	-
Combustion Turbine	-	-	8	-	-	-	-	-	61	-	-	-
Oil/Gas Steam	-	-	2,513	27	-	-	-	-	568	27	-	-
Coal	-	-	-	492	-	-	-	-	-	197	-	-
Wood	-	-	19	-	-	-	-	-	44	-	-	-
Miscellaneous	-	-	377	49	-	-	-	-	478	7	-	-
Nuclear	-	-	-	-	-	-	-	-	-	-	-	-
Imports + Demand Response	-	-	604	201	-	-	-	-	604	101	-	-
Conventional Hydroelectric	-	-	-	-	-	-	-	-	-	-	-	-
Wind	-	-	-	-	-	-	-	-	-	-	-	-
Solar	-	-	-	-	-	-	-	-	-	-	-	-
Pumped + Energy Storage	-	-	-	-	-	-	-	-	-	-	-	-
Battery Storage	-	-	-	-	-	-	-	-	-	-	-	-
Retired												
Capacity (MW, thousands)	**2,456**	**2,456**	**2,456**	**0**	**2,456**	**2,456**	**4,668**	**4,668**	**4,668**	**0**	**4,668**	**4,668**
Combined Cycle	-	-	-	-	-	-	-	-	-	-	-	-
Combustion Turbine	-	-	-	-	-	-	7	7	7	-	7	7
Oil/Gas Steam	1,600	1,600	1,600	-	1,600	1,600	3,805	3,805	3,805	-	3,805	3,805
Coal	856	856	856	-	856	856	856	856	856	-	856	856
Wood	-	-	-	-	-	-	-	-	-	-	-	-
Miscellaneous	-	-	-	-	-	-	-	-	-	-	-	-
Nuclear	-	-	-	-	-	-	-	-	-	-	-	-
Imports + Demand Response	-	-	-	-	-	-	-	-	-	-	-	-
Conventional Hydroelectric	-	-	-	-	-	-	-	-	-	-	-	-
Wind	-	-	-	-	-	-	-	-	-	-	-	-
Solar	-	-	-	-	-	-	-	-	-	-	-	-
Pumped + Energy Storage	-	-	-	-	-	-	-	-	-	-	-	-
Battery Storage	-	-	-	-	-	-	-	-	-	-	-	-

ISO-NE FCM 2016 Economic Analysis Scenario Outcomes
Expected Reserve Shortage Hours = 12

	2025 (Unconstrained)					
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Net CONE	$8.70	$8.70	$8.70	$8.70	$8.70	$8.70
Clearing Price ($/kW-Month)	$9.04	$9.04	$5.16	$7.03	$9.01	$9.04
Cleared Capacity @ Marginal Total (MW, thousands)	**35,300**	**35,297**	**35,518**	**35,728**	**35,275**	**35,300**
Total FCM Payments ($, millions)	**$3,829**	**$3,829**	**$2,199**	**$3,014**	**$3,814**	**$3,829**
Average FCM Payments ($ per MWh)	$25.19	$25.20	$13.63	$19.79	$25.08	$25.20
Capacity Above ICR	-2	-5	714	426	-27	-2
Not Cleared Capacity (MW, thousands)	2	2	5,080	1,041	27	2
Total Energy Revenue ($, millions)	$8,659	$8,325	$7,688	$8,737	$8,819	$8,382

	2030 (Unconstrained)					
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Net CONE	$9.61	$9.61	$9.61	$9.61	$9.61	$9.61
Clearing Price ($/kW-Month)	$9.58	$10.01	$5.15	$7.43	$9.57	$10.10
Cleared Capacity @ Marginal Total (MW, thousands)	**36,919**	**36,916**	**37,173**	**37,383**	**36,920**	**36,920**
Total FCM Payments ($, millions)	**$4,244**	**$4,434**	**$2,297**	**$3,333**	**$4,240**	**$4,475**
Average FCM Payments ($ per MWh)	$26.60	$27.90	$13.08	$20.87	$26.57	$28.15
Capacity Above ICR	0	-3	900	464	1	1
Not Cleared Capacity (MW, thousands)	0	0	6,739	281	0	0
Total Energy Revenue ($, millions)	$11,262	$7,444	$8,051	$11,453	$11,362	$6,992

Note: Results are reported in nominal dollars (e.g., 2025 results are in $2025).

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