Renewable and Clean Energy Mechanisms 2.0 Study – Phase I: Scenario Analysis

Winter 2017

New England States Committee on Electricity

NESCOE

Overview

Context
Analytical Approach and Modeling Assumptions
    Scenario Analysis ➡ Mechanisms Analysis
Modeling Results
    Energy, Capacity, and Emissions
    Missing Money
Phase I: Scenario Analysis - Observations
Next Steps

What the Analysis will Not Provide

The modeling is illustrative, rather than predictive. It is based on many assumptions, any one or more of which history may prove wrong to varying degrees. The analysis will provide *directionally indicative* information about a range of hypothetical scenarios. It is not a plan, and it is a not a collective or individual state view of or preference about the future. The costs LEI's model identifies are based on assumptions and therefore should not be interpreted as an actual price tag.

The Study does *not* attempt to:

- **Precisely forecast the timing of future generator retirements, or infrastructure development.**
- **Evaluate cost-effectiveness under an avoided cost approach.**
- **Optimize the level, timing, or location of renewable and clean energy resources.**
- **Suggest winners or losers.**

This study should be viewed accordingly, and critically.

NESCOE welcomes from market participants or others any facts or data that clarify, correct, or should be considered in reviewing the study results.

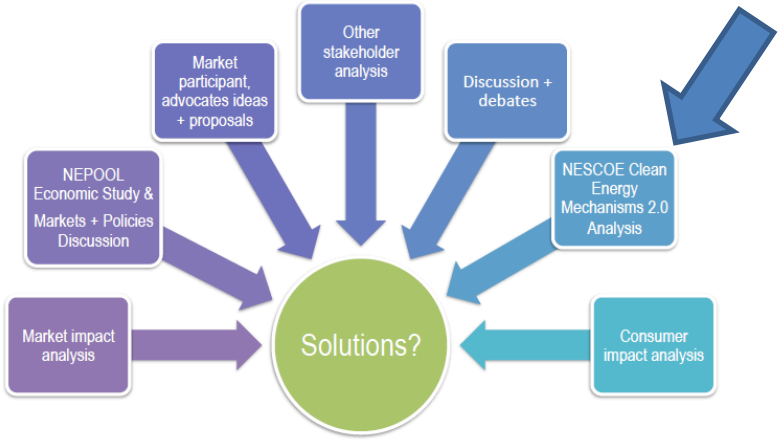
Context for Mechanisms 2.0 Study

Mechanisms to Support Public Policy Resources in the New England States

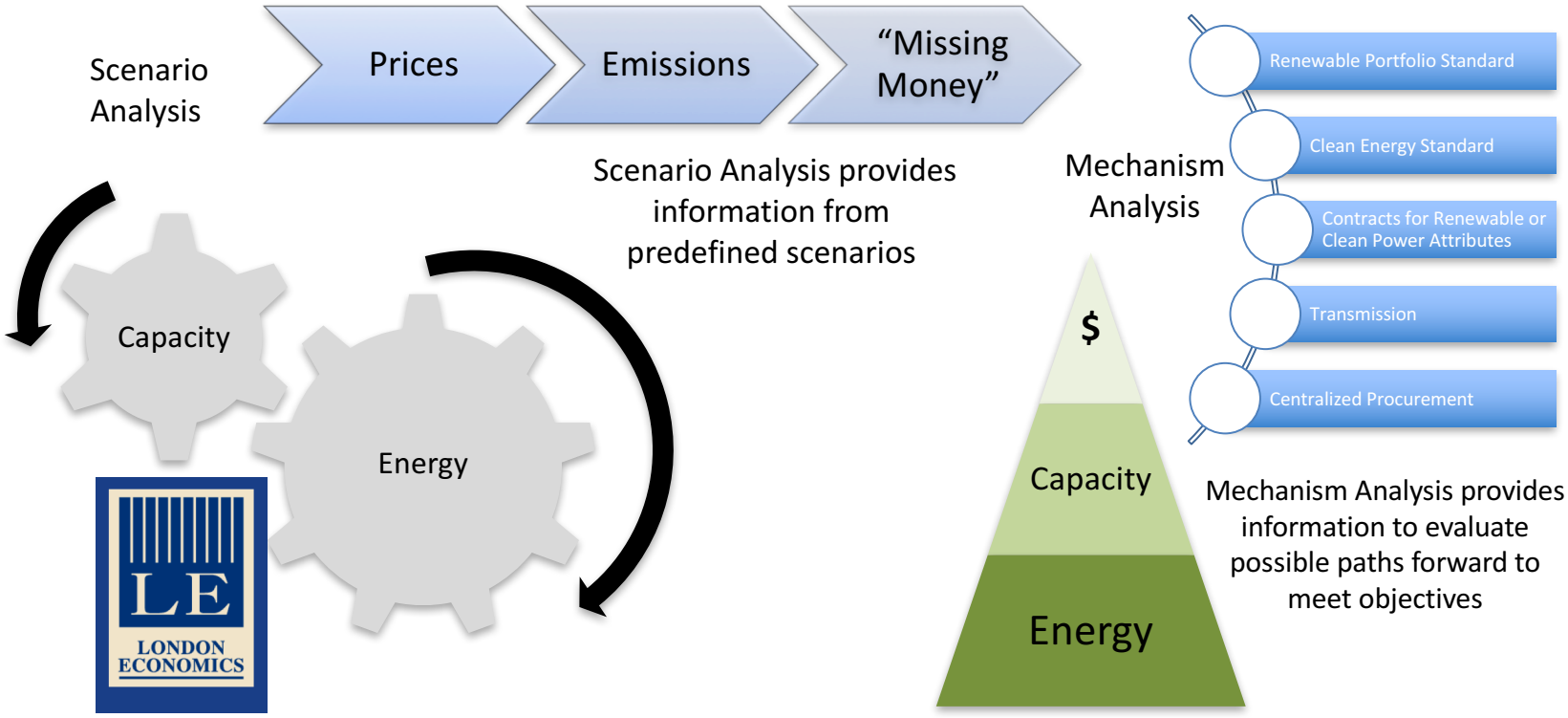
December 18, 2015

NESCOE
New England States Committee on Electricity

NEPOOL
NEW ENGLAND POWER POOL



Mechanisms 2.0 Analytical Approach

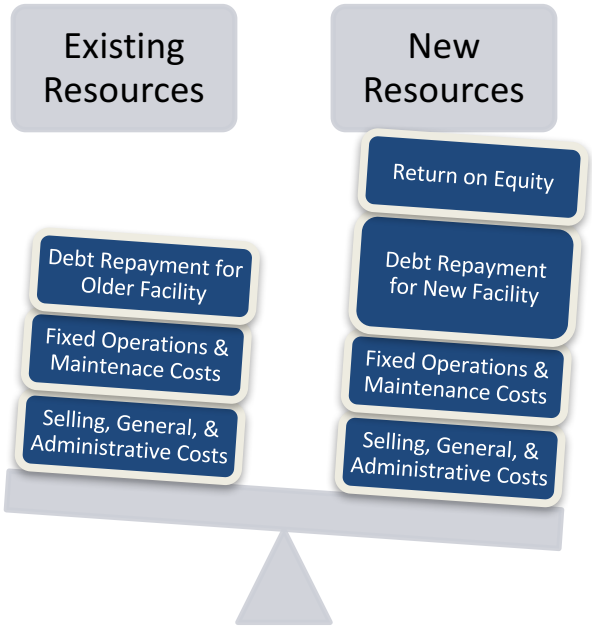


As in the background paper, producing information about a range of mechanisms is not intended to, and should not be interpreted to, suggest a preference for any particular mechanism. The work product is not a plan: it will only provide a directionally indicative sense of a range of hypothetical futures.

LEI Modeling and Economic Analysis

Modeling results inform

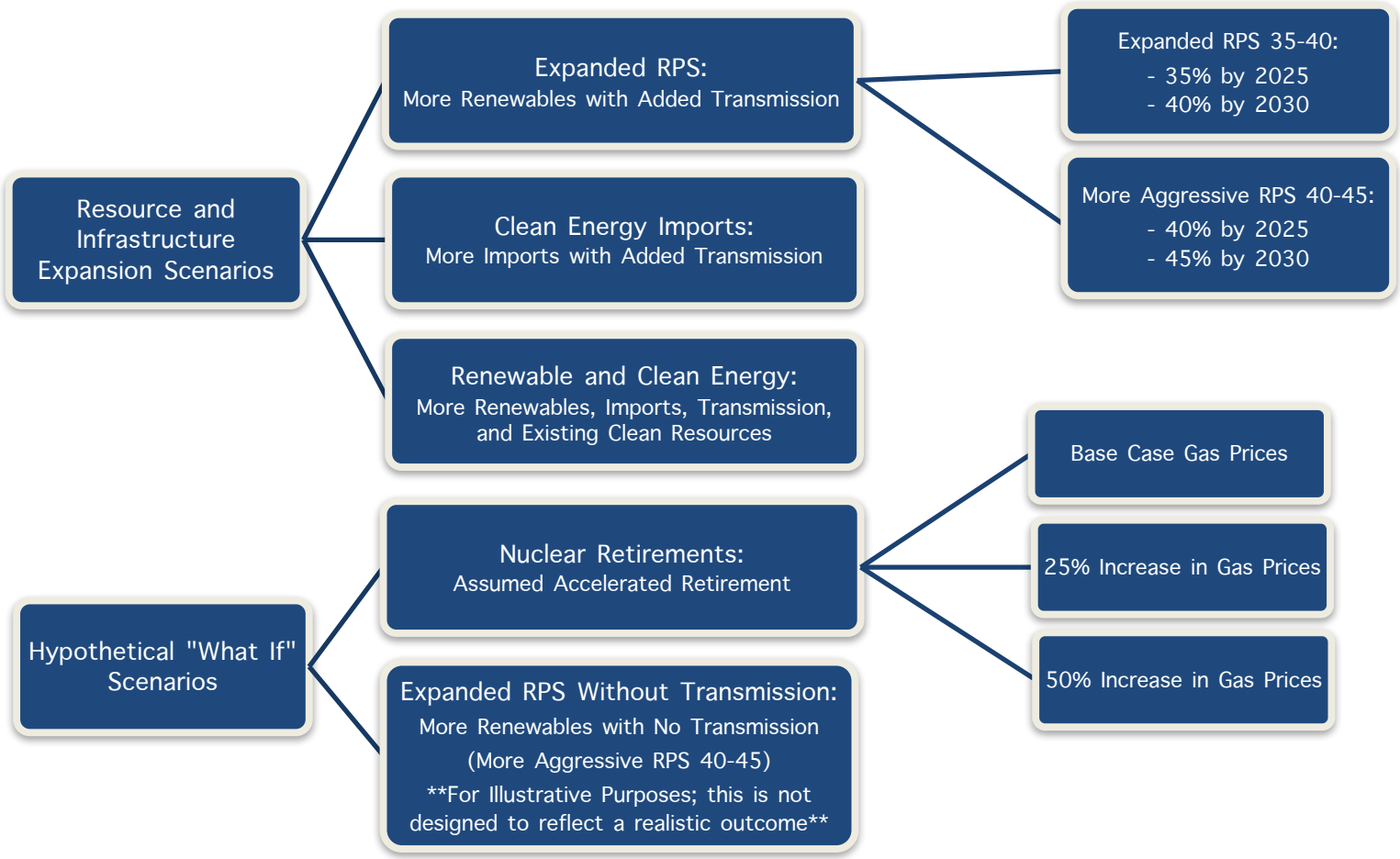
LEI developed going forward cost estimates for new and existing resource types



”Missing Money” estimates for each resource type inform the mechanisms analysis

This assumption affects the results and should be considered when interpreting “Missing Money” estimates

Scenario Analysis Design



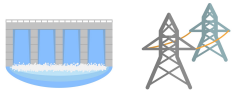
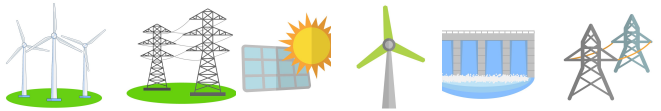
Mechanisms 2.0 – Base Case

- **Represents "Business As Usual"**
  - A variation on London Economics International's (LEI) multi-client Base Case
- **Continuation of existing state policies related to RPS and carbon emissions**
  - Current RPS targets with transmission transfer limits based on recent ISO-NE analysis
    - LEI adds on-shore wind capacity until transmission interfaces constrain new entry
  - Current RGGI allowance price forwards through 2020 are escalated at an assumed inflation rate (2%)
- **"Just in time" economic new entry and retirements based on forecasted market dynamics**
  - Results of Forward Capacity Auctions (FCA) through FCA 10 incorporated into new entry and retirements
  - Integrated energy and capacity market modeling through the study period; includes convex demand curves
  - Cost of New Entry (CONE): Combined Cycle Gas Turbine is Offer Review Trigger Price ($9.46/kW-month) based on recent FCA results and perceived CONE trend
- **Baseline expectations for load growth under weather normal conditions**
  - ISO-NE CELT 50/50 Load Forecast, net of Energy Efficiency and behind-the-meter Solar PV
- **LEI's proprietary fuel price forecasts, based on known and committed infrastructure projects**
  - Levelized Cost of Pipeline model for Algonquin City Gate natural gas delivered prices
  - Current forwards and actual historical prices escalated at EIA-forecasted growth rates for oil and coal
- **Imports from neighboring systems assumed to continue historical trends over existing ties**
- **No Clean Energy RFP respondents have been included in the Base Case**

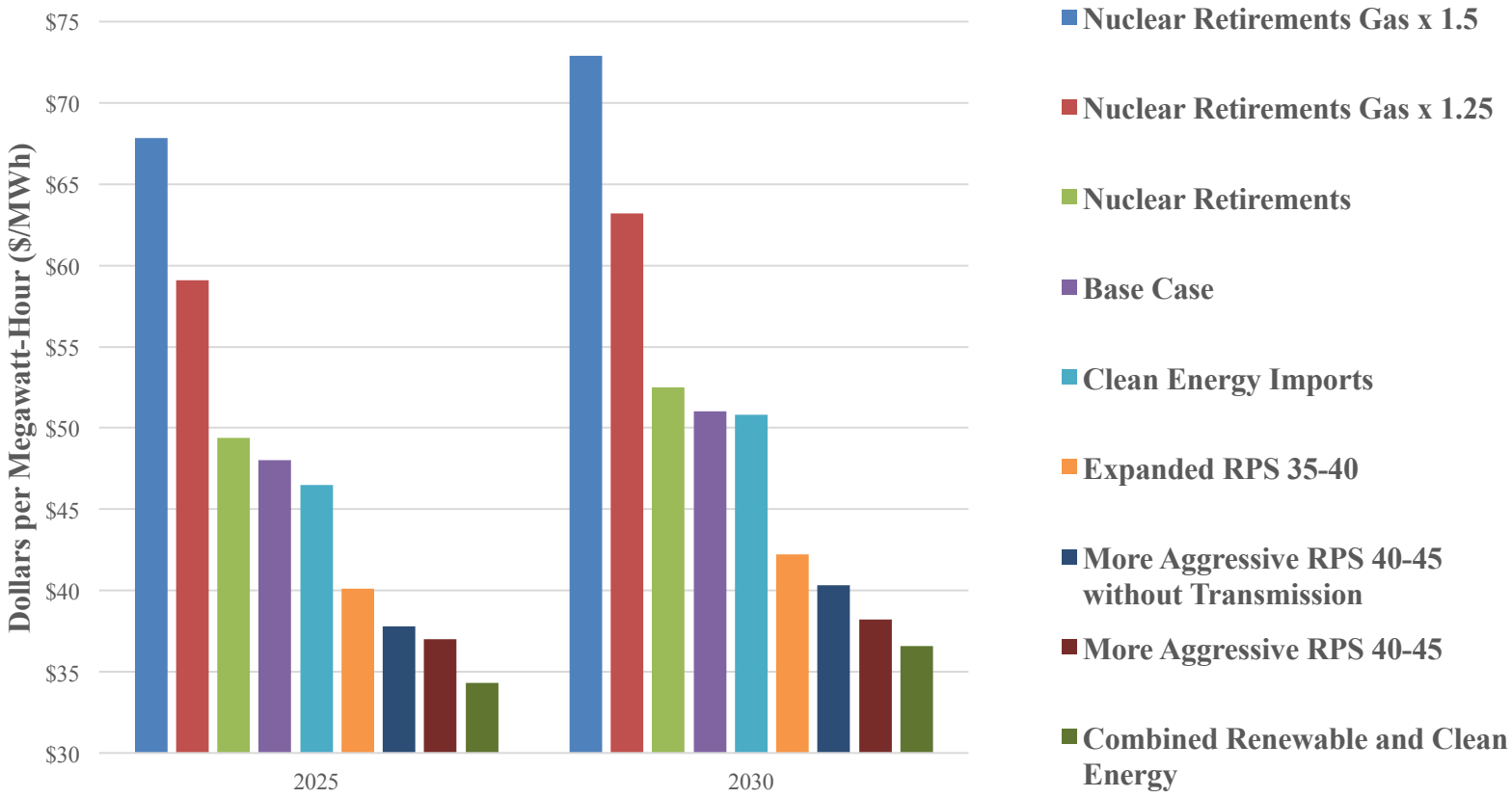
Scenario Design - Assumptions

Scenario			Generation		Transmission	Imports
↓			Retirements	New Entry		
				2025	2030		
Base Case			FCA 10	FCA 10 + 1,155 MW On-Shore Wind + 277 MW Solar PV + 30 MW Off--Shore Wind + 2,194 MW Natural Gas	FCA 10 + 1,155 MW On-Shore Wind + 402 MW Solar PV + 30 MW Off--Shore Wind + 3,694 MW Natural Gas	ISO-NE RSP List (*June 2016 PAC Transmission Transfer Capabilities Update*)	Historical trends continue over existing ties
Alternative Scenarios ***Inherit Assumptions from Base Case*	**Expanded RPS**	35% by 2025 40% by 2030		+2,750 MW On-Shore Wind +600 MW Solar PV +1,500 MW Off-Shore Wind +1,694 MW Natural Gas	+3,575 MW On-Shore Wind +1,000 MW Solar PV +2,000 MW Off-Shore Wind +1,694 MW Natural Gas	+ 2,400 MW HVDC	
		40% by 2025 45% by 2025		+4,250 MW On-Shore Wind +1,000 MW Solar PV +2,000 MW Off-Shore Wind +1,694 MW Natural Gas	+5,500 MW On-Shore Wind +1,250 MW Solar PV +2,500 MW Off-Shore Wind +1,694 MW Natural Gas	+ 3,600 MW HVDC	
	Clean Energy Imports			+1,694 MW Natural Gas	+ 2,694 MW Natural Gas	+1,000 MW HVDC	+1000 MW CSO (7.9 TWh/year)
	Nuclear Retirements		3,350 MW Nuclear units retire by 2025	+ 5,194 MW Natural Gas	+ 7,194 MW Natural Gas		
	Combined Renewable and Clean Energy			+4,250 MW On-Shore Wind +1,000 MW Solar PV +2,000 MW Off-Shore Wind +1,694 MW Natural Gas	+5,500 MW On-Shore Wind +1,250 MW Solar PV +2,500 MW Off-Shore Wind +2,194 MW Natural Gas	+3600 MW HVDC +1000 MW HVDC	+1000 MW CSO (7.9 TWh/year)
	No Transmission			+4,250 MW On-Shore Wind +1,000 MW Solar PV +2,000 MW Off-Shore Wind +1,694 MW Natural Gas	+5,500 MW On-Shore Wind +1,250 MW Solar PV +2,500 MW Off-Shore Wind +1,694 MW Natural Gas	~~+3600 MW HVDC~~	

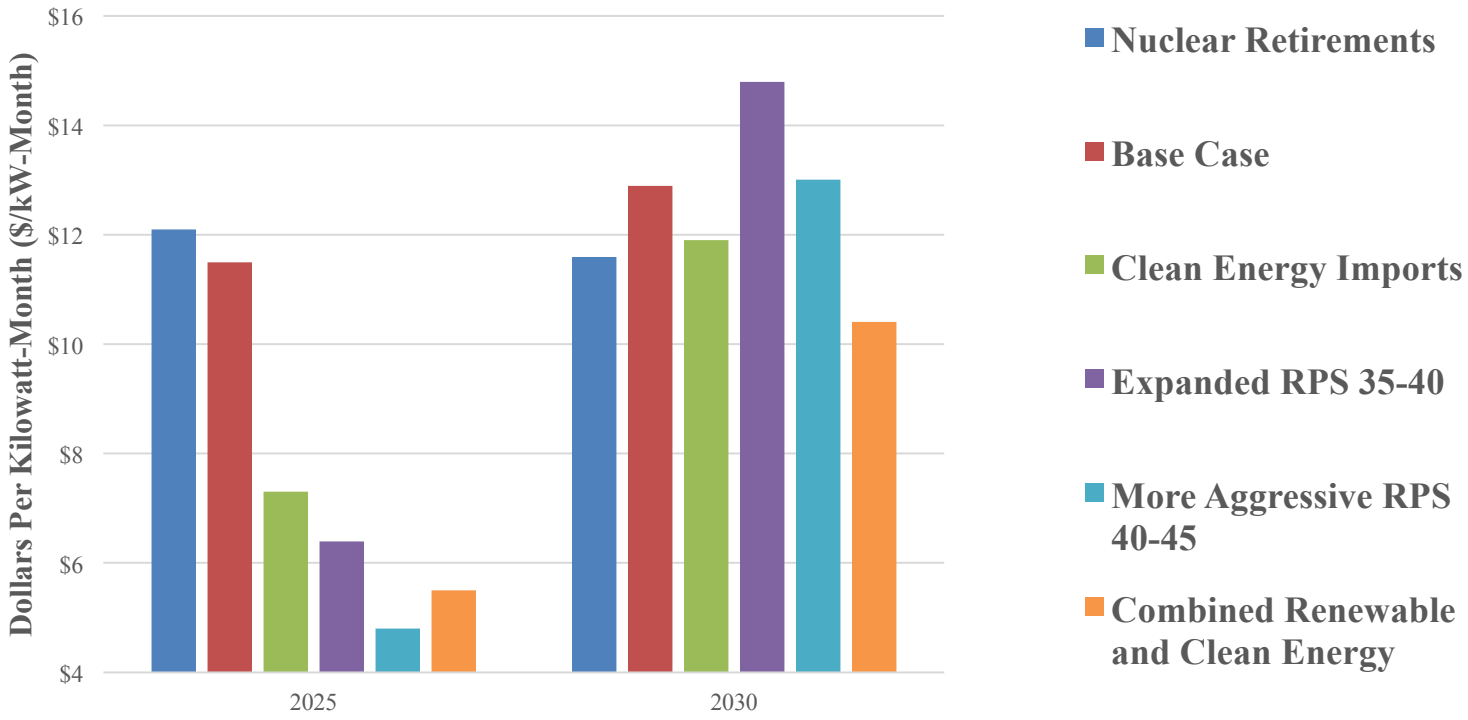
Scenario Design: Assumptions

Scenario	
Base Case	
1: Expanded RPS 35%-40% (“Expanded”)	
2: More Aggressive RPS 40%-45% (“Aggressive”)	
3: Clean Energy Imports (“Imports”)	
4: Combined Renewable and Clean Energy (“Combined”)	
5: Nuclear Retirements (“No Nuclear”)	
6: Expanded RPS Without Transmission (“No Transmission”)	

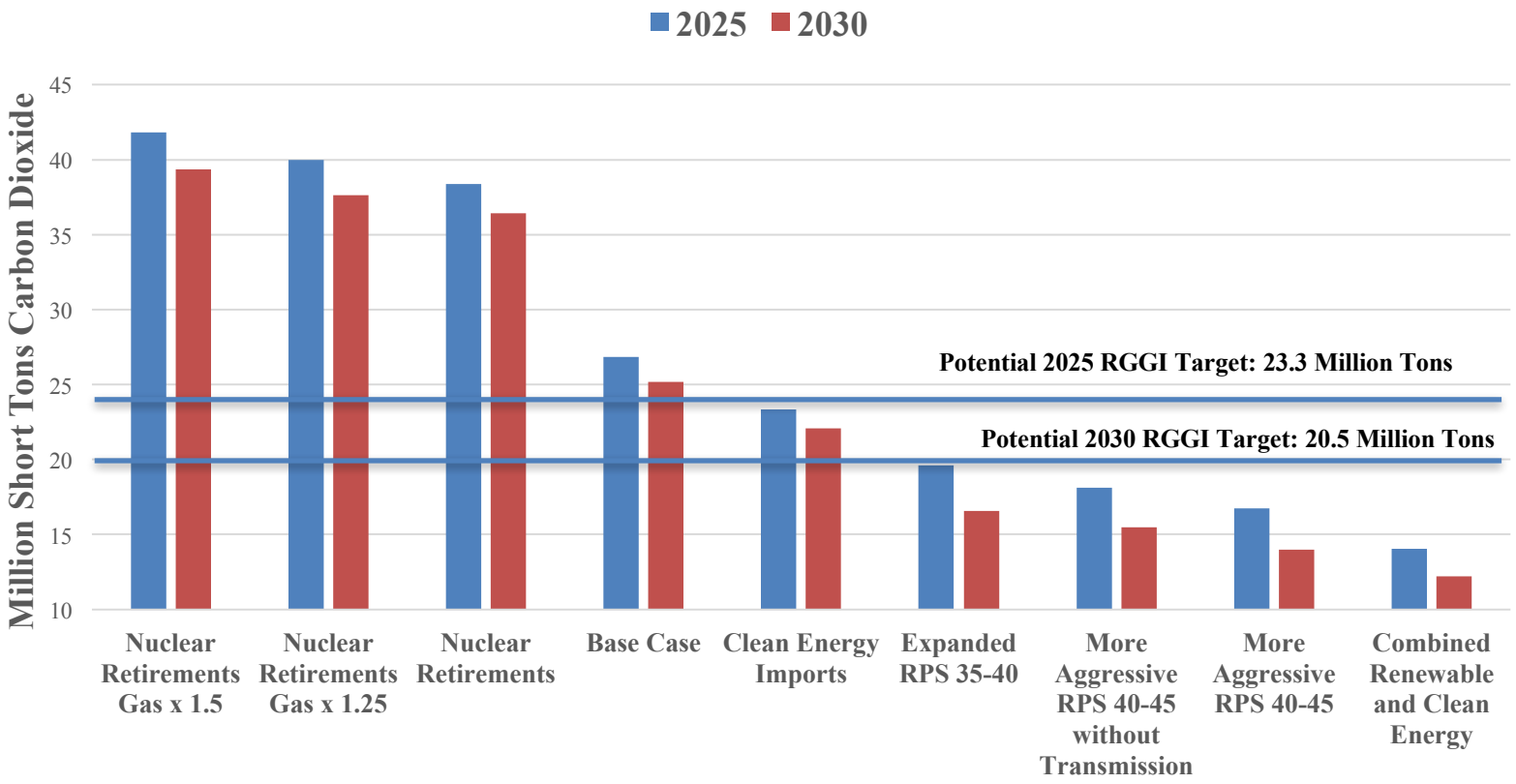
Forecasted Energy Market Prices



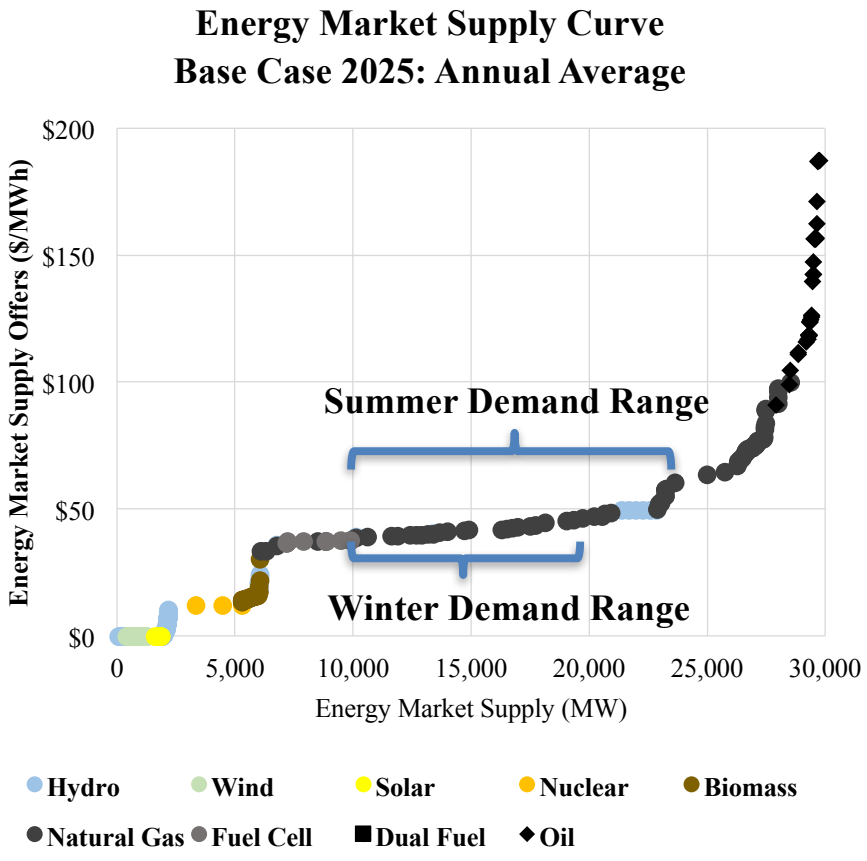
Forecasted Capacity Market Prices

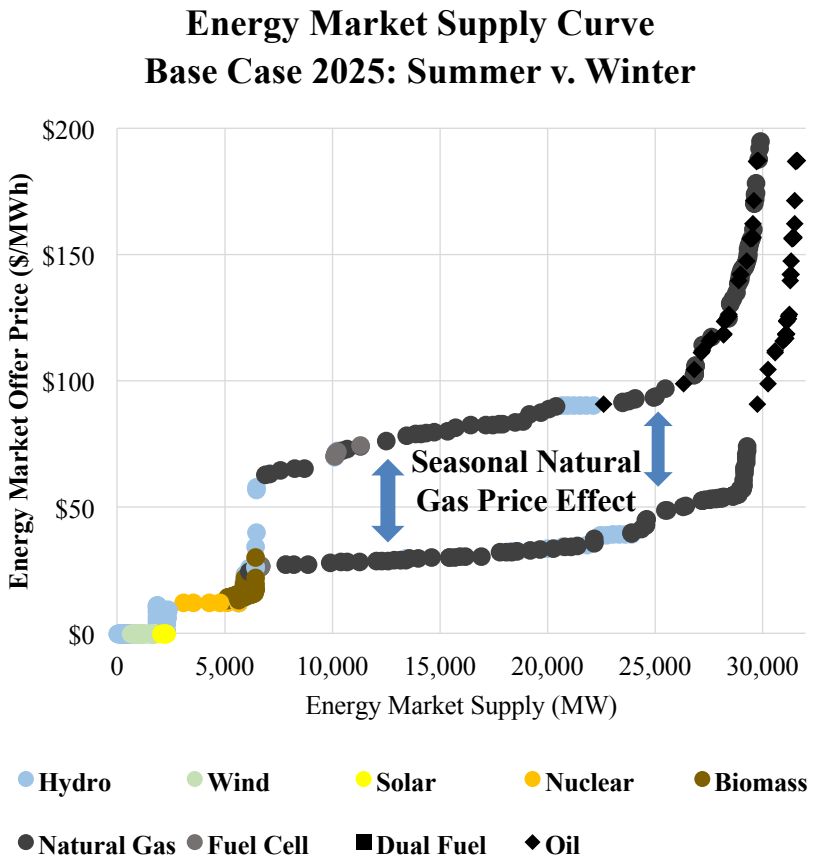


Forecasted Power Sector Carbon Emissions

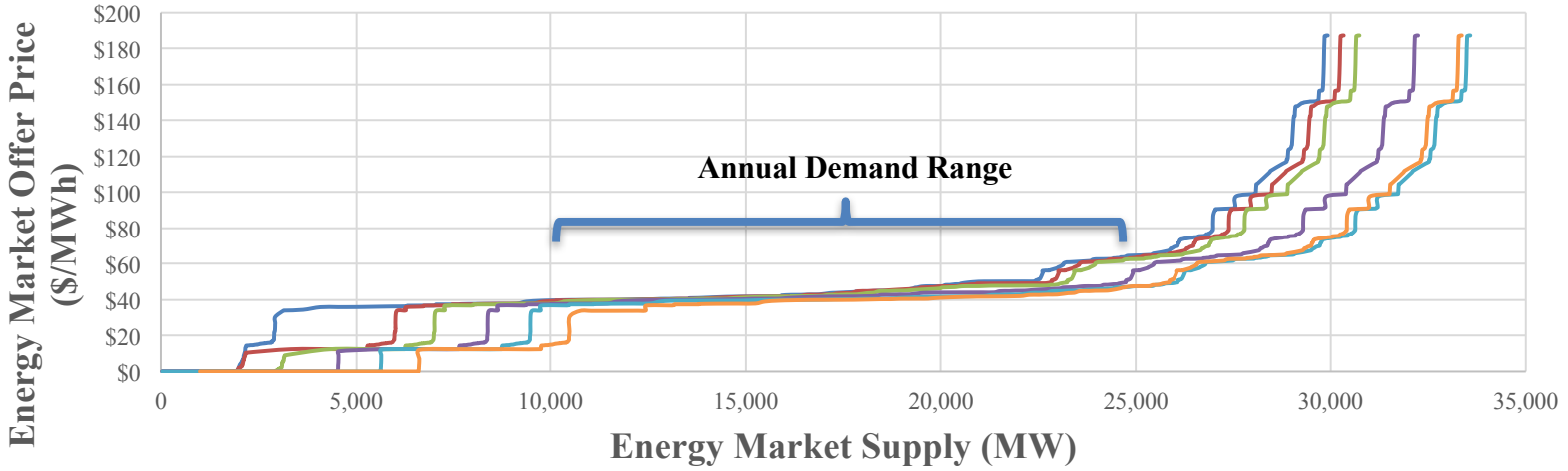


Energy Market Competitive Dynamics

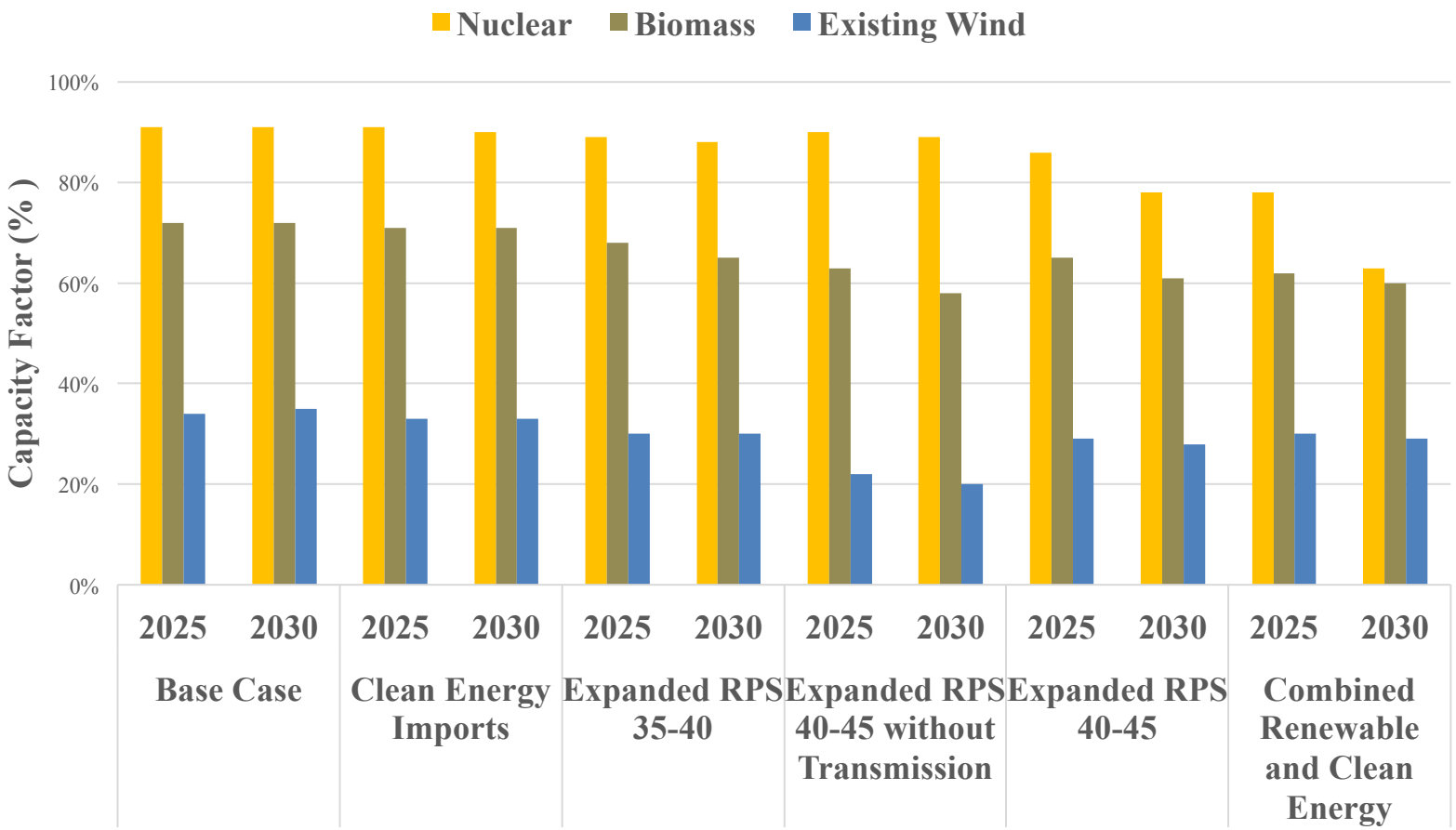




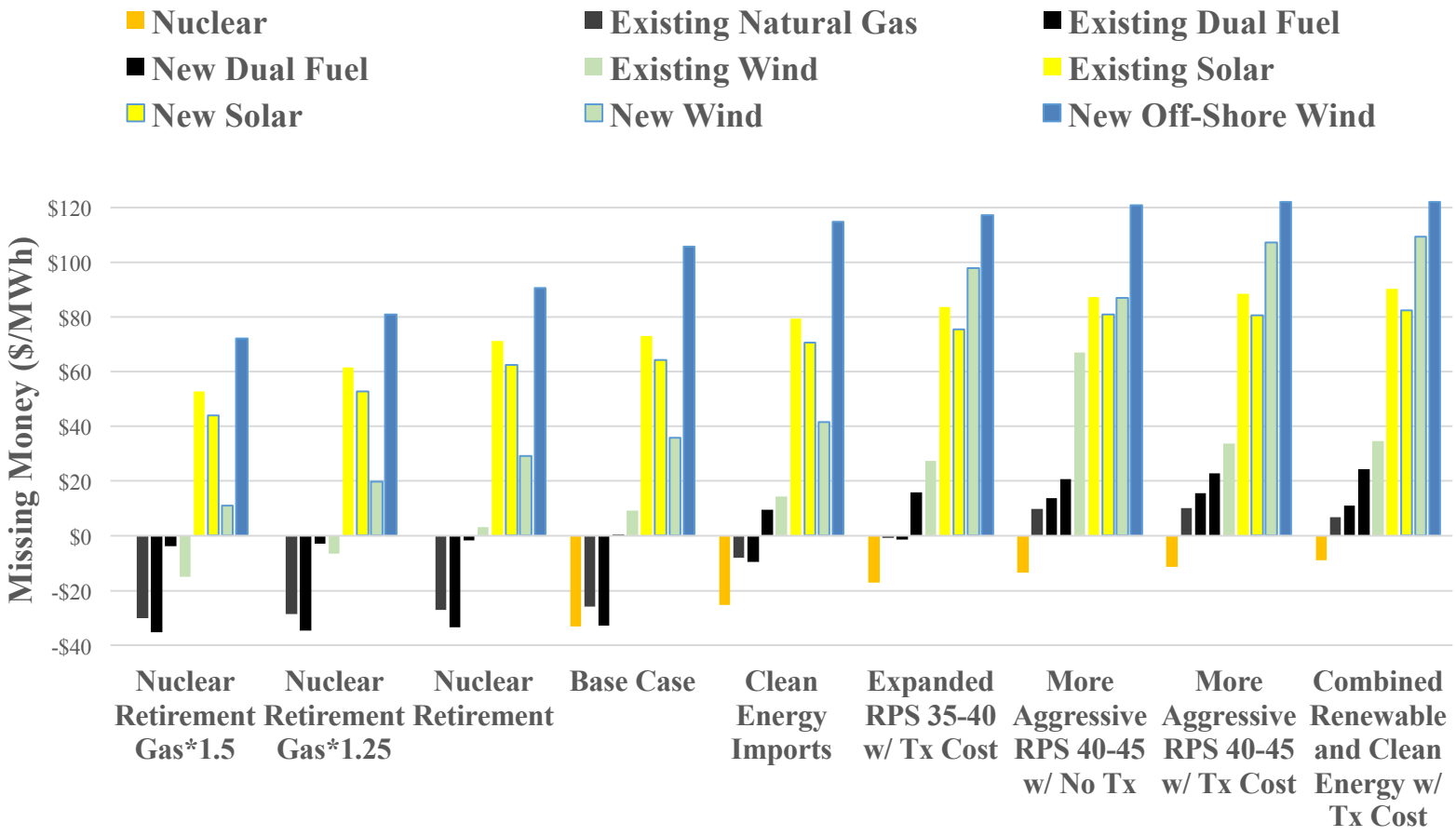
Scenario Analysis and Energy Market Competition



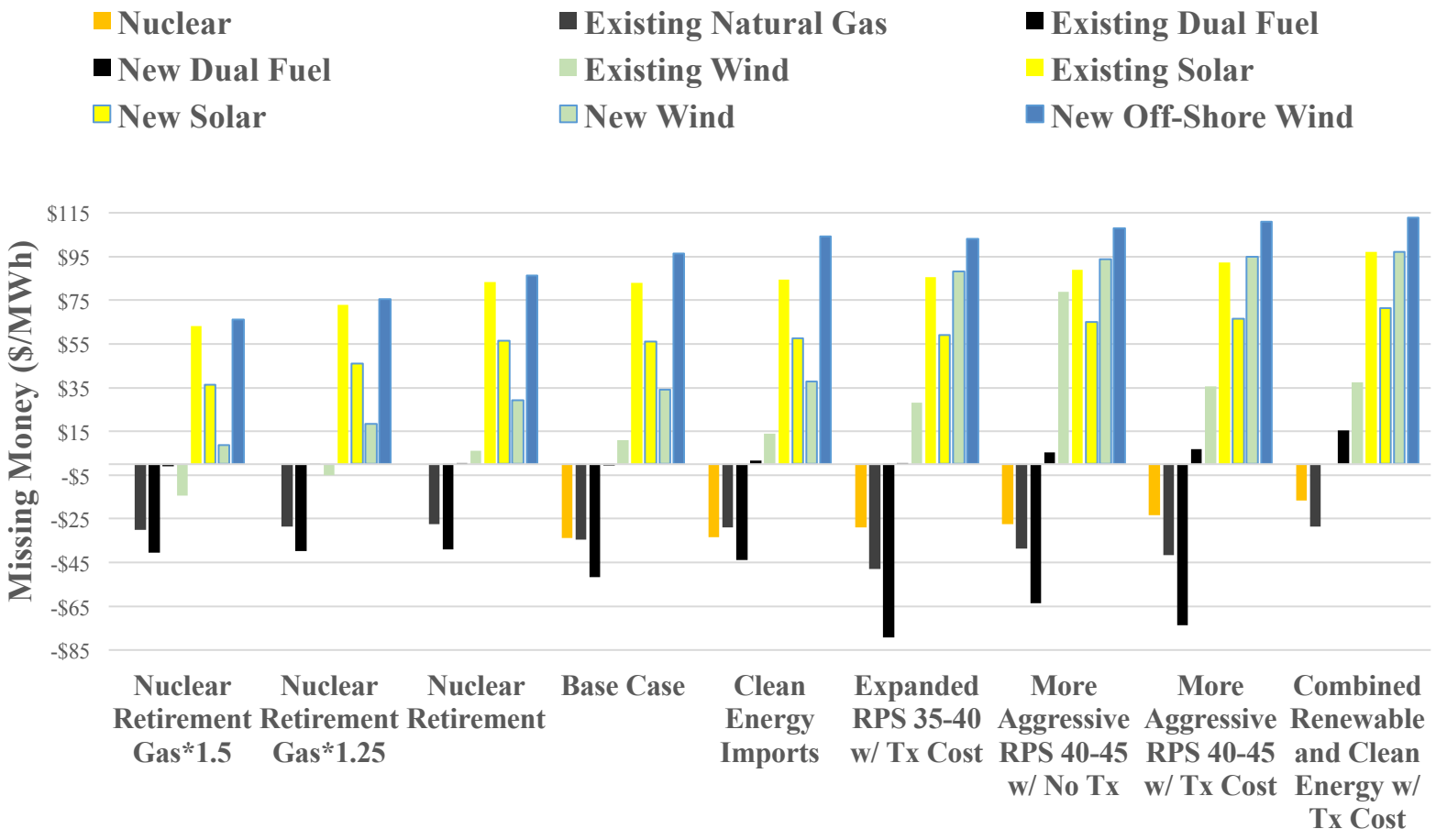
Excess Supply Effect on Production



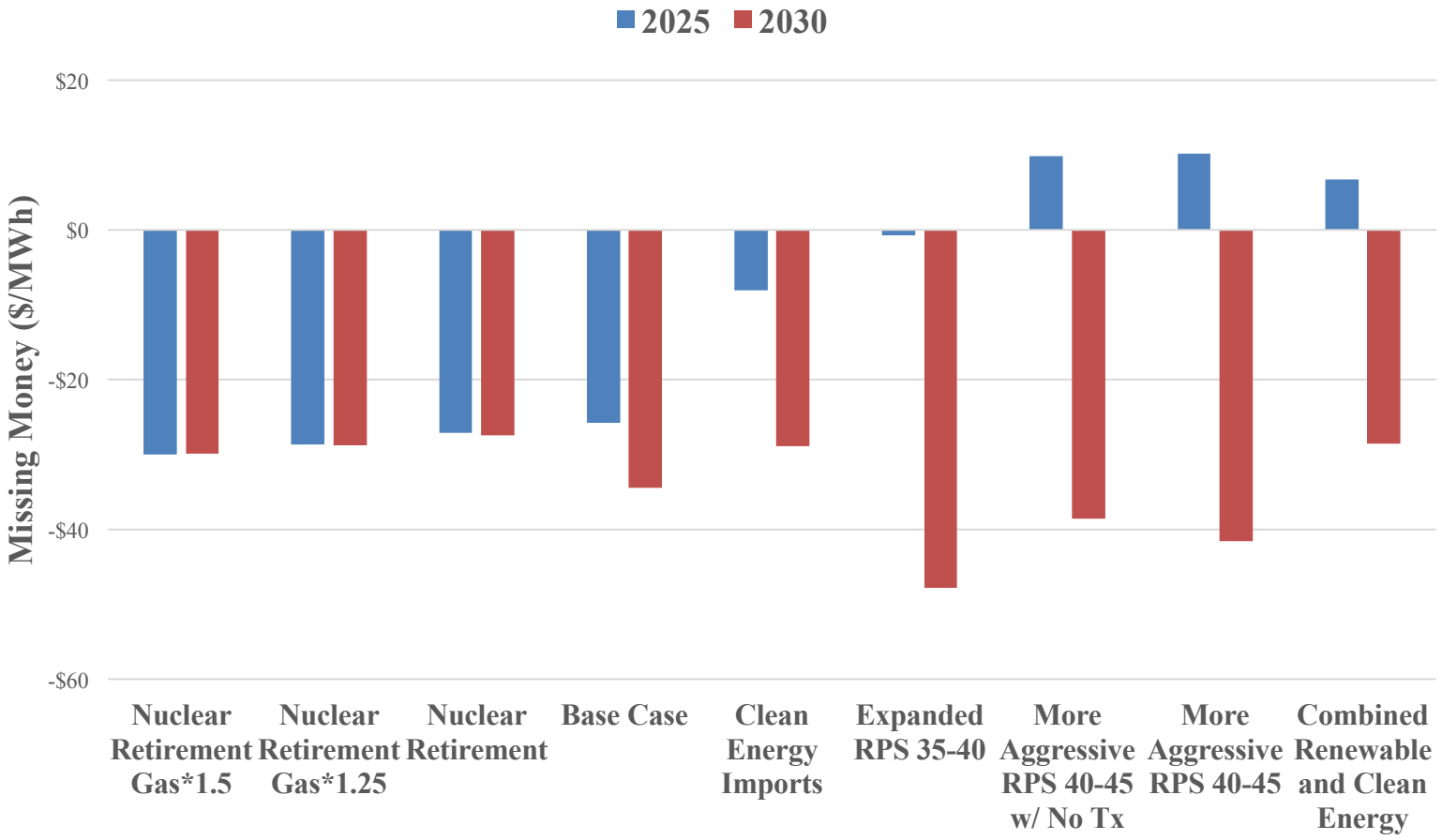
Estimated Missing Money: Selected Resource Types - 2025



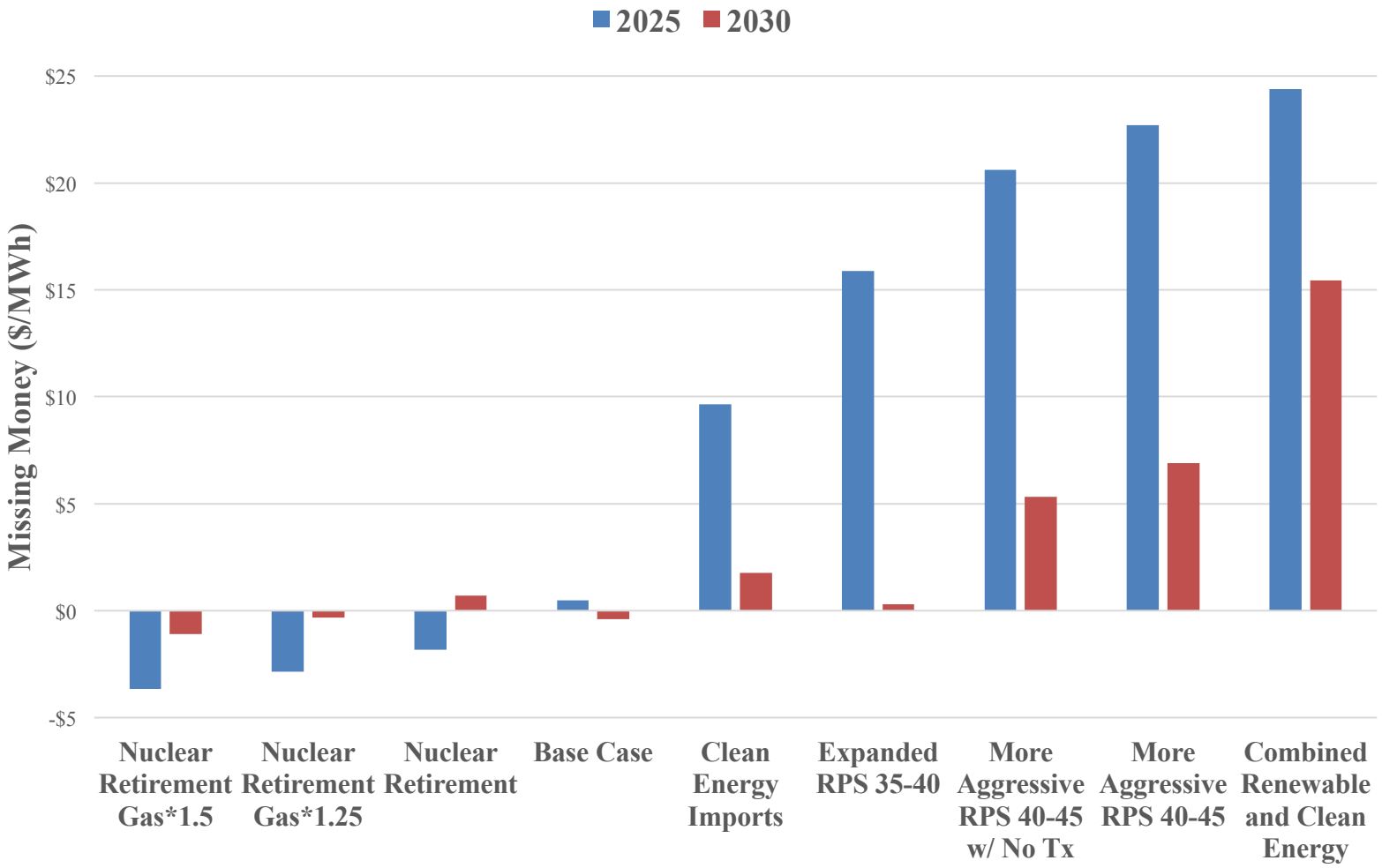
Estimated Missing Money: Selected Resource Types - 2030



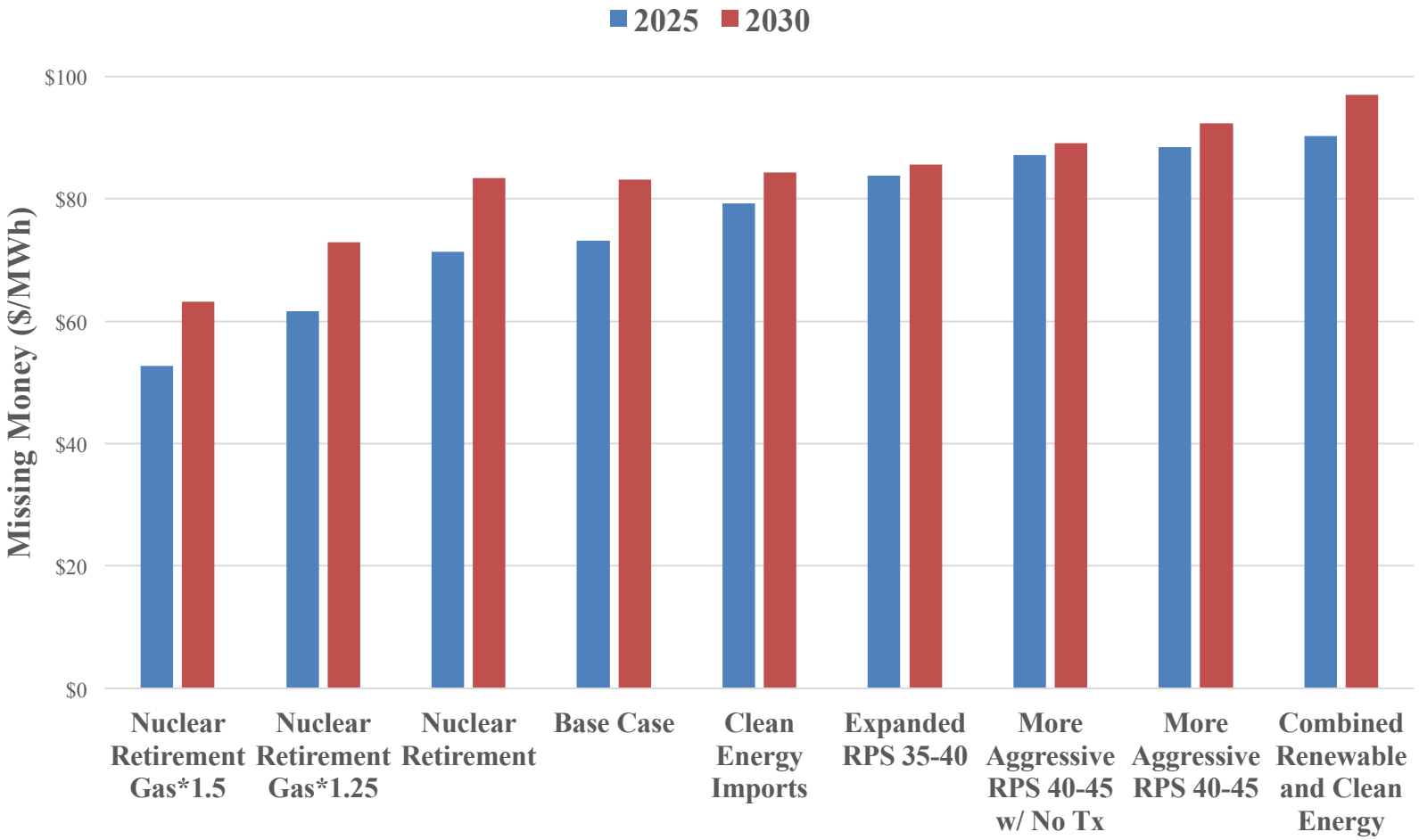
Estimated Missing Money: Existing Natural Gas



Estimated Missing Money: New Dual Fuel



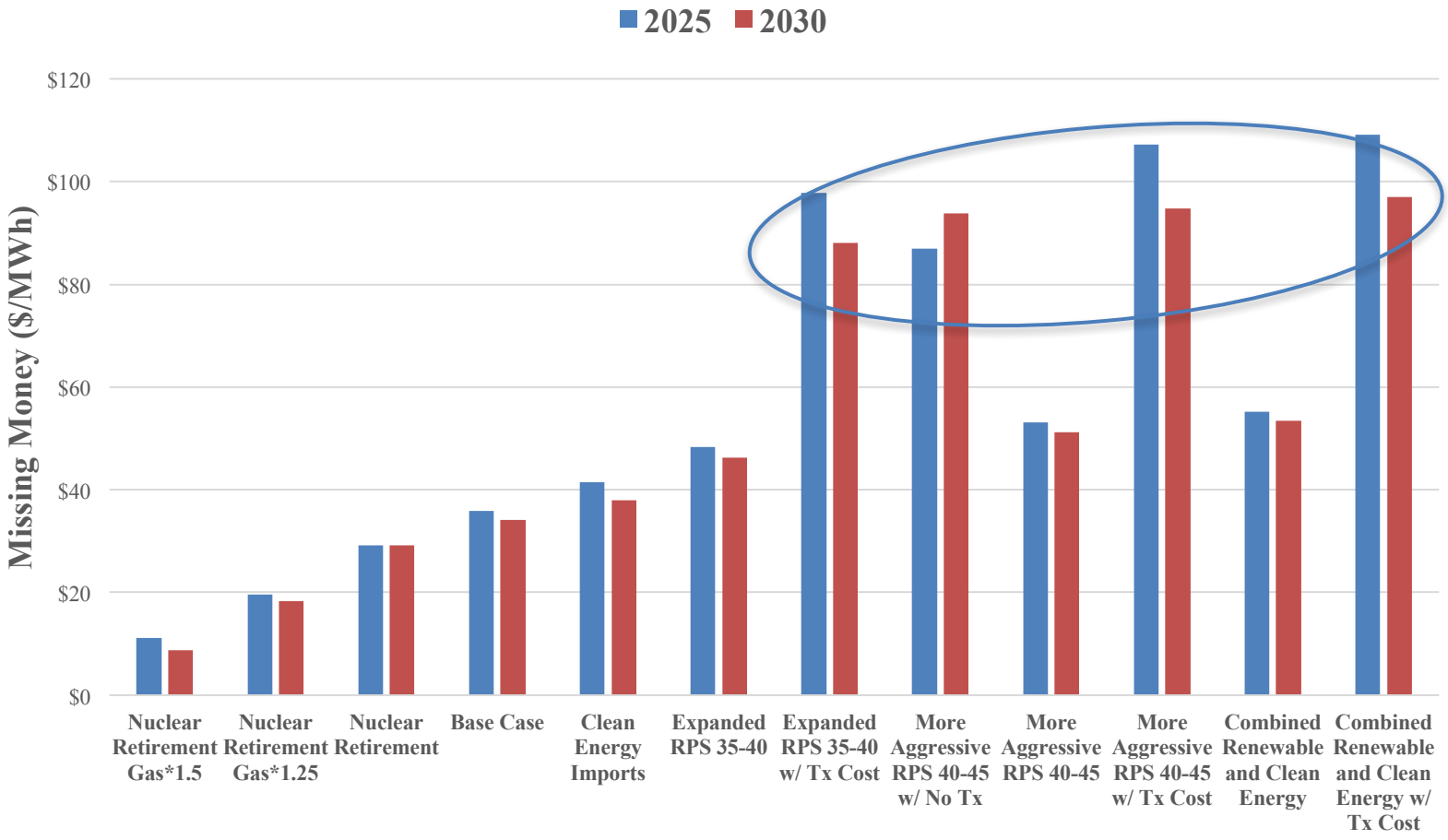
Estimated Missing Money: Existing Solar PV



Expanded RPS Scenarios and Treatment of Transmission for New On-Shore Wind Resources

Scenario:	Transmission for Deliverability	Assumption of Transmission Costs Responsibility
Expanded RPS 35%-40%	Included in the Model (assumes adequate transmission has been built), Enabling Renewable Energy Delivery	Outside of the Markets as an Elective Transmission Upgrade ("ETU") or Public Policy Project
		Paid for by New On-Shore Wind Resources in their interconnection agreements
More Aggressive RPS 40%-45%	Included in the Model (assumes adequate transmission has been built), Enabling Renewable Energy Delivery	Outside of the Markets as an ETU or Public Policy Project
		Paid for by New On-Shore Wind Resources in their interconnection agreements
More Aggressive RPS 40%-45% without Transmission	Not modeled, resulting in Congestion and Curtailments	None

Estimated Missing Money: New On-shore Wind Resources



Phase I: Scenario Analysis Observations

1. **When the LEI model adds *new* renewable generating resources or additional clean energy imports to the New England system with zero or very low marginal costs, those added resources have the effect of decreasing the amount of money that all resources earn from New England's capacity and energy markets.**

2. **Under Base Case load conditions, if the region adds more than 25,000,000 MWh (annually) of *new* renewable resources and/or clean energy imports by 2025, *existing* renewable and clean energy resources produce less power. The assumed load forecast in all scenarios includes regional energy efficiency programs and distributed generation impacts consistent with the 2016 ISO-NE Capacity Energy Loads and Transmission ("CELT") Report's load forecast net of passive demand resources and behind-the-meter solar photovoltaics.**

3. **In the Base Case, if New England maintains *current* RPS targets and does not add transmission for new on-shore wind, the modeling shows that there will not be enough renewable resources to satisfy the states' aggregated RPS targets in 2025 and 2030.**

4. **If New England does not build new transmission to allow *new* on-shore wind resources to move power to population centers, both *new and existing* on-shore wind resources will operate less often and earn less revenue in 2025 and 2030.**

5. **Under every hypothetical scenario, LEI's analysis projects that nuclear units, existing oil combustion turbines, oil internal combustion turbines, oil steam, and pumped storage remain profitable in 2025 and 2030.**

6. **If New England's nuclear resources retire and/or if New England has only enough renewable resources to meet current RPS levels, New England's emissions will increase significantly.**

7. **Different types of renewable and clean energy resources have different effects on wholesale electricity costs and emissions.**

NESCOE welcomes from market participants or others any facts or data that clarify, correct, or should be considered in reviewing the study results

Questions?

More information is available at nescoe.com

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