POTOMAC ECONOMICS

MMU Analysis of Capacity Market Structure

Presented by:

Joe Coscia
NYISO Market Monitoring Unit
Potomac Economics

May 22, 2025

Introduction

- NYISO's ongoing Capacity Market Structure Review seeks to examine the current market structure and explore alternatives
- Stakeholders have highlighted concerns with uniform capacity prices with reference points based on the Net CONE
- The MMU performed quantitative analysis of alternative approaches for determining capacity prices (e.g., a bifurcated market or reference point based on going-forward costs)
  - This presentation presents our methodology, assumptions and initial results
  - We plan to return to a future meeting with additional cases or refinements based on stakeholder feedback

Stakeholder Concerns with Uniform Pricing

- Our goal is to explore stakeholder concerns related to the market's role in cost-effectively meeting reliability requirements:
  - Is there still value in a market designed to attract new entry, when in practice new investment is driven by state contracts?
  - Do uniform Net CONE-based demand curves result in excessive rents to existing resources at consumers' expense?
  - Would a capacity market that is bifurcated or designed only to 'retain' improve market efficiency and/or consumer costs?

- Our analysis is not designed to consider approaches in which the capacity market is the primary means of procuring state policy resources

Outline of Presentation

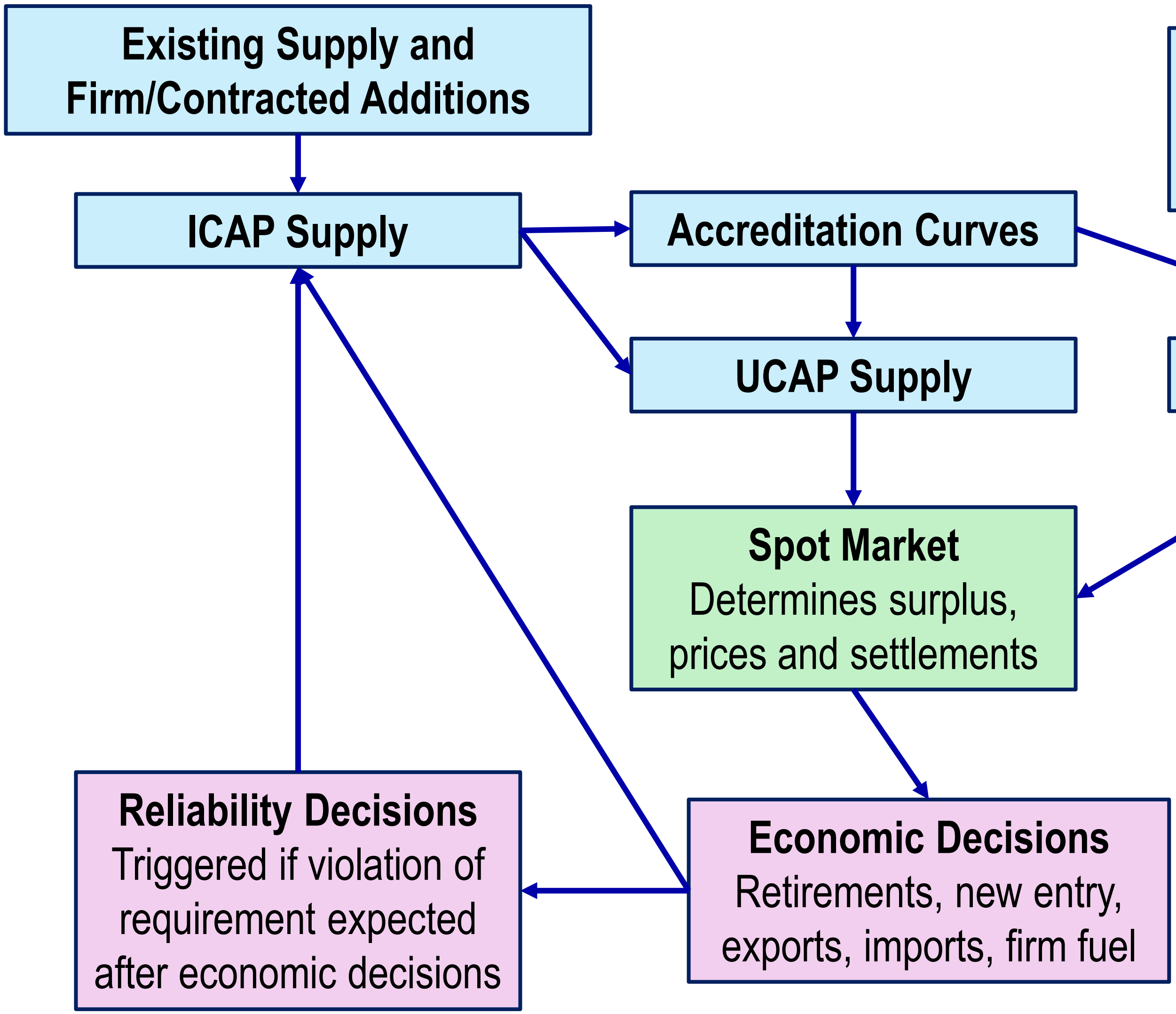
- **Modeling Framework**
- **Base Case Assumptions**
- **Initial Results**
  – Detailed case walkthrough
  – Comparative summary of cases
- **Observations and next steps**

Modeling Framework

Overview of Modeling Approach

- 20-year simulation of capacity market outcomes (2026-2045)
- Calculate zonal surplus, prices and settlements in each year using spot market demand curves
- Assume significant new entry of renewables and storage driven by state contracts
- In each year, economic decisions of existing and new supply are made based on current and expected future capacity prices
  - The incentives for these decisions are affected by the choice of market structure and reference point values in each case

Quantitative Modeling Framework



Economic Retirement Decisions

- Generators retire if the NPV of expected revenues minus going-forward costs (GFCs) is negative
  - May temporarily accept losses due to expected future profits
- GFCs represent average revenues needed to maintain the unit in good repair, including periodic capex
  - Retirement amounts may represent a combination of economic retirement and performance degradation with low revenues
- In practice, GFCs may include only limited capex in most years and periodic major costs driven by equipment failures or end of life

Economic New Investment Decisions

- Economic new entry occurs when expected future revenues exceed the potential project's levelized net cost of new entry (Net CONE)
  - Economic entrants are modeled with merchant cost of capital required to justify entry despite market risk
- Features of forward-looking decision model:
  - Price expectations formed based on outlook for next decade (simulate future prices based on information available)
  - Imperfect foresight (future load conditions may differ from expectation, future economic entry and retirements are unknown)
  - Lag occurs between decision and entry due to development lead time (2 years for battery, 3 years for GT/DEFR)

External Market Transactions

- Modeled external interfaces include: ISO-NE, PJM, IESO, Quebec, Linden VFT, Neptune, Cross Sound Cable, CHPE
- External area prices represented by a base price assumption in each year/season and demand curve slope
- Capacity imports/exports occur until external area and NYISO prices converge or interface import/export limits are reached
- Imports under long term contracts modeled as fixed
- PJM import quantities must transact annually, other markets may vary seasonally

Firm Fuel Decisions

- NYISO MC approved modifications to accredit fossil generators based on winter firm fuel status in April 2025
  - NYSRC intends to model winter fuel availability in upcoming IRM studies, likely causing non-firm CAFs to decline over time
- Gas-only generators modeled as annually deciding firm gas transportation quantity based on revenues from increased UCAP
  - Firm CAF assumed to be 100% in all seasons; non-firm CAF assumed to be 100% summer and 0% winter
  - Cost of firm gas transportation modeled as an upward-sloping supply curve

Reliability Decisions

- Each year after determining economic entry and retirement decisions, look ahead to identify reliability needs in coming years
  - Reliability need is indicated by expected shortfall of UCAP Supply relative to UCAP Requirement
- Identify the lowest-cost new build candidate that can address the need, and trigger a build considering the solution's lead time
  - If a new solution cannot be built in time to address the need, any existing unit seeking to retire economically is retained under contract
- Resources under reliability contracts receive contract payments for the difference between their capacity revenues and CONE or GFC
  - Contracted revenue is reflected in cost of capital when estimating CONE

Market Design Assumptions

- The simulated timeframe includes major anticipated system changes, including the Long Island PPTN projects and the transition to a winter-peaking system
- We assume the following to produce sensible results as these changes take place:
  - Implementation of seasonal requirements and accreditation, based on draft proposals from NYISO's *Winter Reliability Capacity Enhancements* project
  - Conversion of the G-J Locality to a G-K Locality following completion of the Long Island PPTN

Limitations of Analysis

- A key advantage of uniform pricing is to incentivize beneficial actions when prices indicate scarcity
  - Planners may have limited information or control over decisions by dispersed suppliers and consumers

- Examples of decisions not included in our model framework:
  - Changes in demand response program participation
  - End user behavior and equipment choices (managed EV charging, heat pump technology, smart heating/cooling, etc)
  - Upgrades and DMNC improvements of existing units
  - Prevention of forced outages
  - Amount, design, and BTM supply of large loads

Cases

Technology Scenarios

- Cases have the following features:
  - **Technology Scenario**
  - **Market Structure**
  - **Reference Point Basis**
  - **Scenario Assumptions**
- The analysis compares outcomes for a set of Cases combining alternative Technology Scenario, Market Structure and Reference Point Basis for a common set of assumptions

Technology Scenarios

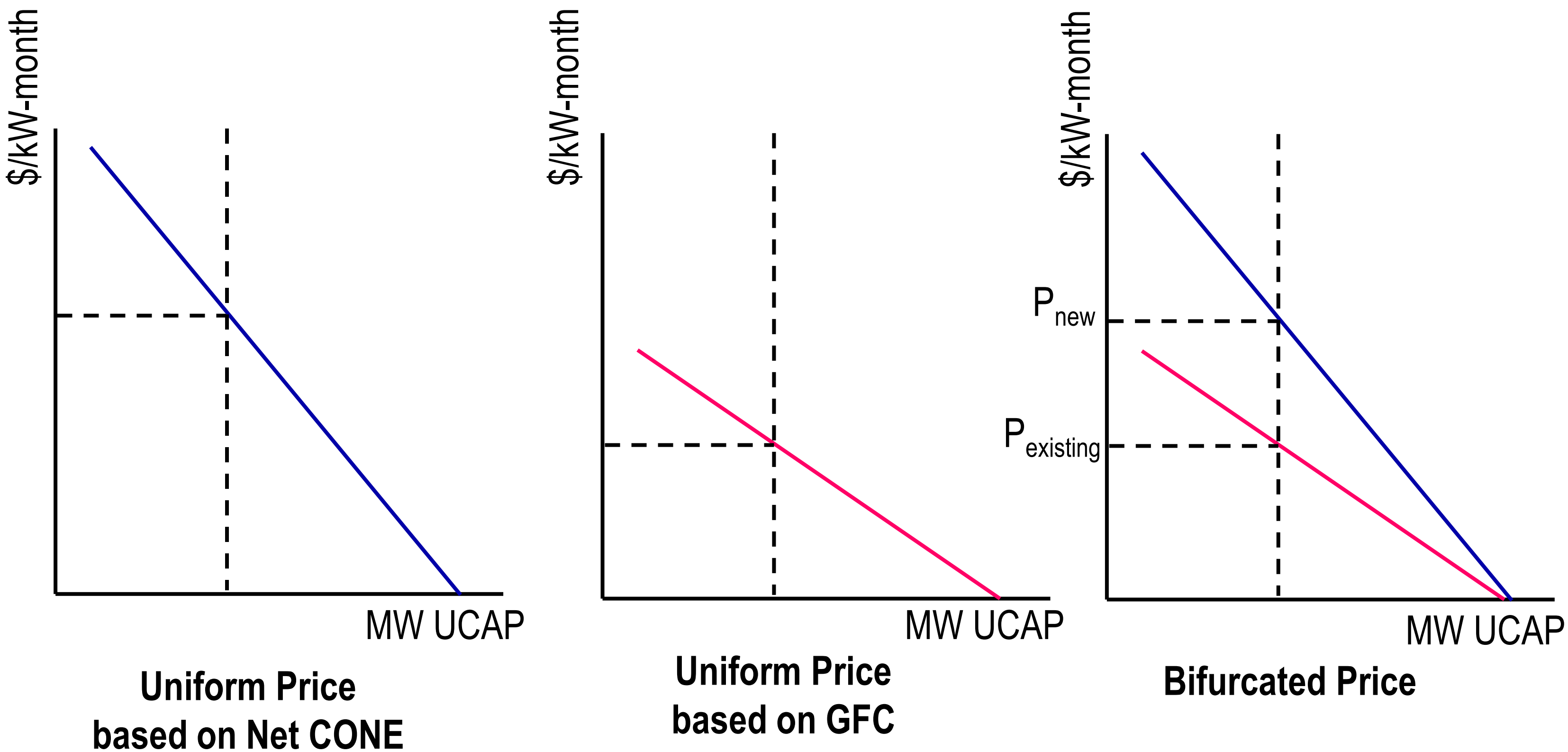
- **Zero by 2040**: all existing fossil units must retire by 2040, DEFR peaking technology assumed to be commercially available
- **DEFR Delayed 1**: existing fossil units may remain in service for resource adequacy, only zero-emissions built for additional RA needs
- **DEFR Delayed 2**: existing fossil and new GT units may be built or remain in service for resource adequacy
- These scenarios are designed to examine how alternative market designs could perform under a range of techno-economic conditions, **not** to endorse or predict any policy decisions

Market Structure and Reference Point Scenarios

- **Market Structure: Uniform vs. Bifurcated**
  - Uniform: a single set of demand curves and reference points for each zone (status quo)
  - Bifurcated: a separate demand curve with the same UCAP requirements and a lower reference point is used for settlements of resources that exist before the 2029-2033 DCR

- **Reference Point Basis Scenarios**
  - Current Approach: Set reference points every 4 years based on lowest-cost feasible option (battery w/ growing duration ⟶ DEFR)
  - Going-Forward Cost (upper end of existing units by zone)
  - Gas Turbine with 20-year amortization

Illustration of Market Structure and Reference Points



Summary of Proposed Cases

Technology Scenario	Market Structure	Reference Point Basis
Zero by 2040	Uniform	Lowest cost allowable build
Zero by 2040	Uniform	GFC
Zero by 2040	Uniform	20-Year GT
Zero by 2040	Bifurcated	Lowest cost allowable build / GFC
DEFR Delayed 1 (no new fossil)	Uniform	Lowest cost allowable build
DEFR Delayed 1 (no new fossil)	Uniform	GFC
DEFR Delayed 1 (no new fossil)	Uniform	20-Year GT
DEFR Delayed 1 (no new fossil)	Bifurcated	Lowest cost allowable build / GFC
DEFR Delayed 2 (new GT allowed for RA)	Uniform	Lowest cost allowable build
DEFR Delayed 2 (new GT allowed for RA)	Uniform	GFC
DEFR Delayed 2 (new GT allowed for RA)	Uniform	20-Year GT
DEFR Delayed 2 (new GT allowed for RA)	Bifurcated	Lowest cost allowable build / GFC

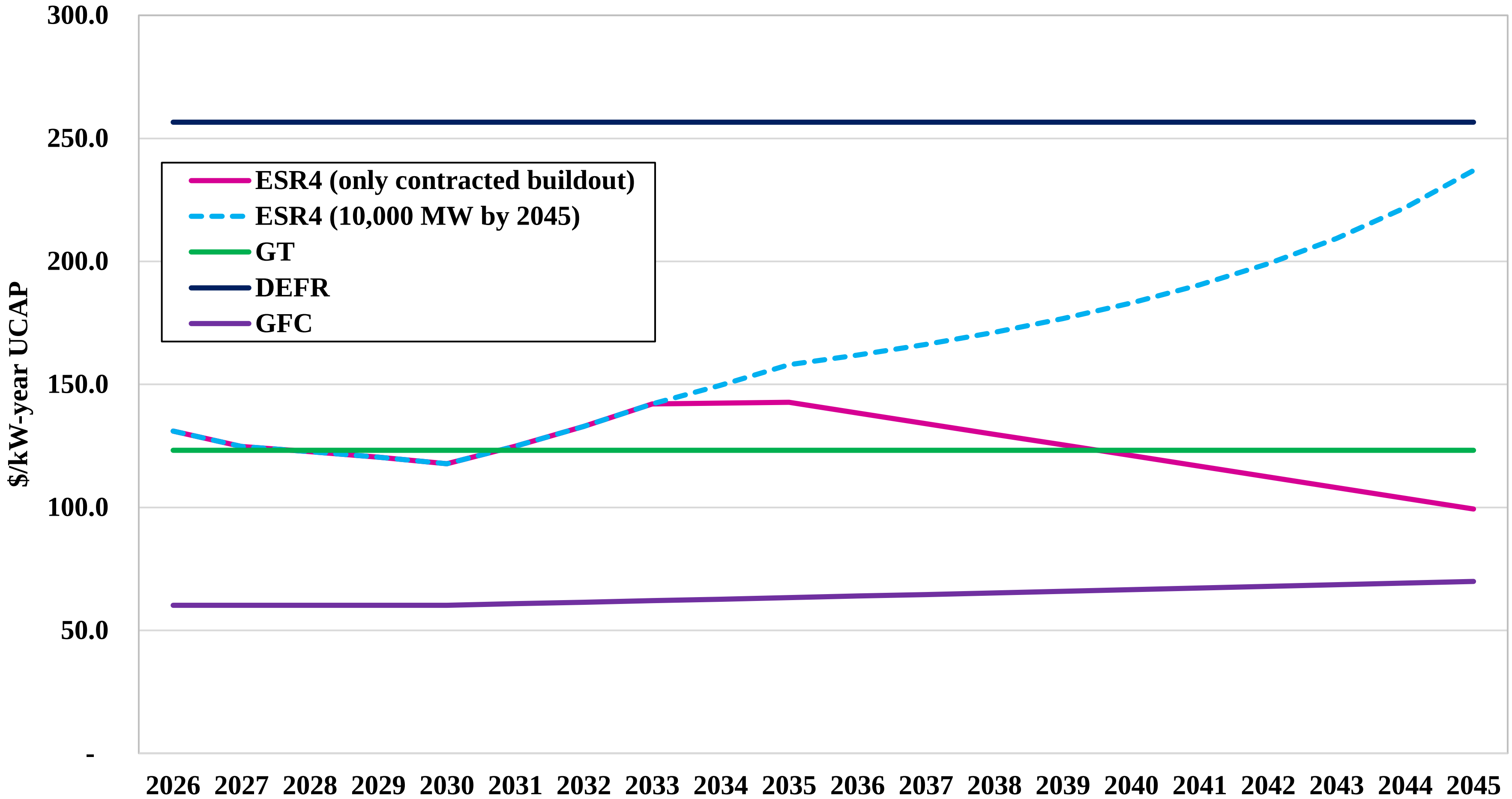
All cases use the current demand curve reference points based on a 2-hour battery before 2029

Initial Base Case Modeling Assumptions

Overview of Base Case Assumptions

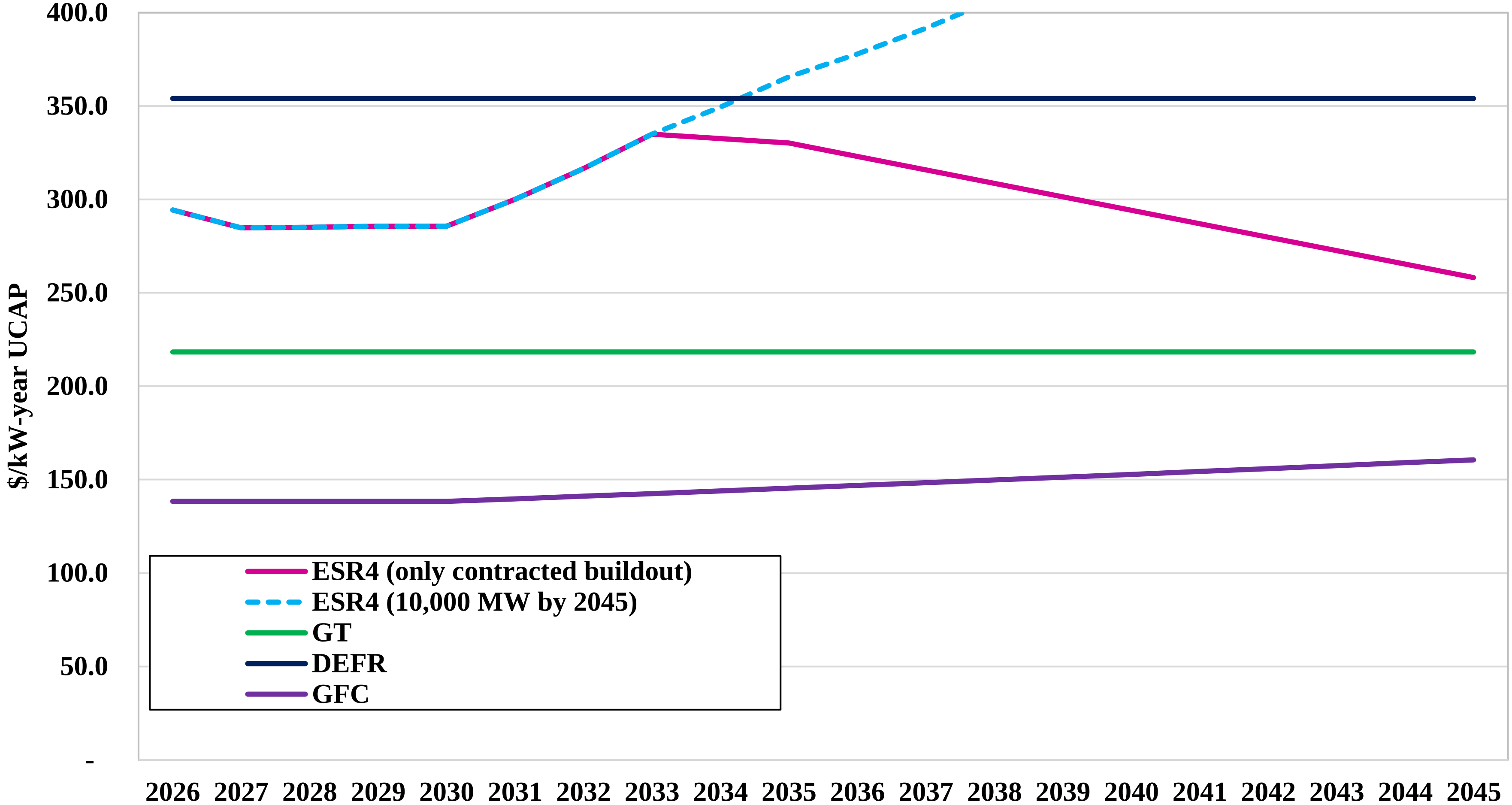
- **Load Forecast**: 2025 Gold Book Baseline
  - 37 GW summer and 44 GW winter peak by 2045
- **Firm Additions/Retirements**: CHPE (2026), LI PPTN (2030), CPNY (2031), NYPA peaker retirements (~400 MW) (2031)
- **Existing Steam Turbine GFCs ($/kW-yr)**: $50 A-F, $55 GHI, $120 NYC, $80 LI
- **External Markets**:
  - transition from recent price levels to Net CONE values by 2035
  - Maximum import/export amounts respect NYCA external ICAP rights and neighboring market limitations

Annual Reference Values (UCAP) – NYCA ($2025)



GFC-based reference value assumed to include 10% adder over actual GFC

Annual Reference Values (UCAP) – NYC ($2025)

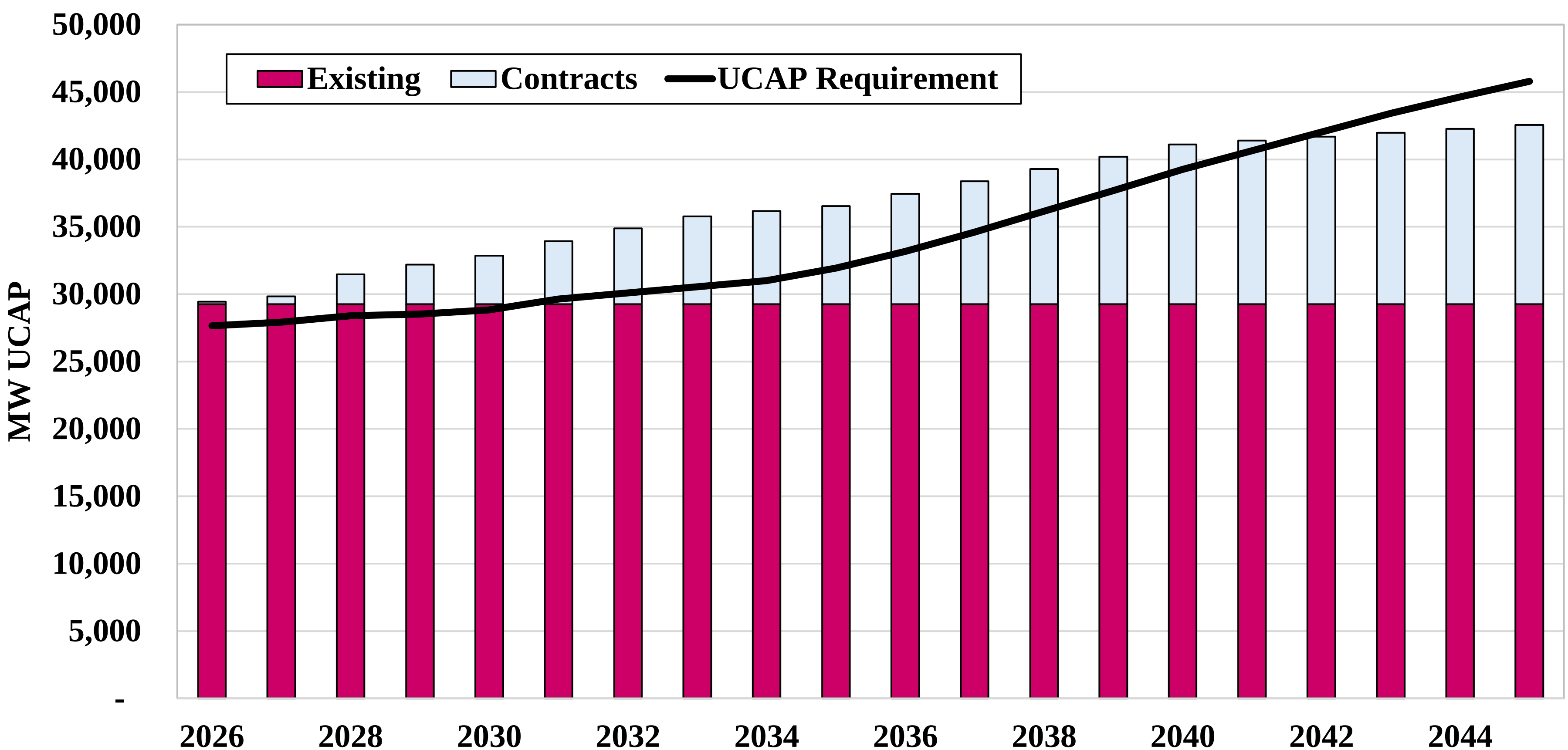


GFC-based reference value assumed to include 10% adder over actual GFC

State Contracted Resources in Base Case

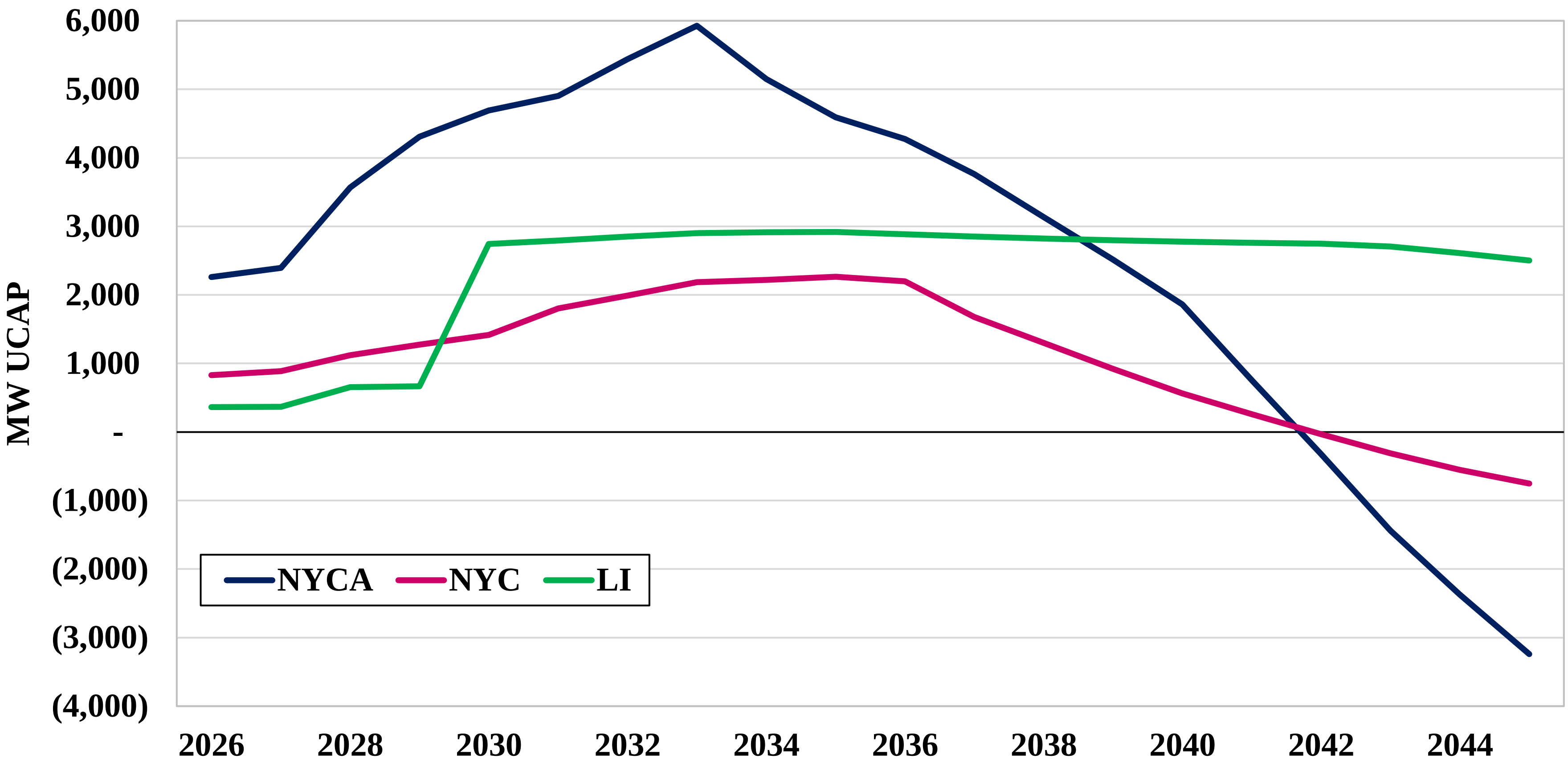
- Entry of state-contracted renewable and zero-emissions capacity to meet 70% of load by 2033 and equivalent of 100% of load by 2040
  - Pattern of new additions based on existing contracts, recent state contracting trends and NYISO Outlook study
- 9 GW offshore wind by 2035
- 6 GW battery storage by 2033
  - Modeled incremental supply-side storage net of ~1,300 MW BTM storage from Gold Book by 2033
  - Includes NYPSC requirements for 600 MW 8-hour storage and minimum 30% in NYC

Net Supply Before Economic Decisions (Winter)



- UCAP supply *before* economic retirement/entry and non-firm imports/exports
  - Supply and requirements are shown here in terms of total ELCC
- State-contracted resources drive large surpluses in next decade
- Load growth outstrips UCAP supply from state-contracted resources in long term

UCAP Surplus Before Economic Decisions



- UCAP surplus *before* economic retirement/entry and non-firm imports/exports
- Entry of new transmission (CHPE, LI PPTN, CPNY) affects near-term downstate surplus
- Includes Neptune and Linden VFT (treated as economic decisions in model)

Results – Detailed Analysis

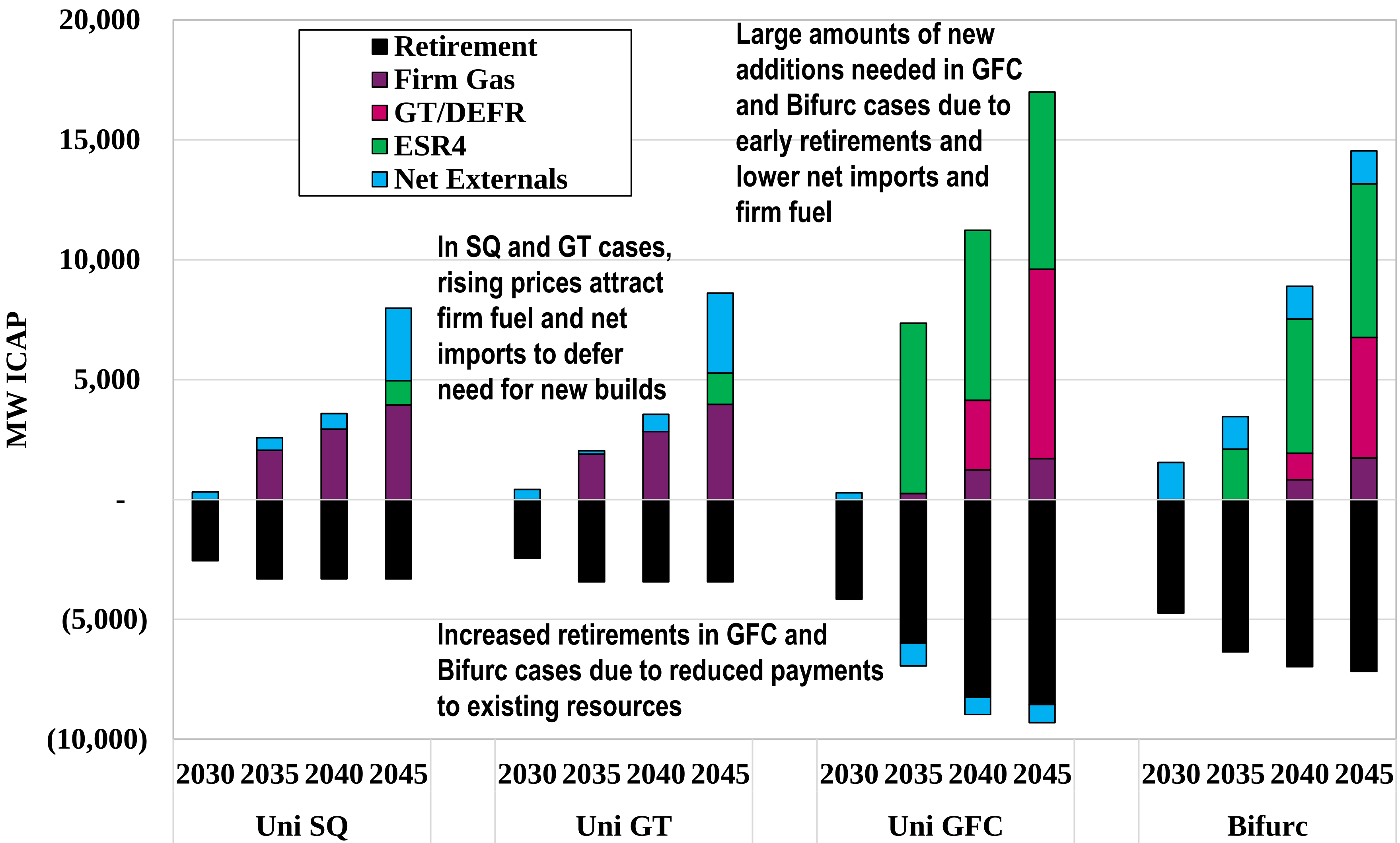
Detailed Results – Baseline DEFR Delay 1 Case

- The following slides present detailed outputs from cases using the **DEFR Delayed 1** technology scenario and baseline load forecast
  - This technology scenario does not allow any new fossil capacity
- The purpose of these detailed results is to provide intuition for the drivers of summary results
- Labeling of cases:
  - Uni SQ: uniform price, lowest cost allowable technology as ref. point
  - Uni GT: uniform price, GT w/ 20-year amortization as ref. point
  - Uni GFC: uniform price, existing unit GFC as ref. point
  - Bifurc: bifurcated with demand curves based on status quo approach for new and GFC for existing

Metrics to Consider

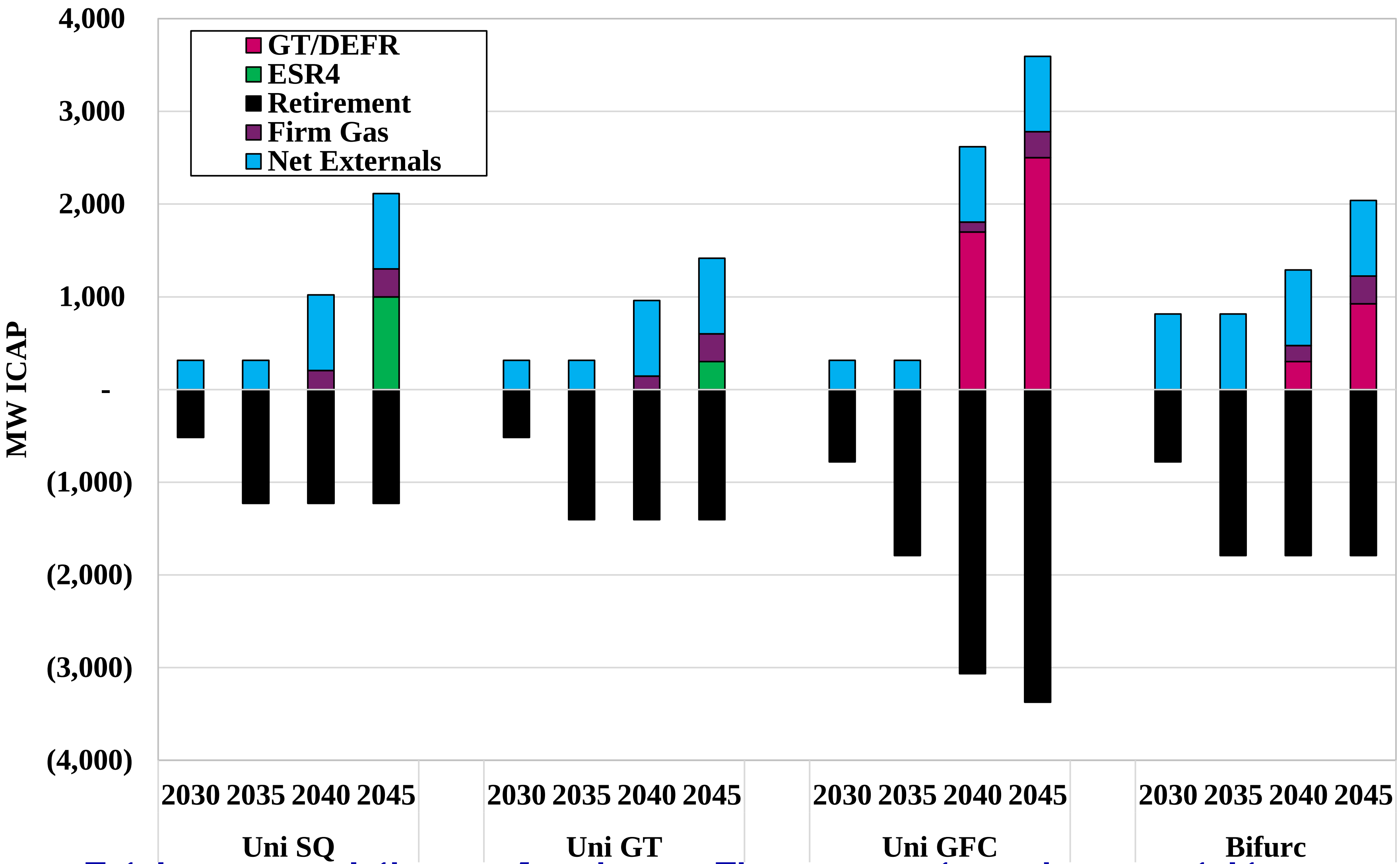
- **Consumer payments**
  - "Net consumer payment": Total capacity market payment net of settlements to state-contracted units and units owned by NYPA and TOs
  - Differences in payment to existing clean resources (hydro, SCRs, wind) and projects built by merchant investment since 2003 capacity market inception
- **Reliability**
  - Surplus relative to minimum reserve margin requirements
- **Investment Costs**
  - Costs of new existing units, new additions, imports and firm fuel in each case (e.g. economic efficiency)

Economic and Reliability Supply Changes, Statewide



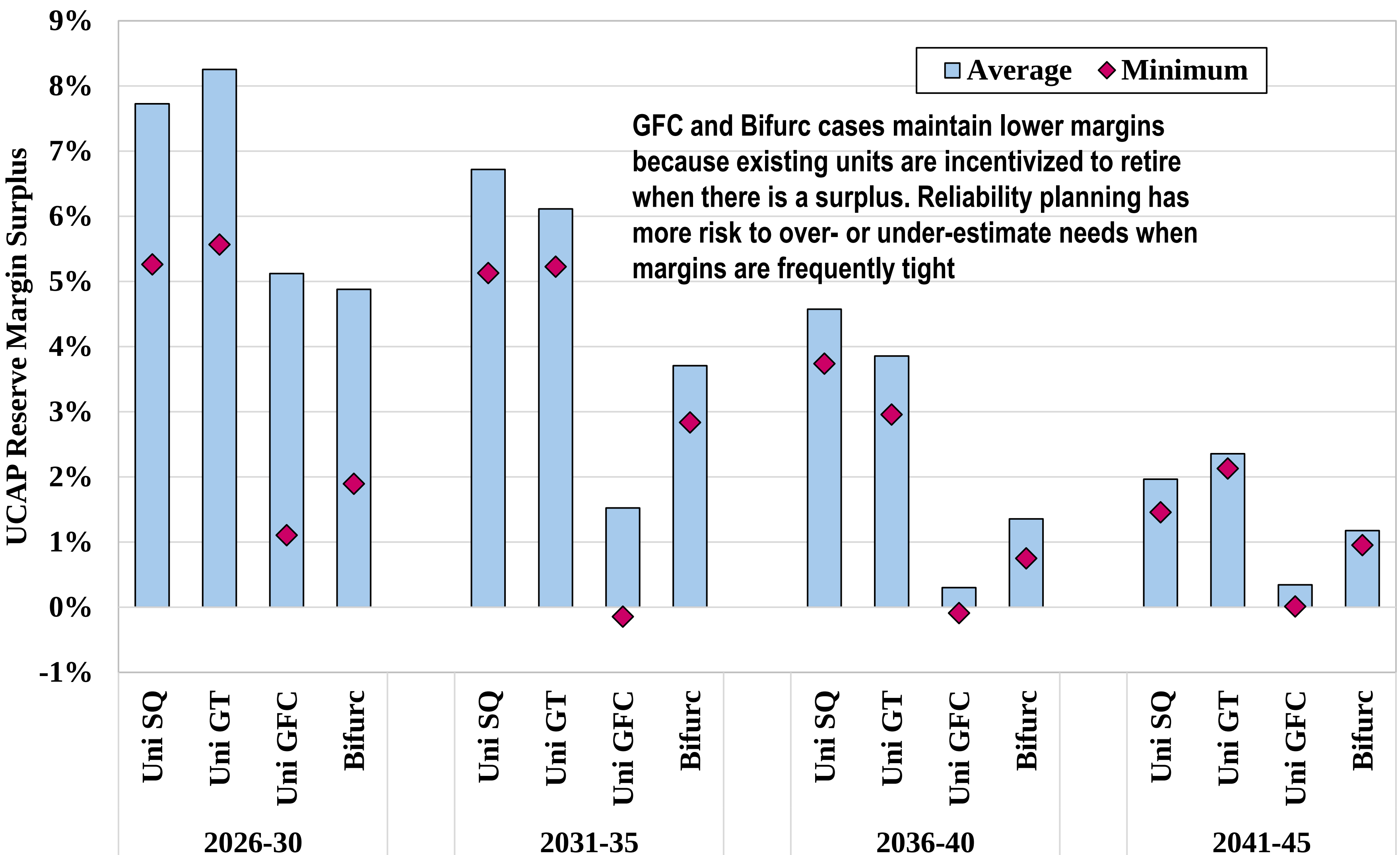
Totals are cumulative as of each year. These amounts are incremental to firm (state contracted) supply additions

Economic and Reliability Supply Changes, NYC

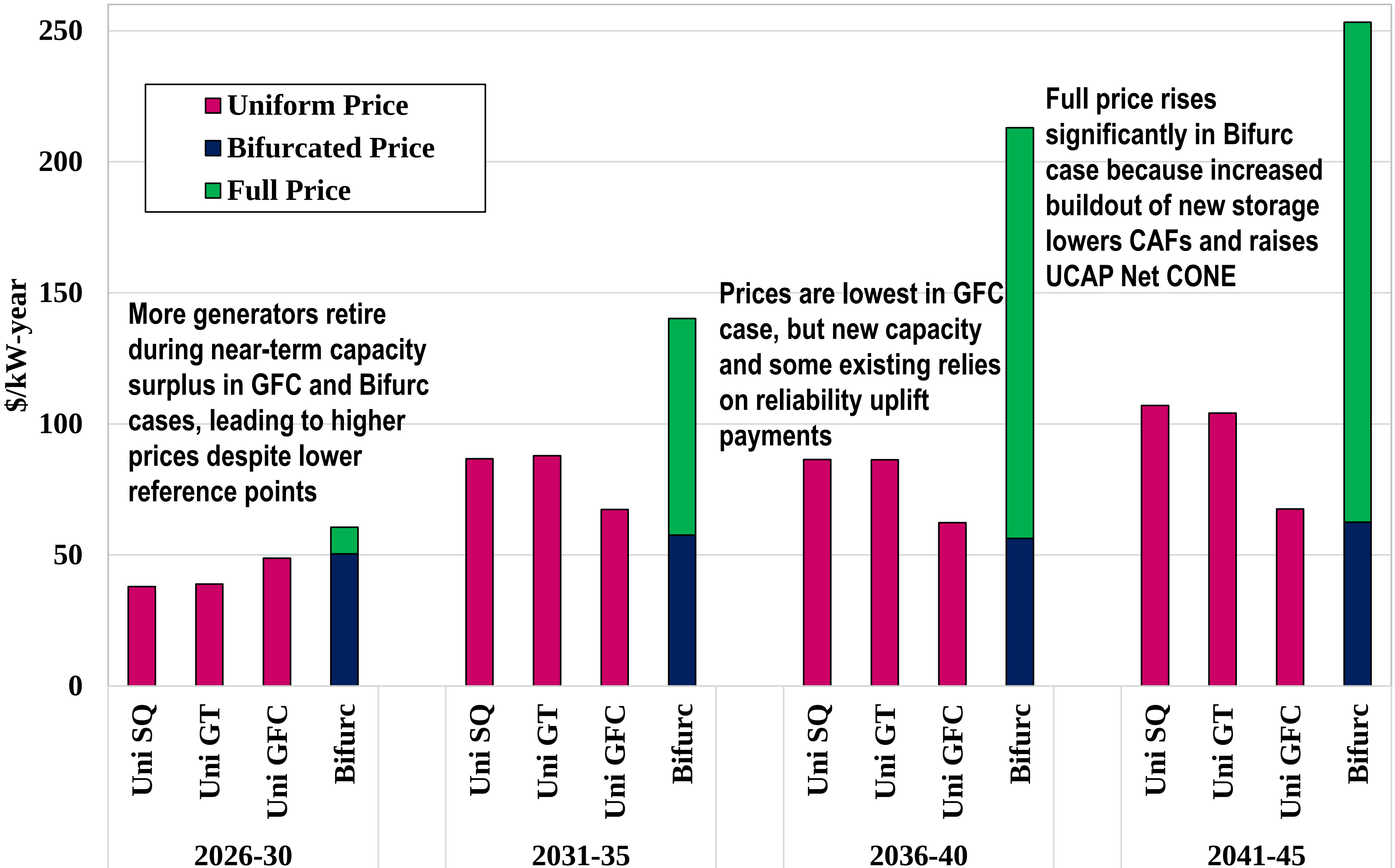


Totals are cumulative as of each year. These amounts are incremental to firm (state contracted) supply additions

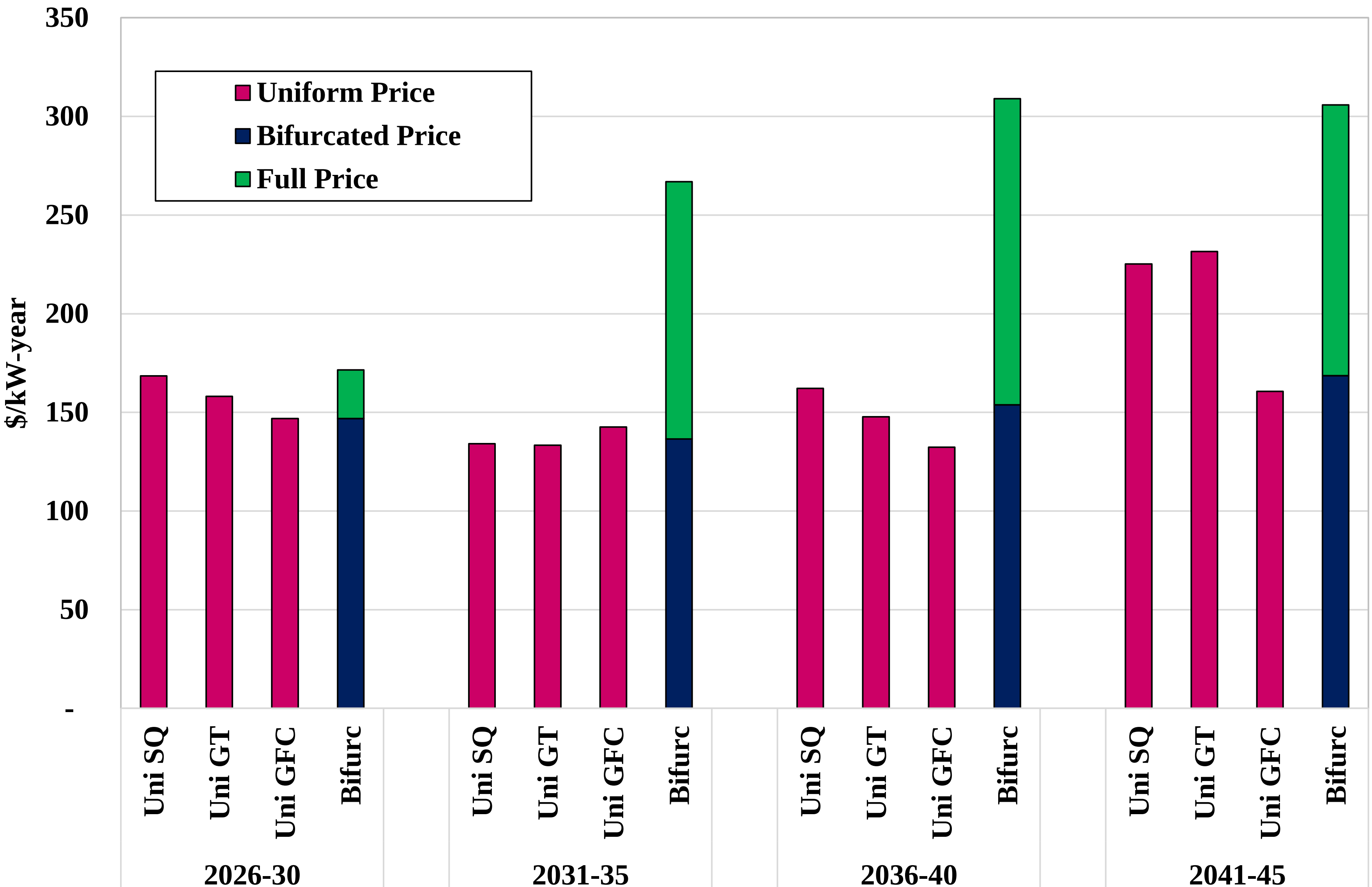
UCAP Surplus After Economic and Reliability Decisions



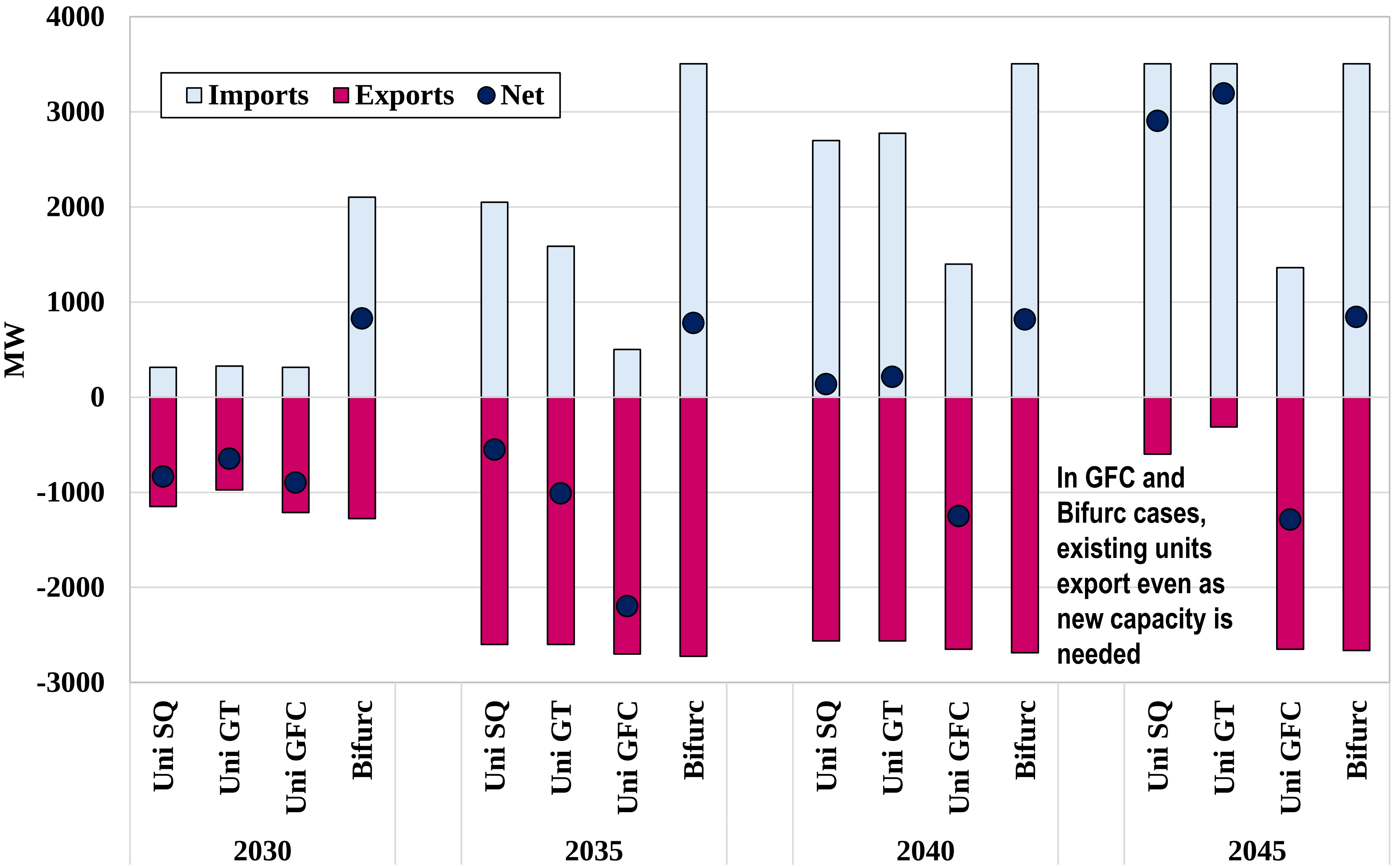
NYCA Capacity Price



NYC Capacity Price

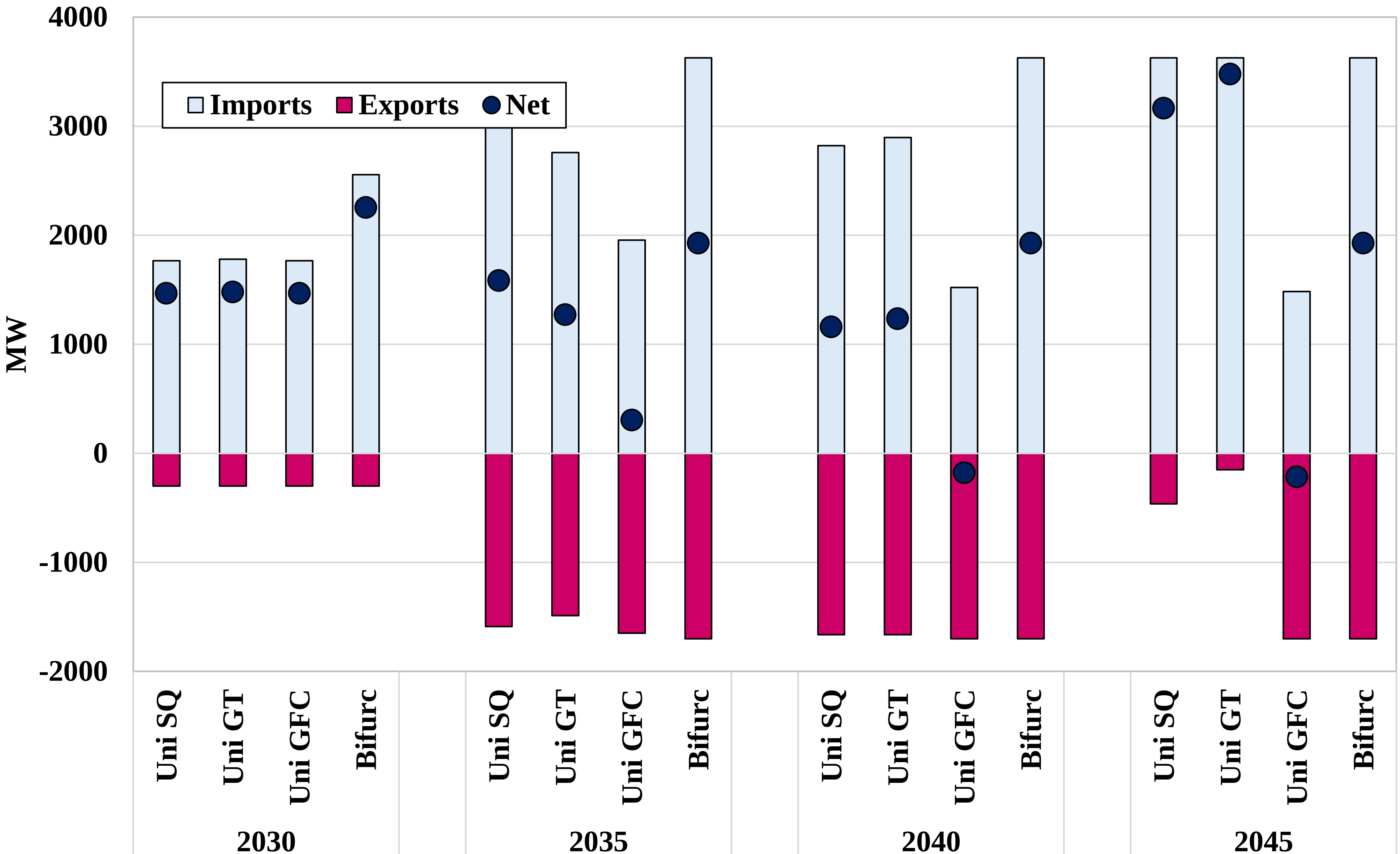


Imports and Exports – Winter



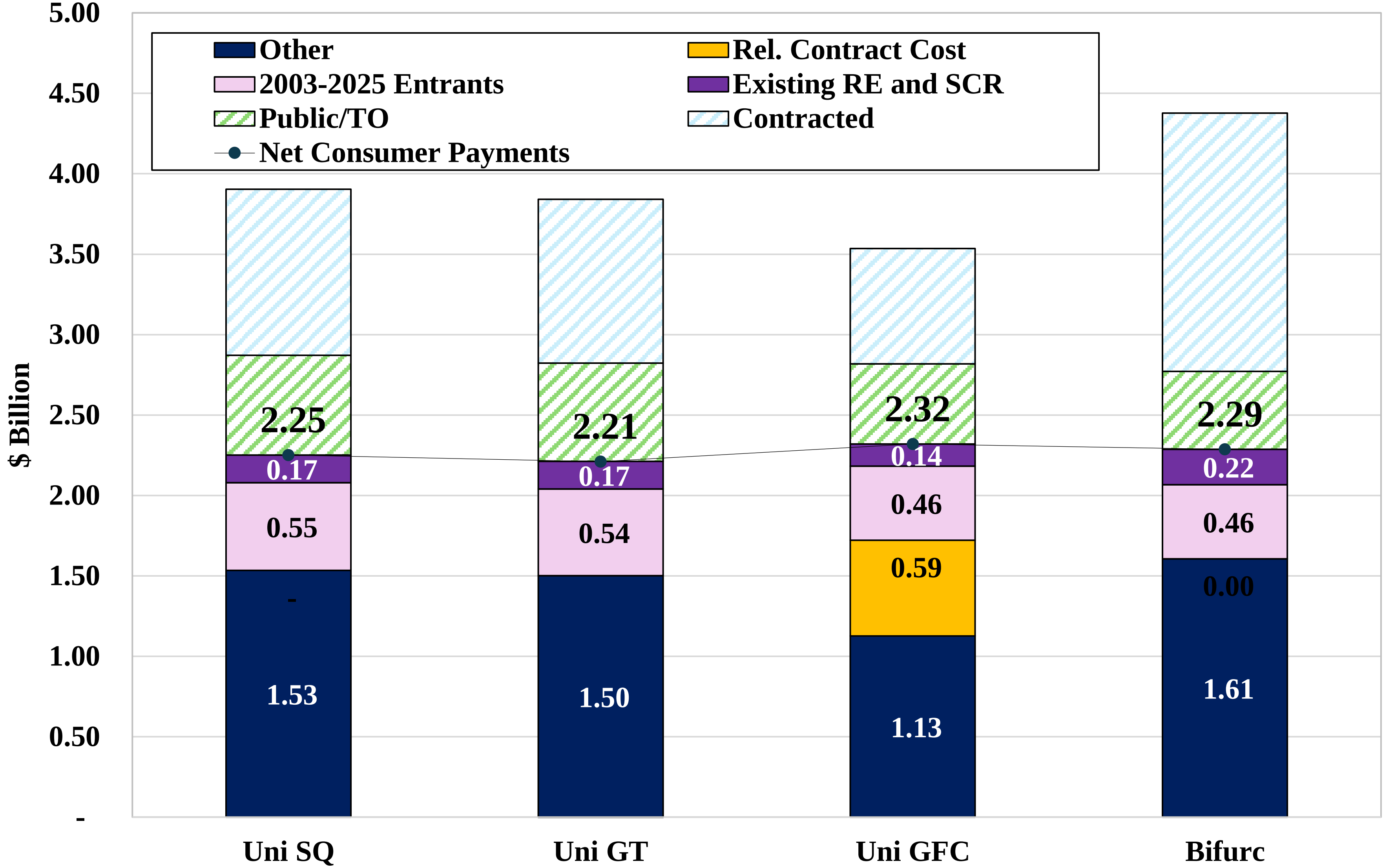
Includes both firm and economic external interface and UDR quantities

Imports and Exports – Summer

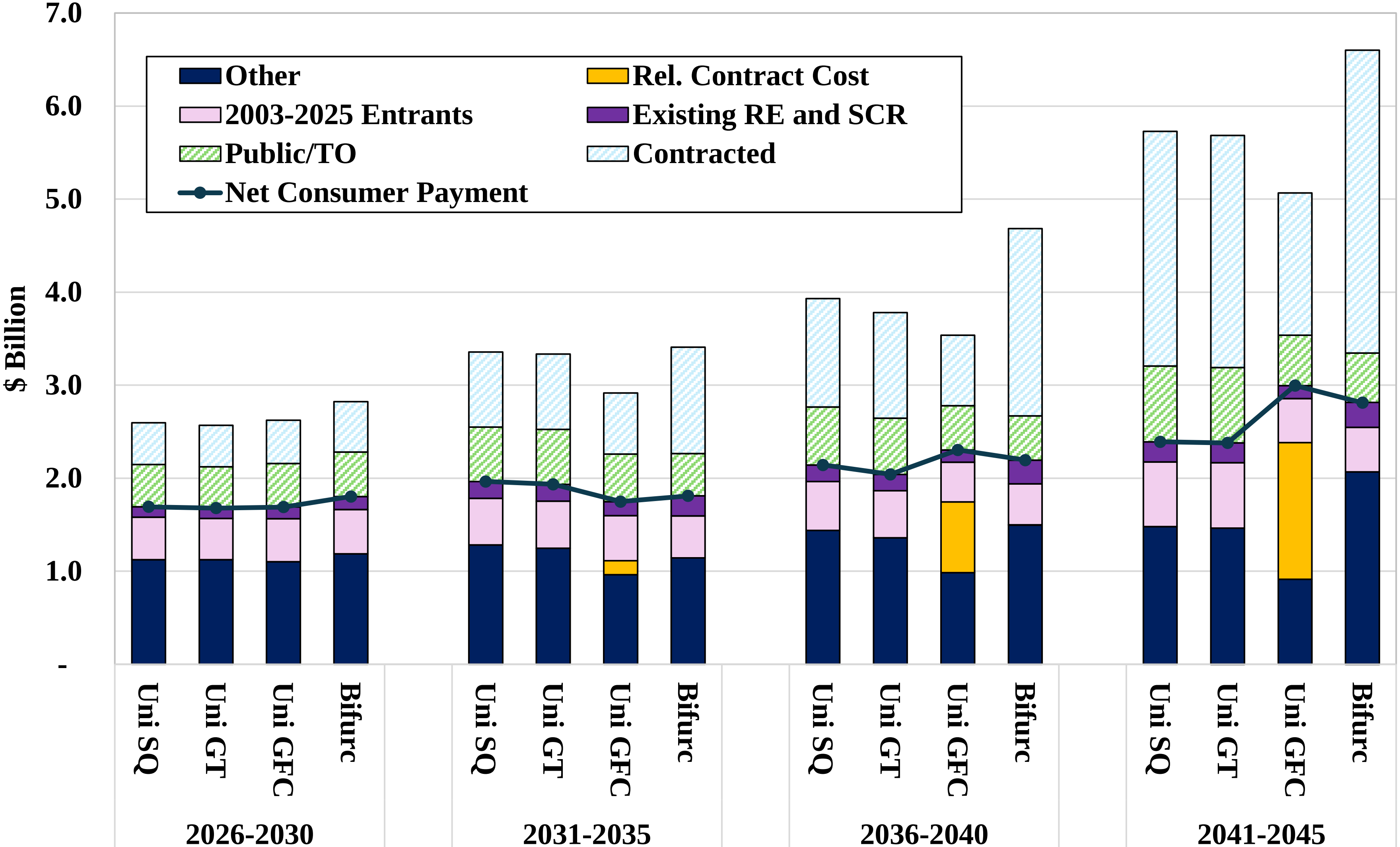


Includes both firm and economic external interface and UDR quantities

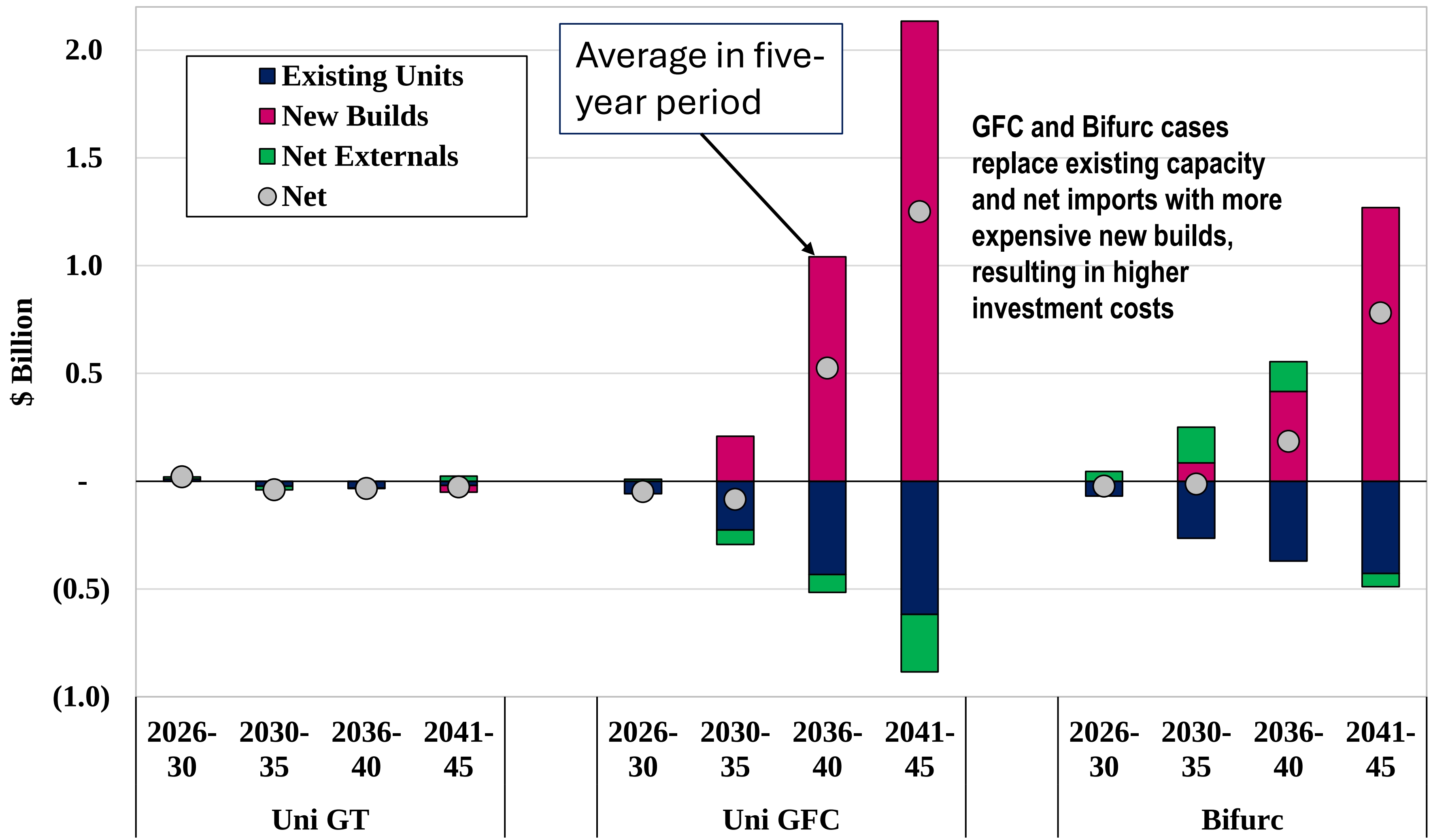
Capacity Market Payments (20-Year Average)



Capacity Market Payments Over Time



Investment Costs (Relative to Uni SQ Case)



Results – Comparison of Cases

Summary of Outcomes – Base Assumptions

Technology Scenario	Structure and Ref Point	Settlements (20-year average): Total Capacity Payment	Net Consumer Capacity Payment	Existing RE and SCR	2003-25 Entrants	Surplus: Average Surplus	Minimum Surplus	Investment Costs: 20-Year Average vs. Status Quo	2036-2045 Average vs. Status Quo
Zero by 2040	Uni SQ	5.14	3.07	0.23	0.34	6%	1%	0.0	0.0
	Uni GT	4.56	2.95	0.18	0.35	5%	0%	-0.1	-0.2
	Uni GFC	4.31	3.19	0.14	0.32	2%	-1%	0.2	0.6
	Bifurc	5.02	3.05	0.22	0.32	3%	0%	0.1	0.1
DEFR Delayed 1 (No new fossil)	Uni SQ	3.90	2.25	0.17	0.55	5%	1%	0.0	0.0
	Uni GT	3.84	2.21	0.17	0.54	5%	2%	0.0	0.0
	Uni GFC	3.53	2.32	0.14	0.46	2%	0%	0.4	0.9
	Bifurc	4.38	2.29	0.22	0.46	3%	1%	0.2	0.5
DEFR Delayed 2 (New GT allowed)	Uni SQ	3.69	2.11	0.17	0.51	5%	2%	0.0	0.0
	Uni GT	3.69	2.11	0.17	0.51	5%	2%	0.0	0.0
	Uni GFC	3.22	1.95	0.14	0.47	2%	0%	0.0	0.2
	Bifurc	3.59	2.02	0.17	0.47	3%	0%	0.1	0.2

Settlement and Investment Cost values in 2025$ billion

Summary of Outcomes – Low Load

Technology Scenario	Structure and Ref Point	Settlements (20-year average): Total Capacity Payment	Net Consumer Capacity Payment	Existing RE and SCR	2003-25 Entrants	Surplus: Average Surplus	Minimum Surplus	Investment Costs: 20-Year Average vs. Status Quo	2036-2045 Average vs. Status Quo
Zero by 2040	Uni SQ	4.08	2.32	0.22	0.32	7%	1%	0.0	0.0
	Uni GT	3.63	2.21	0.18	0.32	5%	0%	-0.1	-0.2
	Uni GFC	3.42	2.40	0.13	0.33	3%	0%	0.1	0.4
	Bifurc	3.89	2.29	0.20	0.30	5%	0%	0.1	0.1
DEFR Delayed 1 (No new fossil)	Uni SQ	2.83	1.54	0.14	0.46	6%	2%	0.0	0.0
	Uni GT	2.89	1.58	0.15	0.47	6%	2%	0.0	0.0
	Uni GFC	2.80	1.70	0.13	0.45	3%	0%	0.2	0.5
	Bifurc	3.35	1.70	0.19	0.45	4%	1%	0.1	0.2
DEFR Delayed 2 (New GT allowed)	Uni SQ	2.89	1.58	0.15	0.47	6%	2%	0.0	0.0
	Uni GT	2.89	1.58	0.15	0.47	6%	2%	0.0	0.0
	Uni GFC	2.70	1.55	0.13	0.47	2%	0%	0.0	0.2
	Bifurc	2.95	1.56	0.16	0.46	3%	1%	0.1	0.1

Settlement and Investment Cost values in 2025$ billion

Observations

Observations – Consumer Costs

- GFC and Bifurcated approaches raised long term average consumer costs or achieved minor consumer savings, compared to Status Quo and GT approaches

- Savings from paying reduced prices to existing units were offset by more retirements and greatly increased need for expensive new capacity over time

- In cases with apparent consumer savings from GFC and Bifurcated approaches, a large portion of savings came from:
  - Reduced payments to resources that made major investments since the capacity market demand curves were implemented
  - Reduced payment to existing wind, small hydro and SCRs

Observations – Surplus and Reliability

- The GFC and Bifurcated cases consistently maintained lower levels of surplus than the Status Quo and GT approaches
  - These cases set reference points for existing units based on GFCs, encouraging retirements during even modest surpluses

- Frequently operating at low surplus creates a challenge for reliability planning
  - Procuring to meet requirements is risky given that future conditions (load, exports, project delays, etc) are uncertain
  - Procuring conservatively results in prolonged surplus conditions leading to more retirements of existing capacity
    - This approach could lead to a large share of the generation fleet requiring RMR contracts

Observations – Investment Costs

- The Status Quo and GT cases consistently had lower investment costs than the GFC and Bifurcated cases

- Approaches with price discrimination incentivize less efficient behavior, ultimately resulting in greater need for expensive new capacity over time
  - Premature retirement of lower-cost existing units
  - Incentives for existing to export even when margins are tight
  - Weak incentives for existing to acquire firm fuel
  - Weak incentives to attract imports in GFC case

Conclusions and Next Steps

Value of Uniform Clearing Price

- Our results suggest there are advantages to uniform clearing prices linked to the Net Cost of New Entry *even when there is little or no merchant investment in the peaking technology*
  - Prospect of higher future prices incentivizes existing units to remain in service during 'bust' cycles when prices are below GFC
  - Rising prices during periods of scarcity attract imports, discourage exports and justify improvements to existing units (e.g. firm fuel, uprates)

- Uniform prices reward investments and behaviors consistently with the long term avoided cost of meeting reliability requirements

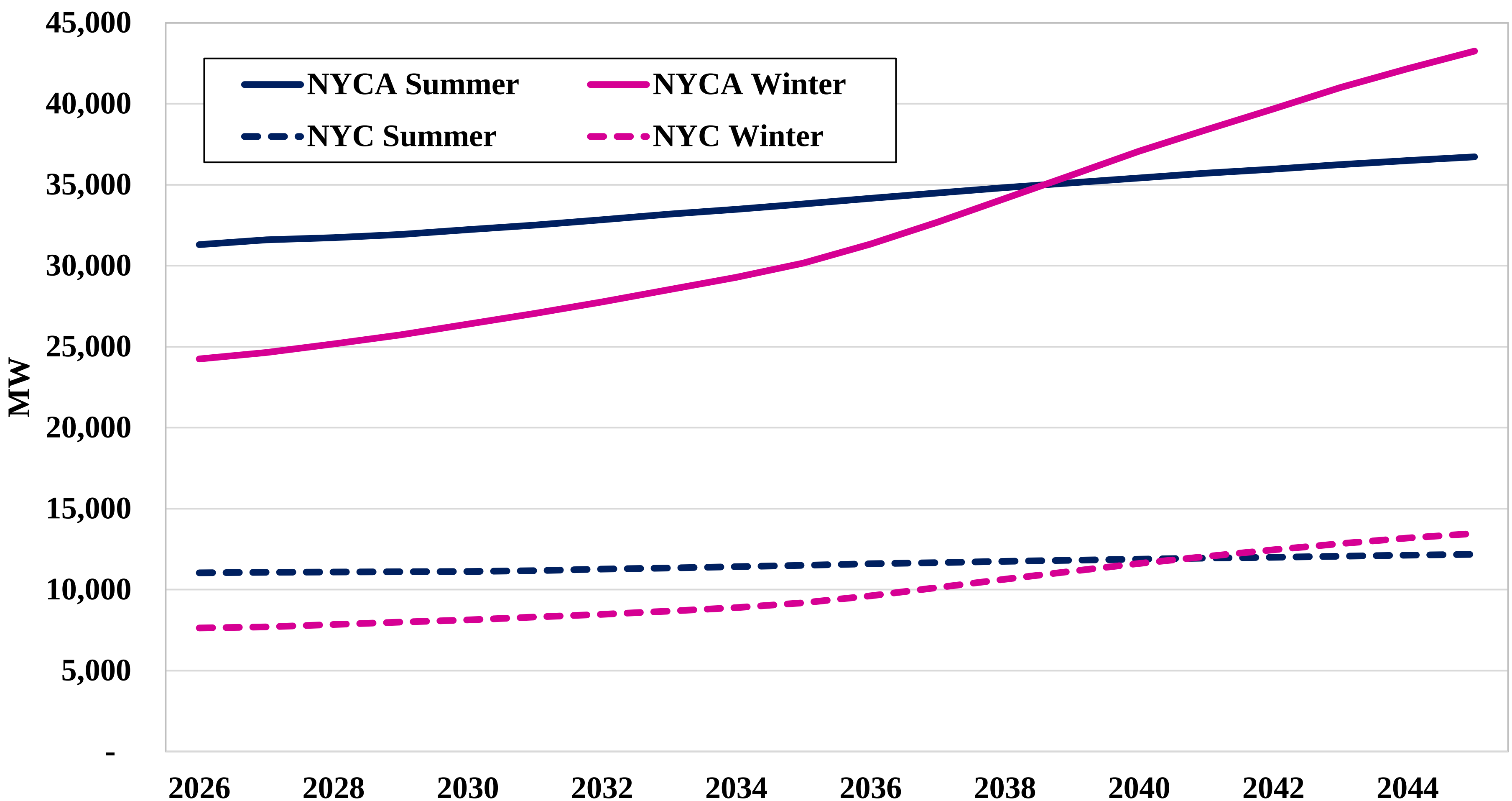
Next Steps

- We will return to an upcoming ICAPWG with updated results and additional cases based on stakeholder feedback
  - Higher near term load growth
  - Delays in state renewable and/or storage deployment
  - Others based on stakeholder feedback

- Please provide any feedback or requested cases for analysis by email to jcoscia@potomaceconomics.com

Appendix
Base Case Assumptions Detail

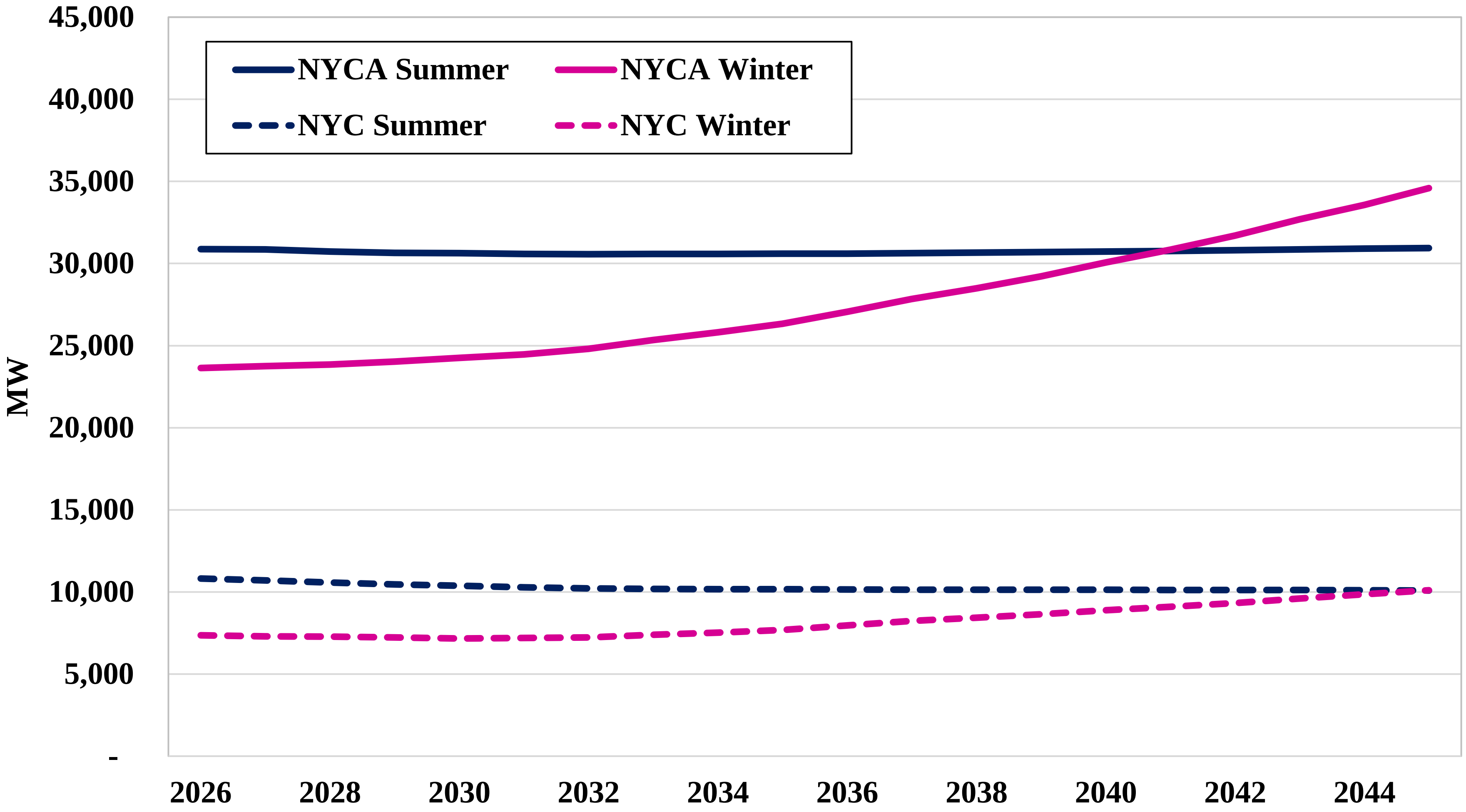
Load Forecast - Baseline



- **2025 Gold Book load forecast**
- **Flexible large loads netted out from modeled peak load**

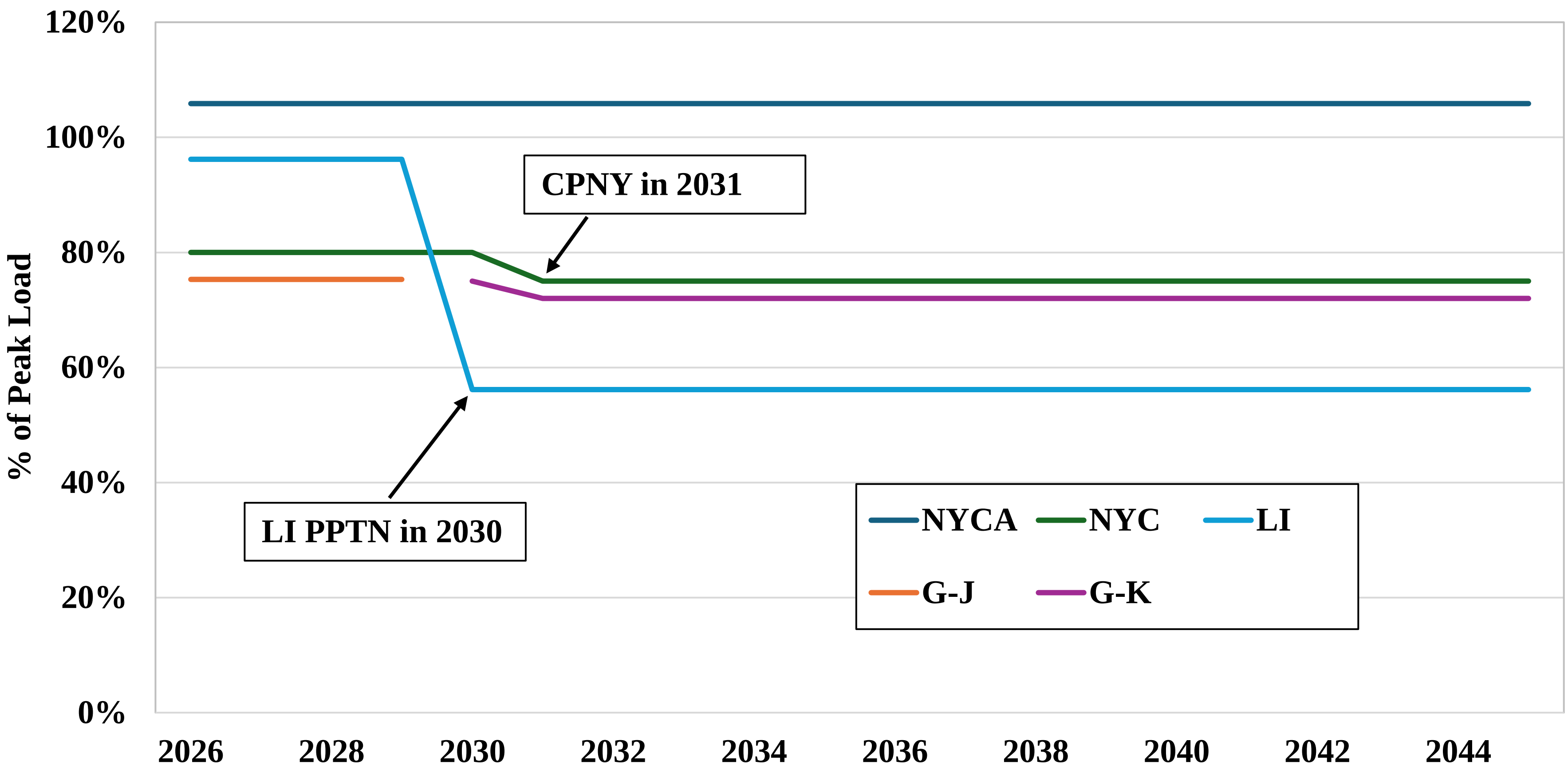
POTOMAC ECONOMICS

Load Forecast – Low Scenario



- **2025 Gold Book Lower Demand Scenario**
- **Lower mainly due to slower electrification and more managed EV charging**

UCAP Reserve Margins



- UCAP reserve margin targets by zone before effects of declining CAFs
- Recent historic levels held constant except for major new transmission

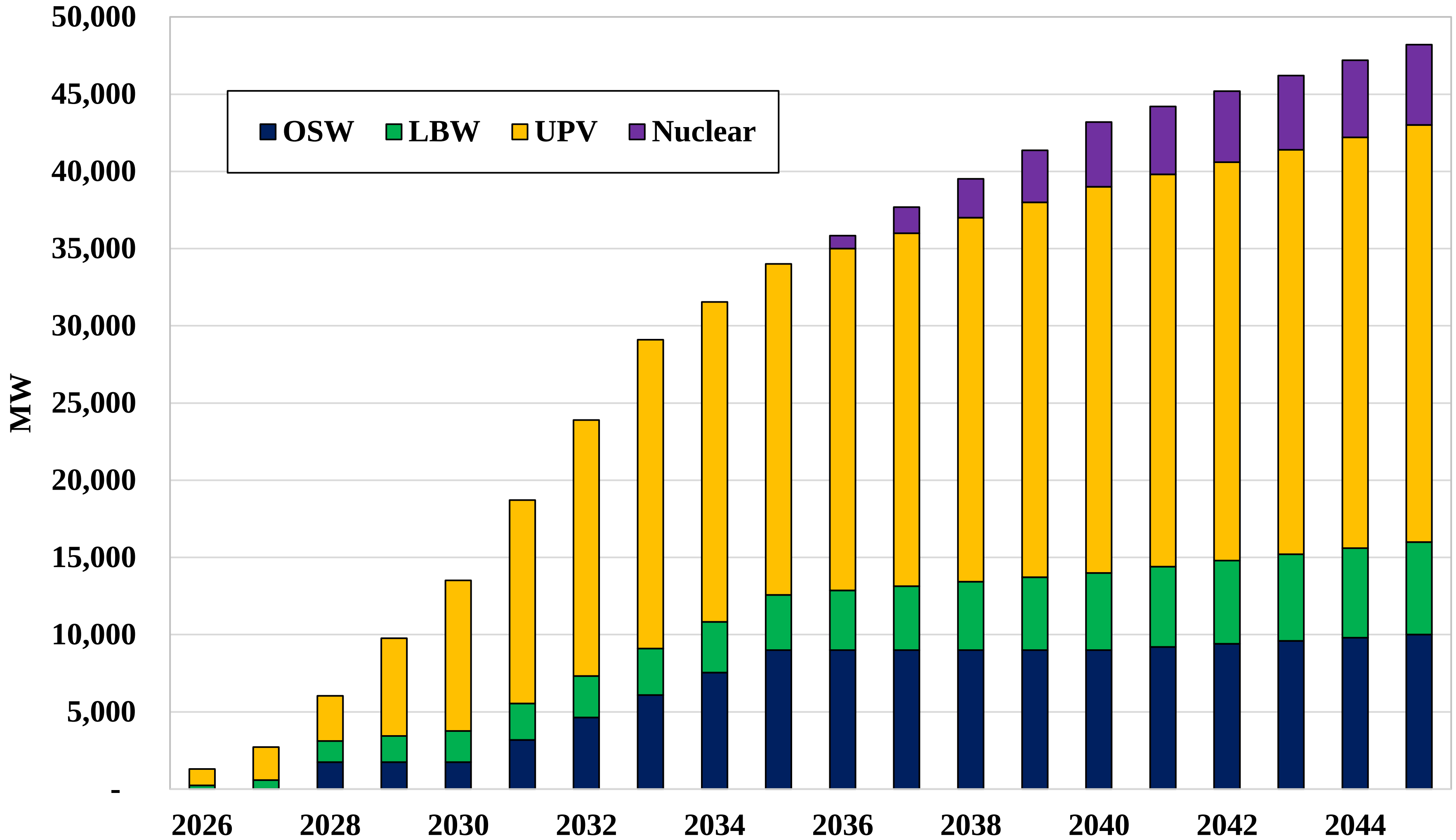
Firm Additions and Retirements

- Champlain Hudson Power Express (CHPE) in 2026
  - 1,250 MW in NYC
  - Modeled as firm import in summer, economic import option in winter
- Clean Path NY in 2031
  - Modeled as ~650 MW reduction to NYC and G-K LCR
- NYPA NYC Peakers (~400 MW) retire in 2031
- Remaining units affected by DEC Peaker Rule cease selling capacity in ozone season (May-Sep) in 2026

State Contracted Resources

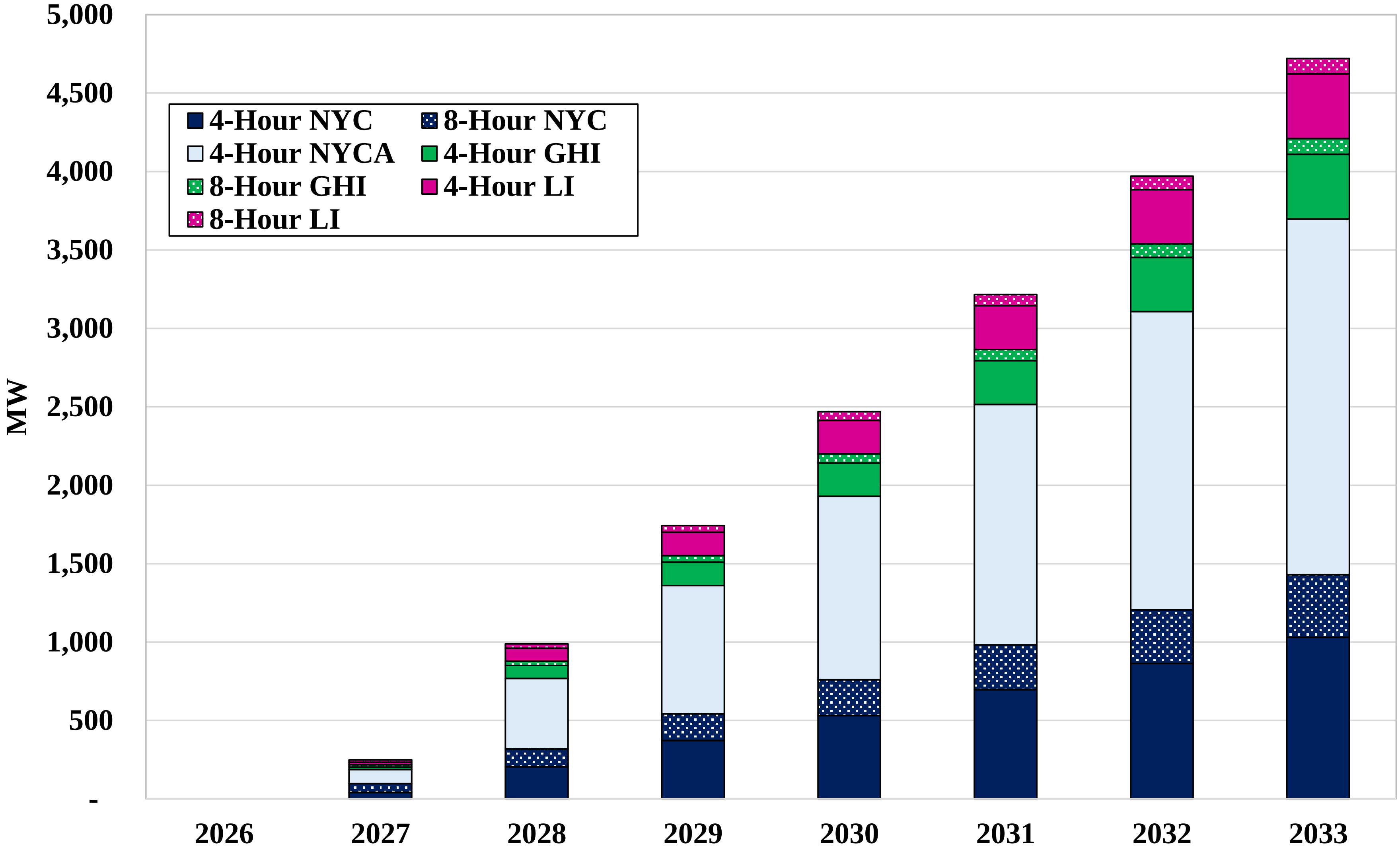
- Entry of state-contracted renewable and zero-emissions capacity to meet 70% of load by 2033 and equivalent of 100% of load by 2040
  - Pattern of new additions based on existing contracts, recent state contracting trends and NYISO Outlook study
- 9 GW offshore wind by 2035
- 6 GW battery storage by 2033
  - Modeled incremental supply-side storage net of ~1,300 MW BTM storage from Gold Book by 2033
  - Includes NYPSC requirements for 600 MW 8-hour storage and minimum 30% in NYC

State Contracted Renewables and Zero Emissions



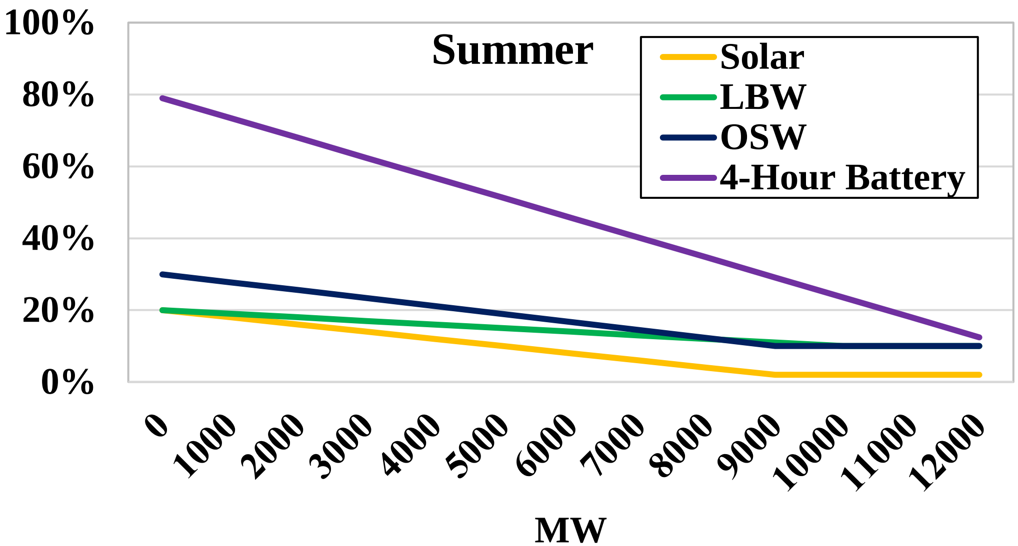
These resources are modeled as fixed new entry under state contracts regardless of capacity prices in case

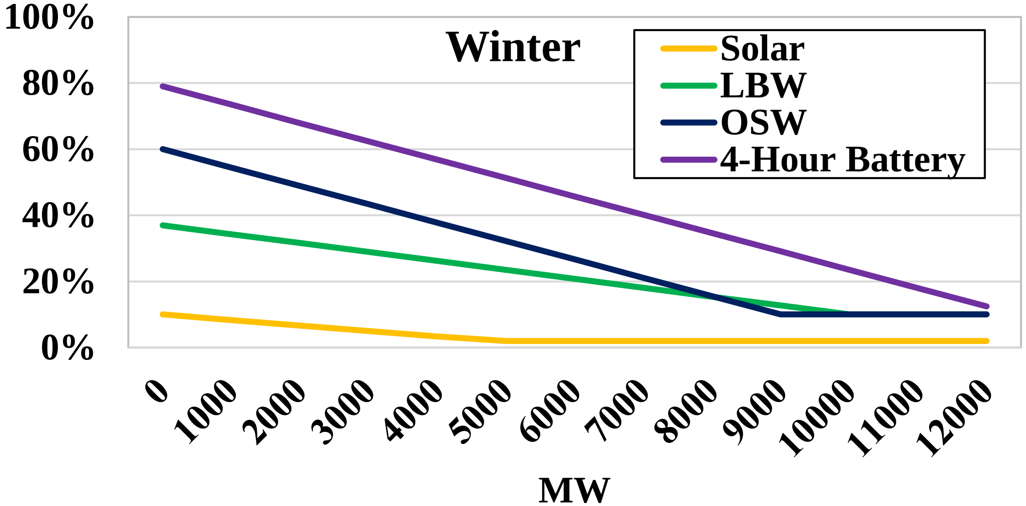
State Contracted Storage



These resources are modeled as fixed new entry under state contracts regardless of capacity prices in case

CAF Curves





- Simplified curves reflecting declining CAFs for renewables and storage
- Based on analysis by Brattle Group and MMU
- Adjustment applied to locality requirements for transmission security value
  - Limits OSW contribution to 10% summer, 20% winter
  - Limit 4-hour ESR contribution in NYC to 44%

GFCs and Net Cost of New Entry

2025$/kW-year ICAP	Rest of State	GHI	NYC	LI
Steam Turbine GFC	50	55	120	80
4-Hour Battery (2026)	101	105	228	95
4-Hour Battery (2030)	78	81	187	92
4-Hour Battery (2045)	55	55	142	64
Gas Turbine (20-year)	118	139	210	172
DEFR	257	269	354	282

- Existing unit GFCs escalated 1% per year in real terms
- 4-Hour Battery based on 2024 Demand Curve Reset
  - Applied cost reductions over time based on trajectory from 2024 NREL Annual Technology Baseline
- Gas Turbine based on 2024 Demand Curve Reset model
  - Value shown for LI reflects lower EAS revenues after LI PPTN
- DEFR based on NYISO 2023 Outlook ‘Low Capital / High Operating’ technology

External Area Import and Export Limits

Interface Limits (MW)	Import Limit	Export Limit
ISO-NE	0	1400
IESO	0	300 Summer, 400 Winter
Quebec	1120	1000
PJM	1200	0
Linden VFT	315	0
CHPE	1250	0
Neptune	660	0
Cross Sound Cable	330	0

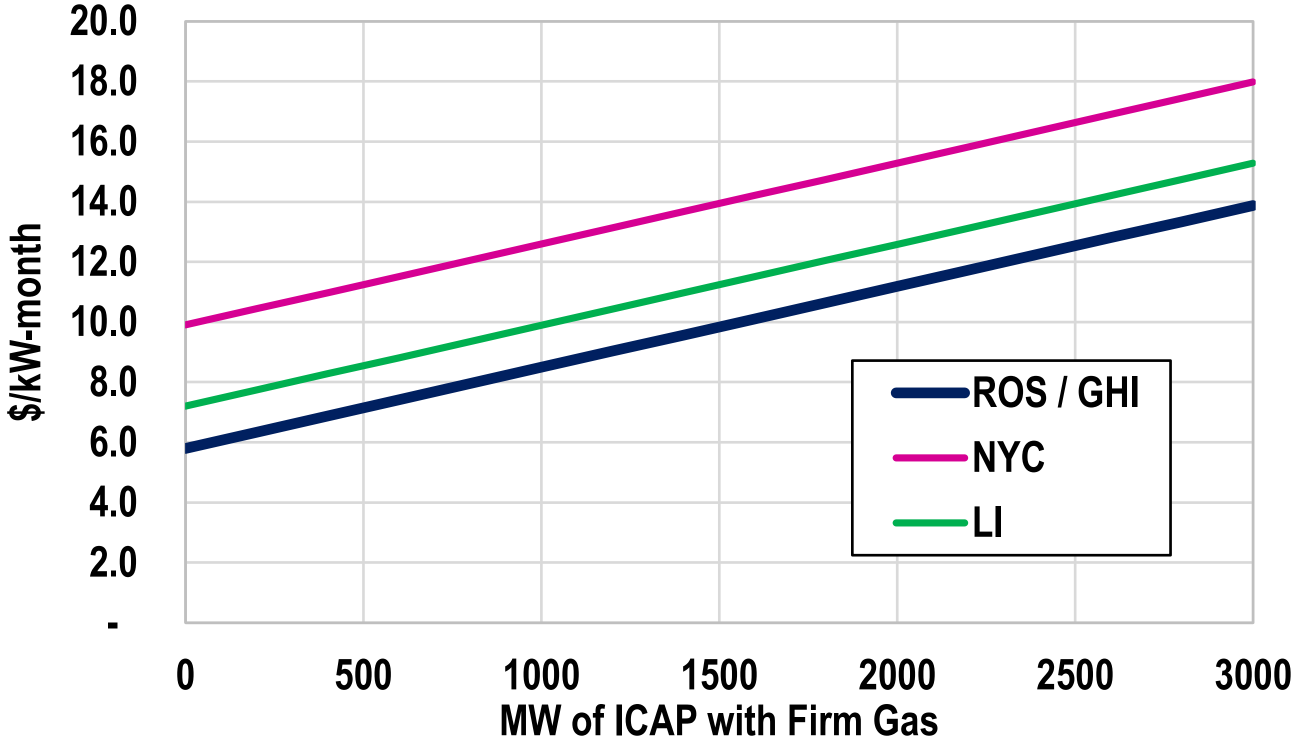
- Limits based on latest External ICAP Rights study and MARS topology
- Modeled firm imports:
  - 1,122 MW from Quebec in summer
  - 1,250 MW from CHPE in summer
  - Neptune modeled as firm until contract expiration in 2027

External Area Prices ($/kW-month)

	ISO-NE		IESO		PJM
	Summer	Winter	Summer	Winter	Annual
2026	3.6	3.6	15.2	9.3	8.2
2027	3.6	3.6	15.2	9.3	8.1
2028	3.9	4.7	15.2	9.3	7.9
2029	4.2	5.7	15.2	9.3	7.8
2030	4.5	6.8	15.2	9.3	7.7
2031	4.8	7.9	14.0	10.5	7.5
2032	5.1	8.9	12.8	11.6	7.4
2033	5.4	10.0	11.6	12.8	7.2
2034	5.7	11.0	10.5	14.0	7.1
2035	6.1	12.1	9.3	15.2	7.0
2036	6.1	12.1	9.3	15.2	7.0
2037	6.1	12.1	9.3	15.2	7.0
2038	6.1	12.1	9.3	15.2	7.0
2039	6.1	12.1	9.3	15.2	7.0
2040	6.1	12.1	9.3	15.2	7.0
2041	6.1	12.1	9.3	15.2	7.0
2042	6.1	12.1	9.3	15.2	7.0
2043	6.1	12.1	9.3	15.2	7.0
2044	6.1	12.1	9.3	15.2	7.0
2045	6.1	12.1	9.3	15.2	7.0

- Near term prices based on recent capacity auctions
- Long term prices for ISO-NE and PJM reflect Net CONE
- ISO-NE assumed to adopt seasonal prompt market
- ISO-NE and IESO assumed to be winter peaking by mid-2030s
- Capacity imports/exports from Quebec/CHPE priced consistently with ISO-NE

Firm Fuel Costs



- Cost of firm fuel estimated from historic forward and spot spark spread data
- Seasonal cost allocated across all months in winter period
- Price increases with higher level of purchases