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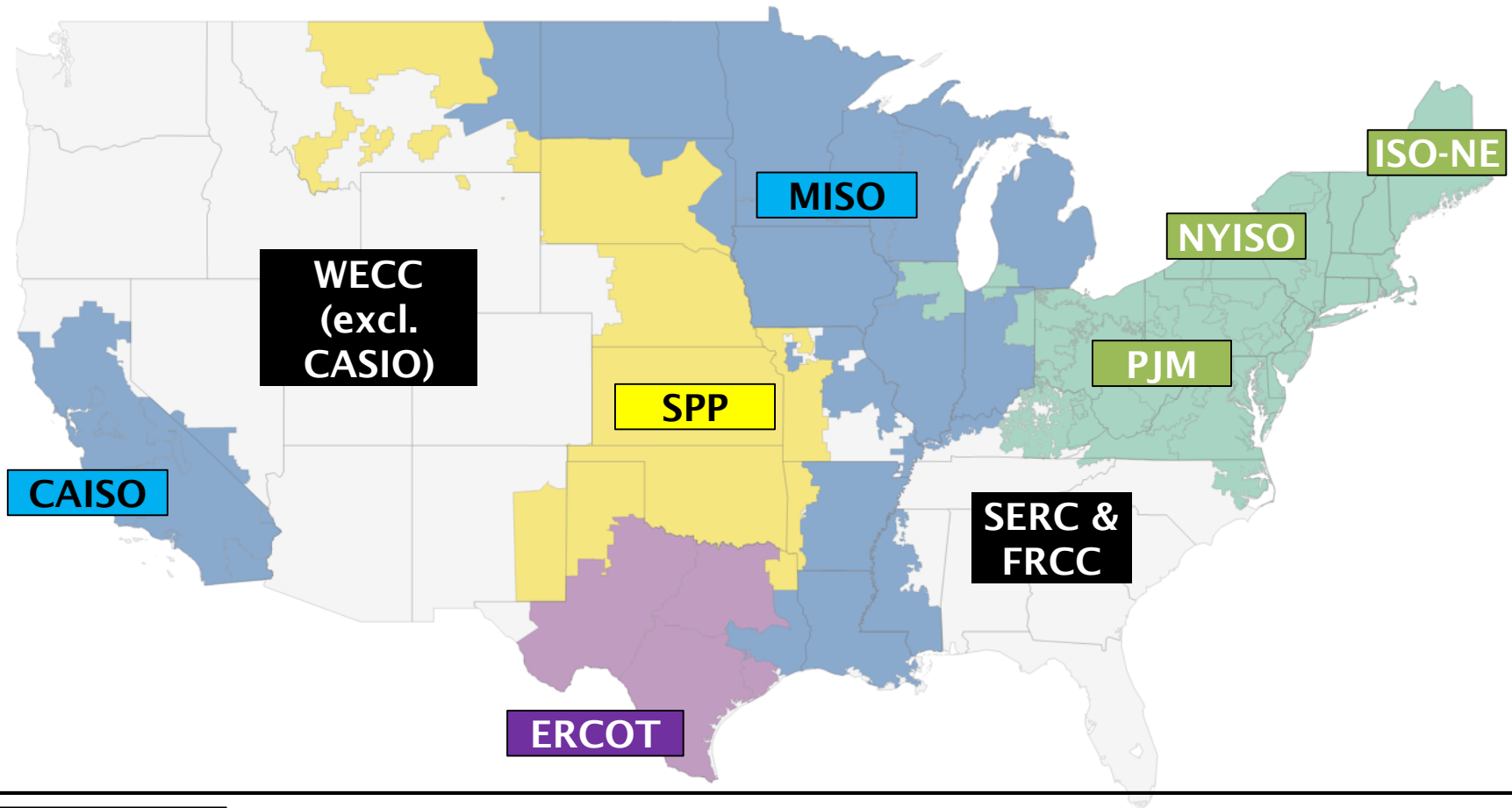
Reflections on US market developments

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Range of wholesale market situations across the US



Wholesale market dominated by vertically integrated utilities

Energy only market

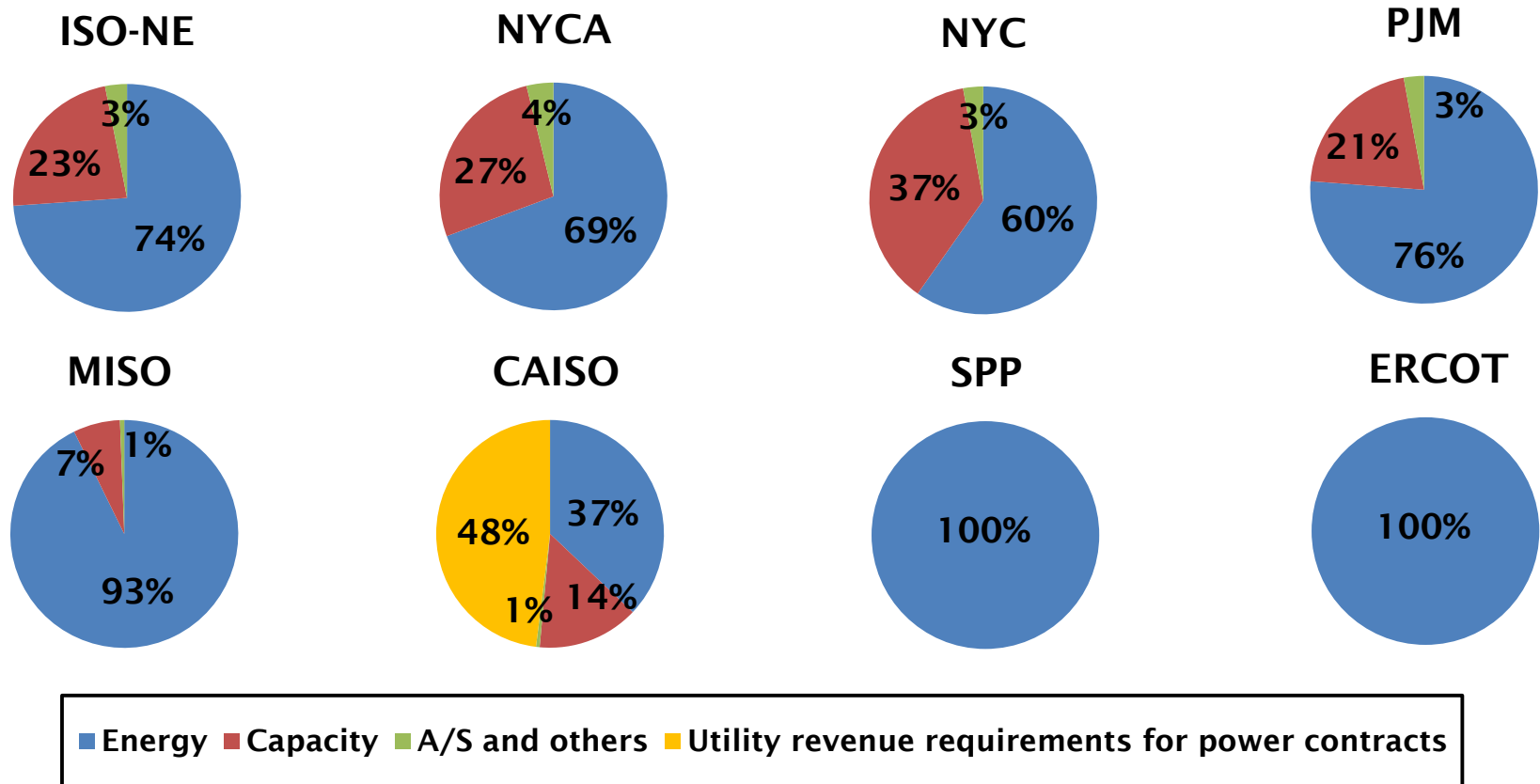
Essentially energy only with capacity backstop

ISO/RTO administered energy market with voluntary (or bilateral) spot capacity market

ISO/RTO administered energy and centralized capacity market

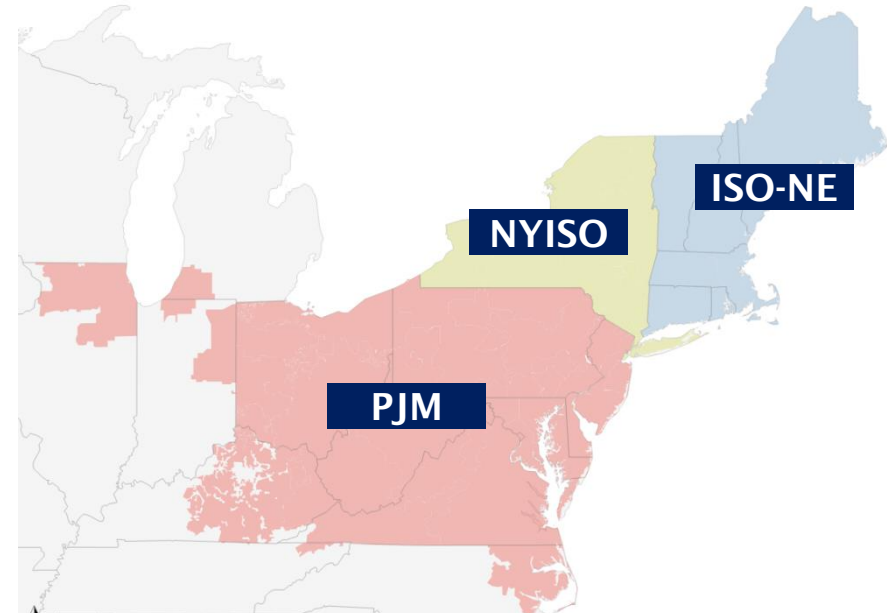
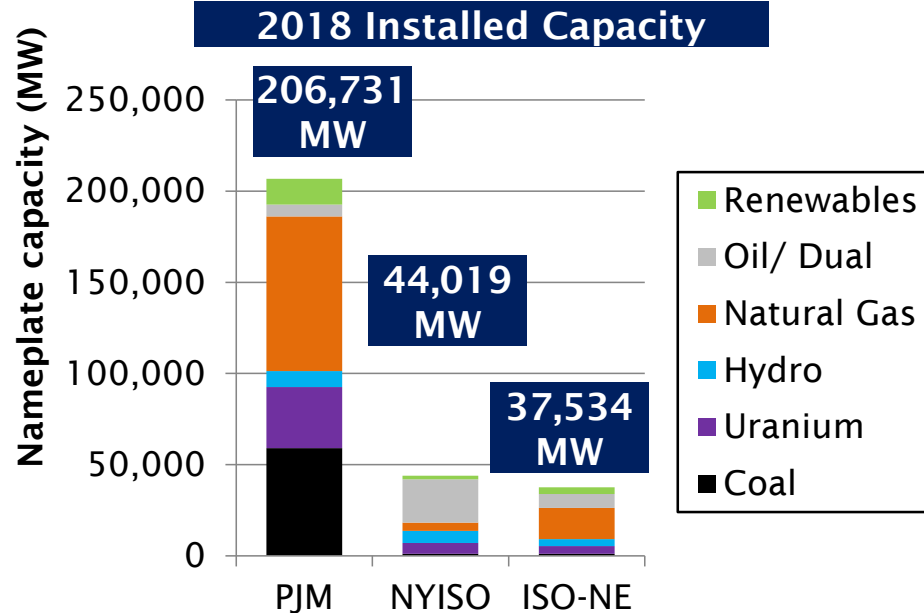
Capacity has been 20% to almost 40% of total wholesale market costs in regions with centralized capacity

Historical wholesale market cost shares, 2015 to 2017 average



Sources: ISO New England, New York Independent System Operator, Inc., PJM Interconnection LLC, Midcontinent Independent System Operator, California Independent System Operator, Southwest Power Pool, Electric Reliability Council of Texas

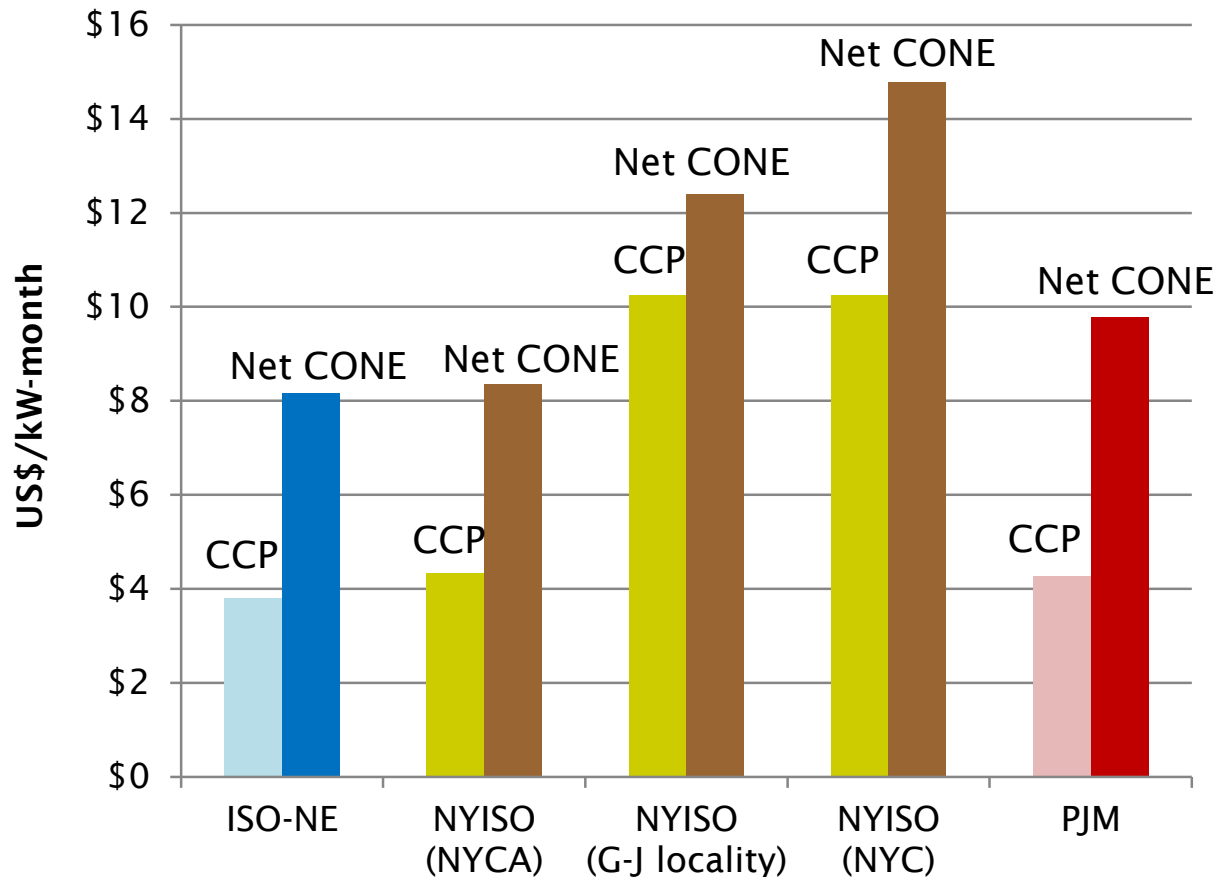
Three US markets use a centralized capacity market with a downward sloping demand curve



(US\$)	PJM	New York	New England
Energy prices, implied market heat rate, 2018	APS zone: \$36.8/MWh (13.8 MMBtu/MWh)	Capital zone: \$37.8/MWh (8.4 MMBtu/MWh)	Internal Hub: \$44.1/MWh (8.9 MMBtu/MWh)
Capacity prices, 2018	RTO: \$4.22/kW-month	NYCA: \$1.81/kW-month	\$8.5/kW-month (existing)
All-in prices, 2018	APS zone: \$ 42.6 /MWh	Capital zone: \$40.3/MWh	Internal Hub: \$55.8/MWh
Energy prices, 2020 forwards	PJM West: \$33.0/MWh	Capital zone: \$36.8/MWh	Mass Hub: \$43.3/MWh

Latest capacity market pricing outcomes indicative of a surplus supply situation

Net CONE and Capacity Clearing Price ("CCP")



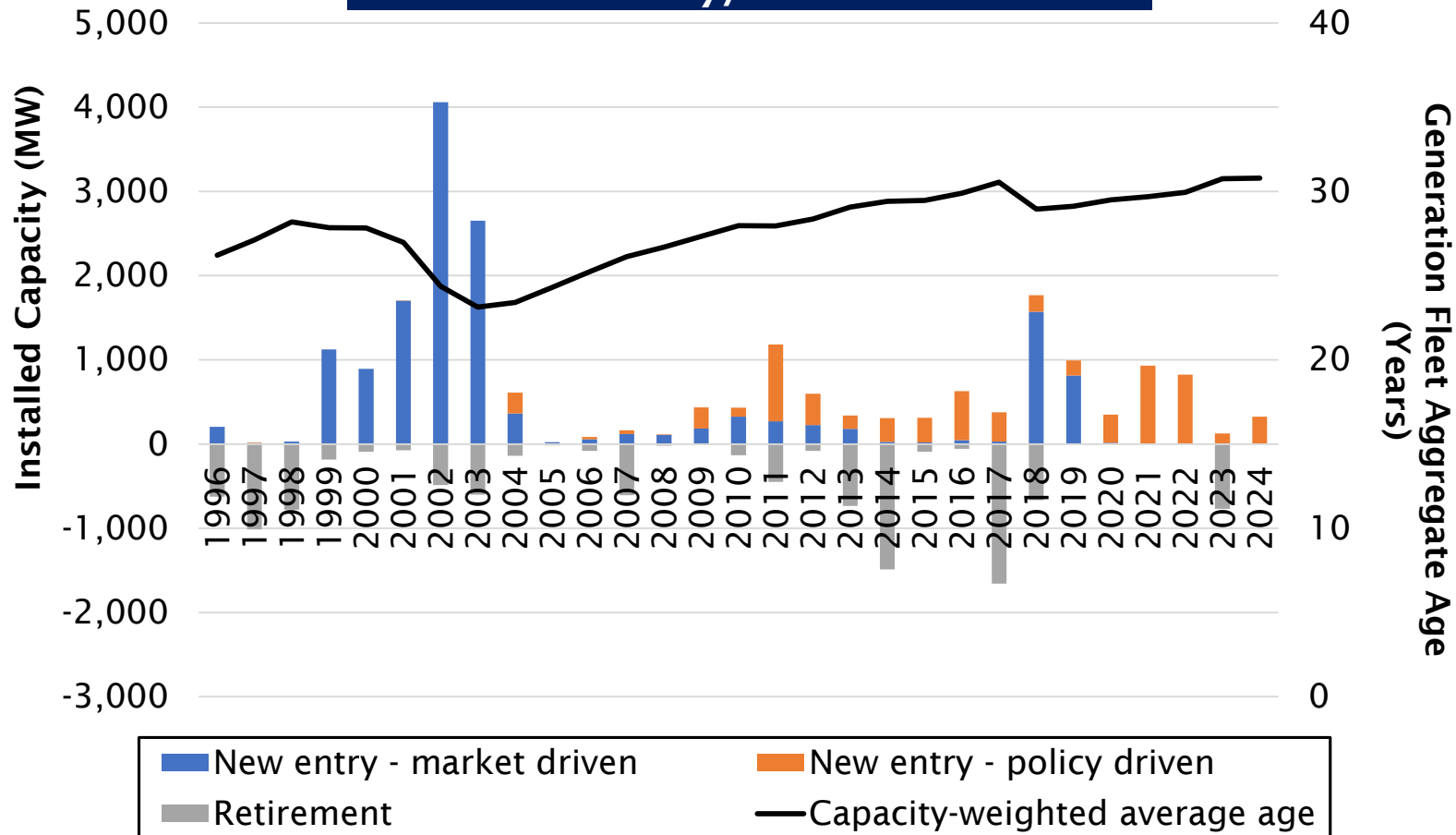
ISO-NE: FCA#13 (February 2019) for 2022-2023 delivery year

NYISO: June 2018 spot auction

PJM: 2018 BRA for 2021-2022 delivery year

New England had a construction boom more than 15 years ago, but in last five years, new generation additions made up of policy-driven renewables

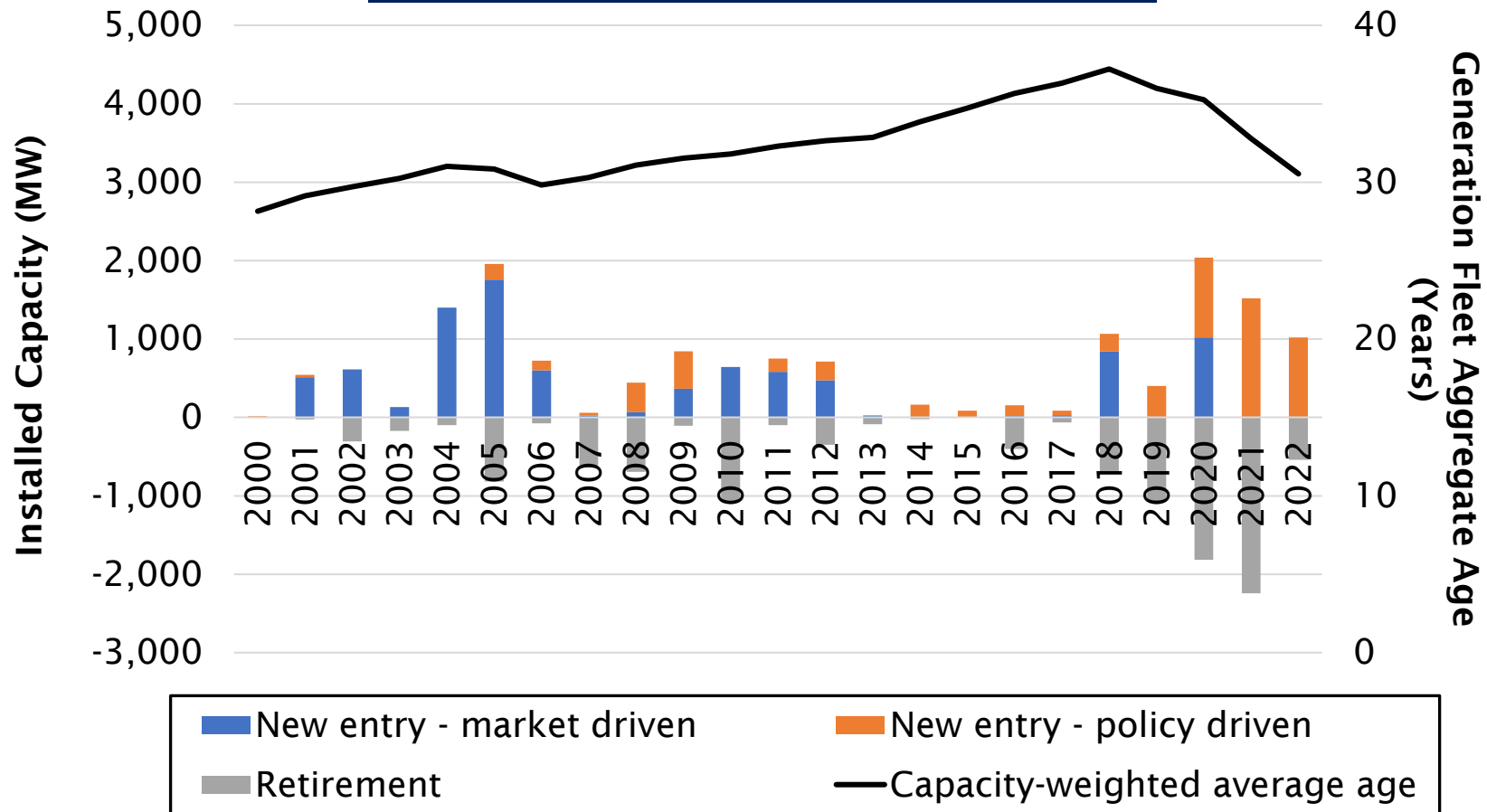
ISO-NE age of generation fleet and new entry/retirement



Note: Most of the retirements in New England have been coal and nuclear. Coal retirements are a function of both environmental policy and economics.

NYISO saw robust gas-fired investment in first decade of operations, with more sporadic gas entry recently and a lot of policy-driven renewables

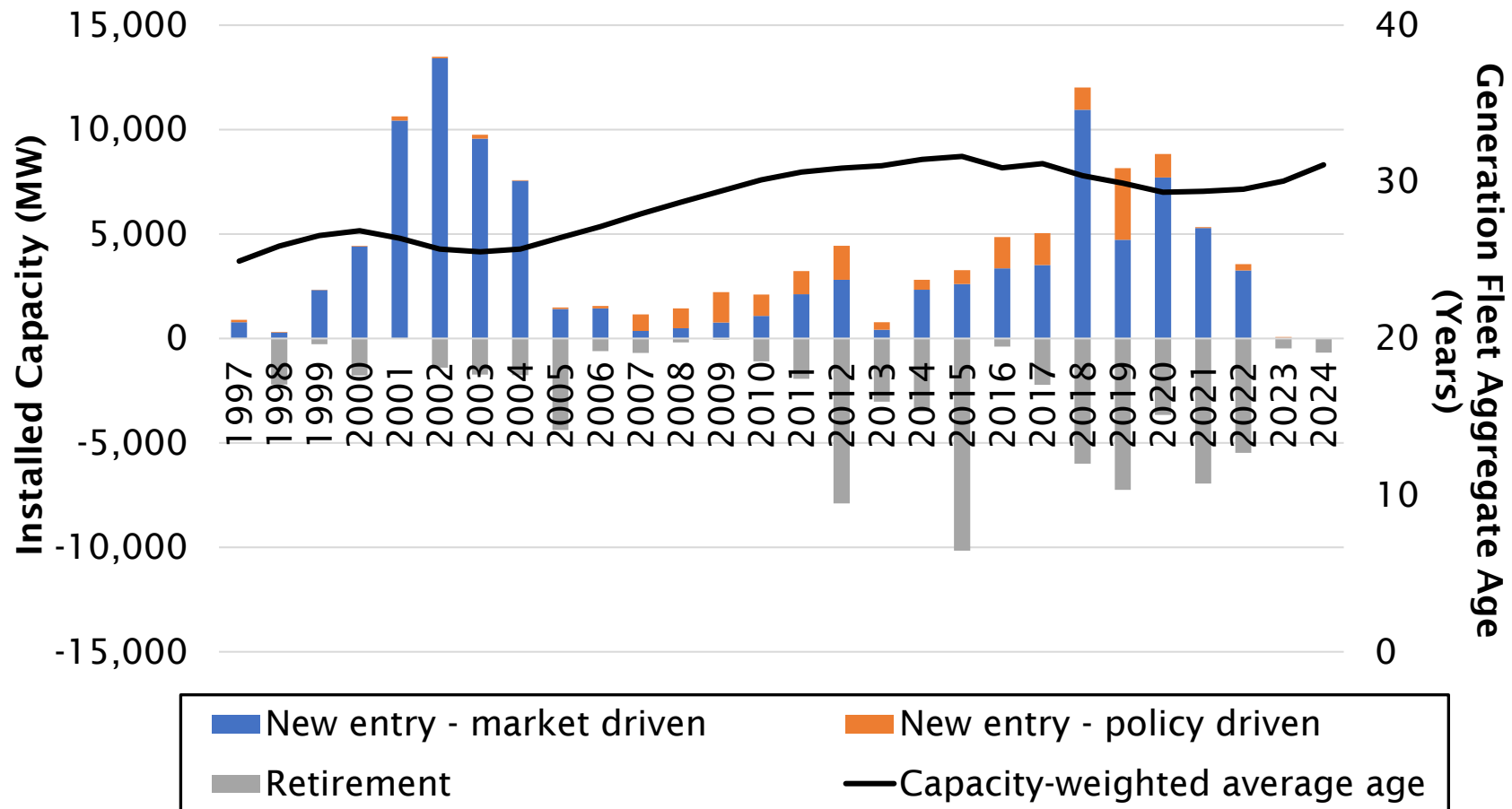
NYISO age of generation fleet and new entry/ retirement



Note: We do not distinguish between the various drivers for retirements. Most retirements are based on some element of economics, although some have a political angle as well..

PJM has experienced waves of market-driven investment: large market, more opportunities for new additions

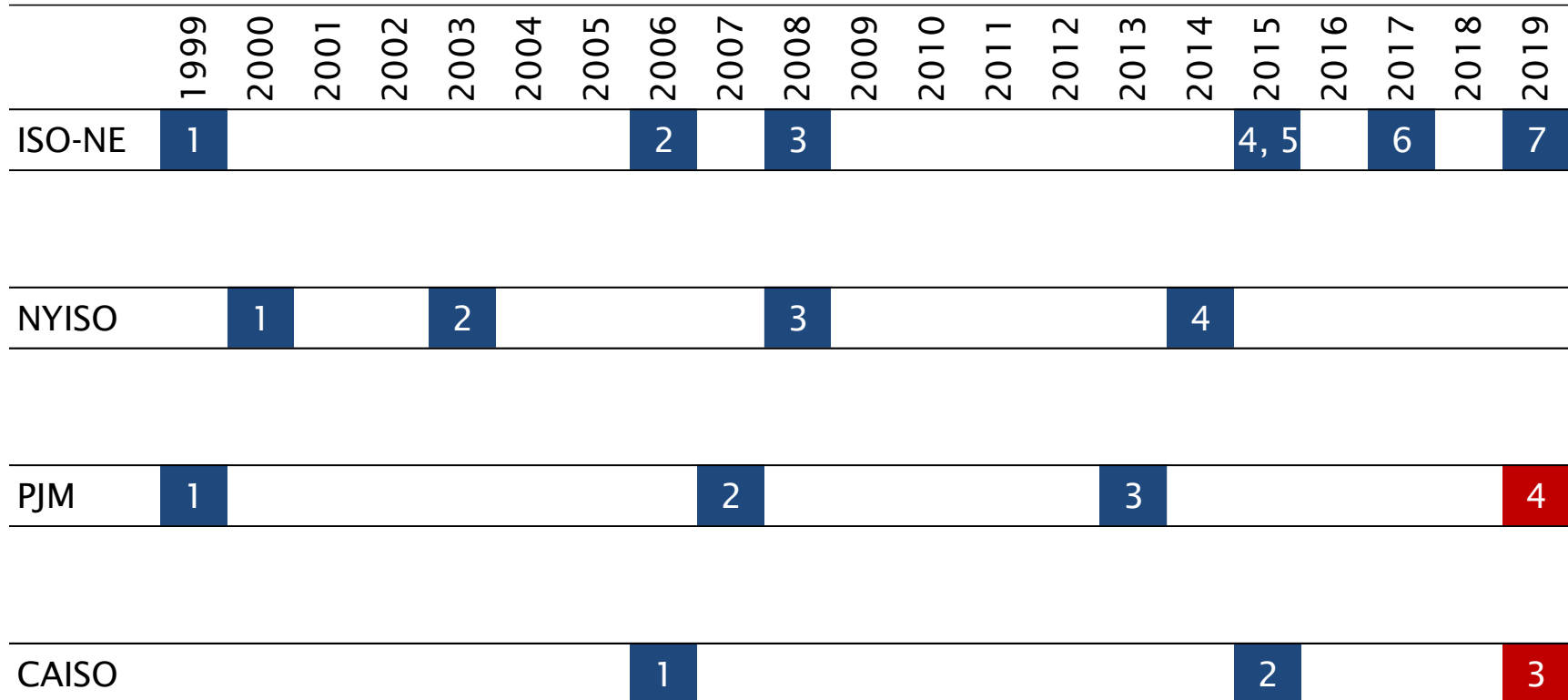
PJM age of generation fleet and new entry/retirement



Note: Most of retirements are coal-fired, and a result of both environmental policy and market economics

Capacity market rules have evolved at 3 to 5 year intervals on average

Timeline of capacity market reform in selected ISOs





 = capacity market reform

 = pending proposal

Capacity market rules have evolved at 3 to 5 year intervals on average (continued)

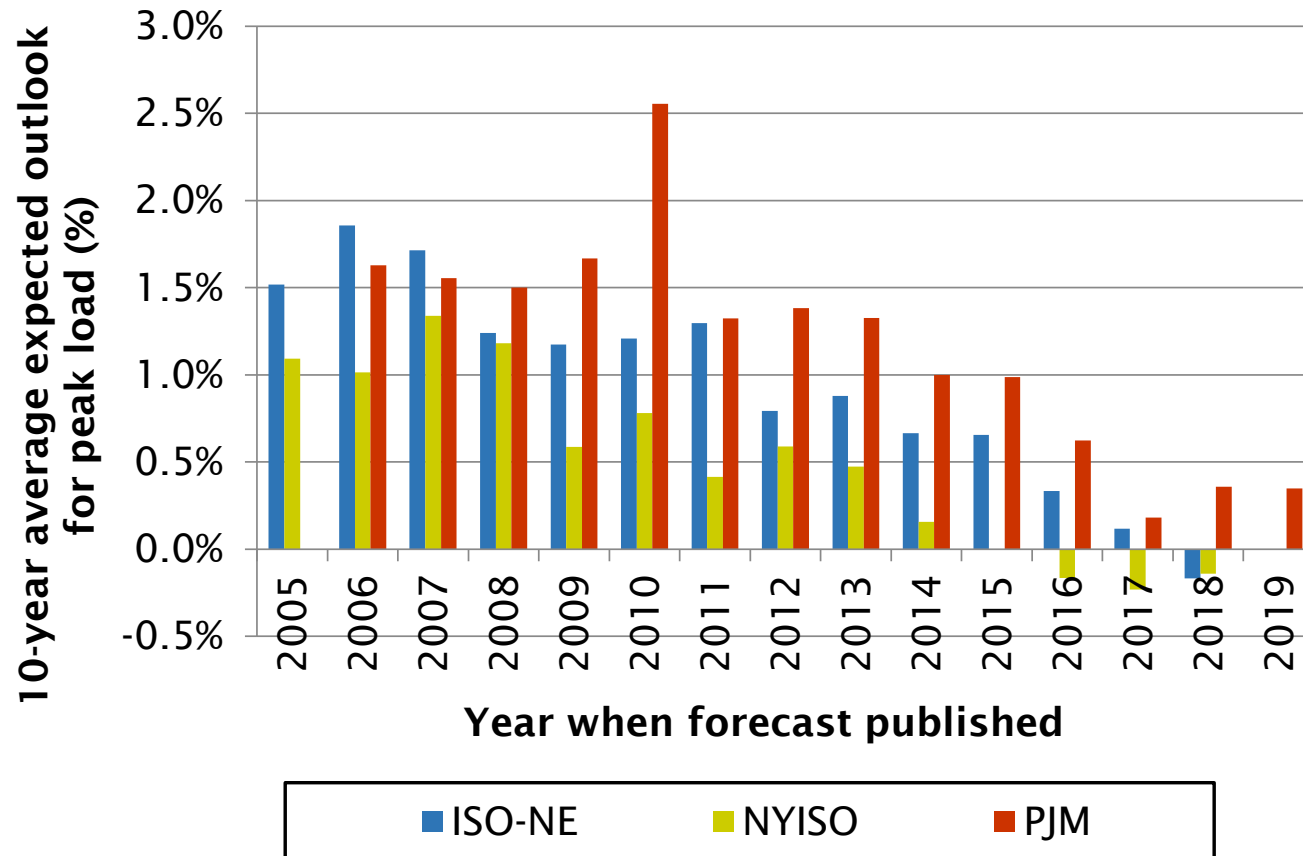
Legend

New England	New York	PJM	CAISO
1: spot ICAP market	1: spot ICAP market	1: Spot ICAP market	1: System and Local Resource Adequacy instituted by state regulator (spot capacity, bilateral)
2: FCM adopted (with transition period)	2: addition of sloped demand curve	2: move to RPM, first Base Residual Auction held	2: CAISO wins FERC approval for Flexible RA
3: first Forward Capacity Auction	3: addition of Buyer side mitigation (MOPR)	3: introduction of Capacity Performance scheme	3: proposal to move to forward capacity procurement
4: addition of sloped demand curve	4: addition of new zone: G-J Locality	4: awaiting FERC decision on RCO proposal (MOPR)	
5: introduction of Performance Incentive scheme			
6: move to MRI demand curve			
7: CASPR implemented (to accommodate “sponsored resources”)			

 = capacity market reform
 = pending proposal

Power markets were designed in an era of positive load growth... but that is no longer true for the future

10-year average expected outlook for peak load in each vintage of forecast year



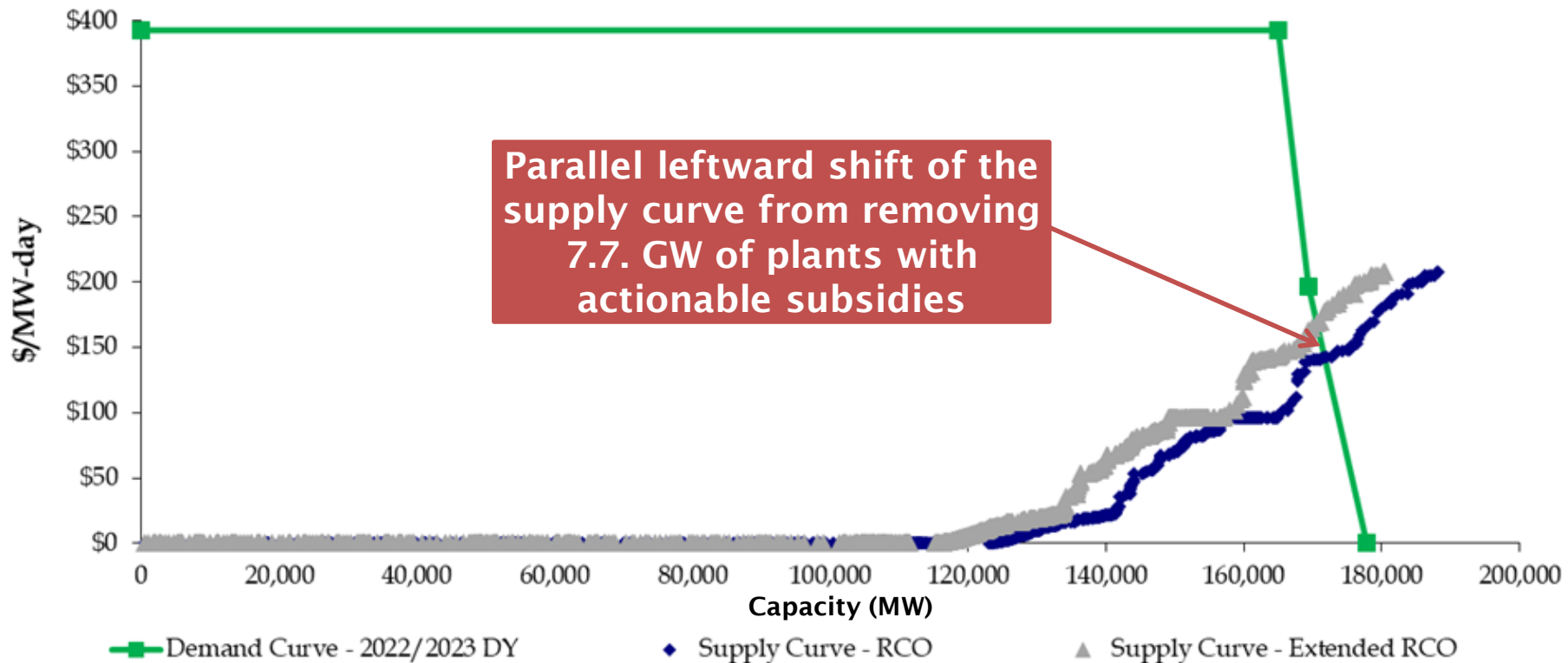
Sources: ISO-NE CELT, NYISO Gold Book, PJM Load Forecast

Markets intended to drive investment, but are out-of-market policies and “events” in driver seat?



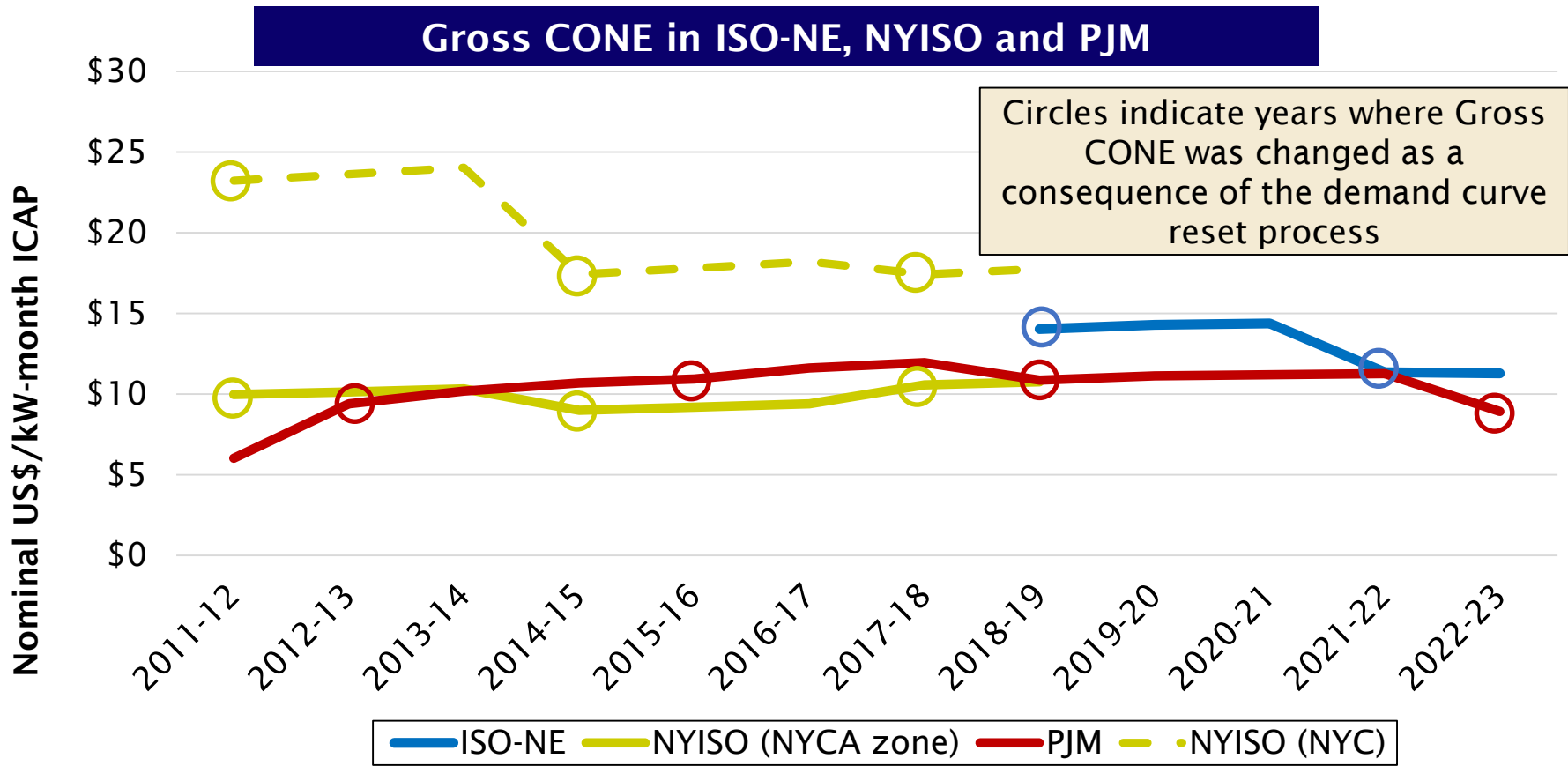
LEI expects the RCO proposal to have negligible impact on the PJM RTO capacity price, but Extended RCO proposal will raise capacity prices by as much as 20%

Forecast for 2022/2023 Delivery Year - PJM RTO under Resource Curve Out (“RCO”) and the Extended RCO



Most often, the Gross CONE has come down at the periodic demand curve re-sets

- ▶ This is consistent with technology improvements in electric generation equipment, which the US Department of Energy has recorded to be as much as 28% on average for gas-fired generation from 2013 to 2015*



Sources for Gross CONE: ISO-NE: CONE and ORTP Updates; PJM: BRA Planning period parameters; NYISO: 2010, 2013 and 2016 Demand Curve Reports

* Source: EIA. "Construction costs for most power plant types have fallen in recent years". July 5, 2017. <<https://www.eia.gov/todayinenergy/detail.php?id=31912>>

Technological innovation, changes in supply, and policy mandates are guiding developments in power markets



Decarbonization

State policies driving renewable generation mandates or carbon pricing mechanisms

Examples include NY's CES, Massachusetts procurement of offshore wind and large hydro

Innovation

Technical innovation driving down costs of renewable generation and storage resources - capital costs for wind resources declined by 25% and solar by 70% over the last 10 years

Emergence of smart grids and new business models for utilities



Changes in supply

Low natural gas prices and policy-driven entry of renewable generation is forcing retirement of older coal and nuclear assets

More capacity market rule changes on the horizon

Resilience

Resilience of the electric grid is challenged by evolving supply mix, so that utilities must examine ways of maintaining reliability of the transmission system

Out of market mechanisms are being implemented to ensure resilience

