NYISO – Market Issues Working Group

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New York's Climate Leadership and Community Protection Act (CLCPA) mandates a more stringent CES, altering both the "electricity demand system" and the energy market.

The *Grid in Transition Series* is an opportunity to:

- Discuss the immediate needs of NYISO and its Stakeholders
- Assess/address upcoming energy market challenges and opportunities in the near- and long-term
- Find ways to reduce GHGs and provide power reliably and economically

Today's objectives:

- Review CLCPA mandates as they pertain to the energy market
- Characterize the issues and challenges in meeting those targets
- Highlight the potential market enhancements needed to address the changing energy system
- Examine potential interactions between the energy market and other NYISO markets

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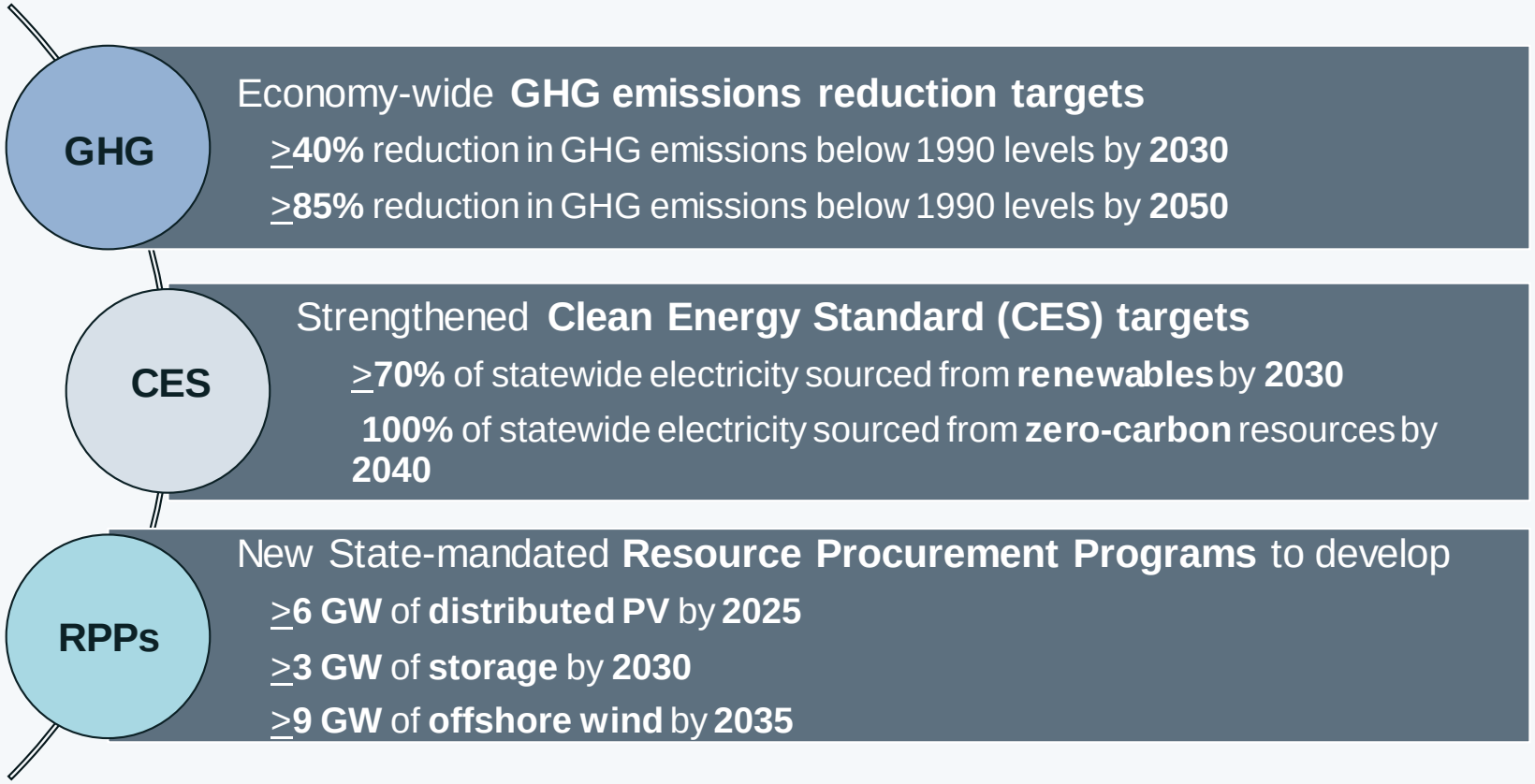
The CLCPA mandates some of the most ambitious clean energy and decarbonization targets in the United States.

Its impact to the energy market will be profound.



NYISO and its stakeholders need to consider the long-term challenges and opportunities in the energy market, along with near-term energy market enhancements needed to meet these goals

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The attributes of an efficient energy market with high renewables penetration need to be explored.

Current energy market design may not be compatible with the CLCPA mandates.

CURRENT ENERGY MARKET DESIGN

- Variable, intermittent resources amplify price volatility – still relatively muted today
- Day-ahead and Real-time prices driven by natural gas prices
- Nodal market clearing prices, with infra-marginal units earning rents
- Regulation and reserves provided by existing resources
- Operating reserves provided by committed but unloaded dispatchable capacity
- Power price spikes of limited magnitude compared to those observed in energy-only markets like ERCOT under scarcity conditions

RENEWABLES DOMINATED ENERGY MARKET

- Renewable resources have (near) zero variable costs, reducing and flattening LBMPs
- Energy market spreads may not be enough to cover round-trip efficiency hurdles and support storage; new market monitoring tests may be needed for low-variable cost resources
- Net load ramps will be steeper leading to more cycling of thermal plants that remain in the market
- Reduction in energy market revenue places greater emphasis on expanding ancillary service revenues
- Weather-dependence of wind, solar might not always track load
- Potential for curtailment and negative pricing – even in the absence of transmission constraints
- Investment in flexible, dispatchable, controllable resources necessary to meet future reliability needs

Other market products are also impacted – for example, the reserves market pays for opportunity costs associated with not bidding into the energy market. All else equal, these opportunity costs would effectively diminish in a high-penetration renewables market.

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Transitioning to a renewable energy dominated supply mix presents unique energy market challenges.

Immediate issues to be addressed:

Price formation, including negative power prices

Net load ramping requirements – function of generation technologies

Curtailment of renewables

Matching demand and meeting reliability requirements

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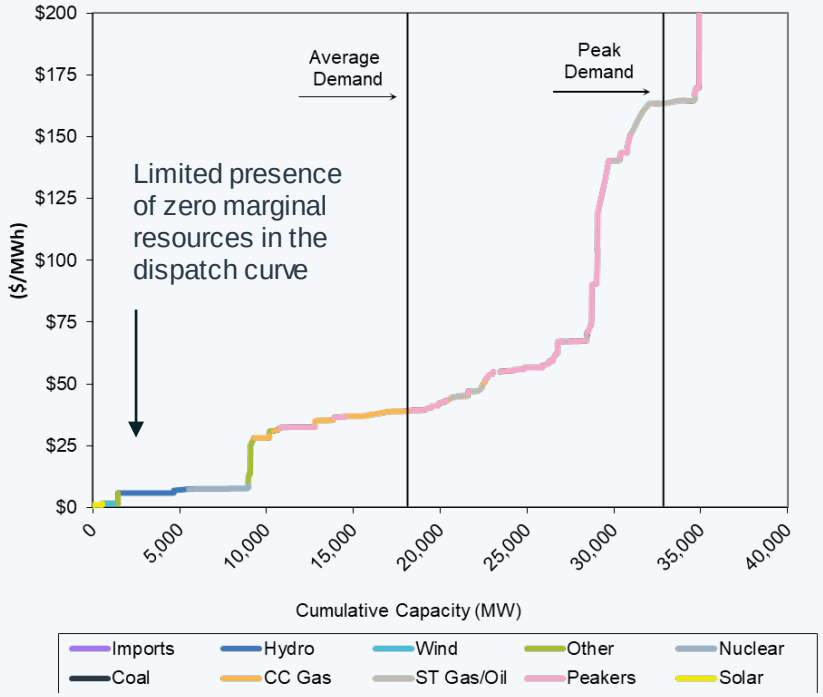
Zero marginal cost resources suppress market-clearing power prices, and diminish energy margins.

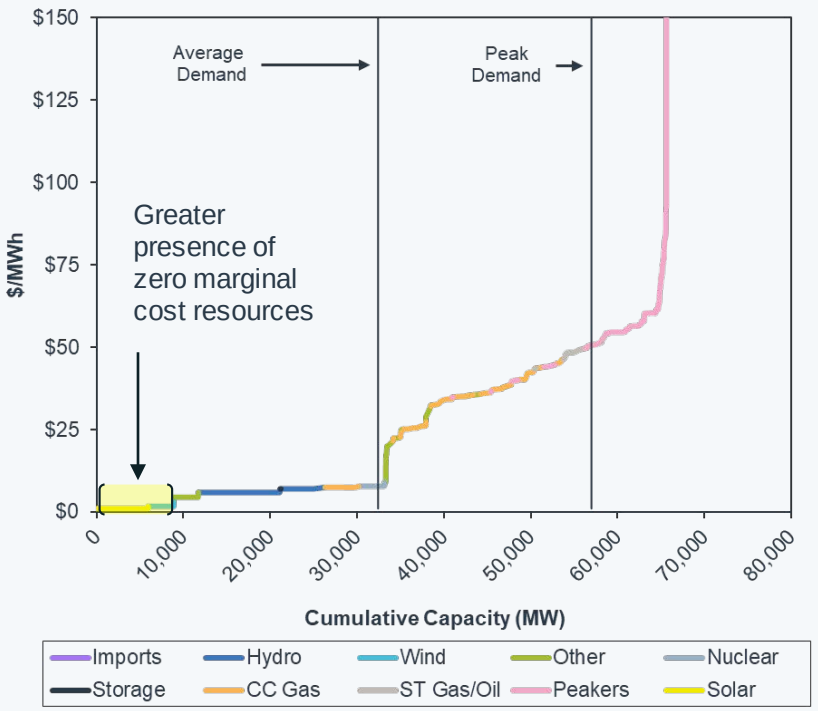
Absent market design changes, CLCPA mandates could lead to a supply stack dominated by resources with near-uniformly low marginal costs - this is already being observed in markets like CAISO and ERCOT. Production-based incentives like the Production Tax Credit and REC contracts encourage negative bidding.

NYISO 2020 Dispatch Curve



- Dominated by units which run and bid based on variable costs (fuel costs) and typically set the market price.
- Subsidized resources (price takers) supply baseload energy

CAISO 2020 Dispatch Curve



- High penetration of zero marginal cost resources can lead to negative prices in hours of lower demand
- Overproduction in some hours leads to curtailment (for both economics and reliability)

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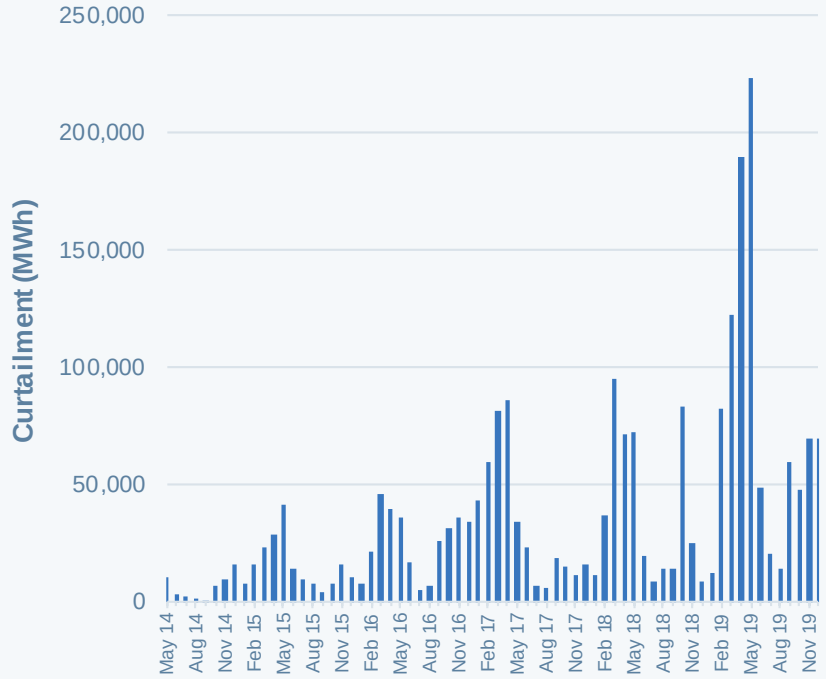
The risk of curtailment will need to be addressed to handle the high penetration of renewables in New York.

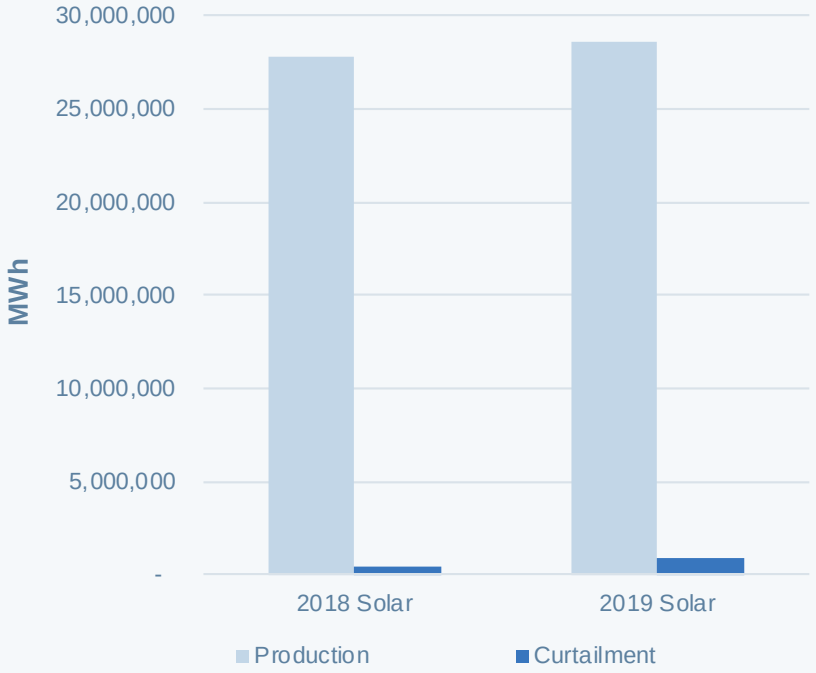
California provides insight into the level of curtailment which may occur in a system with high levels of renewables. At about 40% renewables penetration (as a % of retail load), CAISO is already seeing meaningful and increasing levels of curtailment. All else equal, increasing renewables on the system could exacerbate that.

Annual Aggregate CAISO Wind and Solar Curtailment 2014 - 2019



Source: CAISO

Annual CAISO Solar Production and Curtailment 2018 - 2019



Source: CAISO

Solar energy was curtailed, at least partially, for 38% of all five minute intervals throughout 2019 in CAISO. In addition, **annual curtailment of solar increased from 1.6% of production to 3.2% of production between 2018 and 2019**.

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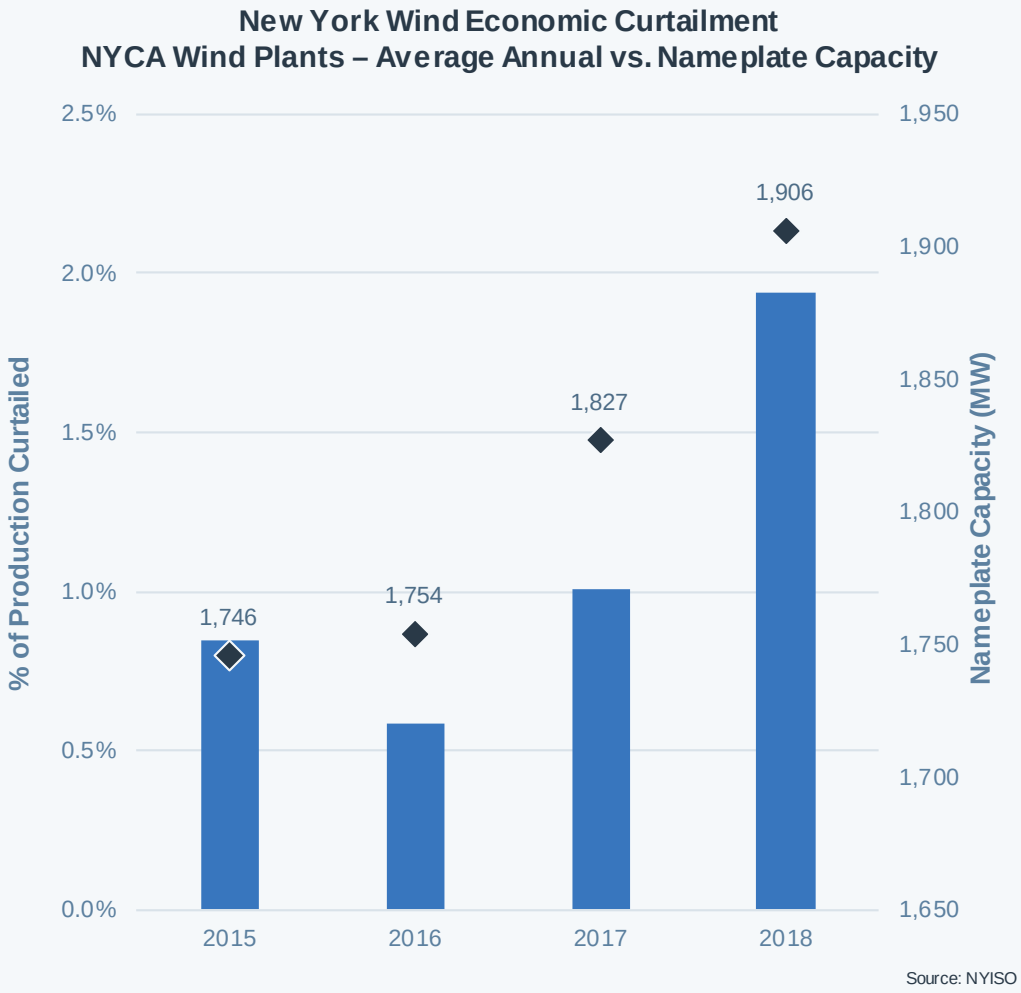
NYCA wind plants are already seeing meaningful and increasing percentages of economic curtailment.

- Despite the limited nameplate capacity of wind (~2 GW in 2018) in New York State, plants are already seeing increasing levels of curtailment
- The CLCPA's 9 GW offshore wind mandate alone will require more than a 4x increase in nameplate wind capacity above today's levels
- A similar dynamic is likely to be observed through the addition of utility-scale solar and land based wind



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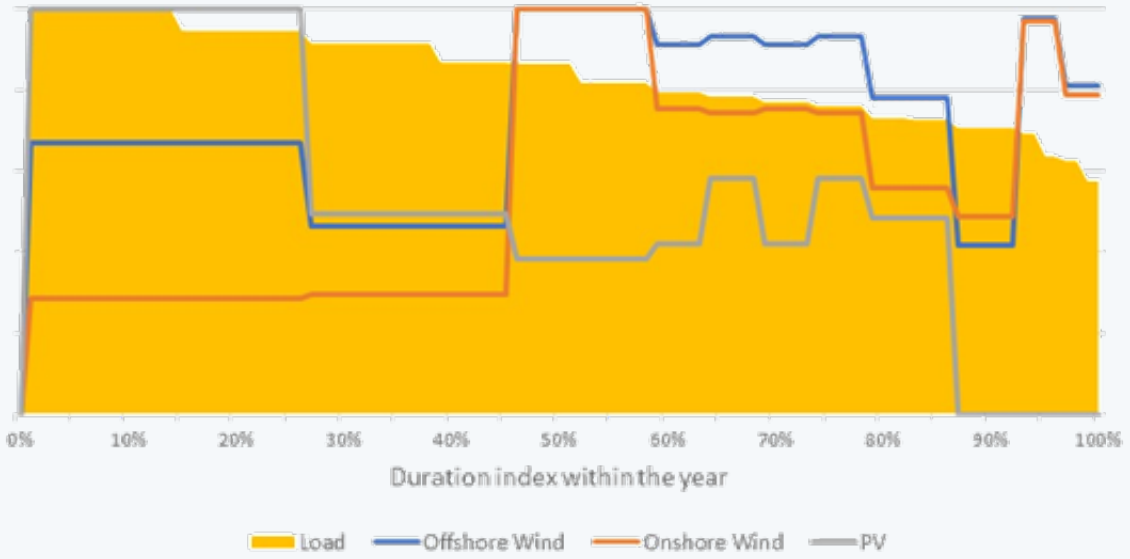
Even without transmission constraints there could be significant renewable curtailment by 2030.

Meeting a 70% CES will require sizable expansion of wind and solar capacity

Onshore wind and photovoltaics are low capacity factor resources

Even taken together, renewables' output misses large chunks of NYISO's load shape



If wind and PV are used to achieve the CES, there may well be significant overproduction and curtailment in some periods

Overproduction relative to NYCA-wide load – not a transmission issue

3,000 MW of new storage may not be enough to avoid curtailment

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Renewables must be supplemented with resources like dispatchable generation and/or energy storage and transmission.

Challenges to reliability and affordability:

1. Flexible, dispatchable, reliable energy typically provided by thermal fleets that are not being replaced
2. Penetration of non-firm variable and intermittent generation resources that are unable to match output with load one-for-one (and thus have low UCAP credits)
3. Peak load shifting into later hours
4. Limited controllability of BTM resources/DERs

Potential **solutions** to support a high-renewables penetration electricity system:

1. Additional energy storage
2. Low capacity factor peaking units utilizing an increasing share of fuels derived by renewable electricity
3. Market products that incentivize reliability (e.g., controlled output from renewables, more granular ancillaries, payments for ramp-ability, etc.)
4. Load flexibility
5. Transmission upgrades to allow export of surplus renewable generation to other zones or RTOs

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