NEPOOL IMAPP Stakeholder Discussion August 30, 2016

Capacity markets & efficient renewable procurement in a carbon-constrained world:

Two-Tier Pricing

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I. Objectives and Context

Market & policy design goals

1. Ensure that the Forward Capacity Market continues to support investment in existing and new resources where and when needed, while accommodating State actions to meet carbon goals.

2. Explore a market-based forward procurement strategy for renewable generation resources to improve overall investment efficiency.

These goals are initial steps towards establishing the market mechanisms necessary to competitively deploy clean energy *MWh* and *MW*

Challenge: to create an investment climate that supports the "4 Product Future"

'4 product future'

1 **Renewables**

- ✓ Renewables will provide the vast majority of energy needed by consumers. Utility-scale renewables growth will track strongly along existing (and expanding) state RPS targets. Distributed renewables will also grow, enabled by rate design, state policies, consumer demand and improving economics.

2 **Storage**

- ✓ Utility-scale or commercially-sited energy storage can balance variable renewables generation and manage peak demands while providing critical grid support products (e.g. ancillaries).

3 **Controllable demand**

- ✓ Smart, controllable loads, e.g. connected water heaters, will become pervasive in end-use devices and can address capacity / demand-shift challenges imposed by high penetrations of weather-dependent renewables. This will provide value to customers and the grid.

4 **Fast-ramping gas**

- ✓ Fast-start gas capacity can provide flexible, dispatchable capacity to ramp as needed to balance renewables.

IMAPP solution set

- ✓ **Carbon Shadow Pricing** – enhances energy market revenues for non-emitting resources in the near term.
- ✓ **Forward Clean Energy Market (FCEM)** – Potential market-based structure for financing new renewables.
- ✓ **Two-tier Pricing in the Forward Capacity Market (FCM)** – maintains price signals and revenue for existing and needed new conventional resources during market transition.

Today's presentation focuses on the context and market mechanics underpinning two-tier pricing in the FCM

II. Why Focus on the Capacity Market?

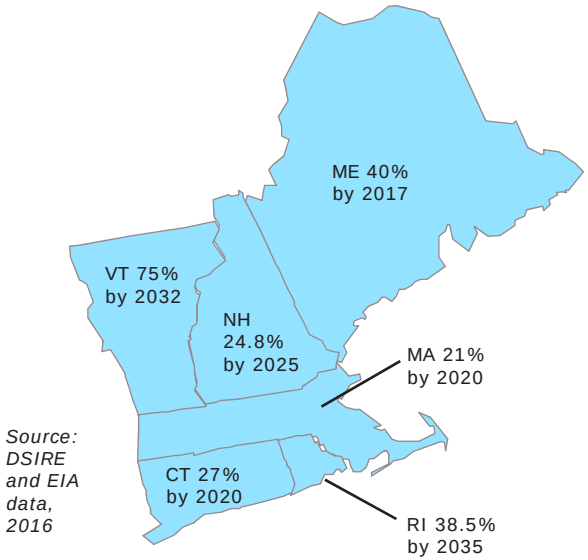
Capacity markets are critical for enabling a clean energy future

- ✓ ISO-NE states have ambitious renewable energy deployment and carbon reduction targets (e.g. MA's Global Warming Solutions Act).
- ✓ Public policy generally focuses on deploying zero-carbon, renewable *MWh* – however, equally important are *dispatchable*, high-performance capacity resources – *MW* – necessary for operational security and reliability in a renewables-centric power system. Capacity markets are the primary tool for competitive capital allocation to drive investment in these dispatchable, clean MW.
- ✓ Capacity markets must also support existing resources as long as they are needed and enable investment in economic conventional and renewable resources. Over time, FCM (perhaps complemented by FCEM) should become the vehicle for financing all resources, including renewables.

Two-tier pricing is a necessary mechanism as markets evolve to transition today's fleet into a mix of renewables and storage complemented by flexible, fast-ramping resources

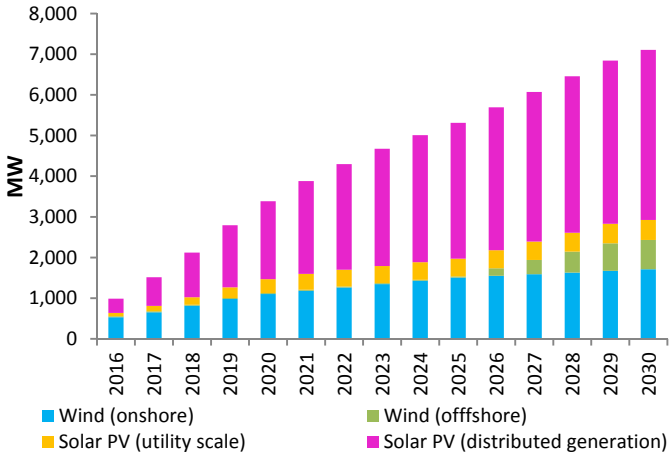
New England states have ambitious goals for deploying renewables

New England Renewable Portfolio Standards (RPS), by state and year



Source: DSIRE and EIA data, 2016

Est. renewable capacity additions in ISO-NE, by resource and year



Source: Data from IHS CERA North America Power Market Fundamentals Rivalry Apr 2016, assumes state RPS goals and eventual federal climate policy post-2025.

✓ The combined New England state RPS targets are projected to comprise a minimum of **28% of the region's retail sales coming from renewable sources in 2030-2035**. Based on 2015 EIA data and ISO-NE generation data, renewable energy represents **8% of ISO-NE states' total retail sales in 2015**.

✓ By 2030, additional renewable capacity could equal 23% of ISO-NE's 2015 capacity base, according to some estimates.

As renewables become the dominant form of generation in the power system, the capacity market will become more important

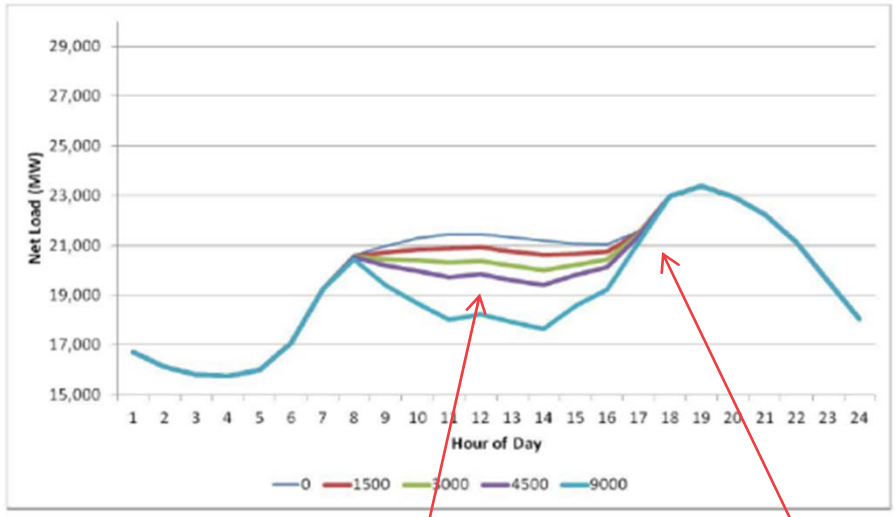
States continue to pursue out-of-market contracts

- ✓ While an FCEM may ultimately fund development of renewables, New England states are currently engaged in pursuing long-term contracts for renewable energy resources.
- ✓ Such contracts include a three-state RFP for up to 5 TWh/yr (or more) of clean energy; perhaps as much as 1,900MW.
- ✓ Massachusetts' new statute calls for 9.45 TWh/yr of clean energy and 1,600MW of off-shore wind.
- ✓ Without a mechanism to protect FCM price formation, these contracts could cause significant price suppression, dampen investment signals for new fast-start resources, and lead to premature retirements with long-lasting consequences as we transition to FCEM and a renewables-centric fleet.

Successful renewables integration requires new investment in fast-start, flexible capacity

- ✓ Increased penetration of renewables will reshape supply-demand dynamics in the power system, such that net load ("load minus renewables") drops during the day and overnight, and relatively peaks during earlier morning and later evening hours.
- ✓ California's renewables-centric load shapes are not exclusively a West Coast phenomenon. The chart shows what an emerging East Coast "duck" curve might look like in New York.
- ✓ Fast-start, flexible capacity resources are necessary for backing-up a renewables-centric power system.
- ✓ A high performance, gas-fired, capacity 'backbone' is a necessary component of a renewables-centric, low-carbon future.

From the "Duck" to the "Platypus":
NY Winter Net Load with Levels of Solar Integration (MW)
(3,000 MW penetration represents NY-Sun 2024 target)



Source: NYISO's Solar Integration Study

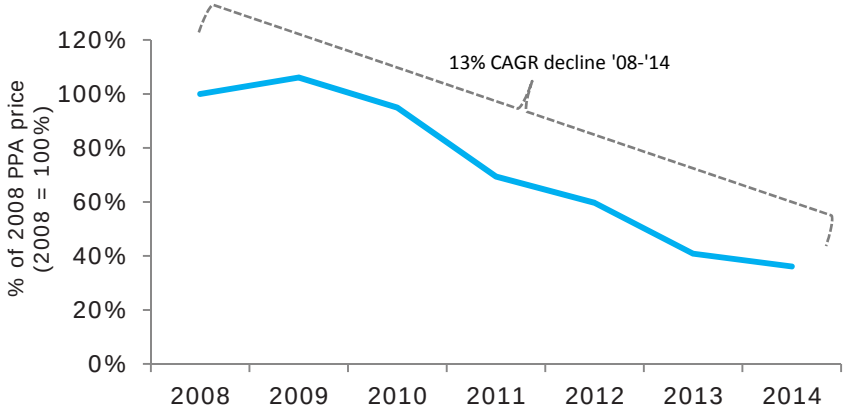
Increasing quantities of solar generation relative to load reduces net load, dampening wholesale prices.

Post-sundown solar drop-off, and increased demand, results in fast-start, flexible capacity resources.

Capacity markets will need to facilitate investment into high-performance, flexible MWs to support renewables

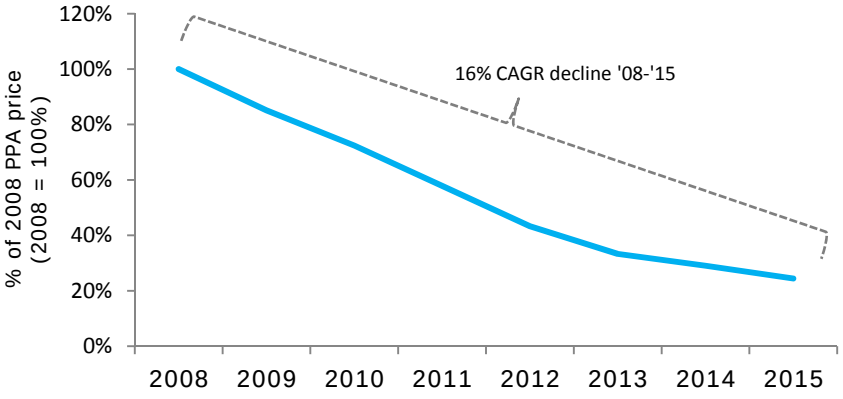
Ongoing cost declines bode well for new, innovative financing mechanisms for renewables – like the FCEM

Generation-weighted levelized wind PPA prices as a percentage of the 2008 price
by year of PPA execution date, national avgs



Source: LBNL, NREL data

Generation-weighted levelized solar PV PPA prices as a percentage of the 2008 price
by year of PPA execution date, national utility-scale avgs



Source: LBNL, NREL data

As technology costs continue to decline, FCM and a potential FCEM could become viable paths to finance new renewables

III. Two-Tier Pricing

Rationale behind a two-tier capacity market proposal

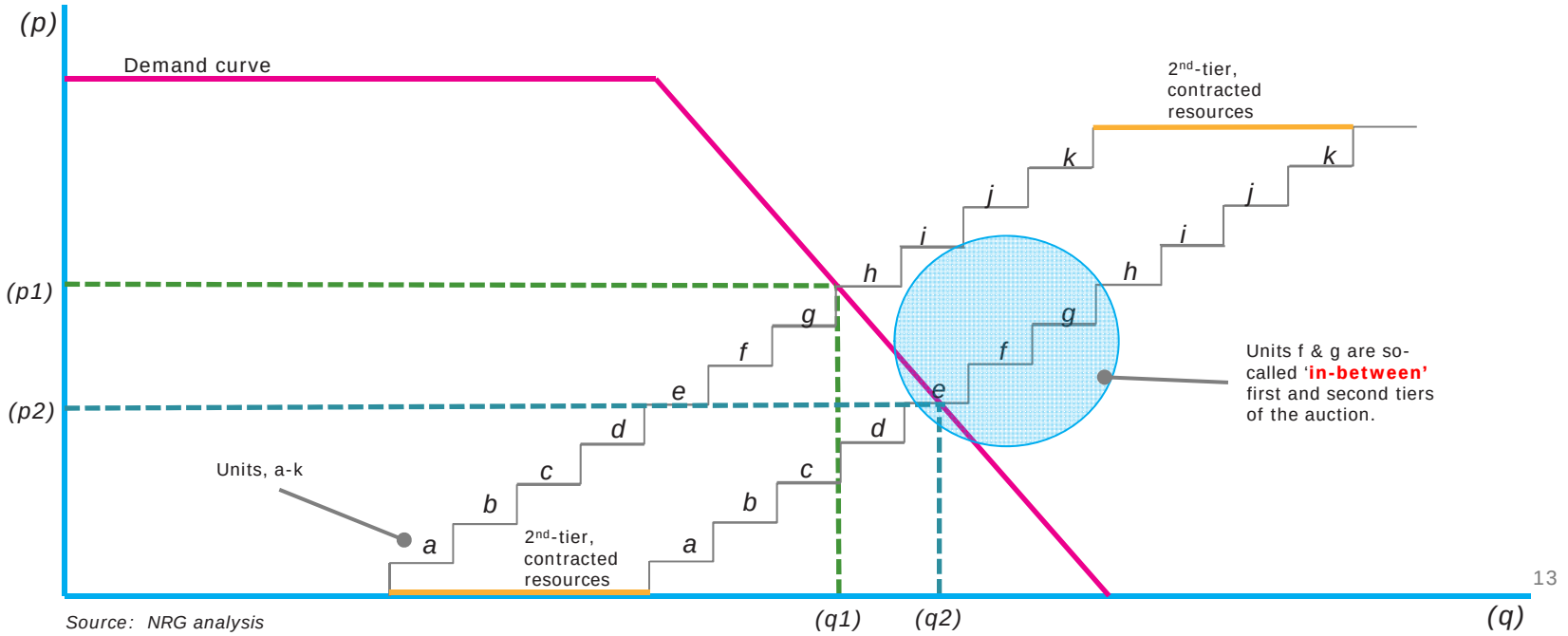
Goals:

- ✓ Create a financeable capacity market structure that continues to incent investment when and where needed, even as state-contracted resources proliferate.
- ✓ Ensure that resources relying on market revenues receive adequate revenues to maintain reliability.
- ✓ Allow state-contracted resources to assume a CSO and contribute to meeting net ICR, while recognizing that their fixed-cost recovery is coming from outside the market.
- ✓ Ensure that all resources have similar performance obligations.

Two-tier pricing supports existing and needed new investment and provides states the flexibility to contract to meet carbon goals, while evolving toward competitive, in-market entry by renewables

Mechanics of two-tier pricing – NRG Proposal

- ✓ The capacity auction would occur in two stages. All resources, including resources receiving out-of-market contracts to support state policy goals, would be subject to offer price mitigation in the 1st stage. The 1st stage of the auction would clear a quantity q1 at price p1 in the diagram below.
- ✓ In the 2nd stage, any resources receiving out-of-market revenues and not cleared in the 1st stage would be entered into the auction as price-takers, but with no changes to other resources' offers. The second stage would establish a clearing price p2.
- ✓ Resources receiving out-of-market revenues that did not clear in the 1st stage of the auction would get paid p2; all other resources that cleared the 1st stage would get paid p1.
- ✓ All resources may be subject to pro-rating to manage auction quantity and cost (see subsequent slides).
- ✓ Offer floor mitigation would apply in subsequent years to resources receiving out-of-market revenues until the resource clears in a 1st–stage auction.



Source: NRG analysis

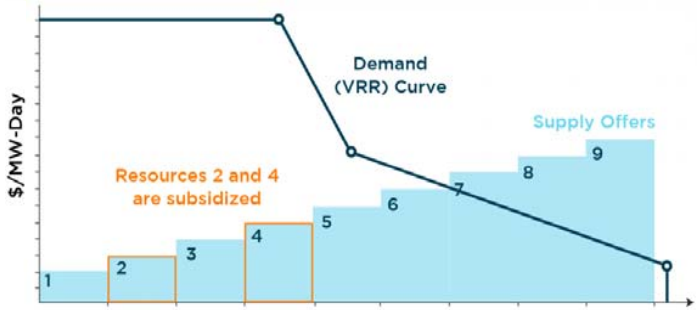
PJM has also discussed capacity market reforms, and offered a version of two-tier pricing

- ✓ To accommodate both state policy goals and competitive markets, PJM has released a discussion proposal that includes a two-tier pricing mechanism.
- ✓ PJM's proposal seeks to balance several aspects that underlie the changes necessary ahead to establish a low-carbon power system:
  - o Enable states to pursue public policy objectives;
  - o Protect price formation / competitive signals in power markets;
  - o Avoid or manage the over-procurement of energy resources.
- ✓ NRG agrees with these goals, though we arrive at different design choices to achieve them.

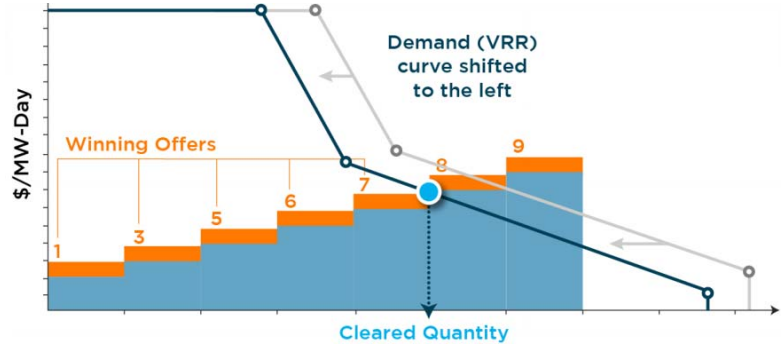
High-level summary of PJM's capacity proposal offered during Grid 20/20

(Source: PJM Grid 20/20 slides)

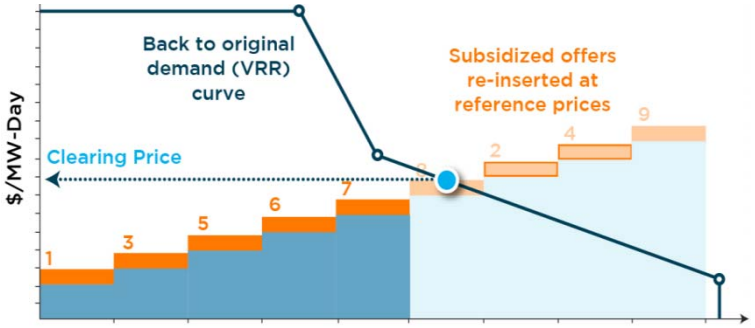
Identify 'subsidized' resources during capacity auction



Shifted demand curve clears against reorganized supply stack



Subsidized resources re-inserted at reference prices



Design considerations for two-tier pricing

NRG analysis, PJM proposal, and market participant feedback have identified several design aspects to explore:

- ✓ The application of offer floor mitigation.
- ✓ Mechanics of the auction; constructing the offer curve; clearing demand.
- ✓ Treatment of ‘in-between’ resources.
- ✓ Interaction of FCM with FCEM for pricing, offer incentives, mitigation and price formation.

Application of Offer Floor Mitigation

NRG's perspective: to fully develop a clearing price without price impacts of state policy (SP) contracts, offer floor mitigation would apply to all resources (new and existing) that receive 'out-of-market revenues' as defined in ISO-NE MR1 Appendix A.21:

> "Out-of-market revenues are any revenues that are: (a) not tradable throughout the New England Control Area or that are restricted to resources within a particular state or other geographic sub-region; or (b) not available to all resources of the same physical type within the New England Control Area, regardless of the resource owner," or
>
> "supported by a regulated rate, charge, or other regulated cost recovery mechanism"

SP Resources would be subject to offer floor mitigation in subsequent auctions until cleared at the 'P1' price.

- ✓ Replace RTR Exemption with two-tier pricing; including elimination of the 200MW/600MW caps

Other options or points for consideration?

Auction mechanics

NRG's perspective: Using the unadjusted demand curve produces the most accurate pricing; pro-rating for in-between resources reduces risk and maintains incentive for marginal cost offers

Other points for consideration:

- ✓ Clear against the full demand curve, or an adjusted curve (as proposed by PJM)?
- ✓ Ensuring incentives for submittal of competitive offers:
  - o Descending clock vs. sealed-bid?
  - o Incentives to shade offers to clear at the lower price and get paid the higher price?
  - o Order of establishing price with and without the state policy resources as price-takers?
- ✓ Others?

Treatment of In-between Resources

NRG's perspective: Two-tier pricing creates a set of resources that would clear at the higher price but not at the lower price (the 'in-between' resources). The potential for these resources to receive *no* CSO even though the clearing price is above their offer creates risk and distorts offer incentives. Pro-rating for in-between resources reduces risk and maintains incentive for marginal cost offers

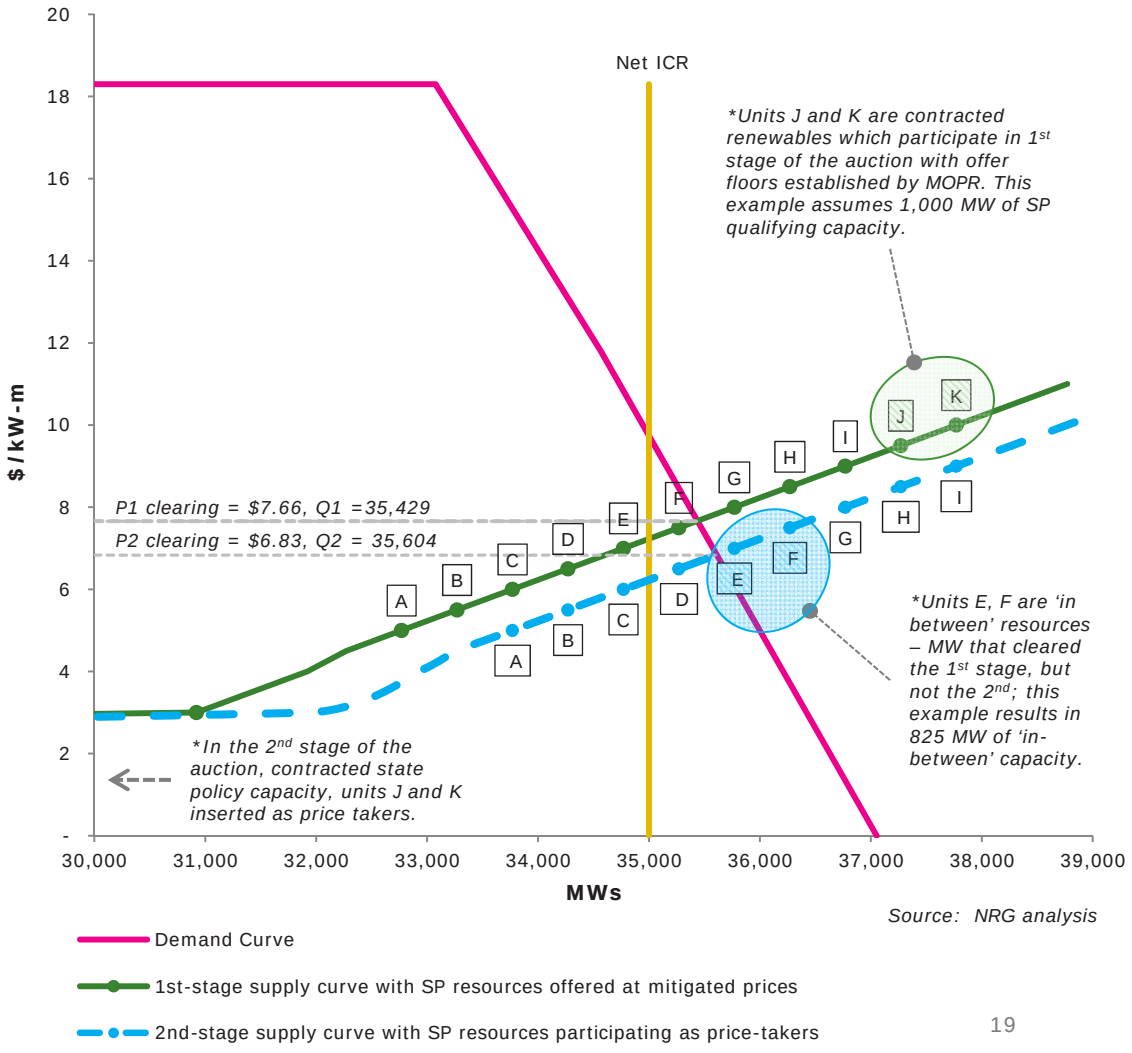
Other points for consideration:

- ✓ Award a full CSO to in-between resources?
- ✓ Award no CSO to in-between resources (as proposed by PJM)?
- ✓ Pro-rate quantity? Pro-rate price?
- ✓ What is the 'basis' for pro-rating: total market cost? Total market quantity? Some other benchmark?
- ✓ Others?

An example for considering in-between resources

- ✓ With full application of mitigation, i.e., all resources offering at a competitive level, the clearing price in this example is $7.66/kW-mo, and the cleared quantity is 35,429MW.
- ✓ The total market cost is $7.66/kW-mo x 35,429MW = $3,257 million
- ✓ With 1,000MW of State Policy (SP) Qualified Capacity inserted as price-takers in the 2nd stage, the clearing price is $6.83/kW-mo, and the cleared quantity is 35,604MW
  - o Because of the slopes of the supply and demand curves, the in-between resources in this example are 825MW, less than the 1,000MW of SP resources
- ✓ The total (market) cost of the second stage would be $6.83/kW-mo x 35,604MW = $2,918 million
  - o This is the price-suppression effect of out-of-market capacity
  - o Out-of-market payments to SP resources would be an additional cost to consumers.

Illustrative two-tier auction pricing

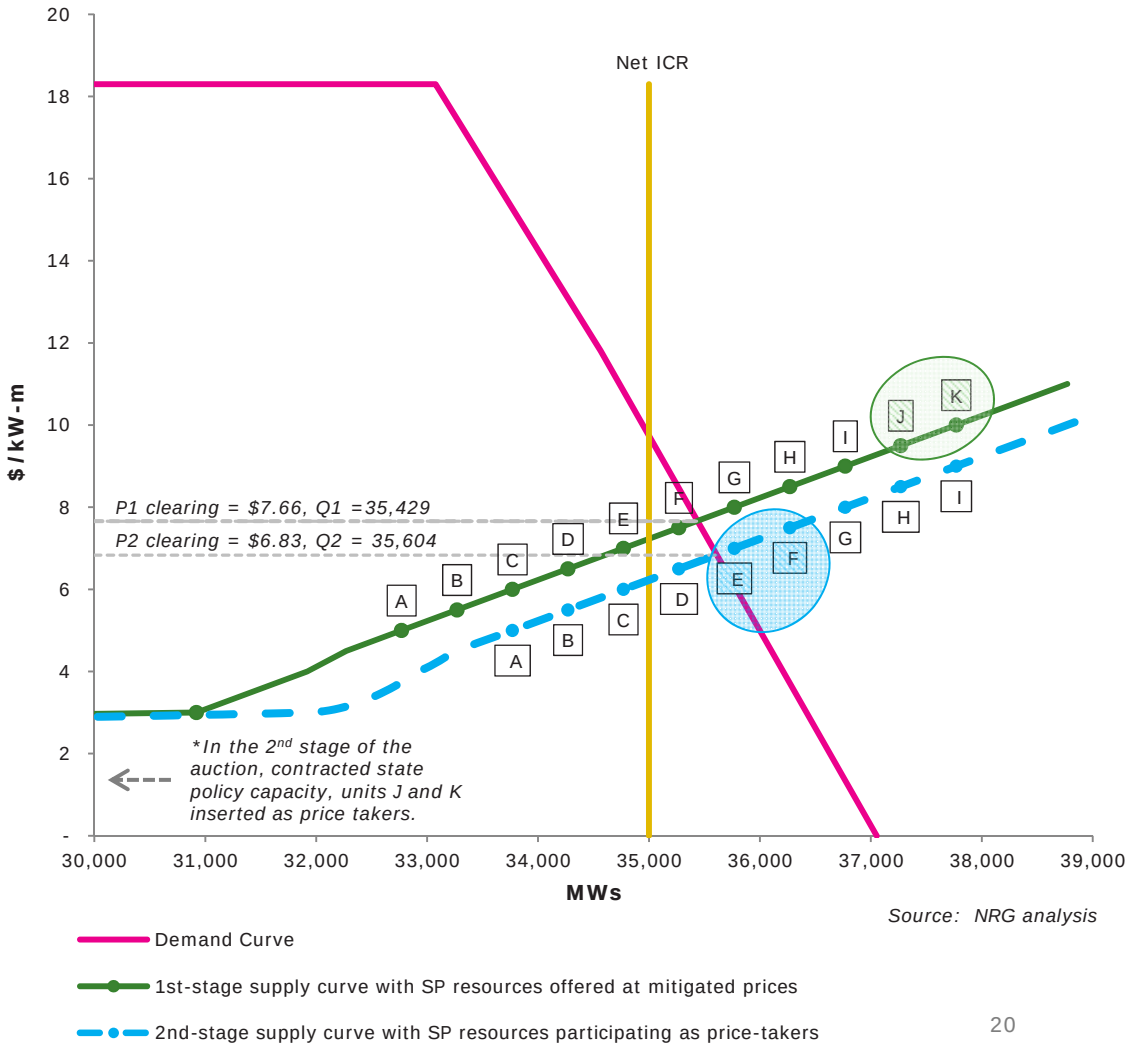


Source: NRG analysis

Treatment of in-between resources – one 'bookend'

- ✓ At one extreme, all 'in-between' resources would get a full CSO
- ✓ The total (market) cost for this approach is:
  - o (P1 X Q1) + (P2 x Q*sp*), or
  - o ($7.66/kw-mo x 35,429MW) + $6.83/kW-mo x 1,000MW) = $3,339 million
- ✓ In this approach, the market purchases more capacity than specified by the demand curve at either P1 or P2, and results in a higher cost than the 'fully mitigated' market
- ✓ The out-of-market payments to SP resources would be an additional cost to consumers

Illustrative two-tier auction pricing

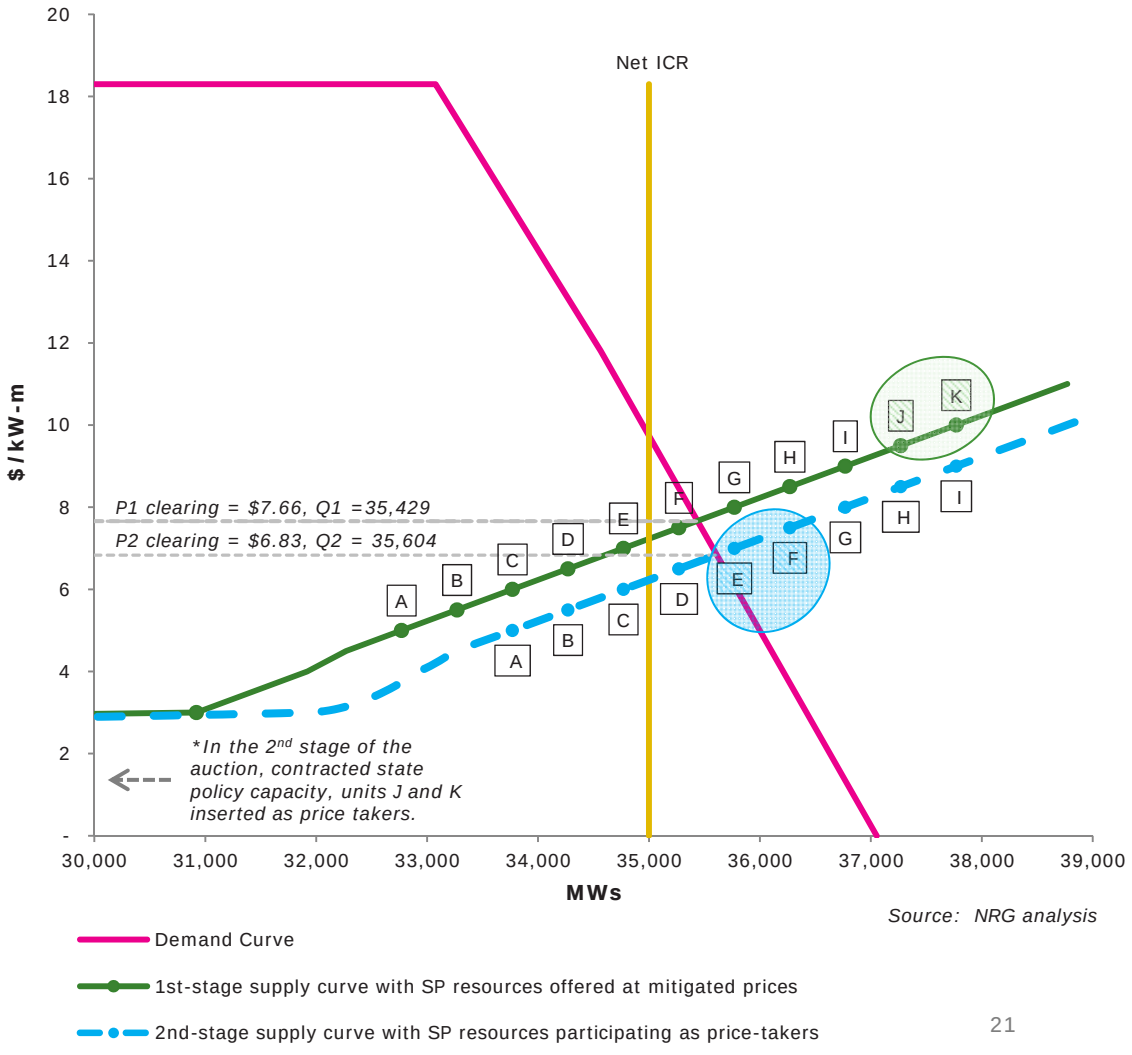


Source: NRG analysis

Treatment of in-between resources – the other 'bookend'

- ✓ At the other extreme, there is no CSO awarded to 'in-between' resources.
- ✓ If the 825 MW of in-between capacity of Units E & F receives no CSO, the total (market) cost would be:
  - o (P1 x (Q1 – $Q_{in\text{-}between}$)) + (P2 x Q*sp*), or
  - o $7.66/kW-mo x (35,429-825)MW + $6.83/kW-mo x 1,000MW = $3,263 million
- ✓ This approach leads to higher risk for resources anticipating being 'in-between,' which is likely to show up in offer behavior.
- ✓ If a resource's actual marginal costs are anticipated to be between P1 and P2, creates incentives to reduce offer to get below P2 in order to receive P1, which could affect price formation for P1 as well as for P2.
- ✓ The out-of-market payments to SP resources would be an additional cost to consumers

Illustrative two-tier auction pricing

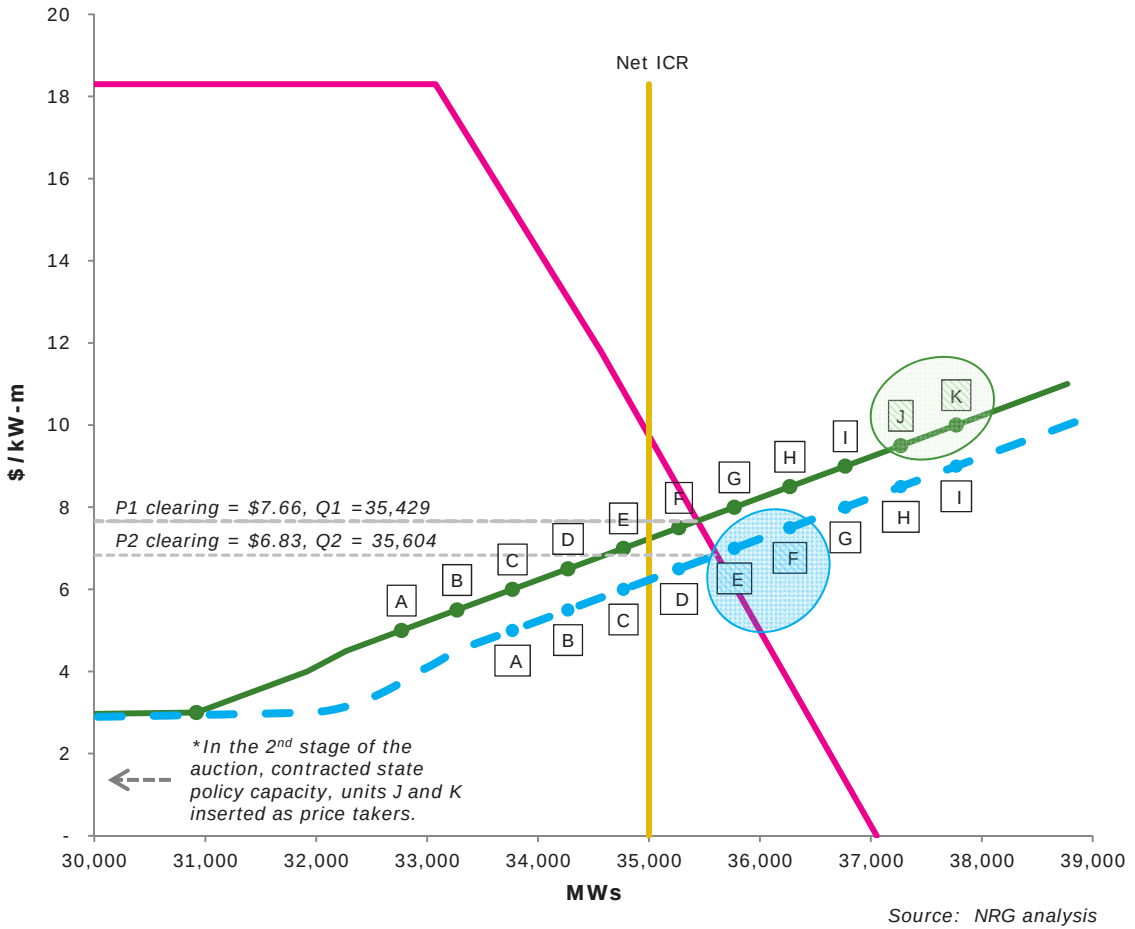


Source: NRG analysis

Treatment of in-between resources – a middle option

- ✓ One approach to managing over-procurement is to pro-rate CSO quantity for all resources cleared at P1 and all SP resources.
  - o For example, pro-rate all CSO awards so that the resulting total (market) cost is equal to the mitigated case, P1 x Q1
  - o In our example, the pro-rating factor would be 3,257/3,339 = ~97.5%. A 100MW resource would receive a 97.5MW CSO.
- ✓ All resources being paid in the capacity market share the cost of the additional quantity purchased
- ✓ Other pro-rating approaches could be chosen, e.g., limiting total quantity to no more than the quantity that would clear at P2, or perhaps some other benchmark.
- ✓ Pro-rated quantity would be eligible for reconfiguration auctions, including SP resources that have not yet cleared at P1.

Illustrative two-tier auction pricing



Source: NRG analysis

Treatment of in-between resources – summary comparison

- ✓ **NRG's perspective:** Either of the 'bookend' approaches has clear negative impacts; to avoid or mitigate those impacts, NRG recommends a middle course.
- ✓ Two possible approaches to pro-rating CSO awards are illustrated here; there are others that could be explored

CSO award Options	Total Quantity Purchased (MW)	Total (Market) Cost
Full mitigation of OOM Resources	Q1 35,429	35,429MW x $7.66/kW-mo = $3,257 million
Option 1: *CSO for all resources*	Q1 + Q*sp* 35,429 + 1,000 = 36,429	35,429MW x $7.66/kW-mo + 1,000MW x $6.83/kW-mo = $3,339 million
Option 2: *No CSO for in-between*	(Q1 – Q*in-between*) + Q*sp* (35,429 - 825) + 1,000 = 35,604	(35,429 - 825)MW x $7.66/kW-mo + 1,000 x $6.83/kW-mo = $3,263 million
Option 3A: *Pro-rate MW to limit total costs*	(Q1 + Q*sp*) x (3,257 / 3,339) (35,429 +1,000) x 0.975 = 34,559 + 975 = 35,535	34,559MW x $7.66/kW-mo + 975MW x $6.83/kW-mo = $3,257 million
Option 3B: *Pro-rate MW to limit total quantity*	Q2 = 35,604MW Pro-rate Q1 and Q*sp* by Q2 / (Q1 + Qsp) 35,604 / (35,429 + 1,000) = 97.7%	(35,429MW x 0.977) x $7.66/kW-mo + (1,000 x 0.977) x $6.83/kW-mo 34,627MW x $7.66/kW-mo + 977MW x $6.83/kW-mo = $3,263 million
Others?		

Interaction of FCM and FCEM

Some points for consideration:

- ✓ Both markets are intended to support fixed cost recovery and enable cost-effective financing
- ✓ Which market clears first? Are FCEM resources required to / able to / prohibited from participating in FCM? How are rational offers established in each market? Does clearing in one market depend on clearing in the other?
- ✓ Are FCEM revenues treated as 'in-market' revenues for FCM mitigation (or vice-versa)? What are the implications of including/excluding these revenues for mitigation purposes?
- ✓ Others?

Questions?