NEPOOL Stakeholder Discussion
August 11, 2016

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

Pete Fuller

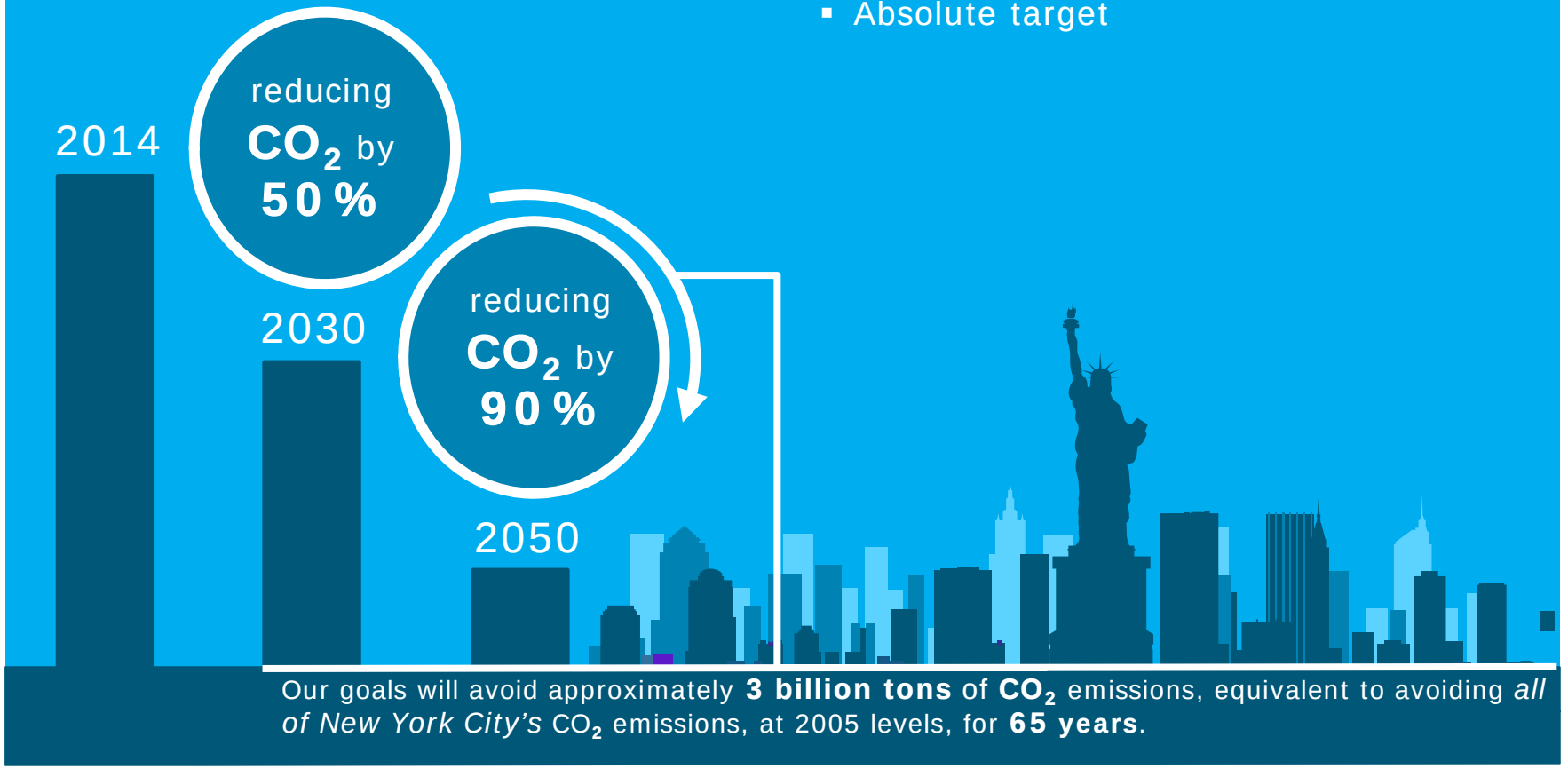
The new context for wholesale electricity markets

- ✓ Wholesale markets were designed to deliver reliability at the lowest cost;
  - o They were <u>not</u> designed to optimize for low carbon emissions;
  - o Our new challenge is to adapt the operation of electric markets to the imperative for lower carbon emissions;
- ✓ We should strive to do so in a cost-effective manner by improving investment incentives for cleaner generation while maintaining the investment role of wholesale capacity markets;
- ✓ We can utilize market mechanisms to achieve the maximum emission reductions at the lowest cost;
- ✓ A major aspect of the challenge is that the foundation of energy pricing has relied on heat rates and fossil fuels to set LMP. With increasing penetration of zero marginal cost energy sources, LMPs will trend down and be less remunerative.

NRG is committed to sustainability & a low-carbon future

NRG's GOAL | **Grow our business while:**

- 2014 baseline –125 million tons of CO_2
- Absolute target



Our goals will avoid approximately **3 billion tons** of **CO_2** emissions, equivalent to avoiding *all of New York City's* CO_2 emissions, at 2005 levels, for **65 years**.

Market & policy design goals

1. Ensure that the Forward Capacity Market continues to support investment in 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.

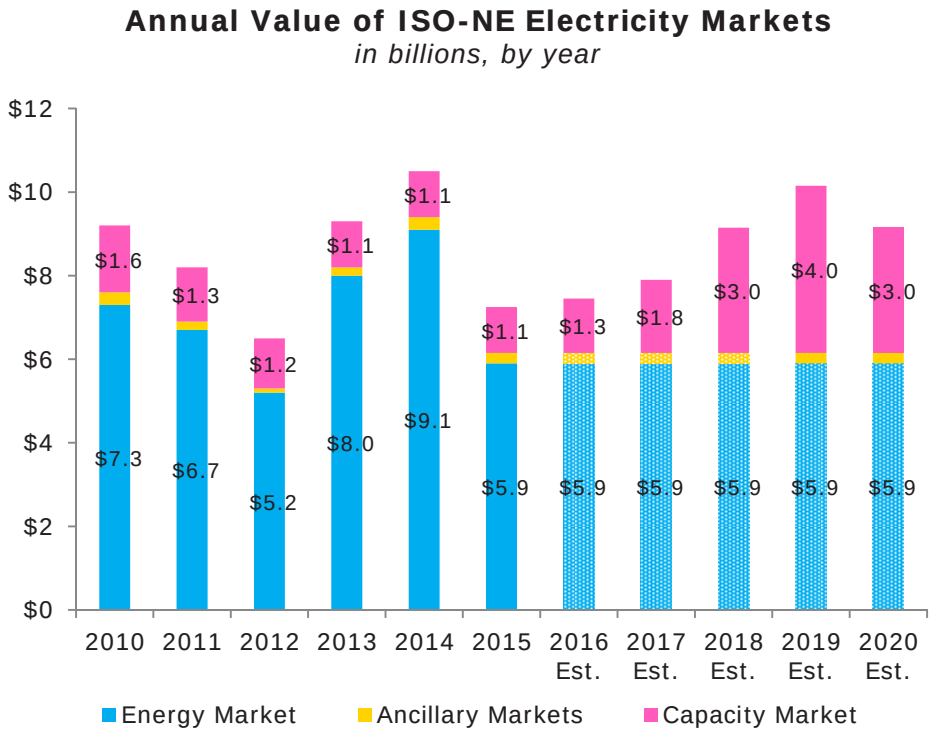


Capacity market reform proposal: two-tier pricing

Capacity markets must evolve as energy margins are compressed

We see two long-term trends occurring in the market as renewables penetration increases:

- ✓*Trend 1*: Energy revenues will decrease as more zero-marginal cost renewables come online.
- ✓*Trend 2*: A renewables-centric power system will necessitate the need for high performance, flexible ramping capacity.



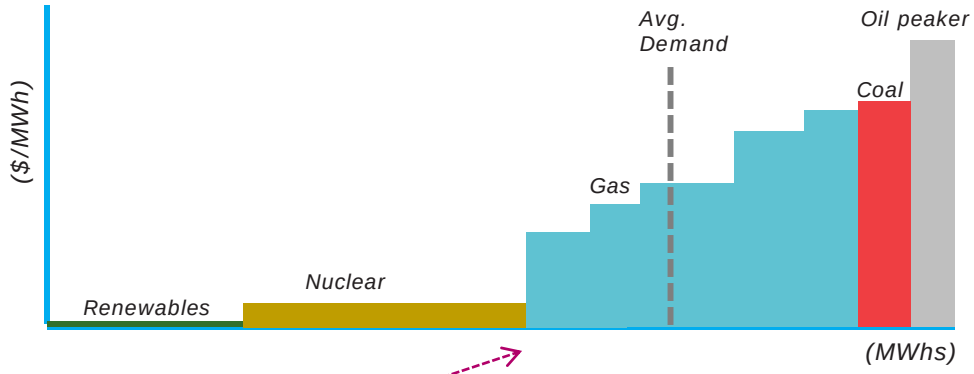
Source: ISO-NE

As energy revenues decrease, capacity market revenues become more important to the investment thesis

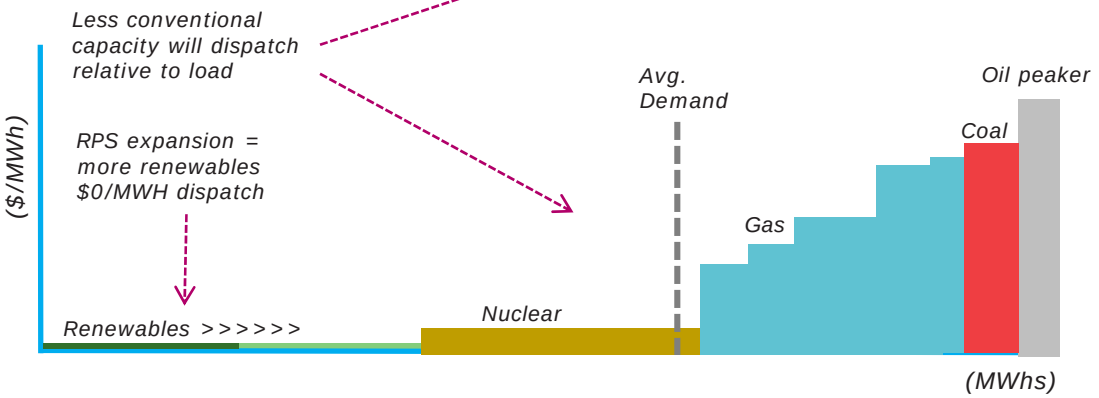
Trend #1: energy revenues generally decrease as renewables penetration increases

Illustration of power generation dispatch in competitive markets with increasingly levels of contracted renewables generation

Today: Status quo daily dispatch



Tomorrow: Ever-expanding RPS 'merit order' impact on daily dispatch

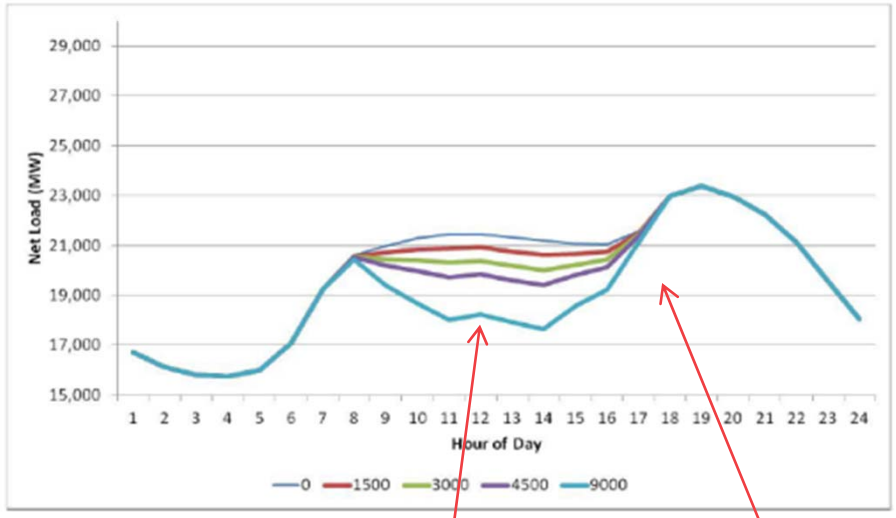


Source: NRG analysis

Trend #2: Successful renewable 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.

Challenge: to create an investment climate that supports the "Four 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.

Rationale behind a two-tier capacity market proposal

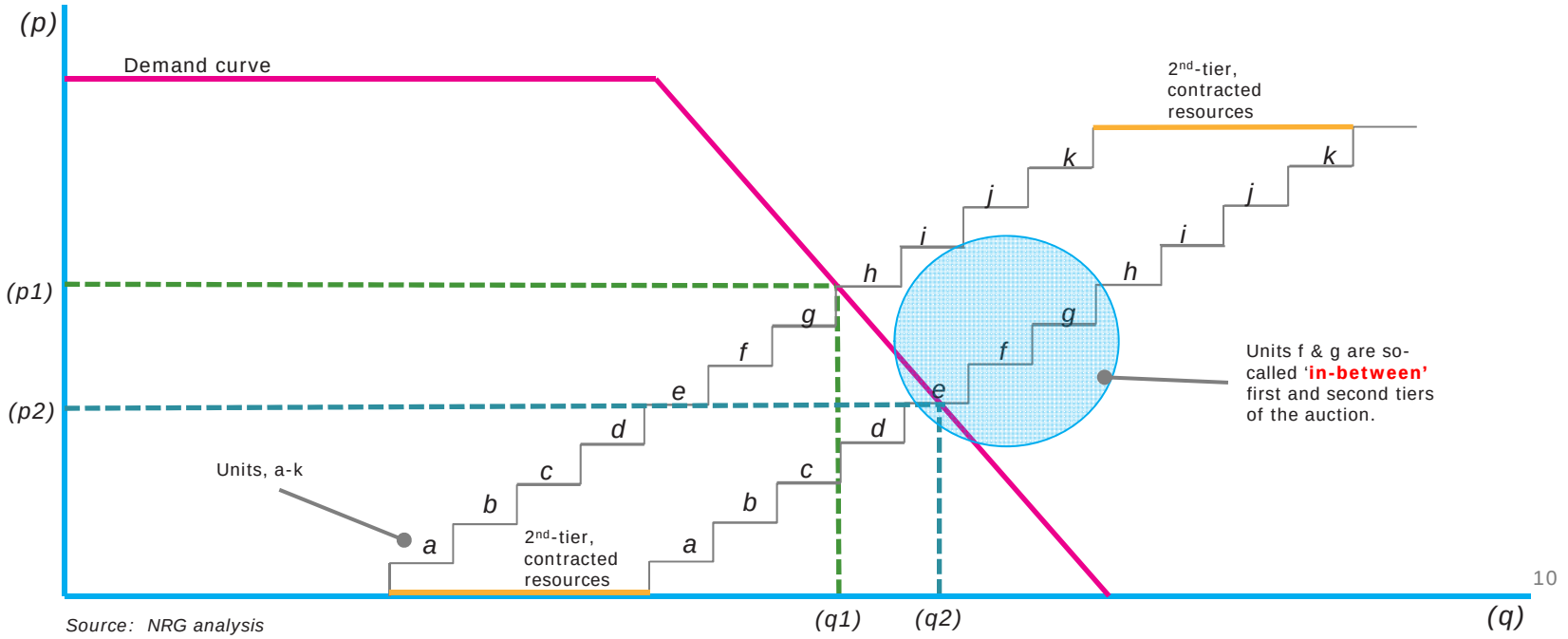
Goals:

- ✓ 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 clearing price to maintain reliability.
- ✓ Allow state-contracted resources to assume a CSO, 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 ensures reliability & continued investment, while providing states the flexibility to contract to meet carbon goals

Mechanics of two-tier pricing

- ✓ The capacity auction would occur in two steps. All resources, including resources receiving out-of-market contracts to support state policy goals, would be subject to offer price mitigation in the 1st step. The 1st-step auction would clear a quantity q1 @ price p1 in the diagram below.
- ✓ In the 2nd step, any resources receiving out-of-market revenues and not cleared in the 1st step would be entered into the auction as price-takers. The second step would establish a clearing price p2, using the same bid stack, other than the public policy resources.
- ✓ Resources receiving out-of-market revenues that did not clear in the 1st–step auction would get paid p2; all other resources that cleared the 1st –step auction would get paid p1, including the so-called 'in-between' units.
- ✓ Offer floor mitigation would apply in subsequent years to resources receiving out-of-market revenues until the resource clears in a 1st–step auction.



Source: NRG analysis

A few more thoughts on two-tier pricing

- ✓FERC previously expressed concern that two-tier pricing would procure more than NICR. That concern no longer exists in a downward sloping demand curve environment.
- ✓Resources which clear in the first auction, but do not clear in the second auction, fall 'in-between' the two market clearings. The treatment of so-called "in between" resources is a challenge. These resources represent the marginal resource needed for reliability in a purely competitive environment, but are not under the curve in the second pass.
- ✓If State contracted resources clear in the first auction, the resource then becomes an Existing Resource and is not subject to further mitigation.



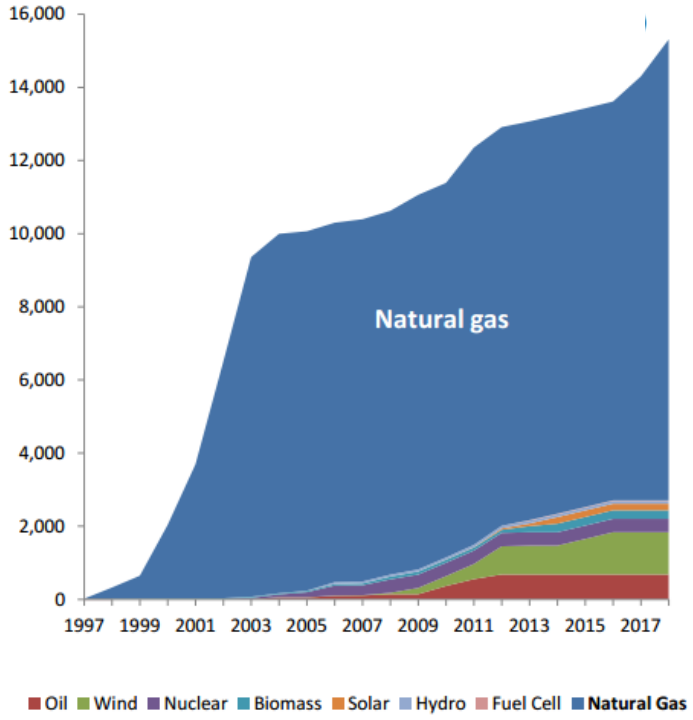
Centralized forward procurement of renewables

Financing New England's four product future

- ✓Two-tier capacity markets will support existing resources and new investment in conventional generation and demand-side resources, but will not finance renewables.
- ✓In the near-term, renewables will be financed based on long-term contracts for renewable attributes.
- ✓To continue the evolution of market-based investment, NRG recommends that New England consider a mix of carbon pricing and a centrally-administered, competitive, forward renewables market.

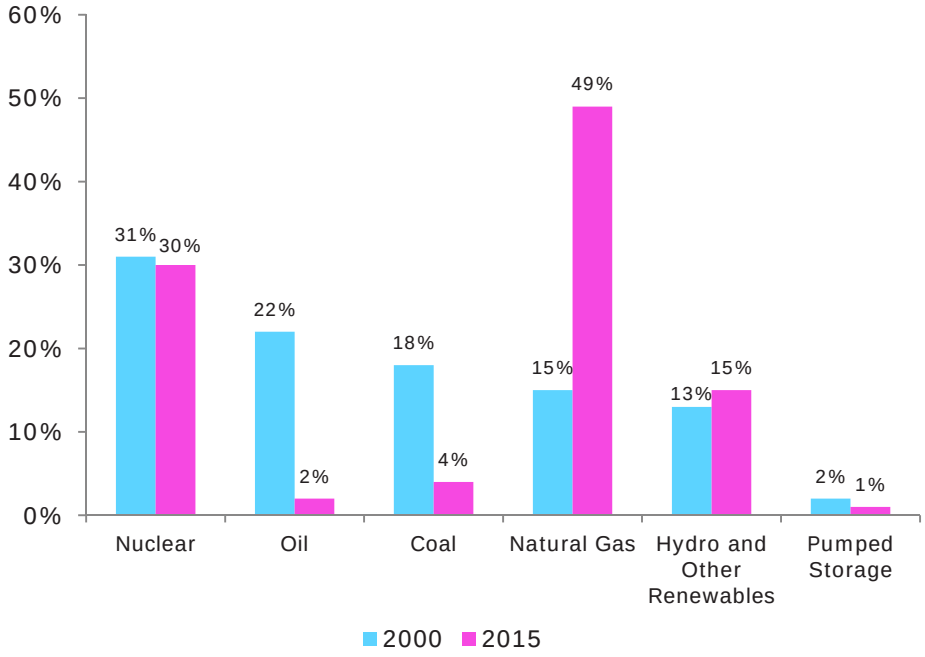
Current market design is successfully driving investment in natural gas resources

Cumulative New Generation Capacity in New England (MW)
1997-2018



Source: ISO-NE

Percent of Total Electric Energy Production by Fuel Type
2000 vs. 2015



Source: ISO-NE

Two-tier pricing reforms are designed to ensure that the capacity market will continue incenting investment in conventional generation, and enabling renewables to enter at their full competitive cost.

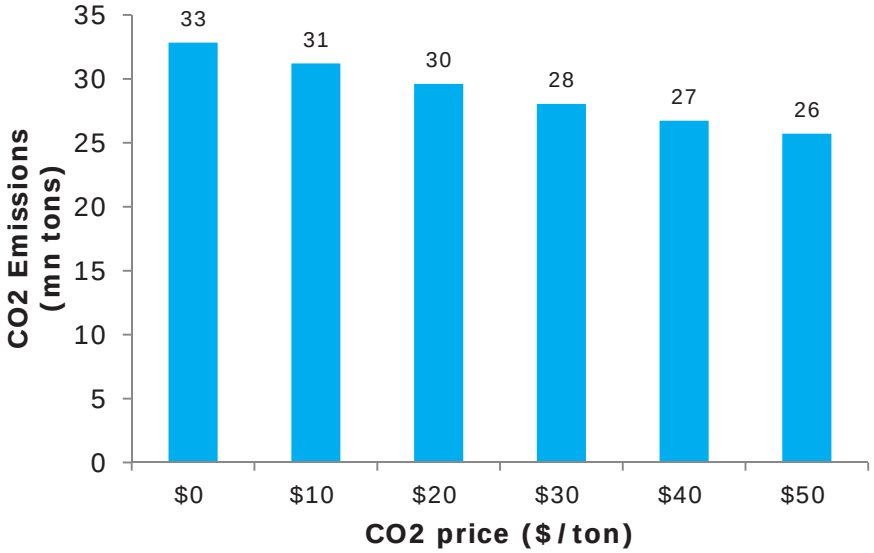
Carbon pricing can help reduce carbon to a point

Carbon pricing in New England:

- ✓ With virtually no coal left in the region's fuel mix, increased carbon pricing has a limited ability to alter the relative cost of fuels in the dispatch stack
- ✓ NRG dispatch modeling shows that progressively higher carbon prices result in, at best, only moderately lower CO2 emissions from the power sector in New England.
- ✓ In a gas-defined generation mix, there are limited marginal benefits to progressively higher carbon prices – even at 10x current RGGI prices
- ✓ Depending on program design, high carbon prices in New England may price the region out of carbon trading programs that emerge under the CPP or other coordinated CO2 mitigation efforts.

Est. Annual New England Power Sector CO2 Emissions

Assuming various carbon prices



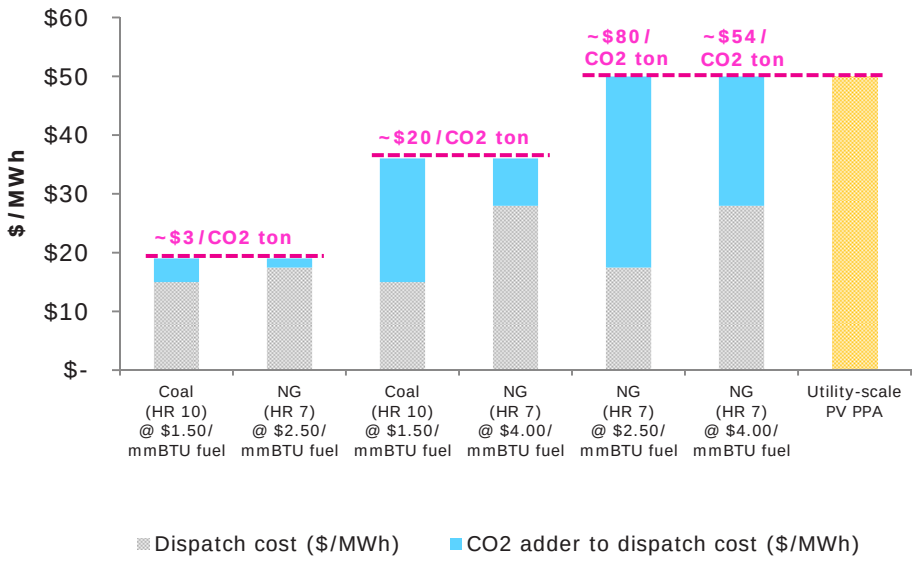
Source: NRG Analysis

Carbon prices much higher than seen to date would be necessary to induce merchant renewables

- ✓MIT's *Future of Solar Energy* study finds that in order for the levelized cost of energy (LCOE) of a utility-scale PV project to be equal to the LCOE of natural gas fired generation, "the CO2 charge would have to rise to **$104** per ton" (see p 109).
- ✓The NYISO IMM found that carbon prices of between **$41 - $115** per ton are needed to incentivize new wind and solar in New York.
- ✓As the grid decarbonizes, CO2 pricing will have less effect on energy prices; CO2 prices will need to rise substantially to maintain any support for merchant renewable investment.

*****Illustrative values only*****

Carbon price required to 'levelize' $/MWH cost among generators



Source: NRG Analysis

A forward market for renewable attributes

- ✓ Traditionally, PPAs have proven to be the most cost-effective means of supporting the deployment of renewable energy infrastructure in MA, CA and overseas (e.g. Germany, Spain, etc.).
- ✓ Renewables projects generally require a 10 – 20 year stream of revenues in order to achieve the best financing terms and allow for project-level financing.
- ✓ A 3-year forward market for renewable attributes *with a 10 – 20 year lock for new resources* could provide an effective financing mechanism.

Forward Clean Energy Market framework

- ✓ Three-year forward procurement open to all renewable energy sources (as defined by each State, *with as much uniformity as possible*).
- ✓ New resources could elect a price lock (of between 10-20 years) to facilitate financing and construction.
- ✓ Existing resources would bid into the auction at their going-forward costs.
  - o So long as RPS standards increase, price would be set by new entry, which decreases over time as the renewable cost curve declines.
- ✓ Auction would procure commitments to deliver MWh targets.
- ✓ Downward sloping demand curve would allow procurement of excess renewables, if available at lower cost.
- ✓ Some questions:
  - o How would forward renewables interact with FCM for obligations and pricing?
  - o Could the renewable attributes be integrated into FCM?
  - o And many others

Questions?