

New England's Wholesale Electricity Markets

Incompatible with Achieving Long Term Regional Emissions Reduction Goals



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The Frictionless Vacuum Disclaimer

- This presentation attempts to explain electricity market concepts at a high level, with simplifications so we can focus on a few key concepts.



Overview

- Wholesale electricity market background
- Policy requirements to decarbonize
- Energy market
- Capacity market

Wholesale Electricity Markets

- Areas with competitive wholesale electricity markets in figure to right. In general:
 - Regulated utilities own wires
 - Generation is independently owned
 - Competes in marketplace without central planning
 - Market signal indicates when/where to build/retire, run/sit idle
 - Market run by an independent entity without any ownership interest (an Independent System Operator, ISO)
- Grey areas are vertically integrated, regulated utilities
- The New England market is run by ISO New England (ISO-NE)

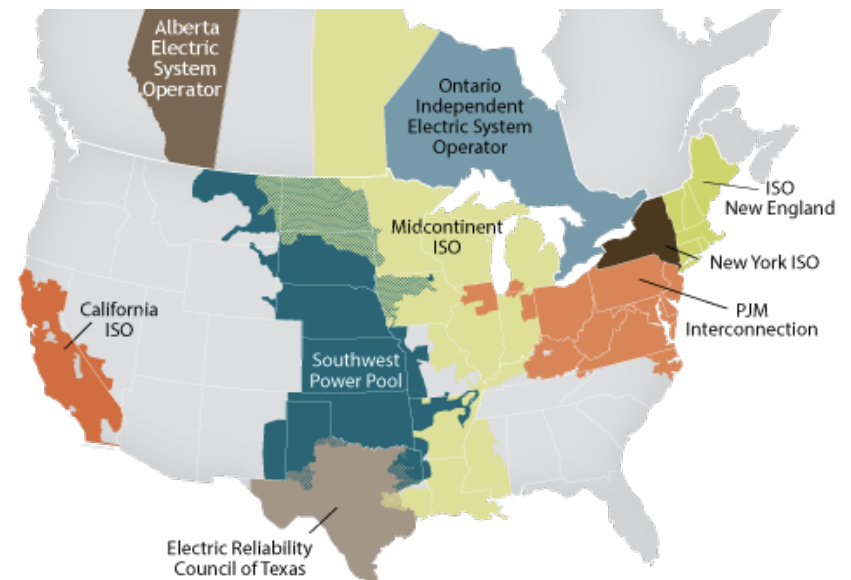
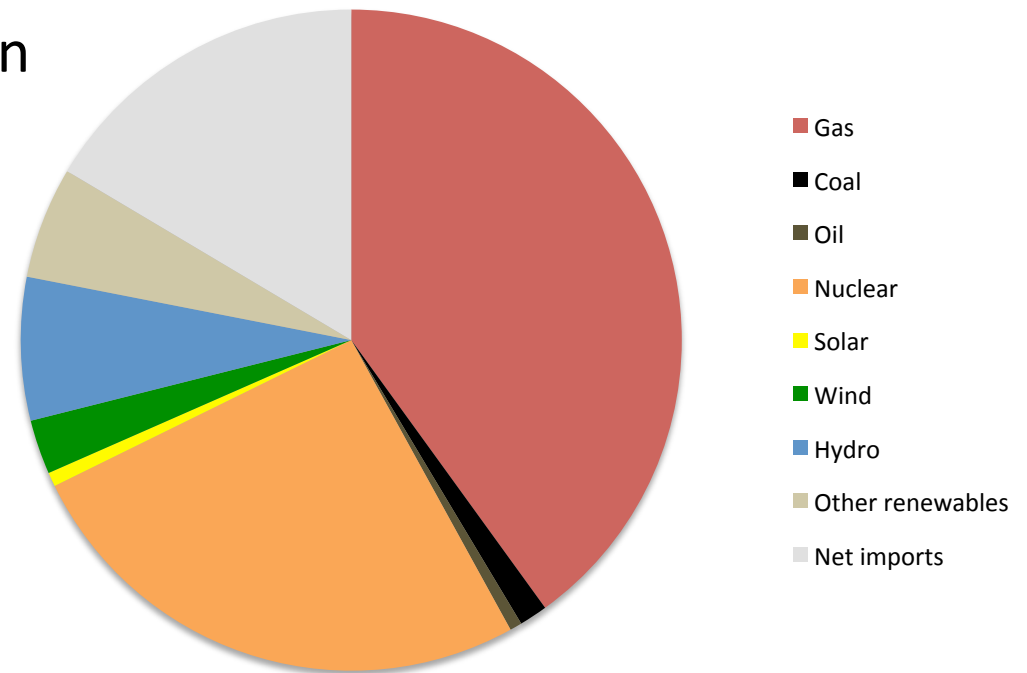


Image Source: www.isorto.org/about

ISO-NE Electric Energy Sources

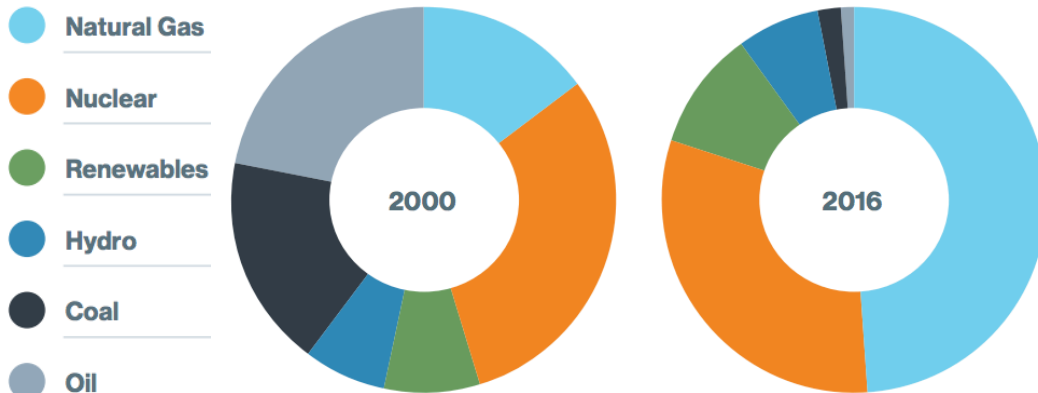
- 121,000 GWh/yr net energy for load in 2017
 - 84.7% domestic generation
 - 42.6% fossil
 - 42.1% low/no carbon
 - 16.7% imports
 - -1.4% pumped storage pumping load
- 35,000 MW installed generation (nameplate)

2017 % Net Energy for Load by Fuel

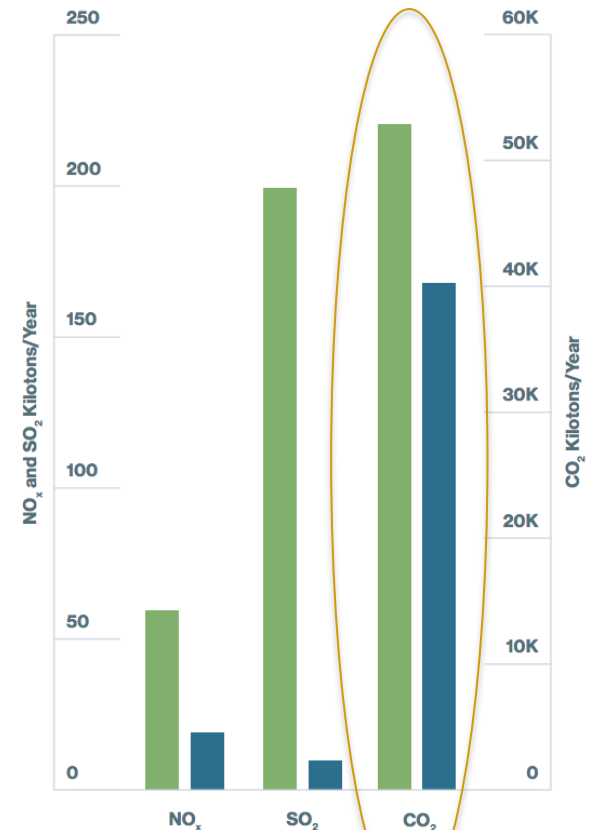


ISO-NE Generator Emissions Reductions

- ISO-NE generation in 2000
 - Oil/coal = 40%
 - Natural gas = 15%
- ISO-NE generation in 2016
 - Oil/coal = 3%
 - Natural gas = 49%
- Air emissions have dropped significantly



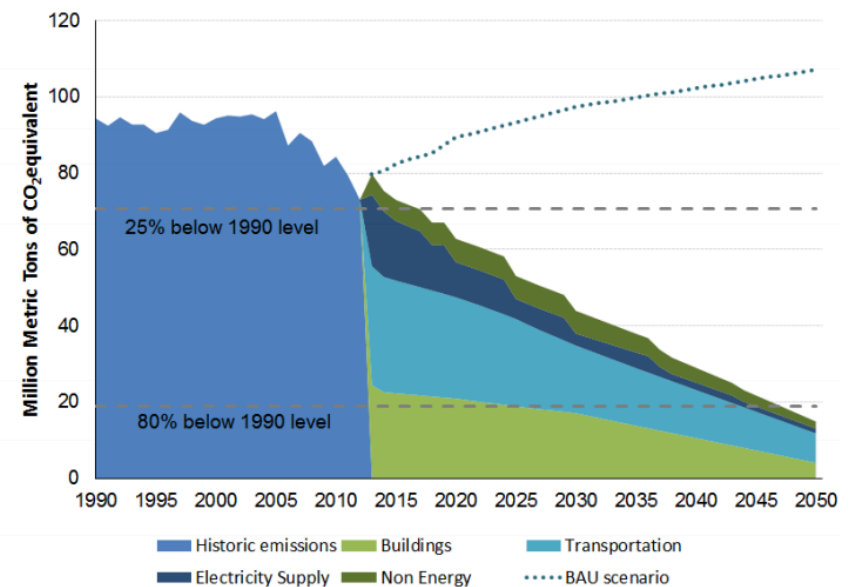
Reductions in Annual Generator Emissions between 2001 and 2015



32 Years Left to Decarbonize Electricity in MA

- MA Global Warming Solutions Act requires greenhouse gas emissions reductions from each sector of MA economy totaling:
 - 25% below 1990 levels in 2020
 - Well on our way to meeting this
 - $\geq 80\%$ below 1990 levels in 2050
 - A fully decarbonized electricity sector
 - A much larger electricity sector, with heating and transportation largely electrified

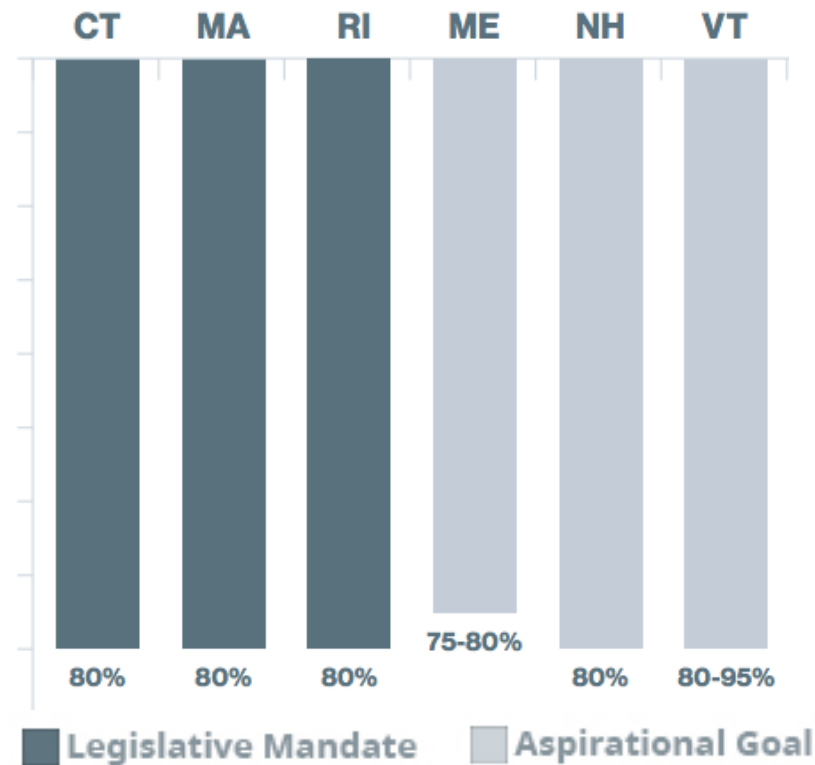
Illustrative long term GHG reductions by sector



Source: Abt Associates (2015).

32 Years Left to Decarbonize in MA New England

% Reduction in GHG Emissions below 1990 levels by 2050*



* Some states have different baseline and target years

32 Years... That's Plenty of Time (Is it?)

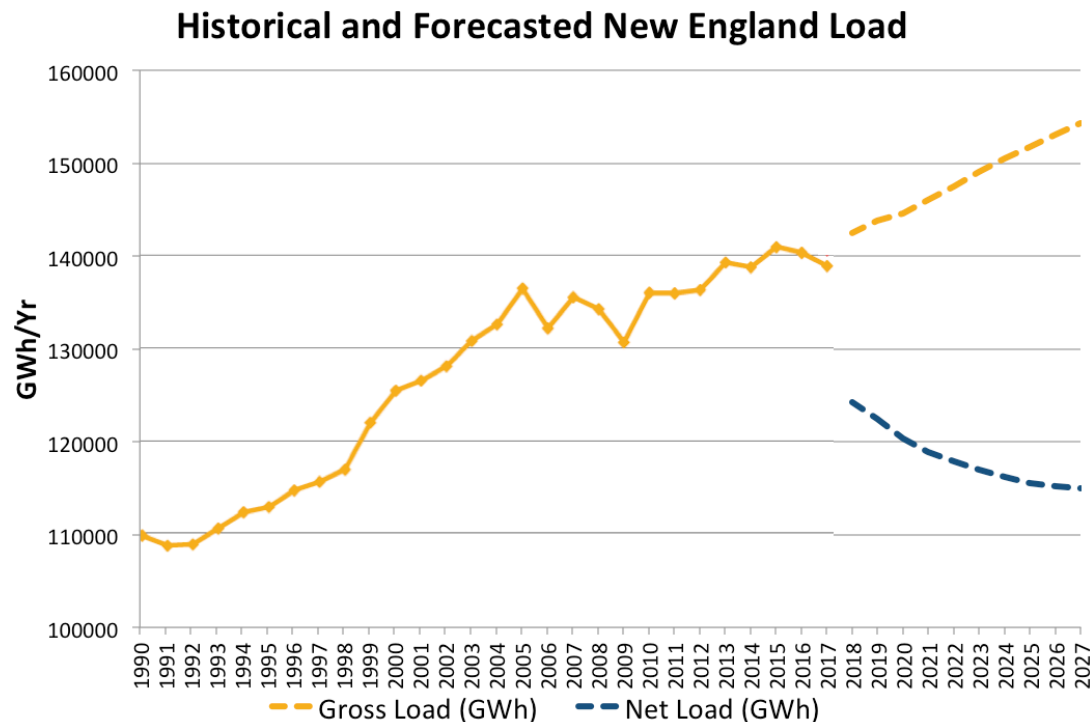
- In 2010 ISO identified ~8,300 MW of coal- and oil-fired generators at risk of retirement due to age and economic trends
 - These plants were 32 to 58 years old
 - Power plant and associated infrastructure is long-lasting
 - A gas plant or pipeline built today will not be at the end of its useful life by 2050
- From 2013 to 2021, ~3,600 MW of these have retired or committed to do so
 - 1,300 MW of nuclear generation have also retired or committed to do so
 - Together, this is about 10% of New England's capacity
- Opportunity to replace with clean energy sources
 - But current market won't do that

Burning More Gas Won't Get Us There

- 2016 ISO-NE CO₂ emissions rates:
 - Average: 710 lb/MWh
 - Average of marginal generating units: 842 lb/MWh
- Kleen Energy CC was the last large natural gas power plant to reach commercial operation in New England (2011)
 - Its 2016 emissions rate: 850 lbs/MWh
- Footprint Power CC, currently under construction
 - Projected emissions rate: 835 lb/MWh
- Diminishing system emissions reductions from new gas plants
- Need to reduce demand and transition to producing ~~more~~ nearly all electricity with low/no carbon resources

Growth in Energy Efficiency

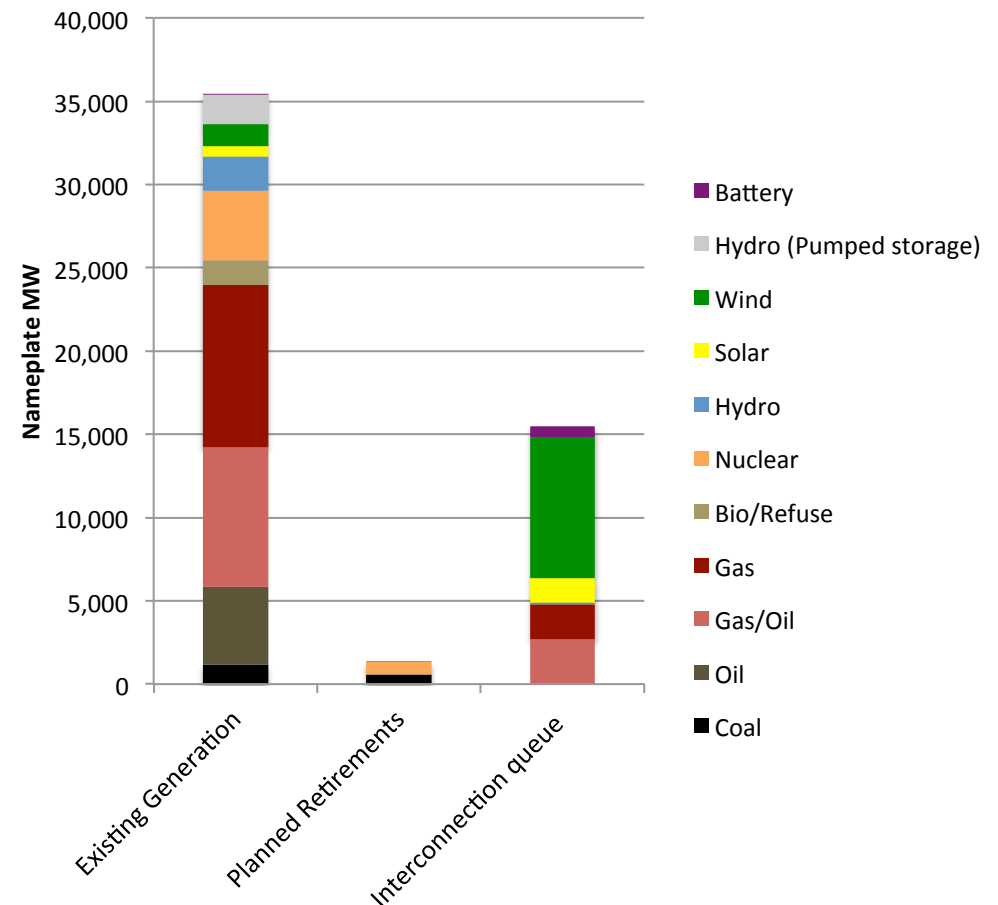
- The New England states spend over \$1 billion annually on energy efficiency measures
 - Net load (after energy efficiency and behind-the-meter PV) is declining



The ISO-NE Generation Fleet

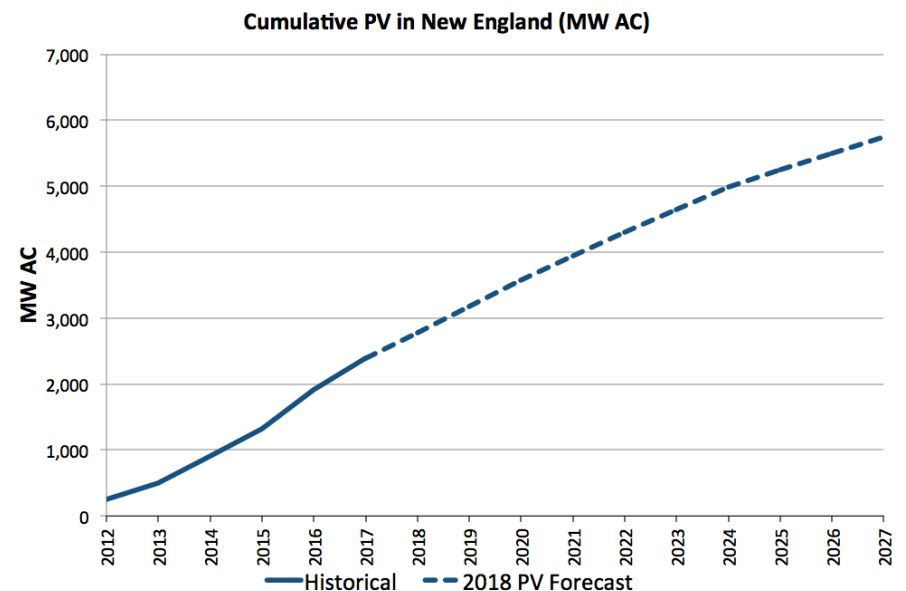
- Today, 68% of generator fleet is fossil-fuel fired
 - 76% of that is gas or dual-fuel (gas/oil)
 - If remaining coal and oil replaced with gas, will barely help with emissions targets
- Under development
 - 30% gas, dual fuel
 - 65% wind, solar*, hydro

New England Generation By Type



Growth in Wind and Solar

- 1,350+ MW onshore wind now operating
 - Up from 375 MW in 2011
 - Over 8 GW under development (but no clear path forward)
- 30 MW offshore wind
 - MA legislation requires solicitation of 1,600 MW more by 2027
- 2,390+ MW solar (PV)
 - Up from 250 MW in 2012
 - ISO forecasts 5,750 MW by 2027
- Wind/PV = 6% of NEL in 2017
 - If offshore/PV built, rises to 10%
 - If all 8 GW onshore wind added (!), rises to 30%
 - If that displaces fossil generation, still leaves 19% of NEL from fossil



Imported Hydro From Canada

- MA legislation calls for the procurement of about 9,450 GWh/yr of clean energy by 2022 (1,078 MW on average)
 - A transmission project to import hydro energy from Canada was just selected for contract negotiation
 - 8% of New England load
 - If displaces fossil generation, leaves 11% of NEL from fossil
- All of this is a great start, but still just the beginning
 - No clear path for the 8 GW of onshore wind
 - Electric load will rise with electrification
- Need a massive fleet turnover in the next three decades
 - Need to retire (and stop building) fossil
 - Need to bring on a huge amount of no/low carbon energy

Contracts & Regulated Rates, Not Markets Driving Growth in Clean Energy

- Not a single wind or solar project built in New England without a long-term contract or regulated rate
 - Same for the large hydro import under negotiation now
- Would prefer to see electricity markets driving this transition, but not designed to do this
 - Won't send price signals for the entry of clean resources
 - Sending counterproductive signals
 - Decarbonization is required by public policy, will continue to happen outside the market if need be
- Dominant discussion in ISO-NE and nationally is how markets can accommodate or achieve public policy goals
 - Either we figure it out or markets will be gone in under 32 yrs

Electricity Markets

- Three key components
 - Energy (\$4.1 billion in 2016)
 - Price paid for energy produced (\$/MWh)
 - Reserves (\$0.1 billion)
 - Price paid for ability to provide additional energy quickly (10-30 minutes) if needed (\$/MWh)
 - Backup in case of contingencies like a large power plant or importing transmission line tripping off unexpectedly
 - Capacity (\$1.2 billion)
 - Price paid for commitment, made years in advance, to be available to provide energy and reserves (\$/MW)
- Intent is to use competition to procure/operate the most economically efficient resource mix
 - Subject to maintaining reliability

Fossil vs Carbon Free Economics

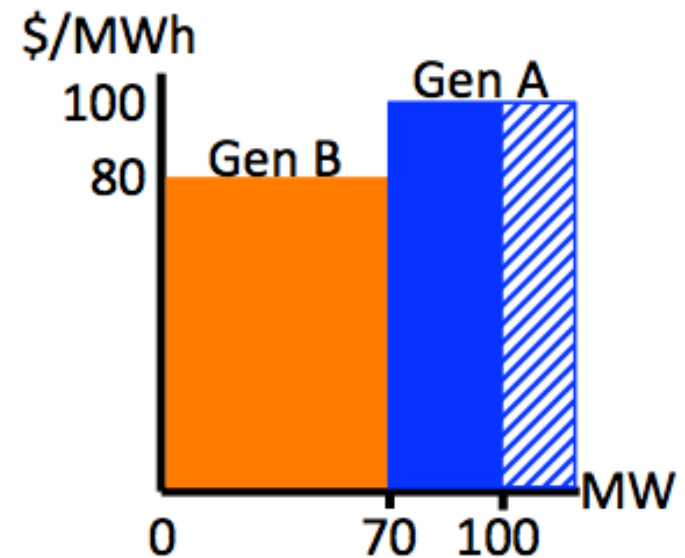
- New gas-fired generation
 - Inexpensive to build
 - Expensive to run (fossil fuels cost money)
- New carbon free resources
 - Higher cost to build
 - Inexpensive (often free) to run

Energy Market Pricing

- Each supplier offers its variable cost of producing energy
 - Fixed, capital costs not included in offer
 - If fuel is free, essentially no variable cost
 - Variable cost can be negative (cost to shut down, lost revenue)
- ISO-NE auction selects how much energy each available generator should produce based on offer costs
 - Lowest priced offers able to meet demand are accepted
 - Subject to reliability and physical constraints
 - “Economic Dispatch”
- Uniform clearing price auction
 - Highest accepted offer sets price paid to all accepted offers

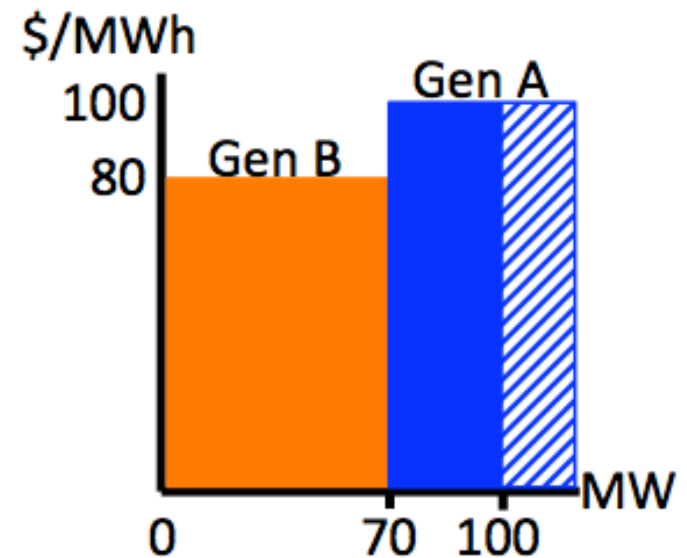
Simple Market Pricing Example

- Imagine Gen A and Gen B are the only generators to offer in the market to supply 100 MWh of load.
 - Gen A offers 50 MWh at \$100/MWh
 - Gen B offers 70 MWh at \$80/MWh
- All 70 MWh of the less expensive Gen B are accepted. Only 30 MWh of the more expensive Gen A are accepted.
- Gen A sets the price paid to both generators at \$100/MWh.
- This is how market has historically worked with conventional generation, though with hundreds of offers rather than two.



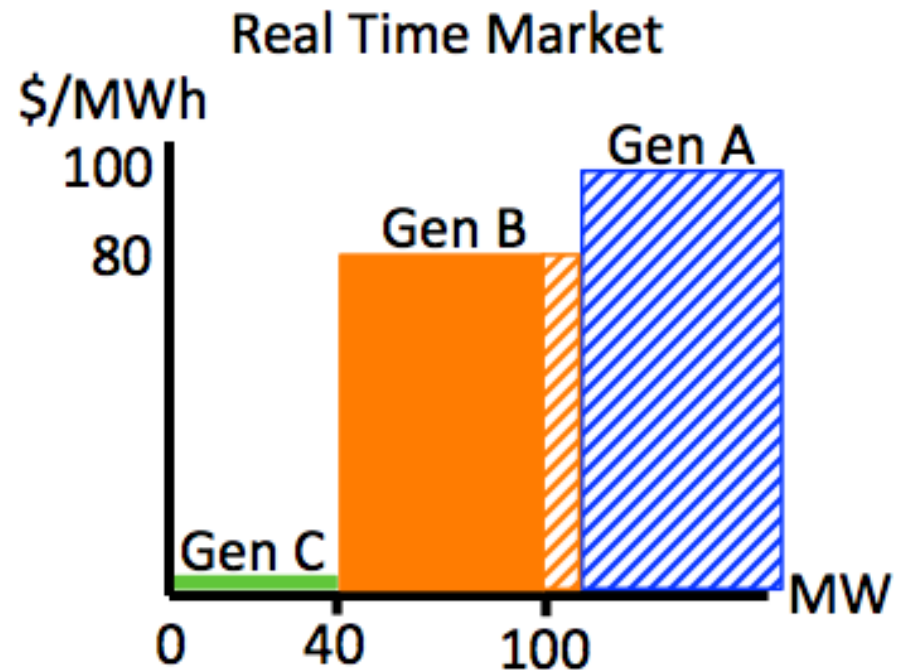
Simple Market Pricing Example

- Generator production cost:
 - Gen A: 30 MWh * \$100/MWh = \$3,000
 - Gen B: 70 MWh * \$80/MWh = \$5,600
- The generators are paid:
 - Gen A: 30 MWh * \$100/MWh = \$3,000
 - Gen B: 70 MWh * \$100/MWh = \$7,000
- Profits:
 - Gen A = \$0 (it was marginal)
 - Gen B = \$1400 (it was inframarginal)



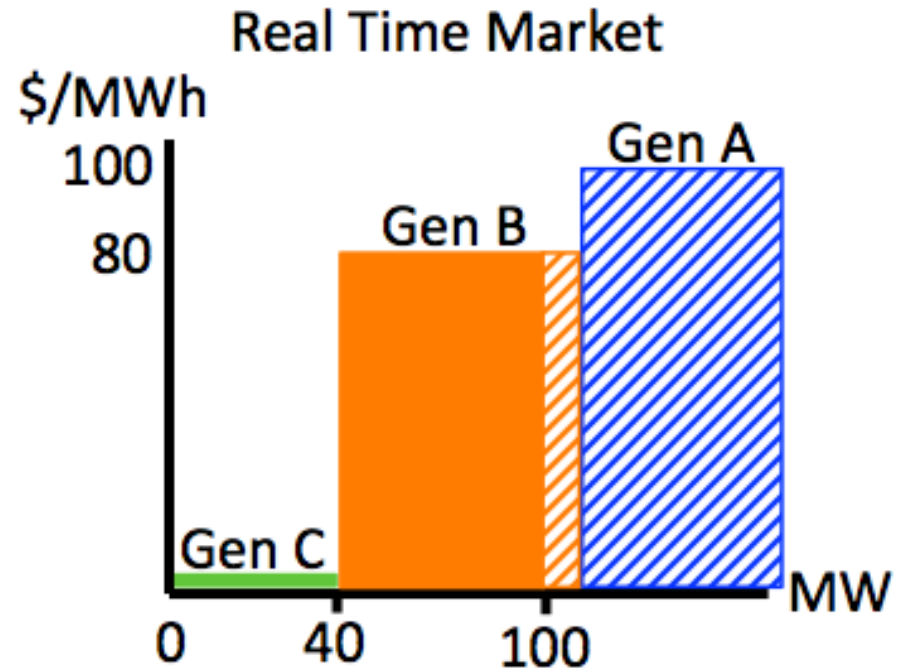
Adding Zero Fuel Cost Supply to Simple Market Pricing Example

- Imagine 40 MWh of wind energy (Gen C) becomes available with no fuel cost
 - variable production cost = \$0/MWh
- Now market only needs 60 MWh from the more expensive Gen B (10 MW less than in prior example)
- No longer needs any energy from the most expensive Gen A (30 MWh less than in prior example).
- Gen B now sets the price at \$80/MWh.



Adding Zero Fuel Cost Supply to Simple Market Pricing Example

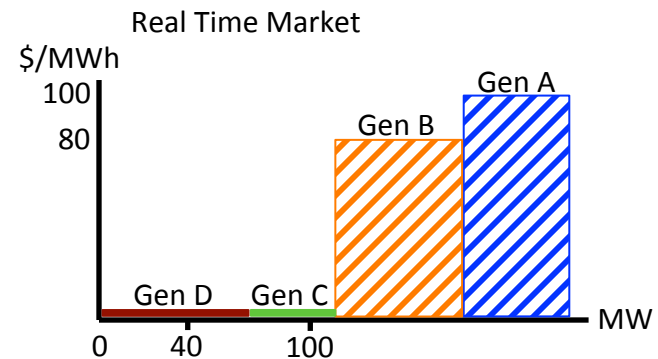
- Gen A went
 - from being marginal with \$0 profits
 - to being out of merit with \$0 profits
- Gen B went
 - from being inframarginal with \$1,400 profits
 - to being marginal with \$0 profits
- Gen C is
 - inframarginal with \$3,200 profits
 - With low levels of renewables, they can earn large profits in energy market to pay for their fixed costs



Simple Market Pricing Example

More Zero-Cost Supply

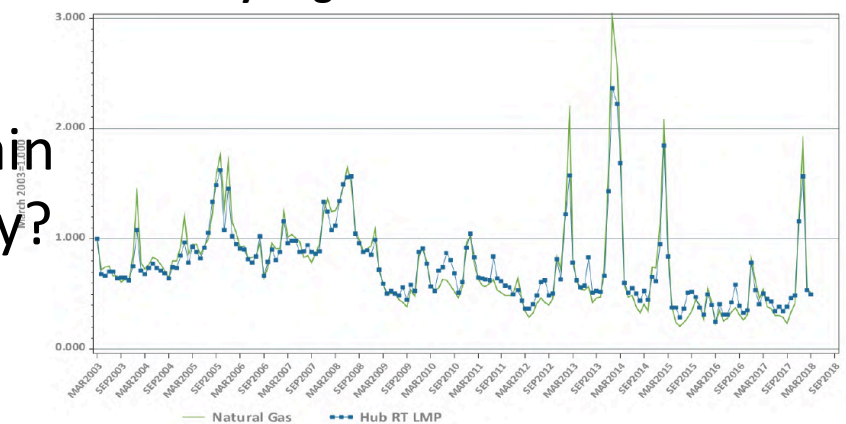
- Imagine another 70 MWh of zero-priced energy (Gen D).
 - 110 MWh of zero-priced energy is available.
 - Market only needs 100 MWh
 - Energy price = \$0/MWh
- Nobody earns any profits in energy market
- Generators C and D
 - Not losing money
 - Also not earning any money to pay off their fixed costs



Energy Market Profits In A Clean Energy Future

- Natural gas marginal ~80% of time in recent years
 - Energy price closely tracks gas price
- The more free-fuel resources added, the more often they will set price at \$0/MWh (or negative)
 - If solar is marginal when it's sunny, wind when it's windy, etc, very little money left in the energy market.
 - No profits for anyone.
- How will generation be financed?
- And what is the incentive to maintain equipment, actually produce energy? (question for another day)

Monthly Avg Gas and RT Hub LMP Index



ISO-NE Forward Capacity Market

- FCM procures resources with sufficient capability to meet forecasted peak demand for energy and reserves three years in the future
- Uniform clearing price Forward Capacity Auction (FCA) held annually
- New resources can lock in the auction clearing price for up to 7 years
 - Intended to provide financeable market commitment
- Existing resources are price-takers and receive the annual auction price unless they withdraw (“de-list”) their capacity from the market

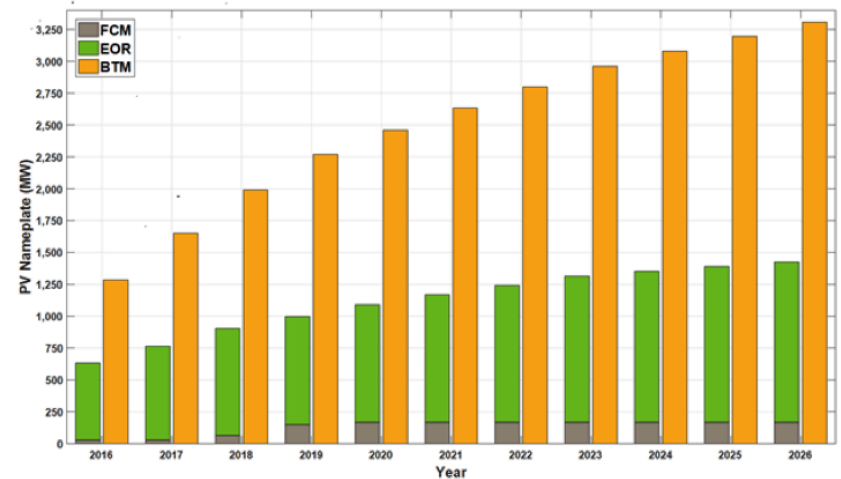
ISO-NE Forward Capacity Market

- Meant to provide the missing money to cover fixed costs that aren't recovered through energy and ancillary services markets.
- Meant to drive decisions about new resource investments, retirements
- The price signal it sends is to build more gas, not to build more clean energy resources
 - Multiple aspects of FCM cause this outcome
 - Works against policy requirements to decarbonize

Capacity Market

Too Complex, Risky for Small Resources

- The FCM is complex and risky
 - Getting more so every year
- Cost/benefit for small, distributed generation (like PV) isn't clear
- Significant build out happening outside of FCM
 - Green bars are forecasted PV completely ignored by FCM. Neither reduces capacity procured nor gets counted towards meeting capacity needs.
 - By 2026, projected to be 1250 MW (AC nameplate). Equivalent to over 500 MW FCM capacity.
 - That is a large gas plant that will get built unnecessarily (or not allowed to retire).



Capacity Market

Minimum Offer Price Rule

- Because of FCM's importance to maintaining resource adequacy by driving investment decisions, market is protected from buyer-side market power that could cause price suppression
- If a buyer subsidizes a resource so that it clears in the auction when it wouldn't otherwise, could lower the auction price paid to every capacity resource
 - Buyers could lower their total costs by subsidizing a small quantity of uneconomic resources
 - The market price wouldn't be the competitive cost of new capacity
- The MOPR prevents this
 - Sets a minimum, unsubsidized price each new capacity resource can offer
 - MOPR doesn't differentiate between subsidies intended to lower FCM price and subsidies for "legitimate" policy reasons like decarbonization

Capacity Market Offer Review Trigger Prices

- ISO periodically calculates these minimum unsubsidized prices by technology type (the “ORTP”)
- Meant to be the capacity price needed to make the financials work for a competitive new resource of a given technology type
 - Calculation excludes “out of market” (OOM) revenues
- ORTPs were calculated most recently in 2016 for FCA 12

	FCA 12 ORTP (\$/kW-mo)
Combined Cycle	\$7.86
Simple Cycle	\$6.50
Wind	\$11.03
PV	\$26.32

Capacity Market Minimum Offer Price Rule

- Even if viable at a price below its ORTP, a new resource is not allowed to offer capacity below ORTP without approval
 - If viable due to “out of market” revenues, approval will be denied
- This means the capacity market
 - will procure “lower cost” new resources like gas plants first
 - will not procure subsidized “high cost” new wind/solar resources (even if they are built and operating) unless new gas plants offered are insufficient to meet region’s needs
- Leads to
 - Over procurement
 - Procurement of the very resources these policies are trying to replace

	FCA 12 ORTP (\$/kW-mo)
Combined Cycle	\$7.86
Simple Cycle	\$6.50
Wind	\$11.03
PV	\$26.32

Capacity Market Accommodations for Public Policy

- There are some exceptions that allow these “higher cost” policy-backed resources into the capacity market
- The Renewable Technology Resource Exemption allowed up to 200 MW per year of new capacity from renewable resources to offer at any price
 - Exemption now being phased out
- A capacity substitution auction was created to replace the exemption
 - Allows new clean energy resources to take the place of retiring resources (called CASPR)
 - The substitution auction is extremely illiquid and appears unlikely to allow many new clean resources into the market

Capacity Market

What if Clean Energy Is Competitive?

- If a project can show it has lower costs than ISO assumed in the ORTP or higher market revenue projections, then ISO may allow it to offer at a lower price in the FCA
 - These projects are cost effective without out of market revenues
 - This has often been the case for onshore wind.
 - Solar inching closer to this threshold each year but isn't there yet.
 - These resources can lock in their first year capacity price for 7 years and then float with the market, just like gas plants
- But unlike gas plants, this still doesn't make them financeable...

Capacity Market Can Make Gas Plants Financeable

- At the break-even capacity prices calculated by ISO, gas plants would lock in revenue equal to roughly two thirds of their capital costs, to be received over their first 7 years of operations.
 - This leaves only one third of capital costs that need to be recovered through other sources subject to market risk (e.g., energy and ancillary services or capacity revenue beyond their first 7 years).

	FCA 12 ORTP (\$/kW-mo)	Share of overnight capital costs locked in at ORTP
Combined Cycle	\$7.86	63%
Simple Cycle	\$6.50	65%
Wind	\$11.03	10%
PV	\$26.32	16%

Capacity Market Won't Make Clean Energy Financeable

- At wind and solar break even capacity prices, would lock in revenue of only 10% to 16% of their capital costs
 - This leaves 84% to 90% of their capital costs to be recovered through sources subject to market price risk
- No wonder these resources need long-term contracts outside of the markets!
 - Not necessarily more expensive, but lack comparable market certainty

	FCA 12 ORTP (\$/kW-mo)	Share of overnight capital costs locked in at ORTP
Combined Cycle	\$7.86	63%
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Capacity Market

What Happens If No Energy Profits?

- As zero-fuel-cost resources proliferate, they will set the energy market price at \$0/MWh with increasing frequency.
- If we assume energy market prices have dropped to \$0/MWh in all hours, the break even capacity price difference between a gas turbine and wind or solar becomes even more pronounced.
- The more zero-fuel-cost (clean) resources we have, the more strongly the market will drive procurement of low-capital cost resources like gas turbines.

	FCA 12 ORTP (\$/kW-mo)	FCA 12 ORTP If No Energy Revenue (\$/kW-mo)
Simple Cycle	\$6.50	\$6.75
Wind	\$11.03	\$55.16
PV	\$26.32	\$68.54

Carbon Pricing Won't Fix This

- A carbon price will lead to higher energy prices, higher profits for clean energy resources
 - Only temporarily: once clean resources are marginal most of the time, carbon pricing impact is eliminated.
 - Even with higher energy price, still not financeable. Still lack comparable revenue certainty to what gas plant can get from FCM today.

	FCA 12 ORTP (\$/kW-mo)	FCA 12 ORTP If No Energy Revenue (\$/kW-mo)
Simple Cycle	\$6.50	\$6.75
Wind	\$11.03	\$55.16
PV	\$26.32	\$68.54

Achieving Policy Requirements Through the Market

- Recognizing policy requirements as explicit constraints on the capacity market could solve this problem.
 - Capacity market could have requirement to purchase a certain quantity of clean energy resources or no more than a certain quantity of fossil resources
 - Price for clean resources would be sufficient for financing
 - But who determines the requirements, how are costs allocated?
 - State policies are similar, but not identical.
- Raises states' rights problems
 - ISO-NE market is federally regulated
 - Are states ready to cede implementation of their policies to the federal government?

Conclusions

- The energy market
 - Has less and less money in it as the region builds more clean energy
 - Is too volatile for financing, regardless
- The capacity market
 - Will ignore many (most?) clean resources built for policy reasons
 - Doesn't provide financeable revenue stream for clean energy
 - The more clean energy added to the system, the more the FCM will drive towards the procurement of gas plants
- Yet policy requires more clean energy, less fossil energy
 - Forces states to achieve policy goals outside of the markets through long term contracts, regulated rates, incentive programs
 - Distorts markets, so market rules created to protect against or correct for these OOM actions.

Conclusions

- Accommodation
 - If the policy resources get too large compared to the market, what is the real market that's left?
- I like the idea of markets. But this just isn't going to work much longer the way we've designed them.
- The transition is happening.
 - “the clean energy train has left the station” - Gina McCarthy, former EPA administrator
- If we're going to have markets that last, need to figure this out

Questions?



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