A (gentle) introduction to wholesale markets

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Power systems are *really* complicated

- Modern power systems are the largest machine on the planet.
- Even New England's relatively small footprint weaves together:
  - 350 dispatchable power plants (think gas, nuclear, hydro),
  - 50 wind farms,
  - 180,000 solar facilities (from roof tops to utility scale),
  - Millions of customers.
- Collectively, power plants match their output to consumer demand in every second of the day; every day of the year.

So, how do you coordinate it all? **Markets!**

Markets were developed to ensure reliable and affordable operation of the power system and to make sure that consumers could be served 24x7x365.

ISO-NE markets help coordinate power sales and delivery:

- Across the region from Connecticut to Maine, and
- From second to second, minute to minute, hour to hour….year to year.

In many ways, the ISO-NE markets share common foundation with markets for potatoes, gasoline, &c.

- Markets can help ensure efficient resource allocation.
- Markets can offer incentives to encourage development of new resources.
- Markets can spur innovation.

The Goals of ISO-NE Markets

Energy Market

Goal: buy energy to meet demand in each hour of year, at least cost.

Time Scale: 5 Minutes to 1 Day

Ancillary Services

Goal: Maintain reliability over seconds-hours. Correct for minor deviations; provide back-up in case a power plant breaks down; ensure grid can be "rebooted" after a blackout.

Time Scale: Seconds to Hours

Forward Capacity Market

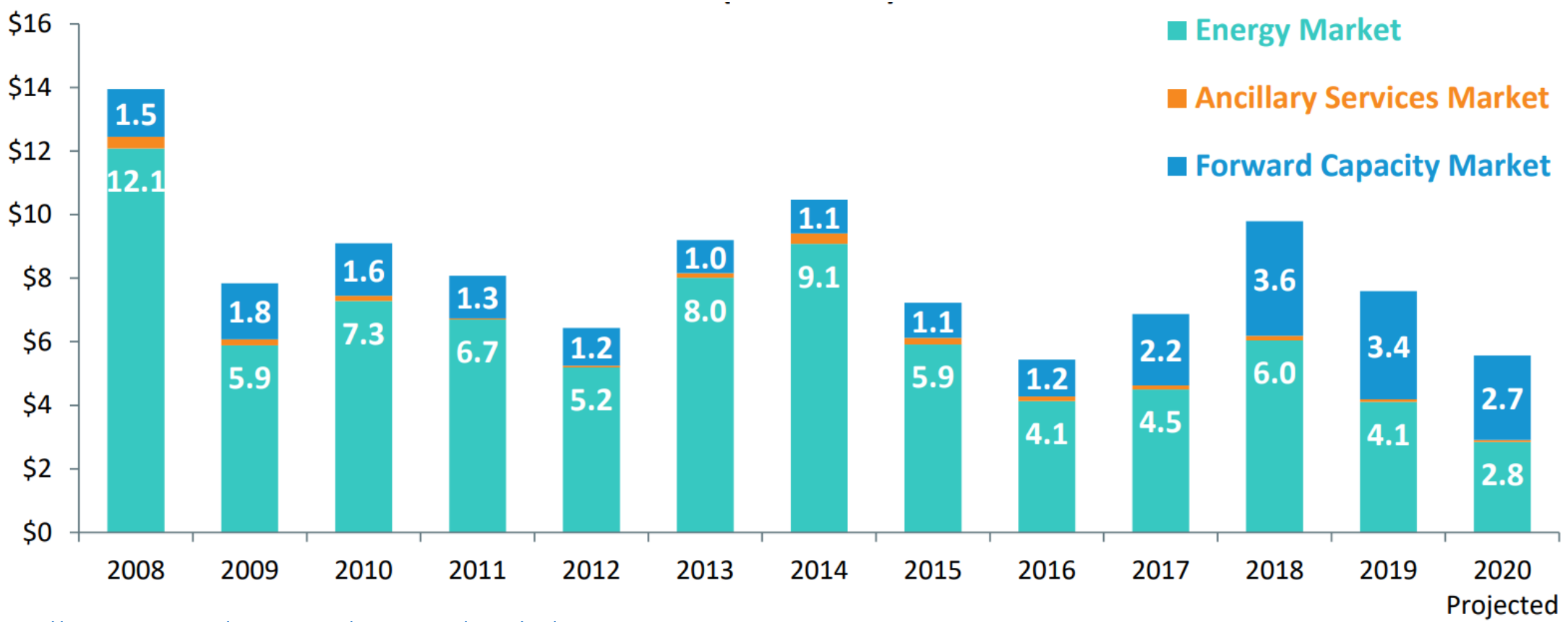
Goals:

(a) Ensure that the region has enough generating capacity to be able to always produce electricity.

(b) Build new power plants if there may be insufficient "iron-in-the-ground."

Time Scale: 3-Years in the Future.

Wholesale Market Costs, $bn (2008-2019)



Source: https://www.iso-ne.com/static-assets/documents/2020/12/clg_johnson_iso_update_dec_2_2020_final.pdf

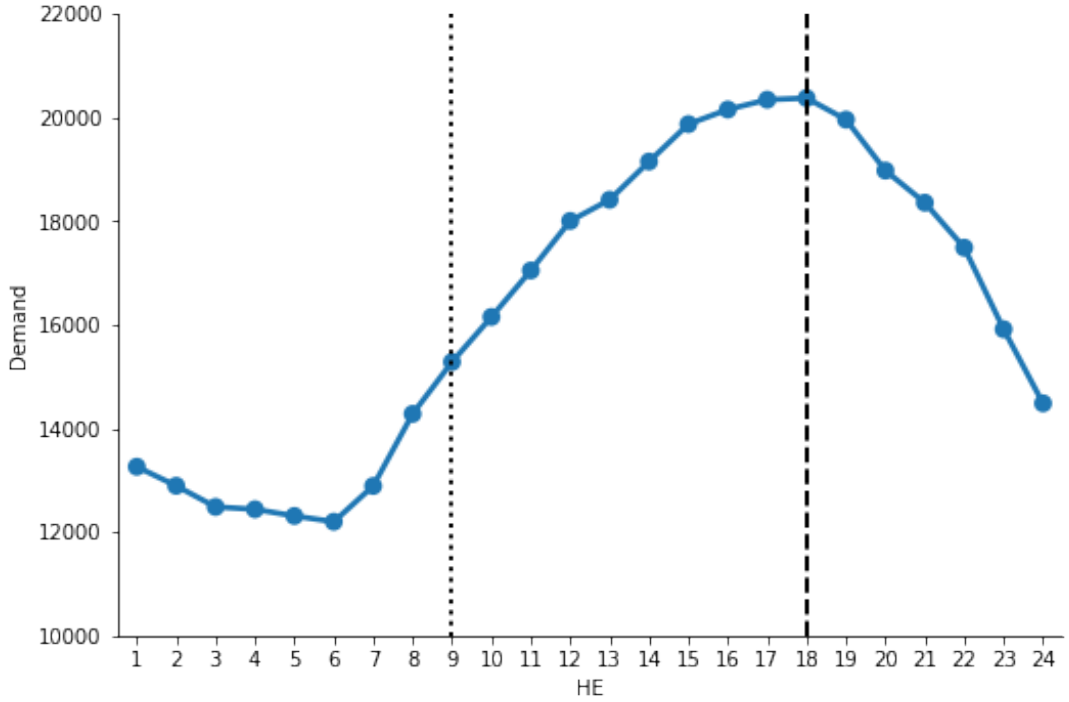
Energy Market

Energy Market Basics

- Energy market is where power plants sell electricity to buyers.
- The energy market sets the wholesale price of electricity in every hour based on:
  - What it costs power plants to make and sell electricity (known as “supply”),
  - How much electricity the region needs in that hour (known as “demand”)
- Power plants are selected to run in each hour based on “economic merit.” Overall, system relies on the cheapest set of plants needed to serve load and ensure reliability.
  - Prices vary over the course of the day and over the course of the year.
- All operating power plants get paid the same uniform price (in general).
- Energy market is technology and emissions neutral.
  - There is no explicit preference for generating power from one kind of plant or another...
  - But, some carbon emission costs are embedded in the offers that power plants make to sell electricity. Prices are set through the multi-state Regional Greenhouse Gas Initiative (“RGGI”) and is currently about $6/ton.

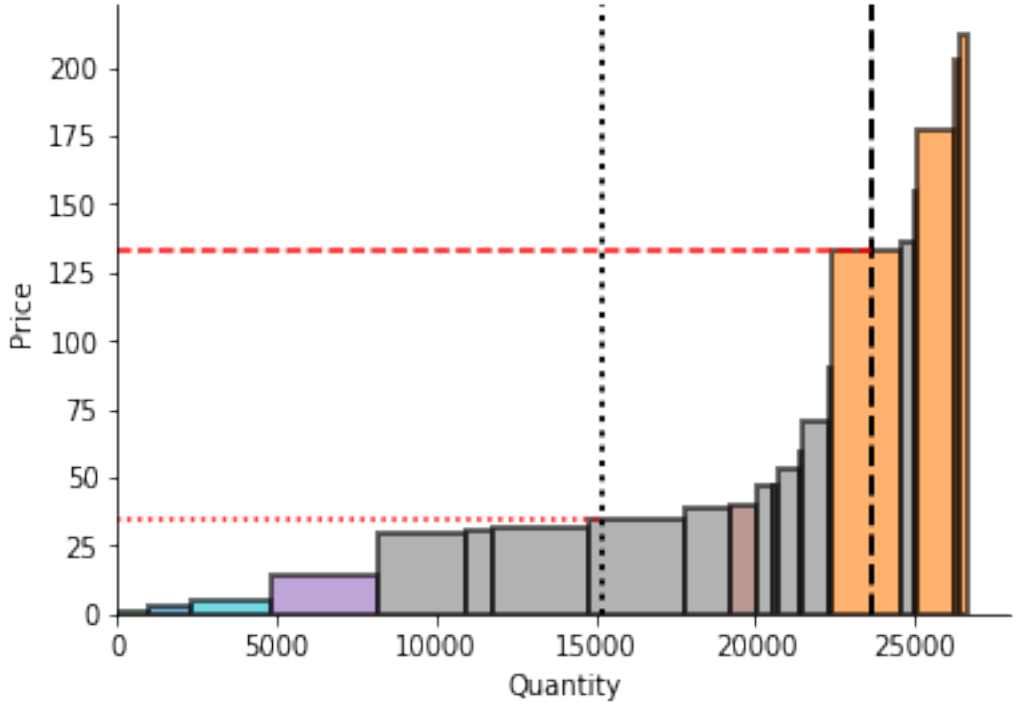
The price of energy is set where supply meets demand and varies over the day/year

THE DEMAND CURVE charts how the electricity consumption changes over the course of the day.



There's a regular pattern to the day's electricity use, but the exact amount can vary by season, day of the week, and more.

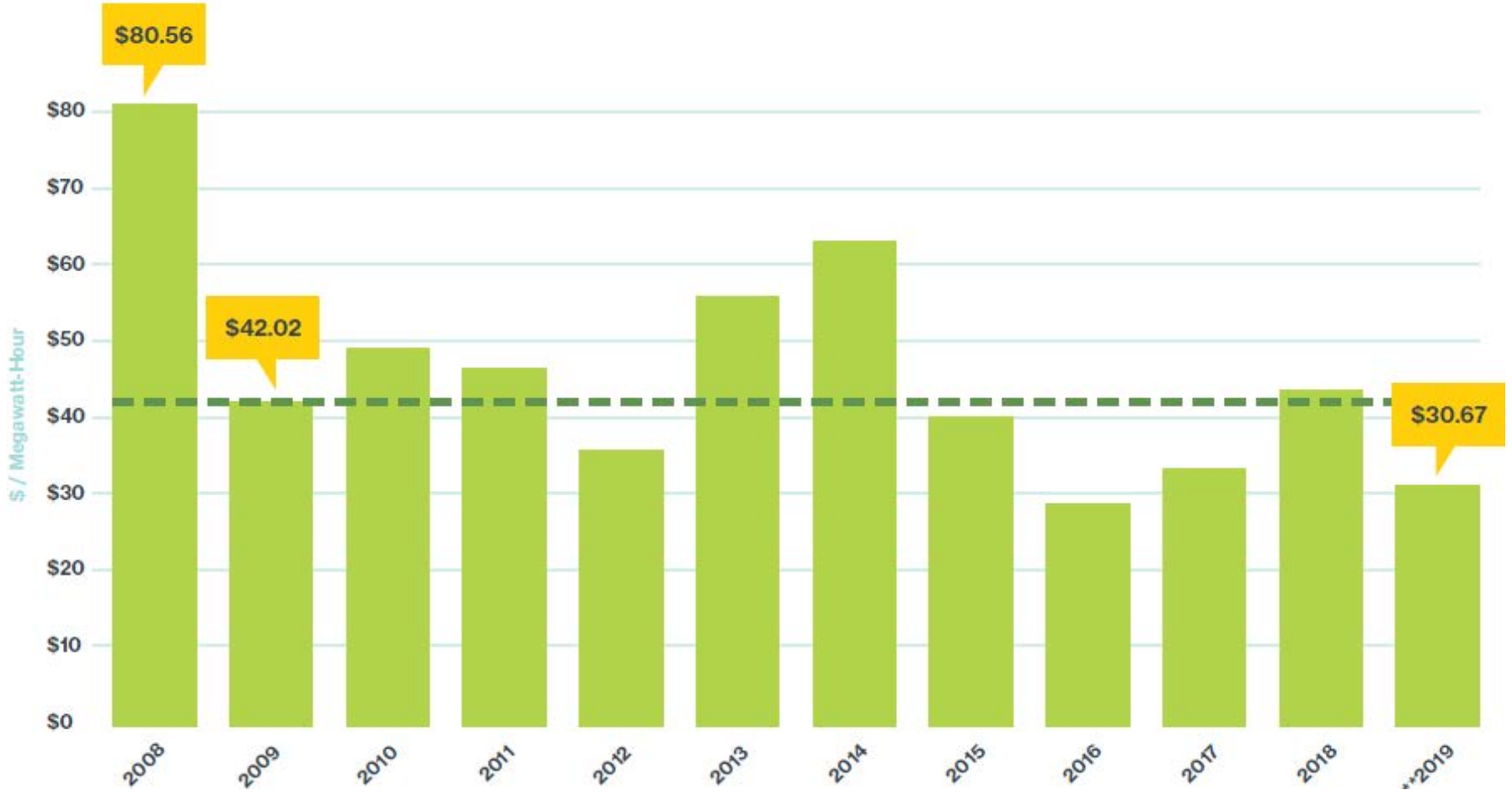
THE OFFER CURVE shows the price at which power plants are willing to sell electricity.



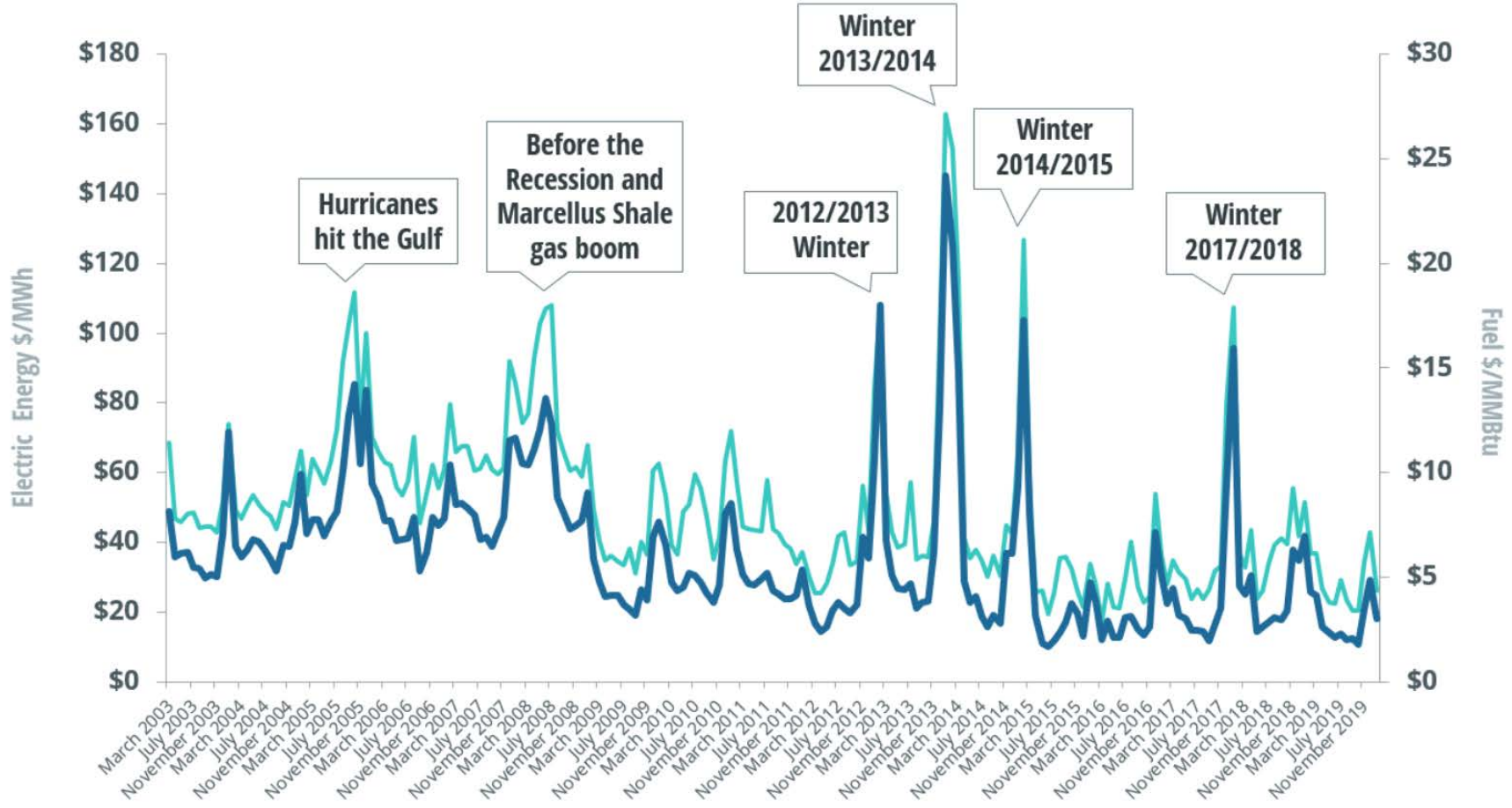
Offers depend on many factors including fuel type, technology, plant efficiency.

Prices can vary across the region based on system congestion

Average energy costs are generally around $40/MWh (4 cents/kWh; 20% of Retail Rate)



The price of natural gas currently drives the price of electricity



Source: ISO-NE, https://www.iso-ne.com/about/key-stats/markets

Participation by Clean Resources

- Clean and renewable resources can/do participate in the energy market.
  - Small facilities can participate as price-takers, where they get paid based on what they produce.
  - Larger wind/solar facilities make more sophisticated offers based on their expected hourly generation.
- Energy storage has participated in energy market for as long as the market has existed.
  - Pumped-storage hydro has been active in the region for almost 50 years.
  - Battery technologies are just starting to enter the market.
- Smaller and smaller participants can now participate in energy market (minimum 100kW capacity; roughly 20 household solar arrays).

Ancillary Services

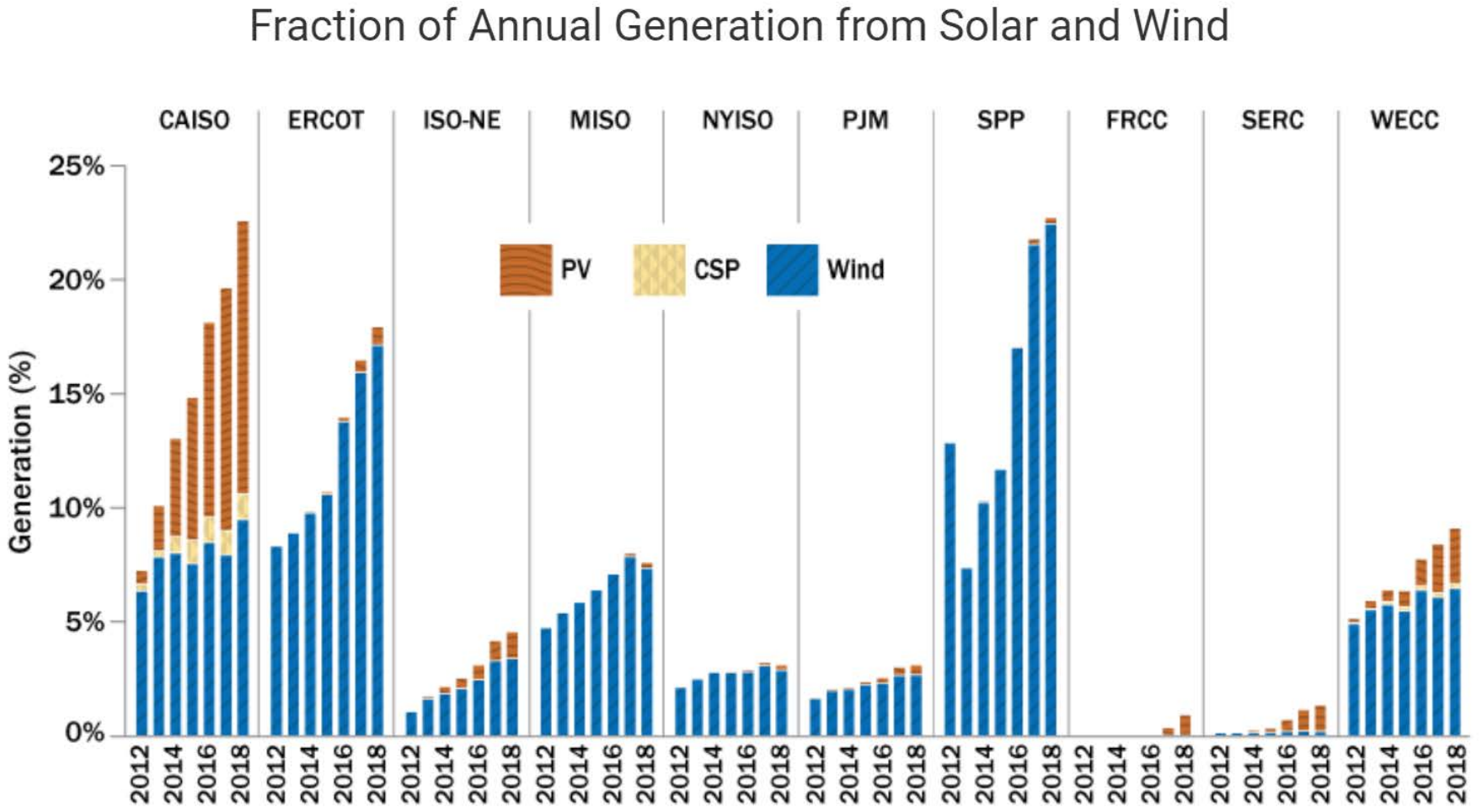
Ancillary Services

- Ancillary services are needed to keep power flowing, 24x7x365.
  - Power system must be kept in perfect balance all the time. Otherwise, the whole grid could collapse and cause region-wide blackouts.
    - These system-wide blackouts are *vanishingly* rare: 1965 and 2003.
- Some ancillary services used to keep supply/demand in balance.
  - Need products to "true-up" for variability over seconds/minutes.
- Some ancillary services used to provide back-up energy.
  - Need to keep extra power plants ready-to-operate (within 10 minutes) to protect system in case a different unit unexpectedly breaks.
- Some ancillary services pay power plants to be able to "reboot" the grid if a black-out occurs.
  - Many power plants can't turn on without grid power so, if the grid is down, they can't turn back on.

Ancillary Services & Clean Energy

- Today's set of ancillary services were designed with large rotating machines in mind (the 20th century grid).
- Ancillary Services likely to become more important in the years to come as intermittent resources produce a larger share of energy (the 21st century grid). For example,
  - Ramping products to ensure that as solar output falls in the evening that other resources can *quickly* take their place.
  - Contingency products to account for forecast uncertainty.
  - Frequency regulation products to make sure all units are in sync.
- Significant work to be done on these topics, but no reason to assume it can't be done.
  - We already see other regions managing very high renewable periods for minutes/hours without any threat to reliability.

Other ISOs successfully manage hours with 60%+ of energy coming from wind/solar



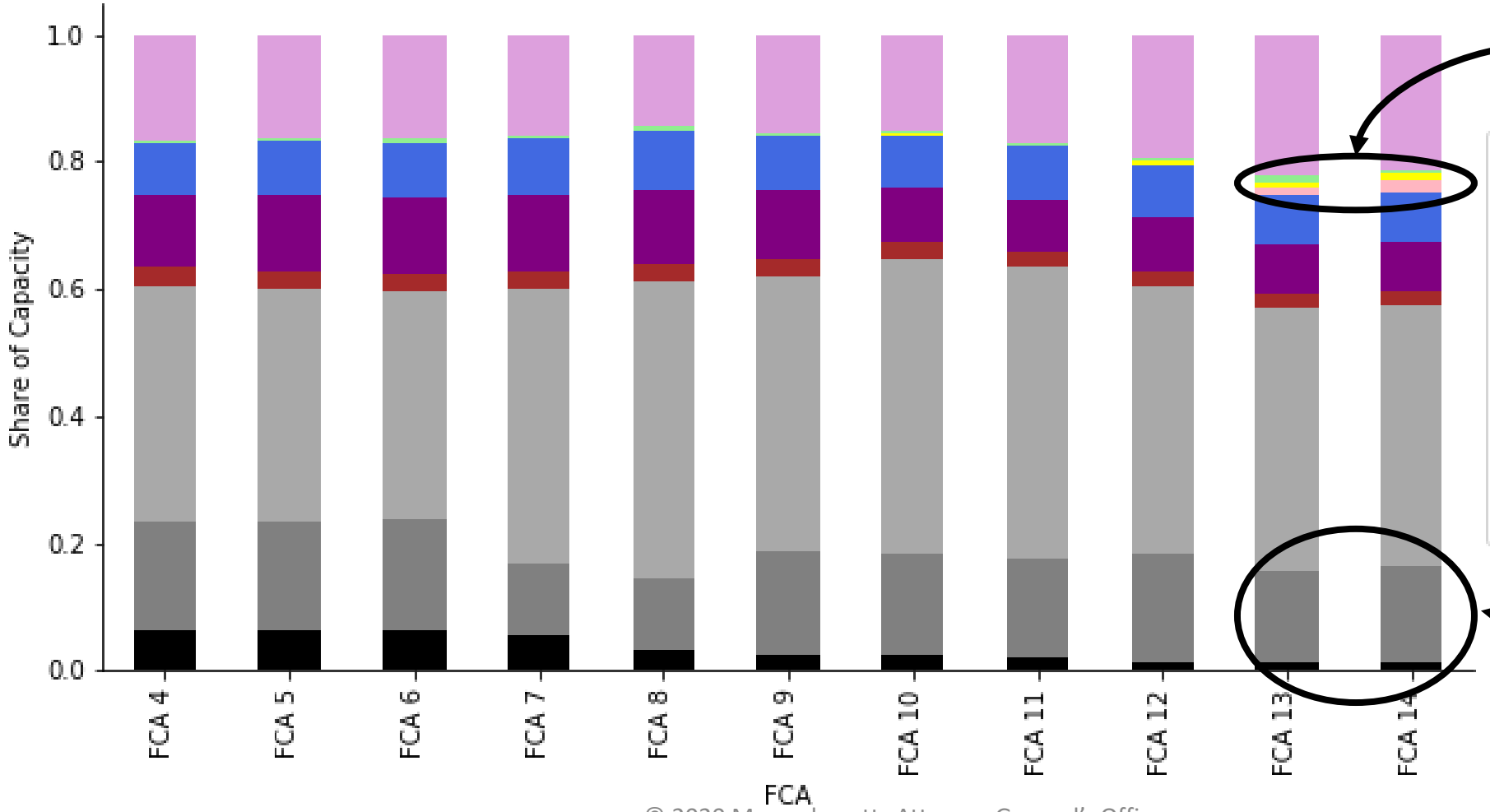
Source: https://www.nrel.gov/news/program/2020/latest-grid-data-book-reveals-key-trends-in-renewable-integration.html

Forward Capacity Market

The Forward Capacity Market (FCM)

- The capacity market is designed to ensure that there is enough "iron in the ground" to provide electricity when demand is at its highest, like the hottest day of the summer. This is need is known as "resource adequacy".
  - Think insurance product to ensure year-round electricity coverage – useful even if you don't generally need it.
  - Or, think about gyms and gym memberships: gyms sized for January 2nd and membership costs are charged irrespective of whether you actually show up.
- The FCM pays resources to be available and encourage development of new power plants if more are expected to be needed.
- The FCM works in tandem with other markets to provide revenue that attracts and sustains power resources needed today and into the future.
  - Over the years, the FCM has helped 12,000 MW of new resources get built, including energy efficiency, demand response, renewable resources and natural gas plants.
  - It has helped retire almost 7,000 MW of older fossil and nuclear plants.

Capacity Obligations through 2025



New clean technologies

Coal and oil make up about 20% of capacity market obligations, despite rarely running

Participation by Clean Resources

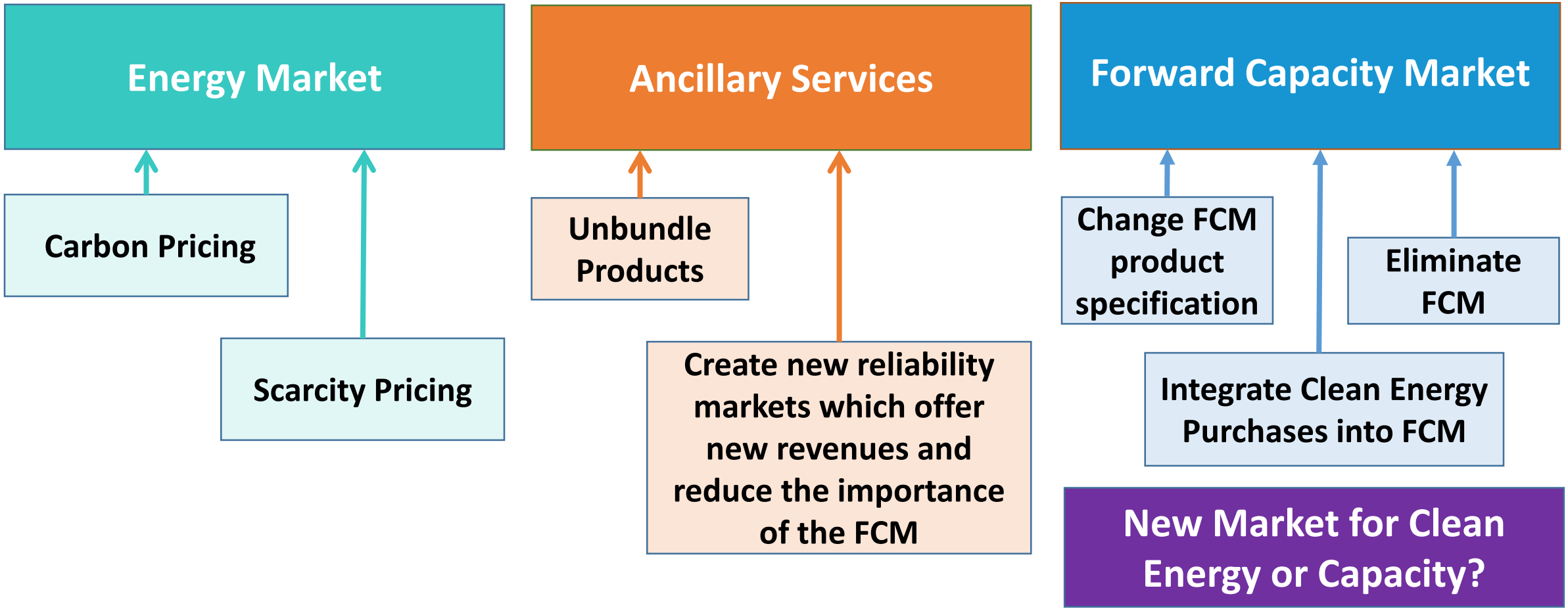
- **Capacity market is the most contentious wholesale market, because it helps finance new power plants and because clean/renewable resources are having trouble participating.**
- Capacity market is "technology neutral" and simply focused on RA.
  - But, in reality, we observe inexpensive gas plants are more likely to participate and earn revenue through it than other technologies like wind or solar.
- Due to ISO-NE and FERC rules, it is hard for resources with long term contracts from state renewable programs (wind, solar, storage, etc) to enter capacity market.
  - These rules say, in effect, that resources getting incentive payments cannot account for that revenue when making capacity market offers.
  - The CAPSR sub-auction is designed to allow these policy resources to take the place of retiring power plants, but this does not seem to be happening.

The case of the missing attribute…

There is no wholesale market to procure clean energy

- ISO-NE markets were developed (and largely successful) in solving the 20th century problem of delivering reliable and affordable energy.
- New England States are increasingly worried that our wholesale markets are not set up to be reliable, affordable, & **clean**.
  - By not formally accounting for "clean" goals, the markets are at risk of being more expensive and dirtier than they need to be.
  - For example, we shouldn't have to buy clean energy through state procurement and then buy separate capacity for resource adequacy. Should be able to recognize RA value of clean energy procured within markets or outside of them.
- Clean energy must be added, but we need to ensure it is done reliably and affordably.
- Many possible ways forward but the region is still in early days of this effort.
  - First attempt at integrating "clean" stalled out and those market reforms were inadequate.
  - Stakeholders are actively evaluating paths forward in the NEPOOL "Future Grid" proceeding. States are holding tech sessions this fall/winter on same themes.

Many possible changes could help more clean energy get built



Conclusions & Key Takeaways

- Power is a commodity and markets are an efficient way to buy/sell it.
- Wholesale markets have been largely successful at meeting their intended goals…but our goals are expanding.
  - The markets for energy & ancillary services offer effective methods to operate existing power plants in an affordable and reliable manner.
  - The capacity market helps ensure that we have enough resources to be able to generate electricity year-round.
- These markets provide a necessary but insufficient foundation on which to reach our clean energy future.
- Many possible paths forward, but premature to know what path makes the most sense. Much work to be done.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Thanks!