

June 20, 2019

Value on the Table

ISO-NE Consumer Liaison Group Meeting

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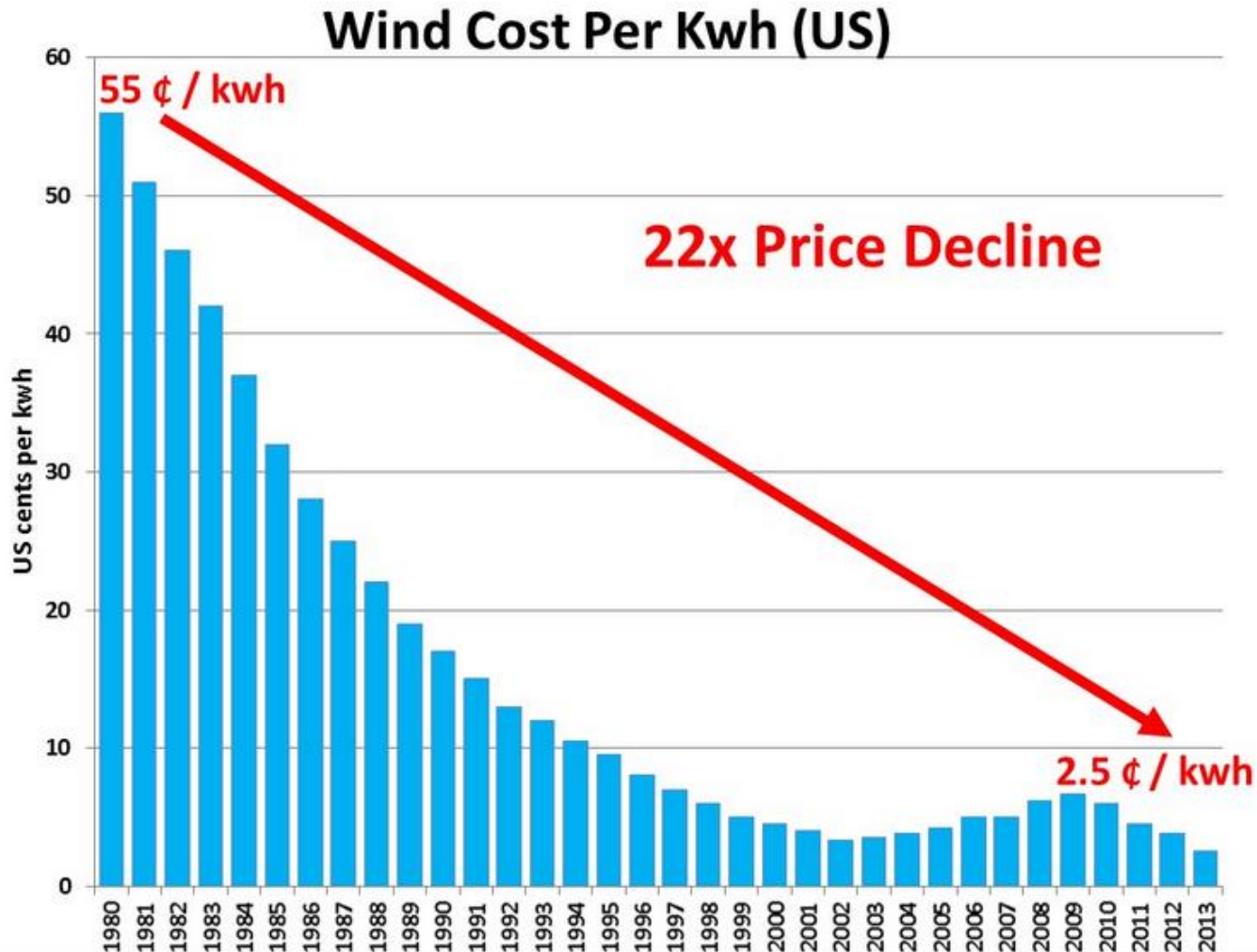
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1 The problem

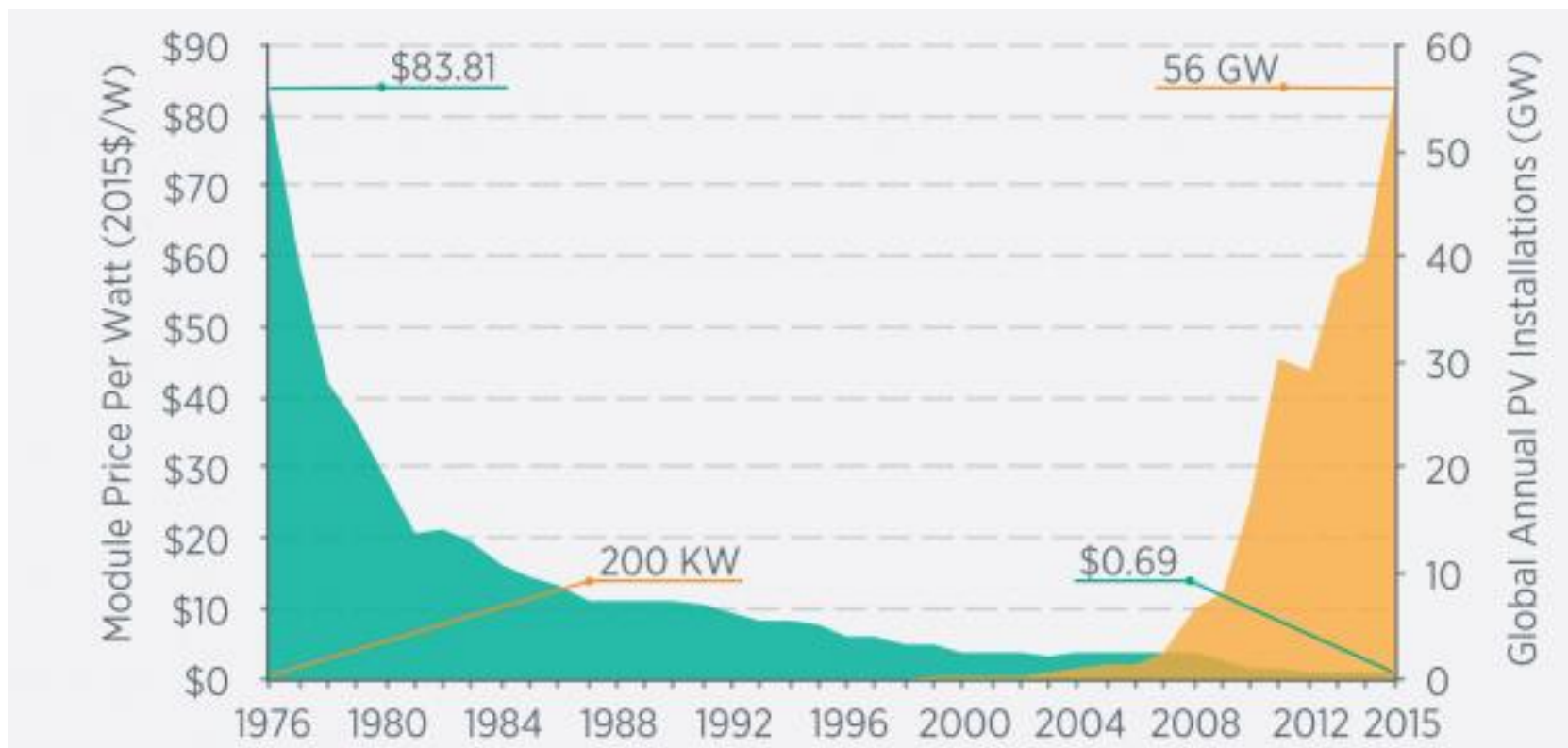
Restructured markets were not designed to operate with or price the modern capabilities that grid-scale and distributed advanced energy technologies now offer at very affordable prices and sometimes no energy market price.



Wind costs dropped a decade ago

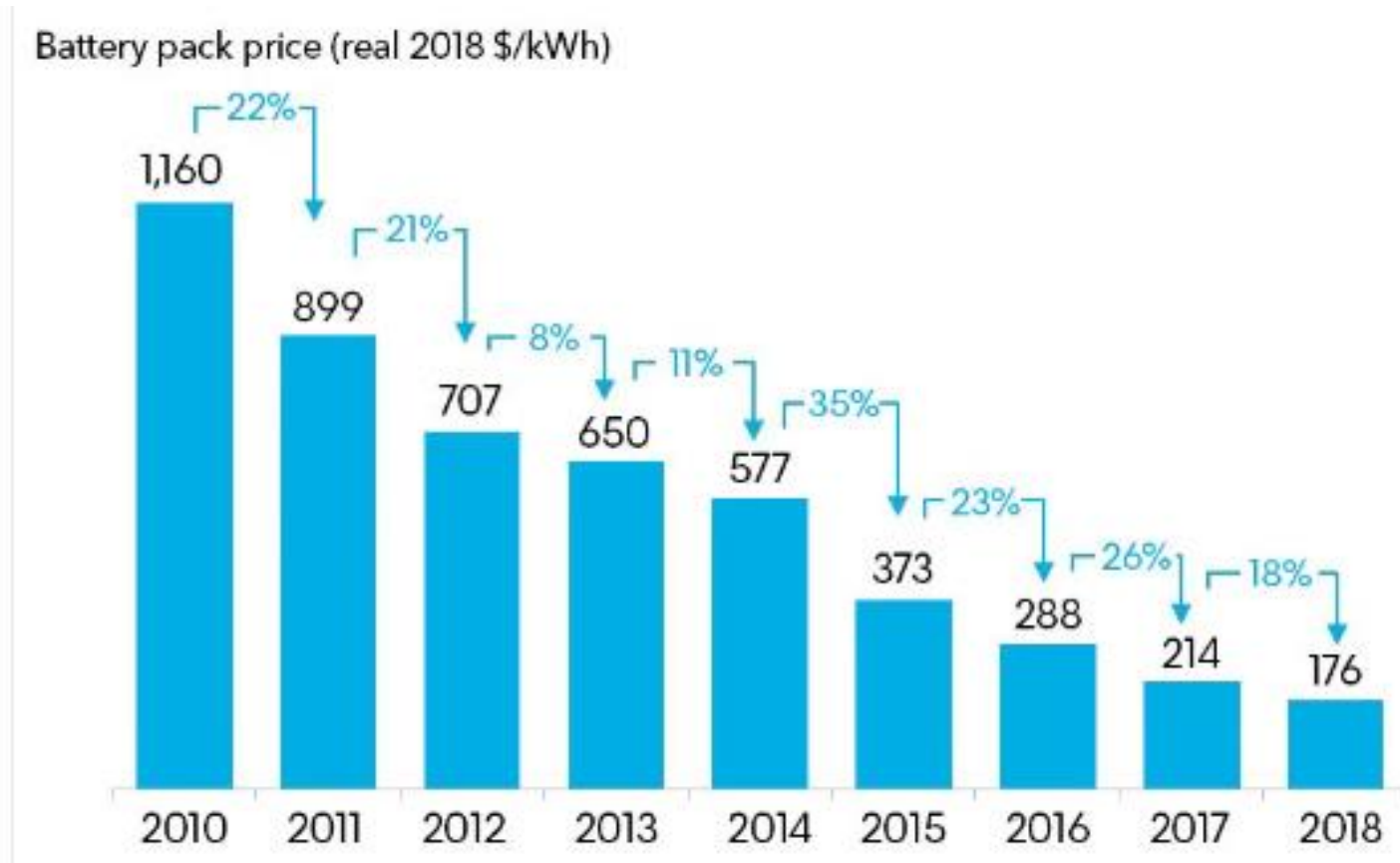


Solar is following close behind



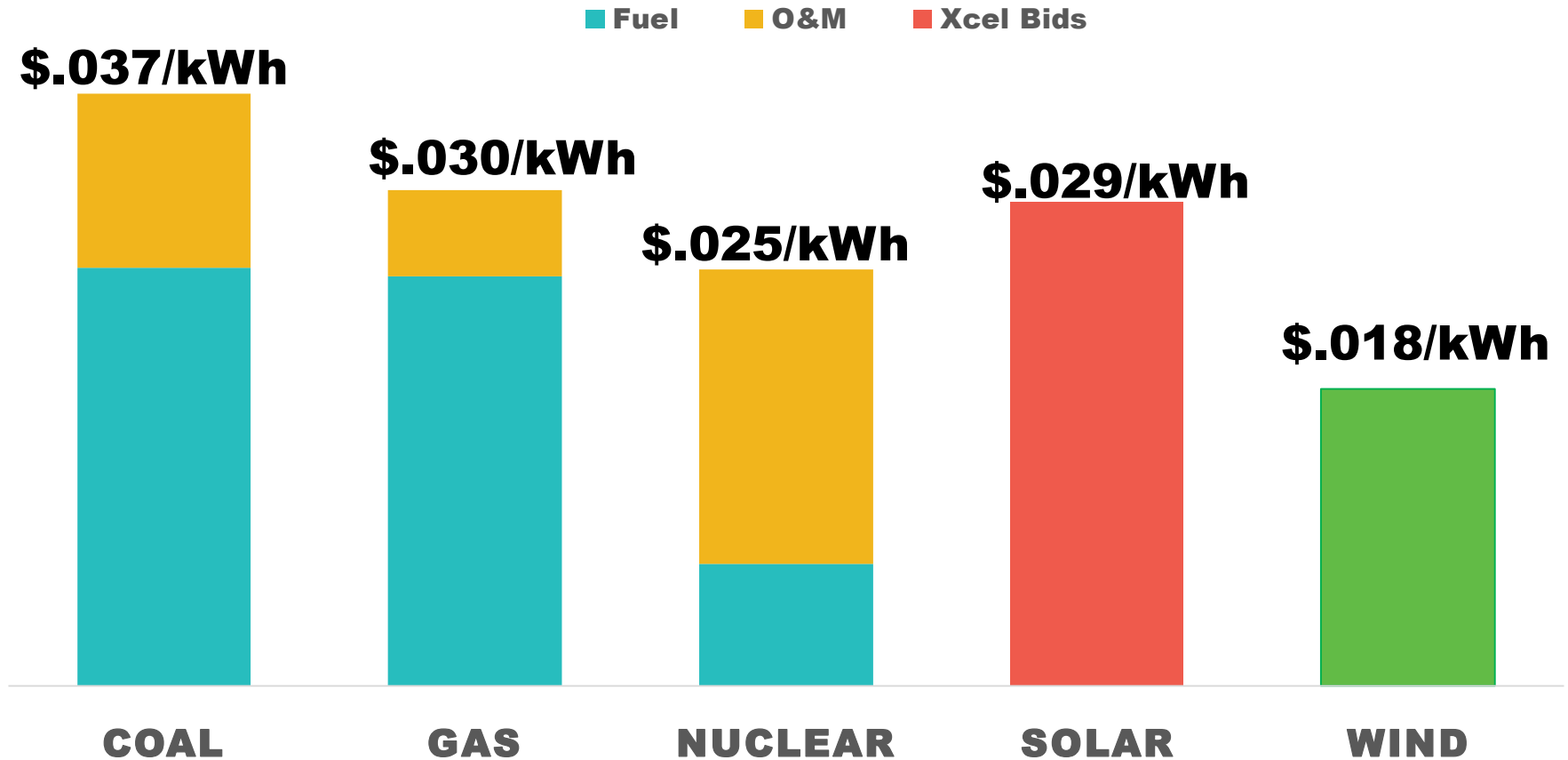
Source:

2018's news: the battery cost slide



Source: BloombergNEF. Data adjusted to be in real 2018 dollars.

Existing plants vs. Xcel bids



Source: Existing Plant Average Fuel and O&M from USEIA Table 8.4 Electric Power Annual 2016

Xcel energy plan - 2018

Wind: \$.011/kWh

Solar: \$.023/kWh

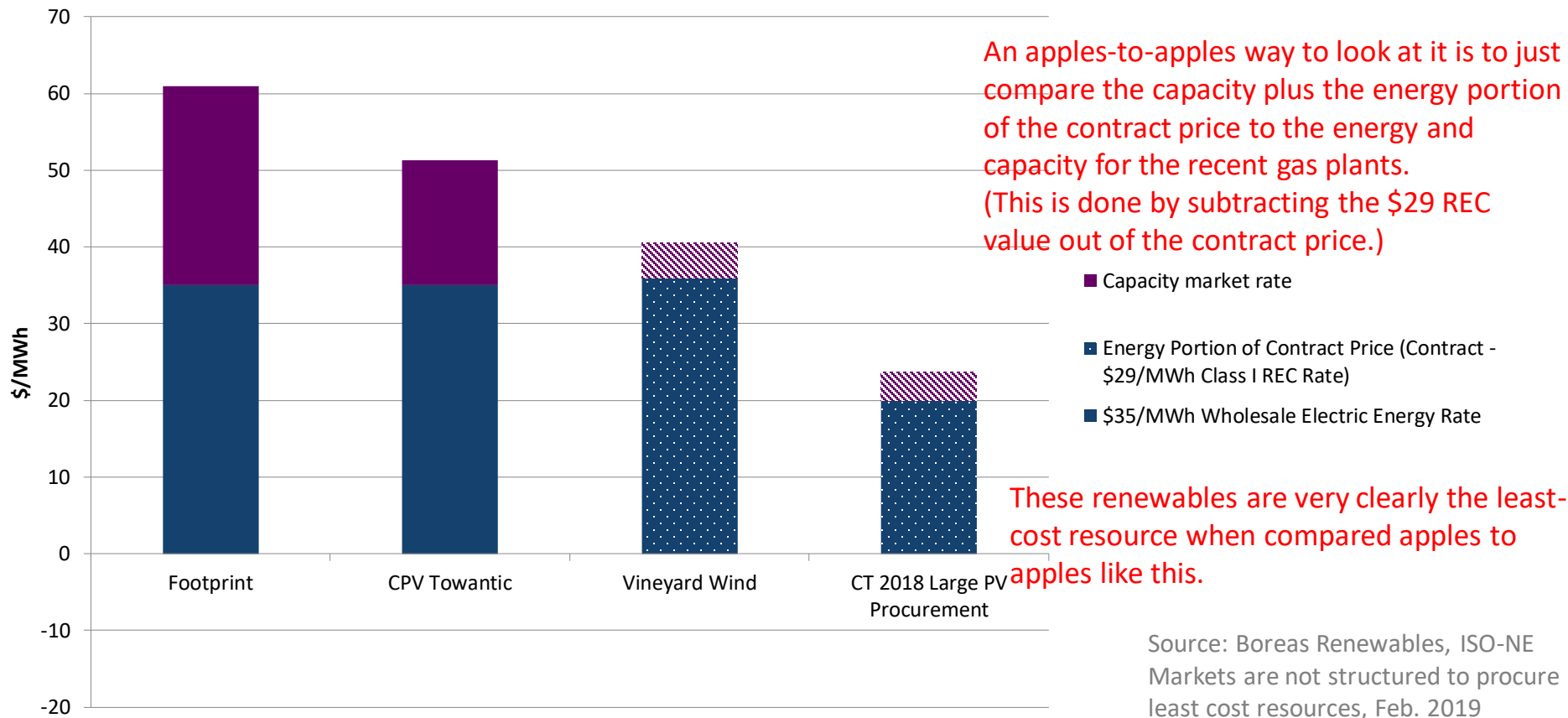
Solar + storage: \$.030/kWh



Image credit: Jeffrey Beall, Wikimedia

In New England, comparing apples to apples, RE is clearly least-cost resource

Recent Gas Plant New Builds vs State Renewables Procurements



Restructured markets are designed on a late 1990s model

Natural gas merchant generators took generation and generation became “competitive”

- Legislators & PUCs said yes
- Privatized gains and risks of generation development, financing, construction, operations
- Energy markets are competitive
- But what is “capacity”?

Over 20 years, what have restructured markets done?

What restructuring does well:

1. Shifts gen risk
2. Encourages merchant natural gas development (combined cycle and gas turbines)
3. Disciplines short-term marginal energy pricing

And didn't anticipate:

1. Fuel price and supply risk
2. High CAPEX, Low OPEX resources (RE, Nuke)
3. Distributed Resources
4. Pricing of clean attributes
5. Anticipate new technological capabilities
6. "Capacity": settle definition
7. Price needed "capabilities"

Capacity markets make gas plants financeable

At the FCA 12 ORTPs (Offer Review Trigger Prices), new gas plants would lock in revenue equal to roughly 2/3 of their capital costs, to be received over first 7 years of operations

- Leaves only 1/3 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 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%

Source:
Boreas
Renewables,
ISO-NE
Markets are
not structured
to procure
least cost
resources,
Feb. 2019

Capacity markets don't make clean energy financeable

- At wind and solar ORTPs, 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
- Many wind/PV resources have and should obtain Resource Specific Minimum Offer Prices at or below gas plant ORTPs, allowing them to clear in FCA
 - Even though they may clear in FCA as least-cost resource, will lock in even less of their capital costs
- 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%
Simple Cycle	\$6.50	65%
Wind	\$11.03	10%
PV	\$26.32	16%

Source:
Boreas
Renewables,
ISO-NE
Markets are
not structured
to procure
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resources,
Feb. 2019

What happens as energy value falls?

- 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 are \$0/MWh in all hours, the ORTP difference between a gas turbine and wind/solar becomes more pronounced.
- The more zero-fuel-cost (clean) resources we have, the more strongly the FCM will drive procurement of low-capital cost resources like gas turbines.
- Current market structure strongly favors low-capital-cost generation, even when that will increase system energy prices.

	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

Source: Boreas Renewables, ISO-NE Markets are not structured to procure least cost resources, Feb. 2019

Assessing Energy Efficiency Resource Performance in All Hours



*First Report of the Demand Resources
Working Group to the Markets Committee*

Henry Yoshimura

CHAIR, DEMAND RESOURCES WORKING GROUP

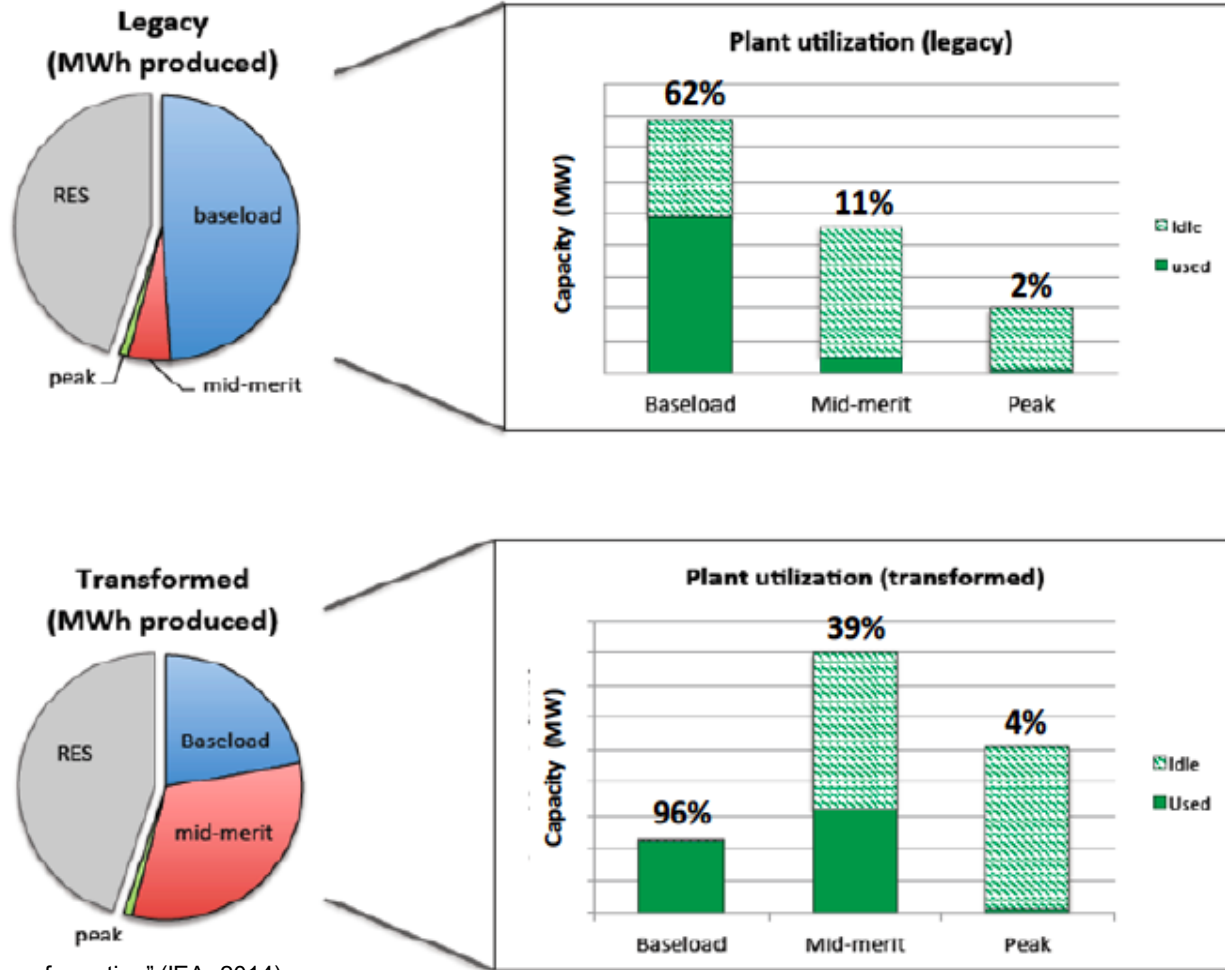
DIRECTOR OF DEMAND RESOURCE STRATEGY, ISO NEW ENGLAND

What has changed and is changing?

- New technologies and capabilities
- Grid operational needs
- Markets that do not address new capabilities and needs



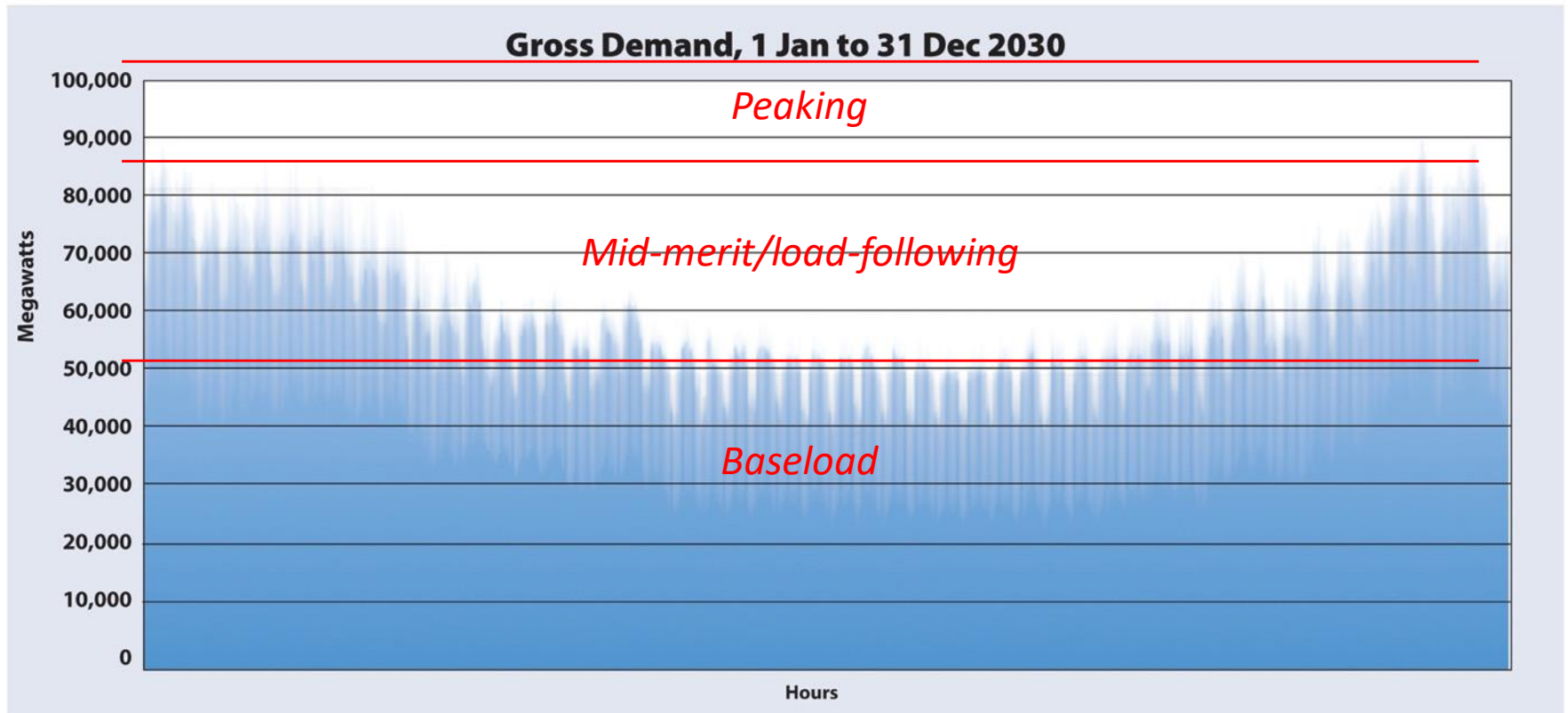
Difficulty in defining needed “capacity” illustrated by changing grid needs:



Source: “The Power of Transformation” (IEA, 2014)

“How much capacity?” depends on “what kind of capability?”

Figure 3

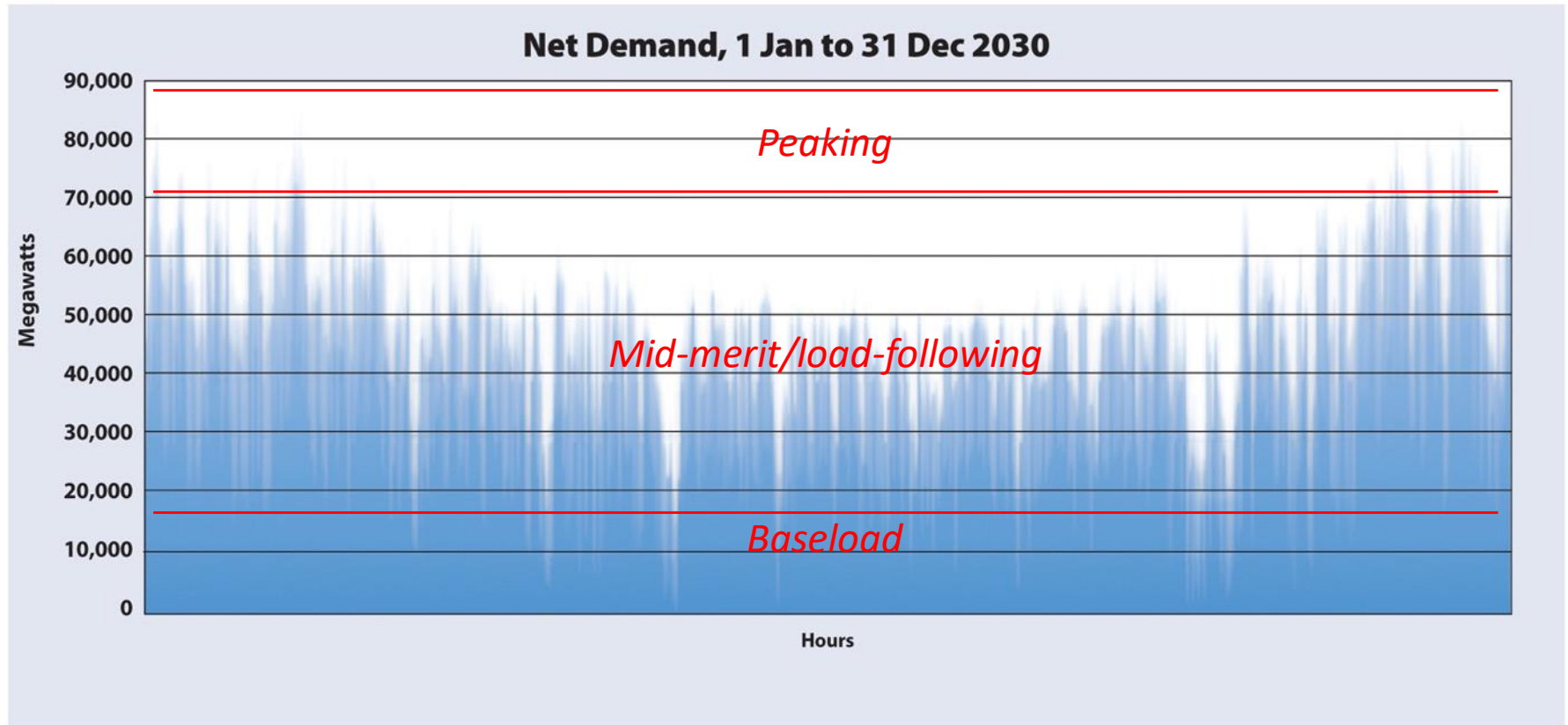


Gross load (2030), Southern UK, 28% variable RES

Source: "Roadmap 2050" (McKinsey/ICL/KEMA 2010)

“How much capacity?” depends on “what kind of capability?”

Figure 4



Net load (2030), Southern UK, 28% variable RES

Source: “Roadmap 2050” (McKinsey/ICL/KEMA 2010)

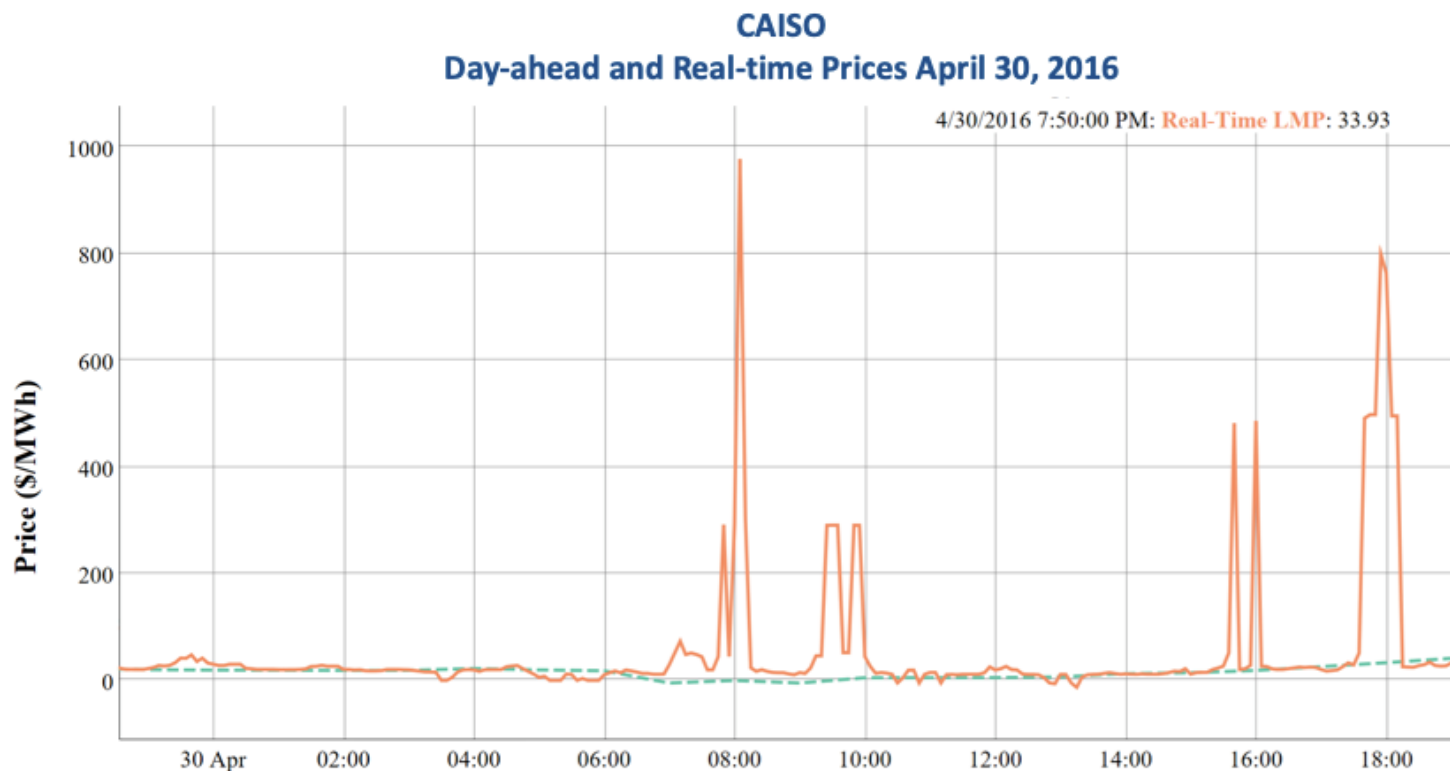
New resources bring new capabilities



Supply side: Inverter-based technologies provide grid support capabilities



Inverter-based technologies excel at being fast



Source: www.ascendanalytics.com

Resource capabilities in real time

	Inverter-Based			Synchronous				Demand Response
	Wind	Solar PV	Storage/Battery	Hydro	Natural Gas	Coal	Nuclear	Demand Response
Disturbance ride-through	Excellent	Very Good	Very Good	Excellent	Good	Good	Good	Good
Reactive and Voltage Support	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Very Good
Slow and arrest frequency decline (arresting period)	Very Good	Very Good	Very Good	Very Good	Good	Good	Very Good	Good
Stabilize frequency (rebound period)	Very Good	Very Good	Very Good	Very Good	Excellent	Very Good	Very Good	Good
Restore frequency (recovery period)	Good	Good	Good	Excellent	Excellent	Very Good	Limited	Good
Frequency Regulation (AGC)	Very Good	Very Good	Excellent	Excellent	Excellent	Very Good	Limited	Excellent
Dispatchability/Flexibility	Good	Good	Excellent	Excellent	Very Good	Very Good	Limited	Good

These services also contribute to frequency restoration, but are also considered essential reliability services on their own.



Excellent



Very Good



Good



Limited



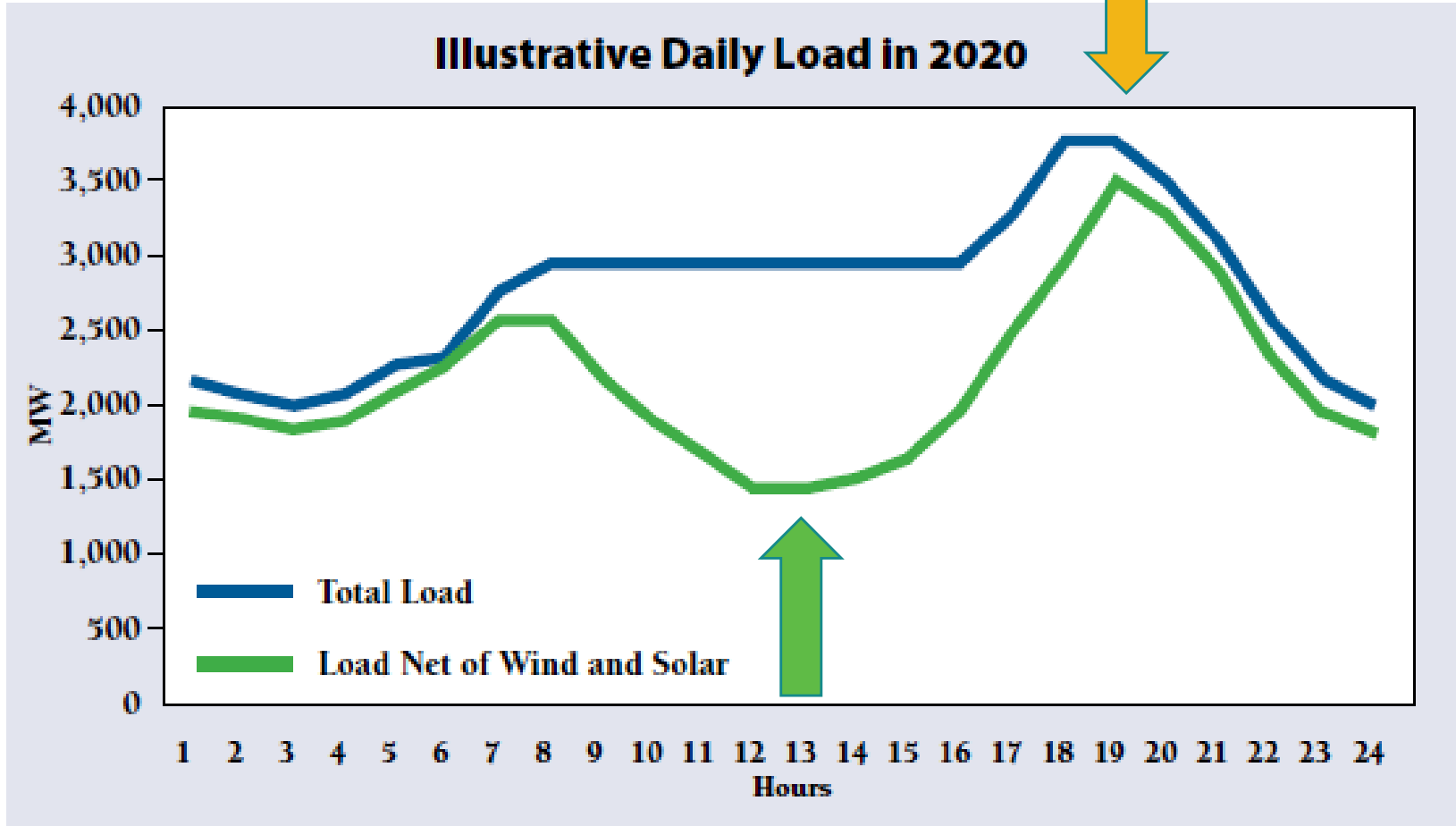
Incapable

Source: www.milligangridsolutions.com

Demand side: New services are available

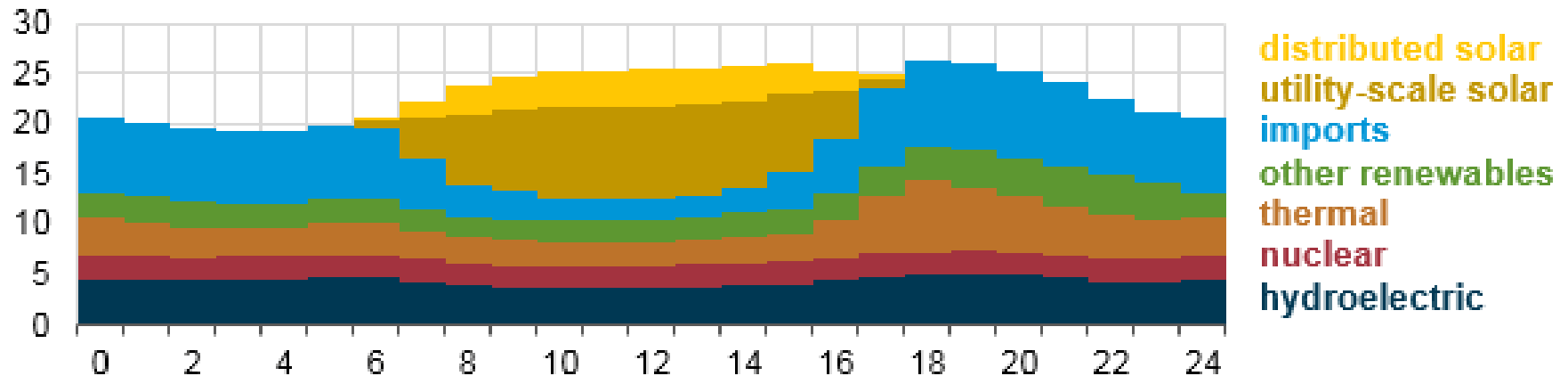


Load-side resources to “shape” the demand curve



Load-side resources can “shift” demand to times when surplus power is available

California Independent System Operator net generation, March 11, 2017
gigawatthours



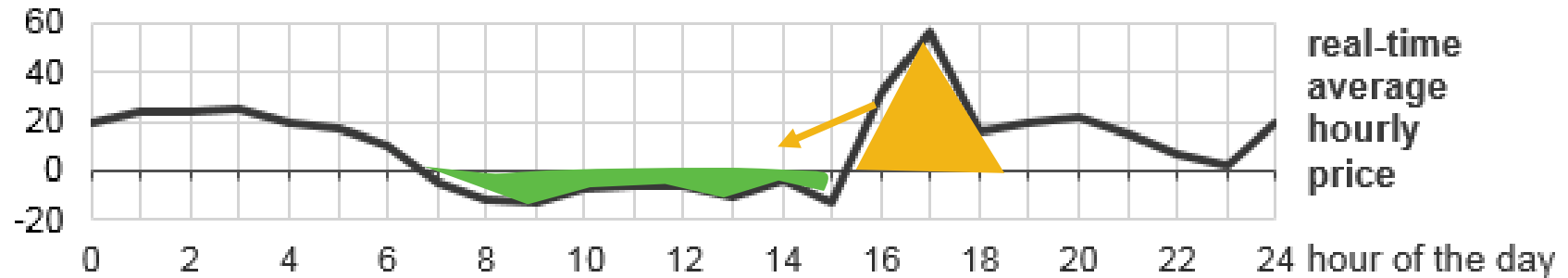
Controlled water heaters

CTA 2045 socket
enables any control
network to connect to
any new water heater

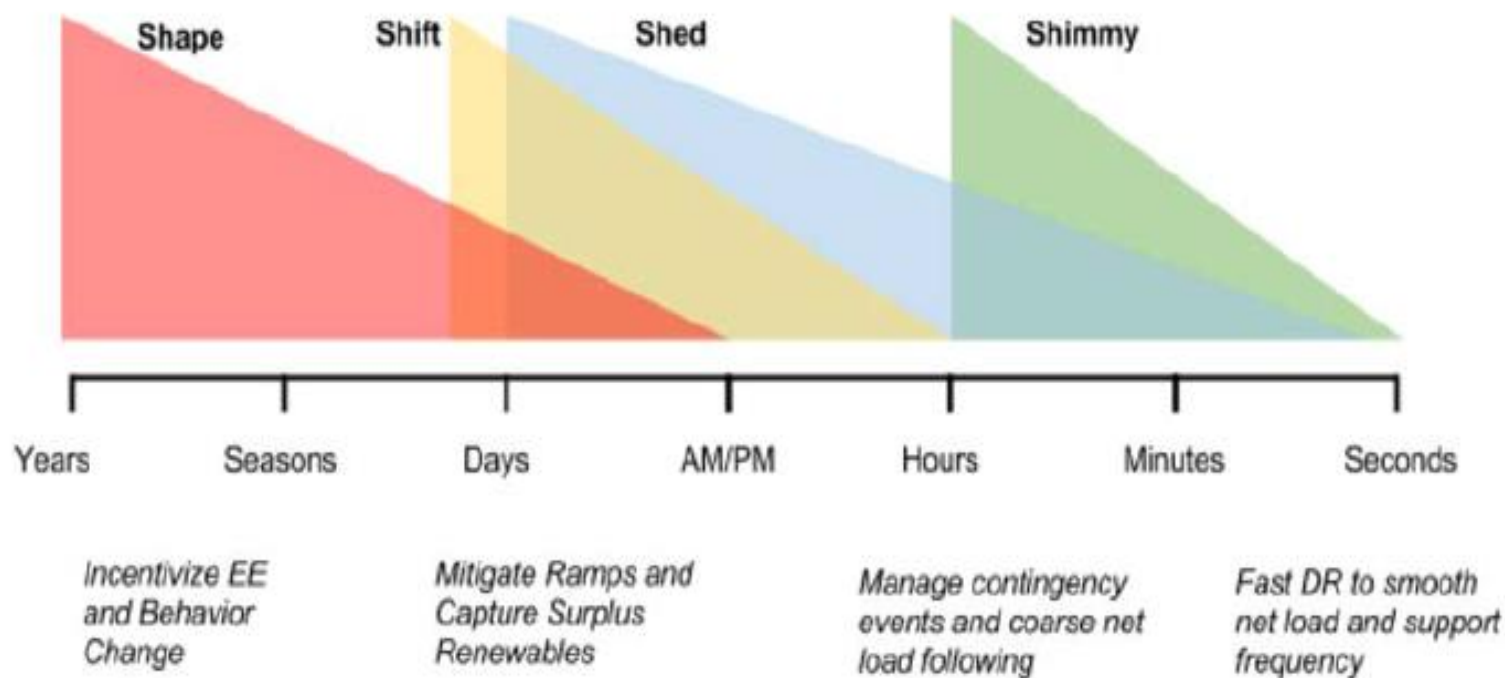


Load-side resources can “shift” demand

dollars per megawatthour

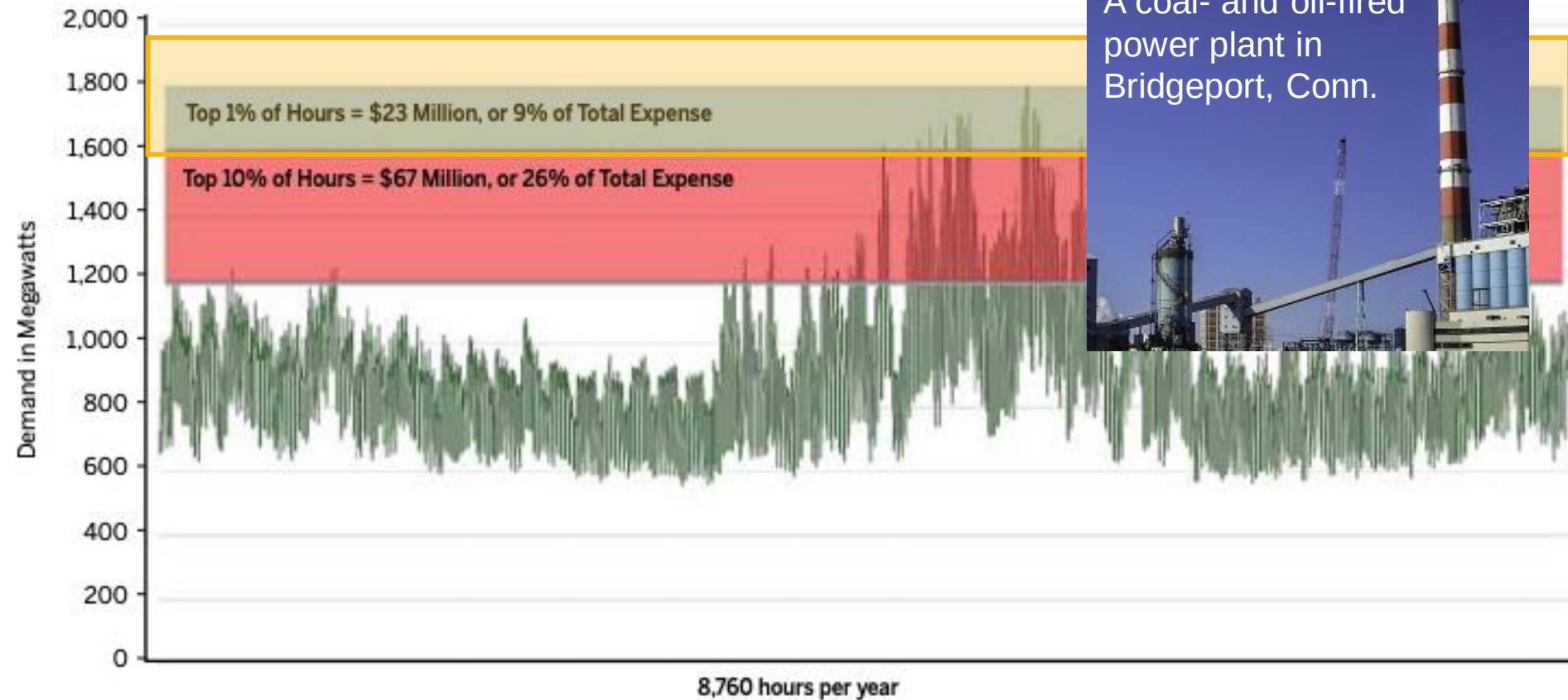


Flexibility strategies for the demand side now span many timescales



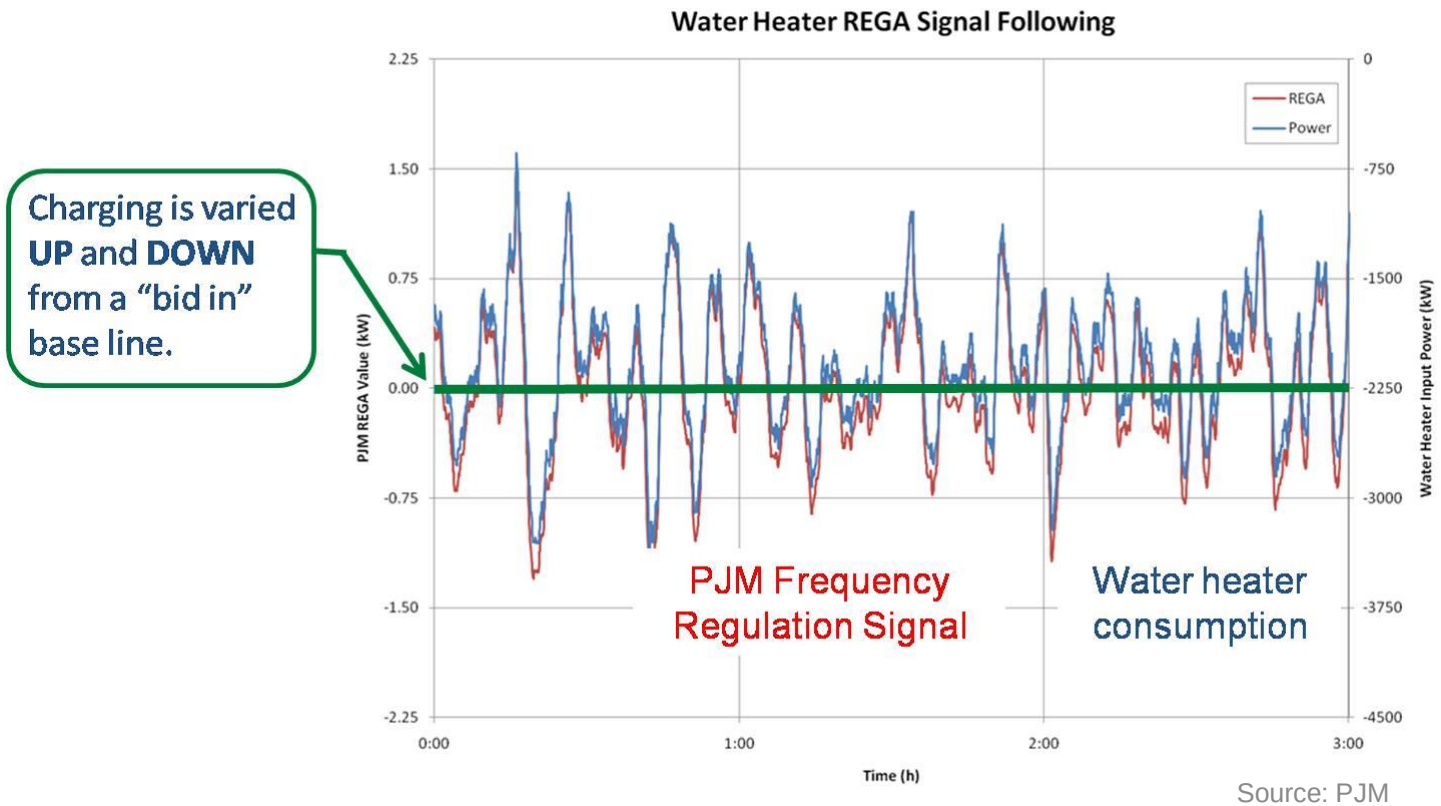
Source: 2015 California Demand Response Potential Study, LBNL, November 2016

Limited curtailment can “shed” during critical hours

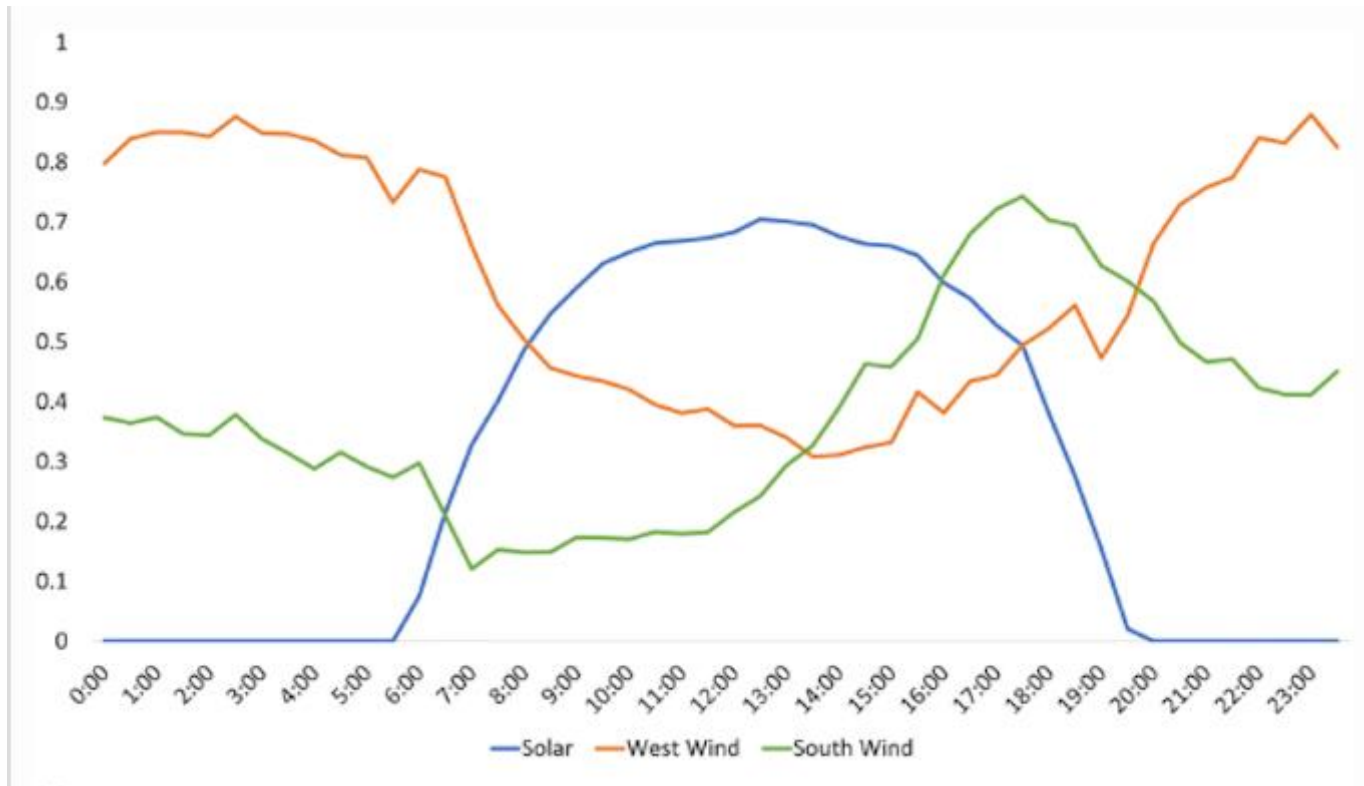


Source: Rhode Island Division of Public Utilities & Carriers, Office of Energy Resources, and Public Utilities Commission. (2017). Rhode Island Power Sector Transformation: Phase One Report to Governor Gina M. Raimondo. Image credit: Conservation Law Foundation

Responsive load and batteries can “shimmy” to meet short-term grid needs

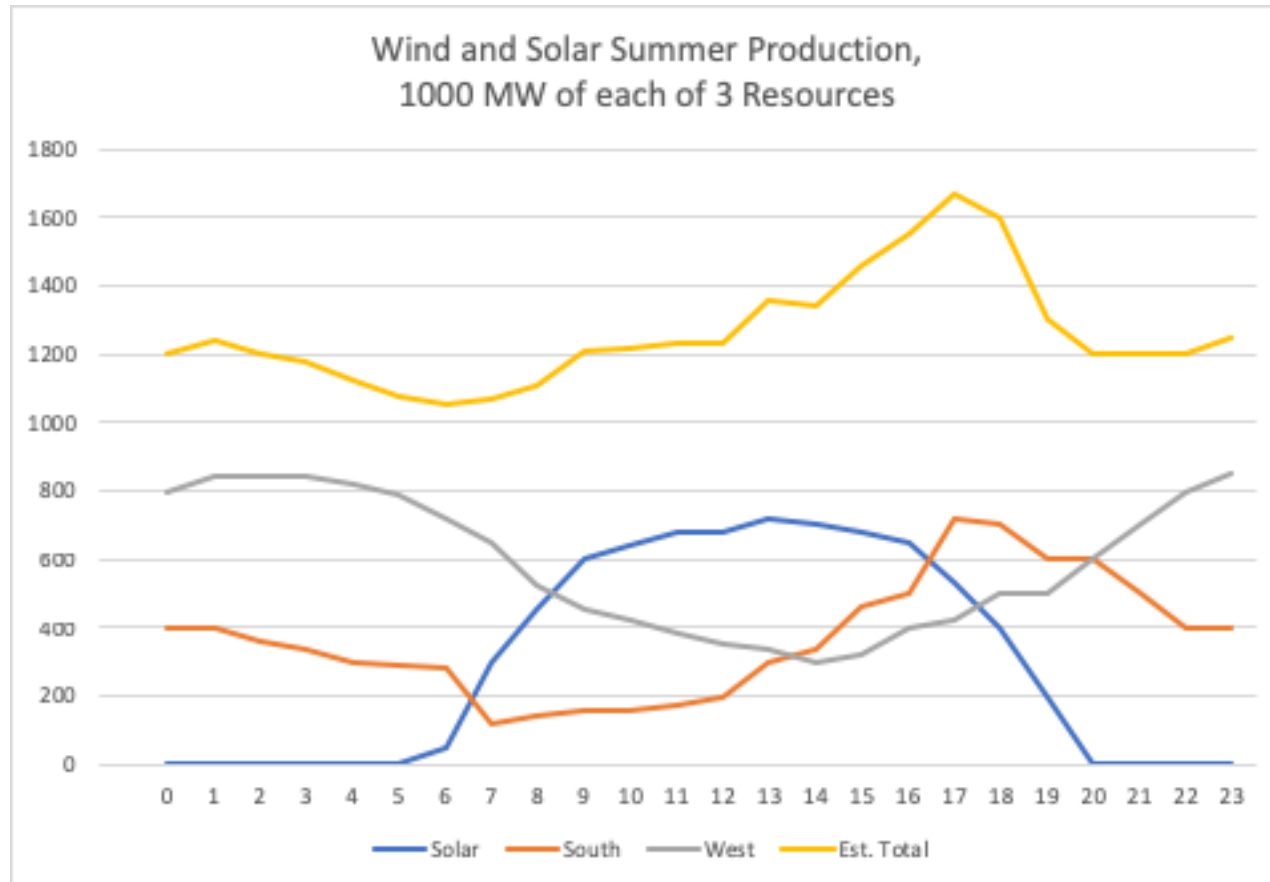


Texas wind resources and solar resources have complementary load capacity profiles



Slusarewicz and Cohen, "Assessing Solar and Wind Complementarity in Texas,"
Renewables: Wind, Water and Solar, 2018, Vol. 5, No. 7.

Combined, a smoother profile that approximates system needs results



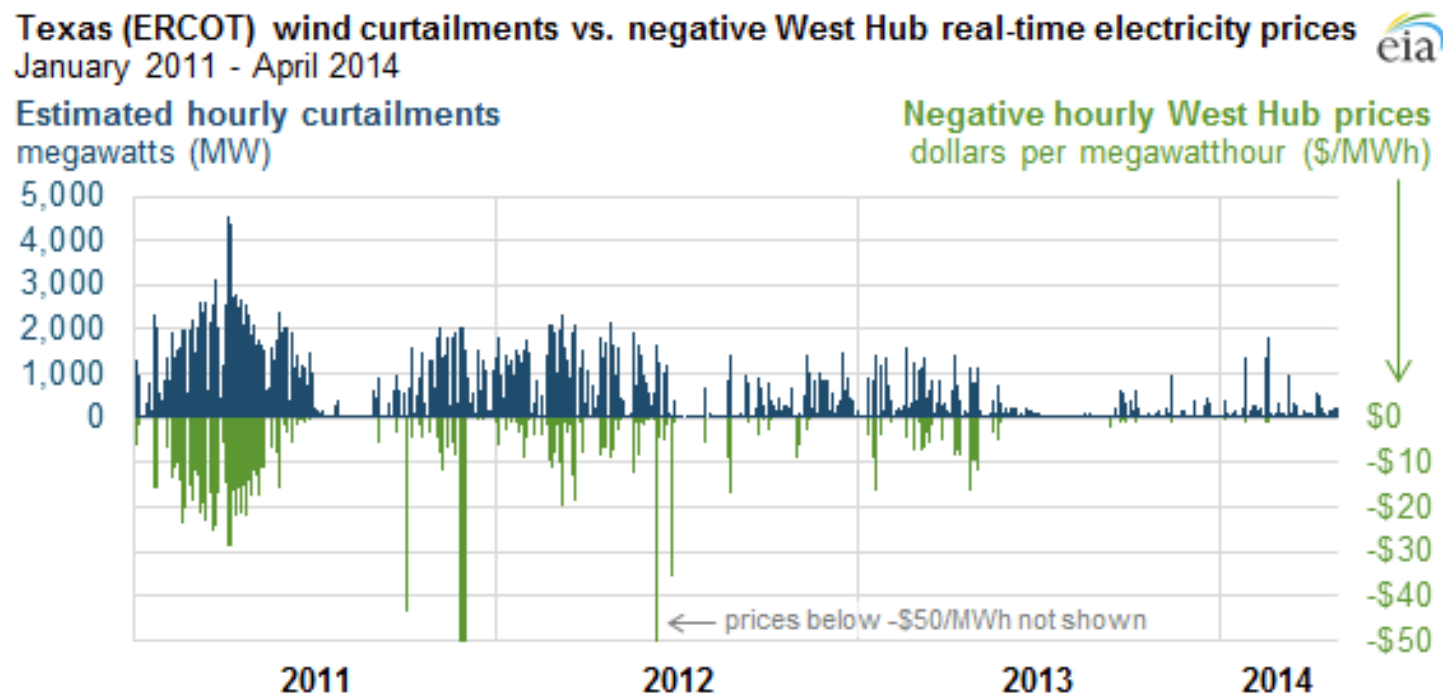
Vintage late 90s bulk-scale solutions need new focus

States are doing this more than ISO-NE, NYISO, PJM

- Clean Bulk Transmission & Grid-Scale Generation
- Grid-scale solutions open up additional local and distributed resource value as Western Interconnection experience shows

Transmission in Texas

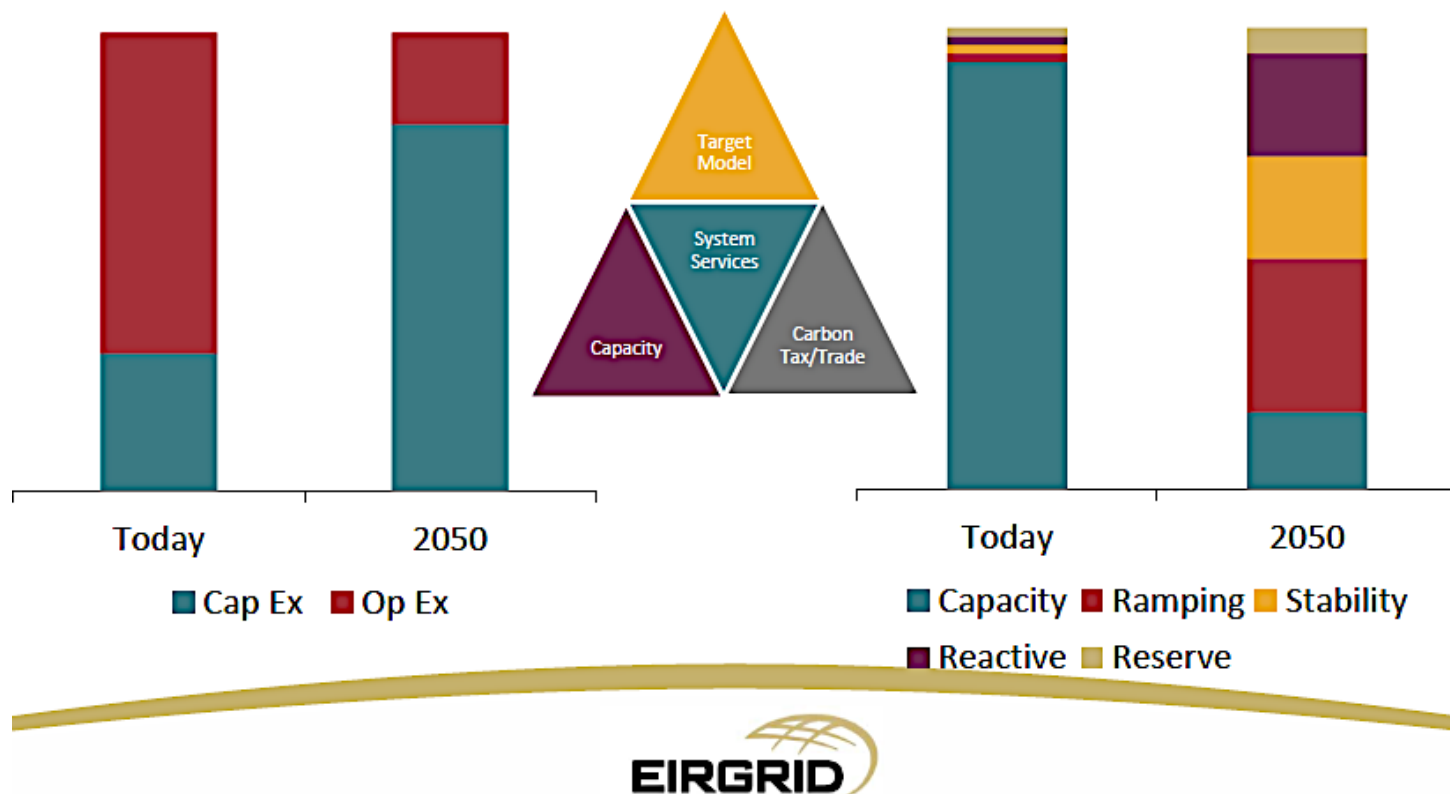
Increasing resource and geographic diversity has significantly reduced curtailments and stabilized prices



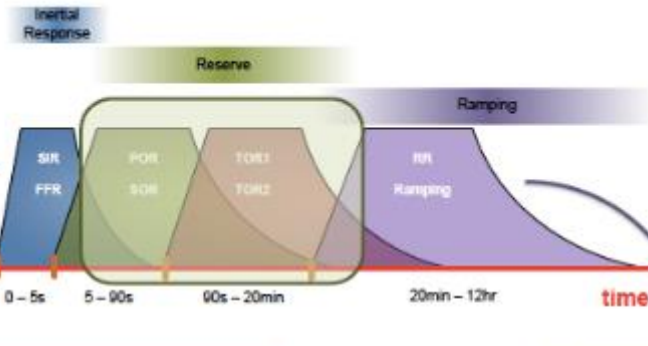
Source: U.S. Energy Information Administration, based on the [Electric Reliability Council of Texas](#) (ERCOT) for curtailments and [SNL Energy](#) for electricity prices

A modern grid needs system services *not* “capacity”

...so market model should reflect this

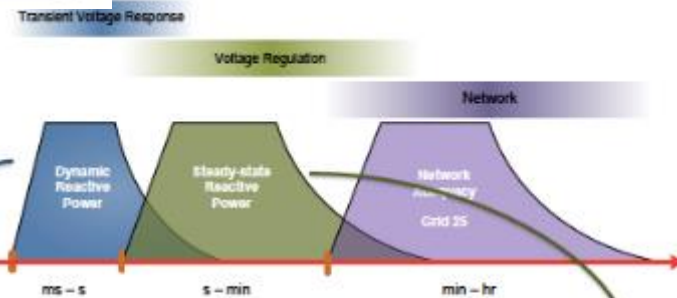


More flexible grid services . . .



- Synchronous Inertial Response
- Fast Frequency Response
- Fast Post-Fault Active Power Recovery

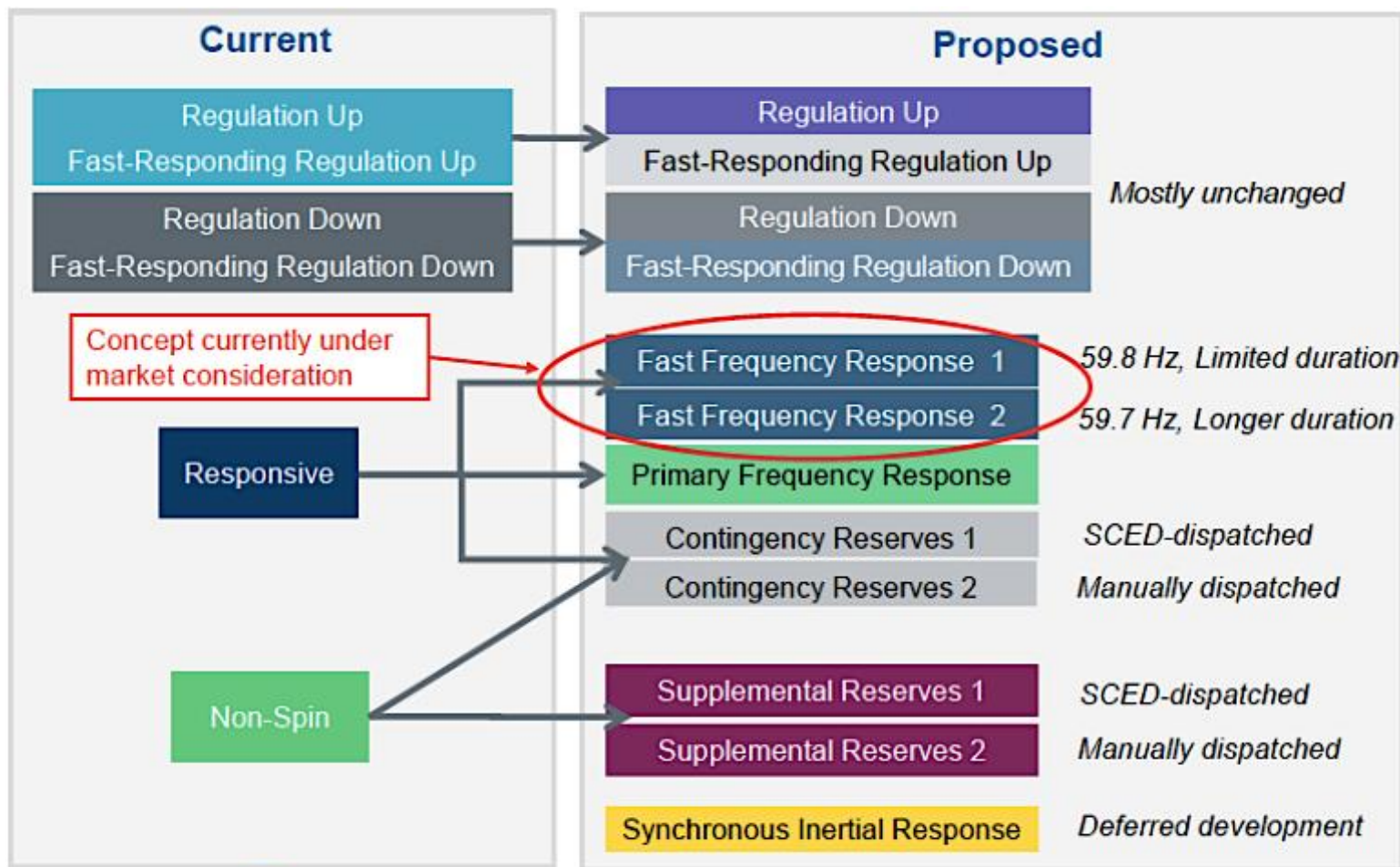
- Ramping Margin



- Dynamic Reactive Power

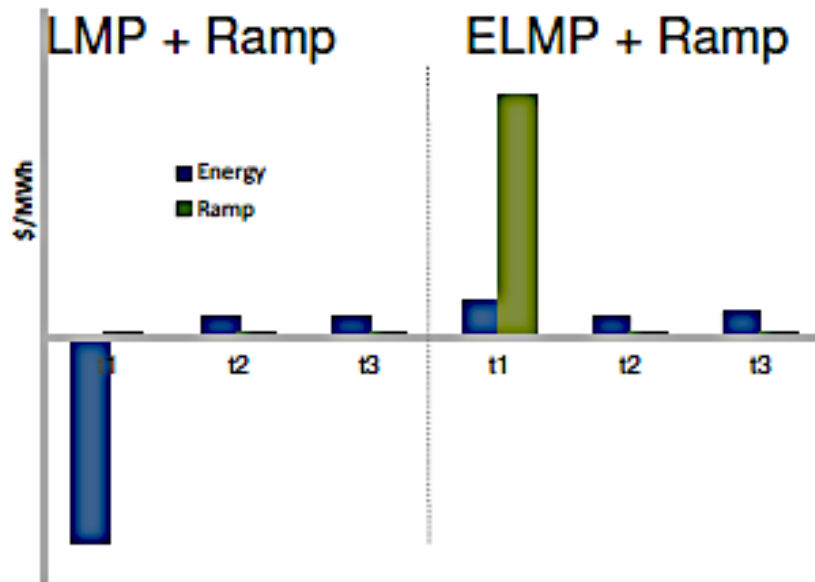
- Steady-state Reactive Power

System services = Capabilities

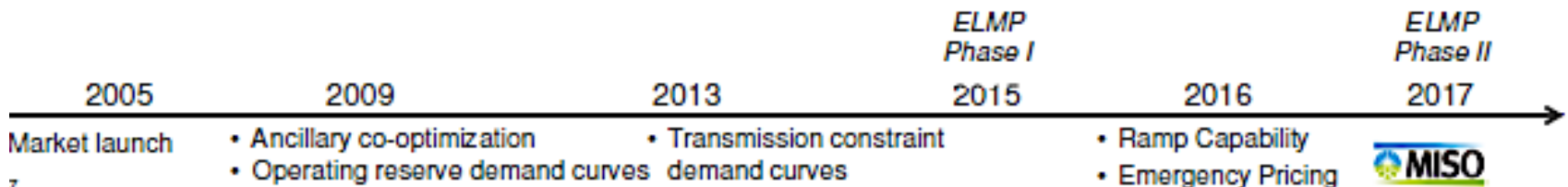


Evolution of price formation for new capabilities

ELMP complements products like ramp by better pricing the total production costs to meet an operating need indicated by a product



- Without ELMP, Ramp reflects only marginal cost
- Without Ramp, ELMP reflects only energy needs



So what's the real marginal cost?

System Resource	Full Marginal Cost (€/MWh)
Generation capacity	20-250
Imports	20-1,000
Secondary (operating) reserves	250-5,000
Emergency generation	500
Primary (regulation) reserves	500-9,000
30-minute responsive back-up	1,400
30-minute controllable demand response	2,400
10-minute controllable demand response	2,600
10-minute responsive back-up	3,700
Emergency load-shedding	9,000

Source: Brattle Group

ENERGY SECURITY IMPROVEMENTS: MARKET- BASED APPROACHES



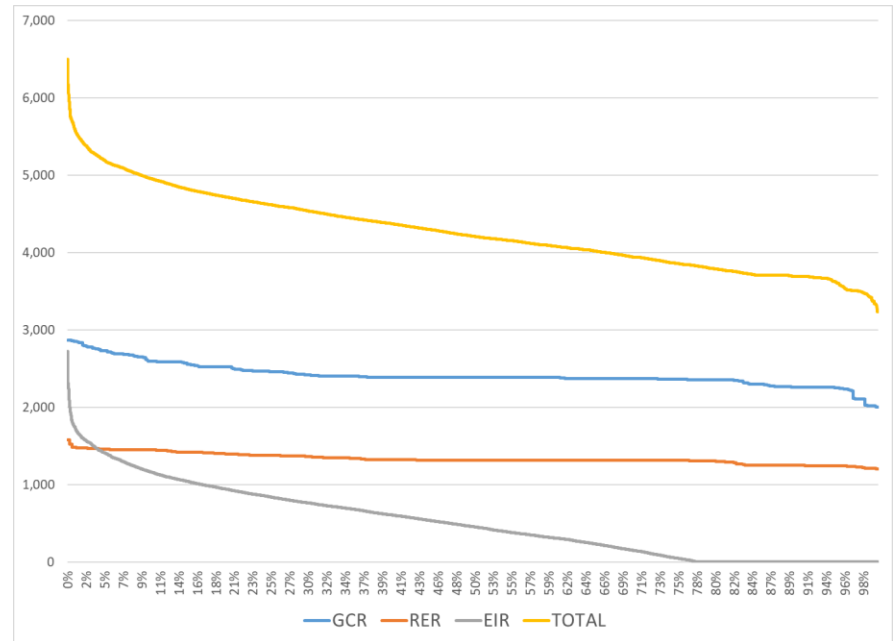
*Discussion of a market-based solution to
improve energy security in the region*

Andrew Gillespie

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New ISO-NE ancillary service requirements?

- **GCR:** Hourly Total Operating Reserve Requirement used in the initial RAA for the operating day
- **RER:** As an approximation, each day's avg. hourly largest single source loss (initial RAA) for the operating day
 - This will be refined as the RER requirements are developed (July MC)
- **EIR:** Hourly difference in physical energy supply cleared in the DAM and scheduled in the RAA (positive values only)



Day-Ahead Implied Ancillary Service Requirements - 2018

(Hourly MW values)

	Average	Minimum	25th Percentile	Median	75th Percentile	Maximum
GCR	2,417	2,005	2,367	2,389	2,465	2,873
RER	1,339	1,205	1,320	1,320	1,382	1,585
EIR	522	0	54	459	844	2,728
Total	4,279	3,234	3,864	4,215	4,622	6,506

Flexibility on fuel security: Canaport LNG is good enough for generators

Claimed nominal capacity of 1,200,000,000 cu ft (34,000,000 m³) LNG per day, enough to heat 5 million homes.

Claimed capable of supplying 20% of gas demand in the northeast U.S. and Canada

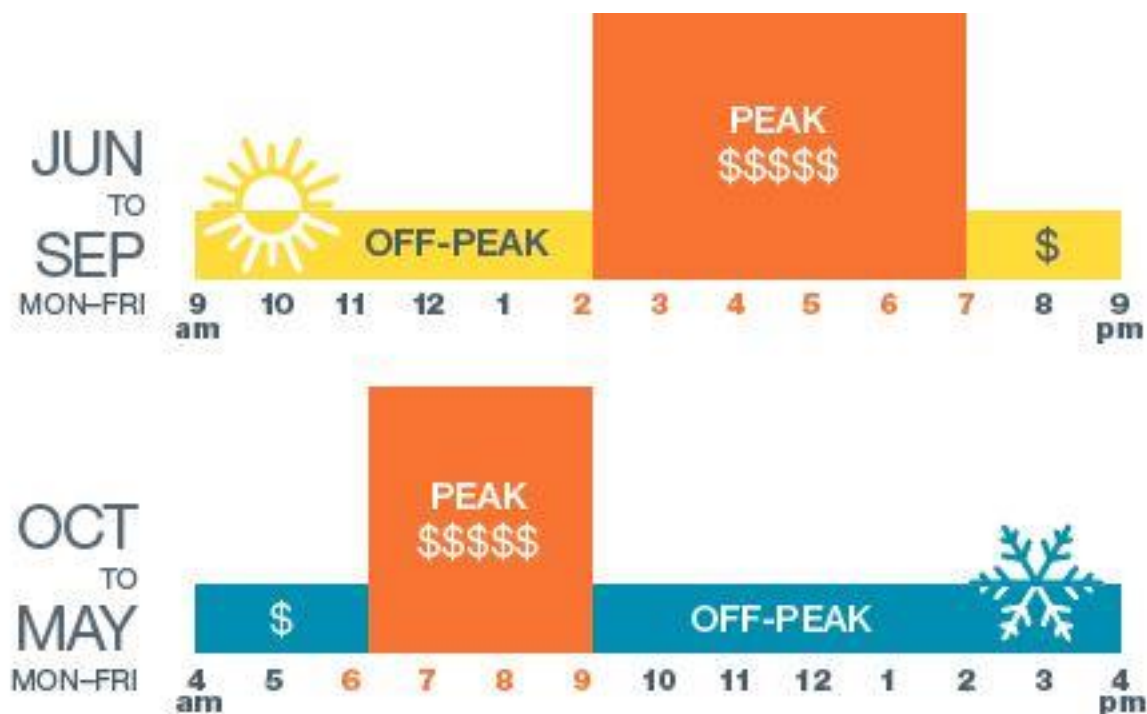


3 Imperative: Save consumers money and modernize the grid



Time variant pricing for supply, distribution, ISO-NE products in a consumer-friendly offering:

BG&E TOU Pilot



Excludes weekends and holidays, which are billed at off-peak rates. Holidays include New Year's Day, President's Day, Good Friday, Memorial Day, Independence Day, Thanksgiving, Christmas and the Monday following if any of these holidays fall on a Sunday.

Open up wholesale markets to aggregated DERs and storage

CAISO initiated the Electricity Storage and Distributed Energy Resources (ESDER) Initiative in 2014 to:

- Enhance the ability of ISO connected and distribution-connected resources to participate in ISO markets

Phase 3 completed in 2018 and market participation enhancements included providing bidding mechanism allowing BTM resources to offer load using load curtailing service

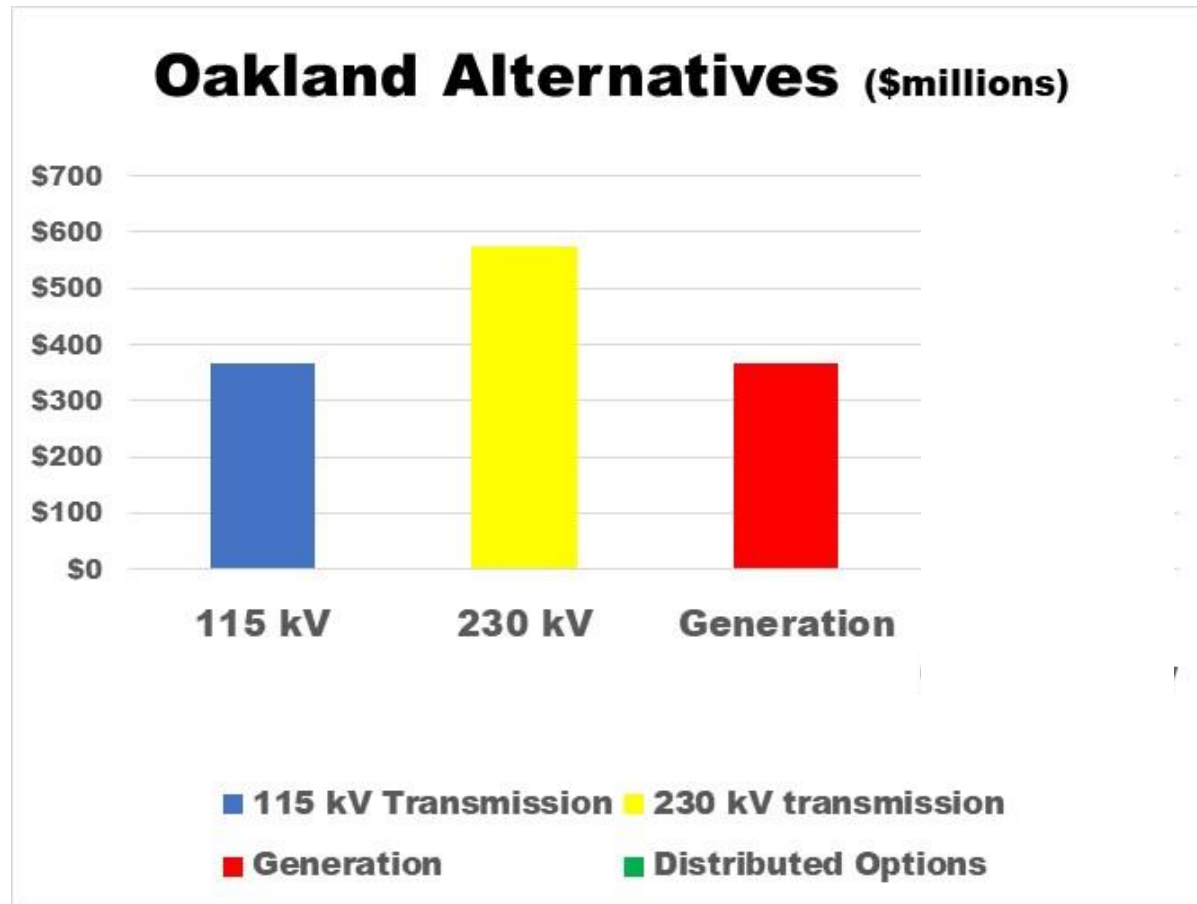
Consider advanced technologies when inflexible units retire ...

PG&E and East Bay Clean Energy project, Oakland Clean Energy Initiative (OCEI), replaces a retiring 165 MW Dynegy gas peaker, obviates need for 115 kV and 230 kV transmission

Combination of resources includes:

- 25-40 MW combination of EE, DR, PVDG (minimum 19 MW of load reducing response)
- 10 MW/40 MWh storage
- Substation upgrades and line re-ratings

... Saving ratepayers money



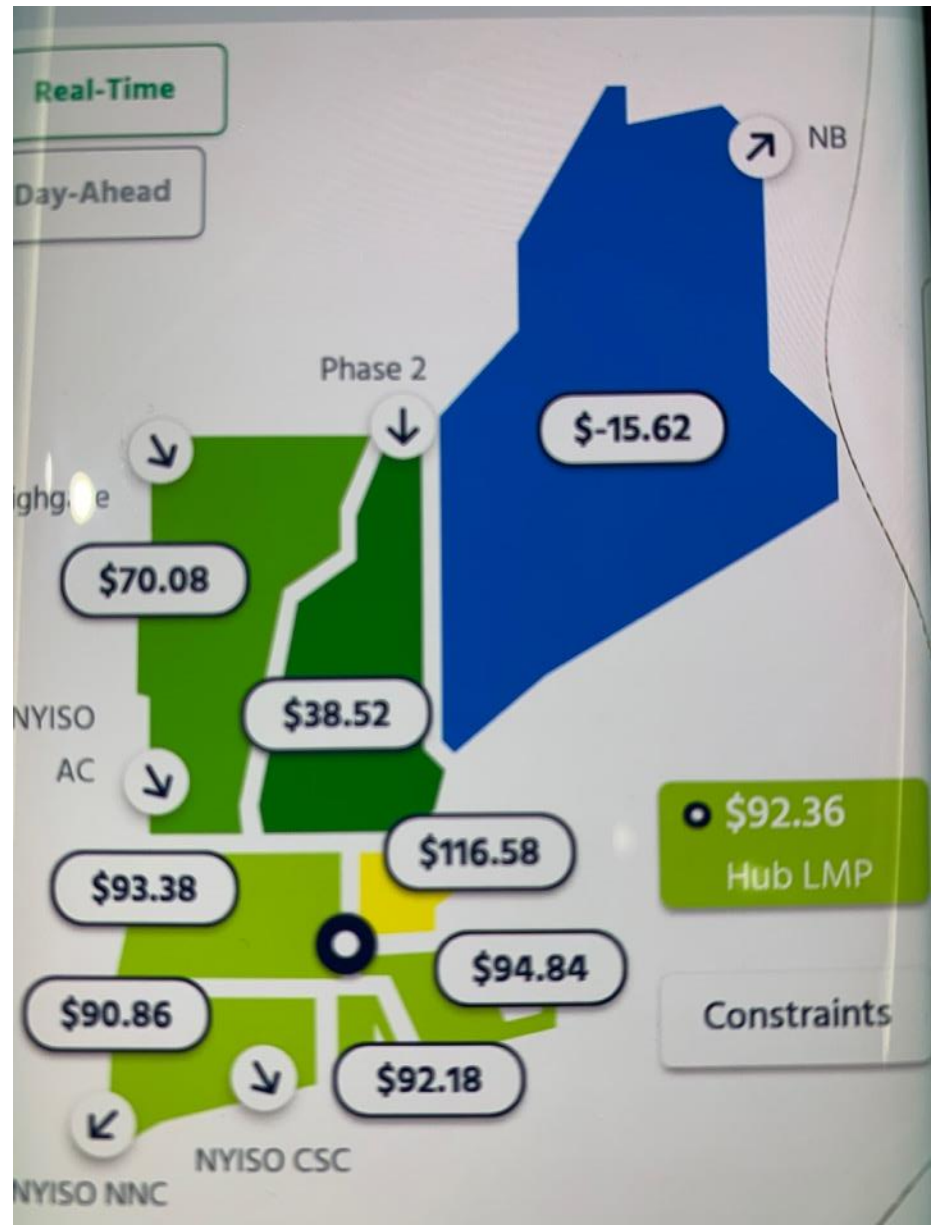
...By using demand response to manage seasonal loads



If there is a significant increase in energy prices or energy demand in the summer months, typically between June and September, your PeakRewards device may receive a signal to cycle your air conditioner up to your chosen cycling level (50%, 75% or 100%).

Source: Baltimore Gas & Electric

...By designing pricing to reflect grid management needs at the regional, utility, zonal, nodal, and circuit levels



About RAP

The Regulatory Assistance Project (RAP)[®] is an independent, non-partisan, non-governmental organization dedicated to accelerating the transition to a clean, reliable, and efficient energy future.

Learn more about our work at raponline.org



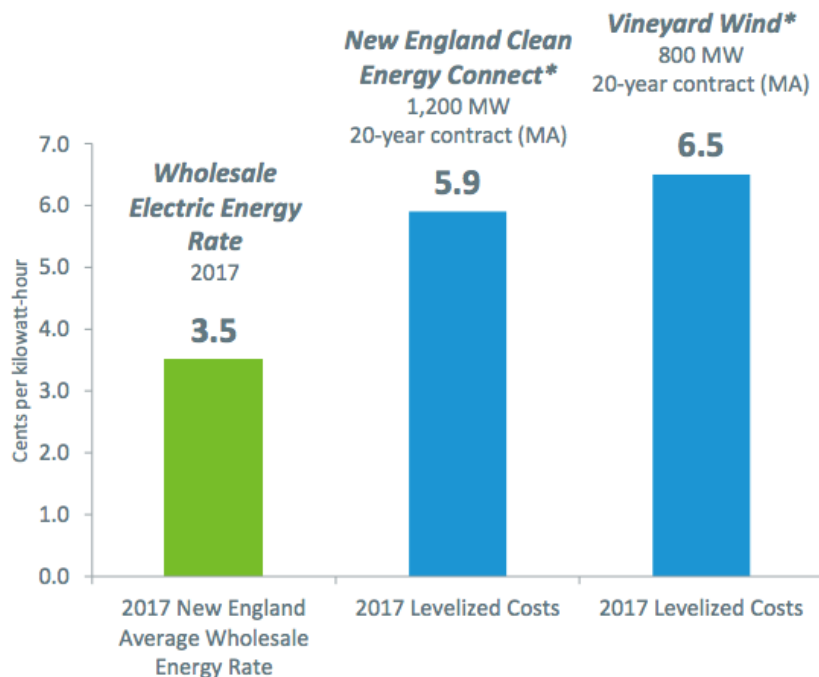
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ISO-NE portrayal of recent state contracts incomplete, compares energy price to energy, capacity plus REC product

State Procurements Are Priced Above Wholesale Energy Market Prices, But Include Different Attributes



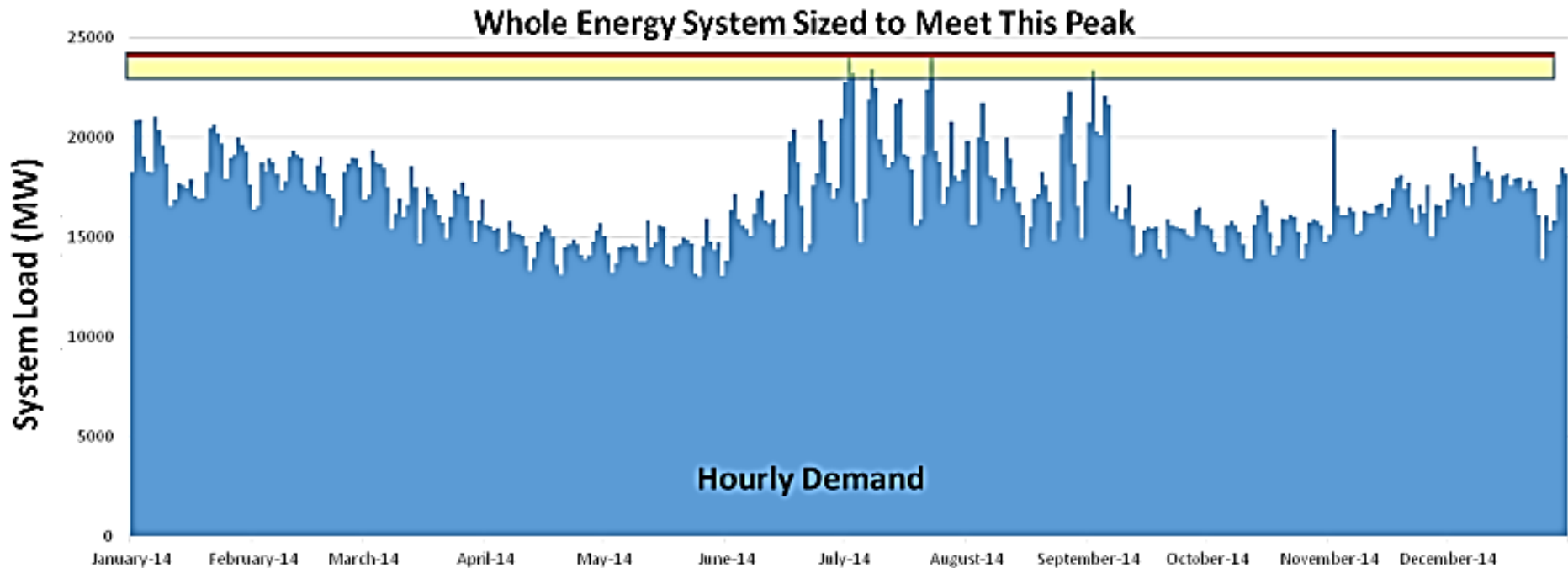
- States are directing their utilities to sign long-term contracts for clean and renewable energy; these contracts include an implied price on carbon
- Retail rates are likely to rise as states continue on a path to decarbonize the economy

**Sample of state procurements; contracts are pending final approval by state public utility commissions*

Source: Boreas Renewables, ISO-NE Markets are not structured to procure least cost resources, Feb. 2019; image from Gordon van Welie presentation to Boston Economic Club, Jan 23, 2019

https://www.iso-ne.com/static-assets/documents/2019/01/boston_economic_club_final.pdf

New England: Expensive peaks



Source: MA DOER, State of Charge Report