



FUTURE WHOLESALE MARKETS

AND IMPLICATIONS FOR RETAIL MARKETS

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AMERICA'S POWER PLAN



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America's Power Plan is a platform for innovative thinking about how to manage the transformation happening in the electric power sector today.

We collect expert information for decision-makers and their staffs, highlighting specific solutions to today's most pressing policy, regulatory, planning, and market design challenges.

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WHAT I'LL COVER:

1. FUTURE WHOLESALE MARKETS MUST...
2. THREE ENDSTATES & IMPLICATIONS FOR RETAIL MARKETS
3. INSIGHTS & IMPLICATIONS FOR RETAIL MARKETS

WHOLESALE MARKETS MUST...

Basically:

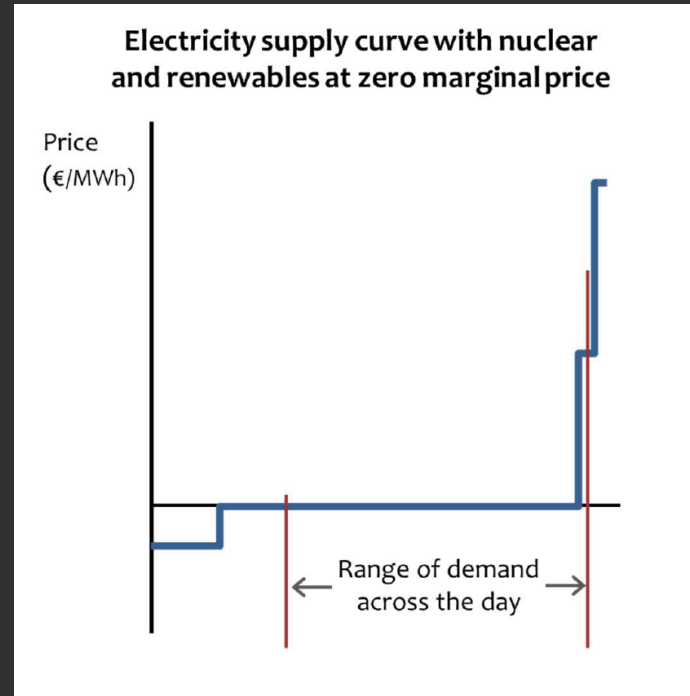
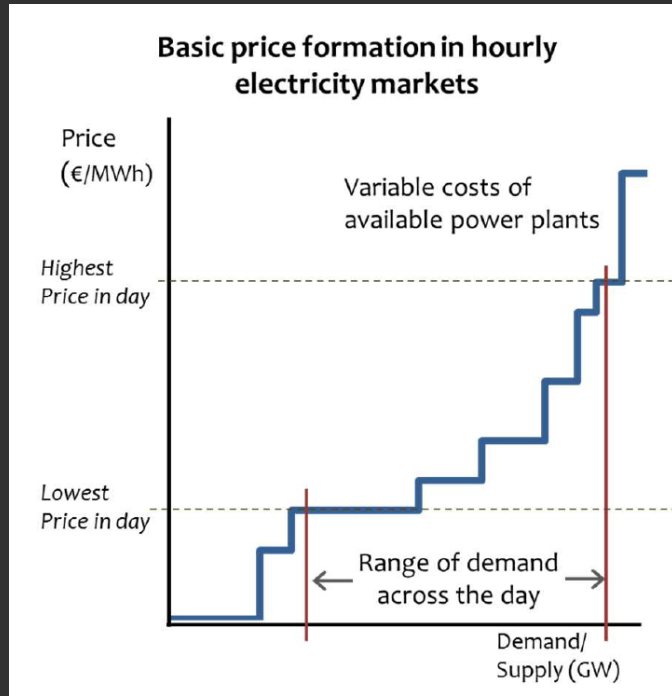
- Provide **long-term cost recovery** for needed grid assets
- Create efficient incentives for **resource adequacy** – including entry *and exit*, including generation *as well as T&D and storage*
- Support efficient **real-time dispatch**

These are **emergent properties** in today's markets, which were well-designed based on characteristics of the **resource mix** we've had.

Resource mix changes may disrupt the equilibrium that generates these properties.

THE SOURCE OF THE CHALLENGE

Slopes vs. spikes

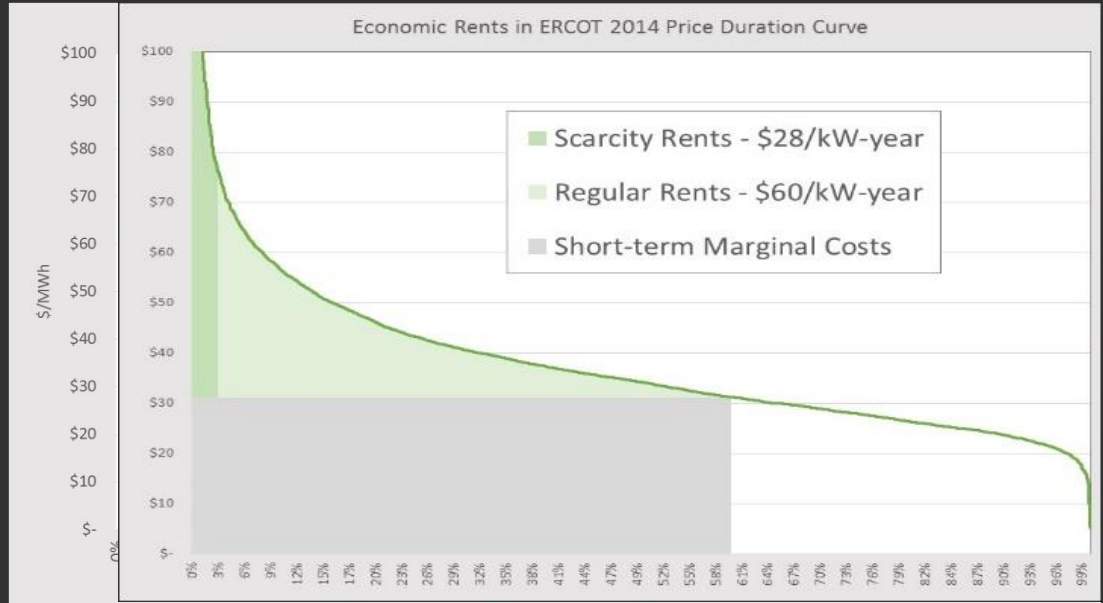


CHANGES TO THE PRICE-DURATION CURVE

Spikier supply flattens and widens this curve, eroding properties of wholesale markets

Changes & implications:

- Middle part of the curve becomes flatter:
 - harder to conduct efficient SCED (*real-time dispatch*)
 - harder *long-term cost recovery*
- Scarcity pricing hours go down:
 - harder to maintain flexible *resource adequacy*



NO EQUILIBRIUM, NO EMERGENT PROPERTIES

This is the problem we are trying to solve

Plenty of theory...and mounting evidence...suggests that a resource mix with lots of low or zero marginal cost resources will disrupt traditional wholesale markets, pushing them out of equilibrium.

Without equilibrium, the critical emergent properties of wholesale markets are at risk:

- Long-term cost recovery for needed grid assets
- Efficient incentives for resource adequacy
- Efficient real-time dispatch

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HOW TO REACH EQUILIBRIUM UNDER NEW CONDITIONS?

Much exciting intellectual foment on this topic:

- [Energy Innovation](#) / America's Power Plan (see *On market designs for a future with a high penetration of variable renewable generation*)
- [Climate Policy Initiative](#) (see *Markets for low-carbon, low-cost electricity systems*)
- [Resources for the Future](#) (see *The future of power markets in a low marginal cost world*)
- [Bloomberg New Energy Finance](#) (see *Six design principles for the power markets of the future*)
- [MIT](#) (see *Zero variable cost power systems*)
- [Harvard](#) (see Bill Hogan's work)
- [Berkeley](#) (see *Power systems without fuel*)
- [National Renewable Energy Laboratory](#)
- [Steve Corneli](#)
- More!

END-STATES: THE EVOLVED ENERGY-MOSTLY MARKET (1 OF 3)

Idea:

- Extension of today's energy market. No price caps. More bilateral hedging.
- Mostly energy market, perhaps expanded role for ancillary services.
- Prices would be more volatile—jumping from near-zero or negative to scarcity pricing.
- Would benefit from price-differentiated demand curve to offset flattening supply curve.

Implications for utilities and 3rd party providers:

- Could interface with customers to produce a time- and price-differentiated demand curve. This would help reduce overall procurement costs and would offer customers new services.
- Properly incented utility could act as a distribution system operator (DSO).
- Opportunities to provider customers insurance products to smooth prices (utility or 3rd party could do this). This arguably happens today, but it could be much more sophisticated.

END-STATES: THE PRODUCT PORTFOLIO

(2 OF 3)

Idea:

- Wholesale power market starts to look more like Wall Street.
- Many differentiated products are traded, each with own characteristics and risk. Long-term (e.g., 15 year) and short term products (e.g., 5 min).
- May be kWh at a certain time, ancillary services, delivery products, etc.
- Relies on much more sophisticated forward modeling.

Implications for utilities and 3rd party providers:

- Better modeling and managing risk of future grid translates to profit.
- Buying a smart portfolio of products becomes a core competency for retailers.
- Properly incented utility could act as distribution system operator (DSO).
- Storage would soar in value in this endstate.

END-STATES: THE PRODUCT PORTFOLIO

(2 OF 3)

Variations on the theme:

- Bifurcated market: one forward market for energy independent of location; one real-time “delivery market” (see Pierpont 2017)
- Bifurcated market: one “firm market” that centralizes today’s bilateral hedges and takes advantage of sophisticated modeling to inform a forward market; one “residual spot market” to mop up in real time (see Gimon 2017)
- Bifurcated market: one for variable resources and one for dispatchable resources – to get at “firm spread” (see Leibreich 2017)

END-STATES: REREGULATION (3 OF 3)

Idea:

- Central planning and associated vertical integration is one way to manage such deep transformation
- Reregulation must be careful to still encourage efficient exit of resources from the mix
- To align utility financial interests with cost-effective retirements and uptake of new, cheap options (resources and services), performance-based regulation is key

Implications for utilities and 3rd party providers:

- Better modeling and managing risk of future grid translates to profit.
- Forward simulations should use timesteps as small as possible.
- Forward simulations should examine scenarios with wide bounds.

END-STATES: REREGULATION...EXPLICIT OR DE FACTO (3 OF 3)

Variations on the theme:

- De facto reregulation can occur if wholesale markets do not get ahead of falling out of equilibrium. Regulators and policymakers will intervene with e.g., targets for specific resources to ensure customers are not left in the dark.

Not a good reason for reregulation:

- Entities holding now uneconomic power plants request reregulation to shift risk back onto customers after reaping rewards from private ownership for decades. There are more cost effective ways to support critical power plants if necessary.

ALMOST DONE:

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INSIGHTS: EXIT SIGNAL AS IMPORTANT AS ENTRY SIGNAL IN TIMES OF TRANSITION

We are oversupplied in every organized market.

Retirement will spur innovation for replacement. Oversupply blunts this.

Healthy markets provide signals for exit if new resources can come in cheaper.

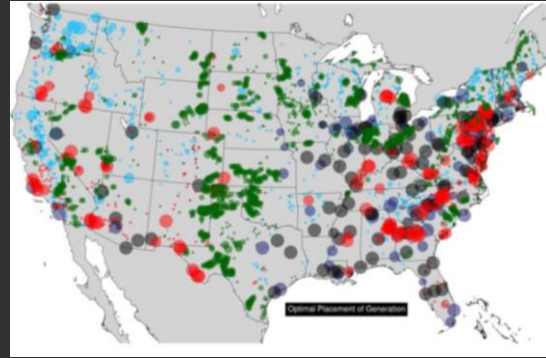
Market	2016 Anticipated Reserve Margin	2016 Required Reference Margin Level	2016 Capacity Above Reserve Margin
MISO	18%	15.2%	2.80% (3.4 GW)
ISO-NE	19.67%	17.6%	2.07% (0.5 GW)
NYISO	25.51%	17.5%	8.01% (2.6 GW)
PJM	28.85%	16.4%	12.45% (17.8 GW)
SPP	27.65%	13.6%	14.05% (7.4 GW)
ERCOT	15.51%	13.75%	1.76% (1.2 GW)
CAISO	24.4%	15%	9.40% (4.5 GW)

Implications for utilities and 3rd party providers:
Retirements are coming. This is a period of transition. There will be value in finding new ways to aggregate retail-level resources and offer them into wholesale markets.

INSIGHTS: 21ST CENTURY OPTIMIZATION TOOLS NEEDED FOR 21ST CENTURY GRID

Both planning and SCED will be more difficult as the resource mix shifts.

Luckily, we are not even close to using state-of-the-art computing methods as standard practice in the electricity sector.



Implications for utilities and 3rd party providers:

Data should be open.

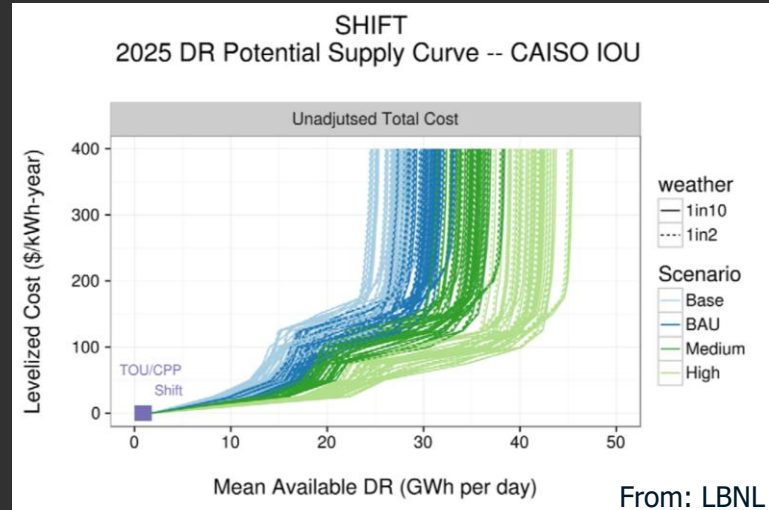
If utilities can structure data and make it actionable, they will earn money from it.

If third parties figure out how to structure and act on that data, they will earn money from it.

INSIGHTS: DEMAND RESPONSE SHOULD KNOCK YOUR SOCKS OFF

BNEF says by 2040 as much as $\frac{3}{4}$ of all load may be available for some kind of DR.

It's particularly important to create a sloped demand curve in times of flattening/spiking supply curves.



Implications for utilities and 3rd party providers:

It will be increasingly valuable to find ways to organize and aggregate demand products that can respond at different prices in different locations.

INSIGHTS: JURISDICTION IS BLURRY

This presentation does not cover questions of jurisdiction, but those are thorny issues that will need to get worked out.



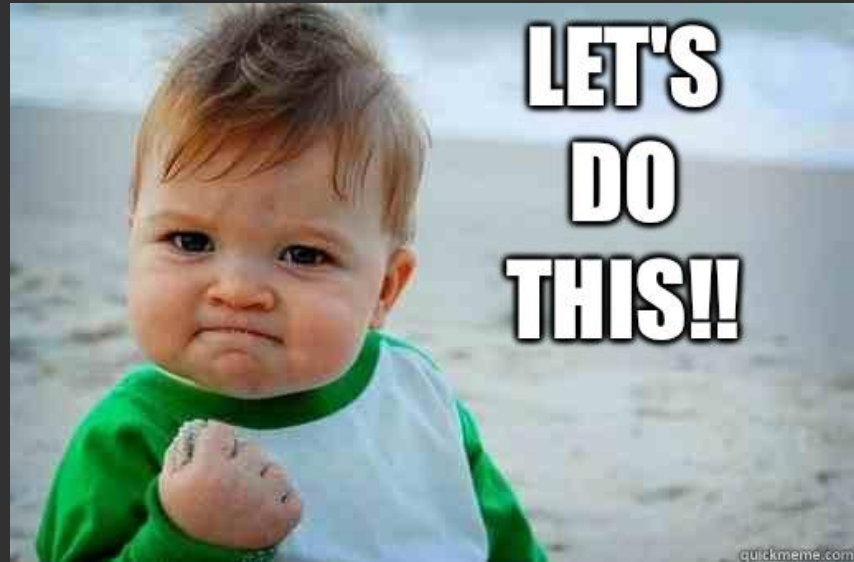
Implications for utilities and 3rd party providers:

Utilities can get in front of this by proactively defining the functions they envision performing in the future: platform, optimization, aggregation, etc.

INSIGHTS: THE TIME FOR THIS WORK IS NOW

Clean energy costs have plummeted. It's now cheaper to build a new wind plant than to keep running an old coal plant in some parts of the country.

Updating our institutions is critical to take advantage of this moment for customers and the planet!



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