RESOURCES for the FUTURE

Market Design Evolution for a Decarbonized Energy Future

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Electricity markets have several goals/desirable features

- Promote efficient and reliable system operation in the short run
- Promote efficient investment in new generation and other resources (storage, etc.) to enable reliable system operation in the future
  - Modeling suggests firm energy sources will be important for cost-effective balancing in a largely renewable system
- Promote innovation and development of new clean energy resources
- Accommodate different climate policies and enable decarbonization
- Promote efficient electricity consumption
- Accommodate growing electricity demand through electrification

Existing Organized Wholesale Electricity Markets

- Not a textbook competitive market
  - Energy markets have price caps that keep prices from getting high – often below VOLL
  - Limit market ability to incentivize efficient investment or efficient use/conservation
  - Leads to missing money for fixed costs of power plants
- Capacity markets fill the gap
  - Ensure sufficient capacity to meet peak load
- Capacity markets have their issues
  - Not grounded in theory and complex
  - May be over procuring and mis-procuring
  - Not consistent with shift toward clean energy

Decarbonization policies also deviate from textbook

- Carbon is not priced in US electricity markets outside of RGGI and CA (and OR and WA)
- When carbon is priced, prices are lower than social cost of carbon or price levels consistent with decarbonization policy goals
- Instead, elec. decarbonization policies encourage clean energy use
  - RPS, CES and tax credits
  - Downward pressure on energy and capacity prices
  - Limit emissions leakage
- Pricing carbon in electricity sector only could discourage electrification, depending on revenue use

New resource adequacy considerations

- Renewable sources and storage devices are energy constrained
  - System with more variable resources faces different operational challenges
  - Renewables and storage can work together to reduce challenges
- Resource adequacy moves from a focus on meeting peak demands to a broader focus on meeting demand in all hours
  - Focus shifts from having sufficient capacity to having sufficient energy
- Market constructs need to encourage investment in resources that meet this challenge
  - Focus on encouraging flexibility and the right mix of resources

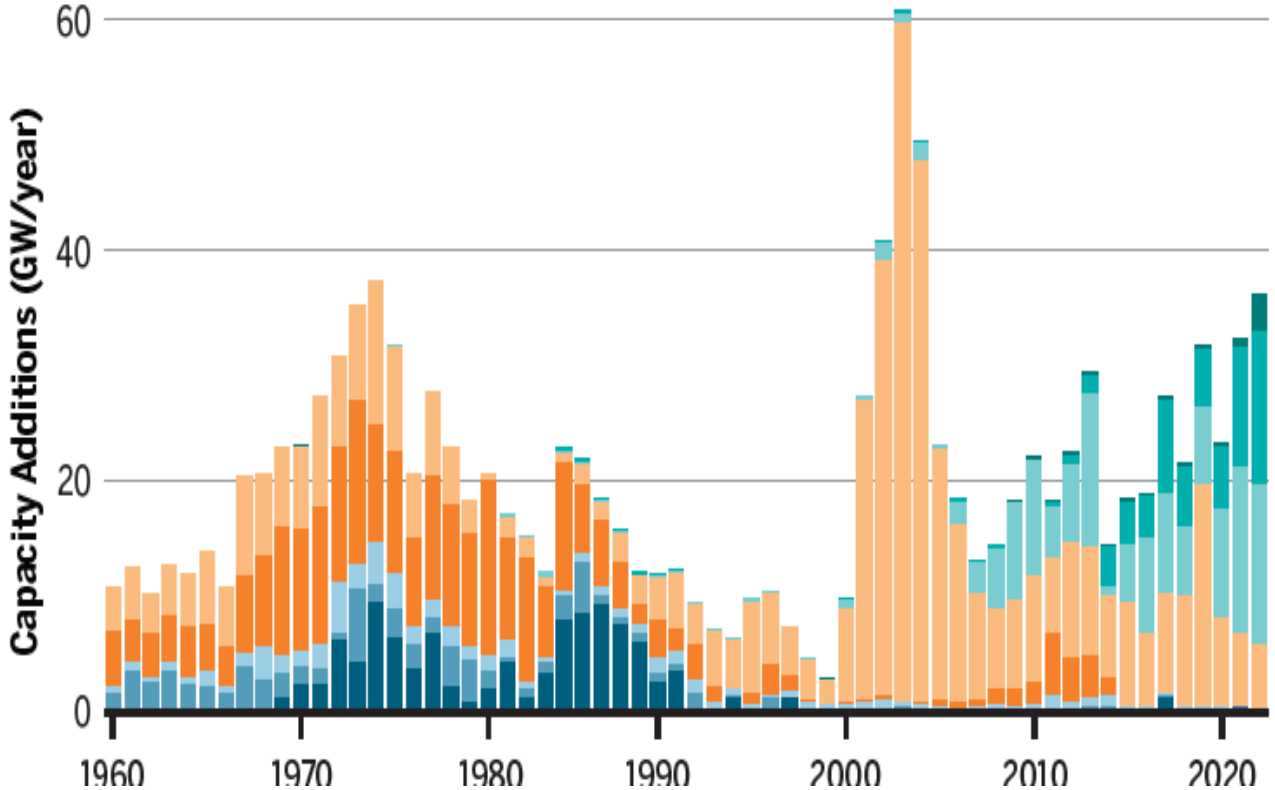
Three concerns about existing markets (Mays & Jenkins)

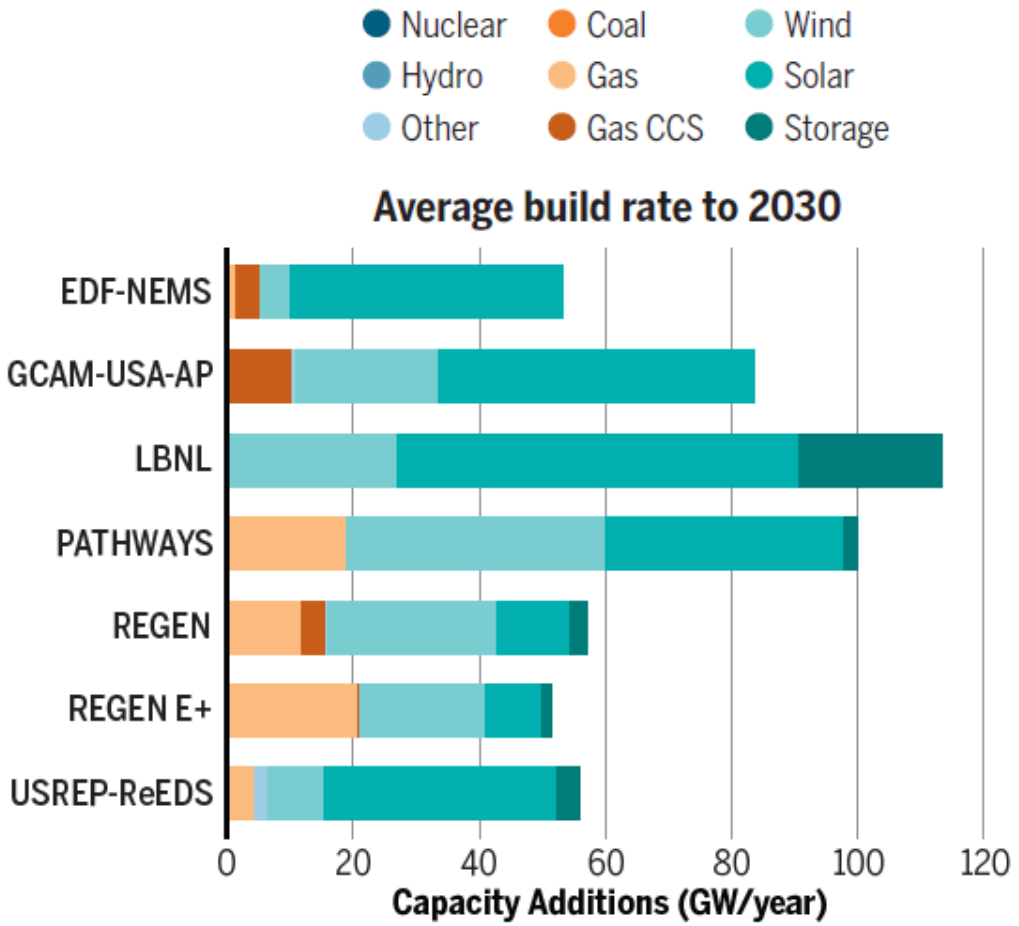
1. Growing reliance on variable resources will exacerbate revenue shortfalls from price caps and system operator actions outside markets and raise need for other sources of revenue that existing RA structures (capacity markets) are not well suited for.

2. Moving to greater reliance on near term energy markets with true shortage pricing will raise risks for investors (and thus costs) absent good decentralized mechanisms for long-term risk sharing

3. Need to decarbonize at ambitious pace will require continued role for climate policies and revenue risks to non-subsidized resources will grow raising the costs of firm resources and of system reliability

Investment pace: annual capacity additions for 2030 goals





Source: Bistline et al., *Science*, May 2022

Organized long-term markets

- Build on existing mechanisms used by states and others to procure clean energy resources
- Markets that help to encourage efficient investment in mix of resources
  - Use competition to procure mix of resources to meet clean energy (and RA goals) at low cost
  - Put pressure on capital costs (more important going forward)
  - Work alongside existing day-ahead and real time markets to encourage efficient operation
- Markets that help to lower capital cost through centralized hedging
- Can work alongside state (federal?) decarbonization policies or internalize clean energy goals into structure
- Can enable competition “for the market” alongside existing SCED markets

Organized long-term markets project with WRI

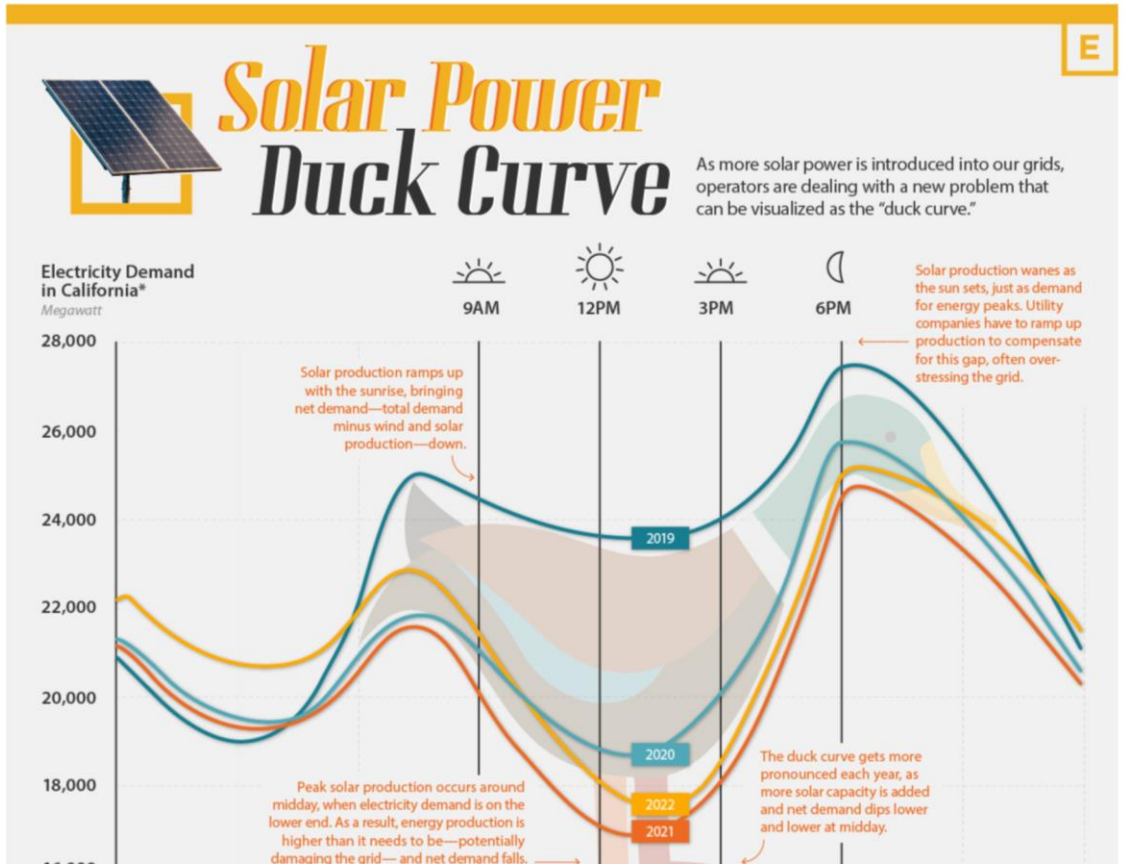
- Invited four authors (Corneli, Tierney, Pierpont and Gimon) to develop ideas for organized long-term markets in four new papers
  - Built on 2018/19 Energy Innovation project on market design
- Prepared summary matrix that compares four proposals along different themes
- Hosted two-day workshop for dissemination, discussion and feedback in late 2020
  - Available at https://www.rff.org/events/workshops/market-design-for-the-clean-energy-transition-advancing-long-term-approaches/
  - Workshop summary available at https://media.rff.org/documents/WRI_RFF_workshop-summary-proceedings.pdf

A Quick Overview

Author	OLTM Goals ("why")	Product ("what")
Pierpont	Promote readily financed clean energy investments	MWh – forward energy schedules (hourly) Swap contracts: as-bid hourly schedule prices for energy prices
Gimon	Promote readily financed, efficient clean energy portfolios with liquid, tradable long-term contracts	MWh – Swap contracts: forward energy schedules for energy prices
Tierney	Resource Adequacy Climate/energy goals Least cost	Capacity (MW) + must-offer available energy Adds new "RA" products: "Local RA" and "Flexible RA"
Corneli	System balance (match load & generation in all hours even under extreme conditions) Decarbonization constraint Least-cost system optimization	"Capability" + must-offer available energy Swap contracts: as-bid project costs for energy revenues

Market also needs to enable flexible demand

- When energy supply is inflexible, and storage is expensive:
  - Move demand to meet supply
- New form of demand management
  - Not just about reducing peaks or encouraging efficiency
  - Raise renewable value and limit curtailment
  - Flatten steep ramps
  - Absorb excess renewables

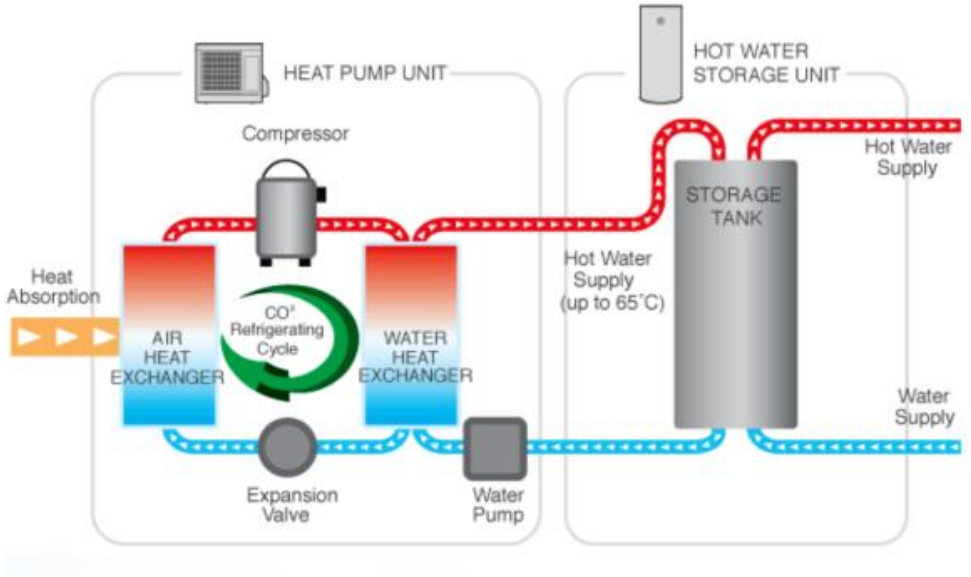


Time varying prices can provide incentives

- Economists have always favored using time varying prices to reduce peak demand
- Energy prices will be lower when renewable abundance risks curtailment
  - Shifting use to those hours will raise value of renewables and lower emissions
  - Imelda at al. (2018): welfare gains from real time pricing in a renewable grid are 4 to 5 times as large as in a fossil fuel grid
- One issue: customers and regulators don’t like dynamic rates
- Automation can
  - Facilitate customer response to changing prices through simple sign up
  - Be acceptable to customers (Blonz et al., 2021)
  - Make adoption of time varying rates more likely

Newly electrified loads have inherent storage features

- Electrification of homes focuses on major end uses
  - Water heaters, space conditioning, EV charging
  - Separate electricity consumption from energy service consumption
- These services are more price responsive than other electricity uses
- Use pricing and scheduling to deal with diurnal patterns and absorb renewables
- Could be coupled with subscription rates to consumers and third part load management (through software)
- FERC Order 2222 requires ISOs/RTOs to enable demand resources to participate in wholesale markets



Concluding Thoughts

- A decarbonized electricity sector will likely play an increasingly larger role as an energy provider in a decarbonized economy
- Keeping electricity costs low and systems reliable will be as important as ever
- Organized long-term markets can help address risks of revenue shortfalls and encourage investments in the right mix of resources
- Exposing consumers (and load aggregators) to time varying prices is more important in a clean energy future than before

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