Meeting Decarbonization Commitments and Security of Supply Criteria:

The Role of Hybrid Markets

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OVERVIEW

- Deep and rapid decarbonization of electricity sectors with intermittent wind and solar, along with storage, creates challenges for harmonizing decarbonization commitments and security of supply (SoS --- Resource Adequacy (RA) in the U.S.) criteria
- Electric power systems dominated by intermittent wind, solar, and storage create challenges for existing short-term wholesale market designs <u>and more importantly</u> the existing framework guiding investments which harmonize deep decarbonization, SoS, and efficiency goals
- Hybrid markets provide a framework for meeting both decarbonization and SoS goals at least cost in liberalized markets
  - "Competition for the Market" relying on repeated competitive procurement auctions for long term PPAs between generators, storage, demand response and counterparties with excellent credit ratings to support efficient investment in generating capacity, storage and demand response to meet decarbonization trajectory and SoS criteria guided by a dynamic long-term "pathway" or plan
  - "Competition in the Market" relying on evolution of short-term markets to provide a platform to manage the "dispatch" of the PPAs to respond to intermittency of wind and solar, utilize storage and zero carbon dispatchable generators, demand response, etc., efficiently and reliably
- Many issues remain to be resolved:
  - Reform SoS evaluation methods with high penetration of intermittent generation with non-zero supply correlations
  - Role and design of indicative planning framework
  - Auction design and bid evaluation
  - Contract design
  - Integration with voluntary entry of corporate LT PPAs and voluntary and mandatory LSE LT PPAs
  - Counterparty identification
  - Integration with transmission expansion decisions

Why not just leave it to existing market designs?

- Short-term wholesale market designs will have to evolve to accommodate intermittency of wind and solar and integration of various storage technologies but this is an evolution rather than revolution.
  - Much progress is being made in the U.S.
- More significant changes in resource procurement will be needed to harmonize traditional efficiency and SoS goals with aggressive quantity based decarbonization commitments
  - Carbon emissions prices are non-existent, too low, too volatile, not credible, or incompatible with decarbonization commitments
  - Different technologies and mixes of technologies have different incremental values for reducing carbon emissions and for meeting existing reliability/SoS criteria
  - Continuing "missing money" problems (entry and exit incentives in U.S.), incompatible reliability criteria, immature demand side, and missing markets for "reliability."
  - Traditional SoS assessment methods for systems dominated by dispatchable generation and increased weather sensitive demand (electrify buildings) will not work in high VRE systems
  - In very high VRE systems, future distribution of short-term wholesale prices will change dramatically but these changes depend on uncertain future costs and mix of VRE generation, the costs and attributes of energy storage, and demand side flexibility
    - Net revenue for more capital intensive VRE will be concentrated in a much smaller number of hours which are sensitive to ISO/TSO behavior
  - Rapid learning by doing creates efficiency opportunities but may delay entry for fear of stranded costs
  - Future short-term market design changes to accommodate VRE, including curtailment mechanisms, and storage are uncertain
  - These factors increase risk, cost of capital, and overall cost of VRE and storage at the present time
  - Private and public organizations with voluntary internal decarbonization goals (e.g. Google, Apple, Walmart, MIT) have turned to long-term PPAs with wind and solar as the least cost mechanism to procure zero carbon electricity
  - But these private decarbonization programs also ignore reliability considerations
  - Evidence on WACC supports the view that long term PPAs reduce WACC considerably

The Walmart View

Driving scale through long-term power purchase agreements (PPAs). To date, we have found the Power Purchase Agreement (PPA) to be a highly effective model for Walmart to leverage our scale and buying power to accelerate renewables. Under these arrangements, Walmart agrees to buy renewable power from an energy provider over a long period of time – often 5, 10, 15 or more years. Long-term PPAs have unlocked enormous renewable potential, but have also required a new way of thinking. Prior to 2006, the renewable energy industry sought 20-25 year PPAs, while Walmart was accustomed to buying power in 1-year or less contracts.

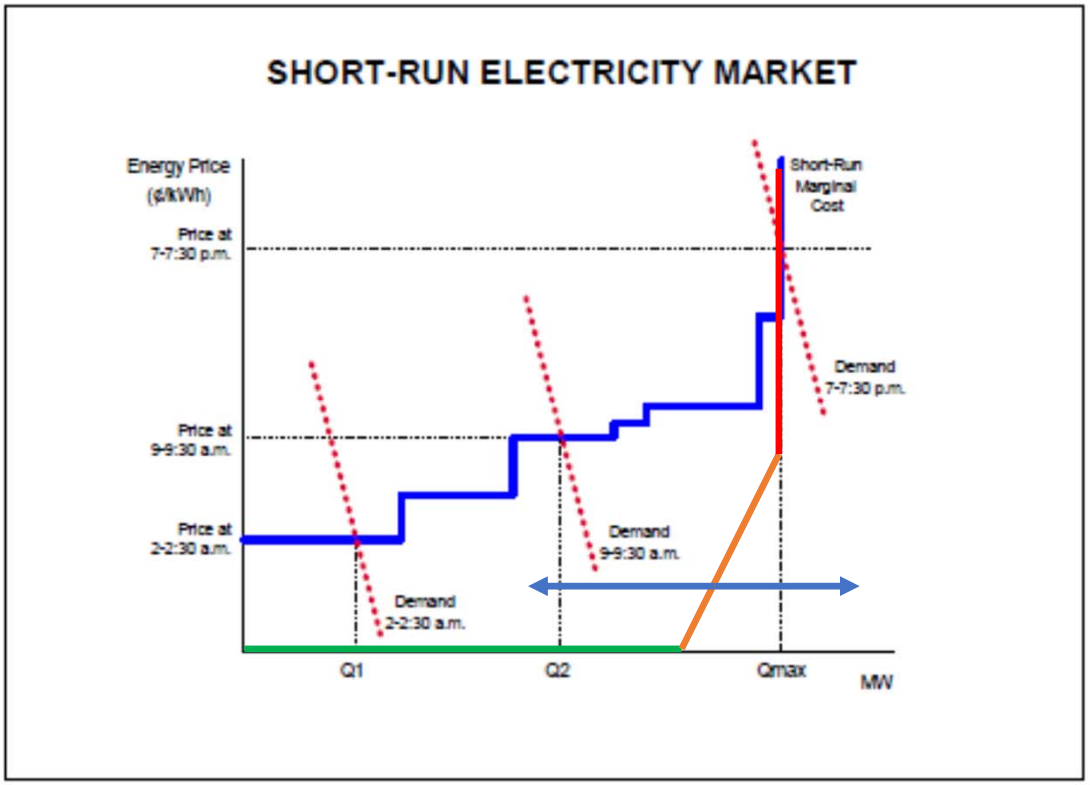
PPAs are mutually beneficial for Walmart and the energy provider. Under PPAs, the energy provider also owns, installs, and operates the renewable energy systems, relieving Walmart of that operation and maintenance responsibility. For project developers, PPAs provide a predictable stream of income, which is what financiers and banks say is the key to the low cost of capital and preferred financing arrangements. When Walmart promises to buy the electricity, the project can be built with low-cost financing and deliver electricity at or below non-renewable power prices.

Source: Walmart

EMR, however, delivered a considerably better outcome with the first competitive auction of renewable CfD contracts, held barely six months after the administered contracts, with the results shown in the final columns of Table 1. Newbery (2016a) argued that the close juxtaposition of these contracts provides an ideal natural experiment. Although both involved 15-year contracts, the first were conducted in parallel with the operation of the ROCs system, and companies could use projects constructed under this regime as their evidence for costs and required rates of return. With the move to auctions, this no longer applied; the contracts would go to those offering the best value, including lowest cost of capital, irrespective of costs under the far more volatile and uncertain ROC system. Using the results in Table 1, Newbery estimated the move to long term contracts awarded through competitive auctions lowered the cost of capital from about 6% to 3% (real) — which, applied to the £75+bn expected investment required, translates into £2.25bn annual saving for 15 years.

Grubb and Newbery EJ-2018

Competitive Auction-based Dispatch Curve with 100% Carbon Free Wind and Solar + Storage

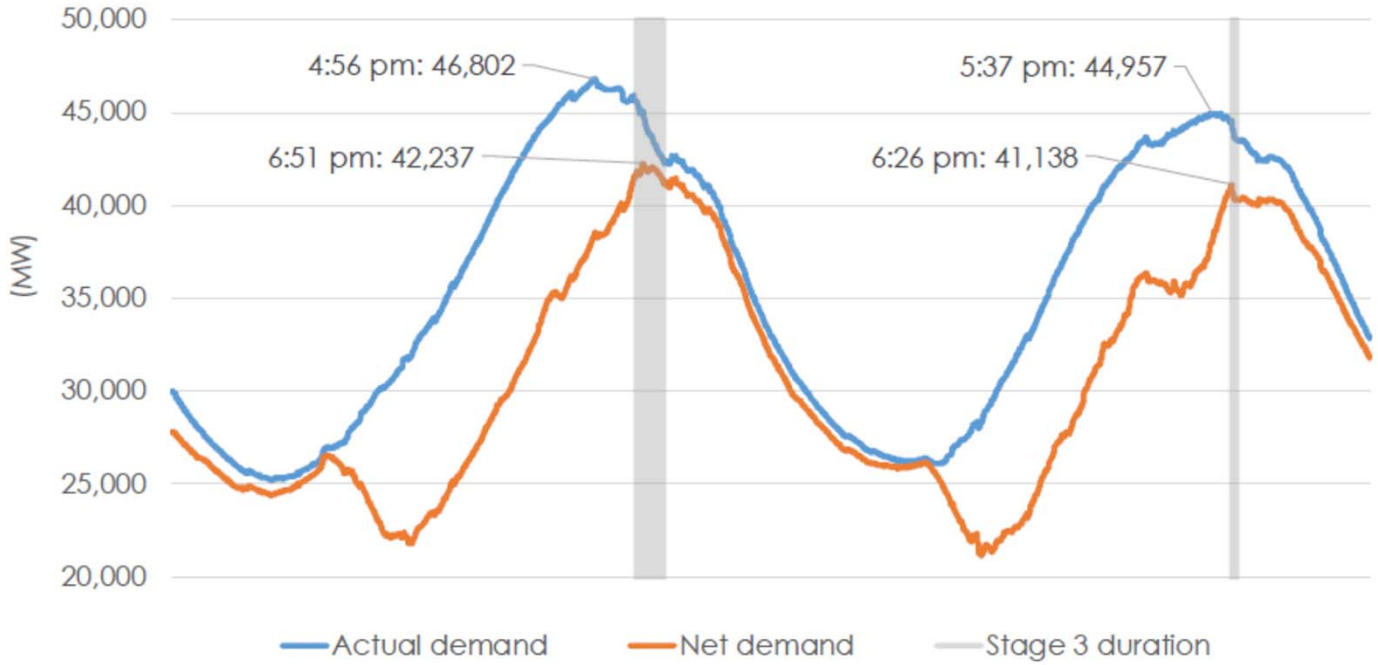


Thank you Bill Hogan for the blue bid-based dispatch curve which I have adapted to include zero MC VRE and Storage

Traditional approach to implement SoS criteria does not work in a high VRE system

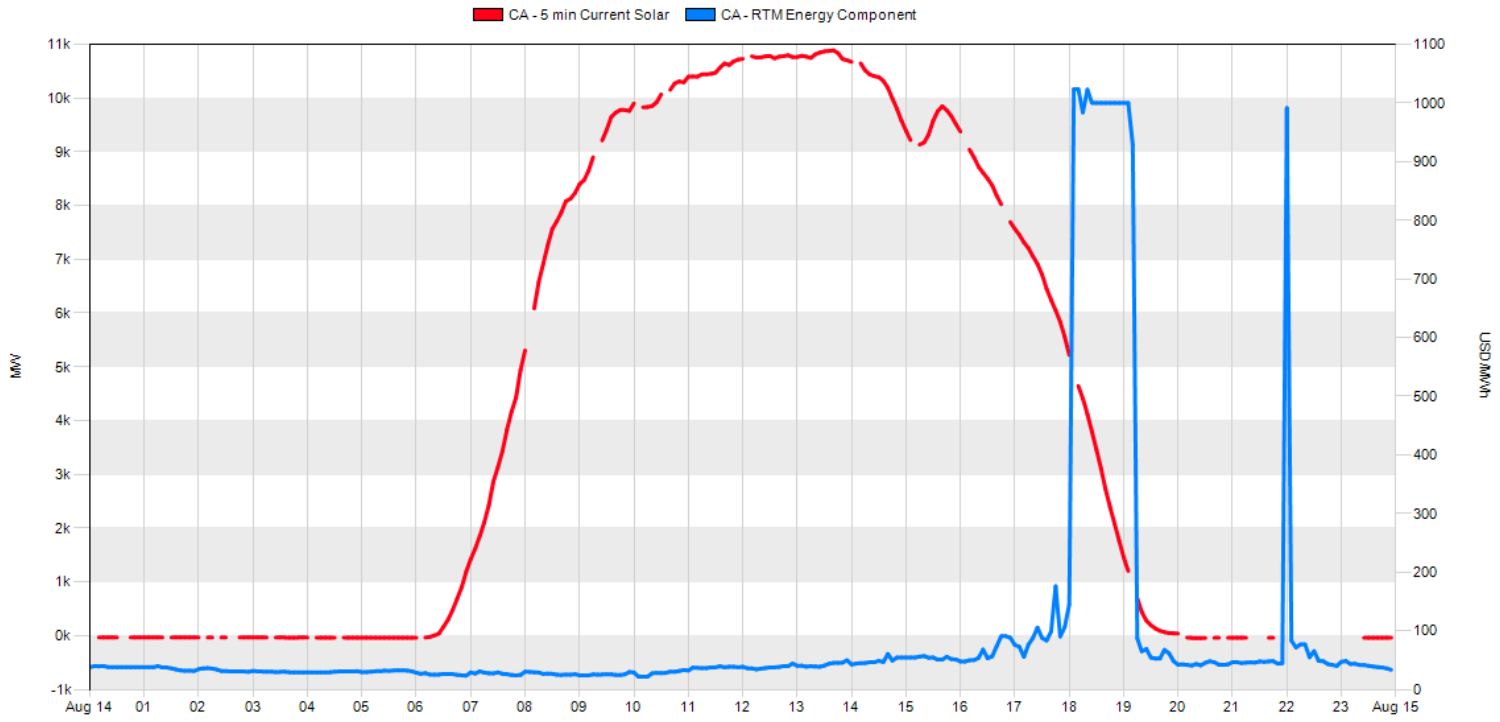
- Stochastic attributes of VRE supplies must be accounted for in many hours not just for forecasts of annual peak demands
  - Variations in NET peak demand drives the reliability of the system
  - This requires a lot of data on wind, solar irradiation, etc. at a very granular level (location, time, length of time series)
- Correlations between generators and between supply and demand become much more important
  - When it's very hot or very cold we get extreme demands and lower performance from generators and demand response
  - When the wind dies down many wind generators in the same geographic areas are affected and produce less
  - When it is raining and cloudy many solar generators in the same geographic areas are affected and will produce less
- Reliability values of different technologies reflect these stochastic attributes as well as the resource mix on the system --- including demand flexibiliy

Figure 4.3: Demand and Net Demand for August 14 and 15



CAISO

CAISO August 14, 2020



Produced with NRGStream Trader 8.1

Region	BTM PV	Fixed PV	Tracking PV	Tracking PV Hybrid	Wind	Wind Hybrid
PGE	4.3%	5.4%	6.9%	99.6%	21.8%	54.0%
SCE/SDGE	3.6%	4.6%	5.4%	99.9%	18.0%	47.0%
AZ APS		4.6%	5.4%	99.0%	38.8%	78.3%
NM EPE		4.6%	5.4%	99.0%	38.8%	78.3%
BPA					32.7%	57.2%
CAISO	**4.0%**	**5.0%**	**6.2%**	**99.8%**	**19.9%**	**50.5%**
Average	**4.0%**	**4.8%**	**5.8%**	**99.4%**	**30.0%**	**62.0%**

Table ES2. Recommended ELCC Values for 2026

Region	BTM PV	Fixed PV	Tracking PV	Tracking PV Hybrid	Wind	Wind Hybrid
PGE	1.3%	2.1%	3.4%	98.8%	17.9%	43.5%
SCE/SDGE	0.6%	1.2%	1.9%	96.4%	17.8%	35.3%
AZ APS		~0.0%	1.9%	96.0%	30.8%	79.2%
NM EPE		~0.0%	1.9%	96.0%	30.8%	79.2%
BPA					32.8%	52.8%
CAISO	**1.0%**	**1.7%**	**2.7%**	**97.6%**	**17.9%**	**39.4%**
Average	**1.0%**	**0.8%**	**2.3%**	**96.8%**	**26.0%**	**58.0%**

CPUC Advice Letters 4243-E, 3560-E, 5868-E, July 21, 2020; See also CPUC Decision 19-09-043, September 26, 2019

Governments are returning to the game to “fix” what they view as incompatibilities with decarbonization commitments

- Positive vs. Normative View
- Mandate competitive procurements supported by long-term PPAs with high credit counterparties to fill part of the gap between trends and commitments
  - Wind, solar, storage, nuclear, etc.
  - 10 to 20 years
  - Repeated sequential auctions
  - Procurement without a plan is bad so long-term capacity planning and dispatch models are being used to develop “pathways” to net zero
  - These indicative plans are the foundation for competitive auctions and can be adjusted based for subsequent auctions based on earlier auction results
  - Merchant pathways, including “corporate” PPAs, are permitted
- And we are moving, perhaps by default, to hybrid markets

Some Issues for Discussion

- How can we develop good flexible long-term resource plans that can be adjusted to reflect learning about technologies, costs, market developments, and harmonize decarbonization commitments with SoS criteria?
  - Support repeated competitive procurement auction mechanisms
  - Concerns about return to “central planning” and interest group capture
  - Uncertainty about technologies, costs, etc.
  - Integration SoS criteria using probabilistic models and transparent values for lost load, duration of outages, depth of outages, etc.
- What are the best auction and bid evaluation designs?
  - All source (multi-attribute) vs. single source
  - All VRE + storage vs. “some” VRE and storage
  - Carbon value vs. reliability value
  - Evaluation of complicated contracts that have many terms and conditions other than price
- How should the long-term PPAs be structured to allow the generators, storage, demand response contracts to be integrated efficiently into short-term wholesale markets?
  - Standard CFD will distort curtailment mechanisms
  - Storage must see the spot prices for energy and ancillary services to perform efficient arbitrage functions
  - How to integrate with expansions of transmission networks and interconnectors?
    - Bundling VRE procurement with transmission procurement with LT PPAs (e.g. offshore wind)