A Summary of Market Design in an Intermittent Renewable Future

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***Abstract*— This paper summarizes the article titled Market Design in an Intermittent Renewable Future by Frank A. Wolak, published in the January/February 2021 edition of IEEE Power and Energy Magazine. Presented is a brief primer on wholesale markets, how intermittent resources are requiring a rethinking of wholesale energy markets, and the Standardized Fixed Price Forward Contract (SFPFC) mechanism proposed by the article as a replacement for firm capacity markets. A critique by committee members in the ISO NE region is also discussed.**

I. Introduction

Regional energy policy and the decreasing cost of intermittent renewable resources is resulting in increased adoption of these resources in the wholesale electricity market. Firm capacity markets have provided a mechanism for ensuring adequate generation capacity during times of high system stress, but these markets were designed with controllable generation sources in mind. The increase of these intermittent renewable resources is changing the dynamics of firm capacity markets such that new market designs may be necessary for an efficient wholesale energy market. A proposed design using Standardized Fixed Priced Forward Contracts is reviewed with respect to market efficiency and regional energy policy goals.

II. Wholesale Market Background

A. *Definitions*

- Wholesale Market: buying and selling of power between generators and resellers
- Marginal Cost: the costs to produce one more unit of a good (ex: one more kWh)
- Market-clearing price: lowest price at the intersection point of supply and demand (clears any excess supply/demand)
- Supplier/Generator: those who supply utility companies the energy to give customers gas and electricity
- Retailer/Reseller: buy power from generators
- Locational Marginal Pricing (LMP): similar to a day ahead model however adjusted to be in real time and to have the prices reflect energy at different locations
    - Accounts for the limits of the transmission system, load/generation patterns
- Local Market Power Mitigation (LMPM): without it there is no limit to offer prices for the supply of energy, limits how the supplier can influence the price

B. *Short-Term Markets*

LMPs are defined by short term markets, and short-term markets are made up of the day-ahead market and real-time market.

The day ahead market is settled first so that suppliers have an idea of generation expectations for the next day. The day ahead market acts as an “optimal conditions” predictor that estimates general prices from actual demand and system constraints. Prices are more stable in the day ahead market than the real-time market [1].

The real-time market is a 30 minute to hour period where suppliers can submit bids to where a single market clearing price is chosen. This clearing price depends on quantity of energy supplied vs. Quantity of energy demanded. If a resource submits a successful bid and commits its generation to meet demand, it “clears” the market. Resources clear starting with the cheapest, until generation demand is met. The price of the last resource becomes the wholesale clearing price [2].

The real time market prices are much more variable as values for bids are always changing until the wholesale clearing price is chosen. To exemplify this, Figure 1 shows calendar year averages (Column 0) for both the Day-Ahead and Real-Time prices settled at the AEP-DAYTON HUB.

ADHUB Historical

Year	DA - AVG	RT - AVG	DA - MAX	RT - MAX	DA -
2009	$32.98	$33.23	$98.36	$167.19	
2010	$37.58	$37.57	$113.87	$305.06	
2011	$38.69	$38.55	$284.05	$790.35	$
2012	$31.22	$31.55	$216.98	$389.69	
2013	$35.01	$33.97	$294.97	$432.58	
2014	$44.09	$42.94	$857.69	$1,819.86	
2015	$31.49	$31.20	$343.05	$380.27	
2016	$27.84	$27.47	$107.04	$253.56	
Grand Total	$34.86	$34.56	$857.69	$1,819.86	

Fig. 1. Historical DA vs RT LMP settlements at AEP-Dayton HUB

On average, Real-Time (abbreviated RT in the chart) prices cleared lower than the Day-Ahead (abbreviated DA on the chart) prices, referencing Column 1. The large range between Real-Time market max and min versus the objectively smaller range between Day-Ahead max and min suggests a greater amount of price volatility within the Real-Time market. [1]

Because of this last-minute bidding setup, suppliers can exploit the system by knowing they will (or not) be needed in real time because of transmission and generation unit operating constraints, thereby increasing supply costs to raise the overall market clearing price.

In a 2016 article by The Guardian, suppliers in Australia were able to manipulate the price of last-cleared resources by “strategically withdrawing supply of electricity for brief moments, pushing up the price they were able to charge for supply of electricity” on more than 40 occasions in 2015. Prices were sometimes driven up “from $100 to $14,000 per megawatt hour”.
Often times, large generators are often in a position where their supply is necessary to meet demand and they become a monopoly supplier. Better power interconnections or alternative energy storage would improve market efficiencies. [3]

Situations like the previous example in Australia were likely caught by an LMPM mechanism. An LMPM mechanism is essentially an algorithm within software that analyzes the real-time and day-ahead market for deviations from purchases and sales. The LMPM also ensures that only generation output levels that are physically feasible will be accepted in both the day-ahead and real time market.

Short Term Market Today and Future Trends

The short term market today acts with both LMP and respective LMPM mechanisms to prevent sudden price increases and reduce risk of rolling blackouts where there isn’t enough generation capacity

As mentioned in the previous article, renewable energies will become more commonplace as a source of generation, but at a much higher cost. An article by the Connecticut Mirror discusses ISO New England's plans to switch towards more clean energy. There is apprehension within Connecticut council members because of higher costs, but with environmental concerns becoming stronger, transmission organizations like ISO New England are leaning into the premiums and proposing to add more than 20,000 MW of renewable power to their network [4].

Long Term Markets (Firm Capacity Market)

Capacity Margins are maintained in the short-term markets to ensure that enough generation is available during times of high system stress, such as during severe weather that increases system demand relative to generation. The generators in this reserve margin do not produce revenue through selling energy, however, and require some other mechanism to remain economically viable. To do this, Capacity Markets provide a Firm Capacity payment to generators to remain on standby for such high stress scenarios.

Calculating Firm Capacity payments is a simple calculation for most controllable generators (most thermal plants). As these generators can be made available at nearly any time of day any time of year, save for maintenance downtime, the payment is calculated as the nameplate capacity of the generators times its annual availability. However, for intermittent resources, such as wind and solar, the firm capacity payment approach begins to break down, as the availability of solar and wind is much less reliable. These systems do receive firm capacity payments, but they are significantly smaller than those received by more controllable generators. As intermittent resources increase to significant numbers in the wholesale market, energy prices may become suppressed while providing little capacity [5]. For this reason, alternatives and modifications to Capacity Markets are being explored.

III. Standardized Fixed Price Forward Contract Proposal

A. SFPFCs

The primary focus of the article was centered on a non-Firm Capacity payment approach to ensuring resource adequacy. The Standardized Fixed Price Forward Contracts approach was proposed. In this proposal, retailers of electricity (distribution utilities, for instance), would be required by a regulator to procure a fractional portion of their energy for the realized system demand several years in advance. Table 1 provides the proposed schedule.

TABLE I. Fractional Energy Purchase Schedule

Fractional Energy Purchases	
Year	***% Energy Purchased***
Current	100%

1	95%
2	90%
3	87%
4	85%

When the delivery window arrives for the procured energy, the supplier may elect to buy energy from the short-term market rather than produce the energy themselves. If the cost of energy in the short-term market is less than their contracted cost to provide energy, the supplier can make an additional profit equal to the difference of their contracted cost minus the short-term market energy cost. Simultaneously, the supplier would also bid into the short-term market at their original contracted cost to hedge against higher short-term market costs. By doing this, the supplier is also providing additional capacity margin should the system become stressed. All of this occurs without firm capacity payments to idle generators and is therefore considered a more efficient approach to ensuring capacity.

B. *Auctions/Mechanics*

SFPFCs would be purchased by retailers up to four years in advance through annual auctions, with true up auctions occurring every year through the current supply year. As a result of this four-year forward horizon approach, new suppliers may be able to enter and compete more easily as financers and investors can have more confidence in the financial success of the generating unit.

SFPFC contracts would be shaped to hourly demand for the delivery period of the contract in four-hour increments. For example, a supplier may contract 100 MWh of energy on some future date. The contract would specify that on that date, the supplier is obligated to provide 10 MWh of energy between 2AM and 6AM, 30 MWh between 6AM and 10 AM, and so on for the remaining MWh in the contract on the delivery date.

Advantages

Eliminating Firm Capacity payments eliminates mandated capacity margins. Instead, capacity margin is established by incentivizing suppliers to cross hedge. Hedging can be accomplished through energy purchases in the short-term market, as well as by entering into agreements with other retailers to manage risk between actual hourly demand and their hourly load obligations.

Regulated retailers can use the forward looking SFPFC prices in their base calculations for setting the regulated retail price (the kWh rate allowed by regulators to the end user). This is thought to provide incentive to the retailer to procure wholesale energy at prices below the SFPFC through hedging.

Lastly, SFPFCs provide some protection to retailers against high short-term market prices. Because of this, the cap on short-term prices may be raised, which increases the incentive for all suppliers to produce energy in high system stress scenarios. This creates capacity when it is most needed, and the windfall from these higher prices can be used to fund investments in storage and demand response technologies.

C. *Critiques*

One notable critique of this SFPFC approach was brought forward in the NEPOOL Participant Committee for ISO NE. This committee points out that the SFPFC approach does not promote any explicit procurement of renewable resources [6], which may be a goal of regional, state, or local energy policy. This lack of explicit promotion may in turn negate the need for a modified wholesale market structure and could defeat state and local energy policies which are the driving force behind increased levels of intermittent renewable resources. However, the article itself acknowledges that there is no perfect wholesale market design, and that any adoption of the SFPFC approach should be adopted with appropriately localized considerations.

IV. Conclusion

Firm Capacity markets may not be best suited to ensuring capacity when intermittent renewable resources become more prevalent in the wholesale energy markets. This will require new approaches to procuring energy while ensuring adequate capacity is available during times of high system stress. The article summarized in this paper proposes one such approach through Standardized Fixed Price Forward Contracts, relying heavily on regulator-mandated energy procurement, cross-hedging, and higher short-term market caps. However, no wholesale market design is likely to be perfect, as evidenced by critiques from regional committees that the proposed SFPFC approach may not explicitly support regional energy policy goals. Any new wholesale market design will have to take into consideration the goals of these regional policies in order to fully balance market efficiency with energy policy.

V. References

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