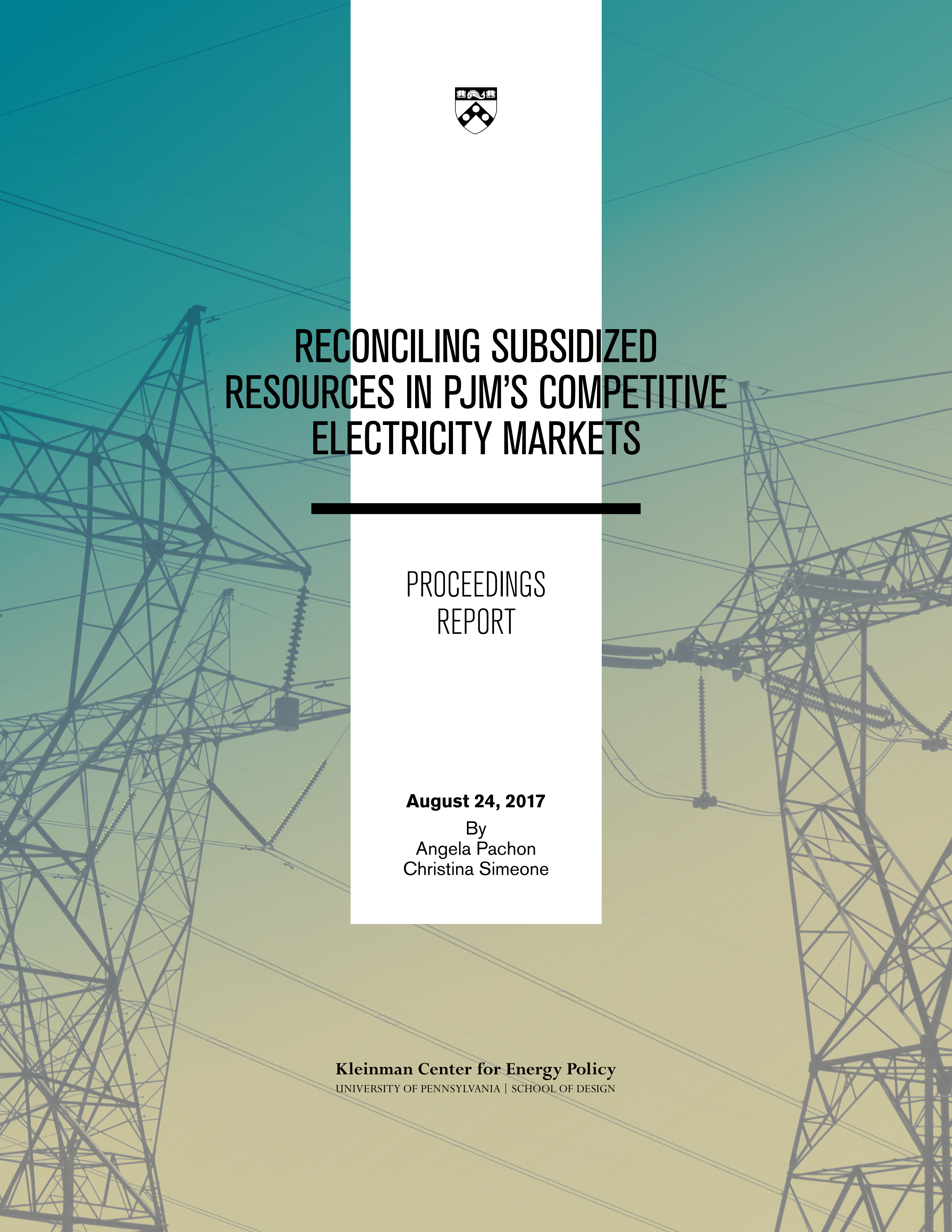

RECONCILING SUBSIDIZED RESOURCES IN PJM'S COMPETITIVE ELECTRICITY MARKETS

PROCEEDINGS
REPORT

August 24, 2017

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Proceedings Report, August 24, 2017 kleinmanenergy.upenn.edu

INTRODUCTION

ON MAY 4, 2017, THE KLEINMAN CENTER FOR ENERGY POLICY (KLEINMAN CENTER) AT THE UNIVERSITY OF PENNSYLVANIA ORGANIZED A ONE-DAY WORKSHOP TO DISCUSS RECONCILING SUBSIDIZED RESOURCES AND COMPETITIVE MARKETS AND OTHER MARKET DESIGN ISSUES THAT COULD HAVE AN IMPACT ON THE PERFORMANCE OF ENERGY AND CAPACITY MARKETS.

The focus of the discussion was PJM Interconnection (PJM) market design, but there were considerations of proposed solutions and practices in other jurisdictions. Although there are important legal and political issues surrounding market design choices, these questions were not in the scope of the workshop.

32 participants attended the workshop including a group of academic economists, PJM market participants, PJM staff, PJM's market monitor, and representatives from the Federal Energy Regulatory Commission (FERC). Kleinman Center staff facilitated the sessions.

Specific objectives for the day were:

- To gain a clear understanding of the different proposals to reconcile subsidized resources that have been explored to date for PJM markets.[1]
- To discuss the benefits and drawbacks of these proposals, as well as other market design ideas and issues that could be considered in the short and long-terms.
- To determine a research agenda necessary to inform market design policy decisions.

This proceedings report summarizes the workshop conversation and attempts to capture the diverse opinions expressed. Since conversation spanned a wide range of topics, this report is organized around the proposals presented and key topics of discussion concerning market design issues. There is no attribution for specific viewpoints, as the workshop took place under Chatham House Rules.[2]

BACKGROUND

Competitive markets were pursued to deliver electricity needs at the lowest cost through the use of market-based competition. Given the historic limitations of the energy market to incentivize investment, the capacity market was created to ensure resources are available to meet future demand.[3] Today there are converging forces affecting the market. These factors include low natural gas prices, renewable energy penetration, declining load growth, and other factors such as out-of-market interventions (i.e. subsidies).

Some questions remain: *Can these markets be relied upon—by sending the right price signals—to efficiently and reliably manage entry and exit of electricity supply resources over the short and long term? And can these markets be modified to effectively achieve the clean energy goals driving many state policies and resource decisions?*

[1] For example, proposals introduced at the Federal Energy Regulatory Commission (FERC) technical conference that took place on May 1st and 2nd in Washington, D.C. Information on this conference can be found at https://www.ferc.gov/EventCalendar/EventDetails.aspx?ID=8663&CalType=%20&CalendarID=116&Date=&View=Listview

[2] The Chatham House Rule states when a meeting, or part thereof, is held under the Chatham House Rule, participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed.

[3] For more information about the historic limitations of energy markets to incent resource adequacy, please see Paul Joskow, "Competitive Electricity Markets and Investment in New Generating Capacity," AEI-Joint Center Working Paper, May 15, 2006, https://papers.ssrn.com/sol3/papers.cfm?abstract-id=902005

Policymakers have expressed concerns about the markets signaling:

- **Premature Resource Retirement.** Are the markets causing premature retirement and closure of resources? If so, what are the implications for achieving state socio-economic (i.e. jobs, economic development) or environmental goals, and what are the implications for long-term electricity reliability?
- **Outcomes Inconsistent with Environmental and Socio-political Goals.** States may have preferences for resources with environmental (e.g. zero-emissions) and socio-political (e.g. jobs, economic vitality) attributes that markets aren't delivering.
- **Overreliance on Natural Gas.** Gas resources are currently the most competitive, but will market driven signals result in overreliance on gas resources that create economic vulnerabilities (e.g. if gas prices rise) or reliability concerns (e.g. reliance on "just in time" gas delivery, or vulnerability to unexpected and unpredictable events)?

As a result of these questions and concerns about the ability of markets to achieve a variety of goals, policymakers are exploring intervening in the markets through use of subsidies.

THE ISSUE OF SUBSIDIES

A market failure (e.g. externalities) could be corrected by a subsidy, making the subsidy consistent with competitive market outcomes. On the other hand, a subsidy can create market distortion when not used to correct for market failure, which may be inconsistent with competitive market outcomes. For example, subsidized resources could depress market prices at the expense of misallocating resources (e.g. over procuring subsidized resources) and reducing incentives for capacity investments in the long-run.[4] Workshop participants explored a long list of issues associated with subsidies, including:

Why Now? Subsidies have existed throughout the electricity supply chain for a very long time (e.g. preferential tax treatment for resource extraction, procurement mandates for renewable energy, nuclear liability limitations), why are they a problem now? Are subsidies producing market distortion that requires market redesign?

How Should Subsidies Be Defined? What subsidies materially impact market outcomes? While all subsidies may be inconsistent with efficient market outcomes, there may be a dividing line between the subsidies that are materially important and those that are immaterial. Does an inventory of all potentially applicable subsidies need to be developed? Is a materiality test for the subsidies, as well as their impacts on the market, needed when assessing market design options?

Discrimination and Distortion. Subsidies that indiscriminately address market failures by internalizing the cost of an externality may be consistent with competitive market outcomes. However, discriminatory subsidies may create market distortion. For example, providing a subsidy to all generators based on carbon emissions to correct a market failure is indiscriminant. Whereas, providing subsidies to only certain generators based on carbon emissions does not correct for the failure on a market-wide basis and is discriminatory.

Subsidies may Misallocate Resources. Subsidies may misallocate resources by increasing gains to politically favored resources. In the absence of subsidies, investment would be directed towards the most economic resources.

Subsidies Can Appear and Disappear Quickly. Designing markets around subsidies is also problematic because subsidies may have a short life, yet can promote inefficient long-term investments. This is because there is a lack of information about future subsidy implementation at the time of initial investment. In addition, subsidies are necessarily subject to change with shifting political and policy directions.

Subsidies May Beget More Subsidies. Depressed market prices resulting from subsidies may lead to self-fulfilling requests for more subsidies. In Europe, gas plants are struggling and requesting subsidies on the grounds that renewable energy subsidies are depressing prices. It is likely that subsidies could beget more subsidies.

Subsidies and the Tradeoff Between New or Old Technologies. New capacity, mostly gas, is being built with project finance - a combination of debt and equity - and with financial hedges to ensure revenues are sufficient to service debt in the early years (five- to seven-years) of the project. If subsidies for nuclear are in place for a long time, then you will have excess capacity and suppressed prices in energy and capacity markets. As these revenue hedges roll off, many modern, high efficiency gas plants could become economically distressed (e.g. can't service debt) as a result of subsidies for old technologies. With subsidies, there are tradeoffs where helping an old technology means harming a new technology.

Honesty About State Intent is Needed. States need to be straightforward and transparent about what attributes they value. It becomes harder to test the effectiveness of the subsidy mechanism if the intent is unclear. For example, some stakeholders assert that recent subsidies established to support existing nuclear power plants were enacted for economic development reasons, but were politically packaged as efforts to address baseload and environmental concerns.

Pricing Negative and Positive Attributes. It is more difficult to assign a positive value to a desired attribute than to assign a negative value to an undesirable attribute.

[4] R.J. Briggs, Andrew Kleit,"Resource adequacy reliability and the impacts of capacity subsidies in competitive electricity markets", Energy Economics, Volume 40, November 2013, Pages 297–305

Inconsistent Subsidy Policy. State subsidy policies have the potential to be developed inconsistently and with vague goals that make understanding the trade-offs associated with implementing subsidies unclear. With few exceptions, there is little consensus in the way policy makers in different states may assign value to a specific attribute. The same attribute may have more or less value in different jurisdictions.

Patchwork of Subsidies. A federal or region-wide solution would be preferred to a patchwork state approach when integrating and accommodating those subsidies, but it is unlikely there will be a federal solution or regional consensus among PJM states. In the meantime, states within PJM are likely to continue to pursue their electricity policy goals.

Prudency of Subsidy. We must acknowledge that decisions to subsidize resources are a political issue.[5] If voters support that decision, it raises the following questions: are these subsidies unfair or inefficient or are they prudent? For investors, the question is should these subsidy policies be expected? Subsidies for economically struggling units may be unexpected, but subsidies for carbon policies may become more common. In understanding these issues, the questions of "who pays the bill?" and "how much will it cost?" matters.

[5] Whether or not the state subsidy policy is within the state's jurisdiction is a legal issue beyond the scope of the workshop.

RECONCILING STATE POLICY AND MARKET OUTCOMES THROUGH MARKET DESIGN

Subsidies may be pursued because market outcomes – delivering the most economically efficient resource portfolio to meet reliability needs - may not be consistent with policymaker preferences. State policies (e.g. subsidies) have the potential to directly or indirectly affect market outcomes. Ability to implement these policies is likely subject to legal tests, a discussion of which was beyond the scope of this workshop. It is worthy to note that there has been tensions and lines drawn between federal authority over regional wholesale markets and state authority over local policies. For example, the Hughes v. Talen U.S. Supreme Court decision[6] and the recently enacted nuclear subsidy programs in New York and Illinois.[7]

Markets operators seemingly have four options:

1. Do nothing,
2. Litigation against state policy,
3. Reconciliation of state policy, or
4. Mitigation of state policy.

The do nothing approach may not be viable given the actions of the states, likelihood of opponent litigation, and concerns over long-term market feasibility. Market participants likely to be harmed by state subsidy programs may be inclined to pursue litigation strategies aimed at overturning these programs. However, for federally regulated market operators (e.g. PJM) that are also subject to implicit state oversight, litigation maybe an awkward strategy. Mitigation of state policies may protect market outcomes, but may create unpredictable political tension between states and PJM.

Some argue that for PJM, it may be more constructive to help states achieve their policy goals through market design that preserves competitive outcomes, rather than oppose or mitigate state actions. Instead, these parties argue electricity markets should try to pursue when possible, the reconciliation of policy and market objectives following some important guiding principles. Two options are presented to achieve such reconciliation, as well as an option to mitigate the impacts of state policy:

1. **Integrate** state policy goals into the markets, where possible. For example, through carbon pricing in the energy market, or through explicit clean energy quantity requirements (see page 10).

2. Where policy integration isn't possible, determining if the markets can **accommodate** state policy while preserving efficient market outcomes – through market design – may be a necessary goal. For example, developing a two-tiered capacity pricing mechanism (see page 14).

3. If integration or accommodation is infeasible, a resultant option would be to **mitigate** the impacts of state policy in order to preserve competitive market outcomes. For example, by placing a bid offer floor price on all existing resources (see page 13).

As these market design goals and options are explored, there are important guiding rules and principles to keep in mind when evaluating reconciliation options.

GUIDING RULES AND PRINCIPLES FOR RECONCILIATION

These general rules and principles are useful for market operators, market participants, and policymakers when assessing market design options.

Guiding Rule #1: Identify the problem you wish to solve. When considering market design options, it is first necessary to understand what is the market failure that needs to be fixed. It is important that policy makers also understand the underlying market failure.

Guiding Rule #2: Identify your goal. Determine the objective(s) to achieve. It is extremely important set aside constraints that preclude one from doing whatever is right. Decide on the desired efficient outcome, define success, and how to measure that success.

Guiding Rule #3: Creatively explore solutions. In theory, what would accomplish the objectives? Be creative in exploring a range of options that would meet intended goals and metrics of success.

[6] In general terms, the Hughes v Talen U.S. Supreme Court decision found that Maryland's efforts to subsidize new generation capacity was preempted under the Federal Power Act. The Hughes v Talen Energy Marketing decision from the U.S. Supreme Court can be found at https://www.supremecourt.gov/opinions/15pdf/14-614_k5fm.pdf

[7] In August 2016, New York established a zero-emission credit (ZEC) program that, *inter alia*, would provide a new revenue stream to certain, but not all, existing nuclear plants in the state based on an administratively set price that incorporates a social cost of carbon. In December 2016, Illinois' legislature passed a law establishing a zero emissions standard (ZES) creating a new revenue stream for two existing nuclear plants in the state. The ZES price is based on the social cost of carbon.

Guiding Rule #4: Reality-test potential solutions. Start the conversation about political and legal issues, and required compromises as they apply to proposed solutions. Don't unnecessarily limit options because of political perceptions.

Guiding Rule #5: Manage expectations last. Thinking about creative market design ideas is a positive exercise, but be careful to manage expectations and not promise something that can't be delivered.

Guiding Principles. With the above guiding rules in mind, any effort to reconcile market and policy objectives should be guided by principles. Some of the principles discussed included:

- **Cost Causality and Socialization.** The entity (e.g. state) that creates the cost should pay for the costs. Costs should not be socialized across the market, impacting market outcomes (e.g. therefore impacting other states). Cost reallocation may be in conflict with the principle of efficiency, as cost reallocation methods typically employ subjective criteria.
- **Efficiency**. Ensure market results remain competitive and efficient, therefore delivering lowest cost.
- **Simplicity and Replicability.** Electricity market design solutions should aim to keep the market simple and replicable, so participants can reasonably predict outcomes in order to make investment decisions, and to maintain competitive markets.
- **Recognition of Winners and Losers.** No solution will result with only winners or only losers. Tradeoffs must be understood and transparently communicated upfront.
- **Symmetry and Fairness.** If there is a need to correct for a market failure, there should be symmetric treatment of low and high prices. For example, the option of price floors (e.g. a bid offer floor, such as the minimum offer price rule) should also include considerations of price caps (e.g. an offer cap).
- **Non-discriminatory.** There should not be discrimination among resources with similar attributes.

In the context of rules and principles to evaluate market redesign options, it is beneficial to first understand perceptions about the current status of these markets.

STATUS OF ENERGY AND CAPACITY MARKETS

There was a discussion about the current status of the markets, with diverse opinions expressed about the performance of energy and capacity markets in PJM. This section attempts to capture these diverse views.

The Energy Market is Working.

Energy market is crown jewel of restructured markets. After adjusting for volatility of fuel prices, load weighted locational marginal price (LMP) in PJM has been remarkably stable since its inception. This was not predicted at the start of these markets.

Energy market price formation is working well; no changes are needed. Some participants cautioned against proposed energy market changes (e.g. changes to LMP) and believe the energy (and capacity) markets should not be changed in order to solve unit-specific problems.

The energy market is delivering low prices for consumers. Supporters argue that low energy market prices are evidence that competition is working and delivering savings for consumers, as intended.

Low priced natural gas incorporated into energy market. PJM is situated over several shale gas plays, making abundant, cheap natural gas available to power producers. As a result, gas resources have been gaining market share in the energy market.

However, Market Issues Exist.

In PJM, some believe there are energy market pricing issues that need to be addressed by evolving energy market price formation.[8] Most of the energy market issues discussed relate to operational signals, but revenue adequacy issues were also discussed and covered in the capacity market section.

Flattening of the supply curve? Some assert there is an ongoing flattening of the supply curve, for example, as a result of excess supply in light of reduced demand and inflexible gas procurement options. This leads to reduced incentives for power generators to respond (e.g. ramp power up or down) to economic dispatch signals (i.e. given the small changes in price). However, there was disagreement over these points, with some suggesting there is no evidence that the real-time supply curve is flat (noting only average summer supply curve data was provided) nor evidence there are issues with response to dispatch signals.

Eliminate the current prohibition on inflexible units setting LMP. PJM has publicly recognized inflexible units' limitations and pays them uplift[9] when they run at prices below their bid costs. Some parties argue that this inappropriately rewards inflexibility and instead, the market should encourage flexible units. FERC began this discussion with its fast-start pricing proposal.[10] Some believe FERC's proposal should be expanded beyond fast-start resources, where others disagree with the proposal or expanding it to other resources.

Implement a mechanism to incentivize load following and balancing. Some maintain there is decreased incentive in PJM to follow dispatch signals due to the flattening of the supply curve, while others disagree and maintain this issue is not occurring. Others maintain there is decreased incentive for gas generators—who have the flexibility to quickly ramp output up or down—to respond to dispatch signals as they have limited options to acquire gas on a flexible basis (e.g. pipeline scheduling practices and gas procurement issues). Some predict an incentive mechanism could drive innovation on gas fuel procurement and alternative energy technologies.

Eliminate negative offer prices that result in price suppression in the energy market. Some argue negative offer prices have been driven by federal production tax credit (PTC), where wind units offer and are paid outside of energy market signals. These parties maintain price suppression occurs when wind units continue to run counter to dispatch signals as a result of PTC incentives. Others argue negative offers are not a substantive issue in PJM.

Improve scarcity pricing. Lack of adequate and locational scarcity pricing in PJM was also cited as a cause of suppressed prices. There was considerable discussion about the benefits and drawbacks of capacity markets versus energy-only markets with

[8] On June 15, 2017, PJM released a white paper entitled, "Energy Price Formation and Valuing Flexibility", outlining fundamental price formation issues it believes need to be addressed. The paper is available on PJM's website at http://www.pjm.com/~/media/library/reports-notices/special-reports/20170615-energy-market-price-formation.ashx

[9] FERC defines "uplift" as charges from a regional transmission organization (RTO) or independent system operator (ISO) collected outside of the market-clearing commodity price; these charges can include payments to reliability must run (RMR) units, other out-of-merit-order power purchases, administrative costs of the RTO/ISO, or other cost categories.

[10] More information on FERC's proposal on minimum pricing requirements for fast-start resources can be found at https://www.ferc.gov/media/news-releases/2016/2016-4/12-15-16-E-2.asp#.WSikjWjyvb0

improved scarcity pricing. In addition, some point out that most retail consumers do not get real-time price signals from the market, therefore the real effects of scarcity pricing in wholesale markets would be limited.

Impact of demand response on energy market price formation. Some believe demand response can help price formation to be more efficient, for example, by introducing more competition. Demand response can also provide operating reserves. On the other hand, some argue demand response can be problematic because of the compensation method created by FERC Order 745, which can be subject to complications, for example, establishing baselines.[11] These parties argue it is more efficient to charge people for what they use rather than compensate them for what they don't use.

How is the Capacity Market Succeeding?

New Entry. Capacity market revenues are necessary and the market is working. For most unit types, both energy and capacity market revenues are needed to keep units in the market. In spite of low gas prices, low energy prices, and modest capacity prices, new entry continues to occur.

No Reliability Problems. PJM has procured significant reserve margins, while keeping market prices low.

Increased Resource Diversity. As a result of low priced natural gas and the economics of new-build high-efficiency gas generation, PJM's fuel mix has become more fuel diverse. On the other hand, some parties argue that given current market conditions, PJM's fuel mix may become too gas dependent in the future.

Improved Transparency. Transparency is one of biggest benefits of the markets. A return to rate regulation moves to a system that lacks public transparency, reducing the ability for people to understand if they are getting a good or a bad deal.

Promotes Innovation. Competition breeds innovation to provide valued services more cost effectively. The advances in natural gas combined cycle and renewable energy technologies are prime examples of innovation at work.

How is the Capacity Market Falling Short?

Price Suppression and Early Retirements. There has been a historical trend of capacity market price suppression, leading to some early retirement of resources. For some, early retirement of less competitive resources is an efficient market outcome. However, others believe PJM's existing markets do not monetize valuable attributes of their generation assets, making these assets appear less competitive.

Not a True Market. Most parties agree the capacity market is already a complex administrative construct rather than a true market providing accurate pricing. For example, some argue that NERC's reliability requirement (i.e. 1 day in 10-year loss of load)[12] is an exogenous requirement that results in more energy supply resources being built than the market would otherwise signal. Others, however, believe the reliability requirement is an endogenous market constraint. Endogenous or exogenous requirements for additional supply means energy market prices will be lower (compared to prices established in absence of the reliability requirement), therefore resulting in reduced net revenues. This is one reason a capacity market is needed to compensate for that lost revenue. As more exogenous requirements (e.g. state subsidies) are added to the capacity market, market prices will continue to be affected. Some argue that state subsidies are a response to long-standing shortcomings of the construct.

Penalty Concern with Capacity Performance Rule. It doesn't seem that the capacity performance requirement that was designed to ensure resources are available when needed in emergencies, has addressed low prices (e.g. by increasing stringency of eligibility criteria needed to qualify as a capacity resource and therefore limiting supply bids). The bonus payment opportunity of the capacity performance rule for resources that exceed performance obligations has not yet emerged since emergency assessment hours have not yet been called. In absence of higher prices and bonuses, prices remain low and there may be an incentive to cut costs, which may compromise performance. Meanwhile, there is a looming threat of penalties for resources that fail to meet performance commitments during assessment hours, which could

[11] Issued in March 2011, FERC Order 745 sought to eliminate barriers to demand response resource participation in competitive power markets. Order 745 required demand response resources be compensated in the same amount as electric generators, via the locational marginal price. A copy of the order can be found on FERC's website at https://www.ferc.gov/EventCalendar/Files/20110315105757-RM10-17-000.pdf

[12] The North American Electric Reliability Corporation (NERC) established a planning standard for resource adequacy based on a one day in ten years loss of load expectation. For more information see http://www.nerc.com/files/BAL-502-RFC-02.pdf

wipe out market participants. On the other hand, some argue these phenomena should be recognized as real and harsh realities of markets and competition.

Total Wholesale Cost Shifts. Where will PJM's capacity market go in the future? As energy costs have also dropped, capacity costs are now over 20 percent of total wholesale market costs, excluding transmission. The capacity market is becoming more important for resource revenue adequacy, a phenomenon driven by low natural gas prices driving down energy prices. As such, the threat of subsidies impacting capacity clearing prices is a greater concern to some resources. Looking forward, greater penetration of zero marginal cost resources (e.g. renewables) is expected to lower energy prices and increase dependency on the capacity market for revenue adequacy.

Baseload Generation Bias. Some participants were of the view that one annual capacity product doesn't make sense. This creates a bias towards baseload generation. Instead, some argue there should be seasonal or diurnal capacity products and perhaps unique auctions for these products, which better match capacity value with resource performance.

Short or Long Term Capacity Commitments to Drive Investments. Is the existing annual capacity commitment optimal or would longer-term commitments better drive investment? Some participants believe capacity markets should be for 10-15 year commitments, so that capacity auctions can drive new investments. Other's believe the existing annual product and commitment period are acceptable.

INTEGRATION PROPOSALS

Two proposals—carbon pricing and price adders—were explored to integrate subsidies into the energy market.

Carbon Pricing

One proposal to introduce a carbon price in the energy market through a price adder reflecting the cost of the carbon externality was presented and discussed. As part of the discussion, the topic of non-carbon price adders came up as an alternative to integrate different attributes of the resources favored by policy makers into the market. A detailed explanation of the carbon price proposal is in **Appendix A.**

PJM could facilitate a regional or sub-regional carbon pricing mechanism by incorporating a carbon price or carbon adder into energy market dispatch via a resource-specific, energy bid adder for carbon emitting resources. The bid adder would be calculated as the price per ton of carbon emissions (e.g. equal to the social cost of carbon estimated by the Federal Government) multiplied by the amount of carbon emissions of each generating unit. The market will clear at a price equal to the marginal costs of the last generating unit plus the adder. Under this proposal, emitting units would be required to give back to PJM the revenues related to the adder. According to the proposal reviewed, these revenues could be rebated to customers in order to keep energy costs low. The value of the carbon emissions attribute would be fully reflected in the energy market and therefore would be incorporated into capacity market bids. If the carbon price were sufficient to meet state goals (e.g. drive renewable investment, reduce emissions), no secondary emissions attribute payment (e.g. state subsidy) would be needed. Other "accommodate" measures may still be needed for generators that are supported by states, to ensure capacity market prices are not distorted.

This approach has a number of benefits:

- Advances state carbon reduction policies while preserving orderly and competitive economic dispatch across the entire footprint.
- Does not require a line to be drawn about what is and what isn't a subsidy. (However, other state policies that exist beyond carbon pricing may require such a distinction).
- Might not require FERC approval. Although some pointed out that it may require a Tariff change at PJM that is subject to FERC review and approval.
- Eliminates the need to "accommodate" subsidies for carbon abatement, assuming the states take no additional actions to acquire or retain low-carbon (or other) resources.
- Provides consistency between different programs. Today there is no consistency in the way states value carbon abatement. For example, in New Jersey the solar renewable energy credit program pays $300/MWh for distributed solar, while the willingness to pay for wind is $7/MWh according to standard renewable energy credits (REC) prices in PJM.
- Gets the price signals right. Provide a visible carbon price signal integrated into the energy market for zero- and low-carbon resources.

At the same time, this approach has challenges:

- Is politically very difficult to implement. It requires a critical mass of states willing to participate and not all the states may be willing to participate.[13]
- Requires solutions to prevent leakage. If a sub-regional approach to carbon pricing is feasible, it still requires a mechanism to prevent leakage between participating and non-participating PJM states.[14]
- Requires agreement among states about the specific price of carbon.

Non-Carbon Adders

As part of the discussion, there were questions on whether other non-environmental attributes favored by policymakers should be valued and how they should be valued. The carbon price option provides a solution to recognize environmental attributes, but it does not address "recognition" of other non-environmental attributes like job creation.

For the valuation question, it was explained that 25 years ago there was an effort to value the social cost of electricity for fuel cycle frameworks. There is a

[13] For example, the New England State Committee on Electricity (NESCOE) has explicitly rejected an ISO-administered, FERC jurisdictional carbon pricing mechanism. See NESCOE's April 7, 2017 memo at http://nepool.com/uploads/IMAPP_20170517_NESCOE_Memo_20170407.pdf

[14] Price leakage occurs when the increased cost to emitting resources in participating states is passed through to consumers in non-participating states. Emissions leakage occurs when fossil fuel based electricity from resources not subject to the carbon price is consumed in participating States

substantial amount of literature in academia[15] valuing in dollar terms all sorts of attributes and concerns (at that time there was not too much concern about carbon, but about NOx and SOx) and how to integrate such negative values into markets. Currently, NOx and SOx are included in PJM markets.

Discussion

There was broad agreement in the room that sector-wide carbon pricing is the most desirable solution to internalize carbon emission externalities of generating resources. There was disagreement on the reasons why this is the most preferred approach. Some of these disagreements included:

Border Adjustment: If carbon pricing is implemented on a sub-regional basis, a carbon price border adjustment could prevent leakage. A border adjustment would also drive more energy price separation between non-carbon and carbon regions, providing an outcome consistent with each region's carbon policy. Despite being an efficient solution, calculating such adjustment has proven to be extremely difficult. In the past RGGI and California did not adopt border adjustments given the technical and legal complexities. In California, instead of a border adjustment, a free carbon allowance at program inception operates to minimize leakage. A new cap-and-trade proposal, SB 775, could introduce a border adjustment. In absence of a border adjustment, it may be necessary to assess the 'cross-border' effects of implementing a sub-regional carbon price.

Windfall Profits and Affordability: With a market price reflective of a carbon price, revenues for all dispatchable units would increase considerably, given the carbon adder to the marginal unit. In Appendix A, Figure 1, introducing a carbon price of $32/ ton of CO2, would increase the market price from $40/MWh to $56/MWh. Revenues would increase for renewable resources because the higher market price; however, this revenue increase could be offset if complimentary "subsidy" or attribute payments (e.g. renewable portfolio standard) received outside the market were eliminated. For emitters, revenues would increase, but they would have to pay back the carbon charge according to their carbon emissions. For nuclear plants, net revenues could increase considerably (for example, by over 50 percent in Figure 1). One proposal was that in addition to the carbon emitters, "baseload" units such as nuclear, should give back part of these extra revenues.

The basis for this proposal is twofold:

- With a carbon price, baseload units like nuclear would receive windfall profits even though they were built when carbon price was not a concern. There was mention of Spain where the nuclear and hydro resources give back a part of these extra revenues coming from a carbon price.
- Affordability is a major concern of the proposal presented. Any carbon price mechanism should be affordable to gain political support. There is a need to reconcile environmental objectives and affordability. These affordability concerns are mitigated if windfalls profits are avoided.

On the other hand, some argued these extra revenues that nuclear units could receive with a carbon price, could not be considered windfall profits. After all, investors took a risk that had potential upsides and downsides. Perhaps these extra revenues are a reward for the early action to invest in zero carbon technology.

Nuclear Plant Economics There was a discussion on if nuclear plants could clear the energy and capacity markets and whether they should be subsidized in the absence of a carbon price.

- In the energy market, nuclear plants are likely to be dispatched even with low market prices, because their fuel costs are low. In addition, these units are inflexible once brought online. Fixed costs, should not affect the nuclear plant bids, because they are not considered variable costs. But nuclear plants have large fixed operating costs, most of which are unavoidable and driven by regulatory requirements. However, these costs can be avoided if the plant retires. These costs may make the plants uneconomical in a low energy market price scenario, if capacity prices are not sufficient to cover all of the plant's fixed costs in excess of net energy market revenues. For some participants, if the market price does not cover the variable and fixed costs of the plants (those that arise unless the plants retire), it means that these plants are less efficient than other technologies. If nuclear plants have become obsolete

[15] See for example "Optimal Adders for Environmental Damage by Public Utilities" (Dallas Burtraw, Winston Harrington, A. Myrick Freeman III, and Alan J. Krupnick) Journal of Environmental Economics and Management, Vol. 29, No. 2, S1-S19, 1995.; or 'Second-Best' Adjustments to Externality Estimates in Electricity Planning with Competition," 1997, Land Economics, (Karen L. Palmer, Dallas Burtraw and Alan J. Krupnick). Vol. 73, No. 2, (May) pp. 224-239.

(in the sense that the market does not provide enough resources to cover their costs) there is no reason why they should stay online. In other markets, when a technology becomes obsolete, regulators do not come in to the rescue. Other participants argue that most nuclear plants in PJM are in fact economic, even given some of the lowest energy prices in PJM history. These participants assert the issue of nuclear plant economics has been exaggerated.

- In the capacity market there were also opposing views. For some, the way the capacity market is designed now in PJM could only favor the cheapest resources to build, which are gas-fired units. In the future, if market pricing converges to zero in the energy market, energy revenue dependent resources like nuclear plants would be uneconomical in the market in the absence of a carbon price or strong capacity market prices (i.e. where nuclear capacity sets the marginal clearing price). Some workshop attendees maintain this phenomenon is not currently occurring. First, because PJM energy market prices are far from a zero net energy revenue market. Second, the sum of net revenues from the energy market and the capacity market covers the avoidable costs for a nuclear plant.

Capacity Market Adjustment: Some were of the view that with a carbon price, there won't be a need to "mitigate" (i.e. minimum offer price rule) or "accommodate" subsidies in the capacity market (see next sections). For others, such "accommodating" approaches are still needed to take into consideration other non-environmental subsidies, market power issues, and the expectations that states will continue to pursue subsidy mechanisms beyond carbon pricing.

Unclear Effectiveness of Carbon Pricing to Reduce Emissions: Some assert that to achieve emissions reductions, carbon pricing has to be high (e.g. sufficient to alter dispatch stack). Pricing may drive emissions reductions, but as the fuel mix gets cleaner and cleaner, even high carbon prices may lead to only moderate carbon emissions reductions. In the long term, carbon prices that are too low are likely to be ineffective in further reducing carbon emissions. Studies indicate that very high carbon prices may be needed to induce investment in merchant renewable energy.

MITIGATION PROPOSAL

One specific proposal was explored, expanding the minimum offer price rule to existing resources, as a way to correct or counteract the impacts of state subsidy policy on the markets.

Expanding the Minimum Offer Price Rule to Existing Resources

The existing minimum offer price rule (MOPR) is a price floor placed on capacity market bids from new gas-fired resources (e.g. combined cycle, combustion turbine and integrated gasification combined cycle). The current iteration of the MOPR was put in place in response to concerns about state efforts to subsidize new generation resources, the effect of which would suppress revenues for both existing capacity resources and dampen market signals for new capacity investments.

Some parties maintain the MOPR bid price floor should be expanded to cover all existing resources (with some extending this to include non-gas resources), in response to state subsidies for existing generation. The basic premise is that an existing resource with a state subsidy would not be permitted to submit a discounted bid (i.e. costs minus the subsidy value) in an effort to clear in the market. The resource could not bid below the price floor, which would be administratively set to approximate a competitive entry bid for that unit or unit technology type.

A detailed explanation of the MOPR proposal is included in **Appendix B.**

Discussion

Does the MOPR reference price change when talking about new or existing resources? For new competitive offers as defined under the capacity performance rule, the MOPR would be appropriate. For existing resources, it would just be going forward costs.

What about a using the Fixed Resource Requirements (FRR)[16] instead of a subsidy? Could a state use the FRR by assigning subsidized supply to a certain amount of load, or prorate across the state's total load. Is this a more viable approach?

FRR is currently restricted to zero load or total load in an area, to avoid gaming the system. There is a significant volume of FRRs currently in the market.[17] Trying to loosen current restrictions, such as assigning subsidized supply to a certain amount of load, would create the same problem trying to be addressed through the MOPR. States can go back to a regulated market and use FRR on a full utility service area basis, but some argue price distortion would occur if the FRR rules were relaxed (e.g. assigning subsidized capacity to only a portion of a service territory load). Also, load under FRR may tend to pay a lot more for capacity compared to capacity market prices, and the FRR capacity price is not transparent.

When is intervention justified to maintain competitive markets? Price caps help prevent against monopoly power and price floors address monopsony power. However, these caps and floors may prevent the market from sending accurate signals. It was also observed that there is the potential for state subsidies to result in uneconomic subsidized resources exercising market power by accelerating the exit of otherwise economic resources. Windfall profits and losses may also be a concern. Reduced prices were one of the reasons policymakers moved to markets. Markets mean there will be winners and losers.

[16] The fixed resource requirement (FRR) is an alternative method for a load serving entity to meet a fixed resource requirement with its own capacity resources, as opposed to having PJM procure capacity resources on its behalf through the capacity auction.

[17] PJM's base residual auction results identify FRR commitments by delivery year. For the 2020/2021 delivery year, 13,931 MW of FRR commitments are listed. In delivery year 2019/2020, 15,385 MW of FRR commitments are listed. More information can be found on Table 5 of PJM's most recent capacity auction report at http://pjm.com/~/media/markets-ops/rpm/rpm-auction-info/2020-2021-base-residual-auction-report.ashx

ACCOMODATION PROPOSAL

One concept was explored—creating a two-tiered capacity market structure—as a mechanism to accommodate state policy into the markets through changes to market design.

Two-Tiered Capacity Pricing

As subsidized resources enter the market, the supply curve shifts to the right. This lowers the market clearing price and increases the overall quantity procured. States have expressed concern about the MOPR expansion because it prevents the supply curve from shifting right. Therefore, states pay a subsidy cost but do not get the benefits of the lower market clearing price, or risk the subsidized unit failing to secure a capacity obligation.

Supporters of two-tiered capacity pricing argue that in the short-term, failure to correct for the effects of the subsidy risks harming market participants who rely solely on markets for compensation. These supporters also assert that in the long-term, failure to correct for subsidies to uneconomic units threatens the viability of competitive markets, in general, and may force a return to regulated generation. The rationale behind the two-tiered capacity pricing proposal is to allow state-subsidized resources to participate while preserving market signals to incent capacity investments.

There are at least three proposed approaches to two-tiered capacity pricing. While these proposals differ in important ways, they all seek to allow for subsidies while mimicking competitive market pricing. In general, there are two capacity auctions. One determines a "competitive" capacity price and the other determines the quantity of capacity to receive capacity obligations. The important differences between these proposals include:

- **Treatment of Infra-Marginal Resources.** In absence of load growth, as subsidized resources enter the market, otherwise economic resources are pushed out of the market. In the two-tiered proposals, these displaced resources may clear in one auction, but not in the other. Two proposals conclude these infra-marginal resources will not secure capacity obligations, one proposal requires all cleared capacity to reduce their capacity commitments in order to ensure economic infra-marginal resources secure capacity payments.
- **Capacity Payments to Subsidized Resources.** In one proposal, subsidized resources do not receive capacity payments, meaning the provider of the subsidy becomes responsible for fully compensating that resource. The other two proposals allow for award of reduced capacity payments to subsidized resources.

More information on the three proposals for two-tiered capacity pricing is included in **Appendix C**.

Discussion

Is the two-tiered system only a short-term fix at best? Some stakeholders maintain this strategy is only a short-term solution that could be effective for two to five years. They assert creating an artificial price to mimic a market price isn't a real market solution and that a long-term fix that gets back to functioning markets is needed. Others suggest that a two-tiered pricing mechanism could be responsive to state actions to inject uneconomic capacity into the markets and should be an option for the long-term.

Under the two-tiered proposals, are customers paying too much for reliability? Some stakeholders note that customers will be paying to assist both infra-marginal resources, plus paying the state subsidy value for preferred resources. It was noted that it is the states' decision to subsidize preferred resources, and it is unreasonable for them not to expect additional costs. Others point out that the various two-tier proposals have explicit mechanisms to avoid "over-purchasing" capacity, and in at least one case, an explicit mechanism to ensure that the cost of capacity in the market is no greater under the two-tier mechanism than it would have been had the subsidies not existed. Some argue infra-marginal resources should not secure capacity payments, in order to preserve price.

Is an artificial price that mimics competition really needed? Some suggest that subsidies for existing uneconomic units are expensive, but even if these subsidies exist it doesn't make sense to set capacity prices beyond marginal costs. The uneconomic subsidized capacity does contribute to overall resource adequacy needs, though this capacity is procured at a higher total cost compared to competitive resources. So, why does the market need to send signals for additional capacity by attempting to construct an artificial market price? Others counter that in order for the market to succeed in supporting both existing and needed new investment, prices need to consistently reflect the economics that would be experienced in the absence of state subsidies for uneconomic units.

Mimicking competitive prices won't work. Some stakeholders argue while two-tiered capacity pricing proposals seek to mimic competitive outcomes, they do not succeed. In most cases subsidized units push unsubsidized competitive units out of the market.

Capacity market has to work on the margin. Parties noted that investments are supposed to be driven by marginal costs and that these subsidies for uneconomic units distort marginal costs. If this distortion is not corrected, then some argue PJM is on a path where new investment only happens for contracted or subsidized resources and the merchant model no longer exists.

Can competition for subsidies be introduced? Some parties suggest subsidies are likely to take place, no matter what. If this is the case, they argue why not introduce competition or reverse auctions for subsidies? This strategy could reduce the subsidy payment value needed to obtain the desired goal. Although competition for the subsidy may offset the benefit for the subsidy recipient. In practice, no one can currently force the states to structure subsidies in this manner. More importantly, a state's subsidy goal may include factors beyond lowest cost, and may extend to economic development goals such as maintaining jobs and plant operations. Other stakeholders point out that a system based on competitive subsidies may be inconsistent with the merchant generator model.

Intervention or protection? Some parties assert PJM shouldn't implement a two-tiered pricing mechanism, since it is another form of market intervention that makes the market not look like a market at all. On the other hand, a do-nothing approach may not be viable either. Some suggest PJM would not be intervening in the markets with this action, rather they would be trying to protect the markets. These parties assert the intervention is happening by state actions.

Tension between economic theory and political reality. Throughout the discussion it was clear there is a strong tension between principled economic theory and political and practical realities.

EVOLUTION OF MARKETS

Presenters and participants were encouraged to contemplate and discuss not only the short-term needs of the markets, but also anticipate potential longer-term market needs to evolve.

Capacity Market

Significant design reform may be inevitable. Capacity markets were designed to deliver reliability at low cost through use of competition. They were not designed to yield other goals, such as zero emissions, jobs, or other attributes. Socio-political goals for carbon reductions are also moving in the way of economic trends, as zero and low carbon resources like renewables, energy storage, and natural gas prices are decreasing. Economics and socio-political goals are intersecting with electricity markets. In absence of market design that values zero carbon resources, states are using command and control techniques to achieve carbon goals. Alternatively, using market forces may be a more cost efficient way to reach these goals, provided markets are properly designed.

What is the future of capacity market prices? Looking forward, concerns were expressed about a future where low gas prices persist and the energy market becomes more depended on competition between heat rates of gas-fired units, along with entry of more zero-bid renewables. What does this mean for the capacity market? It is suspected that resources will become more dependent on capacity market prices for revenue adequacy. However, it is unclear if capacity prices will be sufficient to ensure revenue adequacy.

The path to aligning market design with state goals is not likely to happen quickly. It may need to evolve in a piecemeal fashion as states continue to act. The first phase may require PJM to quickly accommodate or mitigate state actions in order to stabilize market integrity. The second phase could include a more thoughtful and pragmatic approach to integrating and achieving state goals through market design reforms. The third phase may be evolving markets and operations to the needs of the new system, for example, a system with a high penetration of intermittent generation, advanced load control, and other advances.

In the future, is a capacity market needed? As an alternative, a joint energy-reserve market[18] could be developed. Currently, energy market revenues are meant to cover a generator's short-run costs, with net energy market revenues and capacity market revenues supporting long-run costs. This same relationship could be true in a joint energy-reserve market, where energy market revenues cover short-run variable generator costs and net energy market revenues plus net reserve revenues cover long-run fixed costs.

What are the implications of a future with more intermittent renewables? Some assert renewable energy resources will earn reduced energy market revenues as energy market prices lower due to greater reliance on low marginal cost resources (i.e. more renewables). As a result of this, and because renewables have a high proportion of upfront fixed costs compared to variable costs, these resources may become more dependent on the capacity market for revenue adequacy in the future. One can imagine energy prices clearing near zero in the long term, consistent with the variable cost structure of renewable energy. This leads to revenue adequacy being achieved through the capacity market.

How will grid bypass impact the markets? As large energy use (and to a lesser extent residential) consumers invest in self-generation, for environmental or other reasons, how will this impact the wholesale markets?

Energy Market

Electricity is becoming a more heterogeneous good. Electricity was initially thought to be a homogeneous good, but more and more it is looking like this is not the case. Consumers are increasingly valuing "greener" energy. In addition, the evolving resource mix has greater differentiation in operational profiles. While actual electrons are homogenous, electricity production may be heterogeneous. Power markets deal with both these homogenous and heterogeneous aspects of electricity.

As renewable energy increases, is the energy-only market viable? Proponents of an energy-only market structure argue it can be viable by consistently

[18] PJM current has reserve markets (e.g. day ahead reserve, sync reserve). The general concept of a joint energy-reserve market is a system where there is a single energy market price that reflects a price for energy and a price for reserves. This is accomplished by implementing an operational reserve demand curve that reflects demand for energy, plus an additional increment of demand associated with a minimum contingency reserve. This is typically presented as a potential alternative to the capacity market, and relies upon scarcity pricing for financial incentives.

implementing an operating reserve demand curve,[19] which becomes the main source of revenue. These proponents suggest that when the system gets tight, scarcity prices would kick in and revenues would increase. However, prices will be more volatile and accurate LMP and transmission constraint pricing becomes more important. Scarcity pricing is key, although in practice it is difficult to implement. The Electric Reliability Council of Texas (ERCOT) has introduced a model of scarcity pricing, which still has issues to solve.[20] Some question how scarcity pricing will work in oversupply conditions. It is expected that low prices will force units to retire and a new equilibrium will be reached, eventually triggering sufficient scarcity, and increasing prices that could support the revenue needs of the remaining generators. However, some argue the role of the capacity market becomes more important as renewable energy penetration increases (i.e. energy market revenues decrease), and also maintain the capacity market and energy market scarcity pricing can coexist.

Are scarcity pricing and price volatility politically possible? An energy market only approach, with scarcity pricing, has been discussed as an alternative to the capacity market. But, consumers hate the kind of price volatility that would occur with scarcity pricing. Wouldn't this be hard to implement? In theory, you have an operating reserve demand curve and demand participation. As reserves decrease, prices go up. However, in theory, the increase would be gradual, but under stress the prices could go up very quickly. In Texas, policymakers did not want a capacity market, instead they wanted to allow generators to increase offer caps on bids when the system got tight. This would produce higher prices, but could also create market power problems as generators could withhold supply for higher bids. Instead, Texas implemented an operating reserve demand curve that increases prices automatically when the system gets tight, producing high prices independent of generator bids. Also, instead of a 1 day in 10-year loss of load reliability requirement, Texas has a reliability report. Overall, this system has worked so far, but it has not yet been stressed with tight supply conditions.

In a zero marginal cost world, is scarcity pricing the only economic driver? Scarcity pricing, energy LMP reforms, and a capacity market may all be needed as the system moves towards a renewable energy world. On the other hand, if scarcity pricing is sufficient on its own, then capacity markets will shrink and eventually be phased out. Many new pricing elements may be needed as the system evolves. Some believe scarcity pricing is needed no matter what. Some assert scarcity prices may need to be implemented first, then see what changes to the capacity market are warranted.

As renewables increase, what will happen to LMP? Traditional competitive markets have created an operational and investment system based on marginal costs via LMP. However, renewable energy has zero marginal cost in the energy market and therefore LMP-based price signals for investment will erode as penetration of renewables increase. The problem is not renewable energy; the problem is pricing. The traditional pricing approach based on the cost of fuel times a heat rate to build a merit order and dispatch stack may not work in the zero to low marginal cost world we are moving towards. What does the new pricing approach look like? Should LMP still be the centerpiece? What new grid services will be needed to meet future operational needs (e.g. flexibility, ramping)?

Is the renewable energy portfolio policy a path forward? This could increase price transparency. Multiple states could work to develop attribute prices consistent throughout the region that would be deemed just and reasonable. So, if an individual state wants to give different prices to a preferred unit, they would not be permitted to do so. In New York, this idea was rejected. However, if FERC re-established jurisdiction over renewable energy credits (RECs) this would take the authority out of the state's hands.[21] Some believe the new FERC leadership may have a different view on REC jurisdiction, compared to past decisions.

[19] An operating reserve demand curve could be used in a joint energy-reserve market and would reflect demand for energy plus an additional increment of demand associated with a minimum contingency reserve. This would reflect immediate reliability conditions and would be used to establish scarcity pricing on a short-term basis.

[20] More information about ERCOT can be found at http://www.ercot.com

[21] In 2012, FERC issued a letter saying it does not have jurisdiction over unbundled trading of RECs (i.e. those REC contracts that do not have an energy sales component), but maintained jurisdiction over REC transactions when bundled with energy sales.? A copy of this WSPP Inc. order dated April 20, 2012 can be found on FERC's website at https://elibrary.ferc.gov/idmws/common/OpenNat.asp?fileID=12956202

POLITICS AND PRACTICE

Additional issues were discussed related to political and practical realities.

Who determines if subsidies and markets can't efficiently co-exist? There are limitations on the ability of markets to "take" state policy and remain effective. There may be a point where market design cannot correct for the impacts of state policy while still delivering effective outcomes. Someone, perhaps FERC, has to be "calling balls and strikes".

Regulators and others get nervous about markets. They wonder if the markets deliver and can be trusted. However, market failures and externalities impact market performance. Currently, in PJM prices are low and there is an abundance of capacity, there are no reliability concerns. The concerns are mostly political.

Markets are working, losers not accepting results. The markets have delivered all of the intended benefits initially sought. Only now, the losers in the market are unhappy and not accepting the results. Meanwhile, consumers are better off with competition. States should be convinced not to act on behalf of losers and against customers. In traditional cost-of-service regulation there are many protections against a generator's risk of loss. In a market environment there are winners and losers.

Why and when to defend markets. If market price is accurate and not enough to cover existing assets, let them go. New technologies are coming in; costs are coming down. Why protect existing units?

ONGOING RESEARCH AGENDA

One of the goals of the workshop was to identify important research topics and questions valuable to explore as key inputs into the ongoing discourse about the short and long term needs of competitive markets. The following topics were identified:

Subsidies

- What subsidies have material impacts on the markets and what subsidies have immaterial or de minimis impacts?

Carbon Pricing or Adders

- What is an effective method to implement a carbon border adjustment among states in PJM?
- What would be the critical mass of states to join a carbon pricing mechanism?
- For policies like carbon adders, what is the impact on markets and other effective programs (e.g. renewable energy credits and portfolio standards) when subsidies are awarded to specific units or technologies in absence of competition?
- Explore the benefits and drawbacks of different uses of funds for the carbon adder.
- How would a renewable portfolio standard act as a carbon adder?
- Can a border adjustment mechanism be implemented from something like a negative financial transmission rights approach?

Two-Tiered Capacity Pricing

- How would the capacity pro-rationing mechanism in the two-tiered capacity pricing proposal work?

Future of Capacity and Energy Markets

- How much can we rely on demand response to provide capacity to these markets? Many large energy use customers may have already exploited their demand response potential. It remains to be seen how much demand response is available from the residential sector.
- Does elasticity in the capacity market all of a sudden become completely inelastic because everyone begins operating outside of the market (e.g. through contracts and subsidies)? What are the associated costs? Is this a theoretical future created for political messaging, or is this a probable outcome?
- Perform an evaluation of wind and solar performance during reliability assessment hours to determine potential penalty liability or bonus value under capacity performance rules.
- Is a capacity market really needed? Analysis is needed to determine comparative effectiveness of other strategies (e.g. energy market with scarcity pricing and an operational reserve) to ensure resource adequacy through markets?
- Is a single cost for capacity everyday per year appropriate? Would a seasonal capacity product be more cost effective and still provide the required reliability?
- Is scarcity pricing with an operational reserve demand curve a viable or better alternative to securing revenue adequacy, compared to current plans to revise LMP?
- What does the future system look like and what will be the needs of the new system? What are the best market design mechanisms to meet the needs of the future system?
- Fuel diversity and resilience are the nomenclature of the day to express perceptions about what the current system lacks. Is this true, and if so, what market mechanisms are best to meet these needs?
- Have we accurately defined well enough what is needed to properly operate the current and future system? Have we properly defined the products and services needed?
- Would an energy-only market with scarcity pricing address the concerns of existing resources that are seeking subsidies (i.e. existing nuclear plants)?

APPENDIX A: CARBON PRICING

The following carbon pricing proposal description reflects the opinion of the proposer and does not reflect a variety of participant perspectives.

States are pursuing a range of environmental policies that ultimately seek to directly or indirectly reduce carbon emissions, for example:

- Carbon pricing in California and in the Regional Greenhouse Gas Initiative (RGGI)
- Renewable Procurement
- Zero Emission Credits (ZECs) for nuclear

Outside of the limited carbon pricing in place today from RGGI, wholesale markets in the Eastern Regional Transmission Organizations (RTOs) do not incorporate the carbon pollution externality that these state programs target. Because of this, states provide the needed compensation through other avenues like RECs, ZECs, and long-term contracts. While the purpose of these programs is environmental, they have a ripple effect on wholesale markets, energy markets in particular, which is driving concerns about the long-term viability of these markets.

When faced with an unpriced externality that stakeholders nonetheless value, the simplest, most efficient solution is to directly price the externality in markets. In this case that solution is a price on carbon directly incorporated into RTO energy markets.

A properly set carbon price is the most efficient and comprehensive solution because it:

- Directly prices the currently unpriced externality that states value
- Is technological-neutral and non-discriminatory
- Incents all types of electricity-sector carbon reduction. Not just building/retention of zero-carbon resource, such as re-dispatch, demand-side measures and properly deployed and sited storage
- Removes the need for complex schemes to "fix" the impact of state-supported resources on capacity on energy markets
- Does not lead to negative energy bidding or similar distortions

State environmental policies targeting specific zero-carbon generation are significant already and will grow substantially, leading to erosion energy market prices and potential retirement for other zero carbon generation not specifically targeted by state policies. This can ultimately lead to extremely counter-productive results, as in Germany. There, the failure to consistently price the carbon externality has resulted in extraordinarily high prices for consumers with little progress made on reducing emissions.

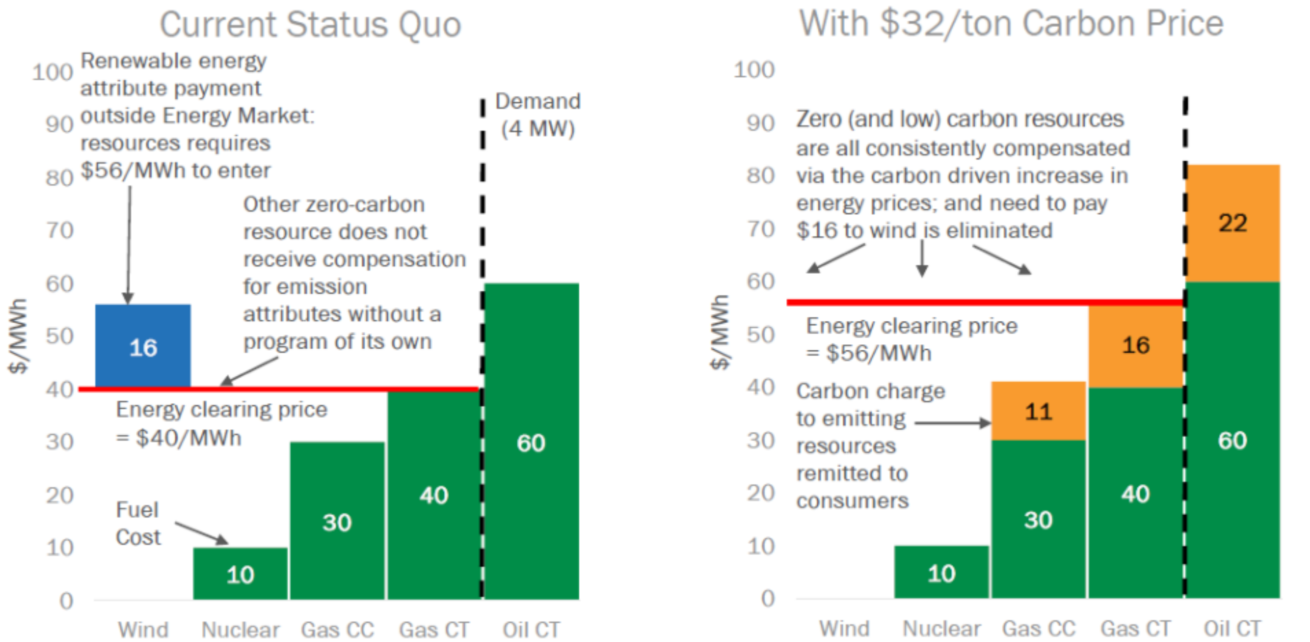
A carbon price integrated into energy markets internalizes the carbon pollution externality and places all zero / low carbon generation on equal footing.

How It Works:

PJM could facilitate a regional or sub-regional solution carbon pricing mechanism by incorporating a carbon price into energy market dispatch via a resource-specific, energy bid adder for carbon emitting resources. The bid adder would be calculated as the price per ton of carbon emissions (for example, equal to the social cost of carbon estimated by the Federal Government) multiplied by the amount of carbon emissions of each generating unit. The market would clear at a price equal to the marginal costs of the last generating unit plus the adder. Emitting units would give back to PJM the revenues related to the adder. Those revenues would then be rebated to customers.

Not all zero-carbon resources are equal in terms of their carbon abatement. Depending on the production profile of the existing supply stack, there may be significant differences. A carbon price correctly values these differences, while existing resource-specific compensation schemes like renewable energy credits typically do not.

"Accommodate" proposals, such as existing Minimum Offer Price Rules, and various proposed enhancements by the RTOs and others typically seek to reverse the price impact of state-supported resources on capacity markets by re-pricing their capacity bid at a "competitive proxy" price that removes the impact of "subsidies" from the bid.



	Gross Margin (Excluding Capacity):				
	Energy	Attribute	Carbon	Fuel	Total
Wind	40	16	0	0	56
Nuclear	40	0	0	(10)	30
Gas CC	40	0	0	(30)	10
Gas CT	40	0	0	(40)	0

	Gross Margin (Excluding Capacity):				
	Energy	Attribute	Carbon	Fuel	Total
Wind	56	0	0	0	56
Nuclear	56	0	0	(10)	46
Gas CC	56	0	(11)	(30)	15
Gas CT	56	0	(16)	(40)	0

Figure 1: *Chart of Energy Market Carbon Pricing Proposal (including gross energy market margins tables)*

If state environmental programs targeting carbon are fully internalized into markets, "accommodate" measures should be irrelevant except to the extent states take additional actions to select and compensate preferred resources outside the wholesale markets.

- Value of carbon emission attribute will be fully reflected in energy market and incorporated into the capacity market bid, with no secondary emission attribute payment needed.
- "Accommodate" measures may still be needed for generators that are supported by states for other reasons, such as pure price suppression.

State programs that seek to replicate market internalization of a carbon price via a carbon attribute payment should be treated in a manner consistent with a market that has fully internalized the carbon externality (i.e. the carbon payment is considered an in-market revenue stream).

- REC and ZEC programs effectively pay a zero-carbon attribute payment to replicate carbon-pricing economics for zero-carbon resources in the absence, today, of a carbon price.
- If set at or below the Social Cost of Carbon, these attribute payments enhance economic efficiency by reducing emissions at a cost at or below the value society places on emission reduction.
- Therefore, for the purposes of setting a "competitive proxy" price in the context of a Minimum Offer Price Rule or similar, this attribute payment should be considered an in-market revenue stream, no different than energy, and thus should reduce the competitive proxy price for affected resources making them highly likely to clear the capacity market despite application of the MOPR.

With or without a carbon price, reflecting the value of the carbon emission attribute in zero-carbon resource's capacity bids appropriately reflects their higher level of competitiveness in a carbon-constrained world. In such a world it is appropriate and indeed economically efficient that these resources displace and ultimately drive the retirement of higher emitting resources without any artificial increase in capacity price.

Regional Basis and Carbon Adjustment:

The most economically efficient way to implement a carbon price is to implement it across the broadest region possible, ideally an entire RTO or even across multiple RTOs. A significant complicating factor, however, is that many RTOs have a large number of participating states with diverse environmental goals and views on carbon. Implementing a carbon price across a diverse RTO like PJM may be politically impossible.

Given the political difficulties, a sub-regional carbon price whereby a subset of like-minded states within an RTO voluntarily join together and agree to allow the RTO to implement a carbon price for their collective sub-region provides a potentially politically-viable approach. However, without border adjustments this approach does have shortcomings:

- Relatively ineffective at reducing carbon emission due to "leakage" of emission to non-carbon states, and
- Electricity price impact of carbon is spread widely over RTO, without regard to carbon/non-carbon borders, with the result that the carbon price impact to electricity prices is too low within the carbon states, and too high in the non-carbon states.

The border adjustment between the carbon and non-carbon states within a RTO makes the impact of the carbon price more efficient, effective at meeting the goals of carbon states, and more fair for customers in neighboring non-carbon states. In particular, relative to a regional carbon price with no border adjustments, it will:

- Reduce carbon emissions leakage.
- Drive more energy price separation between non-carbon and carbon regions, providing a fairer outcome for customers in both regions.
- Provide a stronger carbon price signal for zero and low carbon emissions within the carbon region.

APPENDIX B: EXPANDING THE MINIMUM OFFER PRICE RULE (MOPR)

The following MOPR proposal description reflects the opinion of the proposer and does not reflect a variety of participant perspectives.

The MOPR was developed to protect the formation of competitive prices in the market, in the face of exogenous policy influences. The most recent iteration of the MOPR was developed after New Jersey and Maryland, perceiving reliability concerns and seeking to reduce costs to local load, entered into long-term, above-market price contracts to develop gas-fired power plants in particular locations within their states.

As a result of these subsidies, significant capacity market price suppression was projected from just these few thousand megawatts of subsidized capacity. The proposed solution was to require these (and other new) subsidized resources to bid no less than their actual costs into the market. Unit-specific costs for 20-30 units were reviewed to develop proxy MOPR costs, which proved to be a controversial endeavor. As a result of these and other controversies, three key exemptions from the MOPR were developed, including:

- Cost-of-service based unit exemption – including those owned by vertically integrated utilities, municipalities and cooperatives, as long as your net supply position is relatively equal to your net load obligation.
- Competitive entry test exemption – applicable for those using private capital without subsidies or long-term contracts and not relying on out of market support. This has led to about 100 or so requests that have all been granted.
- Unit-specific cost exemption – This allows resources to request an alternative minimum offer price based on a detailed review of their project-specific costs and revenues.

There have been many exemptions, making the process bulky. However, the MOPR policy has generally resulted in helping deliver the right incentives (i.e. avoiding suppression from subsidies). Another market design mechanism is the fixed resource requirement (FRR), which basically allows entire utility areas that manage reliability needs to operate outside of the capacity market (but allows them to buy additional capacity, if needed). In addition, bi-lateral arrangements are consistent with and are ubiquitous in the capacity market.

As states implement subsidies for existing units that are economically distressed, expansion of the MOPR from new units to also covering existing units has been proposed as a market design strategy to avoid price suppression. The expanded MOPR is modeled on the existing MOPR, with the same exemptions and flexibility. The goal is to protect formation of competitive prices. The principle is that states have choices and rights, but FERC also has responsibilities.

Specifically, states can choose to implement programs with taxpayer or ratepayer money, but FERC is required to act if those actions impact wholesale markets. The expanded MOPR provides the flexibility for states to implement subsidies - while also protecting the integrity of the markets – by correcting for subsidy effects through minimum price floors. For states, the downside is this policy increases the state's subsidy cost by correcting for market price suppression. Therefore, the total subsidy cost is the direct cost of the capacity subsidy, plus the capacity market cost for the resource.

Implementation of the expanded MOPR would start with understanding what is a competitive offer for an existing resource, which is made a bit more straightforward after the transition to capacity performance design. In general, a competitive offer would be the net cost of new entry (net cone), which represents the gross cost of new entry minus the net revenues expected from the unit. However, there are several assumptions and variables that impact net cone, including but not limited to: unit performance during times of high demand (i.e. performance assessment hours), bonus rate, and penalty rate. These variables make it possible to deliver a unit-specific cost below net cone.

However, there has to be a hard floor established. This floor could be net avoidable cost rate (ACR) which is net revenues from the market minus annual out-of-pocket expenses, and accounting for any non-performance charges. The math supporting the MOPR calculations were acknowledged to be involved but feasible and supported by the ACR floor backstop. Gaming is still possible. For example, sellers with large portfolios can swap units around to manipulate the impacts of the MOPR.

As a tool built for the capacity market, the MOPR may not be appropriate for correcting the impacts of renewable portfolio standards (RPS), the subsidy effects of which are primarily an energy market issue. For renewables and the capacity market, the issue may be determining the impact of intermittent renewables during performance assessment hours, given that the opportunity cost for not being a capacity performance resource is the bonus payment (or ability to respond during assessment hours). In addition, intermittent renewable resources have a very small effective amount of capacity compared to their nameplate capacity. Lastly, the ACR of renewables is likely to be negative, eliminating the logic of the MOPR's absolute price floor.

However, others disagree that the MOPR is inappropriate for correcting impacts of RPS subsidies, noting the relationship between energy and capacity markets. Specifically, if a subsidy (i.e. RPS) impacting the energy market results in capacity investment that may not have otherwise occurred, there is a clear impact on the capacity market and MOPR should be a tool available for consideration. These stakeholders dispute the notion that renewables have negative ACRs, stating that if this were the case, the resources would be economic without subsidies.

MOPR is not a panacea, but it is a useful tool in addressing subsidized capacity. In addition to the above discussion, there are other forms of subsidies that are meaningful. For example, subsidized transmission or pipelines significantly lower the costs of new generation, but are not accounted for in the MOPR. The ideal solution would be to avoid subsidies in general. This could be done by the states doing a better job of being discipline in defining their goals and working together with other PJM states to determine the most efficient way to achieve those goals on a region-wide basis.

APPENDIX C: TWO-TIERED CAPACITY PRICING

The following two-tiered capacity pricing proposal description reflects the opinion of the proposer and does not reflect a variety of participant perspectives.

As subsidized resources enter the market, the supply curve shifts to the right. This lowers the market clearing price and increases the overall quantity procured. States object to the MOPR because it prevents the supply curve from shifting right; therefore, states pay a subsidy cost but do not get the benefits of the lower market clearing price and/or the subsidized resource may fail to secure a capacity obligation. However, in the short-term, failure to correct for the effects of the subsidy risks harming other market participants who rely solely on markets for compensation. In the long-term, failure to correct for subsidies threatens the viability of competitive markets in general and may force a return to regulated generation.

The rationale behind the two-tiered capacity pricing proposal is to allow state-subsidized resources to participate while preserving market signals to incent capacity investments. There are a variety of two-tiered capacity proposals, but the basic concept is the capacity auction occurs in two-phases. Below are several approaches to the two-tiered capacity pricing proposal. Key differences include the price subsidized resources are paid through the auction, and treatment of infra-marginal resources.

Option A:

Step One: "Competitive Price" Auction. All resources, including subsidized resources, would be subject to offer price mitigation (i.e. MOPR or other price floor). The auction would be run to determine a quantity (q1) and mitigated price (p1) for capacity resources, that is a proxy for a competitive market price. This auction determines the price that unsubsidized resources with capacity obligations would be paid.

Step Two: "Out-of-Market Price" Auction. All resources receiving subsidies, including those that did not clear the first auction, would be entered back into the auction as price takers, pushing the supply curve to the right. The auction is run and delivers a lower clearing price (p2) for a greater quantity of resources (q2). This price is what will be paid to subsidized resources with capacity obligations. However, given the insertion of low-cost supply, some "infra-marginal" resources (e, f & g) that cleared the first auction will not clear the second auction.

Infra-marginal Treatment. The last step would be to adjust for the infra-marginal resources. This is done by reducing the capacity obligation for all resources cleared in steps one and two (see red line), in order to allow the infra-marginal resources to secure some level of capacity obligation while not exceeding the price determined in step one. While this would reduce compensation for units (by reducing capacity obligations), it also may provide more headroom to hedge against performance penalties.

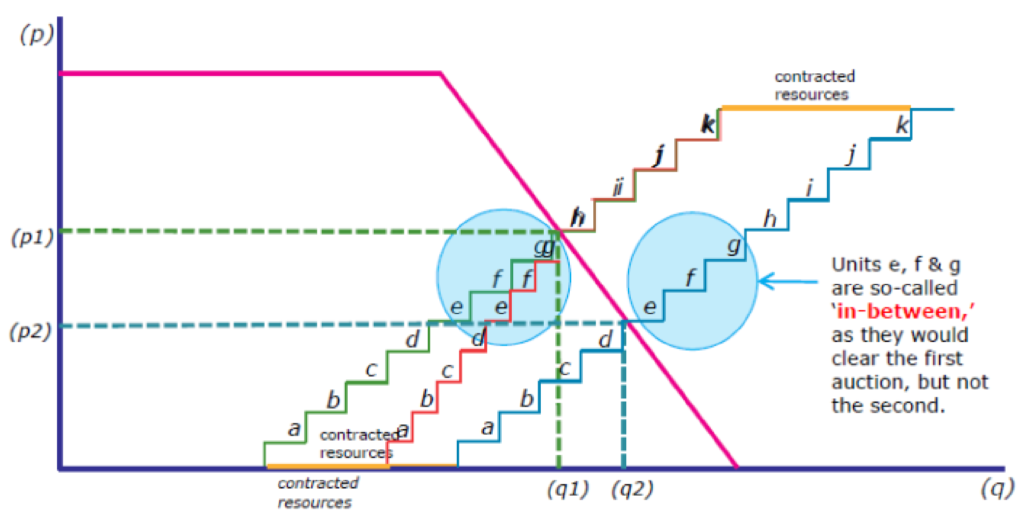


Figure 2: *Option A - Two-Tiered Capacity Pricing Proposal*

Option B:

Step One: "Quantity" Auction. In the first auction, subsidized resources and corresponding load would be removed before running the auction to determine a cleared capacity quantity. Subsidized resources would not receive capacity commitments and the subsidizing entity would be responsible for providing full compensation. This means the choice for states is either do not subsidize resources, or fully compensate resources. There is no incremental subsidization.

Step Two: "Price" Auction. The second auction would reinsert subsidized resources at mitigated prices (i.e. MOPR or other price floor) and the associated demand, and the auction would be run to determine the capacity price.

Infra-Marginal Treatment. Infra-marginal resources that offered below the price in stage two, but did not clear in stage one, would not receive a capacity payment. This means economic units would be pushed out of the market.

Option C:

Step One: "Quantity and Suppressed Price" Auction. The first auction would include subsidized resources without price mitigation, to establish a suppressed price and identify resources that will receive capacity obligations.

Step Two: "Competitive Price" Auction. The second auction would replace subsidized resource offers with mitigated prices (i.e. MOPR or other price floor) and would run the auction to determine a competitive clearing price. PJM would pay all supply (and charge demand) the competitive price, unless states request certain units be paid (and demand charged) the suppressed price.

Infra-Marginal Treatment. Resources that offer above the suppressed price, but below the competitive price would be considered economic. However, only resources that cleared the first auction will be awarded capacity obligations.

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The authors wishes to acknowledge helpful comments from Dr. James R. Hines, who reviewed an earlier draft. Any remaining errors are the responsibility of the author alone.