

Initial Comments on SPP's Draft Ramp Product Report

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August 30, 2018

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We have been engaged by Golden Spread Electric Cooperative, Inc. (GSEC) to contribute comments and analyses to the on-going stakeholder process in SPP regarding the design and implementation of ramp products. Ramp products are anticipated to help with cost-effectively incorporating the increasing amount of intermittent renewable generation in the SPP footprint by helping to create transparent price formation and clear price signals to market participants.

On May 11, 2018, SPP released a draft “Ramp Product” report, which documents and quantifies some of these challenges and proposes the introduction of market-based ramp products as the preferred solution to these challenges. SPP’s analysis and conclusions are consistent with the analysis and recommendations of SPP’s Market Monitoring Unit (MMU) as presented in Chapter 3.3.1 (“Ramp Capability Product”) of the 2017 SPP State of Market (SOM) report.

As part of our effort, we have reviewed the discussion of these issues contained in SPP’s draft Ramp Product report, the most recent SOM report, and other materials from stakeholder discussions provided to us by GSEC. We also had initial discussions with staff at SPP and the MMU. As this effort unfolds, we look forward to continuing a dialog with SPP staff and the MMU, and expand discussions of this initiative to all interested SPP stakeholders.

Our comments first highlight that there is now substantial agreement between SPP operations and the MMU on the need for and benefits of a market-based solution to address SPP ramping needs. We then recommend additional analyses to characterize the ramping needs and propose for SPP’s consideration a number of “design principles” for implementing effective ramp products to address these needs. Finally, we emphasize that the efficiency of new ramp products depends on well-designed scarcity pricing and a greatly reduced reliance on existing processes such as Instantaneous Load Capacity (ILC), Reliability Unit Commitment (RUC), and Short-Term RUC (ST-RUC) that distort price formation, market and investment signals, and lead to increased out-of-market payments.

We Support the Recommendations in SPP’s Ramp Product Report and the MMU’s State of the Market Report

The SPP draft Ramp Product report addresses and quantifies the need for ramp-related market enhancements for the reliable and cost-effective operation of the SPP power system in light of the growing magnitude of intermittent resources and the associated higher net load uncertainties and ramp rates. We agree with the draft report’s assessment of this challenge and with its conclusion that:

...the intermittent nature of the system still imposes challenges due its increasing magnitude. The outcome is scarcity of certain products, which results in higher cost for members' load during these shortage periods. Addressing these uncertainties through a market mechanism allows for better managing the intermittent aspects of the system in SPP in an economical and transparent fashion.¹

The analysis and diagnosis in SPP's draft report is consistent with the analysis and conclusions provided by the MMU in Section 3.3.1 of the 2017 SOM report. The MMU concludes that “[g]iven the limitations with the current market design in preparing for both expected and unexpected ramping needs, and the growing evidence that market outcomes are increasingly affected by ramping constraints, the MMU recommends that SPP and its members develop a ramping capability product.”² We agree with this assessment made by the MMU and with the conclusions reached by SPP in the draft Ramp Product report.

The SPP draft report also discusses the problems with certain proposed alternatives to address ramping needs, including the problems with manually committing more resources to ensure that there is enough ramping capability online when needed by the system. SPP concludes that manually committing more resources “has a multitude of problems” and that such an approach “lacks transparency the participants need, it increases cost more than ramp procurement and it tends to suppress prices unjustly.”³ We agree that market-based solutions are typically more efficient in finding the least cost solution over the long-term if they are well designed. The FERC has also documented the benefits of proper price formation in the market, which we discuss later in our comments.

A market-based approach to procuring ramping reserves can significantly reduce the problems created by manual unit commitment as it would provide transparent market prices for the proposed ramp products, procure the ramp products from the least-cost units recognizing their opportunity cost, and leave market prices for energy and ancillary services consistent with the marginal costs of meeting system needs. Therefore, we agree with SPP's conclusion that “a market mechanism allows for better managing the intermittent aspects of the system in SPP in an economical and transparent fashion.”⁴ The conclusion that a market-based mechanism is more efficient than continued reliance on manual RUC processes is also shared by SPP's MMU. As stated on page 78 of the 2017 SOM report:

¹ SPP Ramp Product report, p. 1.

² State of the Market Report 2017, Southwest Power Pool Market Monitoring Unit, May 8, 2018, p. 78.

³ SPP Ramp Product report, p. 11.

⁴ SPP Ramp Product report, p. 1.

The benefits of a ramp capability product include increasing reliability through an economic signal and improving market signals. A ramp capability product can provide ramp more reliably than the current design because it is systematically procured and readily available. The MMU prefers a market-based solution over manual commitments and commitment of capacity to gain ramp.

To support these conclusions and to illustrate the challenge facing SPP, the draft Ramp Product report and the 2017 SOM quantify the challenges facing SPP due to the increased penetration of variable energy resources (VER). The SOM report shows that the variability of net load from real-time interval-to-interval increased by 10% from 2015 to 2016 and another 19% from 2016 to 2017. This increase in variability has similarly increased the ramping needs in SPP. The analytical results presented in both the draft paper and SOM report underscore the fact that this increase in ramping needs has been driven by both expected (i.e., the forecast) and unexpected (i.e., the uncertainty around that forecast) contributors of net load variability.

The *expected* contributors of net load variability are related to the fact that both load and production from VER resources is variable, but predictable to some degree as it tends to follow daily patterns and weather forecasts. Therefore, SPP can expect to need ramp up capability during the hours when load increases or wind is forecasted to subside. The *unexpected* contributors of net load variability come from forecast errors, as the variability of wind, solar intensity, and changes in load can never be estimated perfectly. These uncertainty ranges around the forecasts imply that the actual quantities of ramp-up or ramp-down requirements often exceed the expected (or forecasted) requirements.

The SPP draft report analyzes data from May 2017 through the end of April 2018, and presents the pattern and depth of real-time shortages for Operating Reserve (OR) Upward Products⁵ observed during that time period. It illustrates that short-term forecasted changes in load and forecasted reductions in VER output are the primary drivers of positive net load changes.⁶ While the fluctuation in net load is mostly due to expected (forecasted) changes, the draft Ramp Product report presents data that highlights how much expected and unexpected changes in renewable generation drive the need for ramp capability.

SPP's draft report plots the intervals containing "OR Upward Product" shortage events and price spikes against the 15 minute change in wind production and the 15 minute wind forecast error, and shows that OR Upward Product shortages events with price spikes are more frequent when the change in wind actual production is negative and the 15 minute

⁵ Operating Reserve Upward Products include Regulation Up Reserve, Spinning Reserve, and Supplemental Reserve.

⁶ SPP Ramp Product report, p. 5.

error in SPP's wind forecast is positive (i.e., there was an unexpected decline in wind generation relative to the forecast).⁷ This fact suggests that unexpected drops in wind production significantly contribute to ramp shortage events, but as the report points out, this is not the complete story as there are instances of OR Upward Product shortage events that occur even when both wind forecast errors and wind production changes from the previous interval are quite small.⁸

The analyses provided in the MMU's SOM 2017 illustrate the net load variability from interval-to-interval in the real-time market and attempts to quantify how much of that is driven by the unexpected sources of net load variability (i.e., forecast errors). The SOM presents the distribution of net load variability interval-to-interval in the real-time and shows that 13% of the intervals have net load changes in excess of 200 MW with some net load changes of over 1,000 MW.⁹

The MMU next presents data on the unexpected sources of net load variability. The data from 2017 indicate that in approximately 6% of real-time intervals (about 500 hours per year) short-term forecast errors of load were greater than 0.5%, with some intervals experiencing forecast errors of more than 1% or greater than 300 MW.¹⁰ Furthermore, the MMU presents data on the distribution of wind forecast errors, showing that during 2017 the wind forecast error was greater than 3% in about 330 hours. **This equates to an unexpected ramping need (up or down, beyond forecasted ramping needs) of about 625 MW on average during these 330 hours.**¹¹ **This forecast error demonstrates the need for additional, more tailored ramping products that should be introduced before their need grows further.**

Recommended Additional Analyses

The analyses presented in the SPP draft Ramp Product report and the MMU's SOM 2017 support the case for implementing new ramp products in the SPP Integrated Marketplace. The SPP and MMU reports also illustrate how the ramping needs in SPP today are driven by both expected and unexpected changes in the VER production and load. While the need for ramp products is clear, it will likely take additional analyses to inform the design

⁷ SPP Ramp Product report, p. 8.

⁸ SPP Ramp Product report, p. 8.

⁹ State of the Market Report 2017, Southwest Power Pool Market Monitoring Unit, May 8, 2018, pp. 74-75.

¹⁰ State of the Market Report 2017, Southwest Power Pool Market Monitoring Unit, May 8, 2018, pp. 76.

¹¹ State of the Market Report 2017, Southwest Power Pool Market Monitoring Unit, May 8, 2018, pp. 77.

of the proposed ramp products and ensure that it is tailored to meet the underlying system needs.

The draft Ramp Product report states that SPP will continue to study the drivers of OR Upward Product shortages, and will attempt to understand the degree that expected and unexpected changes in ramping needs contribute to these shortages. In addition to the analyses already being undertaken by SPP, we recommend the following edits or additions to the draft report, which include several additional analyses:

- Provide more detailed explanation of the data presented in the charts presented in the draft report, including a description of what SPP thinks are the conclusions from each chart.
- Review the information provided by the MMU in Section 3.3.1 of the SOM 2017. Provide SPP's perspective of the data presented and the conclusions drawn by the MMU and possibly include similar "expected and unexpected net load ramp" analyses in the next version of the Ramp Product report.
- Analyze how new ramp products (and related changes to the SPP market engine in conjunction with such products) may allow for SPP operators to reduce capacity committed through the ILC process (in day-ahead) and under the RUC and ST-RUC processes (during the day prior to real-time). This will illustrate one of the key potential benefits of the proposed ramp products. The ability to price and reduce manual RUCs will also add transparency to unit commitment decisions and send better price signals for new resource development.
- Better characterize the distribution and confidence intervals of expected and unexpected net load ramps at various time intervals (5-15 min, 15-30 min, 30-60 min, and 1-4 hours) to evaluate the most important timeframes for ramp products within the hourly dispatch and unit commitment resulting from clearing the day-ahead market. Analyze whether one or multiple ramp products are best able to optimally address the system's ramping needs. It would be helpful to understand how net load ramps for different timeframes (such as 5-15 minutes, 15-30 minutes, 30-60 minutes, and 1-4 hours) have changed over time. For example, the shorter timeframe ramp product may be necessary to manage ramping of the already-committed and fast-start fleet, while the longer timeframe ramp product may be needed to better manage unit commitment decisions for the remaining fleet. It may also be that different types of short- and longer-term ramping needs have been growing differently over time, which would also inform product design decisions.
- Conduct a reliability and benefit-cost analysis at various quantities of each potential ramp product in each timeframe to inform the optimal quantity and value of each product. The economic analysis would consider the reliability value of ramping products for avoiding operating reserve shortages and other

- scarcity events, the operating costs that can be avoided by more efficiently managing the fossil fleet, and possibly value certain members place on avoiding wind resource curtailments. This analysis could help determine the quantity and mix of (for example) 10-min, 30-min, 1-hour, and/or 3-hour ramping needs, as well as the substitutability of each product from a reliability and economic perspective.
- Conduct an economic analysis to estimate the marginal economic plus reliability value of maintaining ramping reserves for each quantity and each ramping product. This will inform the relevant reservation price, operating reserve demand curve, or penalty factor, below which the products should be procured (and above which it should not). Using a graduated price-quantity schedule for procuring various quantities of each ramping product can help to most effectively manage system costs and reliability needs.
 - Analyze the resulting size of out-of-market uplift payments that would need to be paid across all system resources if ramp products are introduced to confirm that energy and ancillary service prices will be more consistent with dispatch instructions. If a large quantity of uplift remains, this suggests that additional pricing reforms likely will be needed.
 - Analyze future years with significantly more wind and solar resources on the system to determine the extent to which the contemplated market enhancement will provide a durable solution set (e.g. with modest changes primarily associated with changed quantities of the same products) or whether additional reforms will be needed to manage the even higher future levels of wind generation. The quantity of additional wind and solar resources to analyze can be determined based on the amount of these resources currently in SPP's interconnection queue and under construction.

Recommended Design Principles for SPP Ramp Products

The SPP draft Ramp Product report documents the increasing challenges related to system ramping needs and making the case for market-based ramp products. It does not yet provide recommendations on how such ramp products should be designed and integrated into the existing market construct. We thus would like to recommend for SPP's and stakeholders' consideration key principles to guide the design process, some of which have already been formulated by the MMU in the 2017 SOM.

The MMU has recommended five guiding principles for the design of the ramp products, and we agree with and support these recommendations. Quoting from page 79 of the 2017 SOM report, the MMU specifically recommends that the ramp products design should include the following five features:

- **“Two products:** ramp capability up and ramp capability down.” We support this recommendation because of varying daily and seasonal conditions both the magnitude of ramp-up and ramp-down needs and the cost of providing these products will differ (and at times significantly so).
- **“Co-optimization** with energy and other products to ensure the most economical solution.” We support this recommendation as a way to achieve lowest system-wide costs while providing appropriate price signals that are consistent across the various energy and ancillary services.
- **“Opportunity cost** basis for pricing.” We agree with this principle, recognizing that providing ramping capabilities (and other services) is associated with opportunity costs that should be reflected in market prices. Some of these opportunity costs will be reflected automatically if pricing is based on co-optimizing the various system needs through the SPP market system. Other resource-specific opportunity costs (such as commitment and fuel-supply related costs) market participants should be able to reflect in their bids for energy and ancillary services.
- **“No limitations** on resource type as long as the resource can reliably provide ramp in the direction for which it is cleared.” We support this MMU recommendation as a means to reduce the cost of providing ramping capability. Resources able to provide ramping services include not only synchronized conventional generation resources with ramping capabilities, but also storage devices, demand-response resources, controllable intermittent resources (in certain circumstances) and, as we discuss in more detail below, non-spinning fast-start resources that can address ramping needs. We stress the importance of carefully considering this principle given that ancillary service products have traditionally been defined and designed in ways that inadvertently limit participation opportunities for non-traditional resources that are becoming an increasingly large share of the fleet.
- **“Consideration of both expected and unexpected** ramping needs.” While the current SPP draft Ramp Product report is focused on unexpected ramping needs, we agree with this MMU recommendation to introduce ramping products that address both expected and unexpected ramping needs. Doing so will result in more of the system’s ramping needs to be covered by market-based products, a more optimal procurement of the total ramp-up and ramp-down quantities needed during any particular period and, as a result, lower system-wide costs.

In addition to these points laid out by the MMU, we recommend that SPP consider the following additional principles. We believe these additional principles will help increase the effectiveness of the ramp products to address the operational concerns raised by SPP’s Ramp Product report, while ensuring that the ramp market functions efficiently as part of the Integrated Marketplace. In particular, we believe that the ramp products should:

- Be **procured on a day-ahead basis**, with an option for real-time adjustments.¹² Day-ahead procurement will allow the ramp market to be co-optimized with the unit commitment decisions made for resources in the day-ahead energy and existing ancillary services market. Day-ahead procurement of ramping need will also increase the number of resources able to provide ramping services. Adjusting the procurements in the real-time market will allow for an opportunity to minimize system costs based on updated system conditions.
- Be targeted to **address all intra-hour load following needs** (e.g., address the 5-60 min load following timeframe) without supplanting regulation reserves (that are used within 5 min). The primary propose of the ramp products should be to help SPP manage its ramping needs beyond the 5 minute real-time dispatch period. Since regulation reserves are specifically designed to manage the load following needs within the 5-minute real-time dispatch period, the new ramp products should help address ramping needs that exist across multiple real-time dispatch intervals. The quantity of regulation services needed to balance within each 5-minute interval may also need to increase with net load variability, but reflects a different system need (not a ramping need).
- Possibly include several **ramp products for different time horizons**. A more complete analysis of expected and unexpected ramping needs may identify distinct durations for continuous ramping capability. For example, it may be optimal to procure a certain quantity of 10 or 15-minute fast-ramp capability but a different quantity of 30 or 60 minute ramping capability. A multi-hour ramping product may be needed to effectively manage the system at the timeframe that gas combined cycle (CC) unit commitments are made. SPP would have discretion on which product to dispatch first to meet the system’s ramping needs over the multi-hour time horizon.
- **Be integrated with (or possibly replace) SPP’s existing Instantaneous Load Capacity (ILC) process**. The existing ILC process is designed to obtain the “headroom” necessary to help SPP address system needs such as the *expected* intra-hour ramping needs. It does so by allowing SPP to commit additional capacity day-ahead to cover the difference between anticipated average hourly load and the maximum within each hour. The minimum level of this ILC “headroom” thus essentially supports expected intra-hour ramping needs in each hour—although SPP operators generally procure more ILC than that the expected hourly need to cover some portion of the *unexpected* ramps and other

¹² Day-ahead procurement should not exclude the option for real-time adjustments (i.e., additional purchases of ramp products if necessary, or adjustments of which resources provide the ramp needs). As the uncertainties surrounding SPP’s ramping needs will resolve themselves moving from day-ahead to real-time, SPP may need the flexibility to adjust the day-ahead procurement of ramp products closer to the real-time.

system needs as well. We recommend that the new ramp products be used to allow for a market-price-based procurement of the ILC “headroom” needed for expected and unexpected intra-hour ramping needs. By integrating this intra-hour function of ILC into the new products SPP should be able to greatly reduce the set-aside of ILC resources, which is not priced and compensated like operating reserves, and thus distorts price formation in the energy and ancillary services markets and results in out-of-market payments. This would produce a more efficient outcome, as ramp products will be priced in the market (unlike ILC commitments).

- Enable **reduced reliance on manual RUC and ST-RUC** by SPP system operators. Well-designed ramp products should allow SPP to further reduce the frequency by which resources are manually committed out-of-market through the RUC or, as is the case for the ST-RUC process, are not integrated with market pricing. We recognize that the proposed ramp products may not be complete substitutes for the manual RUC processes, which can address reliability needs under a broader range of conditions, but well-designed ramp products should allow SPP to substantially reduce the reliance on the manual RUC process. We also hope that a well-designed ramp product could help internalize into market pricing some or all of the system needs currently addressed through ST-RUC. Doing so will allow for improved market-based, system-wide optimization of unit commitment and dispatch, provide price signals in the energy and ancillary services markets that are free of distortion, and reduce the make-whole (uplift, out-of-market) payments incurred by SPP.
- Be aligned with **proper scarcity pricing** in energy and ancillary services markets. Introduction of ramping products should greatly reduce the frequency of ramping shortage events. Nevertheless, maintaining well-designed scarcity pricing is necessary to enable market participation by all resources and provide proper performance incentive for participating resources during real-time dispatch.¹³ For example, resources providing ramping services would face real-time imbalance charges if they are not able to follow ramp-related changes in energy output based on dispatch instructions. Appropriately applying these scarcity prices will improve the overall efficiency of and resources’ performance in the new ramping products. This can also ensure that the value hierarchy of the different types of ancillary service products is reflected, as the market will fall short of the lower-value products first and maintain the higher-value products even as the system approaches scarcity conditions. We note however that, while it may be beneficial to refine SPP

¹³ To help integrate all resources, including demand-side resources, an effective scarcity pricing system should be based on the value of reliability on the demand side (i.e. through penalty factors when falling short of target quantities of ramping and other ancillary service products).

scarcity pricing methodology at some point, the introduction of a ramp product should not be contingent on simultaneously implementing any such refinements.

- Allow for the **participation of non-spinning resources** (with bid-based recovery of startup costs and minimum generation costs) as long as these resources can start up within the necessary timeframe to satisfy the specified ramping requirements (e.g., reach dispatch points within 5-10 minutes). Resources that can physically provide the ramp required by the products, regardless of whether or not they are spinning at the time the products are to be called, should be allowed to participate in the market. Allowing these resources to participate in the ramp market will likely reduce system-wide costs associated with ramping needs.
- Recognize that **ramp products and look-ahead real-time dispatch optimization are complementary**. The potential future introduction of forward looking, multi-period optimization of SPP's real-time market and market-based dispatch (such as CAISO's four and a half hour look-ahead real-time unit commitment) would effectively address only the forecast (*expected*) ramping needs during the look-ahead period. This would yield a more optimal real-time dispatch (including real-time unit commitment) and help reduce system-wide costs. It would not, however, be a substitute for ramping products, which would still be needed to address forecast errors and the associated *unexpected* ramping needs. This is borne out by the CAISO experience, for example, which employs a real-time "flexi-ramp" product¹⁴ in addition to employing look-ahead optimization in its real-time market. While we recommend that both look-ahead real-time optimization and ramping products should ultimately be added to SPP's market design, the ramping products can be and should be introduced independently of SPP's timeline for the potential pursuit of look-ahead optimization in its real-time market.
- Recognize and specifically address the extent to which **SPP differs from other markets**. In many price formation contexts (e.g., fast-start resources), FERC has acknowledged that each organized market is different, and the design of an effective ramping product is no exception. To the extent that the existing ramp products of the other RTO markets (e.g., MISO or CAISO) are used as a starting point for SPP's design, SPP and its stakeholders will need to consider the many ways in which SPP's market and the challenges faced by SPP differ from the other RTOs. For example, SPP does not utilize a multi-period look-ahead to conduct RT dispatch, which will limit SPP's ability to manage unexpected ramping needs.

¹⁴ California Independent System Operator Corp., Open Access Transmission Tariff, Effective July 1, 2018, Section 44.

Ramp Products Will Be Most Effective When Ultimately Complemented by Well-Designed Scarcity Pricing

The MMU's SOM and SPP's Ramp Product report both reach the conclusion that a market-based solution to the ramping challenges presented by increased penetration of VERs is preferable to an out-of-market solution (e.g., manually committing additional capacity). We concur with that conclusion, and the previous section lays out the recommended guiding principles for effectively establishing such a market-based solution to SPP's ramping needs. In the process of designing a market-based approach to addressing SPP's ramping needs, SPP and its members should consider how the effectiveness of ramp products are impacted by scarcity pricing design, and how certain design features can improve the performance of the ramp products and allow for less reliance on manual (out-of-market or unpriced) RUC processes to commit resources. However, as noted before, we do not recommend that the introduction of a market-based ramp product should be made contingent on the simultaneous implementation of any such refinements to scarcity pricing or other market designs.

The role and benefits of scarcity pricing have been documented by many industry stakeholders and by the FERC in multiple rulings, including the recent ruling on settlement intervals and shortage pricings in RTO markets from June 2016. In that ruling (Order No. 825), the FERC reiterates the goals of price formation in the markets, which are to:

- Maximize surplus for consumers and suppliers;
- Provide correct incentives for market participants to follow commitment and dispatch instructions, make efficient investments in facilities and equipment, and maintain reliability;
- Provide transparency so that market participants understand how prices reflect the actual marginal cost of serving load and the operational constraints of reliably operating the system; and
- Ensure that all suppliers have a chance to recover their costs.¹⁵

A well-designed scarcity pricing mechanism is consistent with all these stated goals. Moreover, the goal of providing correct incentives and transparency for all market participants is often undermined in the absence of scarcity pricing. As suggested by SPP in the Ramp Product report, out-of-market solutions to deal with shortage conditions, such as manually committing additional resources, lack transparency and suppress market prices. Therefore, these out-of-market solutions actively work against the goals of price

¹⁵ *Settlement Intervals and Shortage Pricing in Markets Operated by Regional Transmission Organizations and Independent System Operators*, Order No. 825 (Final Rule) 155 FERC ¶ 61,276 (2016), pp. 5-6.

formation established by the FERC. Due to the lack of transparency and the suppression of prices during shortage conditions, these out-of-market solutions, such as manually committing units, create negative side effects for market participants. These negative effects include:

- Suppressing prices during scarcity events can discourage resources from being available during shortage conditions. If scarcity prices are too low, there would not be a sufficiently strong incentive for market participants to ensure that all of their resources (including demand-side resources) are available during scarcity events, or available early in such an event to prevent further potential of scarcity, even though this is the time when resources have the highest value for the system.
- Market participants will bear the cost of out-of-market payments to resources that are manually committed. The uplift cost due to these payments has increased over time due to price suppression experienced during shortage conditions. If the true costs are not transparent to other market participants during the scarcity event, they will not be able to offer more economic solutions.
- The lack of transparency can undermine the effectiveness of the ancillary services markets by obscuring the true cost of serving (or possibly curtailing) load during a scarcity event. In the same manner in which manually committing units suppressed prices in the energy market, the practice will likely artificially decrease prices in the ancillary service markets.

The last point is particularly relevant for the current initiative to design ramp products for the SPP market. Without a significant reduction in ILC, RUC, and ST-RUC, the new ramp market would be inefficient at procuring ramping capability. Prices for the new ramp products would remain below the true cost of serving load under these ramping conditions, and would therefore fail to efficiently attract resources willing to offer into the market. Suppressed market prices for the new ramp products through the existing out-of-market ILC and RUC processes will also eliminate the incentives to invest in flexible capacity or demand side resources that will be ideal for providing the ramp products.

Similarly, appropriate levels of scarcity pricing provide strong incentives for market participants to follow the RTO's commitment and dispatch instructions during shortage situations, as the cost (in the form of imbalance charges) of not being able to respond could be very large under certain circumstances. Scarcity pricing provides a transparent signal that the marginal cost of serving load during shortage conditions is very high. Because scarcity pricing actively provides correct incentives and cost transparency for market participants during shortage conditions, it offers the following benefits:

- Resources will come online at the times when they are most needed and customers will be more likely to engage in economically efficient demand

response. This will minimize the length and severity of shortage conditions, reducing the amount of operating reserves that need to be procured.

- Customers will have a clear price signal to help them develop hedging strategies against real-time price volatility.
- Market participants get a transparent signal that communicates the time and location-specific value of generation or demand response resources in the market. This can help drive investment decisions to more efficient outcomes.
- Flexible resources are appropriately rewarded for the value they provide to the system. This will help potential investors properly value flexibility and will motivate more efficient investment decisions in new generation or demand side resources.
- Resource are encouraged to ensure that they are available when needs are potentially the highest. This provides the incentive to invest in improving availability, which will increase overall reliability for the system.

While the benefits of scarcity pricing have been well documented, including by the FERC itself, achieving those benefits requires that the scarcity pricing mechanism is properly designed. Shortage prices need to actually reflect the marginal cost of serving load under shortage conditions, otherwise cost transparency is lost and the correct incentives are not conveyed to market participants. Prices during shortage conditions should reflect the probability-weighted expected cost of curtailing load. This can be estimated as the probability of losing load multiplied by the value of lost load (VOLL), plus the value of avoiding other system costs that may not already be in market prices such as out-of-market payments to reliability committed units and cost that may be incurred in future intervals due to actions taken to avoid losing load in the current interval.

The introduction of ramp products complemented by a robust suite of other ancillary services products (regulation, spinning, supplement, etc.) and associated scarcity pricing will enhance the effectiveness of the ramp products. This combination will also mean fewer scarcity pricing events, as the ramp products work to alleviate ramp-related shortage conditions. Furthermore, the combination of a ramp market and scarcity pricing will reduce the need for manually committing units to address ramping needs, which will limit the out-of-market payments borne by market participants. Establishing ramp products along with the appropriate market signals conveyed by scarcity pricing will enable a wider set of resources to compete and participate to meet SPP's ramping needs, rather than non-market processes that do not typically consider demand response, storage, or other non-traditional options.

While the ramping products will reduce the number of scarcity pricing events related to ramp limitations, the rapid growth of variable resources and the uncertainty of their generation levels necessarily means that SPP real-time prices will become more volatile over time. Strong scarcity pricing can provide better price signals such that the market

can respond, new investments in generation can be made, and more information can be gleaned and applied through further optimization of the market. Any such increase in the volatility of real-time prices reflects, however, the true market fundamentals associated with the increasingly uncertain and intermittent nature of the SPP system.

Not surprisingly, SPP and its market participants are concerned about how increasing real-time market volatility may affect their cost of service. In this respect it is important to recognize that real-time volatility has very limited financial impact on the overall cost of market participation. There are several reasons for this:

- The primary trend in wholesale energy markets is a the decline of prices as more wind is integrated into the system combined with more price volatility around the lower average prices (even after accounting for brief periods of very high price spikes).
- Because the day-ahead market (generation, loads, and virtual bids) are cleared based on the forecasted average of real-time levels, the uncertainty of actual real-time market conditions is not fully reflected in day-ahead prices. While the average of day-ahead prices will be similar to the average of real-time prices (in part due to virtual bidding), the volatility of real-time prices will generally exceed the volatility of day-ahead prices.
- The vast majority of load and generation MWh are settled against day-ahead prices in the SPP market.
- Only the load and generation MWh imbalances relative to day-ahead schedules are settled in the real-time market, which means only a small portion of total load and generation MWh are exposed to real-time prices. If the MWh deviations from the day-ahead schedule are zero, exposure to real-time prices will be zero irrespective of the level or volatility of real-time market prices.
- In practice, the MWh imbalances and applicable real-time settlements net to very small amounts. While the net financial impacts of real-time imbalances may be larger for individual market participants, on an SPP-wide basis, net real-time settlements amount to only 0.05% to 1.5% of day-ahead settlements on an SPP-wide basis as summarized in the 2017 SOM report:¹⁶
 - Net real-time energy settlements for load equaled about 0.4% of day-ahead energy settlements.
 - Net real-time energy settlements for generation resources equaled about 1.5% of day-ahead energy settlements.

¹⁶ State of the Market Report 2017, Southwest Power Pool Market Monitoring Unit, May 8, 2018, pp. 108-109.

- Net real-time operating reserve¹⁷ settlements for generation resources are only 0.05% of day-ahead settlements.
- High prices driven by scarcity events typically materialize only for very short time intervals, often only encompassing one or several 5-minute real-time pricing intervals.
- The high-price-side of price volatility is likely offset by a low-price-side price volatility, such that the average real-time prices changes relatively little even as price volatility increases.
- The introduction of ramping products is expected to significantly reduce the frequency of ramp-related scarcity events, thus lowering the average of real-time energy prices.

Moreover, while the need for enhancing both ancillary services (e.g., through the introduction of ramp products) and scarcity pricing to address increased ramping relates to higher levels of VER penetration, development of additional wind and solar resources in SPP will continue to reduce the average market price of energy. Introducing stronger scarcity pricing at some point will have only a small offsetting effect on this downward trend in energy market prices for all the reasons listed above.

Recommendations

The analysis provided by SPP in the draft Ramp Product report and by the MMU in the SOM 2017 illustrates the need for ramp products in SPP. We agree with the recommendations provided by SPP and the MMU, and support SPP's initiative to design and implement market-based ramping products as the most effective option to address increasing ramp-related challenges. Through the introduction of ramp products may not be the only market reform that SPP will have to pursue, we agree with SPP and with the MMU that market-based ramp products will reduce the price distortions and out-of-market payments that are inherent in any non-market solution to the ramping problem. In combination with other market reform efforts, the introduction of market-based ramp products will contribute to the reliable and more cost-effective system operations and reduced costs for SPP's members.

The next step of this process should be further analysis to define the exact ramping products, quantities, reservation prices, and participation rules to enable all resources. As discussed in more detail earlier, we also offer the following guiding principles in support of SPP's initiative to create and implement such market-based ramp products:

- **Two products:** ramp capability up and ramp capability down;

¹⁷ This includes regulation-up, regulation-down, spinning, and supplemental reserves.

- **Co-optimization** with energy and other products to ensure the most economical solution;
- **Opportunity cost** basis for pricing;
- **No limitations** on resource type as long as the resource can reliably provide ramp in the direction for which it is cleared; and
- Consideration of both **expected and unexpected** ramping needs.
- Ramp products should be **procured on a day-ahead basis** (with real-time adjustments as necessary).
- The new ramp products **should address all intra-hour load following needs** (e.g., 5-60 min) without supplanting regulation reserves, which are used for system balancing within the 5 minute real-time dispatch interval.
- Possibly include several **ramp products for different time horizons**
- **Be integrated with SPP's existing Instantaneous Load Capacity (ILC) process** to reduce the need to utilize ILC procurement to solve intra-hour ramping needs.
- Enable **reduced reliance on manual RUC and ST-RUC** by SPP system operators for meet SPP ramping needs.
- Be aligned with **proper scarcity pricing** in energy and ancillary services markets.
- Allow for the **participation of non-spinning quick start resources** in the new ramp markets as long as these resources can start up within the necessary timeframe (e.g., 5-10 minutes).
- Recognize that **ramp products will be necessary even with look-ahead real-time dispatch optimization**, if ultimately implemented by SPP.
- To the extent ramp product designs currently used in other markets will serve as a basis for the SPP products, ensure that the SPP design recognizes how **SPP differs from other markets**.

We look forward to hearing feedback from SPP staff, the MMU, and stakeholders as we continuing to work with them in this initiative.

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