SPP Southwest Power Pool

ELECTRIC STORAGE RESOURCES

WHITE PAPER

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EXECUTIVE SUMMARY

Since the inception of the electric industry, utilities have operated under the paradigm that energy must be consumed when it is produced. The recent expansion of electric storage resource (ESR) technology[1] is changing that paradigm, bringing impactful and far-reaching changes to operational, transmission, distribution and resource adequacy processes.

ESRs could provide significant benefits to the Southwest Power Pool, Inc. (SPP) region. ESRs can serve as an alternative to traditional transmission facilities to resolve short-term reliability issues such as voltage support and congestion. If ESRs can support the reliability of the transmission grid, the region may be able to avoid costly transmission upgrades. Storage, when co-located with low-cost generation, can provide an economic energy source for dispatch in SPP's Integrated Marketplace. Another ESR benefit is its ability to respond instantaneously to grid events and to help balance supply and demand.

The decrease in costs to build ESRs, coupled with recent tax law changes favorable to ESRs, have significantly increased requests to interconnect ESR resources to the transmission grid. In late 2017, SPP's generator interconnection queue contained less than 1 GW of ESRs. By mid-2019, ESR requests had expanded to nearly 7 GW.

Storage is a flexible resource. It cannot supply new energy; instead, it allows for a temporal gap between the generation of electrons and their consumption. A single ESR has the ability to both inject energy into the grid and to receive and store energy from the grid. Energy can be received from the transmission grid, from generation located at the same site as the ESR, or from a distribution system. ESRs also have the potential to serve as a transmission facility.

SPP's current Open Access Transmission Tariff (tariff) and business practices do not address some of the unique aspects of ESRs that may require clarification. SPP has a number of initiatives under way to address the integration of ESRs into SPP's markets, planning and operations.

In July 2019, the SPP board of directors approved a recommendation from the Holistic Integrated Tariff Team for SPP to draft a whitepaper to help the organization understand ESRs, their expected role and impact, and how SPP can effectively plan for and utilize this technology moving forward.

[1] Order 841 defines storage as a resource capable of receiving electric energy from the grid and storing it for later injection of electric energy back to the grid.

The authors of this whitepaper identified four over-arching goals for SPP:

1. Capitalize on ESRs' flexibility for acting as both generation and transmission.
2. Maximize ESRs' potential for ensuring reliable and cost-effective energy delivery.
3. Develop cost-recovery mechanisms for ESRs used as either transmission or generation, or as both.
4. Create procedures and tariff language to resolve reliability and operational issues that arise when ESRs are used as generation and/or transmission.

This paper identifies a number of initial ESR issues that need to be resolved. Many, if not most, of these issues must be resolved in concert with each other, requiring efforts across working groups. For example, the technical requirements to analyze ESRs as transmission facilities and the cost-recovery mechanism for ESRs would most efficiently be resolved together.

SPP organizational groups that will be directly involved in considering ESR issues include the Cost Allocation Working Group (CAWG), Market Working Group (MWG), Operating Reliability Working Group (ORWG), Regional Tariff Working Group (RTWG), Supply Adequacy Working Group (SAWG) and the Transmission Working Group (TWG).

The Strategic Planning Committee should recommend to the board the extent and timing of SPP's support for multi-use ESRs; specifically, ESRs used as both transmission and energy/capacity.

The following issues are categorized as technical, cost allocation or other issues. Technical issues must be resolved to incorporate ESRs in SPP's short- and long-term processes and operations. Cost allocation must be resolved to use ESRs as transmission, including the impact of ESRs also used for energy or capacity. Other considerations capture miscellaneous issues.

TRANSMISSION ONLY

Technical issue
Cost allocation issue
Other issue

Tx1. Reconcile ESR duration with transmission planning scenario

Tx2. Document primary transmission use of ESRs

Tx3. Reconcile lifespans of ESRs and other transmission facilities

Tx4. Reconcile ESR cost-recovery policies

Tx5. Develop policy for ESR costs in annual transmission revenue requirement

Tx6. Decide if SPP invoices energy costs for ESR transmission facilities

Tx7. Decide whether to require and invoice transmission service for ESR transmission facilities

Tx8. Determine responsibility for charging ESR transmission facilities

Tx9. Develop market power procedures for ESR transmission facilities

TRANSMISSION AND ENERGY

Tx10. Develop procedures for ESRs used as energy and transmission

Tx11. Coordinate interconnection and transmission planning studies

Tx12. Determine policy for market revenues of ESR transmission facilities

Tx13. Develop settlement procedures for separating energy and transmission

Tx14. Determine responsibility for charging multi-use ESRs

TRANSMISSION AND CAPACITY

Tx15. Develop policy for ESRs used for capacity, energy and transmission

Tx16. Coordinate interconnection, deliverability and transmission planning studies

Tx17. Develop policy regarding upgrade costs for ESRs used for transmission and capacity

Tx18. Determine appropriateness of capacity resource cost recovery in transmission charges

Tx19. Develop procedure for identifying capacity resource costs of ESR transmission

Tx20. Develop capacity accreditation and testing

ENERGY & RELATED SERVICES

E1. Develop ESR transmission planning study process

E2. Develop process for modeling and controlling ESR hybrid configurations

E3. Study costs/benefits and develop tariff changes for fast-start ESR charging

E4. Determine limits for fast-responding ESRs

E5. Determine feasibility of regional aggregation for reserve-only ESRs

E6. Develop requirements for non-conforming load from unregistered ESRs

E7. Determine ESR qualification for essential & other reliability services

- E8 Reconcile ESR duration with reserve duration requirement
- E9. Analyze the cost/benefit of adding SPP charging control

CAPACITY FOR RESOURCE ADEQUACY

- C1. Determine ESR capacity accreditation process
- C2. Determine ESR duration and availability requirement
- C3. Determine maximum amount of ESRs allowed in resource adequacy portfolio

TARIFF ISSUES

- T1. Review tariff's variable energy resource definition
- T2. Develop tariff changes defining ESR retail vs. wholesale service
- T3. Evaluate impact of commercial mobile ESRs
- T4. Evaluate changes to market registration requirement
- T5. Recommend tariff changes for mobile retail ESRs

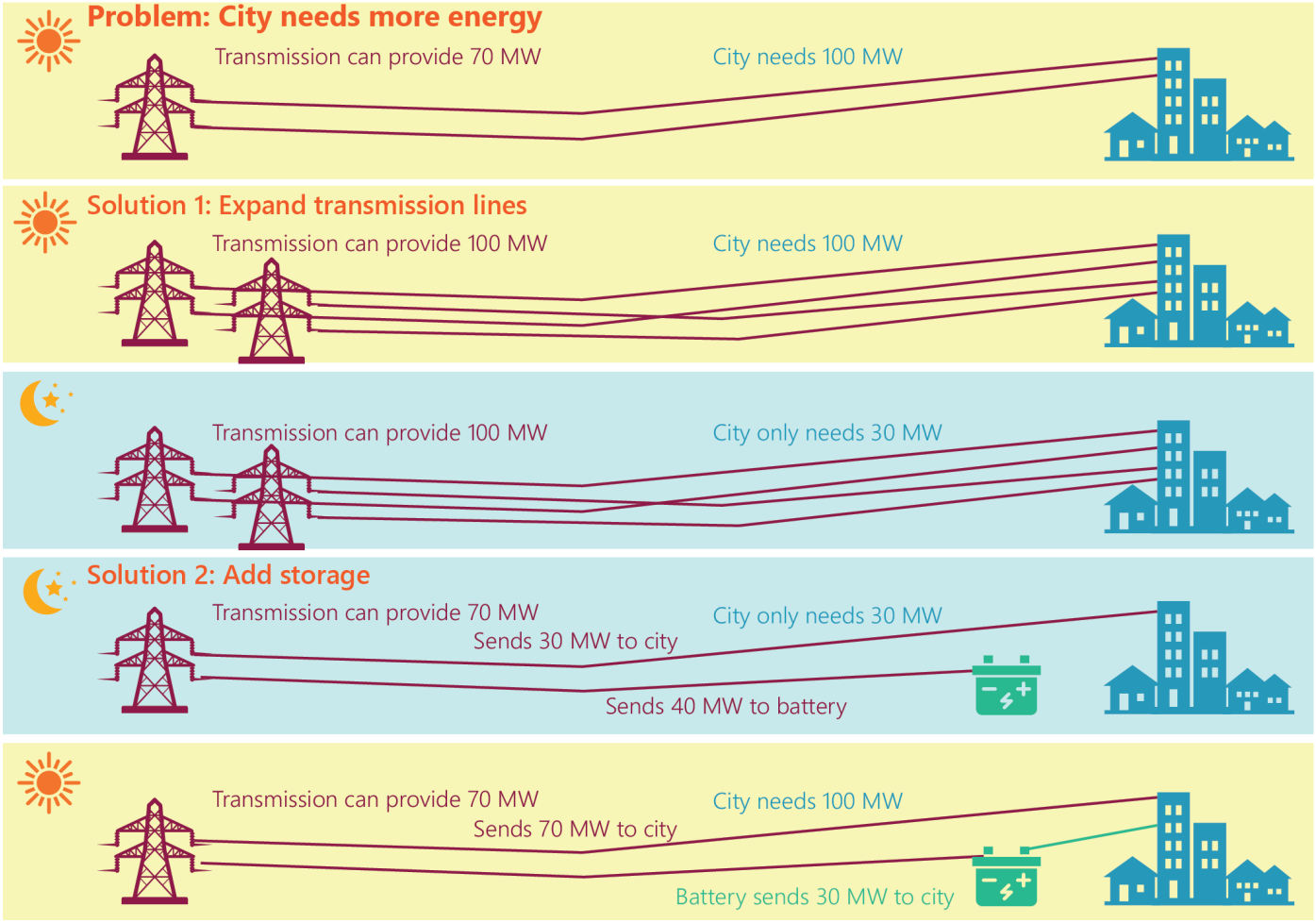
INTRODUCTION

Electric storage is a flexible resource. The same ESR can be used in wholesale and retail markets. A single ESR has the ability to inject energy into the grid and receive and store energy from the grid. ESRs can receive energy from the transmission grid, from a generator located at the same site as the ESR or from a distribution system. An ESR also has the potential to serve as a transmission facility.

ESRs allow the electric utility industry to integrate traditional transmission planning and operations activities to an extent never previously seen.

ESR IS	ESR IS NOT
Technology for storing generation for later use	Generating resource
Versatile, acting as both generation and transmission	Single-use facility
Able to increase generation and transmission efficiencies	Full substitute for generation or transmission
Functional for up to 20 years	Functional as long as other types of generation and transmission (40 years)
Able to participate in wholesale (RTO market) and retail (behind-the-meter) jurisdictions	Free. It costs money to install, some energy is lost in storage, and SPP's markets must be enhanced to realize full value.
Fixed (co-located with a generator) or mobile (e.g. electric vehicles)	
Batteries, flywheels, compressed air, pumped-hydro, electric vehicles, etc.	

The following graphic depicts an ESR's flexibility. In this example, the ESR is pulling energy from the grid and storing it for use when the city needs it. Because the ESR is able to meet demand during peak times, the need for an additional transmission line to power the city is eliminated.



This paper identifies several issues to be resolved in addressing ESRs. Many of these issues must be resolved in concert with each other and across working groups. For example, the technical requirements to analyze an ESR as transmission and an ESR cost-recovery mechanism must be resolved together.

ESRs impact three of SPP's Regional Transmission Organization (RTO) functions:

1) Transmission
2) Energy and related products
3) Capacity for resource adequacy

SPP will modify its tariff to recognize an ESRs' unique ability to simultaneously provide multiple services.

BACKGROUND

HOLISTIC INTEGRATED TARIFF TEAM

In 2018, the SPP Board of Directors and Members Committee created the Holistic Integrated Tariff Team (HITT) to comprehensively review SPP's cost allocation methodologies, transmission planning processes, Integrated Marketplace services and the interplay between planning, real-time reliability and economic operations. The board appointed 15 stakeholders to the HITT, including board members, state regulators and individuals representing SPP's diverse membership sectors. The HITT agreed on 21 high-level recommendations for the board's consideration.

One of the HITT's recommendations was for staff to draft a whitepaper on ESRs. The report stated:

> While technological changes are rapidly developing in the electric industry, energy storage – particularly batteries – is an immediate challenge and opportunity. The impact storage will have on the future is evident by the increasing amount of batteries in SPP's generation interconnection queue and the Federal Energy Regulatory Commission's (FERC) Order 845.
>
> The HITT recommends that SPP staff create a white paper on the many issues related to storage to gain a better understanding of storage and how SPP should address these issues in the future. This white paper will be delivered to the Market and Operations Policy Committee (MOPC), Regional State Committee, and Board of Directors/Members Committee in January 2020. The white paper should include tactical and strategic recommendations. In the interim, MOPC working groups will continue their efforts.

FEDERAL ENERGY REGULATORY COMMISSION ACTION

In November 2016, the Federal Energy Regulatory Commission (FERC) released a Notice of Proposed Rulemaking (NOPR) regarding ESRs and distributed energy resources. In February 2018, FERC issued Order 841 on ESRs with a compliance filing date of December 3, 2018 and an implementation date of December 2019. FERC acknowledged that all matters regarding storage were not addressed in the order and that additional filings will be necessary in the future.

The purpose of the final rule was "to remove barriers to the participation of ESR in the capacity, energy, and ancillary service markets operated by Regional Transmission Organizations (RTO) and Independent System Operators (ISO)." FERC required "each RTO and ISO to revise its tariff to establish a participation model consisting of market rules that, recognizing the physical and operational characteristics of electric storage resources, facilitates their participation in the RTO/ISO markets. The participation model must (1) ensure that a resource using the participation model is eligible to provide all capacity, energy, and ancillary services that the

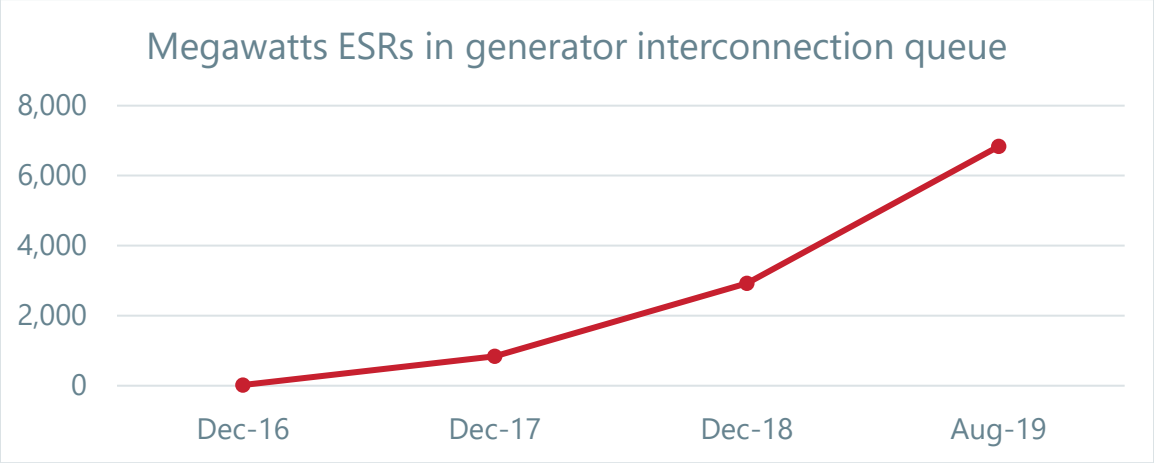
resource is technically capable of providing in the RTO/ISO markets; (2) ensure that a resource using the participation model can be dispatched and can set the wholesale market clearing price as both a wholesale seller and wholesale buyer consistent with existing market rules that govern when a resource can set the wholesale price; (3) account for the physical and operational characteristics of electric storage resources through bidding parameters or other means; and (4) establish a minimum size requirement for participation in the RTO/ISO markets that does not exceed 100 kW. Additionally, each RTO/ISO must specify that the sale of electric energy from the RTO/ISO markets to an electric storage resource that the resource then resells back to those markets must be at the wholesale locational marginal price."[2]

The final order necessitates that an ESR must be allowed to (1) self-determine charging activity[3], (2) provide all services (both market and non-market) that it can technically qualify[4] and (3) be exempt from a transmission service bill for charging because of an RTO instruction to provide a service.

FERC stated that (1) injections to the transmission system are FERC jurisdictional, (2) withdrawals from the transmission system are subject to transmission billing, (3) receiving energy from the grid for purposes of storage (charging) is not an "end-use" but rather a "sale for resale" and (4) provision of an electric service under an RTO tariff must be allowed on a non-discriminatory basis.

SPP GENERATOR INTERCONNECTION QUEUE

The decrease in costs to develop ESRs and recent tax law changes have contributed to a significant increase in requests to interconnect ESRs to the SPP transmission grid. Between December 2018 and August 2019, ESR generator interconnection requests more than doubled.



[2] FERC Order 841 summary paragraph
[3] The ESR operator can choose when and how much energy it will withdraw from the grid to store the energy.
[4] If an ESR technically qualifies to provide services under the existing tariff, it is considered to be qualified for use.

TRANSMISSION ISSUES

ESRs can serve as an alternative to traditional transmission facilities to resolve short-term reliability issues such as voltage support and congestion. If energy can be stored for reliability support, the region may be able to avoid costly transmission upgrades. Storage, when co-located with low-cost generation, can balance the desire for inexpensive energy while minimizing transmission expansion costs.

As SPP considers how to integrate ESRs into its operations and planning processes, it is reviewing how other RTOs and ISOs are preparing for this integration. Only one ISO has filed with FERC[5] regarding the use of ESRs as transmission facilities and another is developing a filing[6].

Midcontinent Independent System Operator (MISO) and California Independent System Operator (CAISO) have implemented rules related to the study of ESRs as transmission facilities. Due to the length of time to perform a transmission planning study, MISO and CAISO are implementing the proposed changes prior to FERC approval.

CAISO chose to limit the flexibility of any ESR used as a transmission alternative solution. Any such resource would be prohibited from participating in the energy and other services market; it would be reserved to address reliability concerns. CAISO is developing a process by which these resources can participate in the energy and other service market activities. MISO has similarly limited the use of ESRs chosen as alternatives to building transmission.

Transmission developers have asked SPP to evaluate ESRs as potential solutions to address identified transmission needs. During SPP's 2019 Integrated Transmission Planning (ITP) assessment's detailed project proposal window, developers submitted ESRs for review. These ESR proposals raised questions about the ITP's ability to address ESRs' unique characteristics in comparison to traditional transmission facilities. As a result, SPP stakeholders are having discussions to determine study considerations needed to properly assess ESRs as transmission facilities.

The reliability study process assesses transmission solutions against a base reliability model representing long-term firm transmission service and a market powerflow model-set. Both of these models represent a single hour of the day. The study process determines if the solution in question addresses needs identified in the study. The solution's benefits are balanced against its cost, then compared to the benefit/cost ratio of any competing solutions. Although the studied ESRs were not selected in the 2019 ITP as alternative solutions, SPP requires planning process changes to better evaluate these new technologies.

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[5] Docket ER20-588-000 for MISO

[6] http://www.caiso.com/StakeholderProcesses/Storage-as-a-transmission-asset

ESR AS TRANSMISSION ONLY

TX1. RECONCILE ESR DURATION WITH TRANSMISSION PLANNING SCENARIO

The planning scenarios used in SPP's transmission planning process are worst-case historical scenarios. Consequently, a scenario may exceed an ESR's duration. Although an ESR's duration may vary significantly, the cost-benefit analysis is impacted by both the MW rating and the duration. For example, the revenue stream for a 200 MW ESR with a four-hour duration likely would be different than revenue from an 800 MW ESR with a one-hour duration, although they are both an 800 MWh ESR.

FERC Order 841 allows an ESR to be derated in the energy market to qualify to provide a service/product. FERC has not addressed ESRs as transmission facilities.

Recommendation: The TWG and ORWG are to develop a procedure for handling an ESR transmission facility when the ESR's duration is insufficient to meet the transmission issue. The ORWG needs to accept this procedure as practical in real-time operations before using it in transmission planning cases. Examples of procedures may be to either derate transmission facilities' output to increase ESRs' duration or combine multiple ESRs to increase their duration.

TX2. DOCUMENT PRIMARY TRANSMISSION USE OF ESRS

Due to ESRs' flexibility to meet various bulk electric system needs, and the difference in revenue streams for those needs, SPP must develop clear documentation of the issues ESRs are resolving. For example, an ESR could be included in SPP's annual transmission revenue requirement (ATRR) for voltage support and would require a rebuild after ten years. At the end of ten years, an evaluation would be conducted to determine if the voltage support is still required and if it is necessary to rebuild the ESR.

Recommendation: SPP staff is to determine documentation necessary for ESRs selected as transmission assets and how to re-evaluate the continuing need for ESRs.

TX3. RECONCILE LIFESPANS OF ESRS AND OTHER TRANSMISSION FACILITIES

Although traditional transmission facilities have varying lives, SPP often uses a life of 40 years for analysis purposes. If an ESR is being considered in lieu of traditional transmission facilities, there may be additional considerations for the ESR's lifespan. For example, should the ESR be assumed in service in the 20-year study versus the 10-year study?

Recommendation: The TWG and CAWG are to develop consistent ESR assumptions for use in SPP's transmission planning studies.

TX4. RECONCILE ESR COST-RECOVERY POLICIES

SPP uses different cost allocation methods for different transmission facility voltages. The cost allocation methodology is based on transmission upgrades' operating voltages. SPP needs to determine whether cost allocation should be based on the ESR's operating voltage, the voltage of the transmission facility that needs an ESR, the voltage of the transmission facility that did not have to be constructed as a result of the ESR, or another criterion.

Recommendation: The CAWG is to review the impact of ESRs on cost allocation and recommend a policy for ESRs used as transmission solutions.

TX5. DEVELOP POLICY FOR ESR COSTS IN ATRR

Transmission owners submit ATRRs to SPP for cost recovery. Due to the significant difference in the lifespans of traditional transmission facilities and ESRs, SPP needs to develop a policy regarding the amortization of ESR costs.

Recommendation: The TWG is to develop a policy regarding the amortization of ESR costs.

TX6. DECIDE IF SPP INVOICES ENERGY COSTS FOR ESR TRANSMISSION FACILITIES

A transmission-only ESR must be charged (receive electricity) to inject. SPP must determine how charging costs will be recovered. A similar issue is how SPP treats energy losses incurred from capacitor banks; these energy losses are shared by all market participants. Should the cost of charging be explicitly settled in the SPP market? Or should charging costs be shared across the region?

Recommendation: The TWG and MWG should determine if ESR charging costs will be explicitly settled or included in energy losses and/or revenue neutrality uplift.

TX7. DECIDE WHETHER TO REQUIRE AND INVOICE TRANSMISSION SERVICE FOR ESR TRANSMISSION FACILITIES

Generally, load pays transmission service charges. ESRs are viewed as a load when charging. When an ESR is a transmission-only facility, it is operating not to provide energy but to provide reliability. It is not a "sale for resale" activity.

A transmission-only ESR is held by a transmission owner, not a market participant. SPP needs to determine if transmission owners should be billed for providing transmission service via transmission-only ESRs, and if so, allow for appropriate recovery of such costs.

Recommendation: The RTWG is to address whether a transmission-only ESR should pay for transmission service related to the charging activity.

TX8. DETERMINE RESPONSIBILITY FOR CHARGING ESR TRANSMISSION FACILITIES

To inject energy to the grid, an ESR must receive energy from the grid. Although SPP is responsible for reliability coordination, not all reliability actions are visible or actionable by SPP, such as voltage support. Generally, those actions are the transmission operator's responsibility.

Some ESRs are co-located with renewable energy resources and charge from those resources. Others, however, are sited as stand-alone units and obtain their charge from the grid. If these resources are not charged at the appropriate time, they may be unable to address the reliability needs for which they were sited.

SPP needs to determine whether SPP, transmission operators or ESR operators should be responsible for maintaining a transmission-only ESR's charge to ensure the resources are available for reliability needs.

Recommendation: The ORWG is to determine who is responsible for maintaining a transmission-only ESR's charge and submit tariff changes.

TX9. DEVELOP MARKET POWER PROCEDURES FOR ESR TRANSMISSION FACILITIES

An ESR may be used to reduce or increase congestion on the transmission system. If an ESR is used to impact congestion, such use could be seen as an exercise of market power. SPP should develop procedures for evaluating the appropriate use of an ESR for impacting congestion.

Recommendation: The SPP independent Market Monitoring Unit (MMU) should study whether market power issues arise from the use of an ESR as a transmission-only asset. If the MMU has concerns, it should work with the MWG and ORWG to develop procedures to mitigate and/or monitor these issues.

ESR AS TRANSMISSION AND ENERGY

An ESR may be initially installed for transmission-only purposes. Due to ESRs' flexibility, it may later be determined that an ESR can also provide energy and related services. Cost allocation and coordination become more complex if an ESR serves as transmission and energy.

For multi-use ESRs, the following issues are in addition to those included in the transmission-only section above. The Strategic Planning Committee should recommend to the board the extent and timing of SPP's support for multi-use ESRs; specifically, ESRs used as both transmission and energy/capacity.

TX10. DEVELOP PROCEDURES FOR ESRS USED AS ENERGY AND TRANSMISSION

For ESRs used for energy and transmission, SPP must define which purpose has priority and coordinate these two functions. For instance, energy may incidentally result from an ESR's use as a transmission facility, regardless of the energy pricing. Conversely, an ESR may need to be charged for transmission use even if market prices are high.

Recommendation: The ORWG and MWG are to develop procedures for ESRs used as both energy and transmission. They should coordinate with the CAWG, RTWG and TWG on these procedures.

TX11. COORDINATE INTERCONNECTION AND TRANSMISSION PLANNING STUDIES

SPP will study a transmission-only ESR as part of a transmission study. For an ESR to participate in the energy market, it must also have an interconnection study.

Recommendation: SPP staff is to recommend and document a process for studying ESRs as both a transmission and energy facility.

TX12. DETERMINE POLICY FOR MARKET REVENUES OF ESR TRANSMISSION FACILITIES

An ESR that is receiving revenues from both energy and transmission may be in an unfair competitive position when transmission revenues, including a rate-of-return, reduce costs of Integrated Marketplace participation. An ESR could either earn a return in excess of the allowed return for a transmission asset ("double-dip") or bid into the market at lower than its marginal cost.

Recommendation: The CAWG and MWG are to develop a policy recommendation to address an ESR's potential "double-dip" of revenues or below-cost bidding in the Integrated Marketplace.

TX13. DEVELOP SETTLEMENT PROCEDURES FOR SEPARATING ENERGY AND TRANSMISSION

When an ESR is participating as both energy and transmission, it is necessary to separate those activities and billing determinants to allow the settlement of both energy and transmission service.

Recommendation: The MWG, ORWG, RTWG and CAWG are to develop the measurement and verification processes for properly settling transmission and energy markets.

TX14. DETERMINE RESPONSIBILITY FOR CHARGING MULTI-USE ESRS

Under FERC Order 841, an ESR participating in the energy and related products market defaults to self-determination on charging decisions. If the ESR is participating as transmission-only, SPP needs to determine whether SPP, transmission operators or ESR operators should be responsible for maintaining an ESR's charge (see recommendation TX8). When an ESR is also participating as both energy and transmission, it may be necessary to determine a different charging responsibility.

Recommendation: The ORWG and MWG are to determine and submit tariff changes regarding the responsibility for maintaining charge for ESRs used as transmission and energy.

ESR AS TRANSMISSION AND RESOURCE ADEQUACY CAPACITY

An ESR may be initially installed for transmission-only purposes. Due to an ESR's flexibility, it may later be determined that the ESR can be used for capacity to meet resource adequacy requirements. If an ESR is to be used for both transmission and resource adequacy capacity, cost allocation and coordination of these two functions becomes more complex.

For multi-use ESRs, the following issues are in addition to the above recommendations. The Strategic Planning Committee should recommend to the board the extent and timing of SPP's support for multi-use ESRs; specifically, ESRs used as both transmission and energy/capacity.

TX15. DEVELOP POLICY FOR ESRS USED FOR CAPACITY, ENERGY AND TRANSMISSION

An ESR justified for transmission purposes might later be considered as capacity to meet resource adequacy obligations. Both policy and operational concerns arise over this cross-functional use. The policy concern is over the ESR's availability to provide energy when called on to perform as capacity versus the ESR's availability to provide the transmission reliability function. The operational concern is the same as that for a resource providing energy and related products: coordinating its use for energy or capacity versus transmission reliability.

Recommendation: The ORWG, MWG and SAWG are to determine whether an ESR installed for transmission reliability can also be considered capacity to meet the resource adequacy obligation. The groups should develop procedures for this cross-functional use, if appropriate.

TX16. COORDINATE INTERCONNECTION, DELIVERABILITY AND TRANSMISSION PLANNING STUDIES

SPP will study a transmission-only ESR as part of a transmission study. An ESR used as capacity to meet resource adequacy obligations must be studied for deliverability to load. For the ESR to inject and withdraw energy to perform as capacity, it must also have an interconnection study.

Recommendation: SPP staff is to recommend and document the processes by which an ESR is studied as a transmission facility, for deliverability to load and for interconnection.

TX17. DEVELOP POLICY REGARDING UPGRADE COSTS FOR ESRS USED FOR TRANSMISSION AND CAPACITY

When an ESR is studied in transmission planning to resolve a transmission reliability issue, any resulting transmission expansion is considered part of the solution. When an ESR is participating as capacity to meet a resource adequacy obligation, transmission expansion may be necessary

under the deliverability analysis to specific load. An ESR's capacity use could result in additional transmission costs when the primary purpose of the ESR is to provide transmission reliability while mitigating or reducing costs.

Recommendation: The TWG and CAWG are to recommend a policy to address studies that result in an increase rather than decrease in transmission costs due to ESRs used for both transmission and capacity.

TX18. DETERMINE APPROPRIATENESS OF CAPACITY RESOURCE COST RECOVERY IN TRANSMISSION CHARGES

Most capacity resources recover their capital costs through either rates charged to their load or through contracts with third parties. An ESR that is a transmission facility will recover its costs (including a return) with an ATRR included in transmission charges. Those transmission charges may be paid by transmission customers throughout the region, including the capacity resource's retail load. When the ESR used for transmission is also considered capacity to satisfy a resource adequacy obligation, the costs of that capacity may actually be borne by parties other than the load-responsible entity.

Recommendation: The CAWG and SAWG are to recommend a policy regarding cost recovery through transmission revenues for an ESR that is also used as resource adequacy capacity.

TX19. DEVELOP PROCEDURE FOR IDENTIFYING CAPACITY RESOURCE COSTS OF ESR TRANSMISSION FACILITIES

If an ESR provides both transmission and capacity, its costs for each service are charged differently (see TX18). Appropriate cost allocation needs to separate the costs for provision of each service. This separation impacts economic analysis in SPP's transmission planning studies.

Recommendation: The CAWG, SAWG, TWG and SPP staff are to recommend a mechanism that separates facility costs related to capacity provision from costs related to transmission provision. The mechanism should consider the impact on SPP's economic planning studies.

TX20. DEVELOP CAPACITY ACCREDITATION AND TESTING METHODOLOGY

As discussed in recommendation C1, SPP does not have an explicit accreditation policy for ESRs. When an ESR is cross-functional, there is an impact on how much accreditation should be attributed to the capacity for resource adequacy and how much should be attributed as a transmission facility. An ESR's cross-functional ability increases accreditation complexity.

Additionally, when an ESR is tested for capacity accreditation, there may be a conflict if the ESR is being used for transmission.

Recommendation: The SAWG and SPP staff are to determine an accreditation and testing methodology that reflects ESRs' use as transmission and capacity.

ENERGY AND RELATED SERVICES ISSUES

ESRs could provide significant benefits to the SPP region. The ability to store excess energy from the grid, respond instantaneously to grid events and balance supply and demand are benefits that ESRs, if implemented correctly, can bring to SPP. Many opportunities present themselves when determining the most efficient way to address the use of ESRs in SPP.

E1. DEVELOP ESR TRANSMISSION PLANNING STUDY PROCESS

ESR is similar to a generator when it injects energy onto the transmission grid. When an ESR is charging, it is load. SPP analyzes new generators in its generator interconnection study process and analyzes new load in its delivery-point-addition study process. Because these are two separate study processes, SPP needs to determine how to study a resource that acts as generation and load.

Recommendation: SPP staff is to work with the TWG to develop a process for analyzing an ESR as both a load and generation.

E2. DEVELOP PROCESS FOR MODELING AND CONTROLLING ESR HYBRID CONFIGURATIONS

The majority of ESRs in SPP are being combined with solar projects for tax credit purposes. The prime locations for ESRs are where wind and solar installations already exist. Storage could be co-located with other generation types as well.

Solar installations are frequently overbuilt when compared to their installed inverter size. This practice, commonly referred as "solar clipping," can allow for an ESR to be continually charged while receiving no energy from the transmission grid.

SPP staff, stakeholders and vendors have, to date, discussed two modeling options for renewable generation co-located with storage: standalone modeling and hybrid modeling.

Standalone modeling requires the ESR and the renewable energy resource to be modeled separately. This type of modeling gives SPP increased visibility into both the ESR and renewable energy source. SPP and stakeholders are already familiar with current renewable energy forecasts and modeling. The largest drawback with standalone modeling is that it can significantly limit the ability of the two injection sources to be optimized. For instance, a 200 MW solar facility and co-located 150 MW ESR may be limited to injecting 200 MW onto the grid. If the solar and ESR are modeled separately, it can be difficult for SPP to determine which resource is used to meet a 200 MW demand and manage accordingly.

Hybrid resource modeling combines the ESR and renewable energy resource into a single modeled resource. The benefits of hybrid modeling are a simplified representation of generation capability at a given point of interconnection and much more flexibility in how the resources are offered into the SPP Integrated Marketplace. The drawbacks to this type of modeling are SPP's potential loss of visibility into each physical resource and potential forecasting issues for the co-located resources. For instance, if a solar facility and co-located ESR are a single modeled resource, a solar forecast will not accurately represent the total capacity and energy available at that location.

Recommendation: The MWG, ORWG and SPP operations staff are to evaluate and recommend a modeling process for co-located ESR and generation.

E3. STUDY COSTS/BENEFITS AND DEVELOP TARIFF CHANGES FOR FAST-START ESR CHARGING

FERC's Section 206 fast-start proceeding caused SPP to begin analyzing the concept of "fast-start negative generation": an offline ESR being directed to receive energy (charging) from the transmission grid. This is similar to the fast-start market design that orders a conventional resource "on" from an offline state to inject energy. With a conventional resource, the costs associated with generating from an offline state are well defined and included in the submitted start-up and no-load costs that the resource submits to SPP.

Mitigation in the SPP Integrated Marketplace was developed to address instances in which a sole resource can influence the outcome of market pricing through its market offer. This impact is commonly referred to as having market power. Historically, the SPP independent MMU and RTO have worked together to create rules that will address instances of resources exercising market power. These rules are enforced through SPP's application of "mitigation" and involve using a resource's cost-based offer to ensure the resource is no longer exercising market power.

SPP's current application of mitigation is for market power in the upward direction: a resource is raising its offer to the market, ensuring further profit. With further proliferation of ESRs, there may be a significant number of resources presenting negative offers. Typically, negative offers for storage will indicate the price to receive energy from the grid. An increased number of negative offers could cause issues with SPP's current mitigation workflows.

Recommendation: The MWG and ORWG are to evaluate the costs and benefits of using an ESR as fast-start negative generation. The groups should develop tariff changes for ESRs as fast-start negative generation, including market mitigation measures as necessary.

E4. DETERMINE LIMITS FOR FAST-RESPONDING ESRS

The bulk electric system depends on a diversity of generator response to operate reliably. An excess of fast-responding ESRs for specific services, such as regulation, may be detrimental to reliability.

Recommendation: The ORWG is to work with SPP staff to determine and recommend fast-response ESR participation limits that may be necessary for specific services, such as regulation, to maintain reliable operations.

E5. DETERMINE FEASIBILITY OF REGIONAL AGGREGATION FOR RESERVE-ONLY ESRS

ESR developers have discussed with SPP staff the possibility of only providing operating reserves. Generally, within SPP, reserves are not locationally constrained; they can be regional. If ESRs provide only reserves, SPP could consider allowing aggregation of smaller ESRs across the SPP region.

Recommendation: The ORWG and MWG are to evaluate whether the aggregation of ESRs across the SPP region would be appropriate from operational and market perspectives. If so, the groups should recommend tariff changes.

E6. DEVELOP REQUIREMENTS FOR NON-CONFORMING LOAD FROM UNREGISTERED ESRS

ESRs could impact retail load and be unregistered in the SPP market; SPP would not have visibility into the separate load and ESR. Eventually, the impact on the retail load could be of such magnitude that SPP would be unable to forecast the load accurately and would need LSEs to submit data to properly balance load and generation.

Recommendation: The ORWG is to analyze and recommend procedure changes necessary to account for load not forecastable by SPP (non-conforming load).

E7. DETERMINE ESR QUALIFICATION FOR ESSENTIAL & OTHER RELIABILITY SERVICES

The HITT recommended that SPP identify essential reliability services (ERS) and other reliability services (ORS). Once these services are identified, the ability of an ESR to provide those services needs to be evaluated.

Recommendation: The MWG, ORWG and RTWG are to identify necessary changes to the tariff for an ESR to provide the appropriate ERS and ORS.

E8. RECONCILE ESR DURATION WITH RESERVE DURATION REQUIREMENT

The SPP market co-optimizes resources between energy and operating reserves. Currently, an operating reserve must be able to provide energy for at least an hour. If an ESR has been providing energy and is then identified to provide contingency reserves, it could have insufficient charge to meet the reserve duration obligation.

Recommendation: SPP staff is to recommend necessary system changes to prevent an inappropriate market co-optimization.

E9. ANALYZE THE COST/BENEFIT OF ADDING SPP CHARGING CONTROL

FERC Order 841 was explicit in its direction to allow an ESR to manage its own state of charge. In some respects, this self-determination has made it easier for SPP to design and implement the initial phase of storage. The market participant can decide the most opportune times to charge.

SPP is receiving increasing requests to add storage resources and expects this trend to continue, along with an increase in traditional generation retirements. To maintain reliable grid operations with increased amounts of ESRs, SPP must be able to ensure the storage is charged and available when needed. Optimizing ESRs in the real-time market over only a single five-minute period will most likely not be a viable long-term solution. SPP should discuss a longer, financially binding solution that can control ESR charging for future projected needs and ensure it is economically beneficial for the ESR. There are multiple ways to solve the optimization issues that are presented with increased storage penetration.

Recommendation: The MWG and ORWG are to work with SPP staff to evaluate the cost/benefit of providing an SPP charging control option.

RESOURCE ADEQUACY CAPACITY ISSUES

In SPP's region there is no retail open access. All load is served through integrated utilities, cooperatives, investor-owned utilities, municipalities, state agencies and federal agencies. These load-serving entities are obligated by their regulators to have sufficient capacity to serve their loads.

SPP builds on this obligation to serve load by requiring load-responsible entities to submit and demonstrate sufficient capacity to meet SPP's resource adequacy obligation. There are ESRs in the SPP generation interconnection queue that will be used for energy and resource adequacy capacity. The resource adequacy capacity mix is changing as more ESRs are accredited. This changing environment requires additional review of capacity requirement.

C1. DETERMINE ESR CAPACITY ACCREDITATION PROCESS

It is recognized that ESRs will be eligible to meet SPP's resource adequacy requirement. In its FERC Order 841 compliance filing, SPP stated that, per SPP Planning Criteria Section 7, an ESR requires a four-hour accreditation value. For example, a 100 MW-hour battery would have an accreditation value of 25 MW, as it would need to be available for four hours.

Due to the uncertainty of exactly how ESRs will be used in future day-to-day operations, SPP staff and the SAWG are studying ESR accreditation using the effective load-carrying capability (ELCC) methodology.

Recommendation: The SAWG is to recommend the ESR accreditation process and coordinate with the ORWG as to the practical application of the process.

C2. DETERMINE ESR DURATION AND AVAILABILITY REQUIREMENT

The ELCC study for capacity accreditation will evaluate several different aspects of potential ESR operation to determine if the four-hour duration is appropriate. The ELCC study will evaluate the possibility of ESRs being dispatched solely to preserve reliability, presumably via SPP market dispatch. It will also evaluate an economic arbitrage dispatch option, which is dispatch by the user when prices are optimal. Additional scenarios will analyze the impact of hybrid facilities (such as ESR/solar, ESR/wind, and ESR/wind/solar) in which the ESR is only charged by its co-located generation, which limits charging capability.

Recommendation: The SAWG and ORWG are to recommend the duration and real-time availability criteria for an ESR to be considered as capacity for resource adequacy obligation.

C3. DETERMINE MAXIMUM AMOUNT OF ESRS ALLOWED IN RESOURCE ADEQUACY PORTFOLIO

An ESR does not create new energy but rather shifts when energy is used. Meeting SPP's resource adequacy obligation with 100% ESRs would create reliability issues because there would be insufficient new energy to charge the ESRs. SPP should consider putting limits on how much ESR capacity could be included in the resource adequacy portfolio.

Recommendation: The SAWG and ORWG are to analyze and recommend a maximum amount of ESRs to be allowed to provide capacity for SPP's resource adequacy obligation as well as any necessary parameters related to application of such a maximum.

OTHER TARIFF ISSUES

The following recommendations address other legal and regulatory concerns associated with ESRs.

T1. REVIEW TARIFF'S VARIABLE ENERGY RESOURCE DEFINITION

The tariff defines a variable energy resource (VER) as "a device for the production of electricity that is characterized by an energy source that (1) is renewable; (2) cannot be stored by the facility owner or operator; and (3) has variability that is beyond the control of the facility owner or operator."

When an ESR is co-located with a VER – such as a solar generator connected to a battery – the energy from the VER is being stored. This could change the definition of VER as an energy source that cannot be stored.

Recommendation: SPP staff and the RTWG are to review the tariff's VER definition to determine if changes are necessary regarding ESRs co-located with VERs. The groups should propose tariff changes if needed.

T2. DEVELOP TARIFF CHANGES DEFINING ESR RETAIL VS. WHOLESALE SERVICE

Order 841 recognized that an ESR may simultaneously provide retail and wholesale service. Currently, the load-service entity (through a market participant) separates wholesale from retail activity. SPP should consider if the tariff needs to include more specificity on this issue.

Recommendation: The CAWG and RTWG are to work with SPP staff to determine if tariff changes are necessary to delineate whether an ESR is providing retail or wholesale service.

T3. EVALUATE IMPACT OF COMMERCIAL MOBILE ESRS

FERC is considering rule changes for commercial mobile ESRs.[7] An example of a commercial mobile ESR is a battery on a railroad car. SPP needs to consider the implications of mobile ESRs, such as whether the transmission service incurred is an export and whether limitations should be placed on treatment of such ESRs as capacity.

Recommendation: The RTWG and SPP staff are to monitor commercial mobile storage developments and recommend any necessary tariff changes regarding transmission service.

T4. EVALUATE CHANGES TO MARKET REGISTRATION REQUIREMENT

The SPP tariff states that any behind-the-meter (on the distribution system) generation of 10 MW or greater must be registered in the energy market. FERC Order 841 states that ESRs injecting to the transmission system may be considered FERC jurisdictional and included in wholesale energy markets, even if the ESR is less than 10 MW and connected to distribution facilities. This issue is one of the items currently appealed to the DC Circuit Court.[8] The SPP tariff registration requirement for behind-the-meter generation may be inconsistent with FERC Order 841.

Recommendation: The RTWG and MWG are to work with SPP staff to recommend any necessary tariff changes to address behind-the-meter generation.

T5. RECOMMEND TARIFF CHANGES FOR MOBILE RETAIL ESRS

In addition to stationary ESRs, advances in plug-in electric vehicles open the possibility of using vehicles as mobile retail ESRs. SPP should discuss if mobile retail ESRs could participate in SPP's wholesale energy market.

Recommendation: The RTWG and CAWG are to consider if mobile retail ESRs should be able to participate in SPP's market and recommend any necessary tariff changes.

[7] Docket EL19-69 for Alternative Transmission Inc.
[8] Cases 19-1142 and 19-1147

APPENDIX

In October 2019, SPP distributed a draft summary of ESR issues to MOPC and CAWG members requesting feedback on any major issues that were not captured. Five parties responded; their verbatim comments are listed below. Although these submittals did not capture any major new issues, the organizational groups who work on ESRs should consider these comments in their discussions.

RESPONSES	ISSUE MAPPING
It's important the ESRs be allowed to derate their capacity in order to meet duration requirements as a transmission asset. Otherwise, this will restrain the economics of other applications for ESRs.	Tx1
When considering the life of an ESR transmission asset, compared to traditional transmission facilities, a 20-year lifetime is an industry standard reference point. However, it is worth pointing out that in different regions, or in different applications of ESRs, there can be a lot of uncertainty in load scenarios. As a result, it would be important that planning allows for flexibility to grow the system over time, and follow the load growth instead of overbuilding to meet a fixed forecast (like 20, 30, or 40 years).	Tx3
Whoever receives compensation, or cost recovery, for the ESR in transmission should be responsible for ensuring that the system can discharge when needed.	Tx8
I believe the paper covers the majority of the issues well. The only gap I see concerns the impact a Transmission ESR could have on congestion rights. I could see situations where folks might want to proposed ESRs as a transmission solution to mitigate transmission line overloads (i.e. charge with the excess energy until demands on a line are reduced & then discharge). Honestly such a thing might make a lot of sense when a line is minimally overloaded AND/OR the ESR could be put in place on a temporary basis during construction. If that were how SPP provided/approved transmission service, that same issue would have to be reflected in their financial instrument markets otherwise the customer would end up not getting their congestion hedge. It's no different than the lack of recognition of any flow control device OR mitigation plan in the TSR -> ARR-> TCR modeling.	Tx10
Since this is such an important part of the operational strategy that is put in place by the system owner, it would be good to also consider technical requirements and performance penalties (to the extent allowed) that should be implemented to incentivize the right behaviors	Tx10

What will be the reporting requirements for ESRs?	Tx10
Are there any other market revenues that need to be coordinated? Are there other system benefits that ESRs provide that might deserve to be compensated?	Tx12
How will SPP measure performance of ESRs?	Tx13
On both of these points, SPP should be designing the market rules for ESRs in a way that maximizes and optimizes the usage of flexible resources that are already on the grid. And, to this point, in a RA study, the storage dispatch schedule for transmission could be considered as a constraint, and then, you can calculate the residual RA capacity the system could provide.	Tx15 Tx20
SPP should also consider how to flexibly integrate ESRs into the existing interconnection queues without the loss of queue positions (consider limiting the injection rights to the same maximum level contained in the original request)	E1
First and foremost we believe there should be a focus on developing policy around the hybrid concept first. This concept is essentially a combination of multiple technologies that are physically and electronically controlled by an owner/operator ("Hybrid Owner/Operator") behind the point of interconnection ("POI") and offered to the market or system operator ("Market/System Operator") as a single resource at that POI. We believe this is the most common track in development.	E2
Specifically, I ask that you directly state that SPP plans to address the barriers to hybrid resources, i.e., co-located energy storage and generation. I also think it's worth addressing these barriers in a "walk, run, jog" manner, recognizing that SPP can productively make short-term fixes while it works out a longer-term framework. Specifically, I think SPP could probably make a short-term fix by allowing such co-located resources to use a single resource ID and same point of interconnection, but otherwise using a conventional generator model. Beyond that, there's a range of areas to improve; ESA's paper on the subject of hybrid resources is attached and identifies a number of places where rules can be improved to fully enable hybrid storage-plus-generation.	E2
SPP should develop a shared point of interconnection for hybrid resources or for two distinct injection points.	E2
Address rules around charge/discharge during EEA events	E7
I have begun my review of the whitepaper and one thing I thought of was temporal make-whole payments. Where SPP would dispatch the ESR to withdrawal/inject at times the owner had not scheduled and how this could limit or reduce compensation for the owner.	E7

This should be the risk and responsibility of the battery operator as long as the duration constraints for reserve products are clearly defined.	E8