



I

2017 PSE Integrated Resource Plan

Regional Transmission Resources

This appendix reviews current regional transmission issues and efforts to address those issues.

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1. OVERVIEW

As the region's resources have grown in conjunction with increasing loads and renewable energy standards, the Pacific Northwest transmission system has not kept pace with expanding demands. As a result, the region experiences transmission constraints during various times of the year, sometimes resulting in curtailments of firm contractual transmission rights.

Existing flowgates and paths managed by the Bonneville Power Administration (BPA), which handles the majority of the region's high-voltage transmission, continue to experience congestion resulting in curtailment. The organization announced that it would perform a Transmission Service Request Study Process (TSEP) in 2017 to identify transmission projects required to grant new transmission service requests as part of its ongoing efforts to address these constraints.

ColumbiaGrid remains critical to the regional understanding of where future transmission reinforcements should occur and which projects or facilities will be most effective. This non-profit organization and its members have completed several studies and developed transmission reinforcement plans to help alleviate regional congestion. Members include PSE, Avista, BPA, Chelan County PUD, Grant County PUD, Seattle City Light, Snohomish County PUD and Tacoma Power.

Increasing levels of variable renewable energy in the region have also put pressure on Balancing Authorities to incorporate mechanisms that allow for scheduling shorter time intervals than traditional markets offer. PSE joined the Energy Imbalance Market (EIM) in October 2016. The EIM optimizes generator dispatch within and between EIM entities every 15 and 5 minutes. PSE expects positive performance and benefits from EIM; however, BPA has expressed concern that PSE's participation is impacting regional transmission usage.



Within the context of a regional transmission system with growing constraints, PSE has identified an opportunity to optimize the use of its transmission contracts with BPA. Originally, PSE acquired firm transmission for the entire output of Hopkins Ridge and the Lower Snake River wind farms consistent with our operating practice of holding firm transmission rights for our generating assets. However, as we have learned more about the operation of wind facilities and their contribution to capacity, we have determined that holding less firm transmission is in the best interests of our customers. Since wind is an intermittent resource, the facilities do not always operate at maximum output. By reassigning a portion of the firm delivery rights associated with each of these plants to Mid-C and making short-term firm transmission purchases when the wind facilities generate energy in excess of the firm transmission that remains dedicated to them, PSE can increase the amount of firm capacity it can use to access the Mid-C market. This opportunity uses transmission rights PSE already has on BPA's system in a way that will lower costs for PSE customers while retaining the ability to bring the wind energy to load.

These items will be discussed in more detail in the sections that follow.



2. THE PACIFIC NORTHWEST TRANSMISSION SYSTEM

Regional Constraints

BPA provides roughly 75 percent of the high-voltage transmission in the Pacific Northwest region. Historically, PSE and other regional utilities have relied on BPA's transmission system to deliver energy to serve retail customers. However, as the region's resource portfolios have grown in conjunction with increasing loads and renewable energy standards, the Pacific Northwest transmission system has not kept pace with the expanding demands. As a result, the region experiences transmission constraints during various times of the year, sometimes resulting in curtailments of firm contractual transmission rights.

The situation poses an operational challenge for PSE in particular, since PSE moves significant amounts of energy and capacity into the Puget Sound area from resources in eastern Washington (east of the Cascades) and from resources along the I-5 corridor.

Figure I-1 illustrates how power travels from remote resources, generally located south of Seattle and east of the Cascades, to PSE's service area. The thick, black bars represent BPA flowgates or paths, which often consist of several transmission lines or sets of parallel lines. The typical flow of winter peak power is indicated by the arrow symbol.

What is a constrained path?

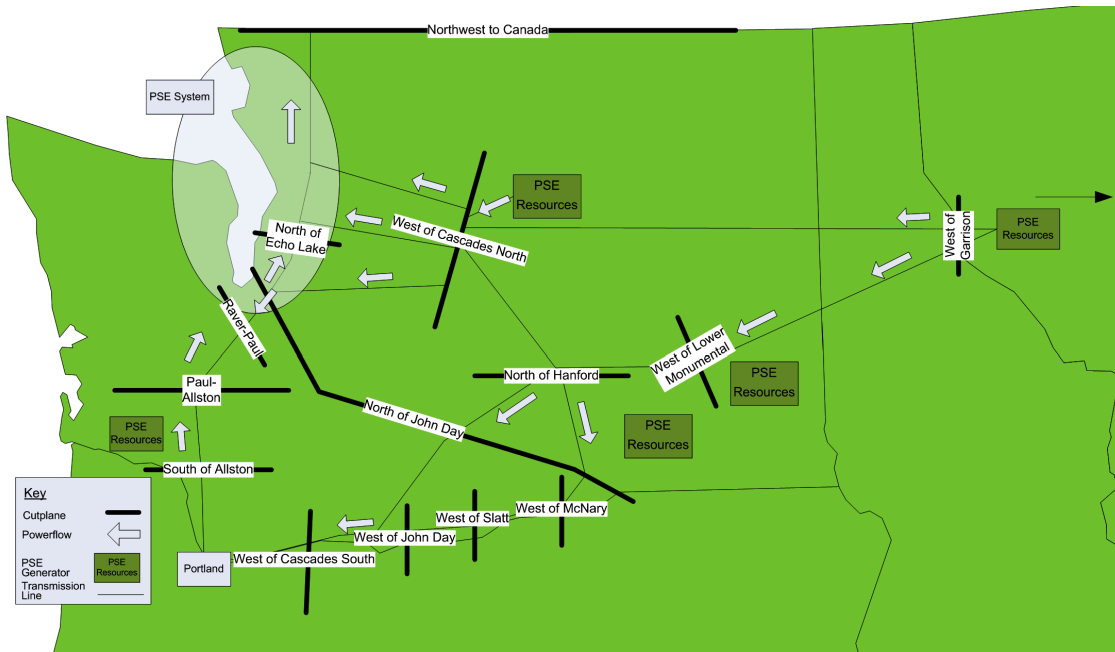
Constrained paths and flowgates are sets of transmission lines that are nearly "full." They have little capacity available to sell, which makes them vulnerable to congestion and curtailment.

What is curtailment?

Curtailments occur when scheduled transmission service must be reduced or canceled due to actual or simulated violation of constraints.



Figure I-1: BPA Transmission System Constraints on PSE Remote Resource Delivery



A summary of the most significant flowgates and paths shown in Figure I-1 are discussed below.

- The majority of energy from PSE’s eastern Washington resources flows across the constrained West of Cascades North flowgate and into the Puget Sound area. This flowgate is most constrained during heavy winter loading periods.
- A portion of the energy flowing from eastern Washington resources also flows over the West of Cascades South flowgate, and as it travels to loads in the Puget Sound area, it flows over the North of John Day and Raver – Paul flowgates. The West of Cascades South flowgate is most constrained during heavy winter loading periods, while the North of John Day and Raver – Paul flowgates are typically most constrained during heavy summer loading periods.
- Energy from PSE resources in Montana flow over the West of Garrison path.
- Congestion issues in the Puget Sound area are monitored by the North of Echo Lake flowgate. Generation support from PSE resources located in Skagit and Whatcom Counties is particularly important in reducing curtailment risk on this flowgate.
- Energy from PSE’s Lower Snake River Wind Project flows across the West of Lower Monumental flowgate.

Some paths are designed to operate close to their limits (like West of Garrison), others are not; this latter group presents areas of the system where PSE sees a particular importance in continuing to study, develop and possibly construct new transmission.



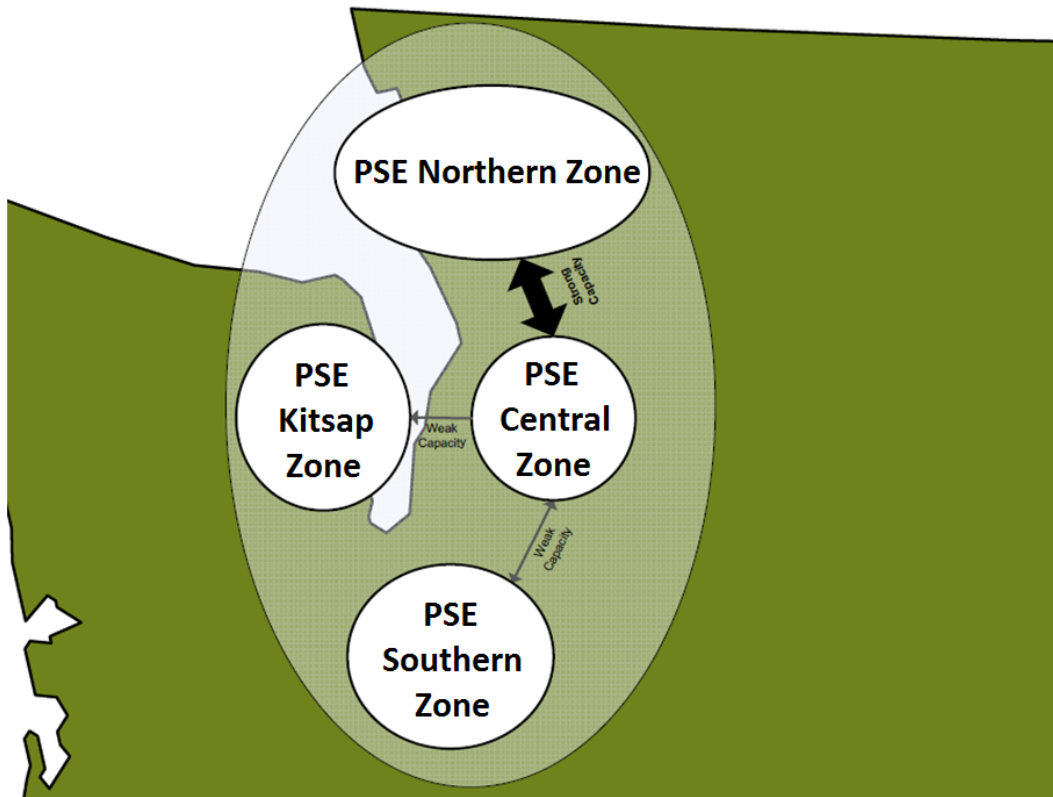
PSE Westside Transmission Constraints

Resources located west of the Cascades near PSE load centers and natural gas pipelines generally have fewer delivery constraints because this energy is typically delivered by the PSE-owned local transmission system. There is currently sufficient transmission capacity on PSE's westside system to move surplus energy produced in one part of the service territory to others. However, in certain areas, if new resources are added or imported, constraints could develop without transmission expansion.

Figure I-2 illustrates the PSE Westside Load Zones and transmission paths.

Figure I-2: Transmission System Constraints on PSE Internal Resource Delivery

PSE Westside Service Territory Load Zones





The illustration above divides PSE's service territory into four geographic load zones connected by different sets of PSE transmission facilities. The arrows indicate relative transmission capacity between the load areas; the thicker the arrow, the greater the transmission capacity.

- Capacity from the Central Zone to the Northern Zone is adequate in the near term. It is unlikely that new resources located in (or imported into) the Central Zone would cause PSE to experience limitations in moving energy from the Central to the Northern Zone in the ten-year time frame examined here.
- Transmission capacity from the Central to Southern Zone is more limited. Here, PSE could experience limitations in moving energy from the Central to the Southern Zone if new resources are added or imported in the next ten years.
- In the Kitsap Zone, PSE may begin to see transmission resource deficits in the long term unless new capacity is built or obtained between the Kitsap and the Central or Southern Zones.

PSE will consider purchased power agreements (PPAs), capacity constraints, the geographic location of PSE's loads and existing resources, and the physical delivery points of remote resources as we continue to analyze and study the potential locations of loads, resources and transmission.



3. PSE TRANSMISSION EFFORTS

PSE continues to participate with study teams and work with regional utility partners to solve congestion issues in the Pacific Northwest.

Participation with study teams like the ColumbiaGrid System Assessment groups has resulted in committed projects by PSE. The committed projects by PSE are:

- Alderton 230/115kV Transformer in Pierce County. A new 230/115 kV transformer at Alderton Substation in central Pierce County with a new 230 kV line from White River. This project is included in PSE's budget and the scheduled completion year is 2017.
- Woodland-Gravelly Lake 115kV Line. This project is in the design and construction phase and is a committed project with a scheduled completion year of 2025.

One of the committed projects by BPA is:

- Raver 500/230 kV transformer and a 230 kV line to Covington Substation. Addition of a 500/230 kV transformer at Raver and a 230 kV terminal at Raver for a Raver-Covington 230 kV line. This project will ensure increased transmission capability in the Puget Sound area.



4. BPA TRANSMISSION EFFORTS

TSR Study and Expansion Process

BPA is the primary option for acquiring contractual transmission in the Northwest. Historically this involved submitting an OASIS (Open Access Same-time Information System) transmission service request to BPA, but the agency now requires participation in its TSR Study and Expansion Process (TSEP), formerly known as Network Open Season (NOS). The TSEP process was designed to obtain financial commitments from transmission customers in advance of any new facility construction. For long-term transmission requests, the process uses cluster studies to analyze impacts and new transmission facility requirements on an aggregated basis. Commencing in 2008, and in accordance with Federal Energy Regulatory Commission (FERC) approval, BPA initiated an NOS process under its Open Access Transmission Tariff (OATT). The multi-step process began with the submission of Transmission Service Requests (TSR) by transmission customers. BPA responded with a Precedent Transmission Service Agreement (PTSA) that requires customers to pledge a security deposit equal to the charge for 12 months of transmission service at the tariff rate. The PTSA obligates the customer to take service for its TSR if BPA satisfies the following conditions:

- BPA determines that it can reasonably provide service for the TSR in the cluster at embedded cost rates, and
- BPA decides to construct the facilities required to provide the service after completing an environmental impact study.

2017 TSEP Study

In 2017, BPA will perform a TSEP Cluster Study that looks at 51 TSRs totaling 2,042 MW of incremental transmission service; these include several PSE transmission service requests. Results of this study, including potential transmission projects to support granting transmission requests, were shared by BPA on June 14, 2016. On May 17, 2017, BPA also announced their decision to not go ahead with their I-5 Corridor Reinforcement project. The study results showed that out of 7 TSRs, only 1 TSR was approved; the other TSRs needed additional system enhancements.



Past NOS Findings

Previously, BPA performed four NOS studies in 2008, 2009, 2010 and 2013. The 2009 and 2013 studies resulted in no new transmission projects. The 2008 and 2010 studies resulted in six new transmission projects. Study results and projects resulting from previous NOS studies can be found on the BPA website.

Wind Curtailments

Wind power plays a significant role in meeting the region's future energy needs and satisfying RPS requirements. In fact, approximately 5,000 MW of new renewable generation (primarily wind power) will be necessary to fulfill the combined RPS requirements of Washington and Oregon. To meet this increase, BPA must continue to build transmission lines and substations to deliver renewable electricity from new wind projects that are often located in remote areas. Integrating this amount of wind energy into the region's electrical grid poses many challenges, and BPA's role will certainly require innovative and cooperative approaches to manage the variability of wind power effectively. Current BPA efforts to manage wind energy include the following.

Dispatcher Standing Order (DSO) 216

DSO 216 enables BPA to either curtail generation schedules or limit generation to the scheduled amount when there is insufficient regulating capacity on the federal hydroelectric system. Regulating capacity is an ancillary service that BPA charges customers for integrating wind. However, that service is not always available, as shown by the historical frequency of DSO 216 curtailments. Curtailments may result in lost energy and/or renewable energy credits (RECs) without compensation.

Oversupply Management Protocol

Similar to DSO 216, BPA uses Oversupply Management Protocol to curtail wind energy, but in this case when there is an oversupply of hydroelectric and wind generation in the region. Curtailments may result in lost energy and/or RECs with compensation.

PSE's future resources – especially renewables – will most likely face tough economic and technical challenges, along with business uncertainties. Continuing to rely on BPA to integrate our wind resources has a limit, which means we must continue to look for alternatives to integrate wind either directly into our Balancing Authority (BA), or seek other innovative, lower-cost approaches.



BPA Transmission Planning and Attachment K¹ Projects

Through its various forums (Attachment K, Capital Investment Review, etc.), BPA is planning to construct the following projects:

- Raver 500/230 kV Transformer, expected energization 2017
- Monroe-Novelty 230kV Line Upgrade, proposed energization 2019
- Monroe 500kV Line Re-terminations, expected energization 2019

These projects increase reliability to Puget Sound area loads by decreasing potential Northern Intertie congestion across various seasons and conditions throughout the calendar year. These projects could also make new capacity available for PSE requests for transmission service from eastside generation alternatives to PSE loads.

¹ / PSE's current Attachment K document is available at http://www.oasis.oati.com/PSE1/PSEIdocs/PSE_Plan_2016_Final.pdf.
BPA's current Attachment K document is available at <https://www.bpa.gov/transmission/CustomerInvolvement/AttachmentK/Pages/default.aspx>



5. REGIONAL TRANSMISSION EFFORTS

Major Proposed Projects

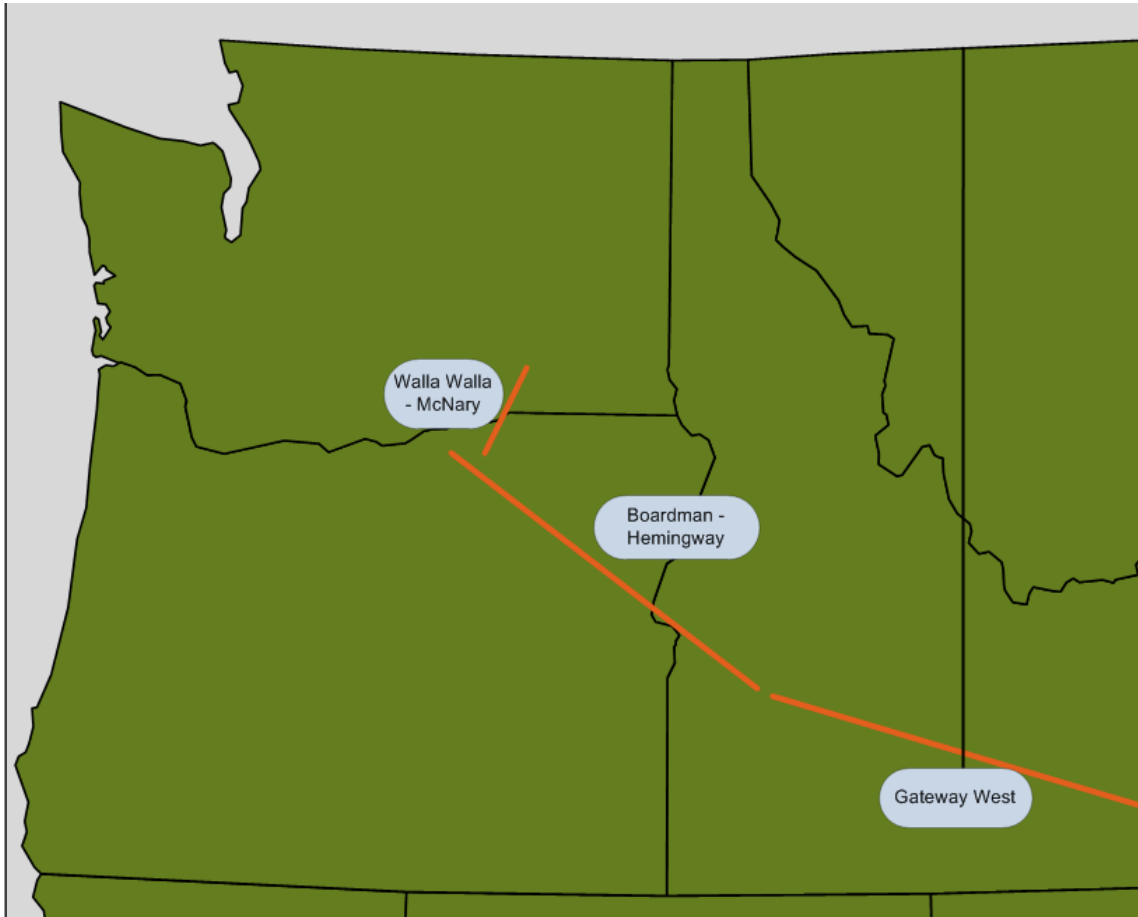
Several major transmission projects are proposed for the Pacific Northwest. These projects may impact each other as well as existing Western Electricity Coordinating Council (WECC) paths. The WECC maintains a public transmission project database where project sponsors can post information and updates for their projects. The projects listed below can be found in the WECC database or at BPA's website. All are assumed to have some effect on the paths and flowgates that PSE uses to transmit energy from remote resources to load. Project names are followed by expected cost, completion date and current status.

- PacifiCorp's Gateway West: ~ \$2.7 billion, tentative completion date 2019 – 2024; final Supplemental Environmental Impact Statement issued by the Bureau of Land Management in October 2016.
- Idaho Power's Boardman to Hemingway: ~ \$900 million, tentative completion date 2022 or later; final Supplemental Environmental Impact Statement issued by the Bureau of Land Management in November 2016.
- PacifiCorp's Walla Walla – McNary 230 kV: cost unknown, construction estimated in 2017; tentative completion date 2017.



These projects are displayed in Figure I-3.

Figure I-3: Proposed Regional Transmission Projects



These projects bring three main benefits to the region:

1. access to significant incremental renewable resources in the northwestern states,
2. improvement in regional transmission reliability, and
3. new market opportunities for dealing with participants outside of the region.



ColumbiaGrid Efforts

ColumbiaGrid is a non-profit membership corporation formed in 2006 to improve the operational efficiency, reliability and planned expansion of the Pacific Northwest transmission grid. While ColumbiaGrid does not own transmission, PSE and other ColumbiaGrid members do own and operate an extensive network of transmission facilities. ColumbiaGrid's members are PSE, Avista, BPA, Chelan County PUD, Grant County PUD, Seattle City Light, Snohomish PUD and Tacoma Power.

ColumbiaGrid has had substantial responsibilities for transmission planning, reliability and other development services. These tasks are defined and funded through a series of "Functional Agreements" with members and other participants. Development of these agreements is carried out in an extensive public process. ColumbiaGrid processes stress transparency and encourage broad participation and interaction with stakeholders, including customers, transmission providers, states and tribes. It also provides a non-discriminatory forum for interested parties to receive and present pertinent information concerning the regional interconnected transmission system.

Planning and Expansion

ColumbiaGrid's planning and expansion efforts are intended to promote single-utility planning and expansion of the regional grid. The Planning and Expansion Functional Agreement (PEFA), which has been signed by all of ColumbiaGrid's members and three non-member participants (Cowlitz County PUD, Douglas County PUD and Enbridge, Inc.), defines the obligations under this program.

The PEFA charges ColumbiaGrid with answering three key questions concerning the transmission network: what should be built, who should build it and who should pay for it. ColumbiaGrid provides a number of services in this planning program, including performing annual transmission adequacy assessments, producing a Biennial Transmission Plan and identifying transmission needs. ColumbiaGrid also facilitates a coordinated planning process for the development of multi-party transmission system projects.

ColumbiaGrid's 2016 System Assessment serves as an input to the 2017 Biennial Transmission Expansion Plan. The Assessment highlights areas of the system that may be vulnerable to deficiencies in meeting reliability standards.² In support of the Biennial Plan, PSE participated in three study teams addressing specific regions: the Puget Sound Area Study Team (PSAST), the Wind Integration Study Team (WIST) and the Cross Cascades North Study Team.

² / The referenced plans and assessments can be found on ColumbiaGrid's web site at <http://www.columbiagrid.org/documents-search.cfm> by using the document search function.



Puget Sound Area Study Team (PSAST)

The ColumbiaGrid PSAST published its “Transmission Expansion Plan for the Puget Sound Area” in October 2010; in 2013, it issued the “Updated Transmission Expansion Plan for the Puget Sound Area to Support Summer North-to-South Transfers.” Since then, area utilities have continued to meet and develop additional scenarios to study. The PSAST projects have now been pulled into the ColumbiaGrid annual assessment and biennial expansion plan.

Wind Integration Study Team (WIST)

WIST was formed by the Northern Tier Transmission Group (NTTG) and ColumbiaGrid to facilitate the integration of renewable generation into the Northwest transmission grid. Its current focus is to study and address system constraints related to increased use of dynamic transfers for variable energy resources. The study team produced a set of reports in 2011 that confirmed the need for dynamic transfer capability limits, explored study methodologies and applied the methodology to several northwestern paths. Work continued through 2012 to quantify the dynamic transfer capability of Pacific Northwest paths and to help identify other dynamic transfer impacts on reliability.

While the Dynamic Transfer Capability Task Force is not currently meeting on a regular basis, ColumbiaGrid facilitated a Dynamic Transfer Capability study on the California – Oregon Intertie (COI) in late 2014 under a separate request by BPA.



Order 1000

The Federal Energy Regulatory Commission's Order 1000 requires transmission providers to:

- participate in a transmission planning process that evaluates alternatives that may resolve the region's transmission needs in a more cost-effective and efficient manner than local planning processes;
- have a methodology for cost allocation for such projects within the region; and
- consider public policy requirements in its planning process.

The Order further requires transmission providers to improve coordination across regional transmission planning processes by developing and implementing procedures for joint evaluation and sharing of information regarding both regional transmission needs and potential interregional transmission facilities. The Order also requires regions to have a common methodology for allocating costs of interregional projects.

PSE recognizes ColumbiaGrid as its regional planning entity. The ColumbiaGrid PEFA addresses many of the Order 1000 requirements for PSE, but an additional Order 1000 Functional Agreement has been created to address incremental changes to the PEFA planning process to ensure that it complies with regional planning requirements.

The Order 1000 Functional Agreement and corresponding changes to the Attachment K to PSE's OATT were filed with FERC on December 18, 2013 in response to FERC's June 20, 2013 Order regarding PSE's original compliance filing of October 11, 2012. On September 18, 2014, FERC issued an Order largely accepting the Order 1000 Functional Agreement filing with some additional modifications. A third compliance filing that addressed those modifications was made on November 17, 2014.

For the interregional portion of the order, PSE worked with ColumbiaGrid and the other regions in the western interconnection (the California Independent System Operator [CAISO], WestConnect and the Northern Tier Transmission Group) to develop the required common language for interregional coordination and cost allocation; this was filed with FERC on June 19, 2013. FERC issued an Order generally accepting the interregional language on December 18, 2014. While no further changes to the Order 1000 Functional Agreement or PSE's Attachment K are anticipated, a filing was made with FERC prior to February 18, 2015 to address changes made by the CAISO in response to the FERC's Interregional Order. PSE and ColumbiaGrid implemented the Order 1000 Agreement beginning with the 2015 ColumbiaGrid planning cycle.



Information regarding Order 1000 is available on the ColumbiaGrid website under Order 1000 at <https://www.columbiagrid.org/1000-overview.cfm>.

Energy Imbalance Market

Increasing levels of variable renewable energy in the region have put pressure on Balancing Authorities to incorporate mechanisms that allow for scheduling shorter time intervals and more optimized coordination than traditional bi-lateral hourly markets offer. The CAISO Energy Imbalance Market (“EIM”) is a sub-hourly market that efficiently addresses Balancing Authority imbalances by economic re-dispatch of participating generating resources and transfers between BAs.

PSE joined the Energy Imbalance Market (EIM) in October 2016. To establish its first EIM transfer path, PSE redirected a portion of its existing BPA point-to-point transmission contracts for use in the 5- to 15-minute balancing energy market. This path connects PSE and PacifiCorp West (PACW) entities for EIM market trades in both directions. Current members of the EIM also include Seattle City Light, Idaho Power Company, Arizona Public Service and NV Energy as well as the Balancing Authority of Northern California.

PSE’s participation in the EIM has triggered new regional transmission concerns and challenges. Because it is changing the transmission usage over BPA’s system, PSE’s EIM transactions are subject to the Dynamic Transfer Limits in BPA’s business practice. This requires that CAISO constrain PSE 5-minute generation dispatch in the EIM according to limits specified by BPA. These limits are meant to monitor BPA flowgates and maintain system reliability.

In the near future, PSE may establish additional EIM transfer paths as new entities join the market. These potential paths may or may not require additional BPA-contracted transmission; however, they will most likely impact physical usage of the BPA transmission system. PSE will continue to work with all stakeholders on these issues.

What is CAISO?

The California Independent System Operator (CAISO) is a non-profit Independent System Operator (ISO), serving California. The CAISO oversees the operation of California’s bulk electric power system, transmission lines, and the electricity market generated and transmitted by its member utilities.



Figure I-4 illustrates the existing transfer paths established between participating EIM entities.

Figure I-4: Established EIM Transfer Paths as of October 2016





6. TRANSMISSION REDIRECT OPPORTUNITIES

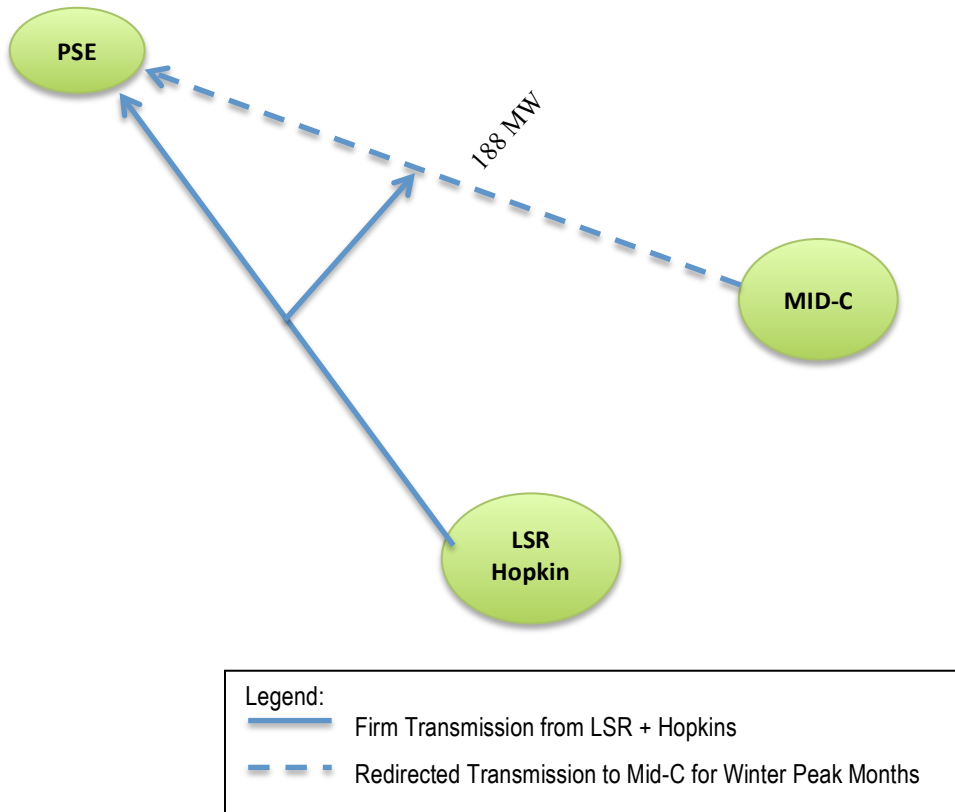
Lower Snake River (LSR) and Hopkins Ridge

For the winter peaking months of November through March, PSE is considering an opportunity to redirect a portion of LSR and Hopkins Ridge transmission to Mid-C to supplement additional firm capacity from Mid-C to PSE's load. PSE has determined that it can redirect 188 MW of LSR/Hopkins transmission to Mid-C, leaving 312 MW of firm transmission dedicated to those facilities. PSE would purchase short-term firm transmission when wind plant output exceeds the firm transmission dedicated to them. PSE is considering this redirect because:

- Additional firm capacity for the Mid-C Market increases PSE's flexibility for bringing energy to PSE's native load.
- 188 MW of redirected transmission capacity enables PSE to defer making a long-term generation decision.
- The output of Hopkins Ridge and LSE correlate poorly to PSE's peak load.
- The cost of short-term firm transmission to serve the wind farms when needed is significantly less than any other capacity resource.



Figure I-5: Illustration of Transmission Redirect to Mid-C from LSR/Hopkins





Colstrip

The transfer capability of the existing Colstrip Transmission System after closure of Colstrip Units 1 & 2 will be determined by studies that have not yet been scoped and designed by the Colstrip Transmission System owners. PSE has begun working with NorthWestern Energy and the other Colstrip Transmission System owners on the design and staffing of these studies. It is anticipated that the studies will be overseen by the Colstrip Transmission System owners acting through the Transmission Committee under the Colstrip Transmission Agreement. The studies would typically include load flow, short circuit, transient, and voltage stability analyses. The transfer capability available on the Colstrip Transmission System for a new resource would be a function of, among other things, the type of new resource, its size and other characteristics, its location and the modifications made to the system to accommodate the new resource. Any modifications to the Colstrip Transmission System required by the introduction of any new resource would: 1) depend on the type of such new resource, its size and other characteristics, and its location, and 2) be identified in studies under the Open Access Transmission Tariffs of the Colstrip Transmission System owners (and the Colstrip Transmission Agreement) in response to requests for interconnection or transmission service on the Colstrip Transmission System. It would be speculative to identify any modifications to the Colstrip Transmission System for any new resource without knowing the size, characteristics and location of such new resource.



7. OUTLOOK AND STRATEGY

PSE needs to advocate for and participate in local and regional transmission projects that relieve congestion, increase transfer capacity and improve reliability for its electric customers. This can be accomplished through the following actions.

Participate in efforts focusing on relieving existing and future transmission congestion.

PSE should continue to participate in the planning of regional transmission projects that decrease congestion and curtailment risk, increase regional reliability and help maintain low power prices for its customers. PSE will pursue these opportunities through various forums, including ColumbiaGrid, BPA's TSEP process and Attachment K, and through its utility partners in the Puget Sound area. Because of our geographical location, PSE will focus on efforts to study and develop projects that relieve congestion on the West of Cascades North, North of Echo Lake and Raver – Paul flowgates.

Refine assessment of future internal transmission constraints related to westside generation alternatives.

PSE has begun to lay out the methodology for determining which internal transmission constraints may interfere with bringing new westside resource options to load. To the extent that PSE acquires incremental westside generation in the future, we will need to determine the quantitative and qualitative constraints involved in bringing that resource to load.

Identify opportunities to obtain additional transmission capacity necessary to deliver energy from eastside generation alternatives.

If PSE identifies cost-effective resources located east of the Cascades, we need to consider the means to build or acquire additional transmission service from those remote resources. PSE should continue to assess the quantitative and qualitative strengths and weaknesses of taking additional transmission service (through a BPA TSEP process) or obtaining physical transmission capacity. PSE will also continue to participate in ColumbiaGrid study groups that seek to refine which West of Cascades North transmission project is most beneficial to the region.