WESTCONNECT REGIONAL TRANSMISSION PLANNING

2018-19 PLANNING CYCLE

REGIONAL TRANSMISSION NEEDS ASSESSMENT REPORT

APPROVED BY WESTCONNECT PLANNING MANAGEMENT COMMITTEE ON

<MONTH> <DAY>, <YEAR>

DRAFT FOR STAKEHOLDER REVIEW
Dated February 25, 2019

Contents

1.0 Introduction and Summary

The purpose of this report is to summarize the regional transmission need identification phase of WestConnect's 2018-19 Regional Transmission Planning Process ("Planning Process"). With stakeholder input, the Planning Subcommittee developed this report to document the regional transmission needs assessment and includes both minority and majority views on decisions and assumptions used in performing the assessment.

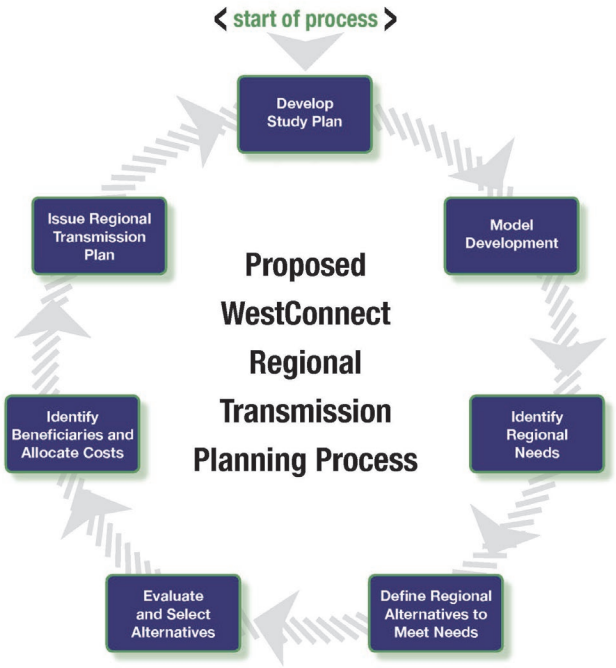
The Planning Management Committee (PMC) has decision-making authority in the implementation of the Planning Process. On December 12, 2018 the PMC approved the Planning Subcommittee's recommendation that no regional transmission needs were identified in the 2018-19 Regional Planning Process. This report provides documentation to the PMC in support of the Planning Subcommittee's recommendation with regard to the regional transmission need identification phase of the Planning Process.

1.1 WestConnect Regional Transmission Planning Process

The identification of regional needs is the third step in the Planning Process. The planning process was developed for compliance with Federal Energy Regulatory Commission (FERC) *Order No. 1000, Transmission Planning and Cost Allocation by Transmission Owning and Operating Public Utilities* (Order No. 1000).[1] The Planning Process is performed biennially, beginning in even-numbered years, and consists of the seven primary steps outlined in **Figure 1**.

[1] *All references to Order No. 1000 include any subsequent orders.*

Figure 1: WestConnect Regional Transmission Planning Process



Additional details of the Planning Process can be reviewed in the WestConnect Regional Planning Process Business Practice Manual (BPM), posted to the WestConnect website here. Readers can access the text of the FERC Order No. 1000 compliance documentation on the WestConnect website here and are encouraged to consult the compliance documentation and BPM for additional process information.

1.2 WestConnect 2018-19 Regional Study Plan

The first step in the Planning Process is the development of a Study Plan. The 2018-19 Regional WestConnect Study Plan ("Study Plan") was approved by the PMC on March 14, 2018. The Study Plan identifies the scope and schedule of planning activities to be conducted during the planning cycle. The Study Plan also describes the models and studies to be developed in the model development portion of the Planning Process.

1.3 2018-19 Regional Model Development

The second step in the Planning Process is the development of regional models. Two types of studies are needed for the Planning Process: reliability ("power flow" and "stability") and economic ("production cost model" or PCM). During the second, third, and fourth quarters of 2018, the Planning Subcommittee developed regional models that were used in the identification of regional transmission needs for the 2018-19 Planning Process. WestConnect conducted an assessment of the region's transmission needs using models developed for the 2028 timeframe, approximately 10 years into the future. WestConnect

will also perform information-only scenario studies, as outlined in the Study Plan, which are designed to evaluate alternate but plausible futures.[2]

Table 1 lists the reliability and economic models developed for the 2018-19 cycle.

Table 1: WestConnect Planning Models

Case Name	Case Description and Scope
2028 Heavy Summer Base Case	Expected peak load for June - August during 1500 to 1700 hours MDT, with typical flows throughout the Western Interconnection
2028 Light Spring Base Case	Light-load conditions in spring months during 1000 to 1400 hours MDT with solar and wind serving a significant but realistic portion of the WECC total load
2028 Base Case PCM	Business-as-usual, expected-future case with median load and hydro conditions and representation of resources consistent with enacted public policies.

For the 2018-19 cycle, the Base Case model development was finalized on January 16, 2019, with the PMC's approval of the 2018-19 Model Development Report (MDR). The MDR describes the development process of the regional base models created with assistance from WestConnect members and other stakeholders. The report details key model assumptions and parameters, such as study timeframe, horizon, area, the Base Transmission Plan, and how public policy requirements were taken into account. Along with the MDR, the PMC approved the regional base models for use in assessments.

2.0 Regional Transmission Needs Assessment

The third step in the WestConnect regional Planning Process is the regional transmission needs assessment and identification of regional needs. The following sections outline the methods, assumptions, and results of the three types of regional need assessments: reliability, economic, and public policy.

2.1 Regional Reliability Needs Assessment

WestConnect conducted the 2018-19 regional reliability assessment on two base cases: the 2028 Heavy Summer Base Case and the 2028 Light Spring Base Case. These models originated from cases developed and approved by the Western Electricity Coordinating Council (WECC). The assessment for regional

[2] *As stated in the Study Plan, WestConnect regional assessments are centered on Base Cases and Scenarios, which when taken together, provide a robust platform that is used to identify the potential for regional transmission needs and emerging regional opportunities. Base Cases are intended to represent "business as usual," "current trends," or the "expected future." They are based on TO-supplied forecasts for load, generation, public policy resources, and transmission plans. Scenarios are intended to complement Base Cases by looking at alternate but plausible futures. They represent futures with resource, load, and public policy assumptions that are different in one or more ways than what is assumed in the Base Cases. The scenario assessments will be performed in 2019 and the results of the scenario assessments will be documented in a separate report.*

needs was based on reliability standards adopted by the North American Electric Reliability Corporation (NERC) TPL-001-4 Table 1 (P0 and P1) and TPL-001-WECC-CRT-3.1 (Transmission System Planning Performance WECC Regional Criterion), and supplemented with any more stringent Transmission Owner with Load Serving Obligations (TOLSO) planning criteria based on TOLSO member feedback. Initial identification of regional issues for further review was defined as system performance issues impacting or between more than one TO Member system.

Study Procedure and Assumptions

The reliability assessment included extensive testing and multiple iterations of model refinements, simulations, participant review of results, and incorporation of modifications and comments into the subsequent round of simulations. The final assessment of the base cases with contingency analysis and transient stability analysis became the final system assessment.

The final evaluation of the base reliability assessment was limited to contingencies meeting specific voltage and generation criteria, as described below.

Steady State Contingency Analysis

Contingency definitions for the steady-state contingency analysis were limited to N-1 contingencies for elements 230-kV and above, generator step-up transformers for generation with at least 200 MW capacity, and member-requested N-2 contingencies. All bulk electric system (BES) branches and buses in the WECC model were monitored with violation reports filtered to exclude branch flows that increased less than 1% and voltage decline less than 0.5%.

Transient Stability Analysis

The following contingencies were evaluated in the transient stability simulations for both cases:

1) 1PV: Tripping 1 Palo Verde (PV) generator and its generator step-up (GSU) transformer with fault on the Palo Verde 500kV bus
2) DP-Com: Tripping Daniel Park-Comanche 345kv Lines 1 & 2 with fault at the Comanche 345kV bus
3) MS-Wind: Fault on Missile Site 345kV Bus, loss of Missile Site – Harvest Mi & Missile Site – Daniels Park 345kV Lines, and loss of Limon and Missile Site Wind Generation
4) LRS-Fault: Fault on Laramie River 345kV Bus, loss of Laramie River – Ault 345kV Line, & loss of Laramie River #3 Generation
5) PV-CR_at_C: Palo Verde – Colorado River 500kV Line, Fault at Colorado River
6) PV-CR_at_P: Palo Verde – Colorado River 500kV Line, Fault at Palo Verde
7) Hass-NG_at_H: Hassyampa – North Gila 500kV Line, Fault at Hassyampa
8) Hass-NG_at_N: Hassyampa – North Gila 500kV Line, Fault at North Gila

Study Results

Upon a comprehensive review of the regional reliability assessment results, no regional needs were identified. This conclusion was reached because neither the Heavy Summer nor Light Spring

assessments identified reliability issues that were between two or more WestConnect members or impacted two or more WestConnect members. Results from the assessment are provided in Appendix B. The results include 14 voltage issues within multi-TO systems and 7 branch overloads and 105 voltage issues within single-TO systems which the Planning Subcommittee determined to be local issues and not regional.

2.2 Regional Economic Needs Assessment

WestConnect performed the 2018-19 regional economic assessment by conducting a PCM study on a 2028 Base Case along with one sensitivity case. The goal of the assessment was to test the base case and the Base Transmission Plan for economic congestion between more than one TOLSO Member's area. The economic base case originated from the WECC 2028 Anchor Dataset (ADS) PCM Version 1.0, and was reviewed and updated by WestConnect members to maintain maintained consistent electric topologies with the reliability base cases within the WestConnect footprint.[3] Detailed model and data assumptions are described in Section 4 of the MDR.

Study Procedure and Assumptions

The Planning Subcommittee conducted the study and reviewed the 2028 Base Case PCM results for regional congestion (i.e., number of hours) and congestion cost (i.e., the cost to re-dispatch more expensive generation because of transmission constraints). As with the reliability assessment, the economic assessment included extensive testing and multiple iterations of model refinements, simulations, participant review of results, and incorporation of modifications and comments into the subsequent round of simulations Wheeling charge assumptions were further vetted through a sensitivity analysis described below.

Given the regional focus of the WestConnect process, the Planning Subcommittee limited its congestion analysis to:

- Transmission elements (or paths/interfaces) between multiple WestConnect member TOs;
- Transmission elements (or paths/interfaces) owned by multiple WestConnect member TOs; and
- Congestion occurring within the footprints of multiple TOs that has potential to be addressed by a regional transmission project or non-transmission alternative.[4]

Sensitivity Study

As the work plan for the base economic model was being developed, there was considerable discussion around the wheeling charge modeling assumptions. A 50% Wheeling Charge Sensitivity Case was created from the 2028 Base Case PCM by reducing the regular, inter-area wheeling charges to 50% of what was assumed in the 2028 Base Case PCM. The other, emission-related wheeling charges were not changed from what was assumed in the 2028 Base Case PCM.

[3] There was one exception to this. The planned Apache ST4 generator was dispatched in the 2028 Heavy Summer Base Case but was turned off in the economic models.

[4] Congestion within a single TO's footprint (and not reasonably related or tied to other TO footprints) is out of scope of the regional planning effort and is alternatively subject to Order 890 economic planning requirements.

Study Results

The objective of the economic needs assessment was to arrive at a set of congested elements that warranted testing for the economic potential for a regional project solution, recognizing that the presence of congestion does not always equate to a regional need for congestion relief at a particular location.

There was no significant congestion to identify a regional need in the base case. For completeness, the Planning Subcommittee conducted the 50% wheeling charge sensitivity study described above to confirm that the wheeling charge assumptions were not hiding potential regional congestion.

The congestion results for the base case and the sensitivity case PCM are provided in Appendix C. The results include 9 congested elements in multi-TO systems and 21 congested elements in single-TO systems which the Planning Subcommittee determined to be local issues and not regional.

2.3 Public Policy Needs Assessment

The WestConnect Regional Planning Process is intended to identify regional needs and the more efficient or cost-effective solutions to satisfy those needs. Enacted public policy was considered in the Planning Process as a part of the base case development. Non-enacted or proposed public policies were considered as part of the scenario planning process. Enacted public policies were incorporated into the base models through the roll-up of local TO plans and their associated load, resource, and transmission assumptions. Given this, regional public policy needs can be identified one of two ways:

1) New regional economic or reliability needs driven by enacted Public Policy Requirements; or

2) Stakeholder review of local TO Public Policy Requirements-driven transmission projects and associated suggestions as to whether one or more TO projects may constitute a public policy-driven regional transmission need.

Study Procedure and Assumptions

WestConnect began the evaluation of regional transmission needs driven by public policy requirements by identifying a list of enacted public policies that impact local TO plans in the WestConnect planning region. This list was developed by the Planning Subcommittee in public meetings and posted in meeting materials. It was agreed that enacted public policies including but not limited to state RPS and distributed generation goals/set-asides would be represented in the base cases.

Study Results

In conducting the regional reliability and economic assessments (see above) the Planning Subcommittee did not find any regional issues driven by enacted public policy requirements. Furthermore, stakeholders did not suggest or recommend the identification of a public policy-driven transmission need based on TO's local transmission plans. Based on these two findings, there are no identified public policy needs in the WestConnect 2018-19 regional Planning Process.

3.0 Stakeholder Involvement

The Planning Process is performed in an open and transparent manner. The Planning Subcommittee and PMC meetings held in support of the regional transmission needs assessment were open to the public,

and each meeting provided an opportunity for stakeholder comment. Notice of all stakeholder meetings and stakeholder comment periods were posted to the WestConnect website[5] and distributed via email.

An open stakeholder meeting to discuss the WestConnect regional transmission needs assessment was conducted on November 15, 2018 and another is scheduled for February 13, 2019. The meetings were and will be announced through WestConnect's stakeholder distribution lists, and all stakeholders are invited to attend.

In response to stakeholder feedback during the 2018-19 cycle, the PMC will be developing a new Stakeholder Tracking Document and an accompanying webpage[6] through which the PMC can better collect, track, and resolve stakeholder comments and concerns going forward.

4.0 Conclusions and Next Steps

Based on the findings from the 2018-19 cycle analysis performed for reliability, economic, and public policy transmission needs as described in this Regional Needs Assessment Report, no regional transmission needs were identified in the 2018-19 needs assessment.

Since no regional transmission needs were identified, the PMC will not collect transmission or non-transmission alternatives for evaluation as there are no regional transmission needs to evaluate the alternatives against.

[5] *WestConnect Regional Planning meeting calendar: http://regplanning.westconnect.com/calendar_rp.htm*

[6] *WestConnect Regional Stakeholder Comments: http://regplanning.westconnect.com/stakeholder_comments.htm*

5.0 Appendix A: Information Confidentiality

The Planning Subcommittee handled confidential information in accordance with the protocols outlined in the BPM. Although the Regional Planning Process is open to all stakeholders, stakeholders are required to comply at all times with certain applicable confidentiality measures necessary to protect confidential information, proprietary information, or Critical Energy Infrastructure Information (CEII).

As it related to the model development portion of the process, confidentiality protections were accorded for the following:

- WestConnect power flow models are considered CEII. Based on this, during the case development process, only those entities having signed the appropriate Non-Disclosure Agreement (NDA) with WECC were granted access to the model. This iteration does not contain any information that is different from what would be typically contained in the original WECC base case.
- Certain generator procurement and contract information gathered during the RPS evaluation was considered commercially sensitive. Based on this assessment, that data was considered confidential and was not shared.
- WestConnect PCM is subject to the WestConnect Non-Disclosure Agreement, and its distribution was limited to signatures of that agreement.

6.0 Appendix B: Results of Reliability Needs Assessment

Table 2: Results of Regional Reliability Assessment Contingency Analysis

Base Case PF	Disturbance(s) [Multiple if affected elements were the same]	Affected Element					Regional Need	Determination
		Owner/ Operator(s)	Affected Element	Value under (Worst) Disturbance	Limit	Issue		
	Base Case	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NO	[redacted]
HS	EPE's PICANTE - AMRAD 345kV Line #1	EPE	AMRAD 345kV Bus	Δ -8.762%	-8%	High % V Decrease	NO	PNM, TSGT, & EPE: the issue is local in nature. The voltage deviation is largely representative of the radial nature of a small remote area off the BES leading to the characterization of this being a local problem. PNM has voltage support tentatively scheduled for 2023 that will address the excessive voltage drop in the area. It should be noted that this solution has been addressed in previous PNM planning cycles and does not result in customer voltages operating outside facility or service limits or a system operating near a voltage stability limit.
			AMRAD_B 345kV Bus	Δ -9.011%			NO	
			ALA_5 115kV Bus	Δ -8.194%			NO	
			HOLLOMAN 115kV Bus	Δ -9.319%			NO	
			MAR 115kV Bus	Δ -9.085%			NO	
			WHITE_SA 115kV Bus	Δ -8.345%			NO	
		TSGT	BLAZER_T 115kV Bus	Δ -10.24%			NO	
			C_CANYON 115kV Bus	Δ -10.53%			NO	
			JARILLA1 115kV Bus	Δ -8.069%			NO	
		PNM	ALAMOGCP 115kV Bus	Δ -9.366%			NO	
			RUIDOSO 115kV Bus	Δ -10.57%			NO	
			TULAROSA 115kV Bus	Δ -9.835%			NO	
			GAVILAN 115kV Bus	Δ -10.62%			NO	
				0.8998 pu kV	0.8999 pu kV	Low V	NO	
HS	PNM's PILLAR - BURNHAM -	PNM	GALLEGOS 230kV Bus	Δ -8.49%	-8%	High % V Decrease	NO	PNM: Gallegos 230 kV Bus does not have any

Base Case PF	Disturbance(s) [Multiple if affected elements were the same]	Affected Element					Regional Need	Determination
		Owner/ Operator(s)	Affected Element	Value under (Worst) Disturbance	Limit	Issue		
	GALLEGOS 230kV Line #1							load served. The load represented on the bus is attached to the line and is lost under the contingency therefore not subject to TPL-001-WECC-CRT-3.1 WR1.2.
	PNM's WESTMESA - SANDIA 345kV Line #1	PNM	PRAGER - MONTANOT 115 Line #1	838.73 Amp	783.19 Amp	Branch Overload	**NO**	PNM: Local Issue. Prager-Montano line is planned to be upgraded to 178 MVA (893.64 Amps).
	WAPA-DSW's PARKER - BLK MESA 230kV Line #1	WAPA-DSW	BLK MESA 230kV Bus	0.8991 pu kV	0.8999 pu kV	Low V	**NO**	WAPA: Rounding, WAPA does not consider this to be a violation.
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	**NO**	[redacted]
	IPA's INTERMT - INT MDUM 230/345kV Transformer #M or IPA's INTERMT - INT MDUM 345kV Line #M	IPA	INTERMT 230kV Bus	1.081 pu kV	1.05 pu kV	High V	**NO**	LADWP: The loss of the Intermountain 345/230kV Transformer #M does not capture a true breaker-to-breaker element. The contingency would include the loss of the transmission line from Intermountain 345kV to Gonder 230 kV. As such, this is not a credible contingency.
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	**NO**	[redacted]
HS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	**NO**	[redacted]

Base Case PF	Disturbance(s) [Multiple if affected elements were the same]	Affected Element					Regional Need	Determination
		Owner/ Operator(s)	Affected Element	Value under (Worst) Disturbance	Limit	Issue		
	[redacted]	[redacted]	[redacted]	[redacted]				
	[redacted]	[redacted]	[redacted]	[redacted]				
	[redacted]	[redacted]	[redacted]	[redacted]				
	[redacted]	[redacted]	[redacted]	[redacted]				
	[redacted]	[redacted]	[redacted]	[redacted]				
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NO	[redacted]
HS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NO	[redacted]
	IPA's ADELANTO - ADELANTX 500kV Line #1	LADWP	INT PF BUS 1 345kV Bus	1.058 pu kV	1.05 pu kV	High V	NO	LADWP: DC Jumper - This does not represent a true breaker-to-breaker element and is not a credible contingency.
			INT PF BUS 2 345kV Bus	1.058 pu kV				
			INT PF BUS 3 345kV Bus	1.057 pu kV				
			INT PF BUS 4 345kV Bus	1.057 pu kV				
			SOL1SUB 345kV Bus	1.057 pu kV				
		IPA	INTERMT 345kV Bus	1.057 pu kV				
			INTERMTX 345kV Bus	1.057 pu kV				
			INTERMTY 345kV Bus	1.055 pu kV				
		PG&E	SOL2SUB 345kV Bus	1.057 pu kV				

Base Case PF	Disturbance(s) [Multiple if affected elements were the same]	Affected Element					Regional Need	Determination
		Owner/ Operator(s)	Affected Element	Value under (Worst) Disturbance	Limit	Issue		
	IPA's ADELANTO - ADELANTY 500kV Line #1	LADWP	INT PF BUS 1 345kV Bus	1.058 pu kV	1.05 pu kV	High V	**NO**	LADWP: DC Jumper - This does not represent a true breaker-to-breaker element and is not a credible contingency.
			INT PF BUS 2 345kV Bus	1.058 pu kV				
			INT PF BUS 3 345kV Bus	1.057 pu kV				
			INT PF BUS 4 345kV Bus	1.057 pu kV				
			SOL1SUB 345kV Bus	1.057 pu kV				
		IPA	INTERMT 345kV Bus	1.057 pu kV				
			INTERMTX 345kV Bus	1.055 pu kV				
			INTERMTY 345kV Bus	1.057 pu kV				
		PG&E	SOL2SUB 345kV Bus	1.057 pu kV				
HS	IPA's INTERMT - INTERMTX 345kV Line #1	LADWP	INT PF BUS 1 345kV Bus	1.058 pu kV	1.05 pu kV	High V	**NO**	LADWP: DC Jumper - This does not represent a true breaker-to-breaker element and is not a credible contingency.
			INT PF BUS 2 345kV Bus	1.058 pu kV			**NO**	
			INT PF BUS 3 345kV Bus	1.057 pu kV			**NO**	
			INT PF BUS 4 345kV Bus	1.057 pu kV			**NO**	
			SOL1SUB 345kV Bus	1.057 pu kV			**NO**	
		IPA	INTERMT 345kV Bus	1.057 pu kV			**NO**	
			INTERMTY 345kV Bus	1.055 pu kV			**NO**	
		PG&E	SOL2SUB 345kV Bus	1.057 pu kV			**NO**	
	IPA's INTERMT - INTERMTY 345kV Line #1	LADWP	INT PF BUS 1 345kV Bus	1.058 pu kV	1.05 pu kV	High V	**NO**	LADWP: DC Jumper - This does not represent a true breaker-to-breaker element and is not a credible contingency.
			INT PF BUS 2 345kV Bus	1.058 pu kV			**NO**	
			INT PF BUS 3 345kV Bus	1.057 pu kV			**NO**	
			INT PF BUS 4 345kV Bus	1.057 pu kV			**NO**	
			SOL1SUB 345kV Bus	1.057 pu kV			**NO**	
		IPA	INTERMT 345kV Bus	1.057 pu kV			**NO**	

Base Case PF	Disturbance(s) [Multiple if affected elements were the same]	Affected Element					Regional Need	Determination
		Owner/ Operator(s)	Affected Element	Value under (Worst) Disturbance	Limit	Issue		
			INTERMTX 345kV Bus	1.055 pu kV			NO	
		PG&E	SOL2SUB 345kV Bus	1.057 pu kV			NO	
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NO	[redacted]
			[redacted]	[redacted]			NO	
			[redacted]	[redacted]			NO	
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NO	[redacted]
			[redacted]	[redacted]			NO	
			[redacted]	[redacted]			NO	
			[redacted]	[redacted]			NO	
HS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NO	[redacted]
			[redacted]	[redacted]			NO	
HS	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NO	[redacted]
			[redacted]	[redacted]			NO	
			[redacted]	[redacted]			NO	
			[redacted]	[redacted]			NO	
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NO	[redacted]
			[redacted]	[redacted]			NO	
			[redacted]	[redacted]			NO	
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NO	[redacted]

Base Case PF	Disturbance(s) [Multiple if affected elements were the same]	Affected Element					Regional Need	Determination
		Owner/ Operator(s)	Affected Element	Value under (Worst) Disturbance	Limit	Issue		
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NO	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NO	[redacted]
			[redacted]	[redacted]	[redacted]			
			[redacted]	[redacted]	[redacted]			
			[redacted]	[redacted]	[redacted]			
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NO	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NO	[redacted]
LSP	IPA's INTERMT - INT MDUM 230/345kV Transformer #M or IPA's INTERMT - INT MDUM 345kV Line #M	IPA	INTERMT 230kV Bus	1.08 pu kV	1.05 pu kV	High V	NO	LADWP: The loss of the Intermountain 345/230kV Transformer #M does not capture a true breaker-to-breaker element. The contingency would include the loss of the transmission line from Intermountain 345kV to Gonder 230 kV. As such, this is not a credible contingency.
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	NO	[redacted]
			[redacted]	[redacted]				
			[redacted]	[redacted]				
LSP		LADWP	INT PF BUS 1 345kV Bus	1.051 pu kV	1.05 pu kV	High V	NO	

Base Case PF	Disturbance(s) [Multiple if affected elements were the same]	Affected Element					Regional Need	Determination
		Owner/ Operator(s)	Affected Element	Value under (Worst) Disturbance	Limit	Issue		
	IPA's ADELANTO - ADELANTX 500kV Line #1		INT PF BUS 2 345kV Bus	1.051 pu kV				LADWP: DC Jumper - This does not represent a true breaker-to-breaker element and is not a credible contingency.
			INT PF BUS 3 345kV Bus	1.051 pu kV				
			INT PF BUS 4 345kV Bus	1.051 pu kV				
			SOL1SUB 345kV Bus	1.051 pu kV				
		IPA	INTERMT 345kV Bus	1.051 pu kV				
			INTERMTX 345kV Bus	1.051 pu kV				
			INTERMTY 345kV Bus	1.05 pu kV				
		PG&E	SOL2SUB 345kV Bus	1.051 pu kV				
	IPA's ADELANTO - ADELANTY 500kV Line #1	LADWP	INT PF BUS 1 345kV Bus	1.051 pu kV	1.05 pu kV	High V	**NO**	LADWP: DC Jumper - This does not represent a true breaker-to-breaker element and is not a credible contingency.
			INT PF BUS 2 345kV Bus	1.051 pu kV				
			INT PF BUS 3 345kV Bus	1.051 pu kV				
			INT PF BUS 4 345kV Bus	1.051 pu kV				
			SOL1SUB 345kV Bus	1.051 pu kV				
		IPA	INTERMT 345kV Bus	1.051 pu kV				
			INTERMTX 345kV Bus	1.05 pu kV				
			INTERMTY 345kV Bus	1.051 pu kV				
		PG&E	SOL2SUB 345kV Bus	1.051 pu kV				
LSP		LADWP	INT PF BUS 1 345kV Bus	1.051 pu kV	1.05 pu kV	High V	**NO**	LADWP: DC Jumper - This does not represent a true
			INT PF BUS 2 345kV Bus	1.051 pu kV				

Base Case PF	Disturbance(s) [Multiple if affected elements were the same]	Affected Element					Regional Need	Determination
		Owner/ Operator(s)	Affected Element	Value under (Worst) Disturbance	Limit	Issue		
	IPA's INTERMT - INTERMTX 345kV Line #1		INT PF BUS 3 345kV Bus	1.051 pu kV				breaker-to-breaker element and is not a credible contingency.
			INT PF BUS 4 345kV Bus	1.051 pu kV				
			SOL1SUB 345kV Bus	1.051 pu kV				
		IPA	INTERMT 345kV Bus	1.051 pu kV				
			INTERMTY 345kV Bus	1.05 pu kV				
		PG&E	SOL2SUB 345kV Bus	1.051 pu kV				
	IPA's INTERMT - INTERMTY 345kV Line #1	LADWP	INT PF BUS 1 345kV Bus	1.051 pu kV	1.05 pu kV	High V	**NO**	LADWP: DC Jumper - This does not represent a true breaker-to-breaker element and is not a credible contingency.
			INT PF BUS 2 345kV Bus	1.051 pu kV				
			INT PF BUS 3 345kV Bus	1.051 pu kV				
			INT PF BUS 4 345kV Bus	1.051 pu kV				
			SOL1SUB 345kV Bus	1.051 pu kV				
		IPA	INTERMT 345kV Bus	1.051 pu kV				
			INTERMTX 345kV Bus	1.05 pu kV				
		PG&E	SOL2SUB 345kV Bus	1.051 pu kV				

Figure 2. Frequency at All WestConnect Load Buses with WECC Voltage Criteria, for All Transient Stability Simulated Contingencies in Each Reliability Base Case

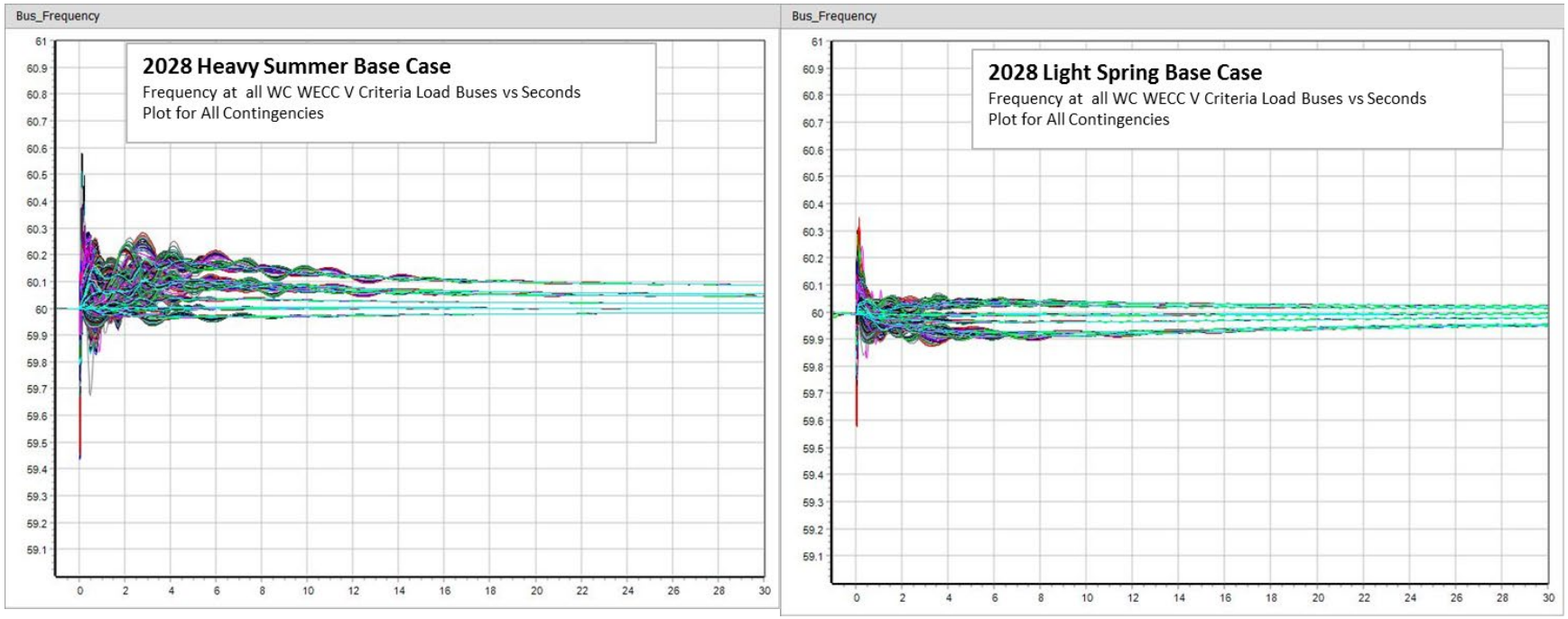


Figure 3. Per Unit Voltage at All WestConnect Load Buses with WECC Voltage Criteria, for All Transient Stability Simulated Contingencies in Each Reliability Base Case

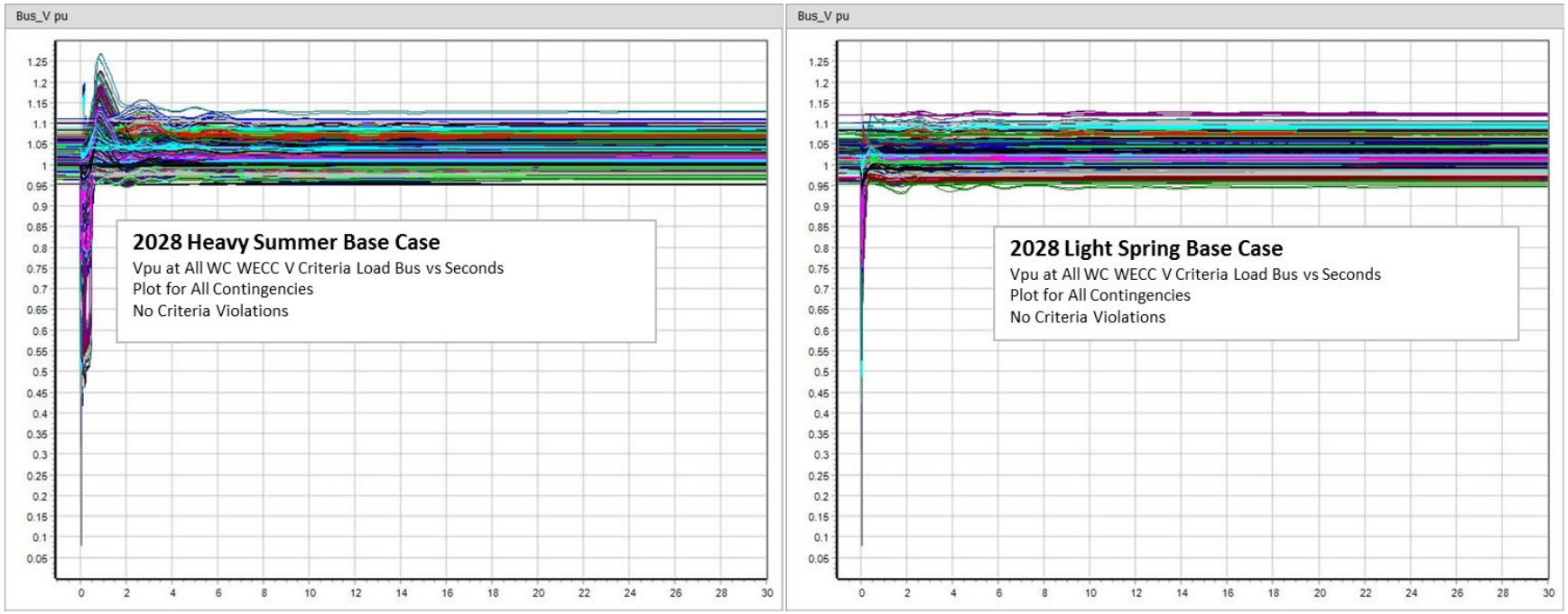


Table 3. Summary of Transient Stability Simulations Which Show No Violations. The Unrestored Load & Tripped Generation Reported by The Simulations Is Acceptable Per TPL standards[7]

Disturbance			HS Summary				LSP Summary			
Area Name	Owner Name	Name	Violations	Tripped Load (Unrestored)	Tripped Gen	Islanded Load	Violations	Tripped Load (Unrestored)	Tripped Gen	Islanded Load
WestConnect	WestConnect	Base	0	0	0	0	0	0	0	0
ARIZONA	APS, City of LA, EPE, IID, PNM, SRP, SCE, SCPPA	1PV	0	2,894	119	65	0	815	102	65
PSCOLORADO	Xcel/PSCO	DP-Com	0	107	0	0	0	68	0	0
PSCOLORADO	Xcel/PSCO	MS-Wind	0	304	0	0	0	103	0	0
WAPA R.M.	BEPC, TSGT	LRS-Fault	0	29	0	0	0	14	102	0
SOCALIF	SCE	PV-CR_at_C	0	640	0	0	0	116	0	0
ARIZONA, SOCALIF	SCE	PV-CR_at_P	0	3,035	119	0	0	831	0	0
ARIZONA, SANDIEGO	APS	Hass-NG_at_H	0	1,775	0	0	0	574	0	0
SANDIEGO	APS	Hass-NG_at_N	0	37	0	0	0	57	0	0

[7] *See TPL-001-4 references noted below:*

- *Note "b." in TPL-001-4: Consequential Load Loss as well as generation loss is acceptable as a consequence of any event excluding P0.*
- *Note "c." in TPL-001-4: Simulate the removal of all elements that Protection Systems and other controls are expected to automatically disconnect for each event.*

7.0 Appendix C: Results of Economic Needs Assessment

Table 4: Results of Regional Economic Needs Assessment

Element Information		Congestion Hours (% Hrs) / Cost ($)		Regional Need	Determination
Owner/ Operator(s)	Branch/Path Name	2028 Base Case	50% Wheeling Charge Sensitivity Case		
TANC|WAPA-SNR|BPA|PACW|PGE|CAISO	P66 COI	69 (0.79%) / 3,795K	99 (1%) / 5,481K	No	TANC & WAPA-SNR: Congestion cost is low and hours are also low.
WAPA-RM|PSCO	SANJN PS-WATRFLW 345kV Line Ckt 1	74 (0.84%) / 2,209K	213 (2%) / 8,118K	No	WAPA-RM, PSCO, & TSGT: Investigation into the congestion shown for the San Juan PST's revealed a modeling error in how Path 31 (TOT2A) flows were calculated, allowing TOT2A to flow beyond its limit. After correcting the branch definition, Path 31 (TOT2A) congests in a direction (south-to-north) in which it has historically never flowed. This observation warrants further exploration in a future cycle.
BEPC|TSGT	SAWMILLCK-LAR.RIVR 230kV Line Ckt 1	4 (0.05%) / 941K	4 (0.05%) / 739K	No	BEPC & TSGT: Only 4 hours of congestion is very minor (<<1% of the year) and can be considered noise, and the cost is relatively small
WAPA-RM|TSGT|DG&T	P30 TOT 1A	8 (0.09%) / 828K	10 (0.11%) / 434K	No	TSGT: Only 8/10 hours of congestion is very minor (<<1% of the year) and can be considered noise

Element Information		Congestion Hours (% Hrs) / Cost ($)		Regional Need	Determination
Owner/ Operator(s)	Branch/Path Name	2028 Base Case	50% Wheeling Charge Sensitivity Case		
TSGT|EPE|PNM	P47 Southern New Mexico	42 (0.48%) / 690K	73 (0.83%) / 1,376K	No	PNM, EPE, & TSGT: congestion is not high enough to be identified as a need. The number of hours of congestion identified in the model simulation is de minimis and the vetting process gave rise to questions about the model results. There was not a high degree of confidence in the congestion results with respect to this path. This factor, coupled with the trivial number of hours of congestion produced in the model simulation, resulted in the conclusion that it did not give rise to an economic-driven regional transmission need.
BEPC|TSGT|PACE	DAVEJOHN-SAWMILLCK 230kV Line Ckt 1	3 (0.03%) / 490K	34 (0.39%) / 720K	No	BEPC & TSGT: Only 3 hours of congestion is very minor (<<1% of the year) and can be considered noise, and the cost is relatively small

Element Information		Congestion Hours (% Hrs) / Cost ($)		Regional Need	Determination
Owner/ Operator(s)	Branch/Path Name	2028 Base Case	50% Wheeling Charge Sensitivity Case		
NVE|LADWP	P32 Pavant-Gonder InterMtn-Gonder 230 kV	36 (0.41%) / 311K	38 (0.43%) / 298K	No	NVE & LADWP: 1. Modeling issue on Intermountain – Gonder 230kV Line (see comment for P29). 2. The observed congestion is in W-E direction, which has not been observed historically and thus is likely a modeling issue. Furthermore, the 235MW path 32 W-E rating is based on the "capacity need" and "flowability" & not the facility ratings or other reliability constraints; therefore, there's a clear potential for its increase in the future, which could be recommended to be pursued by the path owners. 3. The congestion is insignificant both by hours and by cost.
LADWP|NVE	INTERMT-GONDER 230kV Line Ckt 1	1 (0.01%) / 6K		No	NVE & LADWP: Modeling issue. Correct rating for Intermountain – Gonder 230kV Line #1 (402MVA, i.e., 382 MW in PCM sim) wasn't modeled.
TSGT|WAPA-RM	P36 TOT 3	2 (0.02%) / 3K	13 (0.15%) / 220K	No	TSGT & WAPA-RM: Only 2 or 13 hours of congestion is very minor (<<1% of the year) and can be considered noise
[redacted]	[redacted]	[redacted]	[redacted]	No	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	No	[redacted]
TSGT	GLDSTNPS-GLADSTON 230kV Line Ckt 1	1,896 (22%) / 14,825K	2,807 (32%) / 32,331K	No	TSGT: Single entity so local by definition; Phase Shifting transformer
[redacted]	[redacted]	[redacted]	[redacted]	No	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	No	[redacted]
PSCO	LEETSDAL-MONROEPS 230kV Line Ckt 1	307 (4%) / 4,877K	308 (4%) / 5,222K	No	PSCO: This is a load-serving line in the Denver area. If PSCo reliability studies indicate performance issues, plans will be developed to address the local need.

Element Information		Congestion Hours (% Hrs) / Cost ($)		Regional Need	Determination
Owner/ Operator(s)	Branch/Path Name	2028 Base Case	50% Wheeling Charge Sensitivity Case		
[redacted]	[redacted]	[redacted]	[redacted]	No	[redacted]
LADWP|CAISO	P61 Lugo-Victorville 500 kV Line	177 (2%) / 1,885K	197 (2%) / 2,579K	No	LADWP: The transmission path congestion is only in the Lugo-Victorville direction, and historical meter data shows no power flow from Lugo to Victorville.
[redacted]	[redacted]	[redacted]	[redacted]	No	[redacted]
APS	MEADOWBK-SUNYSLOP 230kV Line Ckt 1	47 (0.54%) / 1,439K	47 (0.54%) / 1,383K	No	APS: Internal to APS System
PSCO	STORY-PAWNEE 230kV Line Ckt 1	117 (1%) / 996K	119 (1%) / 1,373K	No	PSCO: Reliability studies have not indicated any performance issues. Furthermore, the congestion of 1% in the PCM is not considered significant by PSCo.
NVE|CAISO	P24 PG&E-Sierra	2 (0.02%) / 627K	1 (0.01%) / 71K	No	NVE: The congestion is negligible (both by hours and by cost); the flow direction is "SPPC export". There's a path 24 limit of 120MW (export) & 100MW (import) on the CAISO/PG&E side, which wasn't applied to the WC model. If applied as a "nomogram", it would likely avoid the congestion. Similar issue for path 24 was recorded in the WestConnect 2016-17 Regional Transmission Plan as well (Appendix H, Table 9, footnote 41).
WAPA-DSW	ROGSWAPA-PINPK 230kV Line Ckt 1&2	6 (0.07%) / 482K	8 (0.09%) / 565K	No	WAPA-DSW: Hours of congestion are small enough to not be considered an issue for WAPA-DSW
PSCO	GREENWD-MONACO12 230kV Line Ckt 1	21 (0.24%) / 358K	17 (0.19%) / 262K	No	PSCO: This is a load-serving line in the Denver metro area. If PSCo reliability studies indicate performance issues, plans will be developed to address the local need. Furthermore, the congestion duration (0.19%) and associated costs are not considered significant by PSCo.

Element Information		Congestion Hours (% Hrs) / Cost ($)		Regional Need	Determination
Owner/ Operator(s)	Branch/Path Name	2028 Base Case	50% Wheeling Charge Sensitivity Case		
LADWP|PACE	INTERMT-MONA 345kV Line Ckt 1&2	72 (0.82%) / 357K	332 (4%) / 1,182K	No	LADWP: The transmission path is congested for less than one percent of the year and incurs relatively low cost.
[redacted]	[redacted]	[redacted]	[redacted]	No	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	No	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	No	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	No	[redacted]
APS	FOURCORN-MOENKOPI 500kV Line Ckt 1	1 (0.01%) / 13K		No	APS: Single hour in a ten-year forecast with minimal cost fails to signal credible congestion
APS	P22 Southwest of Four Corners		1 (0.01%) / 1K	No	APS: Single hour in a ten-year forecast with minimal cost fails to signal credible congestion
	All Congestion Cost:	**$88,870K**	**$125,870K**		
	Multi-Owner Congestion Cost:	**$9,270K**	**$17,390K**		

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