



WESTCONNECT REGIONAL TRANSMISSION PLANNING

2016-17 PLANNING CYCLE

REGIONAL TRANSMISSION NEEDS ASSESSMENT REPORT

APPROVED BY WESTCONNECT PLANNING MANAGEMENT COMMITTEE ON

APRIL 19, 2017

UPDATED JULY 27, 2021 TO REDACT NON-PUBLIC INFORMATION

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Contents

1.0	Introduction	3
1.1	WestConnect Regional Transmission Planning Process	3
1.2	WestConnect 2016-17 Regional Study Plan	4
1.3	2016-17 Regional Model Development.....	4
2.0	Regional Transmission Needs Assessment	6
2.1	Regional Reliability Need Assessment.....	6
2.2	Regional Economic Needs Assessment.....	7
2.3	Public Policy Needs Assessment	10
3.0	Stakeholder Involvement	10
4.0	Conclusions and Next Steps	11
5.0	Appendix A: Information Confidentiality	12
6.0	Appendix B: Results of Reliability Need Assessment	13
7.0	Appendix C: Results of Economic Need Assessment	15

1 **1.0 Introduction**

2 The purpose of this report is to summarize the regional transmission need identification phase of
3 WestConnect’s 2016-2017 Regional Transmission Planning Process (“Planning Process”). With
4 stakeholder input, the Planning Subcommittee developed this report to document the regional
5 transmission needs assessment and includes both minority and majority views on decisions and
6 assumptions used in performing the assessment.

7 The Planning Management Committee (PMC), which has decision-making authority in the
8 implementation of the Planning Process, approved, on [December 21, 2016](#), the Planning Subcommittee’s
9 recommendation that no regional transmission needs were identified in the 2016-17 Regional Planning
10 Process. This report provides documentation to the PMC in support of the Planning Subcommittee’s
11 recommendation with regard to the regional transmission need identification phase of the Planning
12 Process.

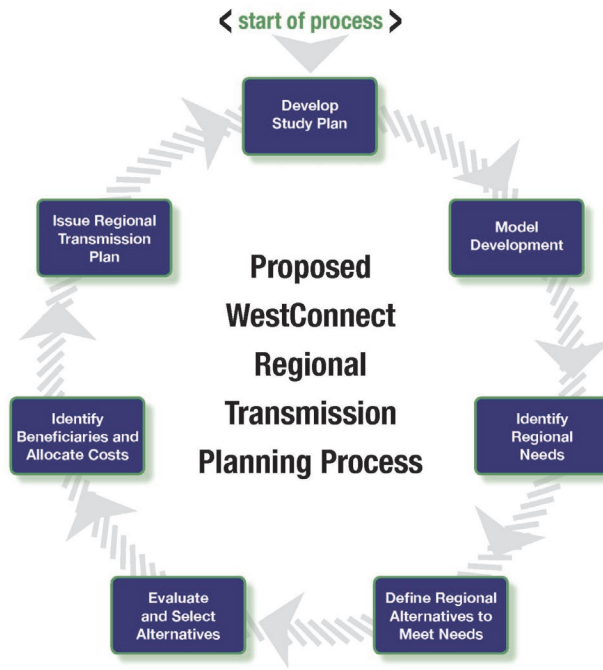
13 **1.1 WestConnect Regional Transmission Planning**
14 **Process**

15 The development of regional models is the third step in the planning process. The planning process was
16 developed for compliance with Federal Energy Regulatory Commission (FERC) [Order No. 1000](#),
17 [Transmission Planning and Cost Allocation by Transmission Owning and Operating Public Utilities](#) (Order
18 No. 1000).¹ The planning process is performed biennially, beginning in even-numbered years, and
19 consists of the seven primary steps outlined in Figure 1.
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¹ All references to Order No. 1000 include any subsequent orders.

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Figure 1: WestConnect Regional Transmission Planning Process



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

7 **1.2 WestConnect 2016-17 Regional Study Plan**

8 The first step in the Planning Process is the development of a 2016-2017 Regional WestConnect Study
9 Plan (“Study Plan”). The [Study Plan](#) was approved by the PMC on March 16, 2016. The Study Plan
10 identifies the scope and schedule of planning activities to be conducted during the planning cycle. The
11 Study Plan also describes the models and studies to be developed in the model development portion of
12 the Planning Process.

13 **1.3 2016-17 Regional Model Development**

14 The second step in the planning process is the development of regional models. Two types of studies are
15 needed for the Planning Process: reliability (“power flow”) and economic (“production cost model” or
16 PCM). During the second, third, and fourth quarter of 2016, the Planning Subcommittee developed
17 regional models that were used in the identification of regional transmission needs for the 2016-17
18 Planning Process. WestConnect conducted an assessment of the region’s transmission needs using
19 models developed for the 2026 timeframe, approximately 10 years into the future.

20 WestConnect regional assessments are centered on base cases and scenarios, which when taken
21 together, provide a robust platform to identify the potential for regional transmission needs and
22 emerging regional opportunities. Base cases are intended to represent “business as usual,” “current
23 trends,” or the “expected future.” Business-as-usual cases based on Transmission Owner (TO)-supplied
24 forecasts for load, generation, public policy resources, and transmission plans. Base case assessments

1 may lead to the identification of regional transmission needs. Scenarios are intended to complement the
 2 base cases by looking at alternate, but plausible futures. They represent futures with resource, load, and
 3 public policy assumptions that are different in one or more ways than what is assumed in the base cases.
 4 Scenario assessments may lead to the identification of regional opportunities.

5 Table 1 lists the reliability and economic models that were developed for the 2016-17 cycle.

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Table 1: WestConnect Planning Models

Reliability Model Case Summary			
	Case Name	Case ID	Case Description and Scope
Base Cases	2026 Heavy Summer Base Case	WC26-HS	Summer peak load conditions during 1500 to 1700 MDT, with typical flows throughout the Western Interconnection
	2026 Light Spring Base Case	WC26-LSP	Light spring load conditions between 0700 to 1000 MDT, with relatively high wind and solar generation
Scenario Cases	CPP – WestConnect Utility Plans Scenario	WC26-CPP1	Reflect individual WestConnect member utility plans for Clean Power Plan (CPP) compliance – <i>export hour of interest from PCM</i>
	CPP – Heavy RE/EE Build Out Scenario	WC26-CPP3	Additional coal retirements, additional RE/EE, minimal new natural gas generation – <i>export hour of interest from PCM</i>

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Economic Model Case Summary			
	Case Name	Case ID	Case Description and Scope
Base Case	2026 Base Case	WC26-PCM	Business-as-usual case based on WECC 2026 Common Case with additional regional updates from PMC members.
Scenario Cases	High Renewables	WC26-PCM-HR	California 50% Renewable Portfolio Standard (RPS) with regional resources (Wyoming wind and New Mexico wind) <i>and</i> increase WestConnect state RPS requirement beyond enacted with other resources
	CPP – WestConnect Utility Plans	WC26-PCM-CPP1	Reflect individual WestConnect member utility plans for CPP compliance
	CPP – Market-based Compliance	WC26-PCM-CPP2	Model CO ₂ price in WestConnect to achieve mass-based regional CPP compliance
	CPP – Heavy RE/EE Build Out	WC26-PCM-CPP3	Additional coal retirements, additional RE/EE, minimal new natural gas generation

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1 For the 2016-17 cycle, the model development phase was finalized on October 18, 2016, with the PMC's
2 approval of the [2016-17 Model Development Report](#) (MDR). The MDR describes the development of the
3 regional models that were created with assistance from WestConnect members and other stakeholders.
4 The report details key model assumptions and parameters, such as study timeframe, horizon, area, the
5 base transmission plan, and how public policy requirements were taken into account. Along with the
6 MDR, the PMC approved the regional base models for use in assessments and approved the assumptions
7 in the scenario models for continued development.

8 **2.0 Regional Transmission Needs Assessment**

9 The third step in the WestConnect regional planning process is the regional transmission needs
10 assessment and identification of regional needs. This process began after the PMC approval of the
11 regional models. The PMC also agreed to a phased approach to the assessments, in that the base
12 assessments would be completed first, followed by the scenario assessments. This decision was based
13 in part to the requirement that WestConnect identify regional needs by the end of the first year of the
14 study cycle. This phased approach does not impact the WestConnect regional need identification as the
15 scenario models do not drive regional needs, as explained further in the Study Plan. Therefore, this
16 Regional Needs Assessment Report only captures the needs assessment performed on the Base Cases.
17 The scenario assessments will be performed in 2017. Scenario assessments are information-only
18 studies. Information on these scenario model assessments will be reviewed by the PMC and
19 stakeholders as the studies are completed. The results of the scenario assessments will be documented
20 in the final WestConnect Regional Transmission Plan Report.

21 The following sections outline the methods, assumptions, and results of the three types of regional need
22 assessments: reliability, economic, and public policy.

23 **2.1 Regional Reliability Need Assessment**

24 WestConnect conducted the 2016-17 regional reliability assessment on two base cases: the 2026 Heavy
25 Summer base case and the 2026 Light Spring base case. These models originated from cases developed
26 and approved by the Western Electricity Coordinating Council (WECC). The assessment for regional
27 needs was based on reliability standards adopted by the North American Electric Reliability Corporation
28 (NERC) [TPL-001-4 Table 1](#) (P0 and P1) and [TPL-001-WECC-CRT-3-1](#) (Transmission System Planning
29 Performance WECC Regional Criterion). Initial identification of regional issues for further review was
30 defined as system performance issues impacting or between more than one TO Member system.

31 **Study Procedure and Assumptions**

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

36 The final evaluation of the base reliability assessment was limited to contingencies that could identify a
37 regional need, as determined by the Planning Subcommittee. The intent was to minimize flagging local
38 or “non-regional” issues. Contingency definitions for the steady-state power flow analysis were limited
39 to N-1 contingencies for elements 230-kV and above, generator step-up transformers for generation
40 with at least 200 MW capacity, and member-requested N-2 contingencies. All bulk electric system (BES)

1 branches and buses in the WECC model were monitored with violation reports filtered to exclude
2 branch flows that increased less than 1% and voltage decline less than 0.5%.

3 **Study Results**

4 Upon a comprehensive review of the regional reliability assessment results, no regional needs were
5 identified. This conclusion was reached because neither the Heavy Summer nor Light Spring
6 assessments identified reliability issues that were between two or more WestConnect members or
7 impacted two or more WestConnect members. Results from the assessment are provided in Appendix B
8 and in a posted workbook that includes the underlying steady-state assessment results.² The results
9 include one branch overload and a couple voltage issues within single-TO systems that were determined
10 to be local issues and not regional.

11 **2.2 Regional Economic Needs Assessment**

12 WestConnect performed the 2016-17 regional economic assessment by conducting a PCM study on a
13 2026 base case along with sensitivity cases. The goal of the assessment was to test the base case and the
14 Base Transmission Plan for economic congestion between more than one Transmission Owner with
15 Load Serving Obligations (TOLSO) Member's area. The economic base case maintained consistent
16 electric topologies with the reliability base cases within the WestConnect footprint.

17 **Study Procedure and Assumptions**

18 The Planning Subcommittee conducted the study and reviewed the PCM base case results for regional
19 congestion (i.e., number of hours) and congestion cost (i.e., the cost to re-dispatch more expensive
20 generation because of transmission constraints). The Planning Subcommittee's goal was to produce a
21 list of the significantly congested elements based on the study assumptions identified for the
22 WestConnect region. During the study work in 2016, modeling and data adjustments were made with
23 each iteration of the PCM base case, and additional sensitivities were run to isolate and better examine
24 regional facts that were challenging to capture within the software's functionality.³ PCM issues such as
25 the Phase Shifting Transformer (PST) modeling, energy imbalance market (EIM), and system
26 nomograms, are recognized by the Planning Subcommittee which may affect the results and therefore
27 require further vetting.

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

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

² <https://doc.westconnect.com/Documents.aspx?NID=17748>

³ Work on the economic model is continuing.

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.

1 Updates to base case

2 The 2026 PCM base case was developed from the WECC 2026 Common Case. A summary of the
3 noteworthy changes and modeling enhancements made to the 2026 Common Case, as well as updates to
4 the PCM software, are listed below.

- 5 • Numerous updates were made within the WestConnect footprint per WestConnect participant
6 input and for consistency between the WestConnect reliability and economic models as well as
7 outside of the WestConnect footprint per interregional coordination with Northern Tier
8 Transmission Group (NTTG), California Independent System Operator (CAISO), ColumbiaGrid,
9 and WECC.
- 10 • Updated reserve requirements for consistency with FERC 789
- 11 • Updated hurdle rate (wheeling charge) modeling based on the latest Open Access Transmission
12 Tariff rate information, which included separate rates for peak and off-peak hours
 - 13 ○ Proxy modeling of the EIM was also developed and studied with a sensitivity case.
- 14 • Developed critical disturbances either submitted by TOLSO Members or those associated with
15 WECC Transfer Paths
 - 16 ○ Initially developed as part of the base case, but ultimately, the TOLSO-submitted
17 disturbances were studied as a sensitivity case
- 18 • Added “EPE Balance” and “TEP Local Gen”⁵ nomograms and conditional constraints
- 19 • Updated PST modeling to ensure the branch thermal rating did not conflict with the operating
20 range
- 21 • Used PCM software version in which the PST operating cost calculation logic was adjusted by
22 the software vendor.⁶

23 Sensitivity Studies

24 As the base economic model was being developed and preliminary assessments were performed, there
25 was considerable discussion around certain modeling assumptions. This discussion focused primarily
26 on EIM, PSTs, and the inclusion of contingency modeling and sensitivity cases that were developed and
27 run to explore these three issues.

- 28 • EIM: EIM refers to the real-time market to manage transmission congestion and optimize
29 procurement of imbalance energy to balance supply and demand deviations for the balancing
30 authorities that have agreed to participate in the CAISO EIM. Accurately modeling EIM in an
31 hourly PCM presented a challenge. First, bids for resources in the EIM are generally submitted in
32 short (5-15 minute) intervals rather than the hourly PCM simulation’s hour time step. Second, load to
33 be served is known because it is a model input and therefore resources dispatched to meet the
34 load match perfectly. Hence there is no imbalance. Third, the PCM uses assumed values for

⁵ The terms “EPE Balance” and “TEP Local Gen” refer to names of specific nomograms in the PCM dataset.

⁶ Even with this adjustment, model output related to certain lines with phase shifters continued to show some amount of congestion in situations where member’s engineering judgement and historical experience ran contrary to the modeling result.

1 transmission charges while there are no transmission charges applied to resources that are
2 eligible to be scheduled in the EIM. Although some WestConnect members participate to some
3 extent in energy imbalance markets, it is not consistent throughout the WestConnect footprint.
4 Preliminary assessments tried to model EIM participation (as currently planned/announced),
5 but the group could not come to consensus on the appropriateness of having EIM in the base
6 models. However, the EIM representation was included in sensitivity analyses. The approximate
7 EIM representation in the sensitivity case was implemented by significantly reducing (by 90%)
8 the hour-ahead, inter-area wheeling charge within the dispatch phase of the PCM simulation.

- 9 • PSTs: The study results from preliminary assessments yielded some interesting results
10 attributed to how PSTs are represented in the PCM. In some instances, existing PSTs operated at
11 a much different frequency in the PCM than they have historically operated in real-time. In
12 addition, it was found that some PSTs were congested, which was not consistent with historic
13 operating best practices for such facilities since they are normally used to relieve congestion
14 rather than cause it. Some adjustments were made to the PST modeling to try to reflect expected
15 operating characteristics and WestConnect agreed to refine the modeling in a reasonable
16 manner, but it was decided that congestion issues associated with PSTs would be discounted
17 until additional confidence could be gained in the PCM. In the PST sensitivity case used to
18 evaluate the PST modeling, all PST-specific settings were removed and the PSTs were simply
19 modeled as regular transformers.
- 20 • Contingencies: Modeling contingencies in a PCM can provide some insight as to how the system
21 may perform when operators make adjustments to dispatch in anticipation of loading issues
22 associated with particular contingencies. This is in contrast to contingency modeling in steady
23 state power flow reliability cases that determine post-contingency loading on remaining
24 elements with no change in resource dispatch. The PCM also evaluates how the system dispatch
25 needs to adapt in each hour such that the modeled constraints in the pre- and post-contingency
26 conditions are met. WestConnect members agreed to remove contingency modeling for the base
27 assessment, but include it as a sensitivity study. The sensitivity case represented disturbances
28 submitted by WestConnect members.

29 Study Results

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

34 There was no regional congestion identified in the base case, and thus, there were no identified regional
35 economic needs. For completeness, the Planning Subcommittee conducted the sensitivity studies
36 described above to confirm that single modeling variables were not hiding potential regional congestion.
37 Only the High Natural Gas Price sensitivity showed significant changes from the base case with generally
38 higher congestion costs for internal system transmission congestion.

39 The congestion results for the base case and the PCM sensitivity studies are provided in Appendix C and
40 in a posted workbook.⁷

⁷ <https://doc.westconnect.com/Documents.aspx?NID=17747>

1 **2.3 Public Policy Needs Assessment**

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

- 8 1) New regional economic or reliability needs driven by enacted Public Policy Requirements; or
- 9 2) Stakeholder review of local TO Public Policy Requirements-driven transmission projects and
10 associated suggestions as to whether one or more TO projects may constitute a public policy-
11 driven regional transmission need.

12 **Study Procedure and Assumptions**

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

19 **Study Results**

20 In conducting the regional reliability and economic assessments (see above) the Planning Subcommittee
21 did not find any regional issues driven by enacted public policy requirements. Furthermore,
22 stakeholders did not suggest or recommend the identification of a public policy-driven transmission
23 need based on TO's local transmission plans. Based on these two findings, there are no identified public
24 policy needs in the WestConnect 2016-17 regional planning process.

25 **3.0 Stakeholder Involvement**

26 The Planning Process is performed in an open and transparent manner. The Planning Subcommittee and
27 PMC meetings held in support of the regional transmission needs assessment were open to the public,
28 and each meeting provided an opportunity for stakeholder comment. Notice of all stakeholder meetings
29 and stakeholder comment periods were posted to the WestConnect website⁸ and distributed via email.

30 Open stakeholder meetings to discuss the WestConnect regional transmission needs assessment were
31 conducted on November 17, 2017 and February 15, 2017. The meetings were announced through
32 WestConnect's stakeholder distribution lists, and all stakeholders were invited to attend.

⁸ WestConnect Regional Planning meeting calendar is available here:
http://regplanning.westconnect.com/calendar_rp.htm

1 **4.0 Conclusions and Next Steps**

2 Based on the findings from the 2016-17 cycle analysis performed for reliability, economic, and public
3 policy transmission needs as described in this Regional Needs Assessment Report, no regional
4 transmission needs were identified in the 2016-17 assessment.

5 Since no regional transmission needs were identified, the PMC will not collect transmission or non-
6 transmission alternatives for evaluation (as there will be no regional transmission needs to evaluate the
7 alternatives against). Whether the scenario study work, and any regional opportunities it might bring to
8 light, warrant further exploration and evaluation will be discussed among the PMC membership at a
9 later point in the Planning Process.

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 powerflow 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.

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6.0 Appendix B: Results of Reliability Need Assessment

Table 2: Results of Regional Reliability Assessment

2026 Base Case	Disturbance	Affected Element					Regional Need	Comment
		Owner/ Operator(s)	Affected Element	Value under Disturbance	Limit	Issue		
LSP	N/A (base case)	SPPC	CRTZ PIPE 120kV Bus (64175)	████████	████████	Low V	NO	Local Issue. Per NVE, can be fixed by ██████████.
			CRTZ S PIPE 120kV Bus (64387)	████████	████████	Low V	NO	
			CROSSROADS 120kV Bus (64655)	████████	████████	Low V	NO	
		LADWP	HYN1314G 230kV Bus (26155)	████████	████████	Low V	NO	Local issue. Per LADWP, can be fixed by ██████████.
			HYN1516G 230kV Bus (26156)	████████	████████	Low V	NO	
			HYN1112G 230kV Bus (26154)	████████	████████	Low V	NO	
			SYL PF BUS 1 230kV Bus (26270)	████████	████████	Low V	NO	
SYL PF BUS 2 230kV Bus (26271)	████████	████████	Low V	NO				
SYLMAR1 230kV Bus (26097)	████████	████████	Low V	NO				

2026 Base Case	Disturbance	Affected Element					Regional Need	Comment
		Owner/ Operator(s)	Affected Element	Value under Disturbance	Limit	Issue		
HS	APS's P1 (████████)	APS	CACTUS - OCOTILLO 230kV Line #1 (14202-14219-1)	████████	████████	Branch Overload	NO	Local Issue. Per APS, detailed power flow case (rather than bulk power flow case) modeling eliminates this issue.
	Either IID's P1 (████████) or IID's P1 (████████)	IID	MW1TAP 92kV Bus (21670)	████████	████████	Low V	NO	IID confirmed local issue and use of ██████ low voltage limit was appropriate.
			MIDWAY 230kV Bus (21699)	████████	████████	Low V	NO	
			MIDWAY 92kV Bus (21700)	████████	████████	Low V	NO	

1 7.0 Appendix C: Results of Economic Need Assessment

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Table 3: Results of Regional Economic Needs Assessment (2026 Base Case)

Element Information		Total Congestion Hours (% Hrs) / Cost (\$)	Regional Need	Comments
Owner/ Operator(s)	Branch/Path Name			
VEA CAISO (WAPA-DSW/VEA Border)	MEAD S_230.0 - BOB SS_230.0	643 (7%) / \$8,062K	NO	
NEVP PG&E CAISO	P24 PG&E-Sierra	493 (6%) / \$1,286K	NO	Modeling Issue; NVE disagrees with the results ⁹
NEVP (NEVP/BPA Border)	HIL TOP - HIL TOP	144 (2%) / \$492K	NO	Congestion is negligible; PST eliminates it completely
PG&E CAISO (TANC/PG&E Border)	LODI_230.0 - EIGHT MI_230.0	128 (1%) / \$175K	NO	
LADWP	RINALDI_230.0 - AIRWAY_230.0	2 (0%) / \$118K	NO	
TANC WAPA-SN BPA PacifiCorp PGE CAISO	P66 COI	4 (0%) / \$58K	NO	
LADWP SCE CAISO	P60 Inyo-Control 115 kV Tie	56 (1%) / \$30K	NO	
PSCO	LEETSDAL_230.0 - MONROEPS_230.0	2 (0%) / \$16K	NO	
NEVP IPCO	P16 Idaho-Sierra	4 (0%) / \$16K	NO	
LADWP Anaheim Riverside Pasadena Burbank Glendale	P29 Intermountain-Gonder 230 kV	1 (0%) / \$9K	NO	
IPCO (NEVP/IPCO Border)	MIDPOINT_345.0 - IDAHO-NV_345.0	3 (0%) / \$6K	NO	
PNM	P48 Northern New Mexico (NM2)	3 (0%) / \$3K	NO	
NEVP	CLARK 6 - CLARK	1 (0%) / \$2K	NO	Congestion is negligible; internal NVE XF which may restrict Clark plant output

⁹ Comments from NVE: This path between Sierra (NVE) & PG&E (CAISO) is an inter-regional tie between the WC & CAISO footprint&; also, it is controlled by a PST. on the NVE's side. Proper modeling information was not obtained from PG&E/CAISO. The congestion is shown only in CAISO->NVE direction, which is limited by a CAISO nomogram to 100MW only (which is not applied to the model). The modeling issues, specifically application of available transmission capacity to the existing paths, application of proper TAC for multiple entities (including CAISO, which is outside of WC) are not resolved at this time & therefore the congestion result as a modeling issue and should be ignored. Furthermore, the amount and cost of congestion (if it would be real) cannot justify any potential mitigation projects.

Element Information		Total Congestion Hours (% Hrs) / Cost (\$)	Regional Need	Comments
Owner/ Operator(s)	Branch/Path Name			
LADWP SCE CAISO Anaheim Riverside	P61 Lugo-Victorville 500 kV Line	1 (0%) / \$1K	NO	
NEVP SCE CAISO	P52 Silver Peak-Control 55 kV	2 (0%) / \$0K	NO	
LADWP PG&E SCE CAISO SDG&E CDWR Pasadena Anaheim Riverside	P41 Sylmar to SCE	2 (0%) / \$0K	NO	
PSCO	GREENWD_230.0 - MONACO12_230.0	1 (0%) / \$0K	NO	
Total Congestion Cost:		\$13,306K		

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Table 4: Results of Regional Economic Needs Assessment Sensitivity Analysis

Element Information		Total Congestion Hours (% Hrs) / Cost (\$)				Comments
Owner/ Operator(s)	Branch/Path Name	High Natural Gas Price ("HighNG")	Phase Shifters Converted to Normal Branches ("NoPST")	EIM Proxy Modeling ("WithEIM")	TOLSO- Submitted Contingencies ("WithOTG")	
APS	CTRYCLUB_230.0 - LINCSTRT_230.0	112 (1%) / \$2,826K	150 (2%) / \$1,657K	148 (2%) / \$1,902K	127 (1%) / \$1,599K	Internal to APS
NEVP PG&E CAISO	P24 PG&E-Sierra	769 (9%) / \$2,038K	624 (7%) / \$4,508K	237 (3%) / \$629K	577 (7%) / \$1,412K	
LADWP	TARZANA_230.0 - OLYMPC_230.0	21 (0%) / \$1,414K	22 (0%) / \$1,535K	16 (0%) / \$955K	19 (0%) / \$1,128K	
NEVP (NEVP/BPA Border)	HIL TOP - HIL TOP	442 (5%) / \$1,891K	-	2 (0%) / \$5K	162 (2%) / \$564K	
LADWP	RINALDI_230.0 - AIRWAY_230.0	2 (0%) / \$62K	3 (0%) / \$155K	4 (0%) / \$168K	4 (0%) / \$156K	
SMUD BPA PacifiCorp PGE CAISO	P66 COI	12 (0%) / \$233K	3 (0%) / \$49K	8 (0%) / \$137K	4 (0%) / \$49K	
PSCO	LEETSDAL_230.0 - MONROEPS_230.0	-	3 (0%) / \$18K	3 (0%) / \$20K	-	
PNM	P48 Northern New Mexico (NM2)	4 (0%) / \$42K	2 (0%) / \$1K	2 (0%) / \$2K	-	
PSCO	GREENWD_230.0 - MONACO12_230.0	10 (0%) / \$110K	2 (0%) / \$2K	2 (0%) / \$1K	4 (0%) / \$13K	

Element Information		Total Congestion Hours (% Hrs) / Cost (\$)				Comments
Owner/ Operator(s)	Branch/Path Name	High Natural Gas Price ("HighNG")	Phase Shifters Converted to Normal Branches ("NoPST")	EIM Proxy Modeling ("WithEIM")	TOLSO- Submitted Contingencies ("WithOTG")	
NEVP	CLARK 6 - CLARK	2 (0%) / \$4K	4 (0%) / \$17K	1 (0%) / \$16K	3 (0%) / \$9K	
LADWP PG&E SCE CAISO SDG&E CDWR Pasadena Anaheim Riverside	P41 Sylmar to SCE	1 (0%) / \$0K	-	2 (0%) / \$1K	-	
APS	MEADOWBK_230.0 - SUNYSLOP_230.0	-	-	-	10 (0%) / \$393K	Internal to APS
NEVP	TRACY E_345.0 - VALMY_345.0	-	-	1 (0%) / \$9K	-	Congestion is negligible; internal NVE path
PSCO	CABINCRK_230.0 - DILLON_230.0	13 (0%) / \$70K	-	-	-	
WAPA-RM PRPA TSGT UAMP	P30 TOT 1A	-	-	2 (0%) / \$3K	-	
NVE LADWP CAISO PacifiCorp	P32 Pavant-Gonder InterMtn-Gonder 230 kV	1 (0%) / \$1K	2 (0%) / \$4K	7 (0%) / \$36K	3 (0%) / \$8K	Congestion is negligible/non-existent
WAPA_RM MBPP PSCO TSGT	P36 TOT 3	45 (1%) / \$1,247K	-	-	-	
EPE PNM Tri-State	P47 Southern New Mexico (NM1)	7 (0%) / \$61K	-	-	-	Congestion is negligible/non-existent, and appears only in the High NG case that assumed extreme prices outside the range of any recognized forecast.
NEVP SCE CAISO	P52 Silver Peak-Control 55 kV	64 (1%) / \$9K	184 (2%) / \$420K	2 (0%) / \$0K	2 (0%) / \$0K	
LADWP SCE CAISO Anaheim Riverside	P61 Lugo-Victorville 500 kV Line	3 (0%) / \$21K	-	-	-	
	Total Congestion Cost:	\$10,029K	\$8,367K	\$3,884K	\$5,330K	