WESTCONNECT REGIONAL TRANSMISSION PLANNING

2018-19 PLANNING CYCLE

MODEL DEVELOPMENT REPORT

APPROVED BY WESTCONNECT PLANNING MANAGEMENT COMMITTEE ON

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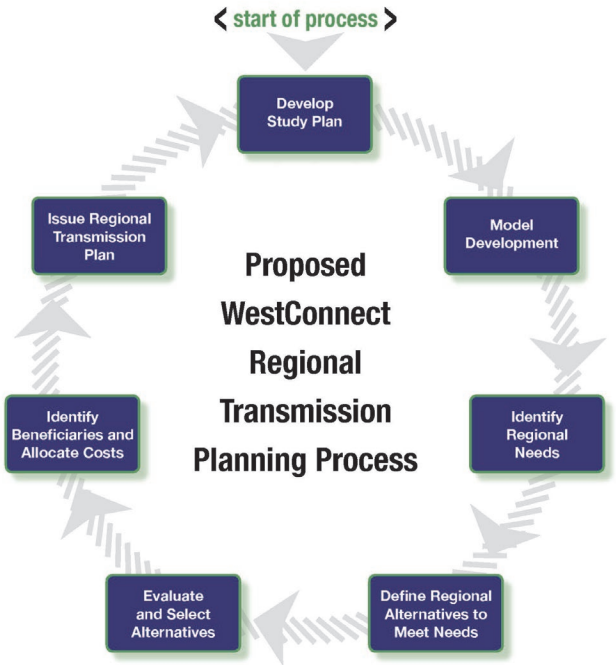
1.0 Introduction

The purpose of this report is to summarize the model development phase of WestConnect's 2018-19 Regional Planning Process. The Planning Subcommittee, which is responsible for developing WestConnect's regional models, has compiled this report to document major assumptions that have been incorporated into the models. The objective of model development is to support the overall purpose of the Regional Planning Process, which is to identify regional transmission needs and the more efficient or cost-effective solutions to satisfy those needs. The Planning Management Committee (PMC), which has decision-making authority over the overall WestConnect planning process, approves the regional models that are then used during the transmission assessment. The results of the regional transmission assessment will be documented in a future report.

1.1 WestConnect Regional Transmission Planning Process

The development of regional models is the second step in the WestConnect Regional Transmission Planning Process ("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 seven steps as outlined in **Figure 1**.

Figure 1: WestConnect Regional Transmission Planning Process



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

Additional details of the Planning Process can be reviewed in the WestConnect Regional Planning Process Business Practice Manual (BPM) posted to the WestConnect website (link). Readers can access the text of the FERC Order No. 1000 compliance documentation on the WestConnect website (link), 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 Regional Study Plan ("Study Plan"). The 2018-19 WestConnect 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 to be developed in the model development portion of the Planning Process.

2.0 Model Development Overview

During the second, third, and fourth quarter of 2018, the Planning Subcommittee developed the regional models to be used in the identification of regional transmission needs for the 2018-19 Planning Process. Two types of studies are performed in the Planning Process: reliability ("power flow") and economic ("production cost model" or PCM) studies. 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]

In response to stakeholder feedback during the 2018-19 cycle, the PMC will be developing a new Stakeholder Tracking Document and an accompanying webpage[3] through which the PMC can better collect, track, and resolve stakeholder comments and concerns going forward.

Table 1 lists the reliability and economic models developed for the 2018-19 cycle for the purposes of identifying regional transmission needs.

Table 1: WestConnect Regional Needs Assessment Planning Models

WestConnect Base Case Name	Case Description	WECC Seed Case
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 Heavy Summer 1 Base Case(28HS1a)

[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.

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

WestConnect Base Case Name	Case Description	WECC Seed Case
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 Light Spring1 Scenario Case (28LSP1-S)
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.	WECC 2028 Anchor Data Set (ADS) PCM Version 1.0 (2028 ADS PCM V1.0)

Study Area

The WestConnect planning process evaluates the regional transmission needs solely of the WestConnect planning region, which is defined as the combined footprints of signatories to the Planning Participation Agreement (PPA) within the Transmission Owner (TO) Member Sector. A list of Members participating in the WestConnect 2018–19 planning process is available on the WestConnect website (link). PMC Members and participants updated WECC models, as described in more detail below to create a more accurate representation of the WestConnect footprint in each case.

To the extent WestConnect received updated modeling data from TOs outside of the WestConnect planning region during the development of the regional models, it was considered, and if appropriate, incorporated into the regional models. In some cases, data was not incorporated because, after review, it was determined the data would not impact conclusions in WestConnect's assessment or, in other instances, the receipt of the data would impact WestConnect's schedule. The goal in seeking input from neighboring planning regions and TOs outside of the WestConnect planning footprint is to maintain a reasonable level of model consistency and align planning assumptions as closely as possible. Details about the types of information received from external participants (e.g., planning regions, other TOs) are included in the model descriptions in the sections that follow.

3.0 Reliability Model Descriptions

The information in this section summarizes each reliability model and provides details about the major assumptions incorporated into the reliability cases. Note that the cases have detailed change records documenting specific data changes made to the original starting point case. This report summarizes each case and does not document each specific assumption.

2028 Heavy Summer Base Case

Description: The case is designed to evaluate the Base Transmission Plan under heavy summer conditions. The seed case was the WECC 2028 Heavy Summer 1 Base Case dated December 20, 2017 (28HS1a), which was updated with the latest topology (i.e., generator, load, and transmission) information from WestConnect participants. The load level and generator dispatch were updated to account for these updates while still representing typical heavy summer load conditions and generator dispatch.

Generation: Within WestConnect, the case features a dispatch of 62,075 MW of thermal and hydro resources and 5,637 MW of wind and solar resources.

Load: The aggregate coincident peak load level for the WestConnect footprint is 65,274 MW. The original WECC case represented the system coincident peak for a heavy summer conditions between the hours of 1500 to 1700 MDT during the months of June – August. WestConnect's intent was to continue these assumptions during its case development.

Transmission: No major planned transmission additions beyond the Base Transmission Plan were included in the case.

Other assumptions: Northern Tier Transmission Group (NTTG) submitted updates to the WECC 28HS1a power flow case to WECC in late June 2018. The NTTG power flow changes were reviewed and select updates that impacted WestConnect determined by the PS were incorporated in the power flow cases. A summary of the changes is below.

- Retirement of Valmy unit #1 and rebalance Sierra area by re-dispatching generation in Sierra, scheduling an import from the SCE to Sierra, and changes to reactor settings.
- Incorporation of minor transmission rating updates in the NTTG area
- Retirement of Dave Johnston and Naughton units.
- Incorporation of PacifiCorp renewables in their 2020 Energy Vision and recommend changes to re-balance the PacifiCorp area by re-dispatching the Hunter and Huntington units.

2028 Light Spring Base Case

Description: The purpose of the case is to assess Base Transmission Plan performance under light-load conditions with solar and wind serving a significant but realistic portion of WestConnect's total load. The case does not include renewable resource capacity additions beyond what is already planned and included in the WestConnect base case future – the case intends to represent likely and expected system conditions. The seed case was the WECC 2028 Light Spring 1 Scenario Case dated December 1, 2017 (28LSP1-S).

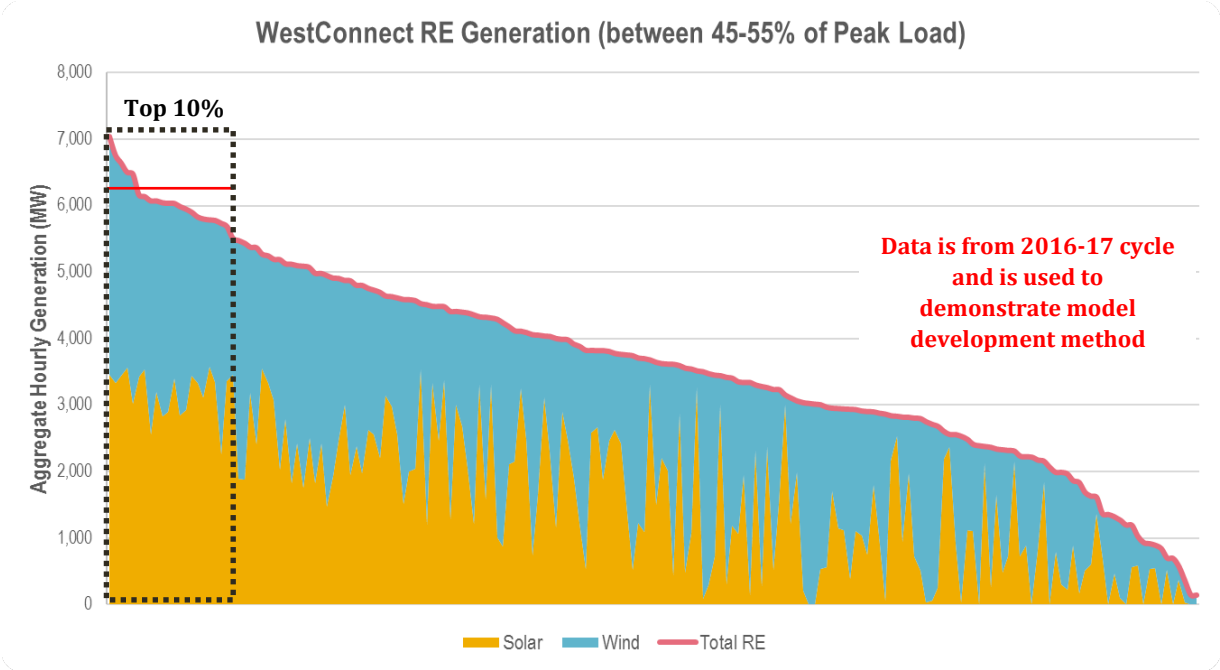
Generation: Within WestConnect, the case features 2,826 MW of wind and 4,377 MW of solar resources. The case description of the WECC 28LSP1-S included wind and solar dispatch targets recommended by WestConnect, the background of which are described below.

As part of the development of the WestConnect 2026 Light Spring Base Case during the 2016-17 cycle, WestConnect used the WECC 2024 Common Case PCM to develop a likely instance of off-peak loading and high renewable generation. Simulated historical weather data was used to adjust the dispatch level for all wind and solar resources in the WestConnect footprint.[4] The use of hourly wind and solar production data ensured a realistic and geographically matched dispatch of non-thermal resources across the WestConnect footprint. To identify the wind and solar dispatch level, the hourly wind and solar production data described above was filtered to only include data corresponding to mid-morning morning hours between 0700 and 1000 MST when load was between 45-55% of the WestConnect peak. The reduced set of hourly wind and solar production data for WestConnect during these hours is shown

[4] *The National Renewable Energy Laboratory (NREL) has created hourly solar and wind meso-scale production data for about 30,000 sites throughout the Western Interconnection. The shapes are based on meteorological modeling that produces historical wind speed and irradiance data for locations across the West. These shapes are used by WECC to develop energy production profiles for wind and solar generation resources in their Common Case production cost modeling dataset. The 2024 Common Case, whose data was used for the analysis described herein, used NREL profiles representing the 2005 historical weather year.*

in **Figure 2**. WestConnect opted to represent a wind and solar dispatch consistent with the average of the top 10% of generation hours (after ranking by combined MW output).

Figure 2: Hourly Production Data used to Estimate Wind and Solar Dispatch



After the wind and solar generators were re-dispatched, as outlined above (based on their geographically-specific generation profiles), the thermal fleet was re-dispatched by PMC members to balance load and resources, keeping interchange between regions and areas roughly the same as in the original WECC case.

The roughly 7,200 MW of wind and solar energy dispatched across WestConnect during the mid-morning hours, as modeled in this case, is intended to represent a realistic and likely future. This level of renewables served 19% of the total WestConnect load in this hour, as noted above.

Load: WestConnect member loads were adjusted slightly from the seed case to attempt to more closely correlate the load forecast to the wind and solar dispatch. The nature of the adjustment (i.e., up, down) was specific to each transmission owner. The total WestConnect load in the case is 41,894 MW, which is 64% of the WestConnect peak load in the WestConnect 2028 Heavy Summer Base Case. The load levels represent the system during 1000 to 1400 hours MDT, the same hours used to develop the wind and solar generator dispatch.

Transmission: Identical transmission assumptions as the 2028 Heavy Summer Base Case – see above for details.

Other assumptions: Identical other assumptions as the 2028 Heavy Summer Base Case – see above for details.

Contingency Definitions, Dynamic Data, and Other Considerations

The regional reliability models identified as "base cases" will be used to identify regional transmission needs. Scenarios will be limited to identifying regional opportunities. Both assessments will be conducted using contingency definitions that were designed to limit the analysis to identifying regional transmission issues.

An initial list of automatically created single branch ("N-1") outages 230 kV and higher was created and participants also submitted multi-element contingency definitions not automatically created. Participants reviewed the outage list and (a) identified invalid single branch outages to remove, and (b) identified other contingencies not included in the list that could potentially flag regional transmission issues.

The dynamic data needed to support the transient stability simulations was developed by first taking the dynamic data from the WECC seed cases and appending additional or revised dynamic data per participant submittals.

The Planning Subcommittee also considered the following when developing the cases:

- **Operating Procedures** – Any special operating procedures required for compliance with NERC reliability standards are considered and included in the power flow cases.
- **Protection Systems** – The impact of protection systems including RAS required for compliance with NERC reliability standards will be included in the power flow cases.
- **Control Devices** – Any special control devices required will be included in the power flow cases.

The quality of the base cases and contingency definitions were improved by iteratively developing draft cases with contingency definitions and performing test simulations. After each draft and test simulation, data owners had the opportunity to examine and submit corrections. This procedure resulted in six review drafts of the base reliability models.

4.0 Economic Model Descriptions

The reliability base models and economic base models maintained consistent electric topologies (e.g., matching load, generator, and branch models) throughout their development with one exception: The planned Apache ST4 generator was dispatched in the 2028 Heavy Summer and Heavy Summer Base Cases, but was turned off in the 2028 Base Case.

2028 Base Case

Description: The case is a PCM dataset designed to represent a likely, median 2028 future. The WECC 2028 Anchor Dataset (ADS) interconnection-wide 10-year PCM ("2028 ADS PCM V1.0" or "28ADS-V1.0"), dated June 29, 2018, served as the seed case for the WestConnect economic model 2028 Base Case. The 2028 ADS PCM V1.0 was reviewed and updated by WestConnect during Quarters 3 and 4 of the 2018-19 planning cycle consistent with the process described below.

Generation:

- WestConnect's latest generator-specific modeling was developed and used to update the dataset. This included but was not limited to: generator type, commission and retirement date,

forced outage rate, outage duration, minimum and maximum capability with applicable de-rates for plant load or seasonal ambient temperature, minimum up and down times, fuel assignments, variable operations and maintenance and start-up costs, linkage to reserve modeling and regional/remote scheduling, linkage to operational nomograms, hydro fixed shape or load/price-driven scheduling, and hourly shapes. **Table 2** provides a summary by fuel category of the generation updates made to the WECC 2028 ADS PCM V1.0. The positive (or negative) values represent the capacity (in MWs) and resulting generated energy (in GWh) added to (or removed from) the WECC 2028 ADS PCM V1.0 in order to create the WestConnect 2028 Base Case PCM.

Table 2: Generation Changes Made to WECC 2028 ADS PCM V1.0.
Percentages are in reference to the totals in the WECC 2028 ADS PCM V1.0

Fuel Category	Annual Generation		Capacity	
	GWh	%	MW	%
Coal	(24,859)	-26.3%	(4,334)	-28.8%
Gas	4,267	3.3%	(213)	-0.5%
Water	(201)	-1.0%	(10)	-0.1%
Uranium	(2,205)	-7.0%	0	0.0%
Solar PV	1,056	8.5%	1,278	24.7%
Solar Thermal	4	0.4%	0	0.0%
Wind	7,484	43.6%	1,557	26.3%
Bio	286	96.9%	8	7.1%
Geothermal	(3,210)	-31.7%	138	10.7%
DG/EE/DR	(9,803)	-54.2%	(4,584)	-50.8%
Other	104	100.9%	249	13.6%
Overall	(27,076)		(5,911)	

- The behind-the-meter distributed generation (BTM-DG) assumptions were retained from the WECC 2028 ADS PCM V1.0 which modeled them on the resource-side, with the exceptions listed below. **Table 3** summarizes the amount of BTM-DG by area represented in the WestConnect 2028 Base Case PCM.

    1. AZPS: A new hourly load shape was provided which represented the combination of the load, BTM-DG, and demand response (DR).

    2. TEPC: The BTM-DG and DR shapes were merged with the load shapes to model the BTM-DG and DR on the load-side.

    3. EPE: BTM-DG and DR shapes were removed since EPE's behind the meter generation was already accounted for as an adjustment in EPE's load numbers.

Table 3: Behind-the-Meter Distributed Generation

Area Name	Capacity (MW)	Generation (GWh)	Capacity Factor (%)	Dispatch at Area Peak Demand (% of Capacity)
AZPS	3,461	5,979	20%	16%
BANC	574	1,373	27%	50%
EPE	0	0	0%	0%
IID	130	291	26%	83%
LDWP	630	1,438	26%	56%
NEVP	599	1,339	25%	70%
PNM	132	289	25%	51%
PSCO	522	1,191	26%	72%
SPPC	83	192	26%	71%
SRP	438	967	25%	64%
TEPC	433	927	24%	29%
WACM	60	139	26%	16%
WALC	324	702	25%	74%

Load: WestConnect made minor modifications to the load shapes and forecasts included in the WECC 2028 ADS PCM V1.0. No changes were made to the load forecasts for areas outside of WestConnect. **Figure 3** and **Figure 4** provide the annual load energy, various load snapshots (peak load and load during system/WECC peak), and the average load on a "PCM Area" basis. The PCM Areas are generally analogous to Balancing Authorities rather than specific utilities. The "PF Load" – load in the WestConnect 2028 Heavy Summer Base Case – is provided for a frame of reference, though, some difference between the PCM and PF load snapshots is typical given:

- The power flow model focuses on an extreme or more-stressed-than-normal system condition whereas the economic model's load shapes do not contain extremely high or low load values since they are developed to support a median year-long simulation.
- The economic model load values include losses whereas the sum of the power flow model loads does not include losses.
- The economic model load shapes do not include the impact of BTM-DG except for AZPS and TEPC whereas the power flow model loads may or may not contain BTM-DG.
- The economic loads in the charts below include exports out of Western Interconnection via the direct current interties along the east side of the Western Interconnection whereas they may or may not be included in the power flow load in the below.

Figure 3: WestConnect PCM Areas' Annual Load (GWh) [with Losses] in WestConnect 2028 Base Case (PCM)

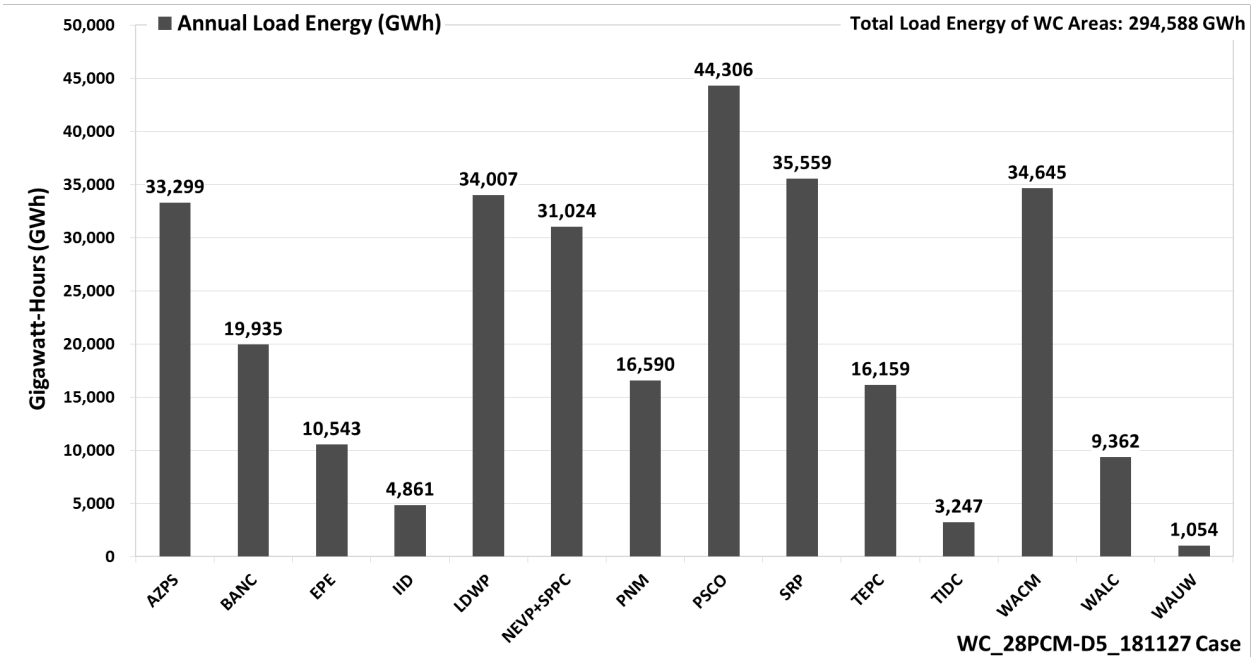
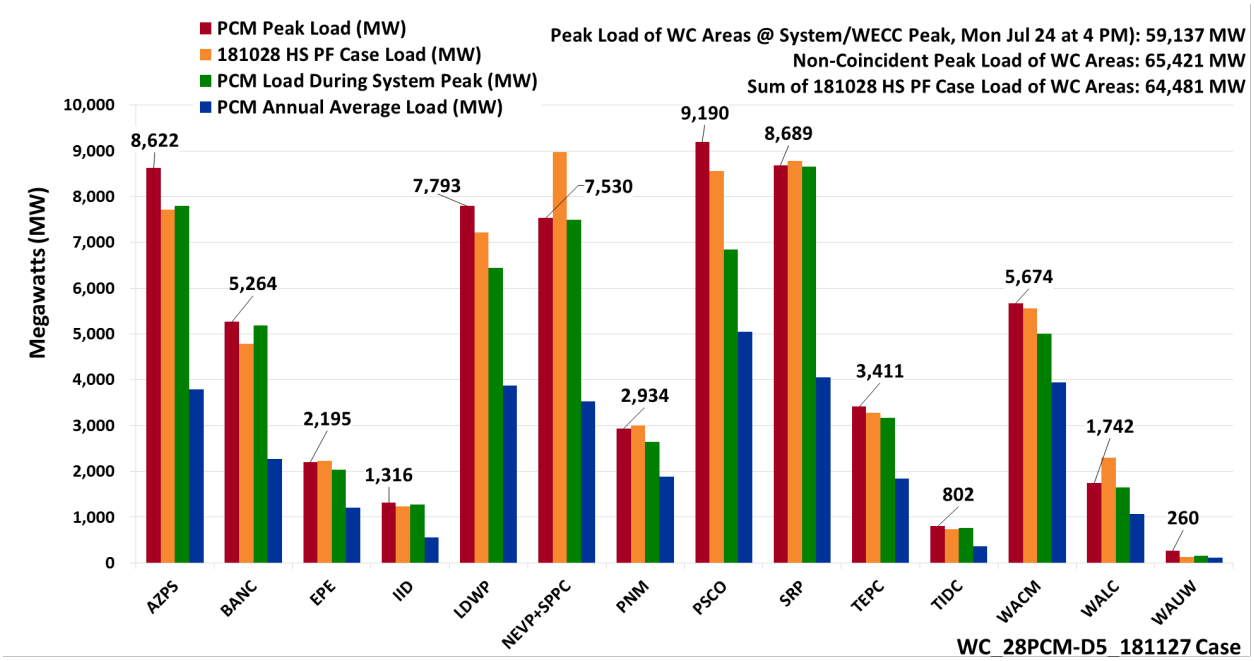


Figure 4: WestConnect PCM Areas' Peak, Load During System Peak, and Average Load (MW) in WestConnect 2028 Base Case (PCM) [with Losses], shown with the Load Heavy Summer Base Case [No Losses]



Transmission: The WECC 2028 ADS PCM V1.0 was updated with the WestConnect member topology to be consistent with the WestConnect Base Transmission Plan and the reliability model topology. WestConnect also reviewed the case for seasonal branch ratings, interfaces, and nomograms – making the below listed changes in each of these categories. The transmission topology outside of WestConnect, including the Common Case Transmission Assumptions, was not modified.

- Increased branch monitoring in the WestConnect footprint: Monitored transmission lines ≥ 200 kV, transformers ≥100 kV, and all phase shifting transformers (PST) (phase angle regulators, or PAR), less Bulk Electric System (BES) exceptions in WestConnect (based on the branch monitoring in the reliability models)
- Updated interface definitions

Other Assumptions:

- Any opportunity to more closely align the economic base case model with the reliability base case model was taken. For example, the summer and winter branch ratings and load distribution factors were aligned with the 2028 Heavy Summer case.
- Fuel price forecasts and emission rate assumptions were consistent with the WECC 2028 ADS PCM V1.0. These assumptions are included in Appendix A.
- Reserve requirements modeling was consistent with the WECC 2028 ADS PCM V1.0.
- Variable Operations and Maintenance (VOM) cost modeling was consistent with the WECC 2028 ADS PCM V1.0.
- Wheeling charges, which represent the transmission service charges associated with transferring power between areas were revised from the original WECC 2028 ADS PCM V1.0 values to peak and off-peak wheeling charges based on the latest Open Access Transmission Tariff (OATT) rate. These assumptions are provided in Appendix A. The WECC 2028 ADS PCM V1.0 also contained additional wheeling charges associated with modeling carbon emission charges applicable to California, and these rates were maintained. Planning Subcommittee members reviewed these updates through draft model releases. Additional details for the wheeling charge modeling assumptions are included below:
    - The regular, inter-area wheeling charges were based upon the OATT on-peak and off-peak non-firm point-to-point transmission service charges (Schedule 8) as well as Schedule 1 (Scheduling System Control and Dispatch Service) and Schedule 2 (Reactive Supply and Voltage Control) charge components of transmission providers in the Western Interconnection.
    - Emission-related wheeling charges: The carbon emission charges applicable to California were representing the California Global Solutions Act (AB 32) modeling and its modeling in the WECC 2028 ADS PCM V1.0 was retained.
- Nomograms and transmission interfaces were modeled by starting with the WECC 2028 ADS PCM V1.0, and then enhanced with additional nomograms and conditional constraints provided by WestConnect members. These input conditions aim to address the operational needs of individual member systems, such as voltage support and other factors, including must run and must take conditions, that drive the need for certain generation resources to be committed in a particular way, consistent with the existing operational practices of the WestConnect member systems. The names of monitored interfaces are included in Appendix A, and the "SMUD Op Nomogram", "EPE Balance", and "TEP Local Gen" were nomograms added to the model to commit local generation.

2028 Wheeling Charge Sensitivity Case

Description: The case was created from the 2028 Base Case PCM by reducing the regular, inter-area wheeling charges to 50% of what they are in the 2028 Base Case PCM. The other, emission-related wheeling charges were not changed from the 2028 Base Case PCM. The inclusion of this sensitivity is based on backcast benchmarking studies WestConnect performed in 2017.

5.0 Modeling Public Policy

Enacted public policies are considered early in the planning process and are incorporated into the base models (both reliability and economic) through the roll-up of local TO plans and their associated load, resource, and transmission assumptions. Enacted public policies that are subject to significant uncertainty within the planning horizon are also considered, but only as a part of a scenario. Examples of several scenario studies addressing "uncertain" public policies can be found on the prior pages.

Table 4 summarizes the enacted public policies that were reflected in regional base economic and power flow models. This table was originally in the WestConnect 2018-19 Regional Study Plan and incorporates two revisions made during the model development: 1) NV Energy's clarifications regarding the Nevada Renewable Portfolio Standard and 2) the additional of the SRP 2020 20% Sustainable Energy Goal. After their review of the models, each TOLSO member provided expressed confirmation that the WestConnect 2028 economic and power flow models met these public policies' conditions for study year 2028.

Table 4. Enacted Public Policies Incorporated into 2028 WestConnect Planning Models

Enacted Public Policy	Description
Arizona Renewable Energy Standard	Requires IOUs and retail suppliers to supply 15% of electricity from renewable resources by 2025), with a minimum of 30% of the renewable resources provided by distributed generation
California SB350	Requires IOUs and municipal utilities to meet a 50% RPS by 2030 and also requires the establishment of annual targets for energy efficiency savings
California AB398/SB32	Requires the California State Air Resources Board to approve a statewide greenhouse gas emissions limit equivalent to the statewide greenhouse gas emissions level in 1990 to be achieved by 2020 and to ensure that statewide greenhouse gas emissions are reduced to at least 40% below the 1990 level by 2030.
Colorado SB 07-100	Requires IOUs to identify Energy Resource Zones, plan transmission to alleviate constraints from those zones, and pursue projects according to the timing of resource development in those zones
Colorado HB10-1001	Established Colorado Renewable Energy Standard (RES) to 30% by 2020 for IOUs (Xcel & Black Hills)
Colorado SB13-252	Requires cooperative utilities to generate 20% of their electricity from renewables by 2020

Enacted Public Policy	Description
Colorado HB10-1365	Requires rate regulated utilities in CO with coal-fired generation to reduce emissions on the smaller of 900 MW of generation of 50% of a company's coal generation fleet. Full implementation to be achieved by 12/31/2017
Nevada SB123	To reduce emissions from coal-fired generators, requires reduction of at least 800 MW generation capacity from coal-fired generation plants, addition of at least 350 MW of generating capacity from renewable energy facilities, and construction of at least 550 MW of generating capacity from other types of generating plants by 2020.
Nevada SB374	Requires net metering be available to each customer-generator who submits a request to the company.
Nevada Renewable Portfolio Standard	The percentage of renewable energy[5] required. Increases every two years until it reaches 25 percent by 2025.
New Mexico Efficient Use of Energy Act	Require utilities to include cost-effective EE and DR programs in their resource portfolios and establish cost-effectiveness as a mandatory criterion for all programs.
New Mexico Renewable Energy Requirements	Subject to the Reasonable Cost Threshold (RCT), the RPS Rule outlines renewable energy requirements that are a function of PNM's retail energy sales. • No less than 10% of retail energy needs for calendar years 2011 through 2014; • No less than 15% of retail energy needs for calendar years 2015 through 2019; • No less than 20% of retail energy needs for calendar year 2020 and subsequent years
SRP 2020 20% Sustainable Energy Goal	SRP has established a goal that by 2020, SRP will meet a target of 20% of its expected retail energy requirements with sustainable resources. Among them are a diversified resource mix of wind, geothermal, large hydro and low-impact hydro, and solar.[6]

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[5] *Is calculated based on number of renewable energy credits; reference Nevada Revised Statute ("NRS") 704.7821*

[6] https://www.srpnet.com/environment/renewable-energy.aspx

Renewable Energy Check

During the model development process, there was interest in seeing whether the WestConnect economic models indicated a renewable energy penetration trajectory consistent with enacted public policies. To address this interest WestConnect conducted a high-level accounting and comparison of each PCM Area's energy sales and renewable energy via the process outlined below.

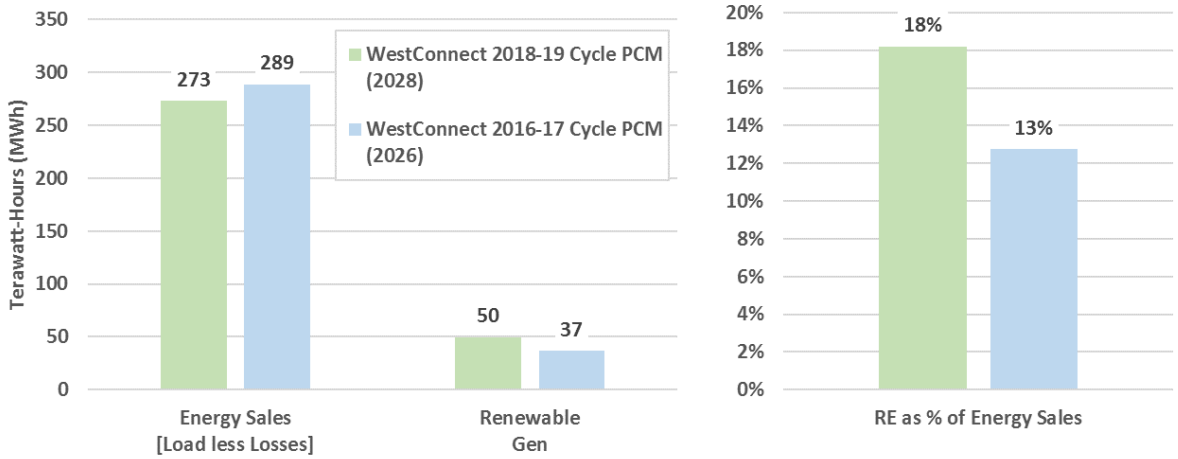
1. Annual generation of Bio, Geothermal, Solar PV, Solar Thermal, & Wind were summed for each PCM Load Area as "Renewable Energy" (RE). The RE for the SRP PCM Area also included specific hydro and a combined solar & battery generation in the SRP PCM Area was counted as RE based on SRP's plan to meet its public policy requirements, but hydro was otherwise not counted as RE. The Reserve Capacity Distribution settings in 2028 Base Case PCM were used to allocate resources to their appropriate remote load area.

2. Each PCM Load Area's "Energy Sales" was determined by taking the "Served Load Includes Losses", subtracting losses, adding the magnitude of negative generation (e.g., pumping loads with hourly profiles), and subtracting behind-the-meter generation (e.g., distributed generator or DG-BTM, energy efficiency or EE, demand response or DR)

3. The "Renewable Energy" was divided by the "Energy Sales" as the "RE as % of Energy Sales" for the 2028 Base Case PCM and the 2026 Base Case PCM from the 2016-17 cycle (to allow for comparison between cycles).

Only the single year results from each study year were used in the RE check and no banking of renewable energy from other years was assumed. **Figure 5** shows the results of the renewable energy check, which the Planning Subcommittee determined show a reasonable trend towards WestConnect members meeting enacted public policies.

Figure 5. Sum of Energy Sales, Renewable Generation, and overall RE as % of Energy Sales based on Single-Year Results from the 2028 Base Case PCM and 2026 Base Case PCM.



6.0 Summary of Regional Base Transmission Plan

WestConnect created the regional base transmission plan at the beginning of the 2018-19 Planning Process to establish the transmission network topology that is reflected in the regional planning models for the 10-year timeframe and evaluated in the regional needs assessments. The base transmission plan consists of the "planned" incremental transmission facilities included by TOs in local transmission plans, as well as regional transmission facilities identified in previous regional transmission plans that are not subject to reevaluation.[7] It also includes any assumptions member TOs may have made with regard to other incremental regional transmission facilities in the development of their local transmission plans. "Conceptual" transmission projects are not included in the base transmission plan.

The base transmission plan was developed using project information collected via the WestConnect Transmission Plan Project List (TPPL), which serves as a project repository for TO member and TO participant local transmission plans as well as independently developed projects. The TPPL data used for the 2018-19 Planning Process was based on updates submitted as of January 26, 2018, with subsequent updates to the data made by members. The full list of approved regional base transmission plan projects can be found in Appendix A of the 2018-19 Regional Study Plan.

6.1 2018-19 Regional Base Transmission Plan Projects

The 2018-19 Base Transmission Plan project list includes 191 planned transmission projects that consist of 75 new or upgraded transmission lines, 61 substations, 21 transmission line and substations, 22 transformers, and 12 other planned projects. From the data reported in the TPPL, these projects span a reported total of 843 miles and add up to a total capital investment of $933.2 Million.[8] **Table 5**, **Table 6**, and **Table 7** summarize the Base Transmission Plan by project type and voltage.

Table 5. Regional Base Transmission Plan Projects by Type, Reported Mileage, and Reported Investment ($K), based on the TPPL data

Type of Project	Number of Projects	Length (Miles)	Planned Investment ($K)
Substation	61	-	$ 220,021
Transmission Line	75	647	$ 357,005
Transmission Line and Substation	21	197	$ 256,732
Transformer	22	-	$ 29,080
Other	12	-	$ 70,309
Total	**191**	**843**	**$ 933,147**

[7] There are not any re-evaluation projects in the 2018-19 Base Transmission Plan.

[8] 29% of the projects listed in the 2018-19 Base Transmission Plan did not report line mileage in the TPPL data and 65% of the projects did not report cost information in the TPPL data.

Table 6. Number of TOLSO Regional Base Transmission Plan Projects by Voltage and TOLSO, based on the TPPL data

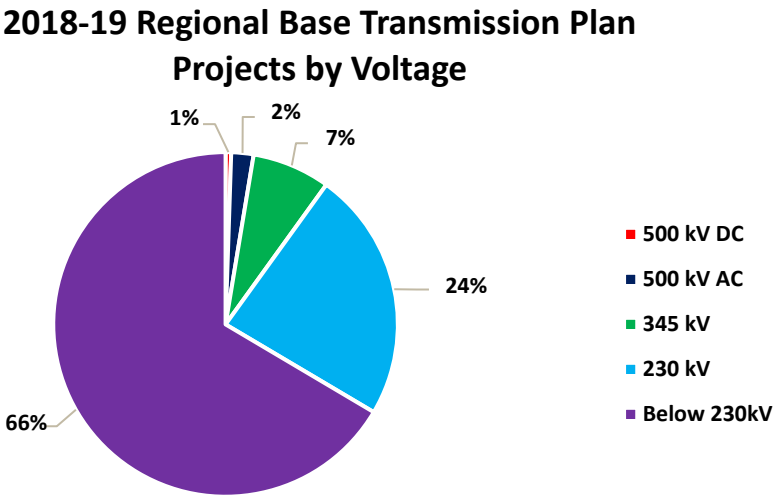
TOLSO	< 230 kV	230 kV	345 kV	500 kV AC	500 kV DC	Total
Arizona Public Service	-	2	-	-	-	**2**
Black Hills Energy	4	-	-	-	-	**4**
Black Hills Power	-	4	-	-	-	**4**
Cheyenne Light Fuel and Power	4	-	-	-	-	**4**
Colorado Springs Utilities	1	1	-	-	-	**2**
El Paso Electric Company	21	-	2	-	-	**23**
Imperial Irrigation District	1	-	-	-	-	**1**
Los Angeles Department of Water and Power	1	14	-	3	1	**19**
NV Energy	16	3	5	-	-	**24**
Platte River Power Authority	-	1	-	-	-	**1**
Public Service Company of Colorado/ Xcel Energy	4	1	1	-	-	**6**
Public Service Company of New Mexico	1		2	-	-	**3**
Sacramento Municipal Utility District		5	-	-	-	**5**
Salt River Project	2	3	-	-	-	**5**
Tri-State Generation and Transmission Association	13	2	1		-	**16**
Tucson Electric Power	48	2	2	1	-	**53**
Western Area Power Administration - DSW	4	1	-	-	-	**5**
Western Area Power Administration - RMR	7	3	1	-	-	**11**
Western Area Power Administration - SNR	-	3	-	-	-	**3**
Total Projects	**127**	**45**	**14**	**4**	**1**	**191**

Table 7. Regional Base Transmission Plan Projects by Voltage, Reported Mileage, and Reported Investment ($K), based on the TPPL data

Type of Project	Number of Projects	Length (Miles)	Planned Investment ($K)
500 kV DC	1	-	$ -
500 kV AC	4	0	$ -
345 kV	14	45	$ 212,030
230 kV	45	282	$ 236,946
Below 230kV	127	517	$ 484,171
Total Projects	**191**	**843**	**$ 933,147**

Review of the of the 2018-19 regional base transmission plan projects showed that 66% were classified as below 230 kV, 24% were classified as 230 kV, 7% were classified as 345 kV; and the remaining 3% were classified as the 500 kV (including both AC and DC). **Figure 6** illustrates the percentage breakout for the 2018-19 regional base transmission plan projects by voltage.

Figure 6. 2018-19 Regional Base Transmission Plan Projects by Voltage, based on the TPPL data



6.2 Updates to the 2016-17 Regional Base Transmission Plan Projects

Review of the 2016-17 Regional Study plan base transmission project showed a number of projects have gone into service, started construction, or have had updates to their development status. The full list of 2016-17 regional base transmission plan projects can be found in the 2016-17 Study Plan Appendix B[9]. Updated information provided to the TPPL showed that 36 projects were placed in service, 9 projects

[9] https://doc.westconnect.com/Documents.aspx?NID=17180&dl=1

were updated to under construction development status, 7 projects were updated to conceptual development status and 6 projects were withdrawn from the 2016-17 base transmission plant. The remaining 2016-17 regional base transmission plan projects continued as planned projects in the 2018-19 regional base transmission plan. Additionally, 95 new planned projects were added to the TPPL and included in the 2018-19 regional base transmission plan. **Table 8**, **Table 9**, and **Table 10** summarize the updates to the 2016-17 regional base transmission plan projects.

Table 8. 2016-17 Regional Base Transmission Plan Projects In-Service, Reported Mileage, and Reported Investment ($K), based on the TPPL data

Type of Project	Number of Projects	Length (Miles)	Planned Investment ($K)
Substation	7	-	$ 27,002
Transmission Line	13	42	$ 28,210
Transmission Line and Substation	2	77	$ 15,800
Transformer	7	-	$ 35,392
Other	7	-	$ 1,447
Total Projects	**36**	**119**	**$ 107,851**

Table 9. 2016-17 Regional Base Transmission Plan Projects Under Construction, Reported Mileage, and Reported Investment ($K), based on the TPPL data

Type of Project	Number of Projects	Length (Miles)	Planned Investment ($K)
Substation	3	-	$ 24,096
Transmission Line	4	153	$ 297,000
Transmission Line and Substation	-	-	$ -
Transformer	1	-	$ 10,000
Other	1	-	$ 38,600
Total Projects	**9**	**153**	**$ 369,696**

Table 10. 2016-17 Planned Regional Base Transmission Plan Projects Withdrawn or Changed to Conceptual by Voltage, based on the TPPL data

Status Change	Type	< 230 kV	230 kV	345 kV	Total
Conceptual	Transmission Line	1	6	0	**7**
Conceptual	Substation	0	0	0	**0**
Withdrawn	Transmission Line	4	0	0	**4**
Withdrawn	Substation	1	0	1	**2**
	Total	**6**	**6**	**1**	**13**

6.3 Regional Base Transmission Plan Projects by State

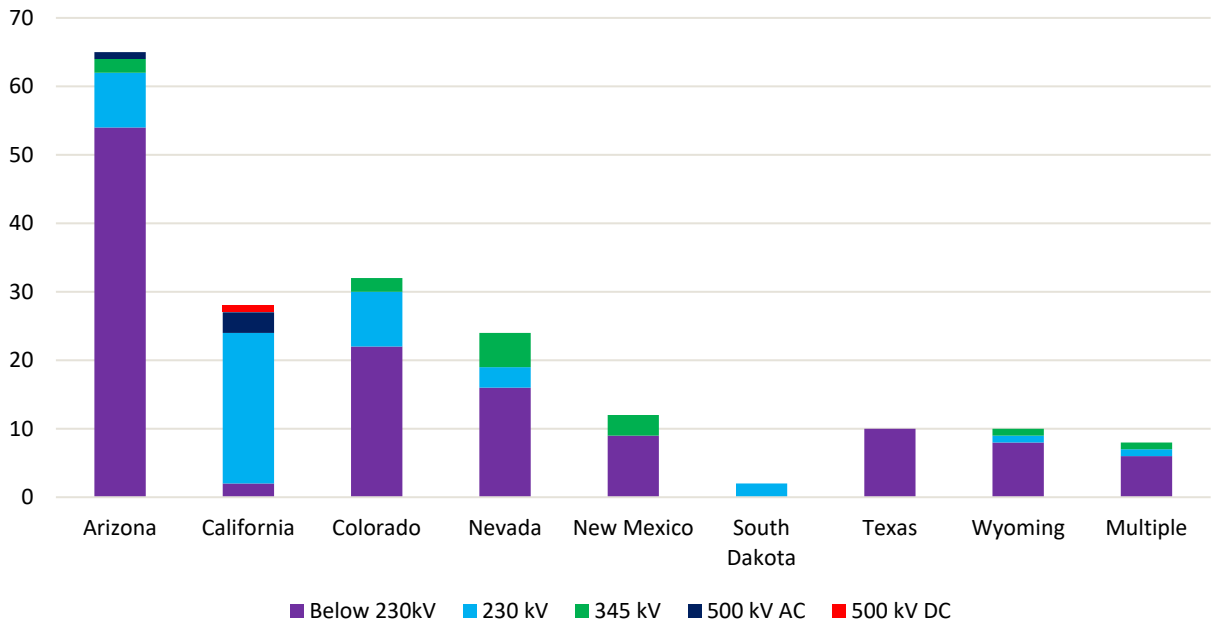
The 2018-19 regional base transmission plan has projects in multiple states in the WestConnect footprint and in some instances, projects span multiple states. **Table 11** summarizes the number of projects by states with aggregated capital investment.

Table 11. Regional Base Transmission Plan Projects by State, Reported Mileage, and Reported Investment ($K), based on the TPPL data

State	Number of Projects	Length (Miles)	Planned Investment ($K)
Arizona	65	237	$ 263,017
California	28	7	$ 22,423
Colorado	32	254	$ 350,296
Nevada	24	11	$ 31,000
New Mexico	12	127	$ 138,109
South Dakota	2	48	$ 23,400
Texas	10	14	$ -
Wyoming	10	20	$ 52,902
Multiple	8	127	$ 52,000
Total Projects	**191**	**843**	**$ 933,147**

Review of the 2018-19 regional base transmission plan projects by state showed that many (34%) of the projects are located in Arizona, 17% of the projects are located in Colorado and 15% are located in California. The remaining projects are located in in Nevada, New Mexico, South Dakota, Texas, and Wyoming. The remaining 4% span multiple states. **Figure 7** illustrates the breakout of projects by voltage and state.

Figure 7. 2018-19 Regional Base Transmission Plan Projects by Voltage and State, based on the TPPL data



6.4 Regional Base Transmission Plan Projects by Driver

Review of the 2018-19 regional base transmission planned projects showed that nearly all of projects (90%) are driven by Reliability needs, 7% are driven by public policy and the remaining 3% are

economic driven. Further review showed that the majority are reliability driven projects (61%) and are below 230 kV. **Table 12**, **Table 13**, and **Figure 8** below breakout the projects by length, planned investment costs and voltage.

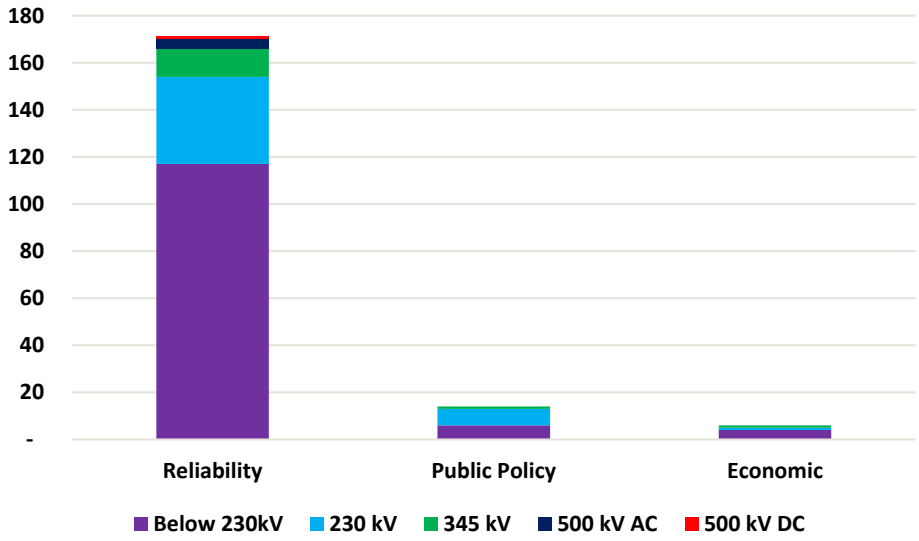
Table 12. Regional Base Transmission Plan Projects by Driver, Reported Mileage, and Reported Investment ($K), based on the TPPL data

Driver	Number of Projects	Length (Miles)	Planned Investment ($K)
Reliability	171	826	$ 858,148
Public Policy	14	4	$ 46,749
Economic	6	13	$ 28,250
Total Projects	**191**	**843**	**$ 933,147**

Table 13. Regional Base Transmission Plan Projects by Driver and Voltage, Reported Mileage, and Reported Investment ($K), based on the TPPL data

Driver	< 230kV	230 kV	345 kV	500 kV AC	500 kV DC
Reliability	117	37	12	4	1
Public Policy	6	7	1	-	-
Economic	4	1	1	-	-
Total Projects	**127**	**45**	**14**	**4**	**1**

Figure 8. 2018-19 Regional Base Transmission Plan Number of Projects by Driver and Voltage, based on the TPPL data



7.0 Scenario Studies

Two scenarios are included in the Study Plan, which WestConnect will perform on an "information-only" basis. Details regarding the process used to develop the scenarios and their purpose in the planning process is located in the Study Plan and provided here for quick reference:

- **Load Stress Study**: The purpose of the Load Stress Study is to test the robustness of the Base Transmission Plan against changes in load. The study will be performed using the peak load condition from the Base Case production cost model. To stress the system, loads will be increased 10%[10] and the generation-load gap will be filled with existing generator capacity not already dispatched in Base Case. In certain areas, renewable capacity may be added if there is not sufficient existing generation to meet the load increase. Details of the redispatch to fill the load-generation gap will need to be addressed through the Planning Subcommittee, the intent of the scenario is to focus on reliability, but a congestion/economic study may be considered if deemed useful.

- **CAISO Export Stress Study**: The purpose of the CAISO Export Stress Study is to evaluate the reliability of the WestConnect regional system if power flows from the CAISO to WestConnect during CAISO overgeneration conditions. The study will be performed using a realistic CAISO export to WestConnect condition from the WestConnect 2028 Base Case production cost model. The export condition will be defined, technically, based on (1) simulation results from the WestConnect 2028 Base Case production cost model filtered for hours in which the CAISO exports to WestConnect; and (2) technical guidance from the CAISO describing the type of conditions that might cause flows from the CAISO to WestConnect to help reduce the flagged hours (if multiple) to a single hour. The details of the analysis will be determined at a later date by the Planning Subcommittee.

8.0 Next Steps

The Planning Subcommittee compiled this report to document major assumptions that have been incorporated into the base regional models. Both draft and final versions of the regional models are made available to PMC Members and others that have executed the WestConnect Confidentiality Agreement.

The regional needs assessment was conducted in parallel with the later stages of the model development process and will culminate with a report from the Planning Subcommittee to the PMC. That report will document the findings of the regional assessments and propose recommendations on any potential regional needs.

[10] *10% is a guideline and may vary, depending on input from TO's*

9.0 Appendix A: 2028 Base Case (PCM) Assumptions

This appendix contains select modeling assumptions reflected in the WestConnect 2028 Base Case (PCM) which, unless otherwise noted, were taken from the WECC 2028 Anchor Dataset (ADS) interconnection-wide 10-year PCM ("2028 ADS PCM V1.0" or "28ADS-V1.0").

Figure 9: WECC Assumptions for Fuel Prices by month (2018$/mmBtu)

Fuel Name in Model	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bio_Agri_Res	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Bio_Blk_Liquor	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Bio_Landfill_Gas	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26	2.26
Bio_Other	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Bio_Sludge_Waste	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Bio_Solid_Waste	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Bio_Wood	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88
Coal_Alberta	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27
Coal_Apache	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
Coal_AZ	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Coal_Battle_River	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27
Coal_CA_South	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Coal_Centennial_Hard	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56	1.56
Coal_Centralia	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07
Coal_Cholla	2.05	2.05	2.05	2.05	2.05	2.05	2.05	2.05	2.05	2.05	2.05	2.05
Coal_CO_East	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Coal_CO_West	2.51	2.51	2.51	2.51	2.51	2.51	2.51	2.51	2.51	2.51	2.51	2.51
Coal_Colstrip	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55
Coal_Comache	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
Coal_Coronado	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
Coal_Craig	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Coal_Escalante	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02
Coal_Four_Corners	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03
Coal_Hayden	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79
Coal_ID	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33
Coal_Intermountain	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84
Coal_Jim_Bridger	2.19	2.19	2.19	2.19	2.19	2.19	2.19	2.19	2.19	2.19	2.19	2.19
Coal_Martin_Drake	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
Coal_MT	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57
Coal_Naughton	2	2	2	2	2	2	2	2	2	2	2	2
Coal_Navajo	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54
Coal_NM	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27
Coal_NV	2.46	2.46	2.46	2.46	2.46	2.46	2.46	2.46	2.46	2.46	2.46	2.46
Coal_PNW	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22
Coal_Reid_Gardner	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71	1.71
Coal_Springerville	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53

Fuel Name in Model	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Coal_Sunnyside	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76
Coal_UT	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96
Coal_Valmy	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04
Coal_WY_E	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
Coal_WY_PRB	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Coal_WY_SW	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14
Coal_Wyodak	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
DefaultFuel	9.99	9.99	9.99	9.99	9.99	9.99	9.99	9.99	9.99	9.99	9.99	9.99
Geothermal	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
NG_AB	3.2845	3.2962	2.9412	2.822	2.9542	3.0328	3.021	2.8291	2.9313	3.1355	3.1482	3.2022
NG_AZ North	3.8748	3.8704	3.3775	3.3626	3.458	3.7063	3.7723	3.6341	3.6441	3.4954	3.4604	3.8025
NG_AZ South	4.0821	4.0775	3.5603	3.5446	3.6447	3.9053	3.9746	3.8296	3.84	3.6839	3.6472	4.0062
NG_Baja	4.344	4.339	3.7843	3.7675	3.8749	4.1544	4.2287	4.0731	4.0843	3.917	3.8776	4.2626
NG_BC	3.9549	3.8831	3.359	3.2229	3.3139	3.4238	3.4497	3.4066	3.4907	3.509	3.6369	4.0692
NG_CA PGaE BB	4.4913	4.4851	4.0851	4.054	4.1667	4.3408	4.3598	4.2765	4.3981	4.3309	4.2713	4.4339
NG_CA PGaE LT	5.3253	5.3191	4.9191	4.888	5.0007	5.1748	5.1938	5.1105	5.2321	5.1649	5.1053	5.2679
NG_CA SDGE	4.722	4.7172	4.1769	4.1604	4.265	4.5373	4.6097	4.4582	4.4691	4.306	4.2677	4.6427
NG_CA SJ Valley	4.3179	4.4343	3.7803	3.761	3.8689	4.1361	4.1723	4.0272	4.0726	3.9197	3.8739	4.2524
NG_CA SoCalB	3.9987	3.9941	3.4835	3.468	3.5669	3.8241	3.8925	3.7494	3.7597	3.6056	3.5694	3.9238
NG_CA SoCalGas	4.6798	4.675	4.1418	4.1256	4.2288	4.4975	4.5689	4.4194	4.4302	4.2693	4.2314	4.6015
NG_CO	3.8584	3.9731	3.3977	3.2702	3.4317	3.6015	3.6186	3.4667	3.4881	3.441	3.416	3.7353
NG_ID North	3.4038	3.3655	2.9536	2.9131	3.0104	3.1411	3.1678	3.0572	3.1035	3.0943	3.1137	3.3843
NG_ID South	3.8076	3.7615	3.2845	3.2164	3.3226	3.4802	3.5105	3.4031	3.4525	3.4073	3.4614	3.7942
NG_MT	3.9062	3.8624	3.3913	3.345	3.4562	3.6057	3.6362	3.5097	3.5627	3.5522	3.5744	3.8838
NG_NM North	3.7868	3.8032	3.3005	3.2634	3.4004	3.6258	3.663	3.5336	3.5106	3.4084	3.3381	3.6645
NG_NM South	3.9023	3.9192	3.4026	3.3644	3.5052	3.7369	3.7751	3.6421	3.6184	3.5134	3.4412	3.7766
NG_NV North	4.3037	4.2992	3.7935	3.7781	3.876	4.1308	4.1986	4.0567	4.067	3.9144	3.8785	4.2295
NG_NV South	4.0018	3.9972	3.4866	3.4711	3.57	3.8272	3.8956	3.7525	3.7628	3.6087	3.5725	3.9269
NG_OR	3.8076	3.7615	3.2845	3.2164	3.3226	3.4802	3.5105	3.4031	3.4525	3.4073	3.4614	3.7942
NG_OR Malin	3.8559	3.8514	3.3591	3.3441	3.4394	3.6875	3.7535	3.6154	3.6254	3.4768	3.4418	3.7836
NG_TX West	3.7558	3.7738	3.3092	3.2792	3.4151	3.6303	3.6645	3.5245	3.5007	3.3933	3.3112	3.5964
NG_UT	3.9697	3.9761	3.4521	3.3819	3.531	3.712	3.7254	3.5951	3.6241	3.5838	3.5833	3.9257
NG_WA	3.8164	3.7446	3.2204	3.0843	3.1753	3.2852	3.3112	3.268	3.3521	3.3704	3.4983	3.9307
NG_WY	3.7584	3.8701	3.3097	3.1855	3.3428	3.5082	3.5248	3.3769	3.3977	3.3519	3.3275	3.6385
Oil_DistillateFuel_2	22.52	22.52	22.52	22.52	22.52	22.52	22.52	22.52	22.52	22.52	22.52	22.52
Oil_DistillateFuel_H	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03	30.03
Oil_DistillateFuel_L	14.19	14.19	14.19	14.19	14.19	14.19	14.19	14.19	14.19	14.19	14.19	14.19
Petroleum Coke	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41
Propane	23.55	23.55	23.55	23.55	23.55	23.55	23.55	23.55	23.55	23.55	23.55	23.55
Purchased_Steam	1	1	1	1	1	1	1	1	1	1	1	1
Refuse	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Synthetic Gas	6.99	6.99	6.99	6.99	6.99	6.99	6.99	6.99	6.99	6.99	6.99	6.99
Uranium	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81
Waste_Heat	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

1

Figure 10: WECC Assumptions for Fuel Emission Rates by Type (lb/mmBtu)

Fuel Name in Model	Emission Type			Fuel Name in Model	Emission Type		
	SO_2	NOx	CO_2		SO_2	NOx	CO_2
Bio_Agri_Res	0.00579	0.1766362	130	NG_CA PGaE LT	0.0006	0.08	117
Bio_Blk_Liquor	0.00579	0.1766362	130	NG_CA SDGE	0.0006	0.08	117
Bio_Landfill_Gas	0.00579	0.1766362	130	NG_CA SJ Valley	0.0006	0.08	117
Bio_Other	0.00579	0.1766362	130	NG_CA SoCalB	0.0006	0.08	117
Bio_Sludge_Waste	0.00579	0.1766362	130	NG_CA SoCalGas	0.0006	0.08	117
Bio_Solid_Waste	0.00579	0.1766362	130	NG_CO	0.0006	0.08	117
Bio_Wood	0.00579	0.1766362	130	NG_ID North	0.0006	0.08	117
Coal_Alberta	0.35	0.5	205	NG_ID South	0.0006	0.08	117
Coal_AZ	0.571	0.459146	205.0311	NG_MT	0.0006	0.08	117
Coal_CA_South	0.3303097	0.3824139	203.5343	NG_NM North	0.0006	0.08	117
Coal_CO_East	0.6911747	0.552889	204.7532	NG_NM South	0.0006	0.08	117
Coal_CO_West	0.6911747	0.552889	205.2	NG_NV North	0.0006	0.08	117
Coal_ID	0.6911747	0.552889	204.7532	NG_NV South	0.0006	0.08	117
Coal_MT	0.6911747	0.552889	204.7532	NG_OR	0.0006	0.08	117
Coal_NM	0.3303097	0.3824139	203.5343	NG_OR Malin	0.0006	0.08	117
Coal_NV	0.112818	0.3485	202.6215	NG_TX West	0.0006	0.08	117
Coal_PNW	0.621817	0.288333	205.2	NG_UT	0.0006	0.08	117
Coal_UT	0.6911747	0.552889	204.7532	NG_WA	0.0006	0.08	117
Coal_WY_E	0.464041	0.276	200	NG_WY	0.0006	0.08	117
Coal_WY_PRB	0.07	0.1	205.2	Oil_DistillateFuel_2	0.00579	0.1766362	156.3
Coal_WY_SW	0.07	0.1	205.2	Oil_DistillateFuel_H	0.00579	0.1766362	156.3
DefaultFuel	0.35	0.276	200	Oil_DistillateFuel_L	0.0006	0.116	161.3
Geothermal	0.00579	0.1766362	20	Petroleum Coke	0	0.028	224
NG_AB	0.0006	0.08	117	Propane	0.00579	0.1766362	123.1133
NG_AZ North	0.0006	0.08	117	Purchased_Steam	0	0.028	224
NG_AZ South	0.0006	0.08	117	Refuse	0.00579	0.1766362	130
NG_Baja	0.0006	0.08	117	Synthetic Gas	0.0006	0.08	117
NG_BC	0.0006	0.08	117	Uranium	0	0	0
NG_CA PGaE BB	0.0006	0.08	117	Waste_Heat	0	0	0

Figure 11: WestConnect Inter-Area Wheeling Rate Assumptions

Wheeling Zone	PCM Area(s)	Export Wheel ($/MWh)	
		Peak Hours	Off-Peak Hours
AB_AESO	AESO	5.2	5.2
BC_BCHA	BCHA	5.4	5.4
BS_IPCO	IPFE,IPMV,IPTV	4.64	2.59
BS_PACE	PAID,PAUT,PAWY	6.902	3.283
CA_BANC+	BANC,TIDC	2.3	2.3
CA_CFE	CFE	12.2	12.2
CA_CISO	CIPB,CIPV,CISC,CISD,VEA	11.5	11.5
CA_IID	IID	2.821	2.821
CA_LDWP	LDWP	12.32	5.86
NW_AVA	AVA	5.77	5.77
NW_BPAT+	BPAT,CHPD,DOPD,GCPD,SCL,TPWR	3.99	3.99
NW_NWMT+	NWMT,WAUW	4.56	4.56
NW_PACW	PACW	6.902	3.283

Wheeling Zone	PCM Area(s)	Export Wheel ($/MWh)	
		Peak Hours	Off-Peak Hours
NW_PGE	PGE	1.02	1.02
NW_PSEI	PSEI	4.033	2.305
RM_PSCO	PSCO	8.238	4.753
RM_WACM	WACM	5.188	5.188
SW_AZPS	AZPS	7.338	4.102
SW_EPE	EPE	5.706	3.326
SW_NVE	NEVP,SPPC	7.09	4.28
SW_PNM	PNM	6.042	5.448
SW_SRP	SRP	4.36	2.48
SW_TEPC	TEPC	7.1	3.686
SW_WALC	WALC	1.811	1.811

Figure 12. Names of Monitored Interfaces in WestConnect 2028 Base Case PCM

Names of Monitored Interfaces in WestConnect 2028 Base Case PCM				
P01 Alberta-British Columbia	P28 Intermountain-Mona 345 kV	P54 Coronado-Silver King 500 kV	xy AZ-CA	zz CCTA 04 Delaney-Sun Valley
P02 Alberta-Saskatchewan	P29 Intermountain-Gonder 230 kV	P55 Brownlee East	xy WY-UT	zz CCTA 05 Desert Basin - Pinal Central
P03 Northwest-British Columbia	P30 TOT 1A	P58 Eldorado-Mead 230 kV Lines	z Aeolus South	zz CCTA 06 Paloverde - Colorado River
P03East Side NW-BC	P31 TOT 2A	P59 WALC Blythe - SCE Blythe 161 kV Sub	z Aeolus West	zz CCTA 07 GW Cent Sigurd-Red Butte
P03West Side NW-BC	P32 Pavant-Gonder InterMtn-Gonder 230 kV	P60 Inyo-Control 115 kV Tie	z CA IPP DC South	zz CCTA 08 GW South - Seg #2 Aeolus-Mona
P04 West of Cascades-North	P33 Bonanza West	P61 Lugo-Victorville 500 kV Line	z CA PG&E-Bay	zz CCTA 09 GW Seg 1A Windstar-Bridger
P05 West of Cascades-South	P35 TOT 2C	P62 Eldorado-McCullough 500 kV Line	z ID Midpoint West	zz CCTA 10 GW Seg1B Bridger-Populus
P06 West of Hatwai	P36 TOT 3	P65N Pacific DC Intertie (PDCI)	z CG Columbia Injection	zz CCTA 11 GW Seg 1C Populus-Borah
P08 Montana to Northwest	P37 TOT 4A	P65S Pacific DC Intertie (PDCI)	z CG Net COB (NW AC Intertie)	zz CCTA 12 GW Seg E Midpoint-Hemingway
P14 Idaho to Northwest	P38 TOT 4B	P66 COI	z CG North of Echo Lake	zz CCTA 14 I-5 Reforce Castle Rock-Troutdale
P15 Midway-LosBanos	P39 TOT 5	P71 South of Allston	z CG North of Hanford	zz CCTA 15 Interior-Lower Mainland
P16 Idaho-Sierra	P40 TOT 7	P73 North of John Day	z CG Paul-Allston	zz CCTA 16 Morgan-Sun Valley
P17 Borah West	P41 Sylmar to SCE	P75 Hemingway-Summer Lake	z CG Raver-Paul	zz CCTA 17 Northwest TL
P18 Montana-Idaho	P42 IID-SCE	P76 Alturas Project	z CG South of Boundary	zz CCTA 19 P8 Upgrade
P19 Bridger West	P45 SDG&E-CFE	P77 Crystal-Allen	z CG South of Custer	zz CCTA 20 Pinal Central-Tortolita

Names of Monitored Interfaces in WestConnect 2028 Base Case PCM				
P20 Path C	P46 West of Colorado River (WOR)	P78 TOT 2B1	z CG West of John Day	zz CCTA 21 PW Pinal Central-Browning
P22 Southwest of Four Corners	P47 Southern New Mexico (NM1)	P79 TOT 2B2	z CG West of Lower Monumental	zz CCTA 23 Wallula-McNary
P23 Four Corners 345/500 Qualified Path	P48 Northern New Mexico (NM2)	P80 Montana Southeast	z CG West of McNary	zzz N Path 18 Exp 2
P24 PG&E-Sierra	P49 East of Colorado River (EOR)	P81 Southern Nevada Transmission Interface (SNTI)	z CG West of Slatt	zzz N Path 18 Imp 2
P25 PacifiCorp/PG&E 115 kV Interconnection	P50 Cholla-Pinnacle Peak	P82 TotBeast	zz CCTA 01 Hemingway-Longhorn	zzz N Path 22_part1
P26 Northern-Southern California	P51 Southern Navajo	P83 Montana Alberta Tie Line	zz CCTA 02 Central Ferry - Lower Monumental	zzz N Path 22_part2
P27 Intermountain Power Project DC Line	P52 Silver Peak-Control 55 kV	Palo Verde East	zz CCTA 03 Delaney-Palo Verde	

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