WESTCONNECT REGIONAL TRANSMISSION PLANNING

2020-21 PLANNING CYCLE

SCENARIO ASSESSMENT REPORT

APPROVED BY WESTCONNECT PLANNING MANAGEMENT COMMITTEE ON

SEPTEMBER 15, 2021

Contents

1.0 Background & Purpose

The purpose of this report is to summarize scenario assessments performed during WestConnect's 2020-21 Regional Transmission Planning Process ("Planning Process"). The Planning Subcommittee ("PS") developed this report to document the assumptions, study methods, and findings from the scenario assessments.

The 2020-21 WestConnect Regional Planning Study Plan ("Study Plan") was approved by the PMC on March 18, 2020. The Study Plan identifies the scope and schedule of activities to be conducted during the planning cycle. In addition to describing the Base Case planning assessments used to identify regional transmission needs, the Study Plan also describes information-only scenario studies that look at alternate but plausible futures. Scenarios represent futures or system conditions with resource, load, and public policy assumptions that are different in one or more ways than what is assumed in the Base Cases.

Members or stakeholders propose scenarios for consideration in the WestConnect planning process through an open submittal window, as outlined in the WestConnect Business Practice Manual. WestConnect held the open window from December 2, 2019 through January 3, 2020. Several proposed scenarios were received and subsequently reviewed by the PS during public meetings on January 14, 2020 and on February 11, 2020. During the meetings, the PS discussed the proposed scenarios, member feedback, and the number of scenarios that would be appropriate to study. These conversations led to the inclusion of two scenarios in the final Study Plan: a Committed Uses ("CU") scenario involving an economic assessment and a New Mexico Export Stress ("NME") scenario involving a reliability assessment. The purpose of the CU scenario is to examine the impacts of modeling contractual rights to transmission capacity and potentially allow for improved modeling in the WestConnect economic assessments. The intent of the NME scenario is to evaluate the reliability of the WestConnect regional system during conditions during New Mexico overgeneration conditions.

2.0 Study Scope

The PS finalized the study scopes and developed the models required to complete the two scenario assessments. **Table 1** summarizes each scenario and the core questions that the studies were designed to investigate.

Table 1: Scenario Case Descriptions & Core Questions

Scenario	Description of Cases	Core Questions to Investigate
Committed Uses	Using Open Access Same-Time Information System ("OASIS") and Energy Imbalance Market ("EIM") Energy Transfer System Resources ("ETSRs") data[1], assumptions were developed to represent firm transmission capacity reservations, firm available transfer capability ("FATC"), total transfer capability ("TTC"), and additional inter-BA transfer flexibility provided by the EIM. These assumptions were used to enhance the wheeling path modeling of the 2030 Base Case Production Cost Model ("PCM").	• Can OASIS data be leveraged to effectively develop the initial CU assumptions? • Did adding CU assumptions to the wheeling path model produce more reasonable results than the Base PCM? • Which set of CU assumptions produced more reasonable results, "with EIM" or "without EIM"?
New Mexico Export	Using the WestConnect-approved 2030 Base Case PCM, a power flow snapshot was developed based on the system conditions in Hour 12 on April 2^{nd} (1200 Mountain Standard Time). This hour was selected by the PS during their [meeting on December 15, 2020](), as a system condition representative of high New Mexico export to the rest of the Western Interconnection. The New Mexico export amounted to 2,046 MW during that hour.[2]	• During high New Mexico export conditions, how reliable is the WestConnect regional transmission system?

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[1] *The OASIS data included data from the Open Access Technology International (OATI) OASIS website (http://www.oasis.oati.com/) and the California ISO OASIS website (http://oasis.caiso.com/).*

[2] *The New Mexico export was originally calculated from PNM Exports less those going to EPE and was 2,054 MW in Hour 12 on April 2^{nd}; however, the New Mexico export calculation was later refined to include the collective flow exiting New Mexico from the PNM and EPE areas, resulting in the 2,046 MW of New Mexico export in Hour 12 on April 2^{nd}.*

3.0 Committed Uses Scenario

3.1 Assumptions, Modeling and Study Techniques

The CU scenario is designed to address the 2030 Base Case PCM's limited representation of contractual rights to – i.e., "committed uses" of – transmission capacity. The focus of the scenario was to improve the real-world accuracy of the WestConnect production cost model by preventing its market optimization methods from encroaching on existing inter-area firm commitments of the transmission system. Due to the complexities of enhancing the modeling of intra-Balancing Authority (BA) transmission rights (e.g., contract paths within a given transmission provider or BA footprint) the Planning Subcommittee agreed to focus the scenario modeling on inter-BA transmission representation and resulting power flows/BA-to-BA interchange.

Several types of committed uses were considered and handled in the CU scenario study. The modeling approach for each is summarized below.

- **Represent all remotely contracted or owned resources** – These committed uses were retained from the 2030 Base Case PCM to represent certain generators (or generator shares) having procured firm transmission rights to deliver their output to the receiving BA; however, the modeling was updated so as not to double-count this capacity with the "Firm Transmission Rights" assumption described in the next bullet. In the 2030 Base Case PCM, these committed uses were modeled as generator exemptions to transmission hurdle rates, which applied a $0/MWh hurdle rate to the flow they induced on inter-BA flows. In the CU cases, the generator exemptions were removed from the generator shares remotely committed to BAs in WestConnect and their capacity was reconciled into the PTP transmission rights assumption.

- **Represent inter-area firm point-to-point ("PTP") transmission rights as sunk cost** – FATC and TTC data was collected for all inter-BA transmission contract paths on OASIS and was aggregated to match the BA-to-BA wheeling paths in the PCM. For each wheeling path, the FATC value was subtracted from the TTC value to arrive at the assumed MWs of previously reserved transmission. A $0/MWh hurdle rate was applied to this amount of flow during the PCM's commitment and dispatch optimizations to reflect the fact that costs associated with this firm transmission are a sunk cost and there is no incremental cost to the rights holder to use the capacity to schedule power between areas. Flow on the inter-area wheeling path above the MWs of reserved transmission capacity up to the TTC value was modeled with the non-firm tariff rate (the hurdle rate in the 2030 Base Case PCM). This modeling approach ensures that area-to-area transfers that occur beyond the firm transmission capacity are not charged an incremental transmission rate.

- **Limit BA exports to sum of inter-area contract path TTCs** – In the CU scenario the BA-to-BA wheeling paths were modeled with an upper limit equal to the sum of inter-area contract path TTCs, in contrast to the 2030 Base Case PCM in which flows between areas can occur up to the sum of the simultaneous physical limit of the individual lines between areas. To allow the solution to converge in extreme instances in which a given area must have higher inter-area flows to maintain reliability, this upper limit was implemented as a soft constraint where flows above the sum of the inter-area TTCs were available but at a high hurdle rate of $750/MWh – an arbitrarily high value used so that such instances were easily identifiable for further investigation, as needed, during the validation of results. Implementing this constraint was based on several assumptions the Planning Subcommittee determined to be reasonable: (1) actual system operations schedules cannot exceed the TTC of a given contract path, (2) the model's simulated physical flows are roughly commensurate with schedules that would occur in system operations, (3) "loop flows" or unscheduled flows are typically minimal, and (4) and operating limit violations rarely happen. By limiting inter-area flows to contract path TTCs, the model should not over-state the ability of one area to export to another.

- **Focus resource commitment on serving local BA load** – The wheeling path modeling was updated to severely limit the inter-area flows to 25% of the inter-area TTC *during the commitment optimization*. This change was made in the CU scenario to reflect the assumption that each BA in WestConnect generally makes its unit commitment decisions with the goal of reliably and economically serving its own load, based on its internal cost and operational objectives. This update is in contrast to the 2030 Base Case PCM's representation of a single optimized grid with unit commitment decisions based on system-wide cost minimization. This severe limitation on inter-area flows was specific to the unit commitment optimization. If the previously discussed transmission commitments summed to a value that was higher than 25% of the inter-area TTC assumption, then that higher value was used for setting the MWs of interchange available to influence a given areas unit commitment. Similar to the limitation of BA exports to sum of inter-area contract path TTCs (above bullet), this limitation was implemented as a soft constraint with a high hurdle rate of $750/MWh imposed on any flow above this amount to ensure the solution would converge in extreme instances in which a higher inter-area flow was necessary in the commitment optimization to maintain reliability – again an arbitrarily high value used so that such instances were easily identifiable for further investigation, as needed, during the validation of the results. By economically incenting the model to develop a unit commitment schedule that is focused on serving local BA load, this overall unit commitment is less optimal and more consistent with actual system operations.

- **Representation of EIM-dedicated transmission capacity** – This assumption leveraged publicly available data on ETSRs, which represent the MWs of transmission capacity between EIM entities available in the market optimization. The ETSR data was collected for all existing EIM participating areas (2019 ETSR data[3]), the 75th percentile of fifteen-minute market (FMM) and real-time market (RTM) ETSR capacity was calculated, and the minimum of the FMM and RTM values was used as a conservative EIM capacity assumption. This amount was given a $0/MWh hurdle rate in the model's dispatch optimization, which is roughly consistent with how the EIM actually functions. It was noted that a valuable enhancement would be to allow for logic that dynamically updates the tariff thresholds in the commitment and dispatch since it would allow greater flexibility when representing dependencies between the Day-Ahead and Real-Time markets. The Planning Subcommittee acknowledged that this EIM capacity representation does not represent all of the nuances of participation in the EIM and decided to evaluate two PCM cases, one with and one without the EIM capacity assumptions.

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[3] *The 2019 ETSR data included nine BAs: AZPS, BCHA, CISO, IPCO, NEVP, PACE, PACW, PGE, and PSEI. The Trading Hub PCM regions (TH_PV, TH_Mead, and TH_Malin) were also included if they were logical intermediaries between these BAs.*

Future EIM participating areas were identified based on their announced intention to join the EIM between now and the 2030 study year.[4] As there was no ETSR data applicable to the wheeling paths between these areas, the EIM capacity for the wheeling paths between the existing EIM participating areas, which averaged to 26% of those wheeling paths' TTC and 11% of the sum of the thermal ratings of branches making up those wheeling paths, was leveraged to estimate the EIM capacity assumption for wheeling paths between future EIM participating area. More specifically, the wheeling path's TTC was multiplied by 26%, the sum of the thermal ratings of branches making up the wheeling path was multiplied by 11%, and the lesser of these two values was used as the final EIM capacity for the inter-EIM wheeling path.

The WestConnect members reviewed the FATC, TTC, Firm Transmission Rights, and EIM assumptions (collectively termed the "CU assumptions") developed from the OASIS and EIM ETSR data, with and without reconciliations between the Firm Transmission Rights and remotely contracted or owned resource capacity, to ensure the assumptions were reasonable. **Table 2** shows the final CU assumptions and **Figure 1** provides an illustration of how one direction of an example wheeling path was modeled to represent the CU assumptions.

Table 2: Committed Uses Assumed by PCM Wheeling Path

PCM Wheeling Path[5]	Committed Uses (MW) and Their Corresponding Direction					
	Firm Transmission Rights		TTC		EIM Capacity[6]	
	Forward	Backward	Forward	Backward	Forward	Backward
W07_NW_BPAT+__CA_BANC+	0	0	0	0	0	0
W09_NW_BPAT+__CA_LDWP	490	200	1,240	589	155	154
W13_NW_BPAT+__SW_NVE	125	19	300	200	30	30
W17_NW_NWMT+__RM_WACM	90	0	90	45	0	0
W24_BS_IPCO__SW_NVE	352	130	743	682	743	682
W26_BS_PACE__CA_LDWP	0	265	1,023	1,194	120	120
W27_BS_PACE__RM_WACM	877	345	2,592	2,352	679	616
W28_BS_PACE__SW_AZPS	550	311	696	1,054	696	1,054
W29_BS_PACE__SW_NVE	164	130	739	710	654	645
W30_BS_PACE__SW_WALC	0	5	0	5	0	0
W31_RM_PSCO__SW_PNM	52	200	110	200	29	33
W32_RM_WACM__RM_PSCO	531	255	1,931	1,486	506	389
W33_RM_WACM__SW_PNM	184	200	329	469	86	123

[4] Future EIM participating areas included 11 BAs: BANC, BPAT, LDWP, NEVP, PNM, PSCO, SRP, TEPC, TIDC, WACM, and WAUW. The Trading Hub PCM regions (TH_PV, TH_Mead, and TH_Malin) were also included if they were logical intermediaries between these BAs.

[5] The names include the PCM regions involved and the PCM regions are analogous to BAs (e.g., SW_AZPS is the AZPS BA): <Wheeling Path ID>_<From PCM Region(s)>__<To PCM Region(s)>. There are two aggregations of multiple PCM regions designated with a "+": (1) NW_BPAT+ includes NW_BPAT, NW_CHPD, NW_DOPD, NW_GCPD, NW_SCL, or NW_TPWR; (2) CA_BANC+ includes CA_BANC and CA_TIDC.

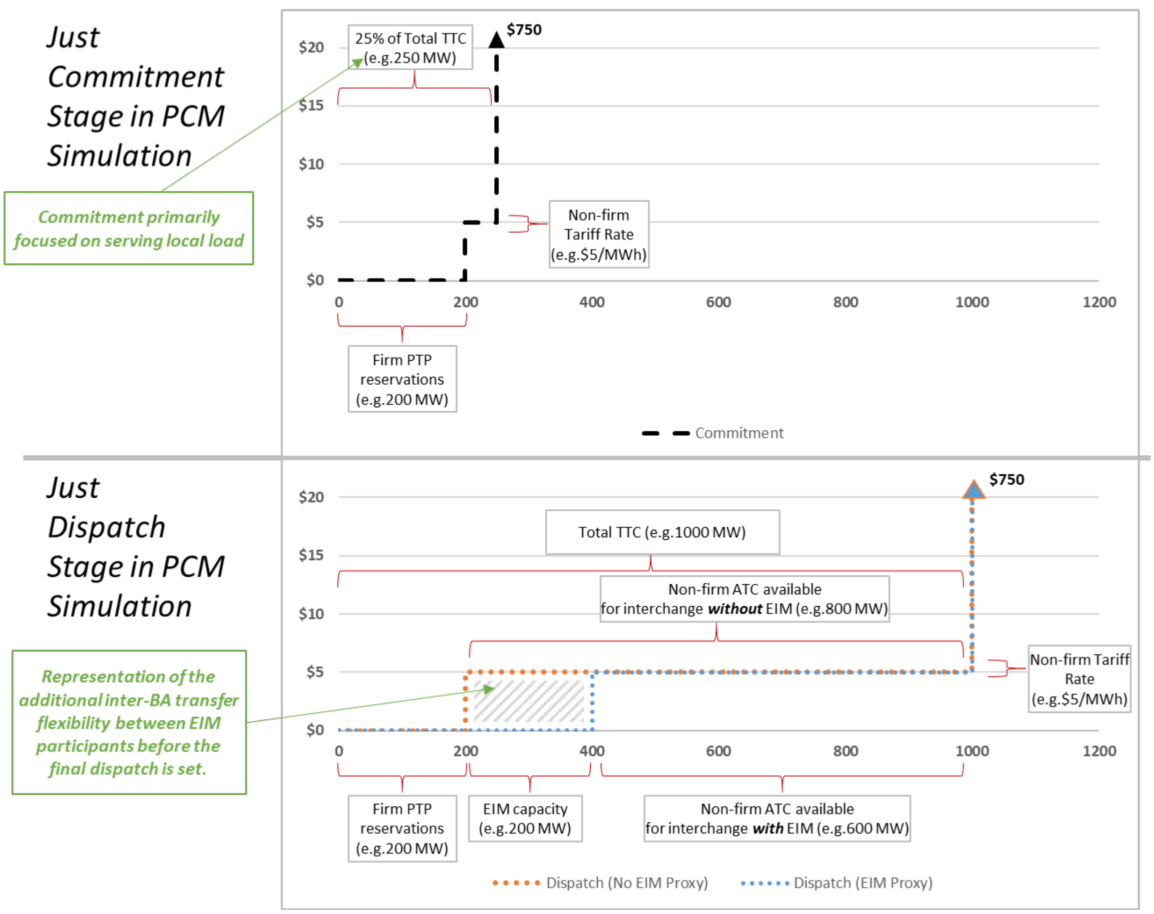
[6] The EIM capacity assumption was only implemented in the dispatch step of "with EIM" CU PCM.

PCM Wheeling Path[5]	Committed Uses (MW) and Their Corresponding Direction					
	Firm Transmission Rights		TTC		EIM Capacity[6]	
	Forward	Backward	Forward	Backward	Forward	Backward
W34_RM_WACM__SW_WALC	1,236	569	1,494	1,494	0	0
W35_SW_AZPS__CA_CISO	51	345	3,071	2,209	3,071	2,209
W36_SW_AZPS__CA_IID	0	0	75	75	0	0
W37_SW_AZPS__CA_LDWP	0	25	1,492	1,500	191	191
W38_SW_AZPS__SW_PNM	686	1,494	1,146	2,368	260	260
W39_SW_AZPS__SW_SRP	722	3,126	2,356	5,495	731	907
W40_SW_AZPS__SW_TEPC	997	230	1,216	772	304	202
W41_SW_AZPS__SW_WALC	1,217	992	4,290	2,337	0	0
W42_SW_NVE__CA_CISO	50	54	4,377	3,921	4,377	3,921
W43_SW_NVE__CA_LDWP	590	443	1,903	1,720	477	451
W44_SW_NVE__SW_WALC	0	0	0	0	0	0
W45_SW_PNM__SW_EPE	472	184	1,834	869	0	0
W46_SW_PNM__SW_WALC	159	170	269	269	0	0
W47_SW_SRP__CA_CISO	0	0	0	0	0	0
W48_SW_SRP__SW_TEPC	1,976	692	2,409	1,837	417	417
W49_SW_SRP__SW_WALC	722	439	832	1,057	0	0
W50_SW_TEPC__SW_EPE	668	530	888	1,228	0	0
W51_SW_TEPC__SW_PNM	774	825	1,770	1,770	209	209
W52_SW_WALC__CA_CISO	60	0	120	0	0	0
W53_SW_WALC__CA_IID	0	87	275	275	0	0
W54_SW_WALC__CA_LDWP	350	284	382	435	0	0
W55_SW_WALC__SW_TEPC	305	370	1,221	1,133	0	0
W56_CA_CISO__CA_BANC+	95	525	329	329	86	86
W58_CA_IID__CA_CISO	962	22	962	600	0	0
W59_CA_LDWP__CA_CISO	737	94	7,061	5,162	1,850	1,353
W61_RM_WACM__SW_AZPS	600	553	1,677	999	195	195
Wa1_SW_TH_PV__CA_CISO	N/A[7]	104	N/A	N/A	N/A	0
Wa2_SW_TH_PV__SW_AZPS	N/A	568	N/A	N/A	N/A	1,071
Wa3_SW_TH_PV__SW_SRP	N/A	0	N/A	N/A	N/A	656
Wb1_SW_TH_Mead__SW_WALC	N/A	0	N/A	N/A	N/A	0
Wb2_SW_TH_Mead__SW_NVE	N/A	162	N/A	N/A	N/A	907
Wb3_SW_TH_Mead__SW_AZPS	N/A	0	N/A	N/A	N/A	0
Wb4_SW_TH_Mead__SW_SRP	N/A	505	N/A	N/A	N/A	731
Wb5_SW_TH_Mead__CA_CISO	N/A	0	N/A	N/A	N/A	268
Wb6_SW_TH_Mead__CA_LDWP	N/A	0	N/A	N/A	N/A	377

[7] *For wheeling paths involving the Trading Hub PCM regions (TH_PV, TH_Mead, and TH_Malin), the CU assumptions were only applied for Firm Transmission Rights and EIM Capacity into the Trading Hub.*

PCM Wheeling Path[5]	Committed Uses (MW) and Their Corresponding Direction					
	Firm Transmission Rights		TTC		EIM Capacity[6]	
	Forward	Backward	Forward	Backward	Forward	Backward
Wc1_NW_TH_Malin__NW_BPA+	N/A	415	N/A	N/A	N/A	0
Wc2_NW_TH_Malin__NW_PACW	N/A	0	N/A	N/A	N/A	79
Wc3_NW_TH_Malin__CA_BANC+	N/A	1,064	N/A	N/A	N/A	234
Wc4_NW_TH_Malin__CA_CISO	N/A	2,588	N/A	N/A	N/A	160

Figure 1: Hurdle rate ($/MWh) vs transfer capability (MW) for one direction of an example wheeling path in the CU PCM cases assuming 1,000 MW of TTC, 800 MW of FATC, 200 MW of Firm Transmission Rights or Firm PTP reservations, and 200 MW of EIM Capacity

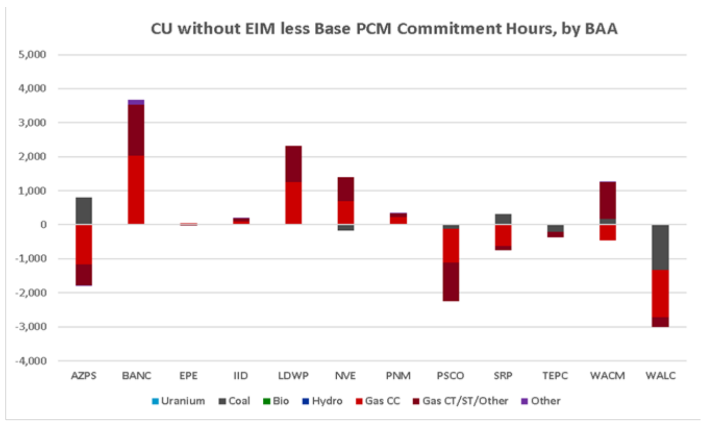


3.2 Study Results

Results from the assessment are provided in Appendix A. The Planning Subcommittee noted several observations when comparing the results of the CU scenario cases with the 2030 Base Case PCM:

1. BA commitment of internal resource capacity is closer to their load level in the CU scenario cases, which suggests the CU assumptions applied during the commitment optimization are an effective way of limiting the PCM's tendency to optimally commit resources for purposes other than serving local BA load. This led to more resource commitment in the CU scenario cases, as shown in **Figure 2**.

Figure 2: Impact of CU assumption on generator commitment hours.

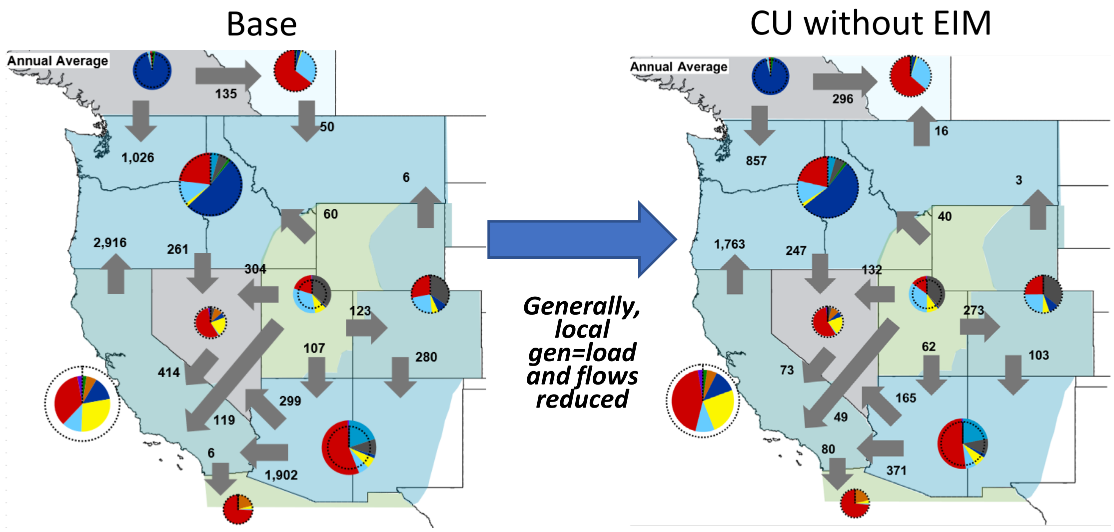


1,501 (0.6%) more commitment hours in WestConnect

2. BA generation dispatch more closely mirrors local/BA load level in the CU scenario cases, which is reasonable given that the CU assumptions in the commitment optimization already closely matched BA load and thereby generally reducing, relative to the Base Case, reliance on imports or exports in the dispatch optimization. However, the lower inter-BA limits in the CU scenario cases (the TTC) still provided the opportunity for inter-BA power flows to balance large excesses or deficits in economic resources when necessary. **Figure 3** provides a high-level visual of how the local generator and load got more similar in the CU scenario cases.

3. Inter-BA power flows generally reduced system-wide relative to the 2030 Base Case PCM even though the CU assumptions were only applied in and bordering the WestConnect footprint. **Figure 3** provides a high-level visual of how the system-wide power flows got smaller in the CU scenario cases.

Figure 3: Impact of CU assumption on local BA generation and load and inter-BA interchange flow. The multi-colored circles are the generation mix and the black circles are load.



4. The inter-BA power flows between EIM participants were higher in the "with EIM" CU case than in the "without EIM" CU case, which is expected given that the "with EIM" CU assumptions provide less limitations on the inter-BA power flows between EIM participants. **Figure 4** shows the average and aggregate reduction in interchange flows from the 2030 Base Case PCM to the CU scenario cases.

Figure 4: Impact of CU assumption on inter-BA interchange flow.

CU "with EIM" less Base

Difference in Magnitude of Flow	Inter-Area Flow In/Around WestConnect (MW)	Inter-Area Flow Outside WestConnect (MW)
Avg	(103)	(176)
Sum	(4,952)	(4,046)

CU "without EIM" less Base

Difference in Magnitude of Flow	Inter-Area Flow In/Around WestConnect (MW)	Inter-Area Flow Outside WestConnect (MW)
Avg	(105)	(179)
Sum	(5,025)	(4,122)

Note the slightly higher flows in the CU with EIM scenario, which is reasonable since that market tends to increase area-to-area transactions

3.3 Summary of Findings

The study's process of leveraging OASIS data, combined with subsequent review by WestConnect members and stakeholders, including the California Independent System Operator, was an effective way to develop the initial CU assumptions to forecast inter-BA contractual transmission rights in and bordering the WestConnect footprint in the 2030 future.

The Planning Subcommittee concluded that both CU PCM simulations (“with EIM” and “without EIM”) produced improved results compared to the WestConnect 2030 Base Case PCM and the results of the “without EIM” CU PCM were most reasonable.

4.0 New Mexico Export Stress Scenario

4.1 Assumptions, Modeling and Study Techniques

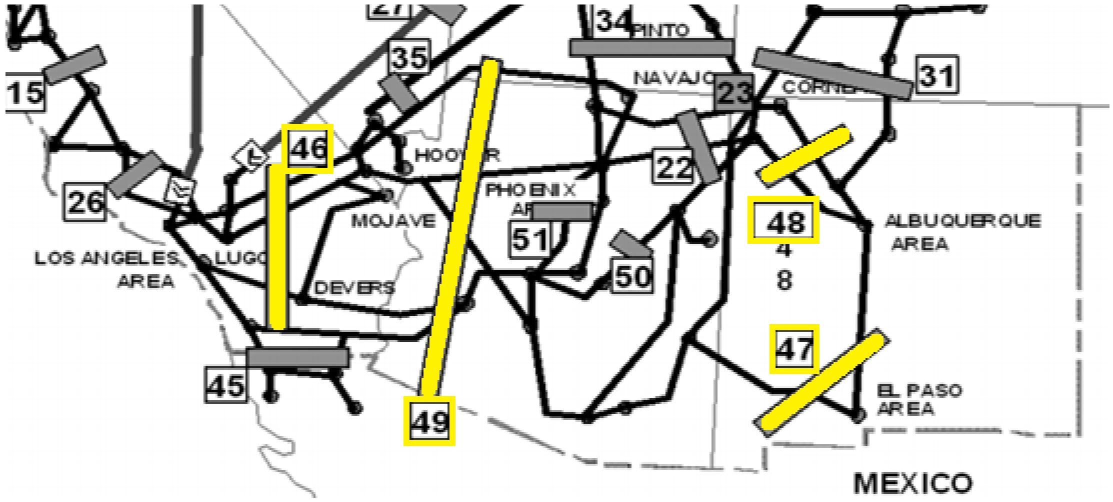
The NME scenario tests the reliability of the WestConnect regional system under a condition with high power flows from New Mexico to the rest of Western Interconnection. Historically, net flow is almost always into New Mexico. This is especially true on the major interfaces between New Mexico and the rest of the system, including WECC Transfer Path 48 (North New Mexico, NM2) and WECC Transfer Path 47 (Southern New Mexico, NM1), which flow in the north/northwest-to-south/southeast direction. As New Mexico adds more solar and wind onto its system (particularly resources contracted to remote areas such as California), certain conditions cause the combined areas of PNM and EPE to have more generation than load to serve, particularly in light-load conditions in the spring and fall. This creates the opportunity for economic (transactional) exports out of New Mexico, as well as physical exports of power (i.e., actual power flow, which are different than energy transactions).

The NME scenario was based on conditions observed in the WestConnect 2030 Base Case PCM. The modeling results were filtered for hours in which there were power flows from New Mexico to the rest of the Western Interconnection. In total, the export condition was observed in 40% of the hours in the study 2030 year, but the PS focused on a review of hours which had both (1) high New Mexico exports – near or above 2,000 MW – and (2) significant east-to-west flow in western Arizona on WECC Transfer Path 46 (West of Colorado River). **Table 3** identifies the condition selected by the PS for study: Hour 12 of April 2nd. During this condition, flow out of New Mexico are 2,046 MW and flow on Path 46 is 6,482 MW.

Table 3: NM Export and WECC Transfer Path Flow on April 2nd Hour 12

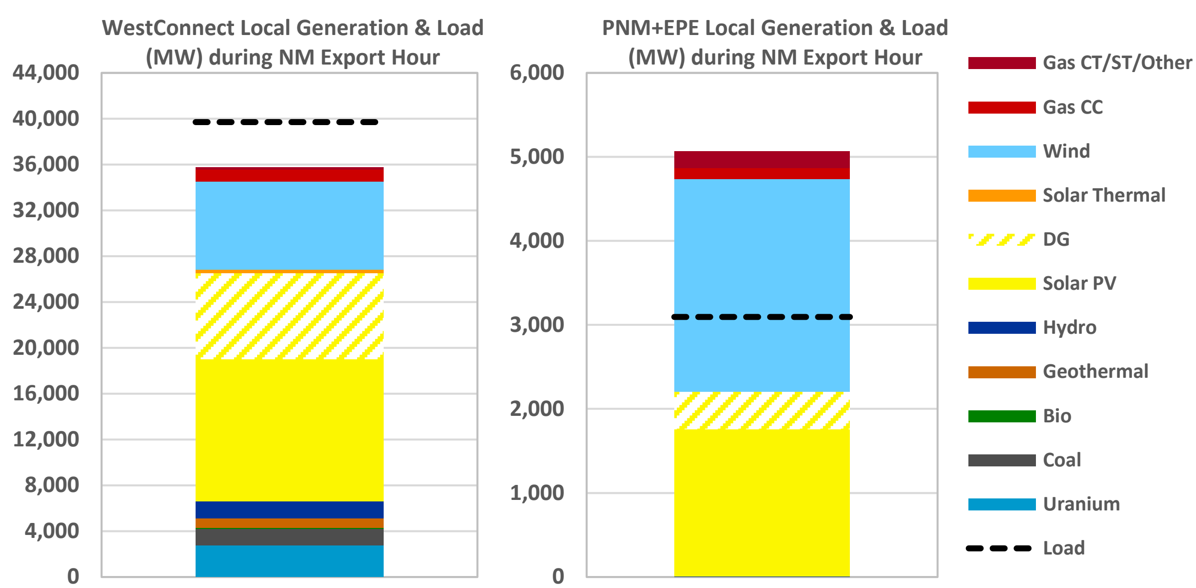
Time (MST)		Flow (MW)				
Date	Hour	NM Export	Path 48 – North New Mexico (NM2)	Path 47 – Southern New Mexico (NM1)	Path 46 – West of Colorado River (WOR)	Path 49 – East of Colorado River (EOR)
4/2/2030	12	2,046	2,606 Southeast →Northwest	346 Southeast →Northwest	6,482 East→West	20 West→East

Figure 5: Subset of Map of WECC Transfer Paths, with Those in Table 3 highlighted[8]



The simulated WestConnect and the PNM+EPE load levels and generation dispatch are summarized in **Figure 6.** The gap between the load and the top of the generation stack represents imports into the given region. When the stack is above the load level, this represents exports. In this selected hour, there was 72 MW of curtailed wind in New Mexico in the WestConnect 2030 Base Case PCM.

Figure 6: WestConnect & PNM+EPE Local Generation & Load[9] **During Selected NM Export on April 2nd Hour 12**



The transmission topology did not change from the Base Case assessments and reflects the 2020-21 Base Transmission Plan additions. The seed case was the approved WestConnect 2030 Light Spring Base

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[8] *https://www.wecc.org/Reliability/2007_WI_TransPath_UtilizationStudy.pdf*

[9] *This "Load" includes transmission losses as well as any generator models pumping, charging, or otherwise pulling power from the system.*

Case. The load, imports, and generator dispatch assumptions for cases, both representing distinct light spring system conditions, are provided in **Table 4**.

Table 4: NME Scenario Assumptions for WestConnect Region, compared with those of the 2030 Light Spring Base Case

Metric	2030 Light Spring Base Case	2030 New Mexico Export Scenario	Delta
Load[10] in WestConnect PF Areas[11] (MW)	37,496[12]	25,869[13]	Decreased 31%
New Mexico Import/Export (MW)	Import: 643	Export: 1,793	Switched from net import to net export (379% change)
Generation Dispatch in WestConnect PF Areas (MW)	Total[14]: 40,880 Thermal: 27,140 Hydro: 3,479 Wind: 3,193 Solar: 6,712 BESS/PSH[15]: 509 Other[16]: -145	Total: 25,722 Thermal: 8,137 Hydro: 1,268 Wind: 6,936 Solar: 12,519 BESS/PSH: -3,053 Other: -87	Total reduced 37% Thermal reduced 70% Hydro reduced 64% Wind increased 117% Solar increased 87% BESS/PSH switched to charging/pumping (700% change) Other got less negative (42% change)
Load in New Mexico and El Paso PF Areas (MW)	3,080	2,414	Decreased 22%

[10] *Load value includes reductions from distributed generation (DG).*

[11] *WestConnect PF Areas included 13 areas in the model: AEPCO, APS, EL PASO, IID, LADWP, NEVADA, NEW MEXICO, PSCOLORADO, SIERRA, SRP, TEP, WAPA L.C., and WAPA R.M.*

[12] *WestConnect portion of WECC coincident load during representative light load conditions during 1000 to 1400 MDT in spring months of March, April, and May with solar and wind serving a significant but realistic portion of the Western Interconnection total load. Case includes renewable resource capacity consistent with any applicable and enacted public policy requirements.*

[13] *Note that this load forecast is based on the 1-in-2 load forecasts contained in the production cost model.*

[14] *Total is positive generation less negative generation.*

[15] *Battery Energy Storage System (BESS) or pumped-storage hydroelectric (PSH) a.k.a. reversible hydro.*

[16] *Other generation includes generators representing DC intertie flow along the eastern side of the WestConnect footprint and motor loads.*

Metric	2030 Light Spring Base Case	2030 New Mexico Export Scenario	Delta
Generation Dispatch in New Mexico and El Paso PF Areas (MW)	Total: 2,583 Thermal: 668 Hydro: 0 Wind: 694 Solar: 1,200 BESS/PSH: 81 Other: -60	Total: 4,587 Thermal: 461 Hydro: 15 Wind: 2,400 Solar: 1,786 BESS/PSH: -16 Other: -60	Total increased 78% Thermal reduced 31% Hydro increased 100% Wind increased 246% Solar increased 49% BESS/PSH switched to charging/pumping (120% change) Other didn't change
Transmission	2020-21 Base Transmission Plan		No change

After initial case development was completed, the PS decided to perform the same evaluation used to identify regional needs in the regional reliability needs assessment, including both steady-state and transient stability contingency analysis in the NME scenario assessment. The assessment 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-3.2 (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.

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 – i.e., elements above 90-kV – in the WECC model were monitored.

The transient stability analysis included simulations of ten member-selected contingencies across the WestConnect footprint. The dynamic data needed to support the transient stability simulations was sourced from the WestConnect 2030 Light Spring Base Case. No update to the composite load modeling was necessary since the NME snapshot was in the same timeframe: shoulder month at 1100 Pacific Standard Time. However, extensive updates to the WestConnect 2030 Light Spring Base Case's dynamic data were necessary to achieve a flat no disturbance transient simulation. The list below summarizes the types of updates.

- Corrected MVA base discrepancy between steady-state and dynamic data
- Dynamic data netted/deactivated to resolve initialized limit violation
- Dynamic data netted/deactivated to resolve instability
- Dynamic data revised to account for different generator operating mode (pumping/charging or generating/discharging)
- Dynamic data set to defaults to resolve instability
- Turned off generators whose dispatch was too low for compatibilities with their dynamic data

System performance issues impacting or between more than one TOLSO Member system were identified for further review by the PS. Local issues were reported and provided to members for informational purposes. The local issues were not the focus of this assessment.

4.2 Study Results

Results from the assessment are provided in Appendix B. The results include 5 branch overloads and 6 voltage deviation issues on multi-owner transmission located in Arizona and New Mexico. After dynamic data updates were made to ensure a flat no disturbance transient simulation, there were no transient stability issues when simulating ten member-selected contingencies across the WestConnect footprint.

4.3 Summary of Findings

The case development was successful in that a New Mexico export condition was identified in the WestConnect 2030 Economic Base Case, and this condition was reasonably replicated in a reliability model in terms of load, generation dispatch, and system flows.

The scenario as modeled overstates the number of solar resources located near the Albuquerque area which results in overloaded lines between the Albuquerque area and the Four Corners area under contingency conditions. Since establishing the model, a portion of the generic renewable resources included in the model near Albuquerque have been defined and located in the Four Corners area which is on the other side of the constraints identified in the scenario case. The analysis also does not consider that a significant portion of the solar resources would not be available for export because of co-located battery storage as well as other local battery storage that has yet to be defined. It is expected that low load high solar hours as modeled in the scenario case will be key hours for battery charging. Both of these reduce the available resources leading to overloads identified in the scenario case. PNM believes the case does model flows approaching the transfer capability limits for resources located in central and eastern New Mexico. It is not, however, clear whether this represents a likely dispatch of such resources. To the degree the case's assumed solar resources in New Mexico do not develop, they still represent a reasonable renewable dispatch given they can be considered a proxy for additional wind resources with no co-located battery storage.

The WestConnect 2030 Light Spring Base Case's dynamic data required many updates outside of the WestConnect footprint to achieve a flat no disturbance transient simulation, which indicates there are issues in the dynamic data of the WECC 2030 Light Spring 1-S Base Case (30LSP1S) and – by extension – these issues may still exist in the WECC master dynamics file (MDF) and, if so, will adversely impact WestConnect's next planning cycle. To help resolve these and similar issues in future WECC Base Cases, WestConnect has developed the below recommendations for WECC's consideration and will provide WECC, upon request by WECC, with the details of the dynamic data updates implemented outside of WestConnect during this assessment so WECC can coordinate with the associated data submitters to resolve similar issues in future WECC Base Cases. Acting on these recommendations will not only benefit WestConnect's future assessments, but will undoubtedly benefit WECC's own Round Trip.

1. The issues flagged in the "Steady-State and Dynamics Dashboard" and "Annual Base Case Compilation and Data Check Log" reports provided with each WECC Base Case should be resolved prior to finalizing the case.

2. For generators capable of negative dispatch (e.g., batteries, pumped-storage hydro, motor loads), the WECC MDF should include dynamic data that works with both positive and negative dispatch and associated comments indicating which set of models is appropriate for each mode of operation.

3. The MVA base of the models in the WECC MDF data should match the MVA base of the models in the WECC Base Cases.

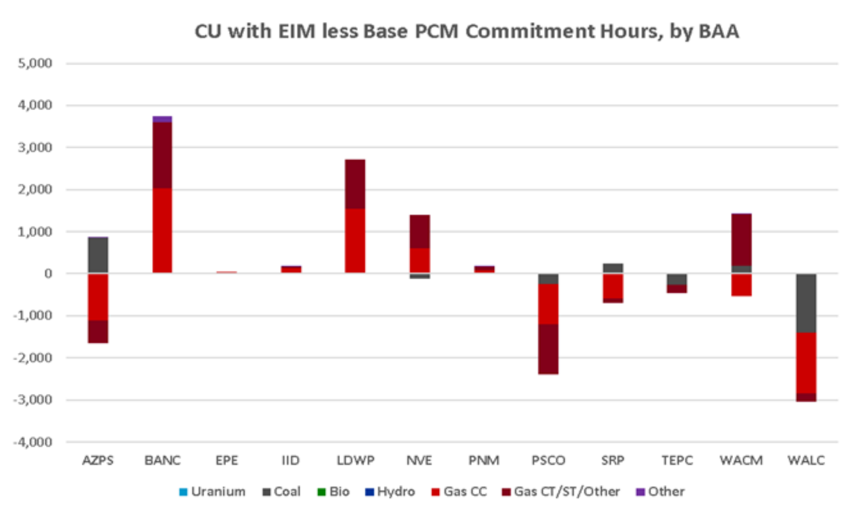
4. As part of finalizing a WECC Base Case, the dynamic data should be tested and validated for all generators in the case that are not retired prior to the represented snapshot, including the generators that may be turned off in the particular snapshot (i.e., it could be dispatched in a sensitivity of the system condition).

5. The MDF should indicate any known operational limitations of the dynamic data being used. For instance, the WECC Wind Power Plant Dynamic Modeling Guide indicates that Phase I wind models only provide reasonable representation of the generator when its dispatch is within 25% to 100% of its rated power and this limitation should accompany the use of any these models in the MDF.

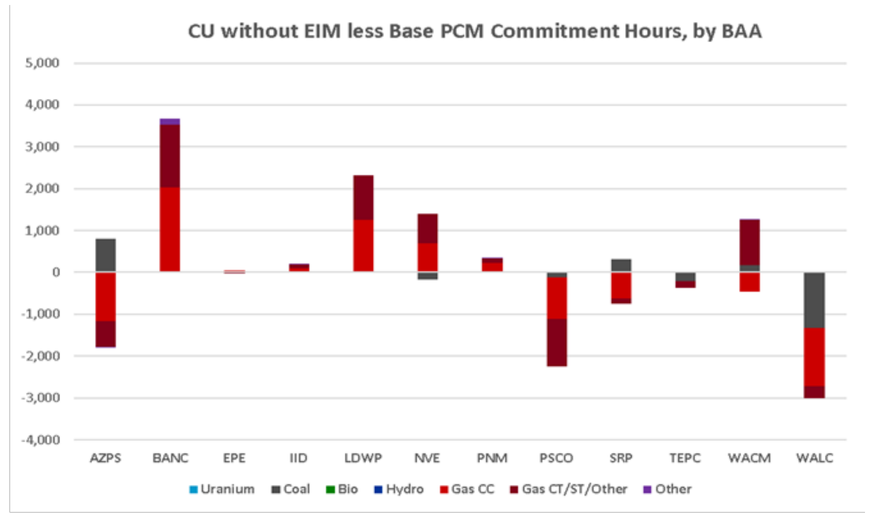
5.0 Appendix A: Committed Uses Scenario Assessment Results

This appendix summarizes result comparisons made between the CU scenario cases and 2030 Base Case PCM.

Figure 7: Impact of CU assumption on generator commitment hours. With few exceptions, most WestConnect BAs more frequently commit local generation to serve load. The EIM representation doesn't significantly change unit commitment, which is a reasonable result given the EIM influences the real-time market rather than day-ahead commitment decisions.



1,918 (0.8%) more commitment hours in WestConnect



1,501 (0.6%) more commitment hours in WestConnect

Figure 8: Impact of CU assumption on inter-BA interchange flow. Inter-BA flows generally reduced system-wide relative to the 2030 Base Case PCM even though the CU assumptions were only applied in and bordering the WestConnect footprint. The inter-BA power flows between EIM participants were higher in the "with EIM" CU case than in the "without EIM" CU case, which is expected given that the "with EIM" CU assumptions provide less limitations on the inter-BA power flows between EIM participants.

CU "with EIM" less Base

Difference in Magnitude of Flow	Inter-Area Flow In/Around WestConnect (MW)	Inter-Area Flow Outside WestConnect (MW)
Avg	(103)	(176)
Sum	(4,952)	(4,046)

CU "without EIM" less Base

Difference in Magnitude of Flow	Inter-Area Flow In/Around WestConnect (MW)	Inter-Area Flow Outside WestConnect (MW)
Avg	(105)	(179)
Sum	(5,025)	(4,122)

Note the slightly higher flows in the CU with EIM scenario, which is reasonable since that market tends to increase area-to-area transactions

Figure 9: Impact of CU assumption on local BA generation and load and inter-BA interchange flow. The multi-colored circles are the generation mix and the black circles are load. Inter-BA flows generally reduced system-wide relative to the 2030 Base Case PCM even though the CU assumptions were only applied in and bordering the WestConnect footprint.

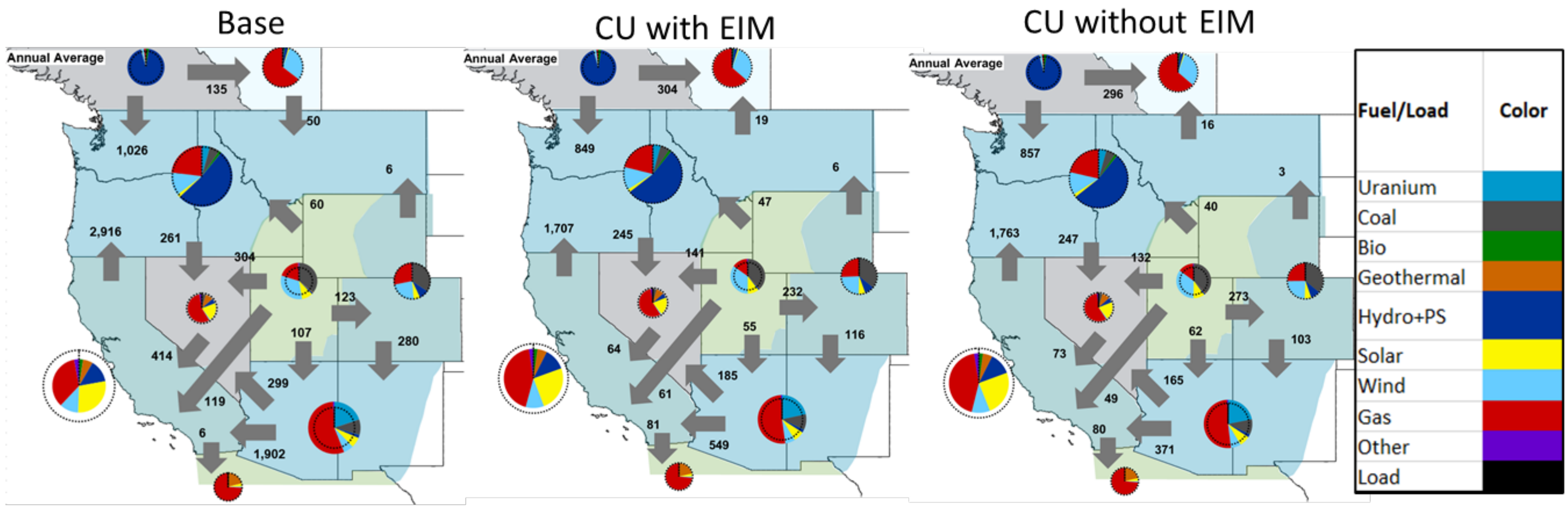


Figure 10: Impact of CU assumptions on generator production cost. This figure only shows the impact of the "with EIM" CU assumptions impact, but the impact of the "without EIM" CU assumptions is comparable. Production cost increased in California and generally reduced elsewhere, which makes sense given that California highly utilized power interchanges with its neighbors in the 2030 Base Case PCM and the CU assumptions limited the availability of such exchanges.

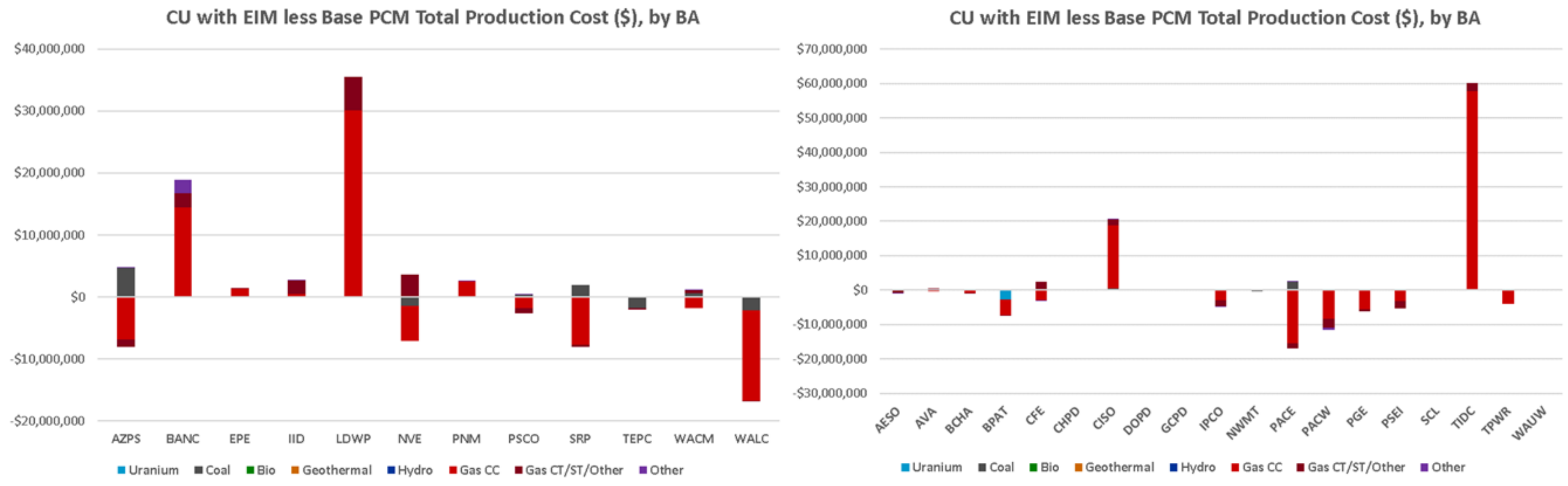


Figure 11: Impact of CU assumptions on wind and solar curtailment. Wind & solar curtailment was slightly higher in the CU scenario cases compared with the 2030 Base Case PCM; however, none of the cases showed an alarming amount of curtailment. Note the left-most charts shows the total amount of curtailment in the 2030 Base Case PCM whereas the other charts only show how that curtailment changed in the CU scenario cases.

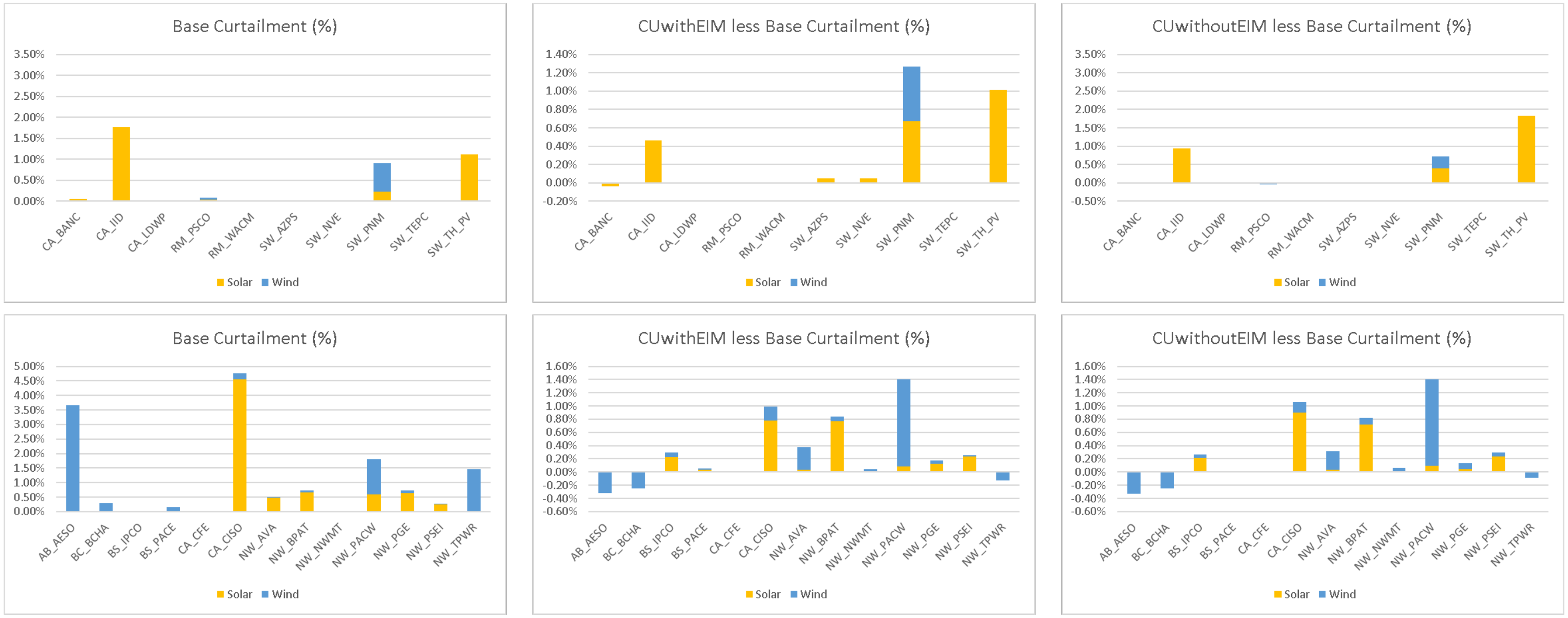


Table 5: Impact of CU assumptions on congestion cost and number of congested hours on Multi-TO transmission facilities. The CU cases have substantially less congestion cost than the Base PCM, which is expected given the reduction inter-BA power flows driven by the CU assumptions.

Element Information		**Congestion Hours (% Hrs) / Cost (K$)** ***[& Penalty Cost Component of Congestion Cost (if any)]***		
Owner/Operator(s)	**Branch/Path Name**	**2030 Base Case PCM**	**CU without EIM**	**CU with EIM**
PSColorado|Tri-State G&T	STORY - PAWNEE 230kV Line #1 (73192_70311_1)	434 (5%) / 5,997	156 (2%) / 1,723	226 (3%) / 3,586
Gila River Power, LP|Sundevil Power Holdings, LLC|Salt River Project|Arizona Public Service	GILARIVR - PANDA 500/230kV Transformer #1 (159970_14238_1)	154 (2%) / 5,164	122 (1%) / 2,312	124 (1%) / 2,394
Intermountain Power Agency|Sierra Pacific Power Co	P29 Intermountain-Gonder 230 kV Interface	139 (2%) / 894		
Basin Electric Power Coop.|Tri-State G&T|PacifiCorp - East	DAVEJOHN - LAR.RIVR 230kV Line #1 (65420_73107_1)	24 (0.27%) / 795	44 (0.50%) / 903	82 (0.94%) / 1,626
WAPA L.M.|DG&T|Tri-State G&T	P30 TOT 1A Interface	33 (0.38%) / 499	19 (0.22%) / 187	78 (0.89%) / 732
EPE El Paso Electric Company|TSGT New Mexico	UVAS - ALTLUNTP 115kV Line #1 (11193_12195_1)	14 (0.16%) / 108	39 (0.45%) / 296	24 (0.27%) / 134
Tri-State G&T|WAPA L.M.|PSColorado|Basin Electric Power Coop.	P36 TOT 3 Interface	4 (0.05%) / 295	3 (0.03%) / 109	6 (0.07%) / 122
Intermountain Power Agency|Sierra Pacific Power Co.	P32 Pavant-Gonder InterMtn-Gonder 230 kV Interface	12 (0.14%) / 79	4 (0.05%) / 16	6 (0.07%) / 27
TSGT New Mexico|PN2 New Mexico	MIMBRES - ALTLUNTP 115kV Line #1 (10206_12195_1)			1 (0.01%) / 1
WAPA L.M.|PSColorado	MIDWAYPS - MIDWAYBR 230kV Line #1 (70286_73413_1)	1 (0.01%) / 2		
	Total Multi-TO Congestion ($)	**$13,833,021**	**$5,546,467**	**$8,621,120**

6.0 Appendix B: New Mexico Export Stress Scenario Assessment Results

The regional issues were either related to facility loadings or voltage. Transmission lines are rated in Amps, transformers are rated in MVA, voltage is reported in per-unit (pu), and voltage increase or decrease is reported as the percentage change from pre- to post-disturbance with the pre-disturbance voltage as the reference. The single-TO issues are provided in the slides of the PMC meeting on June 16, 2021.

Table 6: New Mexico Export Stress Reliability Assessment Contingency Analysis

Disturbance(s)	Affected Element				Comment
	Owner(s)/ Operator	Affected Element	% Of Limit	Issue	
PNM’s P1 Contingency	PNM on APS/PNM border	FOURCORN - ARROY_POI 345kV Line #1	115%	Line Overload	PNM, TSGT, and APS: The scenario as modeled overstates the amount of solar resources located near the Albuquerque area which results in overloaded lines between the Albuquerque area and the Four Corners area under contingency conditions. Since establishing the model, a portion of the generic renewable resources included in the model near Albuquerque have been defined and located in the Four Corners area which is on the other side of the constraints identified in the scenario case. The analysis also does not consider that a significant portion of the solar resources would not be available for export because of co-located battery storage as well as other local battery storage that has yet to be defined. It is expected that low load high solar hours as modeled in the scenario case will be key hours for battery charging. Both of these reduce the available resources leading to overloads identified in the scenario case. PNM believes the case does model flows approaching the transfer capability limits for resources located in central and eastern New Mexico. It is not, however, clear whether this represents a likely dispatch of such resources. To the degree the case’s assumed solar resources in New Mexico do not develop, they still represent a reasonable renewable dispatch given they can be considered a proxy for additional wind resources with no co-located battery storage.
	TSGT	GALLUPPG 115kV Bus	104%	Exceeds Voltage Negative Deviation Limit	
PNM's P1 Contingency	PNM on APS/PNM border	FOURCORN - ARROY_POI 345kV Line #1	115%	Line Overload	
	TSGT	GALLUPPG 115kV Bus	109%	Exceeds Voltage Negative Deviation Limit	
	PNM	MENDOZAT 115kV Bus	103%		
PNM's P1 Contingency, on APS/PNM border	PNM	CABEZON - RIOPUERC 345kV Line #1, Section 1	117%	Line Overload	
		CABEZON - RIOPUERC 345kV Line #1, Section 2	117%		
		SAN_JUAN - CABEZON 345kV Line #1	119%		
		MENDOZAT 115kV Bus	116%	Exceeds Voltage Negative Deviation Limit	
	TSGT	CINIZA 115kV Bus	104%		
		GALLUPPG 115kV Bus	122%		