2018-2019 Transmission Planning Process

Study Scope for

Increased Capabilities for Transfers of Low Carbon Electricity between the Pacific Northwest and California Informational Study

May 23, 2018

Final

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1 Introduction

In Section 9.2 of the ISO 2018-2019 TPP Study Plan[1] it is discussed that on February 15, 2018, the ISO received communication from the Robert B. Weisenmiller, Chair of the CEC and Michael Picker, President of the CPUC[2], requesting that the ISO undertake specific transmission sensitivity studies within the 2018-2019 transmission planning process. The letter provided the following synopsis for the sensitivity study:

- Increasing rated capacity of AC Intertie and Pacific DC Intertie. Explore the costs and benefits of potential increases to AC and DC intertie capacity with the Pacific Northwest, considering a range of options as well as assessing downstream impacts to transmission within California.

- Increasing dynamic transfer capability limits beyond 400 MW. Conduct engineering analyses to determine an upper limit on dynamic transfer capability from the BPA system. Reflect BPA Reliability Action Scheme (RAS) automation efforts and the relationships to voltage variability and stability concerns within both the BPA system and the broader Northwest grid.

- Automating manual controls on key BPA infrastructure. Assume that within a five-year horizon BPA (at Celilo) and operators at Sylmar deploy necessary upgrades to the automatic generation control and Energy Management Systems (EMS) operating at the converter stations to facilitate intra-hour scheduling on the Pacific DC Intertie and perform sensitivity analyses to assess the impacts to Northwest hydro energy transfer capability from a reliability and ramping perspective to support the goal of closing Aliso Canyon.

- Assigning some RA value to firm zero-carbon imports or transfers. Develop a bounding case that assumes maximal utilization of existing infrastructure investments supporting Energy Imbalance Market operations of participating entities in the Northwest, as well as the integration of synchro-phasor data into control room operations. This case will inform further study and explore the maximum annual expected Northwest hydro import capability of the California ISO grid to estimate an upper bound on avoided GHG emissions assuming that RA/RPS counting criteria are not limiting.

These studies would focus on evaluating key options to increase transfer ratings of the AC and DC interties with the Pacific Northwest, and assess what role these systems can play in displacing generation whose reliability is tied to Aliso Canyon.

The expectation is that the insights gained from these sensitivity study can be used to inform a broader assessment of Alison Canyon Phase-Out options, consistent with the direction the state

[1] http://www.caiso.com/Documents/Final2018-2019StudyPlan.pdf

[2] http://www.caiso.com/Documents/CPUCandCECLettertoISO-Feb152018.pdf. The letter is also provided in Appendix A of this report.

agencies have received to develop plans that would allow for the shutdown of the Aliso Canyon Natural Gas Storage Facility.

The intent of this document is to clearly articulate the objective of the study, the assumptions and study methodology, roles and responsibility of different entities in the study and deliverables.

The ISO has collaboratively worked with the California Energy Commission (CEC), the California Public Utilities Commission (CPUC), Bonneville Power Administration (BPA), Los Angeles Department of Water and Power (LADWP), and Southern California Edison (SCE) to develop this study scope. In addition, a high level review of study objectives and scope was provided to other owners and operators of the path including PG&E, TANC, WAPA, PacifiCorp, PGE, city of Glendale, City of Burbank, City of Pasadena, and BANC to ensure alignment on all aspects of this informational (special) study and will do as required throughout study.

2 Objective

The objective of this study is to explore the following four aspects of how to increase the power transfer capability between Pacific Northwest and California taking into account planning, operation, and market considerations.

- Increase the Capacity of AC and DC Intertie
- Increase Dynamic Transfer Capability
- Control Automation
- Assigning RA Value to Imports

For each of the above study items, the existing limitations will be reviewed and documented followed by identifying incremental system enhancements that would be required to address the limitation and increase the transfer capability.

The study will identify possible increase in transfer capability in near term and long term. The near term study will focus on how to increase the transfer capability by utilizing the existing infrastructure under favorable conditions and without significant system reinforcements. The longer term study will evaluate availability of hydro resources in PNW in the long term and how much additional transfer capability is required to fully utilize the hydro resource.

This study is a sensitivity study in 2018-2019 TPP and is done mainly for informational purposes. Therefore it is not expected any transmission project to be approved as part of this study. However minor upgrades may be considered for approval especially if they are beneficial in baseline studies.

3 Study Assumptions and Criteria

This section provides details of studies including the scenarios being studied, assumptions on the modeling of major components in power systems (such as demand, generation, transmission network topology, and imports), contingencies to be evaluated, and reliability standards to be used to measure system performance, and software or analytical tools.

Detail assumptions for BPA and areas of California that are not controlled by the ISO will be obtained from corresponding entities or from WECC case.

3.1 Standards and Criteria

The study will be performed in accordance with the following standards and criteria where applicable

- NERC reliability standards,
- WECC Regional Criteria
- California ISO Planning Standards
- Applicable standards in other jurisdictions

3.2 Study Horizon and Years

Study years: Near term (year 2023) and long term (year 2028)

3.3 Study Areas

- Path 65 (Pacific DC Intertie)
- Path 66 (COI)
- Path 15
- Path 26
- Path 76
- Other areas or transmission elements within California or PNW that could be impacted by the transfer capability increase.

3.4 Transmission Assumptions

The assumptions on transmission projects, reactive power resources, protection systems and control devices modeling will be in line with the 2018-2019 TPP Study Plan[3].

3.5 Load Forecast Assumptions

3.5.1 Energy and Demand Forecast

The 2017/2018 IEPR will be used in this study. Similar to other bulk system studies, the 1-in-5 weather year, mid demand baseline with mid Additional Achievable Energy Efficiency (AAEE) and mid Additional Achievable Photovoltaic (AAPV) savings load forecast will be used for this special study.

The CEC forecast information is available on the CEC website at:

http://www.energy.ca.gov/2017_energypolicy/documents/

The latest generation, load and network topology of BPA and LADWP systems will also be used in the study.

3.5.2 Power Factor Assumptions

Same assumptions as 2018-2019 TPP Study Plan.

3.5.3 Self-Generation

Baseline peak demand in the CEC demand forecast is reduced by projected impacts of self-generation serving on-site customer load. Most of the increase in self-generation over the forecast period comes from PV[4]. In base cases, both baseline PV and AAPV generation production will be modeled explicitly.

PV Self-generation installed capacity for mid demand scenario by the PTO and forecast climate zones are shown in Table 1.

[3] http://www.caiso.com/Documents/Final2018-2019StudyPlan.pdf

[4] http://docketpublic.energy.ca.gov/PublicDocuments/17-IEPR-03/TN222287_20180120T141708_The_California_Energy_Demand_20182030_Revised_Forecast.pdf

Table 1: Mid demand baseline PV self-generation installed capacity by PTO[5] (MW)

PTO	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
PG&E	4163	4632	5109	5565	6009	6437	6844	7230	7599	7955
SCE	2892	3259	3647	4035	4426	4810	5182	5537	5877	6206
SDG&E	1010	1108	1198	1277	1349	1417	1482	1545	1608	1673

Output of the self-generation PV will be selected based on the time of day of the study using the end-use load and PV shapes for the day selected.

Additional Achievable Photovoltaic (AAPV)

The AAPV will be modeled explicitly similar to the baseline PV self-generation. Table 2 below shows AAPV installed capacity for Mid-Mid Scenarios for each IOU planning areas.

Table 2: AAPV installed capacity (MW) for PG&E, SCE and SDG&E planning areas[6]

PTO	2020	2021	2022	2023	2024	2025	2026	2027	2028
PG&E	75	150	226	301	376	452	528	603	677
SCE	72	146	221	295	370	445	521	595	669
SDG&E	13	26	39	53	66	80	93	107	120

Output of the AAPV will be selected based on the time of day of the study using the end-use load and PV shapes for the day selected.

3.6 Generation Assumptions

Retirement of Diablo Canyon, Boardman, Centralia, Colstrip units 1 and 2, and other generation will be modelled in the study.

3.6.1 Renewable Generation assumption

CPUC's Unified Inputs and Assumptions document[7] provides two generation portfolios: the Default Scenario and 42 MMT Scenario. The Default Scenario corresponds to 50% RPS and the 42 MMT Scenario corresponds to a statewide electric sector GHG reduction target of 42 million metric tons (MMT) by 2030 and includes more than 50% renewables. The 2018-2019 TPP Study Plan indicates that the Default Scenario will be used for reliability assessment and 42 MMT Scenario will be used for policy-driven sensitivity study. For this informational study the ISO will

[5] Based on self-generation PV calculation spreadsheet provided by CEC.

[6] https://efiling.energy.ca.gov/GetDocument.aspx?tn=222398

[7] http://www.cpuc.ca.gov/General.aspx?id=6442451972

be using the Default Scenario. The ISO may conduct limited sensitivity studies on the 42 MMT Scenario.

A detailed assessment of hydro resource availability in the PNW will be conducted in the production simulation analysis The ISO will be utilizing the WECC Anchor Data Set (ADS) in the assessment. The ISO will inquire from Planning Regions in the Pacific Northwest (Columbia Grid and NTTG) if they have additional modelling enhancements to the WECC ADS with regards to resources in the Pacific Northwest.

3.7 Major Path Flows and Interchange

Power flow on the major internal paths and paths that cross Balancing Authority boundaries represents the transfers that will be analyzed in the study. Table 3 lists the capability and power flows that will be modeled in each scenario on these paths.

Table 3: Major Path Flows Assumptions

Path	Transfer Capability/SOL (MW)	Scenario in which Path will be stressed
Path 26 (N-S)	4000[8]	Summer Peak
PDCI (N-S)	3220[9]	Summer Peak
PDCI (N-S)	-3100[10]	Winter Peak
Path 66 (N-S)	4800[11]	Summer Peak
Path 15 (N-S)	-5400[12]	Spring Off Peak
Path 26 (N-S)	-3000	Spring Off Peak
Path 66 (N-S)	-3675	Winter Peak
West of River (WOR)	11,200	Summer Peak
East of River (EOR)	10,100	Summer Peak
San Diego Import	2,850	Summer Peak
SCIT	17,870	Summer Peak
Path 45 (N-S)	400	Summer Peak
Path 45 (N-S)	-800	Off Peak

8 May not be achievable under certain system loading conditions.

9 Operationally limited to 3210 MW

10 Operationally limited to -1000 MW

11 For analysis of the existing sytem, Path 66 flows will be modeled to the applicable seasonal nomogram for the base case relative to the northern California hydro dispatch.

12 May not be achievable under certain system loading conditions.

The above path flows will be implemented in the starting base case. Path flows may be modified based on the specific study performed.

3.8 Operating Procedures

For analysis of the existing system, operating procedures, for both normal (pre-contingency) and emergency (post-contingency) conditions, will be modeled in the studies.

Please refer to http://www.caiso.com/thegrid/operations/opsdoc/index.html for the list of publicly available Operating Procedures.

3.9 Special Protection and Remedial Action Schemes (SPS and RAS)

Appendix B provides list of SPS and RAS in California system that will be modelled in this study. SPS and RASes in BPA, LADWP and other systems that might have an impact on this study will be modelled as well.

3.10 Study Scenarios

3.10.1 Near Term

To study high north to south flow in the near term, the favorable conditions in PNW with regards to exporting hydro generation to California will be studied. Favorable system conditions in PNW system could be expected in spring when there is abundant hydro and wind generation in the Lower Columbia area combined with mild temperatures in the Pacific Northwest.

- Higher share of generation comes from further south (Lower Columbia, Central Oregon, Southern Oregon)
- Lower loads in Central Oregon and Southern Oregon (mild temperatures or low demand time of day)
- Westbound flow on Hemingway – Summer Lake

To study high south to north flow in the near term, the favorable conditions in California and PNW will be studied to determine if there are benefits to address operational limits on PDCI. Such conditions could be expected when there is abundant solar generation in California.

- Less generation in the south PNW system
- Higher loads in Central Oregon and Southern Oregon
- Eastbound flow on Hemingway – Summer Lake

3.10.2 Long Term

The starting point for the long term studies is analyzing the availability of hydro resources in PNW to provide energy or resource shaping through production simulation results. If the production simulation results indicate energy or resource shaping benefits could be obtained by increasing transfer capability, study snapshots will be selected for transmission reliability studies. Due to time constraints, these snapshot studies may need to be part of a Phase 2 study. The followings are potential candidates:

- High N-S flow on AC and DC interties
    - High hydro generation and low load in PNW
    - Low PV and gas generation in California
    - High load in California
    - …
- High S-N flow on AC and DC interties
    - High PV generation in California
    - High load and low hydro in PNW
    - …

3.11 Study Base Cases

Depending on the selected snapshot for the studies, a WECC case will be used as the starting point and will be modified to reflect all the study assumptions with regards to transmission, load, generation, and path flows. Table 4 shows potential WECC base cases for each study year. For dynamic stability studies, the latest WECC Master Dynamics File (from January 4, 2018) will be used as a starting point. Dynamic load models will be added to this file.

Table 4: Summary of WECC Base Cases used to represent system outside ISO

Study Year	Season	WECC Base Case
2023	Summer Peak	23HS2a1
	Winter Peak	23HW1a1
	Spring Off-Peak	23HW1a1
2028	Summer Peak	28HS1a1
	Winter Peak	28HW1a1
	Spring Off-Peak	26LSP1Sa
	Winter Off-Peak	28HS1a1

3.12 Contingencies

In CAISO system same assumptions as 2018-2019 TPP Study Plan will be used. If certain contingencies in adjacent systems such as PNW may impact California system, they will be studied as well. PNW and LADWP contingencies required for this study will be provided to CAISO.

3.13 Study Tools

For CAISO studies of CAISO same assumptions as 2018-2019 TPP Study Plan will be used. PNW study assumptions will be provided by PNW entities.

4 Study Methodology

This section provides details of each of the four studies and the study methodology.

4.1 Increase the Capacity of AC and DC Interties

The objective of this study is to determine the existing transfer limits on AC and DC interties and develop alternatives to increase their capacity, if required. This review includes but is not limited to WECC paths such as COI (Path 66), PDCI (Path 65), Path 15, and Path 26. The alternatives may include upgrades to existing system or greenfield projects. Technical and cost analysis of alternatives will determine their reliability and economic benefits.

- Review existing system limits
    - COI rating: 4800 MW N-S and 3675 MW S-N
    - PDCI rating: 3220 MW N-S and 3100 MW S-N N (Operationally it is currently limited to 3210 MW in the N-S and 1000 MW in the S-N direction)
    - Path 15 rating: 2000-3265 MW N-S and 4800-5400 MW S-N
    - Path 26 rating: 4000 MW N-S and 3000 MW S-N

The above ratings are WECC path ratings but might be other operating limits that will be reviewed in the study.

- Existing congestion due to physical or market limitations
    - Day ahead vs. real time
- Common Corridor Contingency
    - Current treatment of the contingency of two of the COI lines as P7
    - Operations potential treatment of two COI lines as conditionally credible contingency – should planning consider as P6 and extreme event in the studies including path rating study.
    - SOL and IROL studies

- Review of previous/other studies
    - 2012 – 2013 TPP Economic Assessment of PDCI Capacity Increase
        - Review of assumptions and cost estimates
    - 2006 study (details to be added)
    - 2009 ABB (Celilo CAS Study Configurations and General Overview)
    - Seasonal OSS COI/PDCI studies
    - Other studies…
    - Aliso Canyon Technical Analysis
        - CAISO sensitivity analysis
        - CPUC initiatives

- Develop Alternatives to Increase Capacity in both direction
    - Develop a bounding case that assumes maximal utilization of existing infrastructure
    -
    - Upgrades or modifications to existing transmission system, controls, …

  - 3rd party greenfield projects. These studies may need to be part of a Phase 2 study.
  - AC or DC development
  - Increasing PDCI rating from 3220 MW N-S to a maximum of 3800 MW N-S
    - Upgrades required at Sylmar Converter Station (Southern terminus of the PDCI)
    - An analysis of the 581 mile HVDC transmission line between the Nevada-Oregon Border (NOB) and Sylmar Converter Station.
    - Cost associated with all upgrades/modifications identified in the analysis. High level costs may be adequate until production cost simulations demonstrate commensurate value.
    - Intermediate upgrades shall also investigated where appropriate, to improve transfer capacity beyond 3220 MW while minimizing the capital investment and outage times.
    - Spinning Reserve Requirements & Costs
    - Impact of increased capacity on real power losses and its cost
    - The potential change in Most Severe Single Contingency (MSSC) and its impact on system planning and operation.
    - Identify impacts on both BPA and LADWP's network and the rest of the system to enable the 3800 MW N-S, and the impact that this would have on the amount of RMR thermal generation commitment. An analysis of the parallel AC system from the NW to Southern California for PDCI contingency outages.
    - Establish S-N rating of PDCI and identify if the S-N TTC is sufficient to accomplish the goal for the 2018-2019 TPP. BPA also has a default operating limit for S>N of 2200 MW. This was determined to be the limit after the NW load tripping was removed from the PDCI RAS. It has not been studied since.
  - Short Term or Long Term availability of the increased ratings. The short term increased rating may not be firm and may only be available under certain favorable conditions. The long term analysis will determine what enhancements are required to make the increase capacity to be firm. Analysis of the short-term will determine system conditions under which the paths would be utilized. The short term assessment also provides certain level of confidence for the increased rating and the overall system performance/resiliency.

- Analysis of Alternatives
  - Cost estimates
  - Reliability benefits
    - Any quantification would be avoided cost. Other benefits will be qualitative.
  - Economic benefits
    - Production simulation
      - Gridview/Plexos or both
  - Flexible capacity need benefit

4.2 Increase Dynamic Transfer Capability

The dynamic transfer capability (DTC) on the COI is currently limited to 400 MW. BPA has studied its capabilities of increasing DTC to 600 MW and are moving forward with implementing this change. BPA will distribute these study results to inform the CAISO TPP evaluation this year.

The CAISO will assess the benefits to California system of going beyond 600 MW and any potential requirements on the ISO controlled grid.

4.3 Control Automation

The CAISO will study whether or not sub-hourly scheduling capability on the PDCI might help to mitigate Aliso Canyon retirement and other RA requirements. BPA has indicated that they will contribute their own initial scoping document to inform the TPP study. BPA also indicated that they will need to coordinate with the other co-owners and the joint operators to inform any additional technical analyses and conclusions, which will be done according to BPA's internal work prioritization and timelines, which may or may not align with CAISO's TPP timelines.

The CAISO's study can identify potential system enhancements on the PDCI south of Nevada-Oregon Border that may be required in order to achieve the sub-hourly scheduling capability.

4.4 Assigning Resource Adequacy (RA) Value to Imports

- Review historical availability of RA import capacity and associated constraints on hydro generation imports that could be shaped through unused storage capacity potential available in the Northwest
- Assess potential for planned increases in transfer capability to increase the available import capacity
-

4.5 Production Cost Simulation and Assessment

It is essential to simulate a reasonable forecast of hydro resources in the PNW system for the long term to be able to estimate potential benefits of increasing transfer capability. Production cost simulation will be used to identify congestion under different hydro scenarios (base, low, and high) in the long term and quantify the production cost benefits of increasing the transfer capability.

This production cost simulation will determine how much excess hydro resources are available in the PNW to either provide energy to California or be used as resource shaping, and explore the maximum annual expected Northwest hydro import capability of the California ISO grid to estimate avoided GHG emissions. Under resource shaping scenario excess solar generation will flow from California to PNW during the day and hydro power will flow to California for evening ramp.

5 Schedule

Study Milestone	Completion date
Draft scope to be posted	4/12/2018
Stakeholder call	4/18/2018
Stakeholder comments	4/25/2018
Final scope	5/23/2018
Preliminary results	Nov. 16, 2018 Stakeholder meeting
Draft report – Final results	Jan 31, 2019 – Draft Transmission plan
Present final results to stakeholders	February 2019 – stakeholder meeting
Final report	March 2019 – Final board-approved plan

APPENDIX A:

Letter from CEC and CPUC to ISO

http://www.caiso.com/Documents/CPUCandCECLettertoISO-Feb152018.pdf

APPENDIX B: System Data

Reactive Resources

Table A-1: Summary of key existing reactive resources modeled in ISO reliability assessments

Substation	Capacity (Mvar)
Gates	225
Los Banos	225
Gregg	150
McCall	132
Mesa	100
Metcalf	350
Olinda	200
Table Mountain	454
Devers	156 & 605 (dynamic capability)
Sunrise San Luis Rey	63
Southbay / Bay Boulevard	100
Miraloma	158
Suncrest	126
Penasquitos	126
Santiago synchronous condensers	3x81 MVAR
Talega synchronous condensers	2x225/-120 MVAR
San Luis Rey synchronous condensers	2x225/-120 MVAR
Miguel synchronous condensers	2x225/-120 MVAR
San Onofre synchronous condenser (planned in-service in August 2018)	1x225/-120 MVAR

Special Protection Schemes

Table A-2: Existing key Special Protection Schemes in the PG&E area on bulk system

PG&E SPS Name
COI RAS
Colusa SPS
Diablo Canyon SPS
Gates 500/230 kV Bank #11 SPS
Midway 500/230 kV Transformer Overload SPS
Path 15 IRAS
Path 26 RAS North to South
Path 26 RAS South to North
Table Mt 500/230 kV Bank #1 SPS

Table A-3: Existing key Special Protection Schemes in SCE area

SCE SPS Name
Midway-Vincent RAS
Pastoria Energy Facility Existing RAS
West-of-Devers Remedial Action Scheme
Blythe Energy RAS
Mountain view Power Project Remedial Action Scheme
South of Lugo N-2 Remedial Action Scheme
Mira Loma Low Voltage Load Shedding
Santiago N-2 Remedial Action Scheme
Ivanpah Area RAS
Lugo-Victorville RAS

Table A-4: Existing key Special Protection Schemes in the SDG&E

SDG&E SPS Name
230kV Otay Mesa Energy Center Generation SPS
ML (Miguel) Bank 80/81 Overload SPS
CFE SPS to protect lines from La Rosita to Tijuana
TL 50001 IV Generator SPS
Path 44 South of SONGS Safety Net