CAISO 2020/21 Transmission Plan: Stakeholder Comments

Submitted by	Company	Date Submitted
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LS Power appreciates the opportunity to submit comments on CAISO's 2020/21 Draft Transmission Plan.

(1) Economic Study: COI congestion & SWIP-North as an economic project

LS Power thanks CAISO staff for conducting congestion analysis for the COI Corridor and economic analysis for the SWIP-North project. We have the following comments/questions related to this analysis. LS Power recommends that CAISO rerun its economic analysis for SWIP-North taking these comments into account prior to finalizing the Transmission Plan.

a) **SWIP-North upgrades should be included** - CAISO should ensure that the existing 500 kV transmission path from Robinson Summit to Harry Allen ("ON Line") is limited to 1000 MW in the base case and is increased to 2000 MW only in the case with SWIP-North. In addition to the new 500 kV transmission line and series capacitors between Midpoint and Robinson Summit, the SWIP-North project also includes key upgrades to existing infrastructure which include the addition of 70% series compensation on ON Line and phase shifting transformers on the existing Robinson Summit-Gonder and Robinson Summit-Falcon 345 kV lines. These upgrades enable increased transfers in the north-to-south (N-S) direction from Midpoint to Harry Allen. It appears CAISO's study did not include these upgrades, resulting in under-utilization of the 2000 MW SWIP-North path in N-S direction (for example, CAISO's study shows line flows not going above 600 MW in the N-S direction).

   After reviewing CAISO's draft economic study results, LS Power hired Hitachi ABB Power Grids to perform an economic analysis for SWIP-North ("ABB Study") using CAISO's 2020-21 TPP production cost model (posted on CAISO's Market Participant Portal). This study concluded that if the SWIP-North upgrades described above are correctly modelled and operated, interface congestion and flow patterns changes significantly. In particular, the study showed higher flows from Midpoint to Eldorado 500 kV path, greater reductions on COI and PDCI congestion, reduced PG&E-Sierra congestion and increased overall imports into CAISO. Congestion reduction and flow

increases led to production cost savings for SWIP-North estimated at $70 million per year, a significant increase compared to the $10 million per year shown in the CAISO study. This study also showed that in addition to modelling SWIP-North upgrades, accurately capturing the initial setting and operation of phase shifters at Robinson Summit is also critical, and altering these assumptions can have a bearing on economic benefits. The ABB Study is provided in Appendix A for CAISO review.

b) **Wheeling charges should be removed** - For the SWIP-North economic study, to correctly calculate economic benefits of a 1000 MW transmission path from Midpoint to Harry Allen, CAISO should have modeled this new 1000 MW path free of any wheeling charges. We understand that the standard ADS PCM model has a NVE wheeling charge of $9/MWh and CAISO's study did not remove this charge. This is an inaccurate assumption. Given the FERC-approved Transmission Use and Capacity Exchange Agreement in place between LS Power affiliates & NV Energy, such a wheeling charge does not apply. Including a wheeling charge will create an artificial hurdle across this path which reduces SWIP-North N-S flows and hence underestimates benefits of SWIP-North.

c) **COI path limits should be correctly enforced for CAISO's share of COI & Day Ahead PACI congestion should be correctly captured -** For the COI congestion analysis, it appears CAISO used the full 4800 MW path rating as the limit for the COI path. As noted in our previous comments, CAISO's share of the 4800 MW path is only 3200 MW (limit of PACI scheduling interface[1]) with the remaining 1600 MW belonging to members of Transmission Agency of Northern California (TANC), an entity outside CAISO. In addition, as CAISO has noted in its prior TPP presentations, 1200 MW out of the 3200 MW PACI scheduling limit comprises of Existing Transfer Capabilities (ETCs) and Transmission Ownership Rights (TORs) that are owned by entities outside CAISO. This leaves only about 2000 MW of the total 4800 MW COI path that is available to CAISO, and this is what CAISO should have used as COI limit for its economic analysis. The other 2800 MW should have been modeled with a large hurdle rate such that it becomes mostly unavailable to the CAISO system. Not correctly capturing these scheduling realties makes 2800 MW on this path available for CAISO with little hurdle, artificially reducing COI N-S congestion. If this constraint is correctly modelled, the CAISO study should show PACI, NOB congestion close to historic levels as noted in CAISO DMM reports[2] over last several years.

[1] PACI is the CAISO scheduling interface and COI is a WECC path. PACI is a subset of COI and its scheduling capability is limited to 3200 MW.

[2] See Table 8.4 in CAISO's 2019 Annual Report on Market Issues and Performance, June 2020. http://www.caiso.com/Documents/2019AnnualReportonMarketIssuesandPerformance.pdf. California Oregon Intertie (COI) comprises of three transmission lines that have a combined flow limit of 4800 MW N-S. CAISO TPP studies enforce this flow limit and capture any congestion on this path. In the Day Ahead scheduling world, congestion is witnessed across the Pacific AC Intertie (PACI) and Nevada-Oregon Border (NOB) scheduling interfaces. PACI is a subset of COI and has a scheduling limit of 3200 MW which represents scheduling rights of CAISO member entities on COI path. NOB is the scheduling interface for Pacific DC Intertie. It is rated at 3220 MW N-S and the transmission capacity is allocated between CAISO member entities and LADWP.

Once CAISO correctly quantifies benefits from item a) above, overall production cost savings from SWIP-North will significantly increase and should more closely match the production cost savings estimated by the ABB Study (Appendix A). It should be noted that the purpose of the ABB Study was simply to replicate the CAISO study with adding the SWIP-North upgrades to determine the impact of the upgrades on economic benefits. The ABB Study did not correct the wheeling charge and Day Ahead PACI/NOB congestion issued noted above.

Further, once CAISO correctly improves its model to address items in b) and c) above, the production cost savings for SWIP-North are expected to further increase and track closely with the benefits shown in a study recently conducted by The Brattle Group[3] ("Brattle Study"). LS Power recently commissioned The Brattle Group to conduct a SWIP-North study evaluating a variety of potential economic, reliability, and public policy benefits. The Brattle Study concluded that the SWIP-North project can provide benefits of up to $105 million annually from Energy Market transfers (aka production cost savings). This study is a good reference for estimating SWIP North economic benefits if items in a), b), and c) above are correctly addressed. In addition to production cost savings, the Brattle Study also estimated additional benefits from the project as described below.

d) **Additional economic benefits of SWIP-North** - In addition to quantifying production cost savings, we recommend that CAISO also capture additional benefits of SWIP North identified by Brattle Study in the report referenced herein. These additional benefits are referenced in Table 4.2-1 of the Draft Transmission Plan and are in line with CAISO's TEAM methodology: 2.5.1 Resource adequacy benefit from incremental importing capability, 2.5.3 Deliverability benefit, 2.5.5 Public-policy benefit, 2.5.6 Renewable integration benefit.

   LS Power's recommendations on how these benefits should be quantified are provided below. The Brattle Study quantified some of these additional benefits as well, which we recommend CAISO use as guiding points to estimate these benefits.

   i. Resource Adequacy (RA) benefit from incremental importing capability

   SWIP-North provides RA benefits to CAISO since the following four conditions noted in CAISO's TEAM methodology are satisfied simultaneously:

   - SWIP-North will increase the import capability into the CAISO controlled grid in the study years. Absent SWIP-North, CAISO's import capability with Idaho Power & PacifiCorp East is limited and the import path between NVE-CAISO in the Sierra Region is congested. SWIP-North will enable a new 1000 MW import capability path between various BAAs.

[3] "SWIP-North Benefits Analysis." February 2021. Michael Hagerty, Johannes Pfeifenberger, and Evan Bennett. The Brattle Group. https://brattlefiles.blob.core.windows.net/files/21438_swip-north_benefits_analysis.pdf

- As evident through CAISO's own stack analysis in CPUC proceedings, there is projected insufficient capacity to maintain resource adequacy in the CAISO BAA starting this year in 2021.[4]
- The existing import capability has been fully utilized to meet RA requirement in the CAISO BAA in the study years. A recent WECC analysis shows that even when all planned internal and import resources are added, Southern California has hours at risk of unserved load.[5]
- The capacity cost in the CAISO BAA is greater than in other BAAs (Idaho Power, PacifiCorp, NV Energy) to which the new transmission connects.

CAISO should estimate the RA/Capacity value of SWIP North based on load diversity (seasonally and hourly) between Idaho and Southern California and capacity cost savings from building new supply in ID vs CA. Recent historical load shapes to determine the reduction in peak requirements should be used for this analysis. Enabling 1000 MW of transmission capacity from CAISO to neighboring regions will allow the flexible ramping requirement for CAISO and the regions to be reduced as they will be able to take advantage of the diversity of resources and shape of the load. These diversity saving benefits should be accounted for. CAISO's Quarterly EIM reports capture these benefits and this is an approach that CAISO Transmission Planning can use as well for this study. The Brattle Group estimates these load diversity benefits to be at least $11 million-$18 million annually.

The value of reduction in peak capacity requirements based on prevailing costs of capacity in Southern California and Idaho should also be estimated. Brattle Study does not estimate these additional capacity benefits based on the ID and CA capacity cost difference of importing up to 1000 MW of firm capacity. However, CAISO has estimated these capacity benefits for other economic transmission projects in past and we recommend CAISO conduct this analysis for SWIP-North project.

ii. Deliverability benefit

SWIP-North will enable deliverability of Out-of-State renewables which are part of Sensitivity portfolio for 2020-21 TPP and will be part of Base and Sensitivity portfolio for 2021-22 TPP.

iii. Public Policy Benefit

SWIP-North will increase the firm import capability with a line that flows directly into the CAISO controlled grid. SWIP-North will have access to thousands of

[4] Testimony of Jeff Billinton on behalf of CAISO in R.20-11-003, January 11, 2021

[5] WECC Western Assessment of Resource Adequacy, Subregional Spotlight: California and Mexico (CAMX). February 12, 2021. https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/Western%20Assessment_California%20and%20Mexico%20Report.pdf&action=default

megawatts of diverse renewable energy resources that can help reduce the cost of reaching renewable energy targets. As noted in CAISO's TEAM methodology "*When there is a lot of curtailment of renewable generation, extra renewable generators will need to be built or procured to meet the goal of renewable portfolio standards (RPS). The cost of meeting the RPS goal will increase because of that. By reducing the curtailment of renewable generation, the cost of meeting the RPS goal will be reduced. This part of cost saving from avoiding over-build is categorized as public-policy benefit".* In CAISO's studies, SWIP-North has shown to help reduce renewable curtailments in CAISO footprint by providing a conduit to export surplus renewable energy from California. These capital cost savings should be captured.

iv. Renewable Integration benefit

As noted in CAISO's Draft Transmission Plan, Interregional coordination can help mitigate integration problems, such as over-supply and curtailment, by allowing sharing energy and ancillary services (A/S) among multiple BAAs.

SWIP-North will increase importing and exporting capability of BAAs (CAISO, NVE, Idaho Power, PacifiCorp) and will facilitate sharing energy among BAAs, so that the potential over-supply and renewable curtailment problems within a single BAA can be relieved by exporting energy to other BAAs, whichever can or need to import energy. SWIP-North will also facilitate sharing A/S Sharing between the areas. The total A/S requirement for the combined areas may reduce if the areas are allowed to share A/S. This benefit should be captured in CAISO's study.

v. GHG reductions and associated savings

GHG reductions in California can be offered by diverse new and existing renewable supply at the other end of SWIP-North.[6]

The Brattle Group indicates that SWIP-North will enable delivery of diverse out-of-state renewables into California. Their study analyzed the benefits of 1000 MW of Idaho wind delivered to California, which is more available than solar in evening peak hours to offset fossil fuel generation. The study concluded that Idaho wind on average reduced 146% more GHG emissions as compared to in-state solar. This GHG emissions benefit amounts to approximately $9/MWh in cost savings to CAISO ratepayers.

e) Other benefits of SWIP-North:

A new transmission line such as SWIP-North, which parallels several existing 500 kV bulk transmission paths connecting the northern area of WECC to the southern area, provides several additional benefits that go beyond traditional economic studies.

[6] OATI OASIS for Idaho Power Company, Generation Interconnection Queue, Accessed 12/1/2020 http://www.oasis.oati.com/ipco/

These benefits should however be quantified so all lead agencies in California and the ratepayers can get a complete picture on the value of such transmission lines.

i. *Potential solution to mitigate blackouts during heatwave situations*

As witnessed during the August 2020 blackout events, the supply conditions within California and the Desert Southwest were extremely tight, especially during the evening peak hours. As shown by preliminary analysis conducted by WECC[7], while the Desert Southwest was experiencing heatwave and supply shortages, the Pacific Northwest was not in such a dire situation. If there was enough N-S transmission capability available, California could have potentially imported energy from the Pacific Northwest. Given this, a natural question that is posed is what value would a new transmission line have provided for days like this. SWIP-North, which provides an alternate 1000 MW path to allow flow from the Pacific Northwest and PacifiCorp East into CAISO, may have prevented load shedding events in California.

ii. *Wildfire risk mitigation:*

We recommend that CAISO evaluate the wildfire risk mitigation benefits of SWIP-North. It is known that the COI corridor and the 500 kV transmission lines north of COI corridor fall under high wildfire risk category. An example scenario occurred during the August 2020 heatwave events, where a weather event caused one of the lines in this corridor to de-rate the COI path by 650 MW.[8] A new transmission line like SWIP-North, with its physical path from Idaho to Nevada, provides an alternate path for energy to get from the Pacific Northwest into CAISO. This diversification of transmission paths can benefit CAISO ratepayers by allowing energy to be re-directed towards CAISO in the event existing COI corridor is congested or its limit reduced. This benefit should be captured in CAISO's analysis.

iii. *Resolving Reliability issues on COI path*

LS Power submitted SWIP-North as a transmission solution to address reliability issues for the Bulk system in the Northern California area. In its review, CAISO concluded that "*while SWIP-N project can mitigate the identified overloads that it claims to mitigate, we don't consider that there is a reliability need for such project, since the overloads can be mitigated with substantially lower cost by operating within the COI nomogram or by congestion management reducing generation in the area of overloads."*

The CAISO-proposed solutions to mitigate the identified reliability concerns are:

- Manage COI flow according to the seasonal nomograms

[7] Western Heatwave Event 2020, Preliminary Findings. November 11, 2020 https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/Western%20Heatwave%20Part%20Two.pdf&action=default&DefaultItemOpen=1

[8] Final Root Cause Analysis of Mid-August 2020 Extreme Heat Wave. January 13, 2021. http://www.caiso.com/Documents/Final-Root-Cause-Analysis-Mid-August-2020-Extreme-Heat-Wave.pdf

- Implement SPS to bypass series capacitors on both 500 kV transmission lines between Round Mountain and Table Mountain if any of these lines overloads.

LS Power recommends that in the next TPP cycle CAISO should look at all benefits a particular transmission project can provide. If a large transmission project such as SWIP-North can help resolve reliability needs, in addition to providing policy and economic benefits, these benefits should be aggregated when evaluating the merits of a project. Any cost savings from deferring the reliability solution should also be attributed to the project.

(2) Interregional Transmission Projects

CAISO noted that it considers SWIP-North to be "an interregional transmission project (ITP) due to the physical interconnections at Robinson Summit, Nevada and Midpoint, Idaho, within the WestConnect and Northern Grid (NG) planning regions, respectively." Additionally, in the Draft Transmission Plan, CAISO said it considered all ITP proposals in its 2020-2021 TPP and did not identify a CAISO need for the proposed ITPs.

LS Power recommends that CAISO continue to evaluate economic, policy and reliability benefits of SWIP-North to CAISO ratepayers as a Regional project. These benefits to CAISO ratepayers should allow CAISO to approve this transmission project without the need for interregional cost allocation. In addition, we would like to remind CAISO that a significant part of the full SWIP corridor has already had interregional cost allocation. The Robinson Summit to Harry Allen portion (ON Line) is a 231 mile portion of the line that began operation in 2014 and is paid for by NV Energy customers. The Midpoint to Robinson Summit portion (SWIP-North) would increase the total capacity on ON Line, creating a 1000 MW corridor from Idaho to CAISO that could be used for the primary benefit of CAISO ratepayers. As noted above, this connection can provide significant economic, reliability, and public policy benefits to CAISO. Therefore, while SWIP-North is a portion of a 506 mile interregional project, the path physically and electrically connects directly at Harry Allen which became a CAISO interface in 2020, and nearly half of the total cost has already been allocated (and placed in service in 2014), so the benefits to CAISO ratepayers and the ability to meet CAISO's regional policy and reliability needs if the remaining SWIP-North portion is completed should continue to be studied under regional framework.[9]

LS Power appreciates the opportunity to provide these comments.

[9] See CAISO tariff section 24.13.

APPENDIX A

SWIP-North Economic Analysis by Hitachi ABB Power Grids

Performed by Hitachi ABB Power Grids

Jinxiang Zhu, 919-389-9350 // Feb 16, 2021

SWIP-North Economic Analysis

Based on a request from LS Power, Hitachi ABB Power Grids performed economic analysis for SWIP-North transmission project. This study was done to model two upgrades that go along with SWIP-North project; 70% series compensation on existing Robinson Summit to Harry Allen Line (ON LINE) & two phase shifters on Robinson Summit-Falcon & Robinson Summit-Gonder 345 kV lines. LS Power's understanding is that CAISO's Economic Study for SWIP-North did not include these upgrades. This study captures those upgrades and replicates production cost simulation using CAISO's base case. This study concludes that if these upgrades are modelled SWIP-North economic benefits increase to $70m per year, as compared to $10m per year shown in CAISO study. This study also concludes that modelling correct initial setting & operation of phase shifters at Robinson Summit is critical and that the benefits of SWIP-North vary with operating assumptions. It should be noted that this study simply replicated CAISO study and did not attempt to change any other modelling assumptions, including the NVE wheeling charges that are built into the ADS PCM model. As per LS Power, these wheeling charges are not applicable to SWIP-North project. If these wheeling charges are removed, the economic benefits of SWIP-North should further increase from what is shown in this report.

Study Approach

ABB used CAISO's TPP 2030 case for this study and as a first step ran production cost simulation for the base case without SWIP-North. This was done to benchmark CAISO's pre SWIP-North results. SWIP-North was then modelled into this case along with the two associated upgrades - 2 Phase Shifters at Robinson Summit and 70% series compensation on the Robinson Summit – Harry Allen line. Steps below outline details:

1. Run "(1) ISO Planning PCM-2030 Base Portfolio" to benchmark CAISO base case congestion results. (name this "ABB Base case")

2. Develop a scenario to model SWIP-North project which comprises the following segments (name this "ABB SWIP-North case"):
    a. Midpoint – Robinson 500kV transmission line with 70% Series Compensation - new line
    b. Add 70% Series Compensation for Robinson to Harry Allen – new SC, existing line
    c. Add two Phase shifters at Robinson 345kV with +/- 600 MW, +/- 48 deg limits, $1/deg cost
    d. Add interfaces for SWIP N, Robinson Summit – Harry Allen (ON LINE), and Harry Allen – Eldorado 500kV lines.

Study Findings

Benchmarking

Congestion on key transmission interfaces for ABB Base case tracks closely with CAISO pre SWIP-North case. Table 1 below shows congestion for key interfaces from ABB study. Table 2 shows congestion for pre SWIP-North case from CAISO study as reported under Table 4.7-1 in CAISO draft report.

Table 1: Pre SWIP-North congestion on select interfaces using ABB base case

Constraints Name	Costs_F (K$)	Duration_F (Hrs)	Costs_B (K$)	Duration_B (Hrs)	Costs T (K$)	Duration_T (Hrs)
DOUBLTTP-FRIARS 138 kV line, subject to SDGE N-2 SX-PQ + PQ-OT 230 kV with RAS	0	0	52,736	2,749	52,736	2,749
WIRLWIND 500/13.8 kV transformer #1	0	0	22,909	295	22,909	295
P66 WECC COI	9,232	267	0	0	9,232	267
P65 WECC Pacific DC Intertie (PDCI)	0	0	8,954	562	8,954	562
P45 WECC SDG&E-CFE	669	130	7,129	1,323	7,798	1,453
DRUM-BRNSWCKP 115 kV line #2	5,532	372	0	0	5,532	372
LE GRAND-CHWCHLASLRJT 115 kV line, subject to PG&E N-1 Panoche-Mendota 115 kV	0	0	4,831	1,365	4,831	1,365
MW_WRLWND_31-MW_WRLWND_32 500 kV line #3	0	0	3,810	77	3,810	77
LCIENEGA-LA FRESA 230 kV line, subject to SCE N-2 La Fresa-El Nido #3 and #4 230 kV	0	0	3,592	84	3,592	84
P60 WECC Inyo-Control 115 kV Tie	3,282	1,433	72	233	3,354	1,666
P26 WECC Northern-Southern California	0	0	2,870	154	2,870	154
P25 WECC PacifiCorp/PG&E 115 kV Interconnection	0	0	2,815	486	2,815	486

Table 2: Pre SWIP-North Congestion on all interfaces as shown in CAISO study, per Table 4.7-1

No.	Area or Branch Group	Constraints Name	Costs_F ($K)	Duration_F (Hrs)	Costs_B ($K)	Duration_B (Hrs)	Costs T ($K)	Duration_T (Hrs)
1	SDGE DOUBLTTP-FRIARS 138 kV	DOUBLTTP-FRIARS 138 kV line, subject to SDGE N-2 SX-PQ + PQ-OT 230 kV with RAS	0	0	52,736	2,749	52,736	2,749
2	SCE Whirlwind Transformer	WIRLWIND 500/13.8 kV transformer #1	0	0	22,909	295	22,909	295
3	PDCI	P65 WECC Pacific DC Intertie (PDCI)	0	0	8,954	562	8,954	562
4	COI Corridor	P66 WECC COI	8,852	259	0	0	8,852	259
5	Path 45	P45 WECC SDG&E-CFE	669	130	7,130	1,323	7,798	1,453
6	PG&E Sierra	DRUM-BRNSWCKP 115 kV line #2	5,532	372	0	0	5,532	372
7	PG&E Fresno	LE GRAND-CHWCHLASLRJT 115 kV line, subject to PG&E N-1 Panoche-Mendota 115 kV	0	0	4,831	1,365	4,831	1,365
8	Path 26 Corridor	MW_WRLWND_31-MW_WRLWND_32 500 kV line #3	0	0	3,810	77	3,810	77
9	SCE LCIENEGA-LA FRESA 230 kV line	LCIENEGA-LA FRESA 230 kV line, subject to SCE N-2 La Fresa-El Nido #3 and #4 230 kV	0	0	3,592	84	3,592	84
10	Path 60 Inyo-Control 115 kV	P60 WECC Inyo-Control 115 kV Tie	3,282	1,433	72	233	3,354	1,666
11	Path 26 Corridor	P26 WECC Northern-Southern California	0	0	2,870	154	2,870	154
12	Path 25 PACW-PG&E 115 kV	P25 WECC PacifiCorp/PG&E 115 kV Interconnection	0	0	2,815	486	2,815	486

SWIP-North production cost modelling

Once benchmarking was done, SWIP-North was correctly modelled in ABB base case to create a new ABB SWIP-North case. Here is what was observed from production cost modelling run for ABB SWIP-North case:

1) The interface congestion & flow patterns changed for ABB SWIP-North as noted below:
   a. COI and PDCI congestion reduced
   b. PG&E-Sierra congestion reduced
   c. Flows on Path 16 & ON LINE & Harry Allen to Eldorado increased
   d. Overall imports into CAISO increased.

Table 3: Major branch & interface congestion cost pre & post SWIP-North

Total Congestion Cost ($)	***Type***	***PCM2030_Base***	***SWIP N 2030_Base***	***Diff***	***Note***
32218_32244_2	Branch	5,531,800	406,387	5,125,413	PG&E-Sierra
P65 WECC Pacific DC Intertie (PDCI)	Interface	8,954,352	7,592,104	1,362,248	Path Rating
P66 WECC COI	Interface	9,232,070	5,075,989	4,156,081	Path Rating

2. SWIP-North utilization significantly increased as the series compensation on Robinson Summit – Harry Allen effectively reduces impedance of the 500 kV path from Midpoint to Harry Allen. In addition, phase shifters at Robinson Summit effectively push the flows on SWIP-North 500 kV path rather than NVE's Falcon & Gonder 345 kV system. This is shown in Figures 1 & 2 below. (Positive flows are in North to South direction)

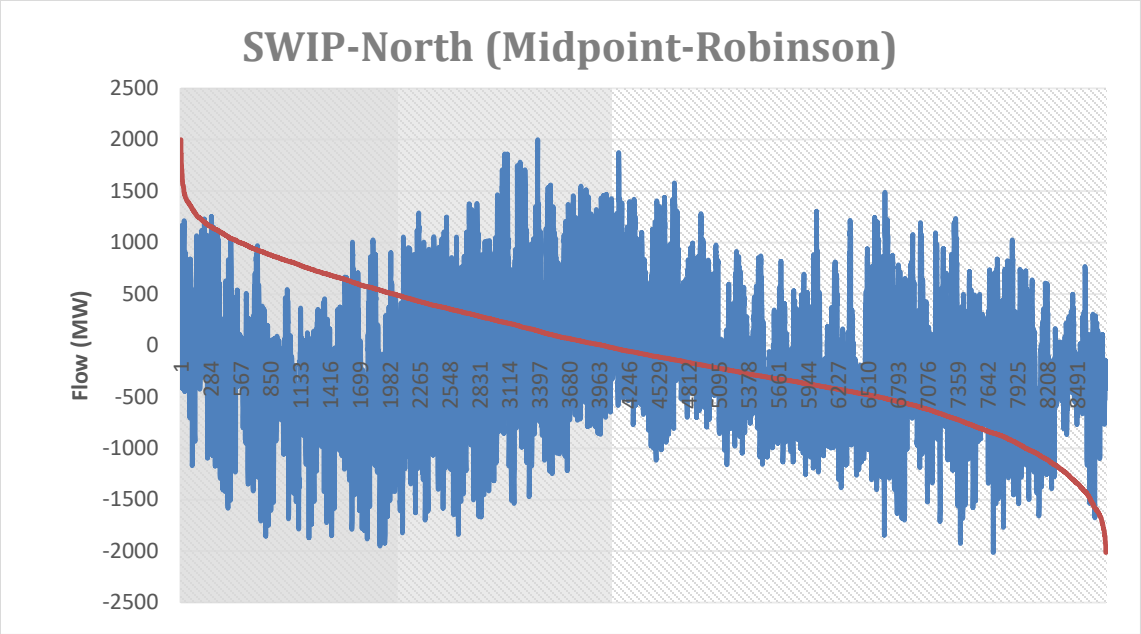

Figure 1: SWIP-North utilization from ABB study (ABB SWIP-North case)

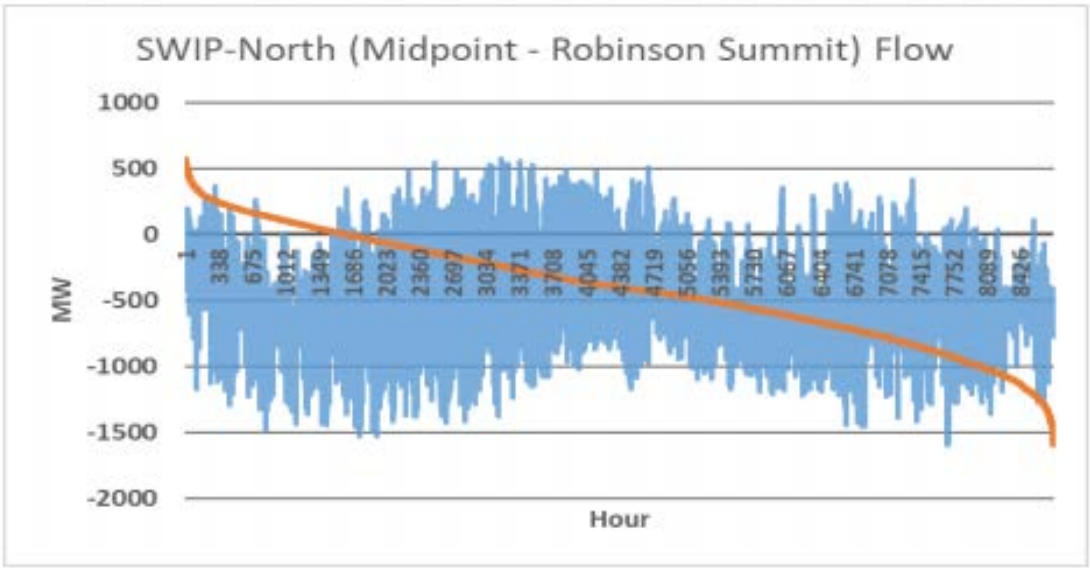

Figure 2: SWIP-North utilization from CAISO's study (as shown in Figure 4.10-2 in CAISO report)

3. Flow duration curves for major paths under pre and post SWIP-North scenarios are shown below:

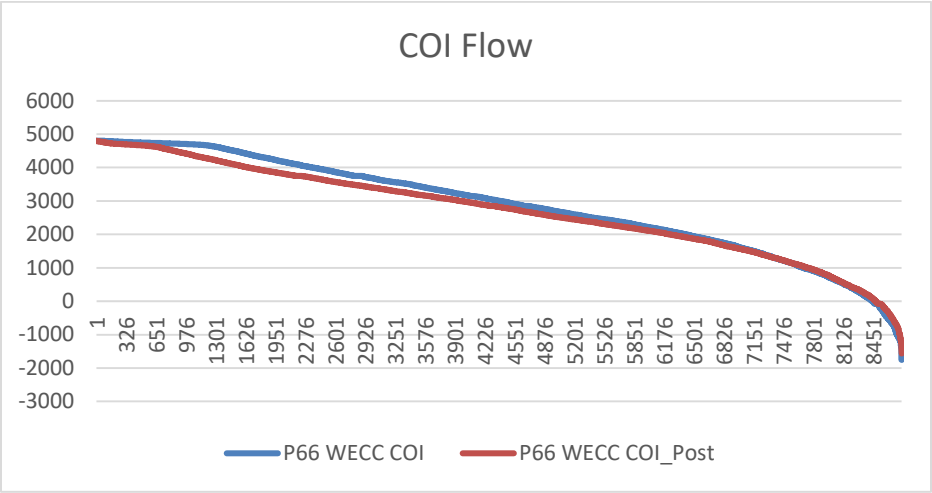

Figure 3: COI Flow duration curve: pre & post SWIP-North

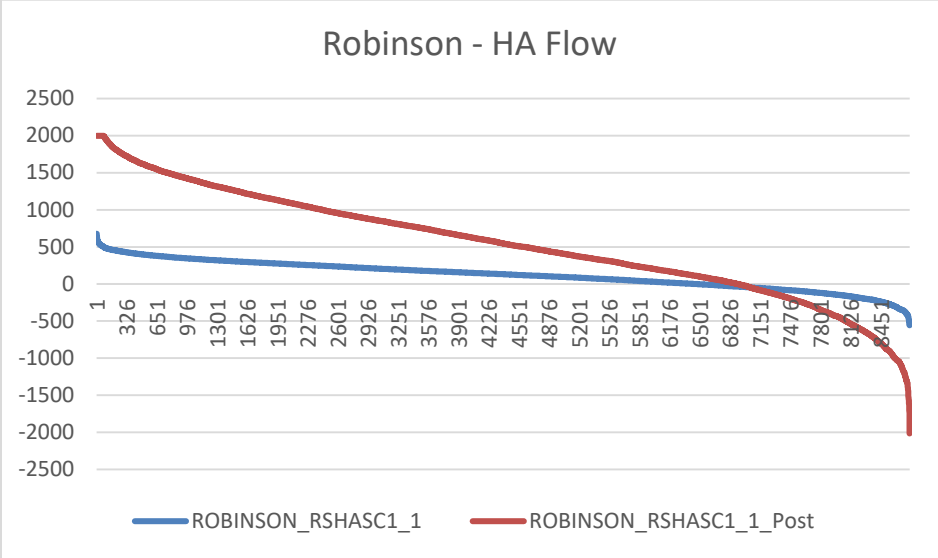

Figure 4: ON LINE Flow duration curve: pre & post SWIP-North

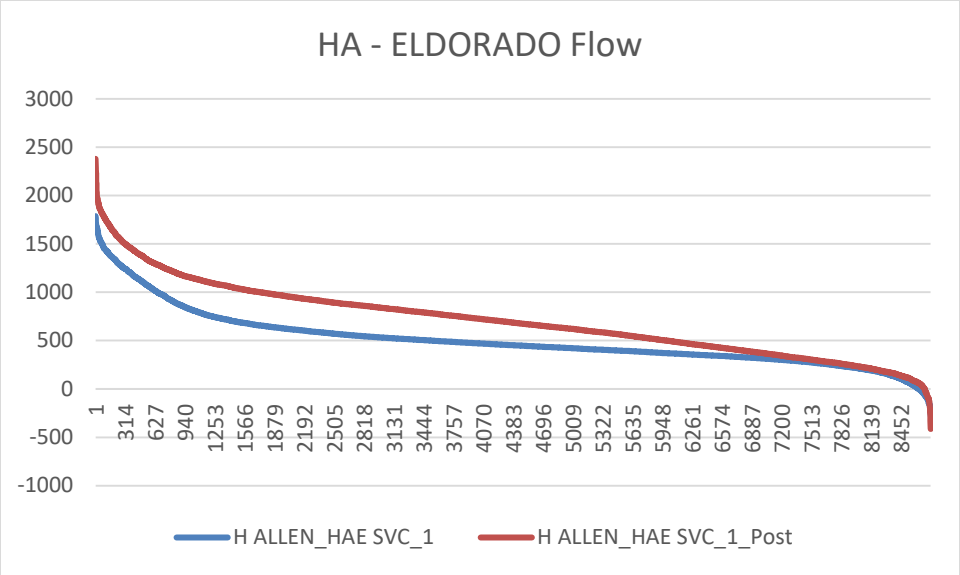

Figure 5: Harry Allen – Eldorado Flow duration curve: pre & post SWIP-North

4. This study resulted in overall $70m per year economic benefits from SWIP-North project to CAISO ratepayers.

5. This study assumed $1/deg cost for Phase Shifter operation at Robinson Summit, which yields more flexibility for Phase shifter movement. A sensitivity scenario was also studied with $10/deg cost which significantly restricts movement of Phase Shifters. This sensitivity scenario reduced the flow on SWIP-North path in N-S direction and resulted in $40m per year benefits for SWIP-North.

Conclusion:

Robinson Summit to Harry Allen series compensation & Robinson Summit phase shifters are key modelling elements & these should be incorporated in CAISO study. Correctly capturing these updates leads to significant increase in utilization of SWIP-North transmission line in N-S and S-N directions. This leads to approximately $40m to $70m per year benefits (depending on phase shifter operation), a significant increase from $10m per year shown in CAISO study.