Imperial Irrigation District v. California Independent System Operator Corporation

USDC-Southern District Case No.: 3:15-cv-01576-AJB-AGS

Expert Report of Brian Rahman, PE, ZGlobal Inc.

Respectfully submitted by:

Brian Rahman PE

ZGlobal, Inc.

November 20, 2017

I graduated from Washington State University in 1991 with a Bachelor of Science in Electrical Engineering. I am licensed (License No. E 14914) as a Professional Engineer in the State of California. I currently reside in Folsom, California.

I began my professional career in 1991 with Pacific Gas and Electric Company as an Operations Engineer. My primary responsibilities as an Operations Engineer was to perform power flow studies of the PG&E bulk electric system. Additionally, I was responsible for establishing operating procedures to insure the safe and reliable operation of the bulk electric system including PG&E High Voltage 500KV transmission lines. During my time with PG&E I served as a Hydro Generation Engineer and Distribution Engineer. As a Hydro Generation Engineer, I provided field engineering support for PG&E's various Hydro-Electric generation facilities. As a Distribution Engineer, I was responsible for distribution engineering for substations and distribution circuits throughout Marin County, CA. As a Distribution Engineer, I was also responsible for coordination of distribution system maintenance, upgrades, and emergency restorations. My combined work history at PG&E afforded me with significant exposure and experience associated with system operations/control, protection systems, power generation operations, and overall utility practices and procedures.

In 1996, I joined the California Independent System Operator (CAISO) as a control room operator working with a team of six individuals responsible for the real-time operation of 80% of the California Grid (Excluding IID) with about 50,000 Megawatts peak demand, which is 50 times IID peak demand. After serving as a control room operator, I served as the manager over market operations. As manager of market operations, I oversaw the daily, hourly, and real-time markets administered by the CAISO with estimated volume of $6 billion of annual transactions[1]. I concluded my time with CAISO as the Program Manager of their Market Redesign and Technology Update (MRTU) project. This $200 Million project was implemented as the replacement to CAISO markets rules after the energy crisis of 2000-2001

I am currently employed by ZGlobal Inc. where I am an executive director and function as a principal consultant on electric utility operations, design, and policy matters. I joined ZGlobal in 2006.

During the past 10 years I have not authored any publications.

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[1] CAISO 1998 Annual Report on Market Issues and Performance, Chapter 1, section 1.2.1, https://www.caiso.com/Documents/Chapter1_1998AnnualReport_MarketIssuesandPerformance.pdf

During the past 4 years I have participated as an expert witness once. This work was done regarding the Tesoro Refining and Marketing Company LLS v. Pacific Gas & Electric Company (Case No. 14 CIV 00930 (JCS)) in the United States District Court, Northern District of California. Prior to the past 4 years, I represented the CAISO as an expert on matters related to system voltages and reliability issues in a case proceed over by an Administrative Law Judge[2].

Additionally, during my time at the CAISO, I provided written testimony to the Federal Energy Regulatory Commission (FERC) related to market rules and functionality. I provided written testimony to FERC on 3 occasions which included comments related to the re-design of the CAISO markets under the Market Re-Design and Technology Upgrade (MRTU) project[3], development of Business Practice Manuals for MRTU[4], and Long-Term transmission rights in organized markets[5].

With respect to the Imperial Irrigation District legal action against California Independent System Operator I have been retained by Lewis Brisbois Bisgaard & Smith LLP to provide expert testimony pertaining to the unauthorized use of the Imperial Irrigation District electric transmission system covering the time span of 2012 through 2016. ZGlobal charges Lewis Brisbois Bisgaard & Smith LLP an hourly rate of $695.00 for my work on this matter. However, my compensation for providing this expert testimony is limited to my existing salary with ZGlobal. I have no personal financial incentive or personal benefit associated with these legal proceedings regardless of their outcome. The contents of this report are based on my technical knowledge, previous utility experience, and analysis of data provided by the Imperial Irrigation District.

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[2] "Arbitration Findings and Award in Cities of Anaheim et al. v. the ISO & Southern California Edison regarding "Allocation of Transmission Cost", Rahman, B., Testimony, Docket No. EL03-54-000, August 27, 2003.

[3] "California Independent System Operator Corporation Electric Tariff Filing to Reflect Market Redesign and Technology Upgrade", Docket No. ER06, declaration and testimony of Brian Rahman, Program Director of CAISO Market Re-design and Technology Upgrade (MRTU), Submitted to FERC on February 9, 2006.

[4] "Post-Technical Conference Response of the California Independent System Operator Corporation on Business Practice Manual Issues", Brian Rahman, Program Director of CAISO Market Re-design and Technology Upgrade (MRTU), submitted to FERC in March 2007, Docket # ER06-615-012 and ER 07-1257-000

[5] "Long-Term Firm Transmission Rights in Organized Electricity Markets" proposal by Brian Rahman, Program Director of CAISO Market Re-design and Technology Upgrade (MRTU), Submitted to FERC Docket Nos. RM06-8-000 and AD05-7-000, March 13, 2007

Statement of Opinion:

The California Independent System Operator (CAISO) has imported energy from the Southwest along with generation from the Mexico and border region to serve CAISO load demands throughout the Southern California region. As a means of delivering these large energy imports, the CAISO relied upon the substantial, unauthorized and intentional use of IID transmission line capacities. The reliance on IID transmission is so frequent that it has occurred every hour since 2012. Moreover, on multiple occasions, the CAISO has imported energy in such large quantities that it violated its own operating procedures and thus putting the IID electric system in jeopardy of significant overloading. Within this report, I will address the following subjects:

1. The California Independent System Operator relied on the Imperial Irrigation District transmission system capacity to enable the import of energy to serve CAISO system demand;

2. The California Independent System Operator failed on numerous occasions to maintain power flows within its published operating procedures, exposing the IID and the grid to possible overloading and violations of reliability standards;

3. The California Independent System Operator reliance on the IID transmission system prevents the IID from fully utilizing the transmission system capacity owned by the IID;

4. CAISO's own analysis concluded that CAISO reliance on the IID transmission system is causing a potential reliability violation;

5. The California Independent System Operator has disadvantaged the IID by limiting the volume of energy exports from IID to the CAISO that qualify for Resource Adequacy (Discrimination via MIC allocation)

The impacts to the IID and the degradation of IID's ability to fully utilize its own transmission assets is the result of CAISO unauthorized and intentional use of these assets to support the import of energy to serve CAISO customer demand within the SDG&E and SCE service areas.

- **The California Independent System Operator relied on the Imperial Irrigation District transmission system capacity to enable the import of energy to serve CAISO system demand**

Due to the physical configuration of the Imperial Irrigation District (IID) and the California Independent System Operator (CAISO) interconnected transmission grid, generation resources connecting to CAISO substations at Imperial Valley (IV), ECO (East San Diego County), Ocotillo, North Gila, Hoodoo Wash, Colorado River and Devers have a varying and significant impact on IID's transmission capacity that impacts the ability for IID's own use of its firm transmission capacity that would otherwise be available to IID transmission customers.

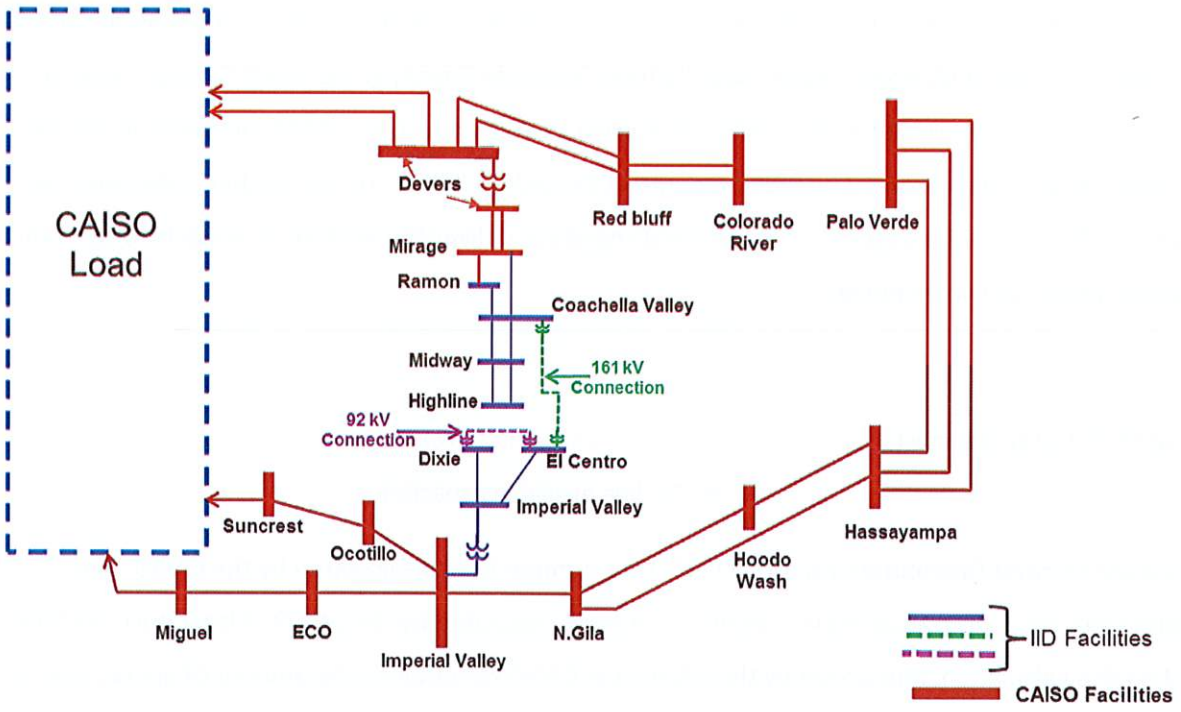

Figure 1 – Simplified Diagram of CAISO major transmission surrounding the IID

(Red = 500 kV, Purple = 230 kV, Green – 161 kV, Magenta = 92 kV)

The figure above provides an overview of the CAISO 500 kV transmission system that surrounds the lower voltage IID transmission system. As Balancing Authorities[6] both the CAISO and IID are required by national (NERC) and regional (WECC) reliability criteria to plan and operate the transmission system in

[6] http://www.nerc.com/files/glossary_of_terms.pdf. See Balancing Authority Area and Balancing Authority.

such a manner as to be able to withstand the loss of a single element of the grid at all times. This means that CAISO imports from the Southwest must withstand the loss of a single element, the 500 kV Southwest Power Link "SWPL"[7] and generation connected to the CAISO at Imperial Valley substation, and CAISO imports to the west must withstand the loss of a single element, the 500 kV Imperial Valley to East County transmission line("IV-Eco)", by ensuring that a back-up transmission path or some other arrangement is in place. The CAISO has made no such provisions.

North-to-South Flow Impacts on IID

Without ensuring a back-up transmission path or alternative arrangement, the CAISO is relying on the unauthorized and intentional use of IID transmission capacity to support the import of power to service CAISO load. The use of IID transmission capacity from Riverside County going south through Imperial County (north-to-south) to deliver the CAISO Southwest energy imports to CAISO customers in the San Diego load center is documented by CAISO Operating Procedure #7820. This procedure calculates the amount of IID transmission capacity that the CAISO needs to deliver the Southwest imports to the San Diego load center as shown below.

Use of IID transmission = (Southwest Power Link (SWPL) import x Outage Transfer Distribution Factor (**OTDF**) – IID "S" line available capacity)

The Outage Transfer Distribution Factor ("OTDF") is a number that is calculated by the CAISO. The unauthorized use of IID transmission is shown in red and calculated by the CAISO at least once-an-hour. Based on this calculation, authorized by the CAISO, the CAISO determines the amount of energy that can be imported from the Southwest, hour-by-hour, to transfer energy to San Diego[8].

[7] Southwest Power Link or SWPL refers to the 500 kV transmission line between N.Gila and Imperial Valley substations. This line is operated by the CAISO.

[8] If the CAISO wanted to import 1,112 MW of energy for a given hour from the Southwest to San Diego (SWPL import), the CAISO determines that it would need to rely on 27% of its 1,112 MW (300 MW) from IID's transmission system. When the total available IID transmission capacity of 370 MVA is considered, the significance of the unauthorized use becomes quite clear. While 300 MW may represent 27% to CAISO, to IID this represents 83% of available transmission capacity that is no longer available for IID use, scheduled or otherwise.

Below is a visual representation of the power flow impacts on the IID that CAISO operating procedure #7820 is designed to limit to avoid overloading on the IID's 230 kV S-line, which provides a physical interconnection between the two adjacent Balancing Authorities, IID and CAISO.

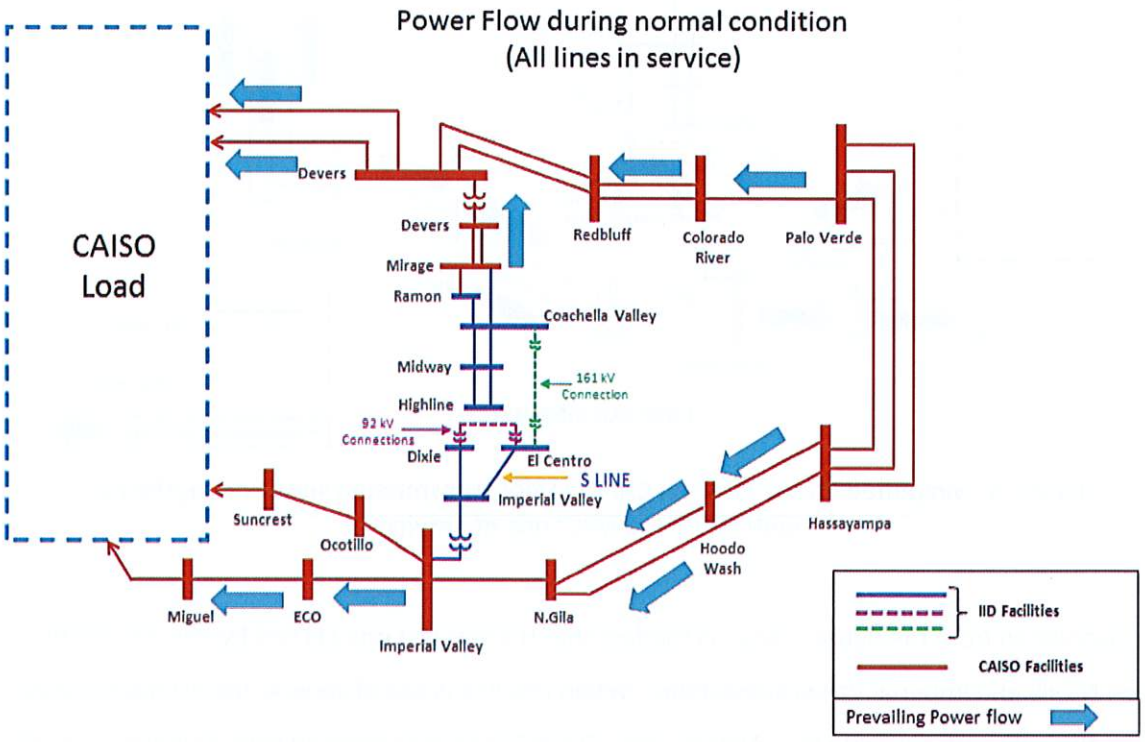

Figure 2 - Simplified Power Flow on CAISO major transmission surrounding the IID with all facilities in service

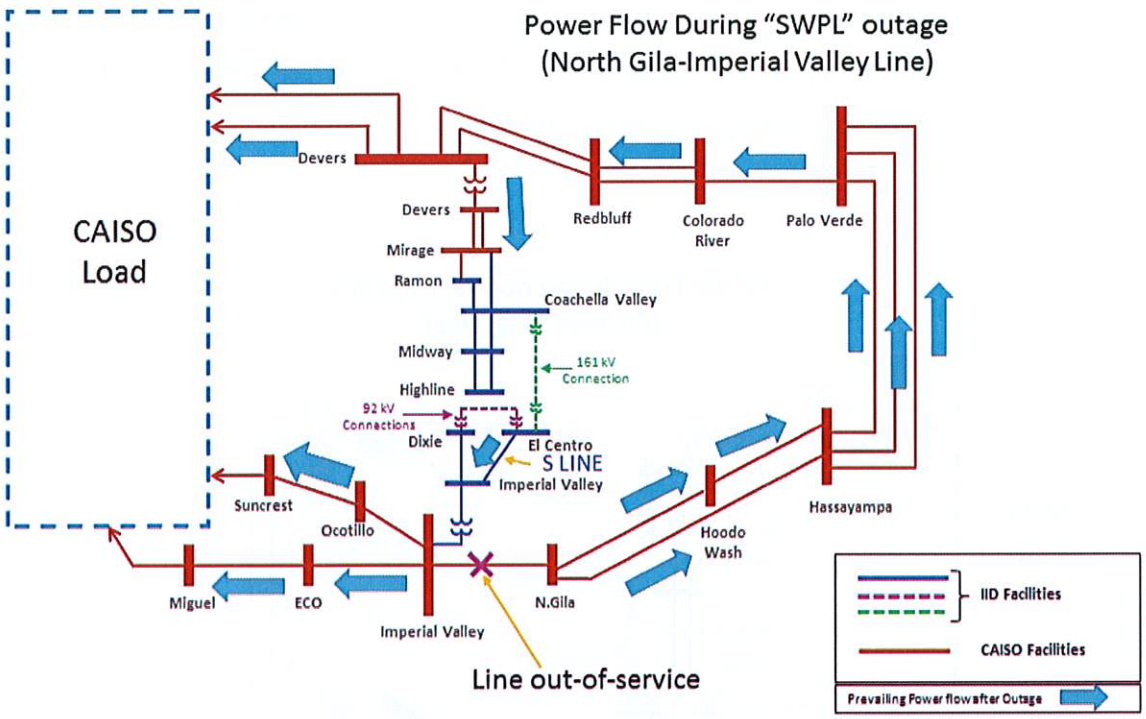

Figure 3 - Simplified Power Flow on CAISO major transmission surrounding the IID with 500 kV "SWPL" out-of-service

A key observation from the figures above is the fact that there is just one (1) 500 kV line, the SWPL, between N.Gila and Imperial Valley substations. When this line is out of service, the IID transmission becomes the only path available for CAISO to serve SDG&E customer demand from southwest imports.

Below is a summary of the OTDFs that the CAISO used from 2012 through 2016.[9]

1. January 1, 2012 to October 31, 2012, the OTDF was 27%
2. November 1, 2012 to November 15, 2013, the OTDF was 22%
3. November 16, 2013 to June 1, 2015, the OTDF was 27%
4. June 16, 2015 to December 31, 2016, the OTDF was 24%

Table 1 below summarizes the unauthorized use of IID transmission by CAISO in the north-to-south direction to allow energy imports from the Southwest.

[9] CAISO Operating Procedures #7820, Effective Dates of 1/28/15, 6/16/16, 1/20/17, and 6/13/17

North to South		
Year	Sum of Unauthorized Reliance on IID Tansmission (MWh)	Percentage of Unautorized Reliance on IID Transmission
2012	1,828,502	60.44%
2013	1,802,099	55.60%
2014	1,784,799	55.07%
2015	1,691,762	52.20%
2016	1,749,650	53.83%
Grand Total	**8,856,811**	**55.36%**

Table 1 – Unauthorized Use of IID's Transmission System in the North-to-South Direction

Table 1 above shows that average substantial, unauthorized and intentional use of IID's transmission facilities by the CAISO is higher than IID's own usage. As neighboring balancing authorities, it is common for neighbors to "lean" on one another on occasion or during adverse system conditions. For example, it may be considered reasonable for a neighbor to have a very small percentage flow impact, say 1 or 2 % on a neighbor's facilities. However, the magnitude of the "leaning" by the CAISO on the IID is many times beyond any reasonable amount, and in fact exceeds the capacity left for use by the IID.

The duration curve below provides a graphic of the CAISO reliance on the IID S-line capacity for the time frame of 2012 through 2016.

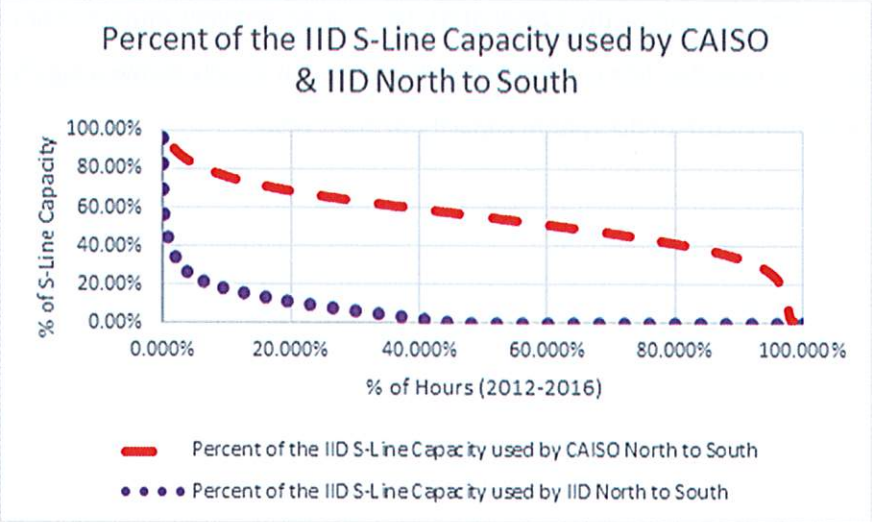

Figure 4 – Duration Curve of CAISO reliance on IID S-line in the North-to-South Direction

Figure 4 above, highlights the excessive reliance by the CAISO on the IID transmission capacity. Inspection of this figures shows us:

a. 40% of all hours between 2012 and 2016, the CAISO was using approximately 60% of the entire IID S-line capacity.
b. 80 % of the time, the CAISO is using at least 40% of the IID's S-line capacity.
c. 95% of the time, the CAISO is using at least 20% of the IID's S-line capacity

On the other hand, IID usage of its own S line capacity is significantly lower than the ISO by a factor of at least five times. For instance, 40% of all hours between 2012 and 2016, the IID was using approximately 2% of the entire IID S-line capacity.

The data depicted in Figure 4 comes directly from the raw data provided by IID. The IID use reflects actual physical energy flow on the S-line. The CAISO use of the S-line was derived from the physical flow measured on the SWPL multiplied by the corresponding OTDF from the CAISO Operating Procedure #7820.

Figure 5 is chart showing the relative use of the total S-line capacity. This bar chart shows the significant difference in use of the S-line capacity between the CAISO and the IID. The "IID Use of S-Line" reflect actual physical usage as recorded by the IID EMS of just 18.9%, while the "CAISO Use of S-Line Capacity" reflects the capacity used by the CAISO of 81.1% to support SWPL imports from the southwest. Regardless of how the data is dissected or presented, it clearly shows a significant unauthorized and intentional use of IID system capacity by the CAISO.

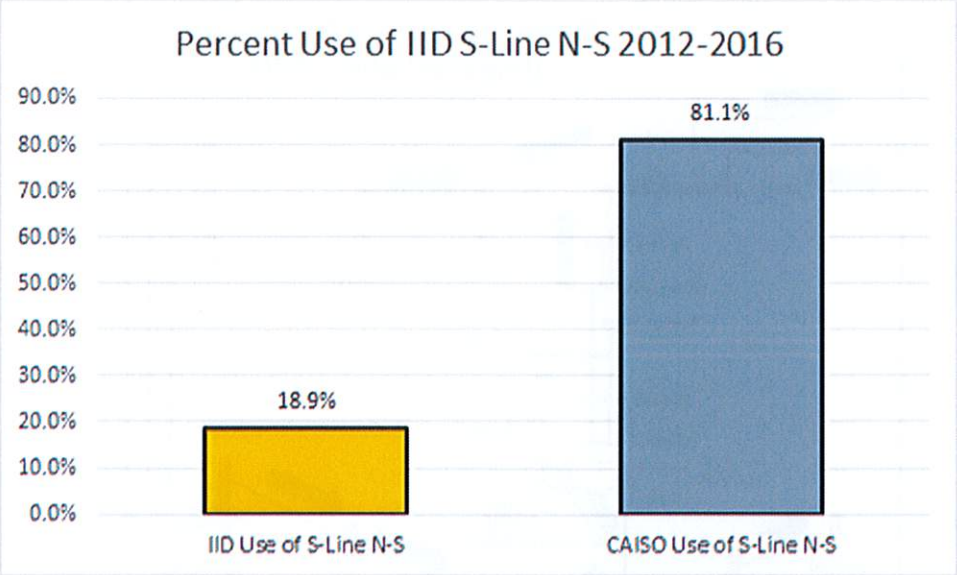

Figure 5 – Percent Use of IID S-line by CAISO vs IID

South-to-North Flow Impacts on IID

Similar to the discussion above for SWPL outage and the corresponding reliance on IID transmission in the North-to-South direction, specific line outages within the CAISO also have significant flow impacts on IID transmission, but in the South-to-North direction. CAISO generation along the California – Mexico border, and within Mexico, connected to Imperial Valley substation combines with southwest imports across the SWPL at Imperial Valley substation and then flow west into CAISO across two 500 kV lines (IV – Ocotillo, and IV – ECO).

Under line outages, specifically the outage of the 500 kV Imperial Valley – ECO or ECO -Miguel transmission line, the power flowing into the Imperial Valley substation will be re-directed due to the change in system configuration. This re-direction occurs naturally based on the relative impedance of the remaining transmission lines compared to that prior to the outage. For the outage of the Imperial Valley – ECO line, flow impacts to IID transmission are in the South-to-North direction. The figure below provides a visual of how CAISO generation and imports rely on the IID transmission to deliver internal CAISO generation to SDG&E load centers.

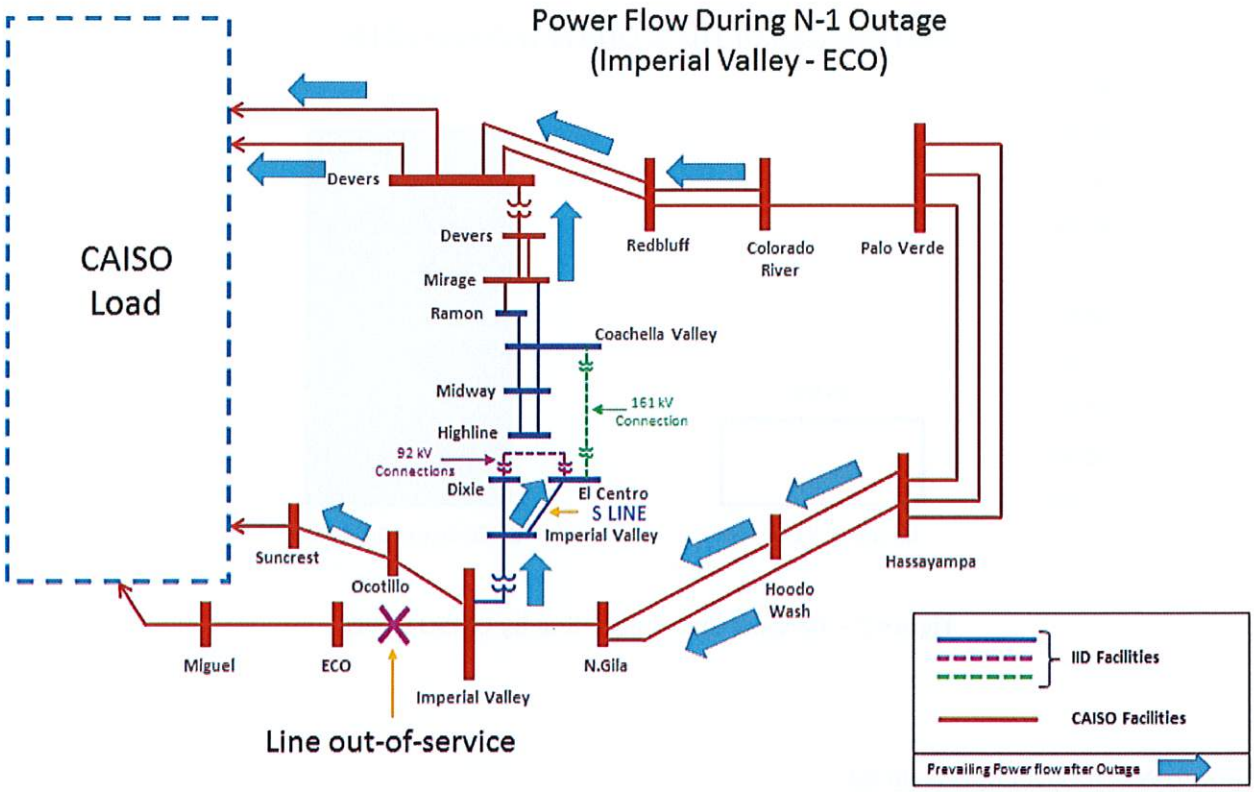

Figure 6 - Simplified Power Flow on CAISO major transmission surrounding the IID with 500 kV "ECO-Miguel" out-of-service

The CAISO reliance on IID transmission capacity in the South-to-North direction can be quantified by the following formula:

$$\text{Use of IID facilities amount} = \textbf{(ECO-IV line flow) x (OTDF)}$$

The OTDF determines how much of IID south-to-north transmission CAISO needs to transfer energy from Imperial Valley substation connected generation and southwest imports to the Southern California load centers within the CAISO. For each year, 2012 through 2016, the OTDF were determined to be the following:

1. 2012 – 3.11%
2. 2013 – 3.06%
3. 2014 – 2.78%
4. 2015 – 3.10%
5. 2016 – 2.99%

The OTDFs were derived from CAISO Transmission Planning cases for the corresponding years[10]. To derive the OTDF, the Imperial Valley – ECO line was removed from service to determine the percentage of the pre-outage flow that was re-directed to the IID S-line. This is the same methodology used by the CAISO to determine the OTDF's for Operating Procedure #7820.

Table 2 below summarizes the unauthorized and intentional use of IID transmission by CAISO in the south-to-north direction. Although not as significant as the north-to south reliance, on average the CAISO utilized IID S-line transmission capacity of 7.62% or 28 MW. As noted above, it is reasonable for a neighboring balancing authority to "lean" on a neighboring balancing authority, however, 7% to 8% is well above a reasonable amount.

South to North		
Year	Sum of Unauthorized Reliance on IID Tansmission (MWh)	Percentage of Unautorized Reliance on IID Transmission
2012	262,410	8.67%
2013	251,688	7.77%
2014	219,811	6.78%
2015	256,187	7.90%
2016	229,493	7.06%
Grand Total	**1,219,590**	**7.62%**

Table 2 – Unauthorized Use of IID's Transmission System in the North-to-South Direction

Table 2 was created using IID provided data and OTDF's calculated using CAISO basecase[11]. The OTDF's reflect the percentage of energy flowing on the Imperial Valley – ECO 500 kV Transmission line that will be re-directed to the IID S-line when the Imperial Valley - ECO line is lost. The percentage of unauthorized reliance on IID transmission is the percentage of S-line capacity that the re-directed energy flow uses. The S-line limit used for this calculation is the normal limit of 370 MW.

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[10] The following CAISO Transmission Planning basecases were used to calculate OTDF's for South to North impacts: RA11_SDGE_2012_SP_imp3300.sav (Exhibit 19), RA11_ SDGE_2013_SP_imp3300.sav (Exhibit 20), RA11_ SDGE_2014_SP_imp3300.sav (Exhibit 21), Reliab1314_SDGE_2015_SP.sav (Exhibit 22), Reliab1415_SDGE_2016_SP.sav (Exhibit 23)

[11] This information can be found in Exhibit 1_2017.11.17 IID v CAISO Damages_Final.xlsx

The duration curve below provides a graphic of the CAISO reliance on the IID S-line capacity for the time frame of 2012 through 2016 in the South-to-North direction.

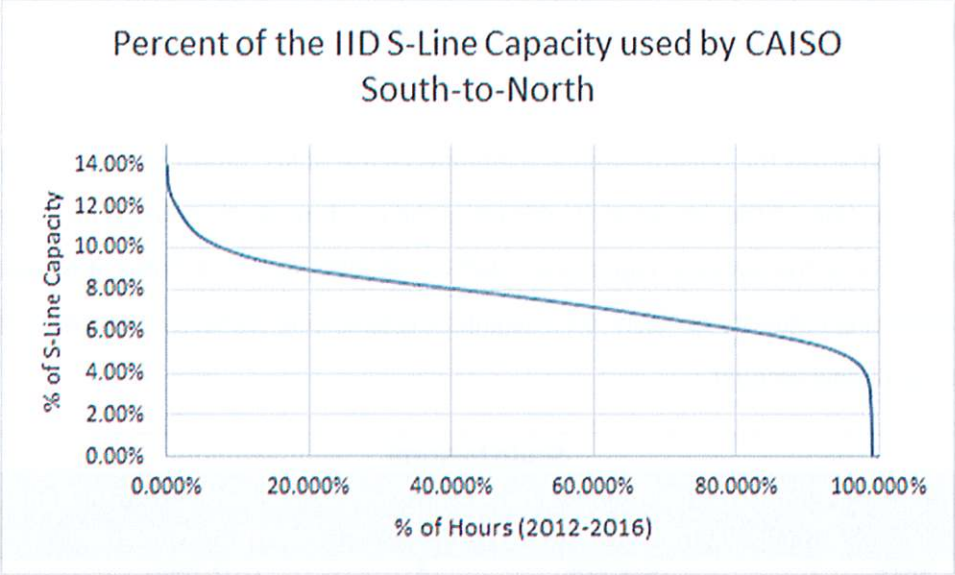

Figure 7 – Duration Curve of CAISO reliance on IID S-line in the South-to-North Direction

Figure 5 above, highlights the excessive reliance by the CAISO on the IID transmission capacity. Although not as severe as in the North-to-South direction, it still shows a significant reliance on IID transmission capacity[12]. Inspection of this figures shows us that for 40% of all hours between 2012 and 2016, the CAISO was using approximately 8% of the entire S-line capacity or 32.5 MW. 80 % of the time, the CAISO is using at least 6%, or 24 MW of the S-line capacity.

[12] Figure 5 was created using raw data provided by IID and ZGlobal calculated OTDF's. This data and figure can be found in excel file "Exhibit 1_2017.11.18 IID v CAISO Damages_Final.xlsx".

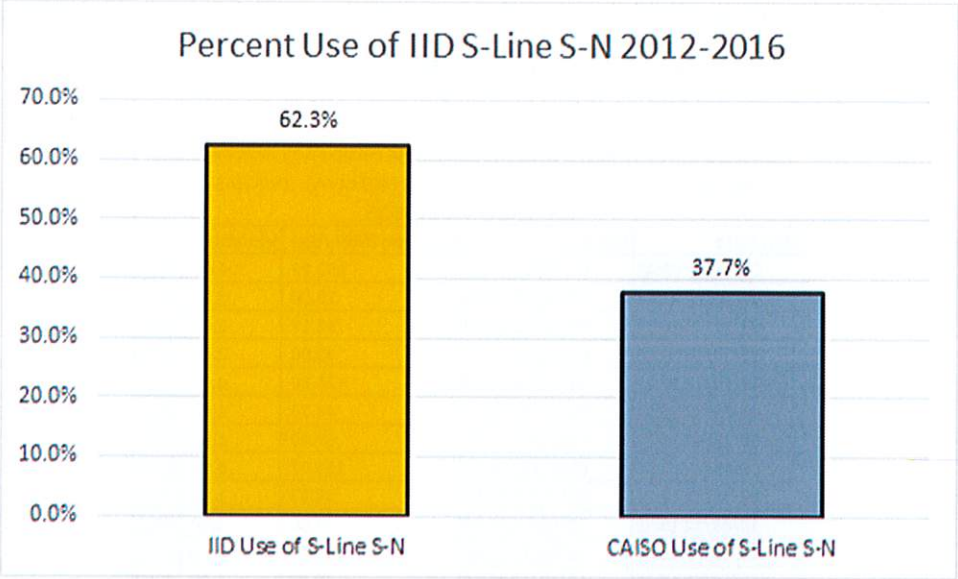

Figure 8 – Percent Use of IID S-line by CAISO vs IID (South to North)

Considering both IID physical usage and CAISO reliance on S-line capacity to support power imports and generation in close proximity to the IID, again we see a significant impact by the CAISO. For South to North impacts, we find that the CAISO relied on 37.6 % of IID system capacity compared to the IID's physical use of 62.3%. Again, we find that the CAISO is utilizing a significant portion of the IID system compared to what the IID is using. The use of this capacity by the CAISO prevents the IID from utilizing its own facilities because of the potential reliability impacts that could arise if the IID neglected to consider the impacts of his unauthorized and intentional use of its transmission capacity.

- **The California Independent System Operator failed on numerous occasions to maintain power flows within its published operating procedures, exposing the IID and the grid to possible overloading and violations of reliability standards**

As discussed above, the CAISO imports power from the southwest across the "SWPL" to serve CAISO customer demand in the SDG&E service area. These imports are restricted to the criteria set forth in CAISO Operating Procedure #7820. Historically, the CAISO has had difficulty keeping SWPL flows within the acceptable and approved limits of the operating procedure. This is another example of how the CAISO disregards its impacts on the IID. The following table shows that the CAISO violated its own operating procedure #7820 as well as basic reliability criteria by exposing the IID S-line to loading above

the 30-minute emergency rating of 407 Mega-Voltamperes (MVA)[13]. In fact, between 2012 and 2016, the CAISO exceeded acceptable line loading causing 76 federal reliability violations.

THE CAISO UNAUTHORIZED AND EXCESSIVE USE OF IID FACILITIES EXCEEDED THE EMERGENCY RATING OF THE IID FACILITIES (407 MVA). THIS HAS CAUSED RELIABILITY VIOLATIONS				
Start Date	End Date	Duration (Minutes)	Violations	Year
08/18/12 08:45	08/18/12 10:55	130.23	4.00	2012
08/18/12 21:44	08/18/12 22:59	75.00	2.00	2012
08/23/12 20:59	08/23/12 22:02	62.17	2.00	2012
09/10/12 09:06	09/10/12 10:28	82.00	2.00	2012
09/10/12 19:13	09/10/12 21:18	125.00	4.00	2012
09/25/12 08:34	09/25/12 09:17	43.73	1.00	2012
09/25/12 10:54	09/25/12 11:31	37.00	1.00	2012
09/25/12 11:55	09/25/12 14:31	156.07	5.00	2012
09/28/12 11:21	09/28/12 11:59	38.37	1.00	2012
10/08/12 19:10	10/08/12 19:44	34.00	1.00	2012
10/09/12 10:06	10/09/12 11:59	112.30	3.00	2012
10/10/12 19:35	10/10/12 20:15	40.50	1.00	2012
10/19/12 08:02	10/19/12 10:34	152.00	5.00	2012
10/20/12 07:24	10/20/12 10:33	189.37	6.00	2012
10/20/12 10:36	10/20/12 11:30	54.00	1.00	2012
10/26/12 09:01	10/26/12 10:59	118.00	3.00	2012
10/30/12 11:17	10/30/12 12:44	86.97	2.00	2012
04/26/13 20:55	04/26/13 21:31	36.00	1.00	2013
02/10/14 19:35	02/10/14 20:29	54.00	1.00	2014
05/12/14 15:13	05/12/14 16:18	65.00	2.00	2014
05/12/14 16:42	05/12/14 21:27	285.00	9.00	2014
05/14/14 14:27	05/14/14 15:49	82.00	2.00	2014
09/08/14 14:23	09/08/14 15:28	65.00	2.00	2014
09/16/14 19:06	09/16/14 19:56	50.00	1.00	2014
10/13/14 19:03	10/13/14 19:44	41.00	1.00	2014
10/13/14 21:11	10/13/14 21:53	42.00	1.00	2014
10/14/14 06:01	10/14/14 07:16	75.00	2.00	2014
10/14/14 20:18	10/14/14 21:16	58.00	1.00	2014
08/28/15 11:22	08/28/15 12:09	47.00	1.00	2015
09/09/15 08:04	09/09/15 10:08	124.00	4.00	2015
09/09/15 10:24	09/09/15 11:09	44.30	1.00	2015
09/10/15 07:27	09/10/15 08:44	77.00	2.00	2015
09/10/15 09:28	09/10/15 10:03	34.47	1.00	2015
Total Violations 2012 through 2016:			76.00	

Table 3 – Documented Federal Reliability Violations of IID's Transmission Facilities Caused by CAISO Southwest Energy Imports[14]

[13] The rating of the IID S-line is 370 MVA (Normal) and 407 MVA (Emergency). For simplicity and conservatism, the calculations and analysis performed for this report have assumed a unity power factor (i.e. PV = 1.0) for all transmission line loading. Under this assumption reactive (VAR) power is assumed to be zero. For a power factor of 1.0, the power factor angle is 0 (i.e. cos (0) = 1) which causes the MVA and MW values to become the same. In reality there is always some amount of reactive power (VAR) loading on transmission lines. The relationship between real (MW), reactive (VAR), and apparent (MVA) power is defined by the following formula: $MVA = \sqrt{MW^2 + MVAR^2}$. So, if VAR loading is assumed to be zero, then MVA = MW.

[14] The 1-minute interval data used to assess the number of violations, similar to most telemetry data, was not complete and included some missing data points. In assessing the number of violations, only those 30-minute periods with more than 85% of the data available were considered for inclusion.

To clarify the situation, a specific example of the CAISOs substantial unauthorized and intentional use of IID's transmission systems is useful. At 11:00 AM on October 26, 2012, the CAISO was importing 1,030 MW from the Southwest. With the goal of delivering the 1,030 MW to San Diego, per CAISO Operating Procedure #7820, the CAISO calculated that it needed to rely on IID transmission for 1,030 MW x 27% = 278 MW. The CAISO's substantial, unauthorized and intentional reliance of IID transmission facilities was 278 MW in the north-to-south direction, consuming 68% of IID's north-to-south transmission capacity. (i.e. 278/407 = .68 or 68%)

The example is shown graphically in the Figure below and noted as "CAISO Use of "S" Line Capacity". For this specific example, at hour 11, the CAISO relied upon almost all the of IID's north-to-south transmission line's capacity to enable the CAISO to import energy from the Southwest.

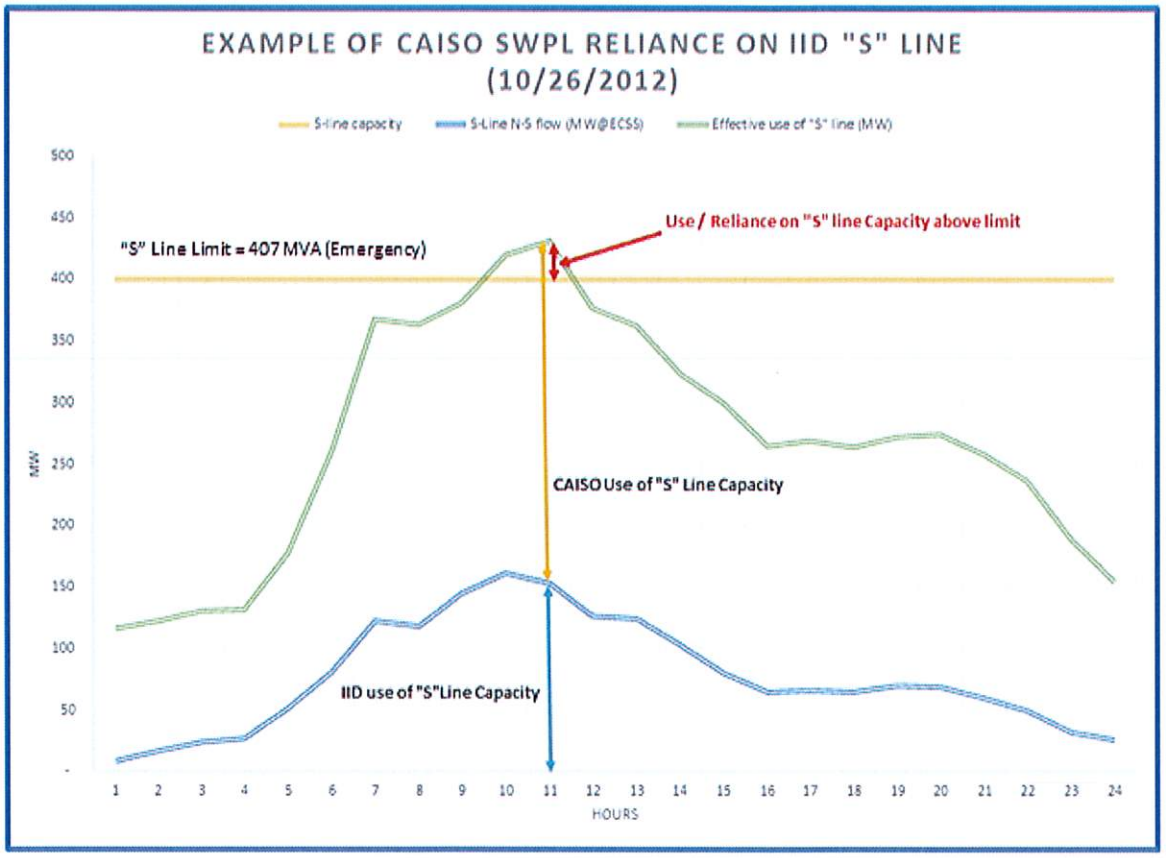

Figure 9 - Sample Day Showing Reliance on "S" Line Capacity for IID and CAISO October 26, 2012

The inability of the CAISO to keep SWPL flows within acceptable reliability limits is a chronic issue as evidenced by the data above and the persistent heavy CAISO imports from the Southwest. The unauthorized and intentional use of IID transmission capacity continues to occur putting the IID at risk of overloading its transmission facilities. As recently as October 23, 2017, the IID again experienced loading above the established emergency rating on the S-line due to loss of the SWPL. Recall that CAISO Operating Procedure #7820 was established to prevent such overloads. However, CAISO does not appear to be following this procedure and continues to put the IID transmission system in jeopardy.

A more recent event that took place on October 23, 2017: Below is a data provided by the IID SCADA (Supervisory Control and Data Acquisition) system for an event that took place on October 23, 2017. On this date, at approximately 10:02 AM, the SWPL line was lost. When the event occurred and the SWPL line was lost, about 25% of the SWPL flow reverse direction and flowed North-to-South through the IID system. During the subsequent 6 minutes, the IID S-line experienced 10 instances ranging from instantaneous to 12 seconds where power flow exceeded the 407 MVA Emergency Operating Limit.

Instance	Date	S-Line at EC (MW)	S-Line at EC (MVAR)	Calculated MVA	Note
1	23-Oct-17 10:02:26	402.7000	-60.5000	407.22	Instantaneous
2	23-Oct-17 10:02:32	403.2000	-61.5000	407.86	12 Seconds Duration (10:02:32-10:02:44)
	23-Oct-17 10:02:34	402.9333	-61.4000	407.58	
	23-Oct-17 10:02:36	402.6667	-61.3000	407.31	
	23-Oct-17 10:02:38	402.4000	-61.5000	407.07	
	23-Oct-17 10:02:40	403.9000	-62.5000	408.71	
	23-Oct-17 10:02:42	402.6000	-62.2000	407.38	
	23-Oct-17 10:02:44	402.8000	-62.4000	407.60	
3	23-Oct-17 10:02:50	404.2000	-63.7000	409.19	4 Seconds Duration (10:02:50-10:02:54)
	23-Oct-17 10:02:52	402.7000	-62.6000	407.54	
	23-Oct-17 10:02:54	402.2500	-62.7000	407.11	
4	23-Oct-17 10:02:58	404.2000	-64.0000	409.24	4 Seconds Duration (10:02:58-10:03:02)
	23-Oct-17 10:03:00	403.4000	-63.7000	408.40	
	23-Oct-17 10:03:02	402.2000	-62.7000	407.06	
5	23-Oct-17 10:03:30	402.6000	-63.9000	407.64	2 Seconds Duration (10:03:30-10:03:32)
	23-Oct-17 10:03:32	402.2667	-63.8000	407.29	
6	23-Oct-17 10:03:38	402.6000	-64.4000	407.72	4 Seconds Duration (10:03:38-10:03:42)
	23-Oct-17 10:03:40	402.8000	-64.6000	407.95	
	23-Oct-17 10:03:42	402.0000	-64.3000	407.11	
7	23-Oct-17 10:03:48	402.2667	-64.6000	407.42	12 Seconds Duration (10:03:48-10:04:00)
	23-Oct-17 10:03:50	402.7333	-64.4000	407.85	
	23-Oct-17 10:03:52	403.2000	-64.2000	408.28	
	23-Oct-17 10:03:54	402.5000	-64.0000	407.56	
	23-Oct-17 10:03:56	402.3000	-64.2500	407.40	
	23-Oct-17 10:03:58	402.7000	-64.5000	407.83	
	23-Oct-17 10:04:00	402.0000	-64.0000	407.06	
8	23-Oct-17 10:04:26	401.9000	-64.4000	407.03	Instantaneous
9	23-Oct-17 10:07:50	403.3000	-65.7000	408.62	4 Seconds Duration (10:07:50-10:07:54)
	23-Oct-17 10:07:52	402.5000	-64.8000	407.68	
	23-Oct-17 10:07:54	401.9667	-64.7000	407.14	
10	23-Oct-17 10:08:04	402.0000	-64.7000	407.17	Instantaneous

Table 4 – October 23, 2017 S-line Overloads above Emergency Limit due to CAISO failure to adhere to CAISO Operating Procedure #7820

Although the October 23, 2017 example did not result in a 30-minute violation as was the case for the 76 instances noted above, the CAISO continues to leverage the use of the IID system in an unreliable, unauthorized, and intentional manner to support Southwest imports to serve CAISO system demand.

- **The California Independent System Operator reliance on the IID transmission system prevents the IID from fully utilizing the transmission system capacity owned by the IID**

To illustrate the CAISO chronic reliance on IID system, an example is presented: on September 10, 2015 at 7:15 am, CAISO was importing 1348 MW on the SWPL line while IID was using 87MW on their S line or (87/407= 21 %). For the ISO to deliver 1348 MW, they had to rely on 323 MW of the IID S- line. The 323 MW that CAISO is relying on does in fact belong to IID and it represent nearly 80% of the IID S- line capacity, IID is not getting paid for this capacity nor, in good faith, is able to sell it to anyone else since IID is aware of CAISO usage of the IID line and it would not follow good utility practice to sell the capacity and jeopardize reliability. For instance, if IID would have sold their remaining capacity of 370 – 87 MW = 283 MW of their S- line, CAISO would have to reduce the energy flowing on their SWPL line from 1348 MW to 125 MW in 30 minutes. This extremely large reduction in flow of 1257 MW is calculated based on CAISO Operating Procedures #7820. For reliability reason, this large reduction in energy must take place in 30 minutes which is physically impossible. In my opinion, for the Palo Verde nuclear plant to reduce its output in such very short time is both impracticable and dangerous.

Ironically, four years earlier, on the afternoon of September 8, 2011, an 11-minute system disturbance occurred in the Desert Southwest, leading to cascading outages and leaving approximately 2.7 million customers without power including approximately 146,000 of IID customers in 115 degrees weather. The outages affected parts of Arizona, Southern California, and Baja California, Mexico. All the San Diego area lost power, with nearly one-and-a-half million customers losing power, some for up to 12 hours. The cause of the outage is the loss of the same SWPL line that was being used to import large quantities of energy into san Diego. On September 8, 2011, ISO was importing 1397 MW[15]. To be able to import such a large quantity, CAISO intentionally used approximately 350 MW of IID's transmission capacity without any compensation.

The Federal Energy Regulatory Commission investigated and concluded the followings" This failure stemmed primarily from weaknesses in two broad areas—operations planning and real-time situational awareness—which, if done properly, would have allowed system operators to proactively operate the system in a secure N-1 state during normal system conditions and to restore the system to a secure N-1 state as soon as possible, but no longer than 30 minutes[16]".

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[15] https://www.ferc.gov/legal/staff-reports/04-27-2012-ferc-nerc-report.pdf, page 27
[16] https://www.ferc.gov/legal/staff-reports/04-27-2012-ferc-nerc-report.pdf, page 8

- **CAISO own analysis concluded that CAISO reliance on the IID transmission system is causing a potential reliability violation**

The IID, as a Balancing Authority, must adhere to all reliability standards and practices as set forth by NERC and WECC. Further, the IID, following good utility practice, should not and will not operate its system in such a manner as to potentially violate reliability standards or exceed approved facility ratings. The IID must be vigilant to prevent overloading of its facilities due to the unauthorized and excessive use of its transmission capacity by the CAISO. In fact, by their own admission, the CAISO has determined in their 2017-2018 Reliability Assessment that the S-line is subject to severe over loading under various line outages including the SWPL as well as internal CAISO transmission lines. The overloading under a high renewables output scenario ranges from 124.2% to 173.3% of the S-line emergency rating. The table below was extracted from the CAISO 2017-2018 Reliability Assessment results posted on the CAISO website.

2017-2018 ISO Reliability Assessment - Preliminary Study Results
Study Area SDG&E Main
Thermal Overload

California ISO

ID	Overloaded Facility	Worst Contingencies	Category	Category Description	Loading (%)										Potential Mitigation Solutions
					B1: 2019 Summer Peak	B2: 2022 Summer Peak	B3: 2027 Summer Peak	B4: 2019 Spring Light Load	B5: 2022 Spring Off-Peak	S1: 22SP High Load & Peak Shift	S2: 19SP Peak Shift	S3: 27SP Peak Shift	S4:22SP High Renewables Output	S5: 22SP Heavy Northbound Flow	
T50	22356 IMPRLVLY 230 21025 ELCENTSW 230 1 1	P1G_TDM_TDM Plant and P1L-50002_ 22536 N GILA 500 22360 IMPRLVLY 500 &1	P3	G-1/L-1	103.7	117.1				131.3	135.6	127.6	124.2		Rely on the CAISO market congestion management and operation procedure to manage the reliability of its controlled transmission grid
T51		P1L-23055RAS1_ 22886 SUNCREST-SYCAMORE TP2 230 2 1 and P1L-50002_ 22536 N GILA 500 22360 IMPRLVLY 500 &1	P6	N-1-1	120.1	133.2	99.5			101.5	106.5	97.3	173.3		
T52		P1T-50012RAS1_ 22464 MIGUEL BK81 500/230 2 1 and P1L-50002_ 22536 N GILA 500 22360 IMPRLVLY 500 &1	P6	N-1-1	120.4	133.4	99.7			102.0	107.0	97.6	173.3		
T53		P1T-50022RAS1_ 22885 SUNCREST BK81 500/230 1 1 and P1L-50002_ 22536 N GILA 500 22360 IMPRLVLY 500 &1	P6	N-1-1	121.8	135.0	101.4			103.1	108.2	99.1	174.3		

Table 5 – CAISO 2017-2018 Reliability Assessment Results for IID S-Line (IMPRVLY 230 – ELCENTSW 230)

Typically, such extreme overloading identified in an annual transmission planning process would be associated with physical (i.e. new facilities, upgraded facilities, etc.) transmission system mitigations. However, the CAISO indicates that this severe overload can be managed with CAISO Congestion Management and Operating Procedure. The Operating Procedure eluded to is presumably #7820 discussed in detail above which CAISO has demonstrated to be an operational challenge to adhere to.

Congestion Management is the practice of adjusting, or re-dispatching, generation on either side of a constrained transmission path or piece of electrical equipment. In many locations this can be a valid and

effective means of mitigation for an overloaded facility. However, in the case of the S-line and its electrical relationship with the southwest imports on the SWPL, this is not a realistic mitigation. The IID S-line has an emergency rating of 407 MVA. An overload of 173.3% equates to a 705.3 MVA on a line with an emergency rating of just 407 MVA. A line loading of 705.3 MVA is 298 MVA above the approved emergency line rating of the S-line. Recall from Operating Procedure #7820, that there is roughly a 25% shift (OTDF) of flow on the SWPL that will shift to the IID S-line under an outage. So, for the CAISO to mitigate, pre-contingency, flows on the SWPL to acceptable levels they would need to reduce generation to the east of SWPL by nearly 1,200 MW. From a practical perspective, the application of congestion management in this instance does not appear to be an effective mitigation. Much of the generation to the east of SWPL is solar, such as the 290 MW Agua Caliente Solar Project, 127 MW Arlington Valley Solar Project, and the combined 253 MW Mesquite Solar 2 and 3 projects. In general, solar projects are "intermittent" generation, meaning they generate only intermittently based on the availability of the sun at the specific location of the solar farm as it may be impacted by clouds or other solar obstructions. Further, solar farms are not typically "dispatchable", meaning that they are not designed or operated in a manner to change output based on a dispatch instruction from the system operator. It is for this reason, and prior actions by the CAISO, that the feasibility of Congestion Management is questionable at best and provides no assurance to the IID that its system is truly available for its own use or that the CAISO actions will not cause additional reliability violations in the future.

IID, following good utility practice, is simply not able to utilize the transmission capacity it owns. If IID was to utilize the S-line capacity for their own purposes of serving IID demand, or to sell it under their Open Access Transmission Tariff (OATT) the risks of overloading would be aggravated. As a conscientious system operator and Balancing Authority subject to reliability standards, the IID is prevented from utilizing its own system due to the significant unauthorized and intentional use of the IID system capacity by the CAISO.

- **The California Independent System Operator has disadvantaged the IID by limiting the volume of energy exports from IID to the CAISO that qualify for Resource Adequacy**

The ability of IID to fully utilize its transmission system is dependent on two factors:

1. The IID must make sure that the transmission capacity it intends to sell is actually available. In the previous sections, I discuss how the CAISO's unauthorized and intentional use of IID transmission capacity, to deliver energy to San Diego area demand, uses significant portions of IID's available transmission capacity.

2. CAISO rules associated with Resource Adequacy that should, but do not, enable generation interconnected to the IID to compete on equal footings with CAISO interconnected generation. CAISO rules do not allow for comparable treatment and disadvantage the IID interconnected generation by establishing zero export capability, for Resource Adequacy capacity, from IID to CAISO.

Annually, the CAISO determines the Maximum Import Capacity or MIC[17] for each intertie into the CAISO. The CAISO definition for MIC is: *"A quantity in MW determined by the CAISO for each Intertie into the CAISO Balancing Authority Area to be deliverable to the CAISO Balancing Authority Area based on CAISO study criteria."*

IID is connected to the CAISO through two transmission lines or interties, Path 42, which connects IID to the CAISO near Palm Springs, CA, and the the S-line (also referred to as the "IID-SDGE BG"). The table below shows the CAISO allowable amount of Resource Adequacy capacity that can be exported from IID into CAISO. From 2008 to 2009, the total amount that could be export from IID to CAISO was 624 MW and 650 MW respectively. From 2010 to 2015, the amount has droppred while at the same time the CAISO imports from the southwest and Arizona have increased.

[17] https://bpmcm.caiso.com/Pages/BPMDetails.aspx?BPM=Definitions%20and%20Acronyms

Year	MIC IID-SCE _ BG	MICIID=SDGE_BG
2008	461	163
2009	487	163
2010	502	0
2011	502	0
2012	517	0
2013	471	0
2014	462	0
2015	462	0
2016	391	150
2017	367	95

Table 6 – CAISO Historical MIC Assignments for IID Imports[18]

As mentioned above, the amount of capacity that can be deliverable from IID to CAISO is called "Maximum Import Capability" or MIC. The CAISO, via its MIC allocation, limits the amount of resource adequacy energy that can be exported from IID to the CAISO. At the same time the CAISO is using the S-line to deliver their energy to San Diego. Each of the CAISO LSE's must demonstrate to the CAISO that they have procured a quantity of Resource Adequacy, or deliverable, energy for overall system reliability purposes. By limiting the amount of MIC, or energy deemed to be deliverable, from the IID, generation within IID is disadvantaged in the procurement process compared to CAISO interconnected generation. This double dealing, in my experience, is capricious and equal to property confiscation.

In 2011, IID protested and the California Public Utilities Commission (CPUC) recognized the disadvantage that renewable energy projects interconnecting to IID's BA faced. On July 7, 2011, the CPUC issued an Assigned Commissioner Ruling (ACR) by Commissioner Ferron that proposed to modify the CAISO's MIC process by developing a forward-looking MIC calculation methodology, as opposed to relying solely on

[18] California IS Maximum RA Import Capability for year 2008 through 2017. Table 6 is a summary for these years for both of the import points from IID including IID-SCE_BG and IID_SDGE_BG.

historical scheduled imports into the CAISO from IID[19]. In that ACR, the MIC from the IID Balancing Authority Area to the CAISO was determined to be 1,400 MW. The ACR specifically stated that it would be unreasonable for CPUC-jurisdictional load serving entities ("LSEs") to assume less than the 1,400 MW of MIC for procurement calculation purposes upon completion of upgrade on the transmission system between IID and CAISO refer to as "Path 42". IID agreed to spend over $40 million to upgrade their transmission system in order to export up to 1400 MW of energy to ISO. Following are a few points to help explain this issue a bit more.

- Since the issuance of its 2012 Transmission Planning Report (2011-2012 TPP), the CAISO has included the Expanded MIC value table showing the MIC from IID to CAISO for a ten-year planning horizon. Since then, this MIC value table has been used by LSE procurement staff in RFO bid evaluations for projects situated in the IID BAA, and in order to assign resource adequacy values to IID projects. Project lenders also use the MIC value table in their project evaluations. As such, the contents of this MIC value table are of paramount importance to projects situated in the IID, to LSE procurement staff, and to project lenders for successful completion of renewable projects in IID service territory.
- A year later and in its 2013-2014 transmission plan, the CAISO reversed its proposed Expanded MIC and went back to the zero incremental deliverability for generators connecting to the IID BA. At the same time, CAISO projects that are a very short distance away from IID BA, and project as far away as Arizona and Mexico were deemed deliverable, and over 2,000 MW were awarded deliverability status and consequently 20 to 25-year contracts with the LSE's.
- The stated reason for the reversal of Expanded MIC from 1400 MW to zero was due to San Onofre Nuclear Generating Station (SONGS) retirement. While this was certainly a major event, it does not fully explain why certain new resources in the Imperial Valley Substation and resources in Arizona and Mexico were granted deliverability on the CAISO system, while new resources within the Imperial Irrigation District could not be developed for the lack of similar "deliverability status" in the form of MIC allocation.

[19] Rulemaking 11-05-005, Filed May 5, 2011: Assigned Commissioner's Ruling Regarding Resource Adequacy value of RPS projects in the Imperial Irrigation District Balancing Authority Area
http://docs.cpuc.ca.gov/efile/RULINGS/136670.pdf

- IID concluded that the reduction of IID Expanded MIC was not due to the retirement of SONGS, but because CAISO was importing energy while illegally using IID transmission to ensure the imported energy from Arizona and Mexico reaches San Diego at the expense of IID.
- CAISO further stated that transmission additions approved in the 2013-2014 TPP cycle restored the future additional amount of deliverability for the Imperial Zone up to 1,000 MW. But, the CAISO has allocated all 1,000 MW of that transmission capability to projects directly connected to the CAISO Controlled Grid and allocated 0 MW for imports from the IID Balancing Authority Area. This was a great concern to IID because, as stated above, it appears that it is not only the upgrades made on the CAISO Controlled Grid, but also upgrades paid for by IID customers, that have enabled this increased deliverability. This practice of reducing MIC in favor of deliverability of resources directly connected to CAISO in Imperial Valley Substation, AZ and MX make it extraordinarily difficult for resources in the IID BAA to compete in competitive solicitations by Load Serving Entities in the CAISO BAA because they receive no RA value. It also strands investment that IID has made on its system to allow deliverability of those resources, shifting costs to IID consumers.
- So long as resources internal to the CAISO interconnect electrically near the IID boundaries even in AZ and MX, MIC is taken away from IID BA and given to resources internal to the CAISO and imports from Arizona and Mexico. I believe that the ISO may not have the right to choose where the energy comes from since they are independent, but certainly they do not have the right to use IID, their neighbor, transmission system with no compensation and implement procedures such as MIC, to ensure that IID transmission is internally reserve for their use.

The CAISO has established a situation where they have disadvantaged and inhibited generation development within the IID. They have done this by restricting the allocation of MIC, or Resource Adequacy capacity, to exports from the IID. However, at the same time, they have assigned Resource Adequacy designation to the generation interconnected near and to the east of the IID that they import to serve San Diego demand. They are able to import large volumes of energy, with Resource Adequacy designation, by leveraging 25% of the IID S-line Capacity as documented in their Operating Procedure #7820

For instance, while MIC is zero from 2010 to 2015 on the IID "S" line or the IID_SDGE BG, this means that the ISO has determined that it can't import energy from IID since the S-line capacity is not available. The

facts are that IID capacity is available, but ISO is using it to import from Arizona without compensating IID. This means that while ISO is preventing energy to flow from IID into San Diego, it allows energy to flow from Arizona to San Diego using IID S-line capacity. For instance, several large generating projects obtained approval from ISO to connect to the grid such as 127 MW Arlington Valley Solar Project, and the combined 400 MW Mesquite Solar 1, 2, and 3 projects. These 527 MW of generation located in Arizona and were allowed to interconnect to ISO while about 25% of the 527 MW or 131 MW relies on IID S-line capacity. These generators represent only a portion of the energy imported by the CAISO that relies on the IID S-line as demonstrated in the section above.

Conclusion

The unauthorized and intentional use by the CAISO of the IID transmission system capacity is significant, has caused numerus reliability violations, and prevents the IID from utilizing its own assets for the benefit of its customers. The CAISO with a peak electric demand of 50,270 MW[20] requires imported power from the southwest to meet its balancing area demand. These imports are at the detriment of the IID. The IID, with a peak electric demand of just 1,070 MW is dwarfed by the magnitude of the CAISO and has been and continues to be seriously impacted by the CAISO. For perspective, the SWPL has a rough capacity of nearly 2,600 MW[21], over twice the all-time system peak demand for IID.

NERC Reliability criteria mandates that neighboring balancing areas coordinate on a regional level to insure the reliability of the interconnected transmission system. However, the CAISO has not been a good neighbor to the IID and has intentionally leveraged the IID system with total disregard to the impact on IID. The CAISO is well aware of the devastating impacts the loss of the SWPL can have on the electric grid having been directly impacted, along with IID, during the extensive September 8, 2011 power outage (i.e. 2011 Southwest Blackout). This outage left nearly seven million people without power and impacted five different utilities including SDG&E (CAISO), APS, CFE (Mexico's electric utility), WAPA, and the IID.

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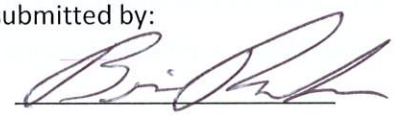
[20] http://www.caiso.com/outlook.html

[21] Normal Line rating from the CAISO 2013-2014 Transmission Planning Process basecase as posted on the CAISO website.

The CAISO has "stacked the deck" against the IID by systematically reducing the amount of MIC assigned to IID import points causing an incredible discrepancy in the amount of generation development that has occurred in the CAISO BA compared to the IID BA. By doing so, it has prevented the development of generation within the IID, and the opportunity for IID to sell its own transmission to generation seeking to export to the CAISO Load Serving Entities. Consequently, the CAISO has prevented the physical flow of energy out of the IID so that the IID transmission capacity, the S-line, is unloaded and available to enable large energy imports across the SWPL.

Bluntly stated, the CAISO is behaving like a bad neighbor with a massive house, many cars, and not enough parking spaces. The IID is the small neighbor with a small house, just enough financial means to have one car, and an extra parking space or two. The CAISO observed an empty "IID" parking space and simply decided to park one of its many cars in it because it happened to be unoccupied. Recall, it is unoccupied because the CAISO has unilaterally established the rules. I feel it is safe to say that most any neighbor would likely have an issue with such treatment. Moreover, such actions by the CAISO are unacceptable in terms of good utility practice, reliability standards, and what in my opinion should be considered outright theft of IID system capacity.

Respectfully submitted by:



Brian Rahman, PE

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