APPENDIX D: Central California Study Results

APPENDIX D-1
HELMS Water Analysis Model

D1. HELMS Water Analysis Model

D1.1 Model Functionality

Overview

The HELMS Water Analysis Model is an hourly model used to predict HELMS generation or pump operation over the water constrained months from June 1 through September 30 of each future summer season over a multi-year long-term plan. Based on the predicted operation of the resource needed to maintain transmission reliability, the model tracks the water levels at the upper HELMS reservoir. The model uses 2007, a recent dry hydro year, as its base year, to reflect conditions in which HELMS operation is most constrained. HELMS operation is tracked in two parallel modes: generation mode and pumping mode.

Regression Equations

Generation mode and pumping mode are each modeled by a set of regression equations that predict flow on key limiting transmission elements. These equations are developed from a series of summer partial-peak and off-peak power flow cases. Transmission element line limits are derived from CAISO operating procedures. The regression equations in pump mode predict when adequate transmission is available in the Fresno area for HELMS pumps to operate without causing a transmission overload. The model evaluates whether 0, 1, 2 or 3 pumps can operate in any one hour. Pumping equations were developed for N-0 conditions only, since HELMS pumps are assumed to trip under N-1 conditions. The regression equations in generation mode predict when HELMS is required to generate to prevent transmission overloads in the Fresno area; generation equations were developed for both N-0 and N-1 conditions and the more stringent constraint is used in every hour.

The relevant variables in the pumping and generation regression equations are as follows:

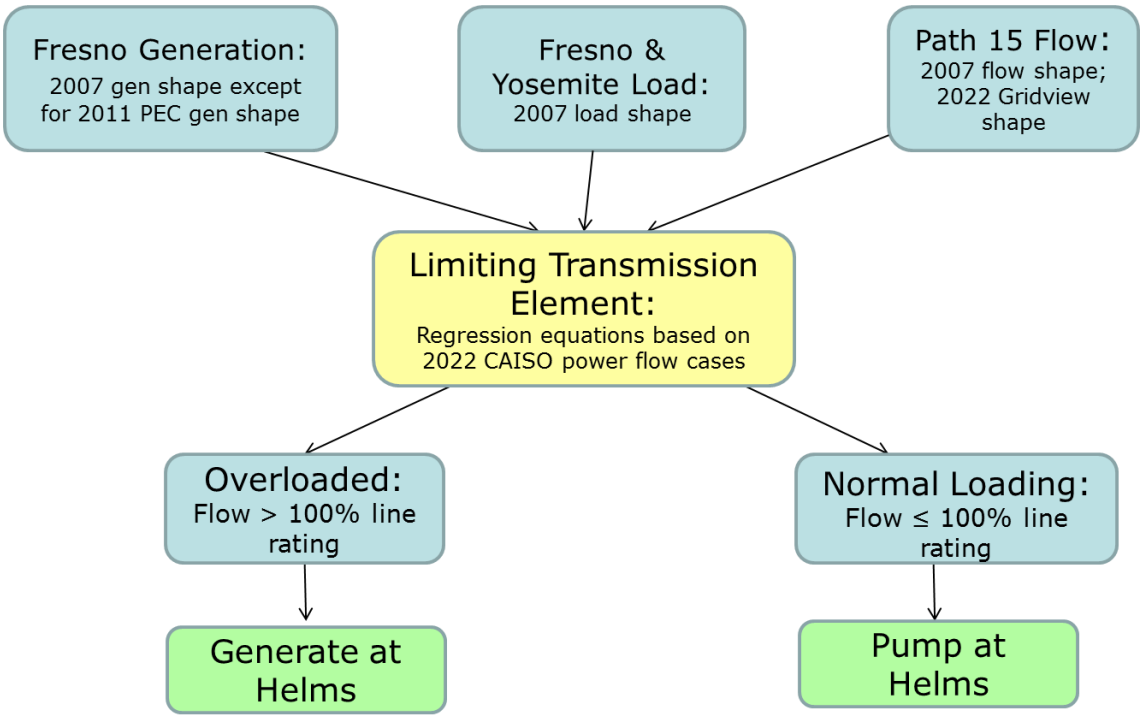
- Fresno/Yosemite area load
- Stanislaus area load
- Path 15 flow
- Panoche Energy Center generation
- Fresno area generation (excluding peakers)
- Fresno area peaker generation
- Melones generation & Zone 357 generation
- HELMS generation

Hourly estimates for each of these variables over the forecast period are included in the model; the source of each estimate is described in detail in the next section. In every summer hour, hourly values for each variable are fed into the pumping and generation regression equations to determine HELMS operation in that hour. First, the model determines whether HELMS is

required to generate in the hour to mitigate transmission overloads. If HELMS is not required to generate at all in an hour, the model determines whether it is able to pump.

This process is reflected in the top portion of Figure D1-1 below.

Figure D1-1



Tracking Reservoir Level

After HELMS operation in the hour has been modeled, the result of the operation is applied to the reservoir water level: in hours when HELMS pumps, the reservoir level increases; when HELMS generates, the reservoir level decreases. Generation or pump operation is converted from MW to acre-feet of water using publicly available pumped storage efficiency data, benchmarked against confidential PG&E HELMS operating efficiency data. Water level tracking also takes into account water releases: PG&E does not own the rights to all of the water collected in the HELMS reservoir, so HELMS is required to periodically release water to downstream agricultural customers. The model uses 2007 historical daily water release data.

The HELMS reservoir starts each year with a water level equal to its historical level on June 1, 2007, and the water level is tracked for every hour in the summer. This process is repeated for each year from 2016 through 2040, with the reservoir level resetting each year. As load grows in the Fresno area each year, transmission becomes more constrained, and HELMS is required to generate in more hours of the summer and is able to pump in fewer hours of the summer. The reservoir gradually reaches lower and lower water levels over the course of summer, reflecting

reduced HELMS flexibility. Eventually, the reservoir hits its minimum operating level, reflecting a time when HELMS generation is not available to mitigate transmission overloads in the area.

D1.2 Model Inputs

Fresno/Yosemite Area Load

The model uses the historical 2007 hourly load shape for the Fresno/Yosemite area provided by PG&E. E3 used regression analysis to calculate a small additional agricultural pumping load in every hour consistent with 1-in-5 dry hydro conditions. The model then compares the peak summer load in 2007 to the annual CEC forecast of 1-in-10 summer peak loads for the Fresno/Yosemite area to calculate an annual load escalation factor for each year over the forecast period. Load in each hour is then multiplied by the annual escalation factor to create a scaled load shape for each year.

Stanislaus Area Load

The Stanislaus area load also uses historical 2007 hourly data as a base load shape, which is then scaled using the same annual load escalation factor calculated for the Fresno/Yosemite area load to develop consistent forecasts for both Fresno and Stanislaus area hourly loads.

Path 15 Flow

Two Path 15 flow shapes are available in the model. The 2007 Path 15 shape uses hourly historical data from the summer of 2007. The 2022 Path 15 shape is the hourly shape generated in the CAISO's 2022 GridView case. The 2022 shape is mapped from 2022 to 2007 using a mapping tool, which aligns weekends and holidays so that shapes align with other 2007 historical data used in the model.

The regression equations used to predict HELMS pumping and generation operation are piecewise functions relative to Path 15 flows: one coefficient is applied to flows below 3000 MW (where positive flow signifies South to North flow), and a second coefficient is applied to flows above 3000 MW.

Panoche Energy Center Generation

The model uses 2011 historical hourly generation data.

Fresno Area Generation (excluding Peakers)

2007 historical generation is used where available. For generators built after 2007, output shapes are assumed to follow the same hourly output shape as the existing aggregated generators of the same type (for example, all biomass generators installed after 2007 use the aggregate shape of all biomass generators installed before 2007, scaled to their nameplate capacity). Shapes for PV installed after 2007 were simulated using NREL's System Advisor Model using Fresno insolation data.

For solar PV, the model places 40% of the expected PV installations at Path 15, rather than in the Fresno RPS generation category, to be consistent the 2012/2013 CPUC TPP Commercial Interest portfolio assumption that 40% of the Westlands PV capacity is located outside of central Fresno, and will not be as effective at mitigating transmission overloads within central Fresno.

Fresno Area Peaker Generation

The model uses historical 2007 generation data where available, scaled up to include generators built post 2007. Peakers can be run at historical levels, which are very low (~4% capacity factor), or they can be scaled up by a factor of 3 (~12% capacity factor) to reflect full peak-period use during the summer. The scaled generation shapes are created by multiplying the total peaker output in every hour by a factor of 3 capped by its maximum capacity.

Melones Generation & Zone 357 Generation

The model uses historical 2007 hourly output data for Melones and Zone 357 generators.

HELMS Generation

The model has an option to include historical 2007 Helms generation as a proxy for future minimum generation requirements. Any incremental generation from Helms that the model determines is needed is to mitigate transmission overloads.

Appendix D-2
PG&E Central CA Study - Bulk

Thermal Overloads. Peak and Partial Peak

ID	Overloaded Facility	Contingency	Category	Category Description	Loading (%)				Potential Mitigation Solutions
					2017 Summer Peak Dry	2017 Summer Partial Peak Dry	2022 Summer Peak Dry	2022 Summer Partial Peak Dry	
CCB-PPP-T-1	WARNEVL-WILSON 230 # 1	normal conditions	A	base case	<95%	117.0%	<95%	140.1%	install series reactor, upgrade the line or congestion management
CCB-PPP-T-2	CAYETANO - USWP-JRW 230		A	base case	<95%	99.9%	<95%	97.0%	congestion management, reduce C. Cos generation
CCB-PPP-T-3	LONETREE- USWP-JRW 230		A	base case	<95%	100.2%	<95%	97.3%	
CCB-PPP-T-4	LLAGAS - GILROY TAP 115		A	base case	<95%	101.3%	<95%	<95%	reduce Gilroy gen
CCB-PPP-T-5	MAGUNDEN-OMAR 230 #1		A	base case	96.7%	96.7%	98.3%	97.5%	SCE facilities, mitigation solutions in the Southern Area studies.
CCB-PPP-T-6	KRAMER - HOLGATE 115 #1		A	base case	<95%	<95%	102.7%	<95%	
CCB-PPP-T-7	KRAMER - INYOKERN 115 #1		A	base case	<95%	<95%	101.5%	109.5%	
CCB-PPP-T-8	COLWATER-TT22409 115 #1		A	base case	<95%	<95%	201.9%	<95%	
CCB-PPP-T-9	CONTROL - INYO 115 #1		A	base case	<95%	<95%	106.3%	<95%	
CCB-PPP-T-10	OXBOW B 230/115 #1		A	base case	<95%	<95%	114.0%	114.0%	
CCB-PPP-T-11	INYO -INYO PS 115 #1		A	base case	<95%	<95%	151.3%	109.8%	
CCB-PPP-T-12	RINALDI-VALLEY 230 kV # 1 and 2		A	base case	<95%	<95%	<95%	100.6%	
CCB-PPP-T-13	MIGUEL - BAY BLVD 230 #1		A	base case	<95%	<95%	112.2%	<95%	SDG&E line, mitigated in Southern studies
CCB-PPP-T-14	WHEELBR-COTWDPGE 115		A	base case	96.6%	99.5%	98.2%	104.6%	reduce Wheelbr generation or upgrade the line

ID	Overloaded Facility	Contingency	Category	Category Description	Loading (%)				Potential Mitigation Solutions
					2017 Summer Peak Dry	2017 Summer Partial Peak Dry	2022 Summer Peak Dry	2022 Summer Partial Peak Dry	
CCB-PPP-T-15	WARNEVL-WILSON 230 # 1	Gates 500/230 kV transformer	B	T-1	<95%	122.3%	<95%	145.9%	install series reactor, upgrade the line or use congestion management
CCB-PPP-T-16		PDCI Bi-pole	B	PDCI	<95%	118.2%	<95%	135.9%	
CCB-PPP-T-17		Tesla-Los Banos 500 kV	B	L-1	<95%	103.4%	<95%	124.4%	
CCB-PPP-T-18		PDCI monopole	B	PDCI	<95%	110.7%	<95%	129.8%	
CCB-PPP-T-19		Tracy-Los Banos 500 kV	B	L-1	<95%	103.3%	<95%	124.2%	
CCB-PPP-T-20		Los Banos-Gates 500 kV #1	B	L-1	<95%	101.2%	<95%	121.4%	
CCB-PPP-T-21		One Diablo unit	B	G-1	<95%	106.2%	<95%	125.9%	
CCB-PPP-T-22		One San Onofre unit	B	G-1	<95%	105.6%	<95%	125.4%	
CCB-PPP-T-23		Los Banos-Midway 500 kV	B	L-1	<95%	100.7%	<95%	120.7%	
CCB-PPP-T-24		Moss Landing-Los Banos 500 kV	B	L-1	<95%	100.3%	<95%	118.9%	
CCB-PPP-T-25		Tesla-Metcalf 500 kV	B	L-1	<95%	103.2%	<95%	124.3%	
CCB-PPP-T-26		Los Banos-Gates 500 kV #3	B	L-1	<95%	100.3%	<95%	120.3%	
CCB-PPP-T-27		Los Banos 500/230 kV transformer	B	L-1	<95%	103.3%	<95%	122.4%	
CCB-PPP-T-28		Vaca Dixon-Tesla 500 kV	B	L-1	<95%	100.9%	<95%	120.7%	
CCB-PPP-T-29		Olinda-Tracy 500 kV	B	L-1	<95%	101.2%	<95%	121.0%	

Thermal Overloads. Peak and Partial Peak

ID	Overloaded Facility	Contingency	Category	Category Description	Loading (%)				Potential Mitigation Solutions
					2017 Summer Peak Dry	2017 Summer Partial Peak Dry	2022 Summer Peak Dry	2022 Summer Partial Peak Dry	
CCB-PPP-T-30		Table Mountain –Tesla 500 kV	B	L-1	<95%	100.4%	<95%	120.2%	
CCB-PPP-T-31		Tesla-Newark 230 kV	B	L-1	<95%	100.5%	<95%	120.4%	
CCB-PPP-T-32	CRAGVIEW - WEED JPS 115 #1	Captain Jack -Olinda 500 kV	B	L-1	99.2%	101.7%	<95%	<95%	adjust Weed phase shifter
CCB-PPP-T-33		Malin-Round Mountain 500 kV #2	B	L-1	96.6%	100.5%	<95%	<95%	
CCB-PPP-T-34		Malin-Round Mountain 500 kV #1	B	L-1	96.1%	100.1%	<95%	<95%	
CCB-PPP-T-35	DELTA - CASCADE 115 #1	Captain Jack -Olinda 500 kV	B	L-1	96.4%	97.4%	<95%	<95%	
CCB-PPP-T-36	DELEVN -CORTINA 230.0 #1	Olinda-Tracy 500 kV	B	L-1	<95%	<95%	100.1%	<95%	reduce Colusa generation through congestion management or SPS, or upgrade the line
CCB-PPP-T-37	COTWDWAP-OLINDAW 230 #1&2	Captain Jack -Olinda 500 kV	B	L-1	97.8%	<95%	<95%	<95%	WAPA project to upgrade
CCB-PPP-T-38	CAYETANO - USWP-JRW 230	C. Costa-Las Positas 230 kV	B	L-1	<95%	103.5%	<95%	100.7%	congestion management, reduce Contra Costa generation
CCB-PPP-T-39	LONETREE- USWP-JRW 230		B	L-1	<95%	103.8%	<95%	101.0%	
CCB-PPP-T-40	COLWATER-TT22409 115 #1	PDCI bi-pole	B	PDCI	<95%	<95%	164.5%	<95%	
CCB-PPP-T-41		PDCI mono-pole	B	PDCI	<95%	<95%	161.0%	<95%	
CCB-PPP-T-42	CONTROL - INYO 115.0 #1	PDCI bi-pole	B	PDCI	<95%	<95%	113.2%	<95%	
CCB-PPP-T-43		PDCI mono-pole	B	PDCI	<95%	<95%	103.8%	<95%	

ID	Overloaded Facility	Contingency	Category	Category Description	Loading (%)				Potential Mitigation Solutions
					2017 Summer Peak Dry	2017 Summer Partial Peak Dry	2022 Summer Peak Dry	2022 Summer Partial Peak Dry	
CCB-PPP-T-44	INYO - INYO PS 115.0 #1	PDCI bi-pole	B	PDCI	<95%	<95%	156.8%	120.1%	SCE facilities, mitigation solutions in the Southern Area studies
CCB-PPP-T-45		PDCI mono-pole	B	PDCI	<95%	<95%	144.9%	109.0%	
CCB-PPP-T-46		SONGS 1 unit	B	G-1	<95%	<95%	134.0%	99.6%	
CCB-PPP-T-47		DIABLO 1 unit	B	G-1	<95%	<95%	133.8%	99.5%	
CCB-PPP-T-48		Midway-Diablo 500 kV # 1 and 2	C	L-2	<95%	<95%	134.0%	<95%	
CCB-PPP-T-49		Round Mtn 500 kVstuck brk	C	BRK	<95%	<95%	134.3%	<95%	
CCB-PPP-T-50		Table Mtn 500 kVstuck brk	C	BRK	<95%	<95%	133.9%	<95%	
CCB-PPP-T-51		Tesla 500 kVstuck brk	C	BRK	<95%	<95%	134.0%	<95%	
CCB-PPP-T-52	DELEVN -CORTINA 230.0 #1	Round Mtn-Table Mtn 500 kV # 1 and 2	C	L-2	<95%	<95%	102.6%	<95%	install SPS to trip Colusa generation or upgrade the line
CCB-PPP-T-53		500 kV double outage south of Table Mtn	C	L-2	<95%	<95%	100.2%	<95%	
CCB-PPP-T-54		500 kV double outage north of Los Banos	C	L-2	<95%	114.0%	<95%	137.6%	
CCB-PPP-T-55		Gates-Gregg&Gates-Mc Call 230 kV	C	L-2	<95%	142.9%	<95%	N/A	
CCB-PPP-T-56		500 kV double outage south of Los Banos	C	L-2	<95%	104.8%	<95%	116.6%	
CCB-PPP-T-57		Los Banos CB#832	C	BRK	<95%	104.8%	<95%	126.0%	

Thermal Overloads. Peak and Partial Peak

ID	Overloaded Facility	Contingency	Category	Category Description	Loading (%)				Potential Mitigation Solutions
					2017 Summer Peak Dry	2017 Summer Partial Peak Dry	2022 Summer Peak Dry	2022 Summer Partial Peak Dry	
CCB-PPP-T-58	WARNEVL-WILSON 230 #1	500 kV double outage north of Midway	C	L-2	<95%	101.2%	<95%	<95%	install series reactor, upgrade the line or use congestion management
CCB-PPP-T-59		500 kV double outage south of Tracy	C	L-2	<95%	100.9%	<95%	126.9%	
CCB-PPP-T-60		Diablo-Midway 500 kV #1&2	C	L-2	<95%	106.7%	<95%	126.6%	
CCB-PPP-T-61		Gates CB #652	C	BRK	<95%	101.1%	<95%	121.0%	
CCB-PPP-T-62		Vaca Dixon CB#732	C	BRK	<95%	100.8%	<95%	120.6%	
CCB-PPP-T-63		Tesla CB#612	C	BRK	<95%	100.4%	<95%	120.4%	
CCB-PPP-T-64		Gates-Arco& Gates-Midway 230 kV	C	L-2	<95%	100.6%	<95%	<95%	
CCB-PPP-T-65	CRAGVIEW - WEED JPS 115 #1	Malin-Round Mntain 500 kV #1 &2	C	L-2	107.4%	109.1%	<95%	<95%	adjust Weed phase shifter
CCB-PPP-T-66		Round Mnt –Table Mnt 500 kV # 1 & 2	C	L-2	95.1%	99.5%	<95%	<95%	
CCB-PPP-T-67	DELTA - CASCADE 115 #1	Malin-Round Mntain 500 kV #1 &2	C	L-2	105.0%	105.1%	<95%	<95%	
CCB-PPP-T-68	ASHLAN - FGRDN T2 230.0 #1	Gregg-Herndon 230 kV #1&2	C	L-2	113.0%	<95%	<95%	<95%	open breaker at Ashlan prior to upgrade, upgrade in 2018
CCB-PPP-T-69	GREGG - FGRDN T2 230.0 #1		C	L-2	138.6%	95.3%	<95%	<95%	
CCB-PPP-T-70	TABLE MTN 500/230 kV # 1	Double outage south of Table Mountain	C	L-2	102.6%	96.6%	111.2%	<95%	modify RAS not to trip Feather River
CCB-PPP-T-71	KEARNEY-HERNDON 230	Gates-Gregg&Gates-Mc Call 230 kV	C	L-2	<95%	110.9%	N/A	N/A	upgrade or congestion management - dispatch Helms

Study Area: **PG&E Bulk - Central California Study**

Thermal Overloads. Peak and Partial Peak

ID	Overloaded Facility	Contingency	Category	Category Description	Loading (%)				Potential Mitigation Solutions
					2017 Summer Peak Dry	2017 Summer Partial Peak Dry	2022 Summer Peak Dry	2022 Summer Partial Peak Dry	
CCB-PPP-T-72		Gates-Gregg&Gates-Mc Call 230 kV (Gates-switching station)	C	L-2	N/A	N/A	no concerns	not solved	dispatch Henrietta peakers and/or new project connected to Gates-Gregg and Gates - Mc Call and/or trip Henrietta load, or install reactive support. Percent overload shown in an assumption of Henrietta peakers dispatched
CCB-PPP-T-73	BELLOTA- WARNERVL 230.0 #1	Gates-Gregg&Gates-Mc Call 230 kV (Gates-switching station) with Henrieta peakers dispatched	C	L-2	N/A	N/A	<95%	99.5%	
CCB-PPP-T-74	WARNERVL - WILSON 230.0 #1		C	L-2	N/A	N/A	<95%	177.5%	
CCB-PPP-T-75	STOREY 2 - WILSON 230.0 #1		C	L-2	N/A	N/A	<95%	97.1%	
CCB-PPP-T-76	STOREY 1 - WILSON 230.0 #1		C	L-2	N/A	N/A	<95%	103.6%	
CCB-PPP-T-77	STOREY 1 - BORDEN 230.0 #2		C	L-2	N/A	N/A	<95%	108.9%	
CCB-PPP-T-78	KEARNEY - HERNDON 230.0 #1		C	L-2	N/A	N/A	<95%	128.9%	
CCB-PPP-T-79	CHWCHLLA - CERTANJ1 115.0 #1		C	L-2	N/A	N/A	<95%	119.7%	
CCB-PPP-T-80	CERTANJ1- SHARON T 115.0 #1		C	L-2	N/A	N/A	<95%	118.9%	
CCB-PPP-T-81	SHARON T -OAKH_JCT 115.0 #1		C	L-2	N/A	N/A	<95%	110.9%	

Thermal Overloads. Peak and Partial Peak

ID	Overloaded Facility	Contingency	Category	Category Description	Loading (%)				Potential Mitigation Solutions
					2017 Summer Peak Dry	2017 Summer Partial Peak Dry	2022 Summer Peak Dry	2022 Summer Partial Peak Dry	
CCB-PPP-T-82	WARNERVL -WILSON 230.0 #1	Gates-Gregg&Gates-Mc Call 230 kV (Switching Station-Gregg and Switching Station-Mc Call)	C	L-2	N/A	N/A	<95%	169.2%	dispatch Helms generation, or upgrade the system
CCB-PPP-T-83	STOREY 1-WILSON 230.0 #1		C	L-2	N/A	N/A	<95%	97.8%	
CCB-PPP-T-84	STOREY 1- BORDEN 230.0 #2		C	L-2	N/A	N/A	<95%	102.2%	
CCB-PPP-T-85	KEARNEY-HERNDON 230.0 #1		C	L-2	N/A	N/A	<95%	122.9%	
CCB-PPP-T-86	CHWCHLLA -CERTANJ1 115.0 #1		C	L-2	N/A	N/A	<95%	114.4%	
CCB-PPP-T-87	CERTANJ1 -SHARON T 115.0 #1		C	L-2	N/A	N/A	<95%	113.7%	
CCB-PPP-T-88	SHARON T-OAKH_JCT 115.0 #1		C	L-2	N/A	N/A	<95%	105.8%	
CCB-PPP-T-89	CAYETANO-USWP JRW 230	C. Costa-Brentwood & C. Costa-Delta 230 kV	C	L-2	<95%	105.9%	<95%	101.7%	congestion management, reduce Contra Costa generation
CCB-PPP-T-90		500 kV double outage north of Tesla	C	L-2	<95%	<95%	<95%	95.2%	
CCB-PPP-T-91	LONETREE - USWP JRW 230	C. Costa-Brentwood & C. Costa-Delta 230 kV	C	L-2	<95%	106.2%	<95%	102.0%	
CCB-PPP-T-92		500 kV double outage north of Tesla	C	L-2	<95%	<95%	<95%	95.5%	
CCB-PPP-T-93	WARNEVL-WILSON 230	Los Banos 500 kV Substation	D	Subst	<95%	131.8%	<95%	153.4%	install series reactor, upgrade the line or use congestion management
CCB-PPP-T-94		2 Diablo units	D	G-2	<95%	114.0%	<95%	133.3%	
CCB-PPP-T-95		2 Palo Verde units	D	G-2	<95%	111.7%	<95%	130.6%	
CCB-PPP-T-96		2 San Onofre units	D	G-2	<95%	111.9%	<95%	131.4%	

ID	Overloaded Facility	Contingency	Category	Category Description	Loading (%)				Potential Mitigation Solutions
					2017 Summer Peak Dry	2017 Summer Partial Peak Dry	2022 Summer Peak Dry	2022 Summer Partial Peak Dry	
CCB-PPP-T-97	CAYETANO-USWP JRW 230	Tesla 500 kV Substation	D	Subst	<95%	100.6%	<95%	102.4%	congestion management
CCB-PPP-T-98	LONETREE - USWP JRW 230		D	Subst	<95%	100.8%	<95%	102.7%	
CCB-PPP-T-99	GATES - MIDWAY 230.0 #1	Midway 500 kV Substation	D	Subst	148.7%	96.9%	116.3%	not solved	acceptable for Category D, use Path 26 S-N RAS for 2022 part peak
CCB-PPP-T-100	GATES - ARCO 230.0 #1		D	Subst	137.7%	95.5%	112.7%	not solved	
CCB-PPP-T-101	GATES 500/230 kV # 1		D	Subst	129.0%	148.5%	<95%	not solved	
CCB-PPP-T-102	MIDWAY - ARCO 230.0 #1		D	Subst	107.5%	<95%	<95%	not solved	
CCB-PPP-T-103	GATES-TEMPLETN 230 # 1		D	Subst	106.9%	<95%	<95%	not solved	
CCB-PPP-T-104	WARNEVL-WILSON 230		D	Subst	<95%	120.1%	<95%	not solved	
CCB-PPP-T-105	SEMITRPC -WSCOPRSN 115	Midway 230 kV Substation	D	Subst	153.1%	<95%	not solved	164.0%	drop load in 115 kV system at Midway for 2022 peak case
CCB-PPP-T-106	WSCOPRSN -CHARKA 115.0 #1		D	subst	156.4%	<95%	not solved	167.2%	
CCB-PPP-T-107	CHARKA-FAMOSO 115.0 #1		D	subst	179.9%	<95%	not solved	193.9%	
CCB-PPP-T-108	FAMOSO -CAWELO C 115.0 #1		D	subst	189.8%	<95%	not solved	205.8%	
CCB-PPP-T-109	LERDO - OGLE JCT 115.0 #1		D	subst	117.0%	<95%	not solved	126.2%	
CCB-PPP-T-110	LERDO LRDO JCT 115.0 #1		D	subst	118.2%	<95%	not solved	127.4%	
CCB-PPP-T-111	OGLE JCT -CAWELO C 115.0 #1		D	subst	187.8%	<95%	not solved	202.8%	

Study Area: **PG&E Bulk - Central California Study**

Thermal Overloads. Peak and Partial Peak

ID	Overloaded Facility	Contingency	Category	Category Description	Loading (%)				Potential Mitigation Solutions
					2017 Summer Peak Dry	2017 Summer Partial Peak Dry	2022 Summer Peak Dry	2022 Summer Partial Peak Dry	
CCB-PPP-T-112	LRDO JCT -KERN OIL 115.0 #1		D	subst	97.7%	<95%	not solved	105.9%	
CCB-PPP-T-113	WARNEVL-WILSON 230		D	subst	<95%	111.6%	not solved	119.5%	
CCB-PPP-T-114	Midway - Temblor 115 kV		D	subst	<95%	137.0%	not solved	<95%	
CCB-PPP-T-115	NOT SOLVED	NE SE SEPARATION	D	sys sep	not solved	not solved	not solved	not solved	system separation according the the scheme
CCB-PPP-T-116		Midway 500 kV Substation	D	subst	solved	solved	solved	not solved	use Path 26 S-N RAS for 2022 Partial peak
CCB-PPP-T-117		Midway 230 kV Substation	D	subst	solved	solved	not solved	solved	drop load in 115 kV system at Midway

Thermal Overloads. Off-Peak

ID	Overloaded Facility	Contingency	Category	Category Description	Loading (%)				Potential Mitigation Solutions
					2017 Spring Off-pk Wet	2017 Winter-Off-pk Dry	2022 Spring Off-pk Wet	2022 Winter-Off-pk Dry	
CCB-OP-T-1	COLWATER-TT22409 115 #1	normal conditions	A	base case	<95%	<95%	194.5%	195.3%	SCE facilities, will be mitigated in the Southern Area studies
CCB-OP-T-2	CONTROL - INYO 115 #1		A	base case	<95%	<95%	123.4%	122.2%	
CCB-OP-T-3	OXBOW B 230/115 #1		A	base case	<95%	<95%	106.1%	106.4%	
CCB-OP-T-4	INYO -INYO PS 115 #1		A	base case	<95%	<95%	170.5%	172.7%	
CCB-OP-T-5	INYO 230/115 #1 and 2		A	base case	<95%	<95%	101.6%	105.3%	
CCB-OP-T-6	SKYRIVER-HIGHWIND 230 # 1		A	base case	<95%	<95%	101.8%	101.9%	
CCB-OP-T-7	WARNEVL-WILSON 230 # 1		A	base case	100.1%	<95%	99.5%	<95%	install series reactor, upgrade the line or congestion management
CCB-OP-T-8	CAYETANO - USWP-JRW 230		A	base case	<95%	<95%	<95%	<95%	congestion management, reduce C. Cos generation
CCB-OP-T-9	LONETREE- USWP-JRW 230		A	base case	<95%	<95%	<95%	<95%	
CCB-OP-T-10	LLAGAS - GILROY TAP 115		A	base case	<95%	<95%	<95%	<95%	reduce Gilroy gen
CCB-OP-T-11	GATES-MIDWAY 500 kV		A	base case	<95%	100.7%	<95%	98.9%	congestion management
CCB-OP-T-12	WHEELBR-COTWDPGE 115		A	base case	<95%	<95%	111.6%	110.9%	reduce Wheelbr generation or upgrade the line
CCB-OP-T-13	WARNEVL-WILSON 230 # 1	PDCI Bi-pole	B	PDCI	101.1%	<95%	100.9%	<95%	install series reactor, upgrade the line or use congestion management
CCB-OP-T-14		Tesla-Los Banos 500 kV	B	L-1	97.4%	<95%	96.3%	<95%	
CCB-OP-T-15		Tracy-Los Banos 500 kV	B	L-1	95.2%	<95%	<95%	<95%	

Thermal Overloads. Off-Peak

ID	Overloaded Facility	Contingency	Category	Category Description	Loading (%)				Potential Mitigation Solutions
					2017 Spring Off-pk Wet	2017 Winter-Off-pk Dry	2022 Spring Off-pk Wet	2022 Winter-Off-pk Dry	
CCB-OP-T-16		Los Banos-Gates 500 kV #1	B	L-1	95.4%	<95%	<95%	<95%	
CCB-OP-T-17	COLWATER-TT22409 115 #1	DIABLO 1 unit	B	G-1	<95%	<95%	155.5%	156.0%	SCE facility, mitigated in the Southern Area studies
CCB-OP-T-18		SONGS 1 unit	B	G-1	<95%	<95%	154.7%	155.1%	
CCB-OP-T-19	MOSSLND2 - TT22113 230 #2	Moss Landing-Los Banos 500 kV	B	L-1	<95%	<95%	100.7%	<95%	trip renewable gen connected to Moss Lng-Panoche 230 kV
CCB-OP-T-20		Moss Landing 500/230 kV	B	T-1	<95%	<95%	100.2%	<95%	
CCB-OP-T-21	GATES - MIDWAY 230.0 #1	Gates 500/230 kV transformer	B	T-1	<95%	106.3%	<95%	<95%	use 30 min rating or trip both Helms pumps
CCB-OP-T-22	GATES - MIDWAY 230.0 #1	Gates-Midway 500 kV	B	L-1	<95%	111.1%	<95%	99.9%	use 30 min rating
CCB-OP-T-23	ARCO-MIDWAY 230 # 1	Gates-Midway 500 kV	B	L-1	<95%	99.2%	<95%	<95%	use 30 min rating or trip both Helms pumps
CCB-OP-T-24	WESTLEY -LOSBANOS 230.0 #1	PDCI bi-pole	B	PDCI	97.6%	<95%	N/A	N/A	upgrade or congestion management
CCB-OP-T-25		Tesla-Los Banos 500 kV	B	L-1	101.1%	<95%	N/A	N/A	
CCB-OP-T-26		Tracy-Los Banos 500 kV	B	L-1	97.2%	<95%	N/A	N/A	
CCB-OP-T-27	WESTLEY- TT22105 230 #1	Tracy-Los Banos 500 kV	B	L-1	N/A	N/A	98.4%	<95%	renewable gen connecting to Westley-Los Banos will upgrade (LGIP)
CCB-OP-T-28		Tesla-Los Banos 500 kV	B	L-1	N/A	N/A	102.1%	<95%	
CCB-OP-T-29		PDCI bi-pole	B	PDCI	N/A	N/A	100.5%	<95%	
CCB-OP-T-30	RIO OSO - BRIGHTON 230.0 #1		B	T-1	127.4%	<95%	111.2%	<95%	

ID	Overloaded Facility	Contingency	Category	Category Description	Loading (%)				Potential Mitigation Solutions
					2017 Spring Off-pk Wet	2017 Winter-Off-pk Dry	2022 Spring Off-pk Wet	2022 Winter-Off-pk Dry	
CCB-OP-T-31	ATLANTC - GOLDHILL 230.0 #1	Table Mtn 500/230 kV x-former w/out SPS	B	T-1	103.5%	<95%	<95%	<95%	existing SPS to trip Hyatt and Thermalito gen mitigates but causes transient frequency violations. Modify SPS
CCB-OP-T-32	PEASE - E.MRY J1 115.0 #1		B	T-1	134.0%	<95%	<95%	<95%	
CCB-OP-T-33	GLEAF TP -RIO OSO 115.0 #1		B	T-1	107.6%	<95%	<95%	<95%	
CCB-OP-T-34	E.NICOLS -RIO OSO 115.0 #1		B	T-1	134.1%	<95%	<95%	<95%	
CCB-OP-T-35	RIO OSO -OLIVH J1 115.0 #1		B	T-1	126.4%	<95%	<95%	<95%	
CCB-OP-T-36	E.MRY J1 - OLIVH J1 115.0 #1		B	T-1	134.4%	<95%	<95%	<95%	
CCB-OP-T-37	WARNEVL-WILSON 230 # 1	500 kV double outage north of Los Banos	C	L-2	110.7%	<95%	109.7%	<95%	upgrade the line or congestion management
CCB-OP-T-38		Gates-Gregg&Gates-Mc Call 230 kV	C	L-2	99.8%	<95%	<95%	<95%	
CCB-OP-T-39		500 kV double outage south of Los Banos	C	L-2	<95%	<95%	96.3%	<95%	
CCB-OP-T-40		Los Banos CB#832	C	BRK	102.3%	<95%	103.0%	<95%	
CCB-OP-T-41		500 kV double outage south of Tracy	C	L-2	96.3%	<95%	<95%	<95%	
CCB-OP-T-42	BELLOTA-WARNEVL 230 # 1	500 kV double outage north of Los Banos	C	L-2	99.3%	<95%	<95%	<95%	series reactor on Warnerville-Wilson or congestion management
CCB-OP-T-43	WESTLEY-LOS BANOS 230.0 #1	500 kV double outage north of Los Banos, tripped 511 MW ld, 1940 MW gen	C	L-2	134.0%	115.5%	N/A	N/A	upgrade or modify SPS to trip more gen at Midway
CCB-OP-T-44		500 kV double outage south of Tracy	C	L-2	100.3%	98.9%	N/A	N/A	upgrade or congestion management

Thermal Overloads. Off-Peak

ID	Overloaded Facility	Contingency	Category	Category Description	Loading (%)				Potential Mitigation Solutions
					2017 Spring Off-pk Wet	2017 Winter-Off-pk Dry	2022 Spring Off-pk Wet	2022 Winter-Off-pk Dry	
CCB-OP-T-45		Los Banos CB#832	C	BRK	97.5%	<95%	N/A	N/A	
CCB-OP-T-46	WESTLEY- TT22105 230 #1	500 kV double outage north of Los Banos, trip 538 MW load, 699 MW gen	C	L-2	N/A	N/A	134.0%	131.3%	renewable gen connecting to Westley-Los Banos will upgrade (LGIP)
CCB-OP-T-47		500 kV double outage south of Tracy	C	L-2	N/A	N/A	100.0%	<95%	
CCB-OP-T-48		Los Banos CB#832	C	BRK	N/A	N/A	100.0%	<95%	
CCB-OP-T-49	LOSBANOS - TT22105 230.0 #1	500 kV double outage north of Los Banos, trip 538 MW load, 699 MW gen	C	L-2	N/A	N/A	126.6%	123.8%	upgrade or modify SPS to trip more gen at MIdway
CCB-OP-T-50	BORDEN-GREGG 230	500 kV double outage north of Los Banos	C	L-2	97.4%	<95%	95.4%	<95%	not a violation
CCB-OP-T-51		Gates-Gregg&Gates-Mc Call 230 kV	C	L-2	95.8%	<95%	N/A	N/A	not a violation
CCB-OP-T-52	PANOCHE-GATES230 #1 & 2	Gates-Gregg&Gates-Mc Call 230 kV	C	L-2	<95%	101.5%	N/A	N/A	trip all Helms pumps and gen at Midway if still OL
CCB-OP-T-53		Gates-Gregg&Gates-Mc Call 230 kV (switch station)	C	L-2	N/A	N/A	<95%	116.7%	trip all Helms pumps and gen at Midway if still OL
CCB-OP-T-54	KEARNEY-HERNDON 230	Gates-Gregg&Gates-Mc Call 230 kV (switch station)	C	L-2	N/A	N/A	<95%	127.5%	trip all Helms pumps
CCB-OP-T-55	ORO LOMA - EL NIDO 115.0 #1		C	L-2	N/A	N/A	<95%	103.0%	trip all Helms pumps
CCB-OP-T-56	GATES - MIDWAY 230.0 #1	500 kV double outage north of Midway	C	L-2	<95%	118.4%	<95%	139.7%	drop renewables at Midway, more load and all Helms pumps and use 30 min rating
CCB-OP-T-57		Midway CB#812	C	BRK	<95%	108.6%	<95%	97.3%	trip one Helms pump
CCB-OP-T-58	ARCO - MIDWAY 230.0 #1	500 kV double outage north of Midway	C	L-2	<95%	104.8%	<95%	119.0%	drop renewables at Midway and all Helms pumps or use 30-min rating

Thermal Overloads. Off-Peak

ID	Overloaded Facility	Contingency	Category	Category Description	Loading (%)				Potential Mitigation Solutions
					2017 Spring Off-pk Wet	2017 Winter-Off-pk Dry	2022 Spring Off-pk Wet	2022 Winter-Off-pk Dry	
CCB-OP-T-59		Midway CB#812	C	BRK	<95%	97.2%	<95%	<95%	trip one Helms pump
CCB-OP-T-60	ARCO - GATES 230.0 #1	500 kV double outage north of Midway	C	L-2	<95%	<95%	<95%	106.6%	use 30 min rating
CCB-OP-T-61	BELLOTA -WARNERVL 230.0 #1	Los Banos 500 kV Substation	D	Subst	not solved	not solved	133.6%	104.5%	acceptable for Cat. D, voltage deviations up to 11.5% SPOP DRY, 15.2% FWOP WET. Trip 1 Diablo unit for 2017
CCB-OP-T-62	WARNERVL -WILSON 230.0 #1		D	Subst	not solved	not solved	174.3%	101.4%	
CCB-OP-T-63	WESTLEY - TT22105 230.0 #1		D	Subst	not solved	not solved	160.2%	147.4%	
CCB-OP-T-64	MOSSLND2 - TT22113 230 #2		D	Subst	not solved	not solved	166.9%	159.9%	
CCB-OP-T-65	GATES 500/230 # 1		D	Subst	not solved	not solved	98.5%	169.9%	
CCB-OP-T-66	MOSSLND1 -COBURN 230.0 #1		D	Subst	not solved	not solved	101.6%	105.7%	
CCB-OP-T-67	LOSBANOS -TT22105 230.0 #1		D	Subst	not solved	not solved	152.3%	139.7%	
CCB-OP-T-68	PANOCHE -GATES 230.0 #1&2		D	Subst	not solved	not solved	156.1%	223.4%	
CCB-OP-T-69	HENTAP1 - TT22128 230.0 #1		D	Subst	not solved	not solved	<95%	120.6%	
CCB-OP-T-70	STOREY 1-BORDEN 230.0 # 2		D	Subst	not solved	not solved	139.3%	<95%	
CCB-OP-T-71	STOREY 2-BORDEN 230.0 # 1		D	Subst	not solved	not solved	115.5%	<95%	
CCB-OP-T-72	STOREY 1-WILSON 230.0 # 1		D	Subst	not solved	not solved	120.1%	<95%	
CCB-OP-T-73	STOREY 2-WILSON 230.0 # 1		D	Subst	not solved	not solved	112.6%	<95%	

Thermal Overloads. Off-Peak

ID	Overloaded Facility	Contingency	Category	Category Description	Loading (%)				Potential Mitigation Solutions
					2017 Spring Off-pk Wet	2017 Winter-Off-pk Dry	2022 Spring Off-pk Wet	2022 Winter-Off-pk Dry	
CCB-OP-T-74	BORDEN-GREGG 230		D	Subst	not solved	not solved	139.2%	<95%	
CCB-OP-T-75	WESTLEY-LOS BANOS 230.0 #1	Tesla 500 kV Substation	D	Subst	106.1%	105.9%	N/A	N/A	upgrade or congestion management
CCB-OP-T-76	WESTLEY - TT22105 230.0 #1		D	Subst	N/A	N/A	109.4%	<95%	
CCB-OP-T-77	WARNERVL -WILSON 230.0 #1		D	Subst	<95%	<95%	100.7%	<95%	
CCB-OP-T-78	GATES - MIDWAY 230.0 #1	Midway 500 kV Substation	D	Subst	not solved	203.8%	<95%	not solved	use S-N RAS for high S-N flow
CCB-OP-T-79	ARCO - MIDWAY 230.0 #1		D	Subst	not solved	175.8%	<95%	not solved	use S-N RAS for high S-N flow
CCB-OP-T-80	GATES - ARCO 230.0 #1		D	Subst	not solved	153.5%	<95%	not solved	use S-N RAS for high S-N flow
CCB-OP-T-81		Midway 230 kV Substation	D	Subst	not solved	not solved	not solved	not solved	trip 115 kV load at Midway
CCB-OP-T-82	NOT SOLVED	NE SE SEPARATION	D	sys sep	not solved	not solved	not solved	not solved	system separation according the the scheme
CCB-OP-T-83		Midway 500 kV Substation	D	subst	not solved	solved	solved	not solved	use S-N RAS for high S-N flow
CCB-OP-T-84		Midway 230 kV Substation	D	subst	not solved	not solved	not solved	not solved	trip 115 kV load at Midway
CCB-OP-T-85		Los Banos 500 kV Substation	D	subst	not solved	not solved	solved	solved	trip 1 Diablo unit
CCB-OP-T-86		Path 26	D	corridor	solved	solved	solved	not solved	use S-N RAS for high S-N flow

Study Area: **PG&E Bulk - Central California Study**

Voltage Deviations

ID	Substation	Contingency	Category	Category Description	Post Cont. Voltage Deviation %				Potential Mitigation Solutions
					2017 Summer Peak Dry	2017 Summer Partial Peak Dry	2022 Summer Peak Dry	2022 Summer Partial Peak Dry	
CCB-VD-P-1	Substations in Northwest , deviation up in partial peak, up to 6%	PDCI BI-pole outage	B	PDCI	<-5%	<-5%	-6.0%	-6.1%	trip capacitors at wind plants, consider exemption for deviation up for PDCI outage

Study Area: PG&E Bulk - Central California Study

Voltage Deviations

ID	Substation	Contingency	Category	Category Description	Post Cont. Voltage Deviation %				Potential Mitigation Solutions
					2017 Spring Off-pk Wet	2017 Winter-Off-pk Dry	2022 Spring Off-pk Wet	2022 Winter-Off-pk Dry	
CCB-VD-OP-1	Substations in Northwest , deviation up in partial peak, up to 6%	PDCI BI-pole outage	B	PDCI	<5%	<5%	up to -7.1%	up to -6.7%	trip capacitors at wind plants, consider exemption for deviation up for PDCI outage

Transient Stability

ID	Contingency	Category	Category Description	Transient Stability Performance				Potential Mitigation Solutions
				2017 Summer Peak Dry	2017 Summer Partial Peak Dry	2022 Summer Peak Dry	2022Summer Partial Peak Dry	
CCB-P-TS-1	3-phase fault Midway-Kern # 1 (Stockdale1) 230 kV	B	L-1	freq. violations in Midway-Wheeler Rdg area, oscillations at Windgap pumps, vlt dip at Windgap 2 up to 50%, Windgap 2 tripped by relay	oscillations on Midway pumps, frq and vlt violations	freq. violations in Midway-Wheeler Rdg area, oscillations at Windgap pumps, vlt dip at Windgap 2 up to 35.2%	freq. violations in Midway-Wheeler Rdg area, oscillations at Windgap pumps, vlt dip at Windgap 2 up to 40.2%, Windgap3 27.7%	trip Windgap2 pumps with a fault on Midway 230, consider exemption for slow frequency and voltage recovery or install dynamic device
CCB-P-TS-2	3-phase fault Midway-Kern # 2 (Stockdale2) or # 3 230 kV	B	L-1		oscillations on Midway pumps, frq and vlt violations			
CCB-P-TS-3	3-phase fault Midway-Gates 230 kV or any Cat B contingency with three-phase fault on Midway 230 kV	B	L-1		oscillations on Midway pumps, frq and vlt violations			
CCB-P-TS-4	3-phase fault Contra Costa-Las Positas 230 kV or any outage with three-phase fault on Contra Costa	B	L-1	4 wind units at Birds Landing tripped for undervoltage	4 wind units at Birds Landing tripped for undervoltage	3 wind generators type 2 at Birds Lndg tripped for under-vlt	2 wind generators type 2 at Birds Lndg tripped for under-vlt	these are existing wind generators that don't have Low Voltage Ride Through capability
CCB-P-TS-5	3-phase fault Gates-Gregg 230 kV or any other outage with a three-phase fault on Gates 230 kV	B	L-1	underfreq ld trip and freq violations at Gates 115 kV	underfreq ld trip and freq violations at Gates 115 kV	Frequency violations at Gates 115 kV	Frequency violations at Gates 115 kV	get detailed load model at Gates 115 kV. If detailed studies confirm the issue, install SVC at Gates 115 kV or move load to 70 kV
CCB-P-TS-6	3-phase fault Gates-Gregg, Gates-Mc Call or any other single or double outage with a 3-phase fault on Gates 230 kV	C	L-2	underfreq ld trip and freq violations at Gates 115 kV	underfreq ld trip and freq violations at Gates 115 kV	Frequency violations at Gates 115 kV	Frequency violations at Gates 115 kV and underfrq load tripping	
CCB-P-TS-7	3-phase fault Contra Costa-Las Positas & C Cos-Lone Tree 230 kV or any contingency with a three-phase fault at Contra Costa 230 kV	C	L-2	4 wind units at Birds Landing tripped for undervoltage	4 wind units at Birds Landing tripped for undervoltage	3 wind generators type 2 at Birds Lndg tripped for under-vlt	2 wind generators type 2 at Birds Lndg tripped for under-vlt	these are existing wind generators that don't have Low Voltage Ride Through capability
CCB-P-TS-8	3-phase fault Contra Costa-Brentwood and C Costa-Delta 230 kV or any contingency with a three-phase fault at Contra Costa 230 kV	C	L-2	4 wind units at Birds Landing tripped for undervoltage	4 wind units at Birds Landing tripped for undervoltage	3 wind generators type 2 at Birds Lndg tripped for under-vlt	2 wind generators type 2 at Birds Lndg tripped for under-vlt	these are existing wind generators that don't have Low Voltage Ride Through capability

Transient Stability

ID	Contingency	Category	Category Description	Transient Stability Performance				Potential Mitigation Solutions
				2017 Summer Peak Dry	2017 Summer Partial Peak Dry	2022 Summer Peak Dry	2022Summer Partial Peak Dry	
CCB-P-TS-9	3-phase fault Gates-Arco and Gates-Midway 230 kV or any contingency with a three-phase fault at Gates 230 kV	C	L-2	underfreq ld trip and freq violations at Gates 115 kV	underfreq ld trip and freq violations at Gates 115 kV	underfreq ld trip and freq violations at Gates 115 kV	underfreq ld trip and freq violations at Gates 115 kV	get detailed load model at Gates 115 kV. If detailed studies confirm the issue, install SVC at Gates 115 kV or move load to 70 kV
CCB-P-TS-10	3-phase fault Midway-Kern #3 and 4 230 kV or any Cat C contingency with a three-phase fault at Midway230 kV	C	L-2	freq. violations in Midway-Wheeler Rdg area, oscillations at Windgap pumps, vlt dip at Windgap 2 up to 49%	no issues	freq. violations in Midway-Wheeler Rdg area, oscillations at Windgap pumps, vlt dip at Windgap 2 up to 35%	freq. violations in Midway-Wheeler Rdg area, oscillations at Windgap pumps, vlt dip at Windgap 2 up to 39.9%	trip Windgap2 pumps with a fault on Midway 230, or install dynamic device
CCB-P-TS-11	outage of two Palo Verde units no fault	D	G-2	no issues	no issues	2 induction motors at Rosebud in NM tripped for under-vlt, large vlt dips in NW	2 induction motors at Rosebud in NM tripped for under-vlt, large vlt dips in NW	acceptable for Cat D
CCB-P-TS-12	outage of two San Onofre units no fault	D	G-2	no issues	no issues	3 generators at Otay Mesa in SDG&E tripped for over-vlt	3 generators at Otay Mesa in SDG&E tripped for over-vlt	acceptable for Cat D
CCB-P-TS-13	3-phase fault Northeast-Southeast separation	D	corridor	system separation, under and over-voltage and frequency load shedding and generation tripping	system separation, under and over-voltage and frequency load shedding and generation tripping	system separation, under and over-voltage and frequency load shedding and generation tripping	system separation, under and over-voltage and frequency load shedding and generation tripping	no cascading outages
CCB-P-TS-14	Path 26 outage with 3-phase fault	D	corridor	Stable with RAS, local oscillations in New Mexico	stable w/RAS, no issues	large vlt dips in New Mex and S. Cal	no issues	acceptable for Cat D

Transient Stability

ID	Contingency	Category	Category Description	Transient Stability Performance				Potential Mitigation Solutions
				2017 Summer Peak Dry	2017 Summer Partial Peak Dry	2022 Summer Peak Dry	2022Summer Partial Peak Dry	
CCB-P-TS-15	Outage of Midway 500 kV substation with 3-phase fault	D	substation	large Vlt and Frq dips, load and gen tripping, stable	no issues, acceptable for Cat D	large voltage and freq dips around Midway	large voltage and freq dips around Midway, Windgap2 pumps and 2 small gen on Midway 70 kV tripped for undervlt	use S-N RAS for high S-N flow
CCB-P-TS-16	Outage of Midway 230 kV substation with 3-phase fault	D	substation	Large vlt and frq dips, acceptable for Cat D	Large vlt and frq dips, acceptable for Cat D	diverged	large voltage and freq dips around Midway	trip 115 kV load in Midway area

Transient Stability

ID	Contingency	Category	Category Description	Transient Stability Performance				Potential Mitigation Solutions
				2017 Spring Off-pk Wet	2017 Winter-Off-pk Dry	2022 Spring Off-pk Wet	2022 Winter-Off-pk Dry	
CCB-OP-TS-1	Captain Jack-Olinda 500 kV	B	L-1	no issues	no issues	40344 DETROIT tripped for over-excitation, vlt dip up to 27.2% Celilo 230	vlt dip up to 27.0% Celilo 230	change Detroit Overexcitation limiter settings, consider exemption for Celilo
CCB-OP-TS-2	Malin-Round Mtn 500 kV # 1 or 2	B	L-1	no issues	no issues			
CCB-OP-TS-3	Round Mtn 500/230 kV	B	T-1	no issues	no issues	40344 DETROIT tripped for over-excitation, also trips with Cat. C	no issues	change Detroit Overexcitation limiter settings
CCB-OP-TS-4	Round Mtn -Table Mtn 500 kV # 1 or 2	B	L-1	no issues	no issues		no issues	
CCB-OP-TS-5	Table Mtn-Tesla 500 kV	B	L-1	no issues	no issues		no issues	
CCB-OP-TS-6	Table Mtn-Vaca Dixon 500 kV	B	L-1	no issues	no issues		no issues	
CCB-OP-TS-7	Tesla-Los Banos 500 kV	B	L-1	no issues	no issues		no issues	
CCB-OP-TS-8	Tesla 500/230 kV	B	T-1	no issues	no issues		no issues	
CCB-OP-TS-9	Tesla -Metcalf 500 kV	B	L-1	no issues	no issues		no issues	
CCB-OP-TS-10	Table Mtn 500/230 kV transfromer w/SPS	B	T-1	frequency violations in Table Mtn area	no issues	40344 DETROIT tripped for over-excitation, freq violations in Table Mtn-Rio Oso area	no issues	modify RAS for off-peak wet
CCB-OP-TS-11	3-phase fault Newark-Ravenswood 230 kV	B	L-1	2 wind units at Birds Lndg tripped for undevoltage	no issues	2 wind generators type 2 at Birds Lndg tripped for under-vlt	no issues	the existing units (Shilo 1 & 2) don't have Low Voltage Ride Through capability

Transient Stability

ID	Contingency	Category	Category Description	Transient Stability Performance				Potential Mitigation Solutions
				2017 Spring Off-pk Wet	2017 Winter-Off-pk Dry	2022 Spring Off-pk Wet	2022 Winter-Off-pk Dry	
CCB-OP-TS-12	3-phase fault Midway-Kern # 1 (Stockdale1) 230 kV	B	L-1	oscillations on Midway pumps, volt and freq violations	oscillations on Midway pumps, frequency violations	freq. violations in Midway-Wheeler Rdg area, oscillations at Windgap pumps, vlt dip at Windgap 2 up to 35.2%	freq. violations in Midway-Wheeler Rdg area, oscillations at Windgap pumps, vlt dip at Windgap 2 up to 37.3%, Windgap 3 27.2%	trip Windgap2 pumps with a fault on Midway 230, consider exemption for slow frequency and voltage recovery or install dynamic device
CCB-OP-TS-13	3-phase fault Midway-Kern # 2 (Stockdale2) or # 3 230 kV	B	L-1		oscillations on Midway pumps, frequency violations			
CCB-OP-TS-14	3-phase fault Midway-Gates 230 kV or any Cat B contingency with three-phase fault on Midway 230 kV	B	L-1	oscillations on Midway pumps, frequency violations, Windgap2 tripped	oscillations on Midway pumps, frq and vlt violations Windgap2 tripped			
CCB-OP-TS-15	3-phase fault Contra Costa-Las Positas 230 kV or any outage with three-phase fault on Contra Costa	B	L-1	3 wind units at Birds Landing tripped for undervoltage	3 wind units at Birds Landing tripped for undervoltage	3 wind generators type 2 at Birds Lndg tripped for under-vlt	3 wind generators type 2 at Birds Lndg tripped for under-vlt	these are existing wind generators that don't have Low Voltage Ride Through capability
CCB-OP-TS-16	3-phase fault Tesla-Newark 230 kV	B	L-1	3 wind units at Birds Lndg tripped for undevoltage	no issues	3 wind generators type 2 at Birds Lndg tripped for under-vlt	2 wind generators type 2 at Birds Lndg tripped for under-vlt	the existing units don't have Low Voltage Ride Through capability
CCB-OP-TS-17	3-phase fault Newark-Ravenswood 230 kV	B	L-1	no issues	no issues	2 wind generators type 2 at Birds Lndg tripped for under-vlt	no issues	the existing units don't have Low Voltage Ride Through capability
CCB-OP-TS-18	3-phase fault Gates-Gregg 230 kV or any other outage with a three-phase fault on Gates 230 kV	B	L-1	underfreq ld trip and freq violations at Gates 115 kV	underfreq ld trip and freq violations at Gates 115 kV	underfreq ld trip and freq violations at Gates 115 kV	underfreq ld trip and freq violations at Gates 115 kV	get detailed load model at Gates 115 kV. If detailed studies confirm the issue, install SVC at Gates 115 kV or move load to 70 kV
CCB-OP-TS-19	3-phase fault Gates-Gregg, Gates-Mc Call or any other single or double outage with a 3-phase fault on Gates 230 kV	C	L-2	underfreq ld trip and freq violations at Gates 115 kV	underfreq ld trip and freq violations at Gates 115 kV	underfreq ld trip and freq violations at Gates 115 kV	underfreq ld trip and freq violations at Gates 115 kV	

Transient Stability

ID	Contingency	Category	Category Description	Transient Stability Performance				Potential Mitigation Solutions
				2017 Spring Off-pk Wet	2017 Winter-Off-pk Dry	2022 Spring Off-pk Wet	2022 Winter-Off-pk Dry	
CCB-OP-TS-20	3-phase fault Contra Costa-Las Positas & C Cos-Lone Tree 230 kV or any contingency with a three-phase fault at Contra Costa 230 kV	C	L-2	3 wind units at Birds Landing tripped for undervoltage	3 wind units at Birds Landing tripped for undervoltage	3 wind generators type 2 at Birds Lndg tripped for under-vlt	3 wind generators type 2 at Birds Lndg tripped for under-vlt	these are existing wind generators that don't have Low Voltage Ride Through capability
CCB-OP-TS-21	3-phase fault Contra Costa-Brentwood and C Costa-Delta 230 kV or any contingency with a three-phase fault at Contra Costa 230 kV	C	L-2	3 wind units at Birds Landing tripped for undervoltage	3 wind units at Birds Landing tripped for undervoltage	3 wind generators type 2 at Birds Lndg tripped for under-vlt	3 wind generators type 2 at Birds Lndg tripped for under-vlt	these are existing wind generators that don't have Low Voltage Ride Through capability
CCB-OP-TS-22	3-phase fault Gates-Arco and Gates-Midway 230 kV or any contingency with a three-phase fault at Gates 230 kV	C	L-2	underfreq ld trip and freq violations at Gates 115 kV	underfreq ld trip and freq violations at Gates 115 kV	Frequency violations at Gates 115 kV	Frequency violations at Gates 115 kV	get detailed load model at Gates 115 kV. If detailed studies confirm the issue, install SVC at Gates 115 kV or move load to 70 kV
CCB-OP-TS-23	3-phase fault Midway-Kern #3 and 4 230 kV or any Cat C contingency with a three-phase fault at Midway230 kV	C	L-2	oscillations on Windgap pumps, Windgap 2 tripped	oscillations on Windgap pumps, Windgap 2 tripped	freq. violations in Midway-Wheeler Rdg area, oscillations at Windgap pumps, vlt dip at Windgap 2 up to 35%	freq. violations in Midway-Wheeler Rdg area, oscillations at Windgap pumps, vlt dip at Windgap 2 up to 36.8%	trip Windgap2 pumps with a fault on Midway 230, or install dynamic device
CCB-OP-TS-24	outage of two Diablo units no fault	D	G-2	no issues	no issues	gen GLCRWNDG (Induction generator) in Montana tripped for undervoltage	gen GLCRWNDG (Induction generator) in Montana tripped for undervoltage	acceptable for Cat D
CCB-OP-TS-25	outage of two Palo Verde units no fault	D	G-2	no issues	no issues			acceptable for Cat D
CCB-OP-TS-26	3-phase fault Northeast-Southeast separation	D	corridor	system separation, under and over-voltage and frequency load shedding and generation tripping	system separation, under and over-voltage and frequency load shedding and generation tripping	system separation, under and over-voltage and frequency load shedding and generation tripping	system separation, under and over-voltage and frequency load shedding and generation tripping	no cascading outages

Transient Stability

ID	Contingency	Category	Category Description	Transient Stability Performance				Potential Mitigation Solutions
				2017 Spring Off-pk Wet	2017 Winter-Off-pk Dry	2022 Spring Off-pk Wet	2022 Winter-Off-pk Dry	
CCB-OP-TS-27	Path 26 outage with 3-phase fault	D	corridor	no issues, acceptable for Cat D	Helms pumps tripped for underfrq, large vlt and freq dips	no issues	large vlt dips in Idaho and Montana	acceptable for Cat D
CCB-OP-TS-28	Outage of Midway 500 kV substation with 3-phase fault	D	substation	no issues, acceptable for Cat D	unstable	no issues	unstable	use Path 26 S-N SPS for high S-N flow
CCB-OP-TS-29	Outage of Midway 230 kV substation with 3-phase fault	D	substation	over frq gen tripping around Midway, large vlt and frq dips	load and gen tripping around Midway, oscillations	diverged	diverged	trip load in 115 kV Midway system

Appendix D-3
PG&E Central CA Study - Local

Study Area: **Central CA Study - Summer Peak**

Thermal Overloads

ID	Overloaded Facility	Contingency	Category	Category Description	Loading (%)				Potential Mitigation Solutions
					2017 Summer Peak Dry	2017 Summer Partial Peak Dry	2022 Summer Peak Dry	2022 Summer Partial Peak Dry	
CC-SP-T-1	Warnerville-Wilson 230kV Line	Base System (N-0)	A	Base Case	32.5%	116.9%	13.4%	139.6%	install series reactor, upgrade the line or congestion management
CC-SP-T-2	Warnerville-Wilson 230kV Line	Melones-North Merced 230kV Line	B	L-1	Not Rec	115.0%	Not Rec	147.4%	
CC-SP-T-3	Warnerville-Wilson 230kV Line	Gates #11 500/230kV Transformer	B	T-1	Not Rec	122.5%	Not Rec	145.0%	
CC-SP-T-4	Warnerville-Wilson 230kV Line	Gates-Gregg 230kV Line	B	L-1	Not Rec	123.3%	Not Rec	140.9%	
CC-SP-T-5	Warnerville-Wilson 230kV Line	Panoche-Kearney 230kV Line	B	L-1	Not Rec	120.3%	Not Rec	139.8%	
CC-SP-T-6	Warnerville-Wilson 230kV Line	McCall #2 230kV Bus Fault	C1	Bus	Not Rec	113.9%	Not Rec	136.3%	
CC-SP-T-7	Warnerville-Wilson 230kV Line	Kearney 230kV Bus Fault	C1	Bus	Not Rec	114.4%	Not Rec	133.9%	
CC-SP-T-8	Warnerville-Wilson 230kV Line	Herndon #1 230kV Bus Fault	C1	Bus	Not Rec	114.0%	Not Rec	133.0%	
CC-SP-T-9	Warnerville-Wilson 230kV Line	Panoche #1 230kV Bus Fault	C1	Bus	Not Rec	117.1%	Not Rec	132.7%	
CC-SP-T-10	Warnerville-Wilson 230kV Line	Los Banos #2 230kV Bus Fault	C1	Bus	Not Rec	114.7%	Not Rec	125.2%	
CC-SP-T-11	Warnerville-Wilson 230kV Line	Helm 230kV Bus Fault	C1	Bus	Not Rec	102.7%	Not Rec	124.9%	
CC-SP-T-12	Warnerville-Wilson 230kV Line	Panoche 230kV CB202	C2	Breaker	Not Rec	170.4%	Not Rec	196.0%	
CC-SP-T-13	Warnerville-Wilson 230kV Line	Gates 230kV CB312	C2	Breaker	Not Rec	129.0%	Not Rec	119.1%	
CC-SP-T-14	Gates #11 500/230kV Transformer	Panoche 230kV CB202	C2	Breaker	Not Rec	107.4%	Not Rec	128.0%	install second Gates 500/230 kV transfromer or use congestion management
CC-SP-T-15	Gates #11 500/230kV Transformer	Wilson-North Merced & Warnerville-Wilson 230kV Lines	C5	L-2	Not Rec	86.1%	Not Rec	100.8%	
CC-SP-T-16	Gates #11 500/230kV Transformer	Bellota-Melones & Warnerville-Wilson 230kV Lines	C5	L-2	Not Rec	89.1%	Not Rec	106.7%	

2012/2013 ISO Reliability Assessment - Central California Results

Study Area: Central CA Study - Off-Peak

Thermal Overloads

ID	Overloaded Facility	Contingency	Category	Category Description	Loading (%)				Potential Mitigation Solutions
					2017 Spring Off Peak Wet	2017 Winter Off Peak Dry	2022 Spring Off Peak Wet	2022 Winter Off Peak Dry	
CC-OP-T-1	Gates-Midway 230kV Line	Gates #11 500/230kV Transformer	B	T-1	Not Rec	116.5%	Not Rec	101.5%	use short term emergency rating
CC-OP-T-2	Warnerville-Wilson 230kV Line	Herndon #1 230kV Bus	C1	Bus	101.7%	Not Rec	98.5%	Not Rec	install series reactor, upgrade the line or congestion management
CC-OP-T-3	Borden-Gregg #1 230kV Line	Herndon #1 230kV Bus	C1	Bus	102.8%	Not Rec	96.1%	Not Rec	upgrade the line or use congestion management
CC-OP-T-4	Warnerville-Wilson 230kV Line	Panoche #2 230kV Bus	C1	Bus	104.7%	Not Rec	90.0%	Not Rec	install series reactor, upgrade the line or congestion management
CC-OP-T-5	Borden-Gregg #1 230kV Line	Panoche #2 230kV Bus	C1	Bus	100.6%	Not Rec	84.2%	Not Rec	upgrade the line or use congestion management
CC-OP-T-6	Panoche-Gates 230kV	Gates 230kV CB312	C2	Breaker	Not Rec	120.5%	Not Rec	77.0%	upgrade the line or use congestion management
CC-OP-T-7	Borden-Gregg #1 230kV Line	Panoche 230kV CB202	C2	Breaker	112.1%	Not Rec	103.5%	Not Rec	upgrade the line or use congestion management
CC-OP-T-8	Wilson-Le Grand 115kV Line	Wilson-Borden #1 & #2 230kV Lines	C5	L-2	Not Run	Not Run	118.4%	Not Rec	upgrade the line or use congestion management

2012/2013 ISO Reliability Assessment - Central California Results

Study Area: **Central CA Study - Summer Peak & Summer Partial Peak**

Voltage Deviations

ID	Substation	Contingency	Category	Category Description	Post Cont. Voltage Deviation %				Potential Mitigation Solutions
					2017 Summer Peak Dry	2017 Summer Partial Peak Dry	2022 Summer Peak Dry	2022 Summer Partial Peak Dry	

No deviations not previously addressed in Reliability Assessment.

2012/2013 ISO Reliability Assessment - Central California Results

Study Area: **Central CA Study - Off-Peak**

Voltage Deviations

ID	Substation	Contingency	Category	Category Description	Post Cont. Voltage Deviation %				Potential Mitigation Solutions
					2017 Spring Off Peak Wet	2017 Winter Off Peak Dry	2022 Spring Off Peak Wet	2022 Winter Off Peak Dry	

No deviations not previously addressed in Reliability Assessment.