Introduction

Neil Millar
Executive Director, Infrastructure Development

2012/2013 Transmission Planning Process Stakeholder Meeting
December 11-12, 2012

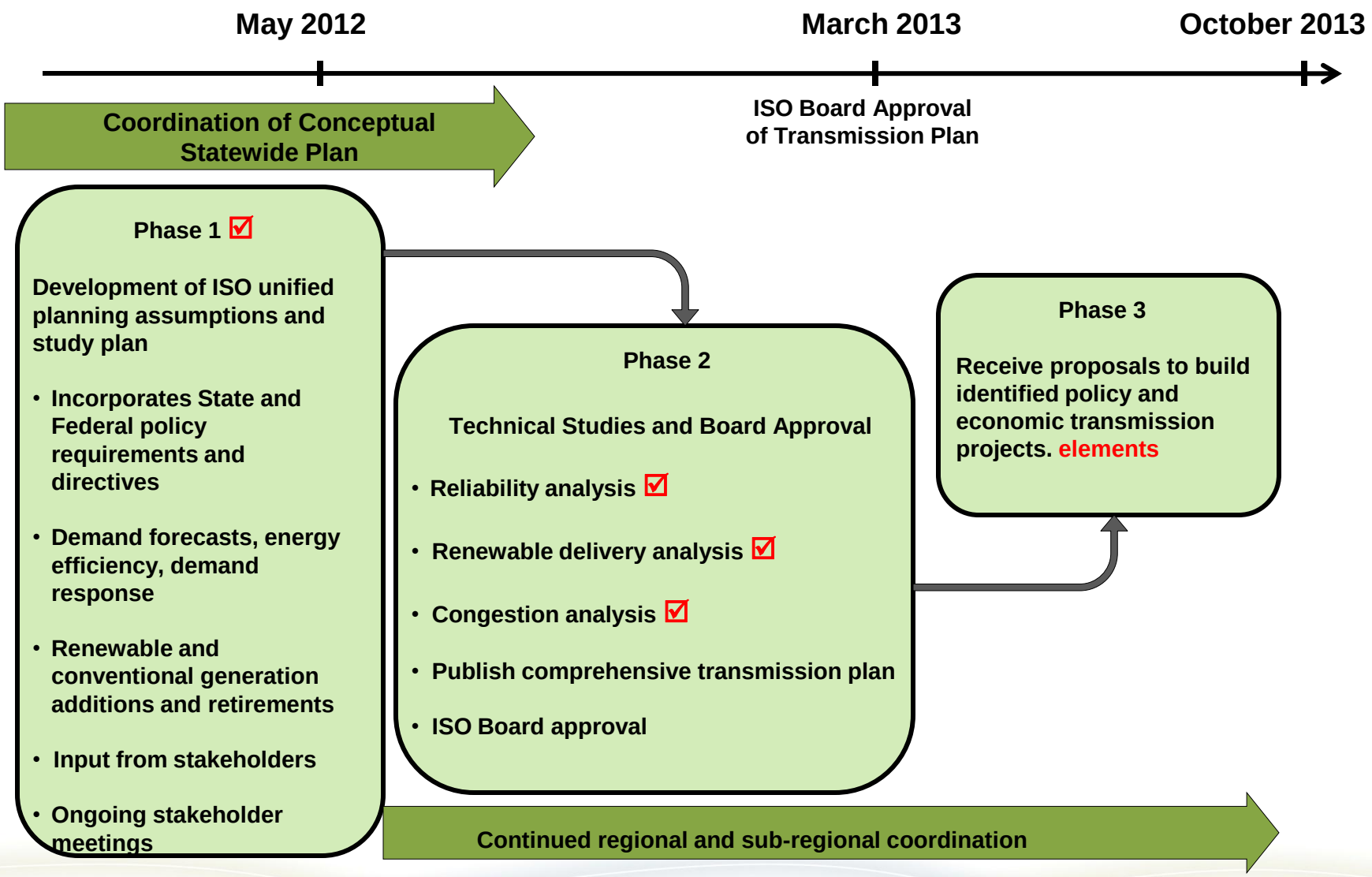
Today's Agenda – December 11th

Topic	Presenter
Opening	Tom Cuccia
Introduction	Neil Millar
Overview	Robert Sparks
Preliminary 33% RPS Results	ISO Regional Transmission Engineers
Deliverability Assessment	ISO Regional Transmission Engineers

Tomorrow's Agenda – December 12th

Topic	Presenter
Opening	Tom Cuccia
Central CA Study	Jeff Billinton
Economic Planning Study	Xiaobo Wang

Status of 2012/2013 Transmission Plan



2012/2013 Transmission Plan's Special Studies and Issues

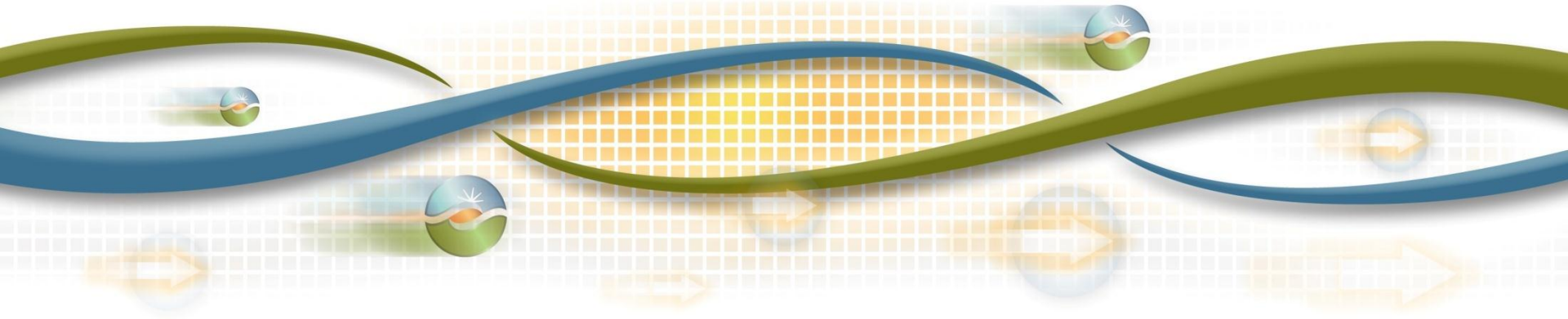
- Nuclear Studies
- Central California study
- Coolwater-Lugo Alternatives – examination of the AV Clearview alternative
- High Out-of-State Import Scenario
- Non-transmission Alternatives
- Input from Renewable Integration Studies
- Transmission Plan Impact on High Voltage TAC

California ISO
Shaping a Renewed Future

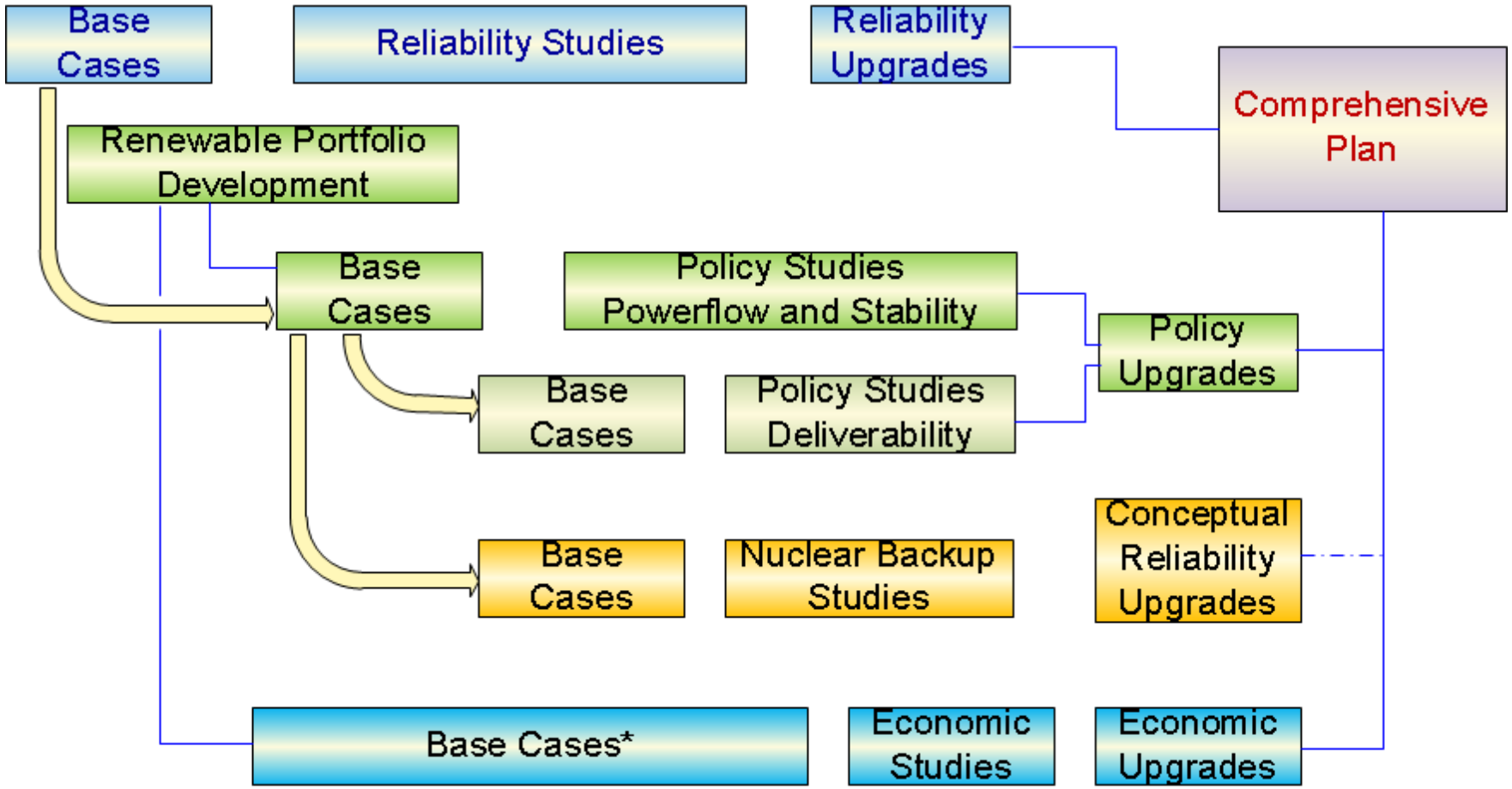
Overview of Transmission Planning Studies

Robert Sparks
Manager, Regional Transmission South

2012/2013 Transmission Planning Process Stakeholder Meeting
December 11-12, 2012



Overview of Transmission Planning Studies



* Includes reliability and policy upgrades

Policy Driven Planning Base Cases & Study Assumptions

Yi Zhang
Senior Regional Transmission Engineer

2012/2013 Transmission Planning Process Stakeholder Meeting
Policy-Driven & Economic Study Preliminary Results

December 11, 2012

Outline of this presentation

- Portfolios
- Basecase development
  - Modeling transmission and generation facilities
  - Modeling renewable portfolios
  - Generation dispatch
- Assessment methods

33% RPS portfolios for 2012/2013 – Commercial Interest (MW)

Zone	Biogas	Biomass	Geotherm	Hydro	Large Scal	Small Sola	Solar Ther	Wind	Grand Total
Alberta								450	450
Arizona					550				550
Baja								100	100
Carrizo South					900				900
Central Valley North		63			145				208
DG-NCA Muni						42			42
DG-SCA Muni						112			112
Distributed Solar - PG&E						1,005			1,005
Distributed Solar - SCE						487			487
Distributed Solar - SDGE						405			405
El Dorado					250		500		750
Imperial	15		474		1,356	30		265	2,140
Kramer			64		320	74	250	56	765
Los Banos					370				370
Merced	5				60				65
Mountain Pass					300		365		665
Nevada C			142						142
NonCREZ	104	7	15		56	72		3	256
Northwest								330	330
Palm Springs						16		182	198
Riverside East					800	5	701		1,506
Round Mountain									0
San Bernardino - Lucerne					45	19		42	106
San Diego South								384	384
Solano	3				28			474	505
Tehachapi	10				1,255	142		1,988	3,395
Westlands		49			1,293	158			1,500
Grand Total	136	119	695	0	7,728	2,567	1,816	4,274	17,335

33% RPS portfolios for 2012/2013 – Cost Constrained (MW)

Zone	Biogas	Biomass	Geotherm	Hydro	Large Scal	Small Sola	Solar Ther	Wind	Grand Total
Alberta								450	450
Arizona					550				550
Baja									0
Carrizo South					900				900
Central Valley North		63			235				298
DG-NCA Muni									0
DG-SCA Muni									0
Distributed Solar - PG&E						1,047			1,047
Distributed Solar - SCE						599			599
Distributed Solar - SDGE						405			405
El Dorado					250				250
Imperial	15		725		370	30			1,140
Kramer						20	42		62
Los Banos									0
Merced	5				15				20
Mountain Pass					680		365		1,045
Nevada C			142						142
NonCREZ	110	7	15		246	22		143	542
Northwest								330	330
Palm Springs						6		182	188
Riverside East					1,467		400		1,867
Round Mountain									0
San Bernardino - Lucerne					219			52	271
San Diego South								384	384
Solano	3				28			474	505
Tehachapi	10				2,501	57		1,998	4,566
Westlands	5	49			1,366	80			1,500
Grand Total	147	119	882	0	8,828	2,266	807	4,013	17,061

33% RPS portfolios for 2012/2013 – Environmentally constrained (MW)

Zone	Biogas	Biomass	Geotherm	Hydro	Large Scal	Small Sola	Solar Ther	Wind	Grand Total
Alberta								450	450
Arizona					550				550
Baja									0
Carrizo South					900				900
Central Valley North		63			235				298
DG-NCA Muni									0
DG-SCA Muni									0
Distributed Solar - PG&E						1,837			1,837
Distributed Solar - SCE						1,978			1,978
Distributed Solar - SDGE						426			426
El Dorado									0
Imperial	15		474		1,356	30		265	2,140
Kramer						2	62		64
Los Banos					370				370
Merced	5				60				65
Mountain Pass							365		365
Nevada C			116						116
NonCREZ	110	135	15	21	56	74		3	413
Northwest								290	290
Palm Springs						16		182	198
Riverside East					959	5	400		1,364
Round Mountain		34							34
San Bernardino - Lucerne	7				45	14		42	108
San Diego South								384	384
Solano	3				28			474	505
Tehachapi	10				1,255	122		1,988	3,375
Westlands		49			1,162	289			1,500
Grand Total	149	281	605	21	6,975	4,792	827	4,078	17,728

33% RPS portfolios for 2012/2013 – High DG(MW)

Zone	Biogas	Biomass	Geotherm	Hydro	Large Scal	Small Sola	Solar Ther	Wind	Grand Total
Alberta								450	450
Arizona					550				550
Baja									0
Carrizo South					900				900
Central Valley North		63			135				198
DG-NCA Muni						50			50
DG-SCA Muni						231			231
Distributed Solar - PG&E						3,591			3,591
Distributed Solar - SCE						2,995			2,995
Distributed Solar - SDGE						490			490
El Dorado					250		500		750
Imperial	15		725		370	30			1,140
Kramer						20	42		62
Los Banos									0
Merced	5				15				20
Mountain Pass					300		365		665
Nevada C			142						142
NonCREZ	104	7	15		56	22		3	206
Northwest								290	290
Palm Springs						6		77	83
Riverside East					1,234		276		1,510
Round Mountain									0
San Bernardino - Lucerne					145			42	187
San Diego South									0
Solano	3				28			474	505
Tehachapi	10				1,302	57		1,060	2,429
Westlands	0	49			861	80			990
Grand Total	136	119	882	0	6,146	7,572	1,183	2,396	18,434

Differences between portfolios present in CPUC/CEC's letter and used in the policy driven planning studies – Commercial Interest

CommInt				
Zone	In basecase	In letter	Diff	Note
Alberta	450	450	0	
Arizona	550	550	0	
Baja	100	100	0	
Carrizo South	900	900	0	
Central Valley North	208	183	25	Re-labeled 25 MW from NonCrez
DG-NCA Muni	42	0	42	Added for Muni
DG-SCA Muni	112	0	112	Added for Muni
Distributed Solar - PG&E	1,005	1047	-42	Replaced by Muni DG
Distributed Solar - SCE	487	599	-111	Replaced by Muni DG
Distributed Solar - SDGE	405	405	0	
El Dorado	750	400	350	VEA/Nevada permtting score adjustment
Imperial	2,140	2125	15	re-labeled from NonCrez
Kramer	765	762	2	re-labeled from NonCrez
Los Banos	370	370	0	
Merced	65	65	0	
Mountain Pass	665	665	0	
Nevada C	142	142	0	
NonCREZ	256	529	-273	Re-labeled to other zones
Northwest	330	330	0	
Palm Springs	198	198	0	
Riverside East	1,506	1400	106	Added to match Energy
Round Mountain	0	0	0	
San Bernardino - Lucerne	106	101	6	re-labeled from NonCrez
San Diego South	384	384	0	
Solano	505	535	-30	re-labeled to Central Valley North and NonCrez
Tehachapi	3,395	3390	5	re-labeled from NonCrez
Westlands	1,500	1500	0	
Grand Total	17,335	17130	206	

Differences between portfolios present in CPUC/CEC's letter and used in the policy driven planning studies – Cost Constrained

Cost Zone	In Basecas	In letter	Difference	Note
Alberta	450	450	0	
Arizona	550	550	0	
Baja	0	0	0	
Carrizo South	900	900	0	
Central Valley North	298	268	30	Re-labeled from Solano to Central Valley North
DG-NCA Muni	0	0	0	
DG-SCA Muni	0	0	0	
Distributed Solar - PG&E	1,047	1,047	0	
Distributed Solar - SCE	599	599	0	
Distributed Solar - SDGE	405	405	0	
El Dorado	250	0	250	Re-labeled from NonCrez to El Dorado
Imperial	1,140	1,125	15	Re-labeled from NonCrez to Imperial
Kramer	62	62	0	
Los Banos	0	0	0	
Merced	20	20	0	
Mountain Pass	1,045	1,045	0	
Nevada C	142	142	0	
NonCREZ	542	1,077	-535	re-labeled to other zones based on the location information
Northwest	330	330	0	
Palm Springs	188	188	0	
Riverside East	1,867	1,400	467	Re-labeled 250 MW from NonCrez; Added 217 MW to match net short energy
Round Mountain	0	0	0	
San Bernardino - Lucerne	271	261	10	Re-labeled from NonCrez to SB-Lucerne
San Diego South	384	384	0	
Solano	505	535	-30	Re-labeled to Central Valley North
Tehachapi	4,566	4,556	10	Re-labeled from NonCrez
Westlands	1,500	1,500	0	
Grand Total	17,061	16,844	217	

Differences between portfolios present in CPUC/CEC's letter and used in the policy driven planning studies – Environmentally Constrained

Env				
Zone	In basecase	In letter	Difference	Note
Alberta	450	450	0	
Arizona	550	550	0	
Baja	0	0	0	
Carrizo South	900	900	0	
Central Valley North	298	268	30	Re-labeled 30 MW from NonCrez
DG-NCA Muni	0	0	0	
DG-SCA Muni	0	0	0	
Distributed Solar - PG&E	1,837	1,837	0	
Distributed Solar - SCE	1,978	1,978	0	
Distributed Solar - SDGE	426	426	0	
El Dorado	0	0	0	
Imperial	2,140	2,125	15	re-labeled from NonCrez
Kramer	64	62	2	re-labeled from NonCrez
Los Banos	370	370	0	
Merced	65	65	0	
Mountain Pass	365	365	0	
Nevada C	116	116	0	
NonCREZ	413	655	-242	
Northwest	290	290	0	
Palm Springs	198	198	0	
Riverside East	1,364	805	559	Added to match Energy
Round Mountain	34	34	0	
San Bernardino - Lucerne	108	108	0	
San Diego South	384	384	0	
Solano	505	535	-30	re-labeled to Central Valley North
Tehachapi	3,375	3,370	5	
Westlands	1,500	1,500	0	
Grand Total	17,728	17,390	339	

Differences between portfolios present in CPUC/CEC's letter and used in the policy driven planning studies – High DG

HDG				
Zone	In basecase	In letter	Difference	Note
Alberta	450	450	0	
Arizona	550	550	0	
Baja	0	0	0	
Carrizo South	900	900	0	
Central Valley North	198	168	30	Re-labeled 30 MW from NonCrez
DG-NCA Muni	50	0	50	Added for Muni
DG-SCA Muni	231	0	231	Added for Muni
Distributed Solar - PG&E	3,591	3641	-50	Replaced by Muni DG
Distributed Solar - SCE	2,995	3226	-231	Replaced by Muni DG
Distributed Solar - SDGE	490	490	0	
El Dorado	750	0	750	Re-labeled 250 MW from NonCrez; Added 500 MW to match Energy
Imperial	1,140	1125	15	re-labeled from NonCrez
Kramer	62	62	0	
Los Banos	0	0	0	
Merced	20	20	0	
Mountain Pass	665	665	0	
Nevada C	142	142	0	
NonCREZ	206	721	-515	Re-labeled to other zones
Northwest	290	290	0	
Palm Springs	83	83	0	
Riverside East	1,510	1060	450	Added to match Energy
Round Mountain	0	0	0	
San Bernardino - Lucerne	187	187	0	
San Diego South	0	0	0	
Solano	505	535	-30	re-labeled to Central Valley North
Tehachapi	2,429	2429	0	
Westlands	990	990	0	
Grand Total	18,434	17734	700	

Basecase development

- Starting from consolidated 2022 reliability assessment basecases
- 1-in-5 coincident peak load forecast for 2022 from CEC, and load distribution from PTOs
- 50% of peak load for off peak studies
- Four 33% RPS portfolios
  - Commercial Interest (Base portfolio)
  - Environmentally constrained portfolio
  - Cost constrained portfolio
  - High DG portfolio

Basecase Development – CPUC and ISO board approved new transmission

- Tehachapi Renewable Transmission Projects (TRTP, CPUC approved)
- Eldorado – Ivanpah 230kV lines (EITP, CPUC approved)
- Colorado River substation and Colorado River – Valley 500kV line (CPUC approved)
- Mirage – Devers 230 kV lines upgrades (ISO board approved 2010/2011 Category 1 upgrade)

Basecase Development – New transmission in executed LGIA and needed by generation in portfolios

All transmission upgrades from the 2022 Reliability Assessment Base cases were modeled. For example:

- Humboldt 60 kV upgrade
- South Contra Costa upgrades
- Borden – Gregg reconductoring
- Carrizo switching station and Carrizo – Midway reconductoring
- Whirlwind #2 500/230 kV transformer
- West of Devers upgrades
- Red Bluff substation
- East County (ECO) substation

Additional Upgrades included in Policy Assessment Base Cases:

- Whirlwind #3 500/230 kV transformer

Basecase Development – Other new transmission

- Transmission upgrades identified and approved by ISO in previous planning cycles
- Transmission upgrades in other areas to interconnect and deliver renewable generation in 33% RPS portfolios
  - Path 42 (IID – SCE)
  - IID Imperial Valley (IID – SDGE)

Basecase Development – New conventional generation

All new generation from the 2022 Reliability Assessment Base cases were modeled. For example:

- Marsh Landing (760 MW)
- Russell City Energy Center (600 MW)
- Oakley Generating Station (624 MW)
- Lodi Energy Center (280 MW)
- GWF Tracy Combined Cycle (145 MW)
- Los Esteros Combined Cycle (140 MW)
- Mariposa Energy Project (184 MW)
- Walnut Creek Energy Center (500 MW)
- Canyon Power Plant (200 MW)
- NRG El Segundo Repowering Project (570 MW)
- Sentinel Peaker Project (850 MW)

Basecase development – Model renewable generators in power flow basecases

- Modeled CPUC's portfolios in transmission planning power flow model
- Representative GIP study data used if an equivalent resource could be matched; otherwise generic model and data were used
- Model distributed generation in CPUC's portfolios connected directly to substations in transmission model

Basecase development – Dynamic data of new renewables

- Representative GIP study data used if an equivalent resource could be matched;
- Otherwise generic model and data were used
  - Synchronous machines (geothermal, biomass, biogas, solar thermal) use typical models that have been used for units with same technology and similar size
  - Wind turbine generators use Type 3
  - Solar PV use Type 4

Basecase development - Dispatch

- Snapshots from production cost simulation results were used as reference for boundary stressed patterns during peak and off-peak load hours
  - Renewable output
  - Import
- Existing conventional generators
  - Dispatched based on variable cost to balance load and maintain path flows
  - Local constraints were considered
  - Peakers were shut off first unless are needed to mitigate normal overload
- Engineering judgment based on historical data and local reliability requirement

Basecase development - Scenarios

Portfolio	Load scenario	New renewable output (MW)	Path 49	Path 26	Path 15	Path 66	Path 65
CommInt	Peak	10439	5375	660	2260	4110	3087
CommInt	Off peak	13507	2350	-2943	4651	-2055	0
Cost	Peak	10226	5404	585	2274	4120	3084
Cost	Off peak	13495	2368	-2959	4166	-1873	0
Env	Peak	10636	5437	223	2746	4195	3096
Env	Off peak	13502	2372	-2999	4262	-2299	0
HDG	Off peak	13940	-91	1451	367	1456	0

Assessment methods

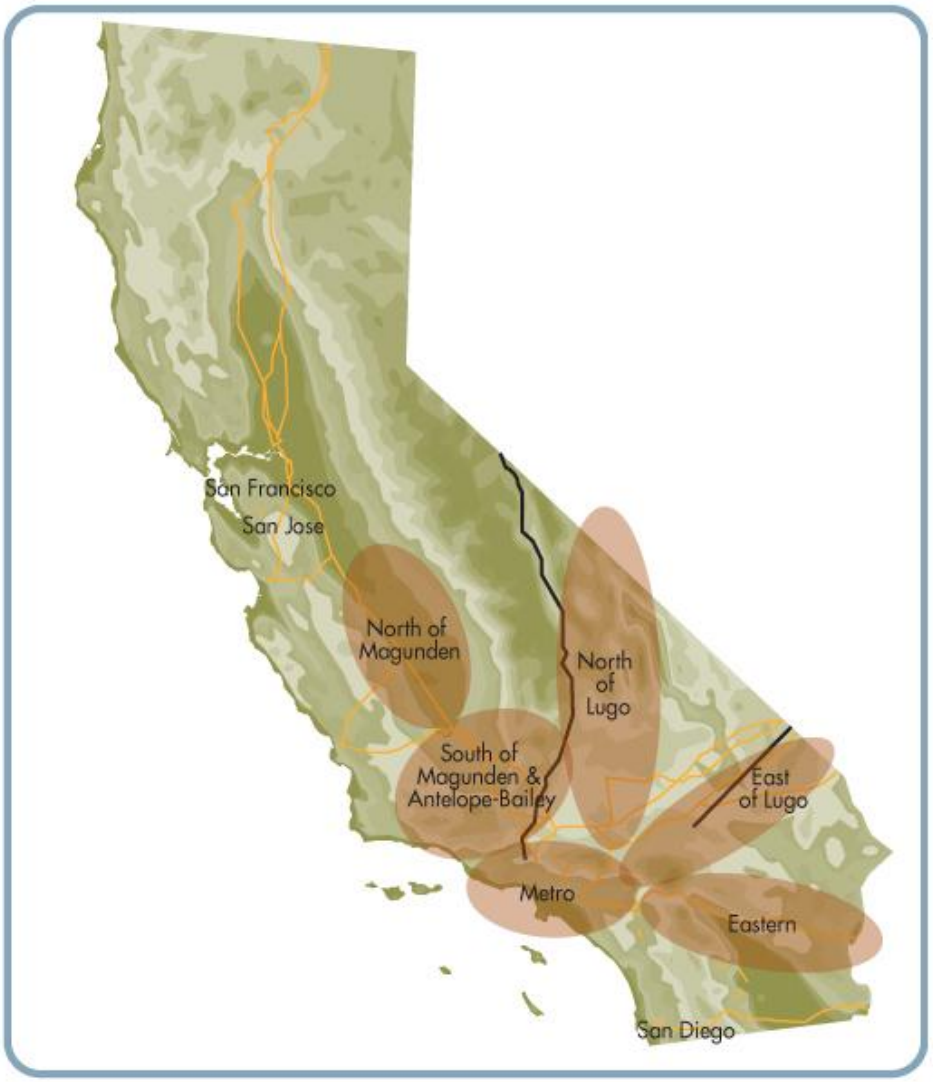
- Power flow and stability assessments
  - Contingency analysis based on power flow
    - All Category B
    - Selected Category 3, and all other Category C
  - Post-transient and Transient simulations
    - Same contingencies that simulated in the NERC compliance reliability assessments
    - Additional contingencies for the anticipated changes in the system
    - Extreme outages that may impact system-wide stability, e.g. Nuclear units G-2
  - Criteria
    - NERC/WECC/CAISO planning standards
    - Overloads and voltage issues that were worse than in NERC compliance reliability assessments have been reported

SCE Policy Driven Powerflow and Stability Results

Sanjay Patil
Regional Transmission Engineer

2012/2013 Transmission Planning Process Stakeholder Meeting
December 11-12, 2012

Study Area (SCE Service Area)



Study Overview

- Seven study cases representing:
  - Four RPS portfolios: Cost-Constrained, Commercial-Interest, Environmentally-Constrained, and High Distributed-Generation
  - Two load levels: Peak, Off-peak (except for HDG)
- Results:
  - Some new or increased thermal, voltage and stability related constraints primarily in the North of Lugo Area
- Possible Solutions:
  - Upgrade phase shifter, upgrade series capacitor, power factor control, new SVD, new and modify SPS's;
  - Reconfigure line to classify outage as L-1-1, reconductor line.

RPS Generation modeled in SCE Area

CREZ	HDG	Env.	CommInt	Cost
Kramer	62	64	765	62
DG	2,995	1,978	487	599
El Dorado	750	0	750	250
Mountain Pass	665	365	665	1,045
Non CREZ	103	114	107	109
Palm Springs	83	198	198	188
Riverside East	1,510	1,364	1,506	1,867
San Bernardino – Lucerne	187	108	106	271
Tehachapi	2,429	3,375	3,395	4,566
Total SCE	8,784	7,566	7,979	8,957

Thermal Overloads and Mitigation (Peak)

Overloaded Facility	Contingency	Flow			Mitigation
		CC	CI	ENV	
COLWATER - TT22409 115 kV	All elements in service (N-0)	<100%	197%	<100%	Localized concern that should be addressed by GIP.
CONTROL - INYO 115 kV			105%		Upgrade INYO PS phase shifter.
INYO - INYO PS 115 kV			151%		
INYOKERN - KRAMER 115 kV			101%		Install SVD in INYOKERN 115 kV area (preferred) or Reconductor INYOKERN 115 kV - KRAMER 115 kV.

Thermal Overloads and Mitigation (Peak)

Overloaded Facility	Contingency	Flow			Mitigation
		CC	CI	ENV	
N/A	IVANPAH - ELDORDO02 230 kV	Diverge	Diverge	Diverge	SPS to trip new renewables in IVANPAH area was proposed in previously conducted GIP studies.
ELDORDO2 - BOB TAP 230 kV	ELDORDO - ELDORDO2 500/230 kV	117%	<100%	<100%	
LUGO - VICTORVL 500 kV	ELDORDO - LUGO 500 kV, MOHAVE - ELDORDO 500 kV	111%	113%	107%	Reconfigure ELDORADO - MOHAVE 500 kV to classify outage as L-1-1 or SPS to trip gen at ELDORADO.
	ELDORDO - LUGO 500 kV, LUGO - MOHAVE 500 kV	110%	112%	106%	Maintain WECC Category D classification or SPS to trip gen at ELDORADO.
ELDORDO - LUGO 500 kV	MCCULLGH - VICTORVL 500 kV ck. 1 & ck. 2	100%	103%	<100%	Upgrade series cap ELDORADO - LUGO 500 kV was identified in Cluster C3 C4 Phase II.

Thermal Overloads and Mitigation (Peak)

Overloaded Facility	Contingency	Flow			Mitigation
		CC	CI	ENV	
N/A	KRAMER - LUGO 230 kV ck. 1 & ck. 2	<100%	Diverge	<100%	- Coolwater – Lugo 230 kV line identified in GIP. - AV Clearview project. - Expansion of KRAMER RAS may not be feasible.
JHINDMWD - EAGLEMTN 115 kV	DEVERS - MIRAGE 230 kV ck. 1 & ck. 2	121%	131%	Diverge	IID is working on Path 42 SPS that should address this concern.
JHINDMWD - J.HINDS 115 kV		145%	156%		
N/A	COACHELV - MIRAGE 230 kV, RAMON - MIRAGE 230 kV	Diverge	Diverge		
	COACHELV - MIRAGE 230 kV, COACHELV - RAMON 230 kV				

Thermal Overloads and Mitigation (Off-Peak)

Overloaded Facility	Contingency	Flow				Mitigation
		CC	CI	ENV	HDG	
COLWATER - TT22409 115 kV	All elements in service (N-0)	<100%	193%	<100%	<100%	Localized concern that should be addressed by GIP.
CONTROL - INYO 115 kV			114%			Upgrade INYO PS phase shifter.
INYO - INYO PS 115 kV			162%			
N/A	IVANPAH - ELDORDO02 230 kV	Diverge	Diverge	Diverge	Diverge	SPS to trip new renewables in IVANPAH area was proposed in previously conducted GIP studies.
ELDORDO2 - BOB TAP 230 kV	ELDORDO - ELDORDO2 500/230 kV	116%	<100%	<100%	<100%	

Thermal Overloads and Mitigation (Off-Peak)

Overloaded Facility	Contingency	Flow				Mitigation
		CC	CI	ENV	HDG	
WINDHUB 230/66 kV ck. 2 or ck. 1	WINDHUB 230/66 kV ck. 1 or ck. 2	116%	<100%	<100%	<100%	SPS to trip new renewables in WINDHUB area was proposed in previously conducted GIP studies.
CONTORL - INYOKERN 115 kV	CONTROL - INYO 115 kV or INYO - COTTONWD 230 kV or INYO - INYO PS 115 kV	<100%	107%			SPS to trip CONTROL 115 kV area generation.
TAP 710 - INYOKERN 115 kV			105%			
CONTORL - TAP 710 115 kV			108%			

Thermal Overloads and Mitigation (Off-Peak)

Overloaded Facility	Contingency	Flow				Mitigation
		CC	CI	ENV	HDG	
TABLE MT - TB MT 1M 500 kV	MPDCI-NS-MONOLOPAR 500 kV	<100%	<100%	<100%	101%	Review shunt switching solution scheme.
	PV-g2-OL-MA				100%	
	IPP-BIPOLAR 500 kV			100%	104%	
N/A	KRAMER - LUGO 230 kV ck. 1 & ck. 2		Diverge	<100%	<100%	- Coolwater – Lugo 230 kV line identified in GIP. - AV Clearview project. - Expansion of KRAMER RAS may not be feasible.

Thermal Overloads and Mitigation (Off-Peak)

<table>
<tr><th rowspan="2">Overloaded Facility</th><th rowspan="2">Contingency</th><th colspan="4">Flow</th><th rowspan="2">Mitigation</th></tr>
<tr><th>CC</th><th>CI</th><th>ENV</th><th>HDG</th></tr>
<tr><td>JHINDMWD - EAGLEMTN 115 kV</td><td rowspan="2">DEVERS - MIRAGE 230 kV ck. 1 & ck. 2</td><td><100%</td><td rowspan="4">Diverge</td><td rowspan="4">Diverge</td><td rowspan="4">Diverge</td><td rowspan="4">IID is working on Path 42 SPS that should address this concern.</td></tr>
<tr><td>JHINDMWD - J.HINDS 115 kV</td><td>108%</td></tr>
<tr><td rowspan="2">N/A</td><td>COACHELV - MIRAGE 230 kV, RAMON - MIRAGE 230 kV</td><td rowspan="2">Diverge</td></tr>
<tr><td>COACHELV - MIRAGE 230 kV, COACHELV - RAMON 230 kV</td></tr>
</table>

High/Low Voltage Concerns and Mitigation (Peak)

Overloaded Facility	Contingency	Voltage			Mitigation
		CC	CI	ENV	
DUNNSIDE 115 kV	All elements in service (N-0)	<1.05	1.050	<1.05	Localized concern that should be addressed by GIP.
INYOKERN 115 kV	INYOKERN - KRAMER 115 kV	>.90	0.868	>.90	Install SVD in INYOKERN 115 kV area.
RANDSBRG 115 kV			0.867		
COSO 115 kV			0.891		
DOWNS 115 kV			0.892		
COSO 115 kV	CONTROL - INYO 115 kV or INYO - COTTONWD 230 kV or INYO - INYO PS 115 kV		0.858		SPS to trip CONTROL 115 kV area generation.

Voltage Deviation Concerns and Mitigation (Peak)

Overloaded Facility	Contingency	Voltage			Mitigation
		CC	CI	ENV	
INYOKERN 115 kV	INYOKERN - KRAMER 115 kV	6%	9%	5%	Install SVD in INYOKERN 115 kV area.
RANDSBRG 115 kV		7%	10%	6%	
COSO 115 kV		<5%	6%	<5%	
DOWNS 115 kV		5%	8%		
COSO 115 kV	CONTROL - INYO 115 kV or INYO - COTTONWD 230 kV or INYO - INYO PS 115 kV	<5%	9%		SPS to trip CONTROL 115 kV area generation.
INYO 115 kV	OWENSCON - INYO 230 kV		6%		

Voltage Deviation Concerns and Mitigation (Peak)

Overloaded Facility	Contingency	Voltage			Mitigation
		CC	CI	ENV	
ELDORDO2 230 kV	ELDORDO - ELDORDO2 500/230 kV	10%	<5%	<5%	SPS to trip new renewables in IVANPAH area was proposed in previously conducted GIP studies.
IVANPAH 230 kV		8%			
BAKER 115 kV		6%			
BOB TAP 230 kV		9%			
CRAZY EYE TP or VEA_Q13 or VEA_Q14 230 kV		6%			

High/Low Voltage Concerns and Mitigation (Off-Peak)

Overloaded Facility	Contingency	Voltage				Mitigation
		CC	CI	ENV	HDG	
DUNNSIDE 115 kV	All elements in service (N-0)	<1.05	1.062	<1.05	<1.05	Localized concern that should be addressed by GIP.
VILLA PK 66 kV			<1.05		1.056	Power factor control for DG at VILLA PK 66 kV.
COSO 115 kV	CONTROL - INYO 115 kV or INYO - COTTONWD 230 kV or INYO - INYO PS 115 kV	>.90	0.837	>.90	>.90	SPS to trip CONTROL 115 kV area generation.

Voltage Deviation Concerns and Mitigation (Off-Peak)

Overloaded Facility	Contingency	Voltage				Mitigation
		CC	CI	ENV	HDG	
INYOKERN 115 kV	INYOKERN - KRAMER 115 kV	<5%	6%	<5%	<5%	Install SVD in INYOKERN 115 kV area.
RANDSBRG 115 kV			8%			
DOWNS 115 kV			5%			
INYO 115 kV	OWENSCON - INYO 230 kV	6%	11%	5%	6%	SPS to trip CONTROL 115 kV area generation.
INYO PS 115 kV		<5%	7%	<5%	<5%	
MAXWELL 500 kV	MPDCI-NS-MONOLOPAR 500 kV		5%	5%		Review shunt switching solution scheme.

Voltage Deviation Concerns and Mitigation (Off-Peak)

Overloaded Facility	Contingency	Voltage				Mitigation
		CC	CI	ENV	HDG	
INYOKERN 115 kV	CONTROL - INYO 115 kV or INYO - COTTONWD 230 kV or INYO - INYO PS 115 kV	<5%	5%	<5%	<5%	SPS to trip CONTROL 115 kV area generation.
COSO 115 kV			11%			
ELDORDO2 230 kV	ELDORDO - ELDORDO2 500/230 kV	5%	<5%	<5%	7%	SPS to trip new renewables in IVANPAH area was proposed in previously conducted GIP studies.
IVANPAH 230 kV					<5%	
BOB TAP 230 kV					6%	

Voltage Deviation Concerns and Mitigation (Off-Peak)

Overloaded Facility	Contingency	Voltage				Mitigation
		CC	CI	ENV	HDG	
CORRECT 66 kV	WINDHUB - WINDHUB 230/66 kV ck. 1 or ck. 2	5%	<5%	<5%	<5%	SPS to trip new renewables in WINDHUB area was proposed in previously conducted GIP studies.
CUMMINGS or LORAINE 66 kV		6%				
BREEZE or MONOLITH or S613A or ARBWIND 66 kV		7%				
MIDWIND or MORWIND or CORUM or GOLDTOWN 66 kV		8%				
TT22565 66 kV		10%				

Voltage Deviation Concerns and Mitigation (Off-Peak)

Overloaded Facility	Contingency	Voltage				Mitigation
		CC	CI	ENV	HDG	
CALCMENT or WINDHUB or SWPOLE31 or SUB_SE15 or DUTCHWND or FLOWIND or CAMRIDGE or OAKWIND or SOUTHWND or NORTHWND or ZONDWIND or CANWIND or ENCANTAP or ENCANWND or VARWIND 66 kV	WINDHUB - WINDHUB 230/66 kV ck. 1 or ck. 2	9%	<5%	<5%	<5%	SPS to trip new renewables in WINDHUB area was proposed in previously conducted GIP studies.

Alternatives considered to the Coolwater-Lugo Project: AV Clearview Transmission Project

Luba Kravchuk
Regional Transmission Engineer

2012/2013 Transmission Planning Process Stakeholder Meeting
December 11-12, 2012

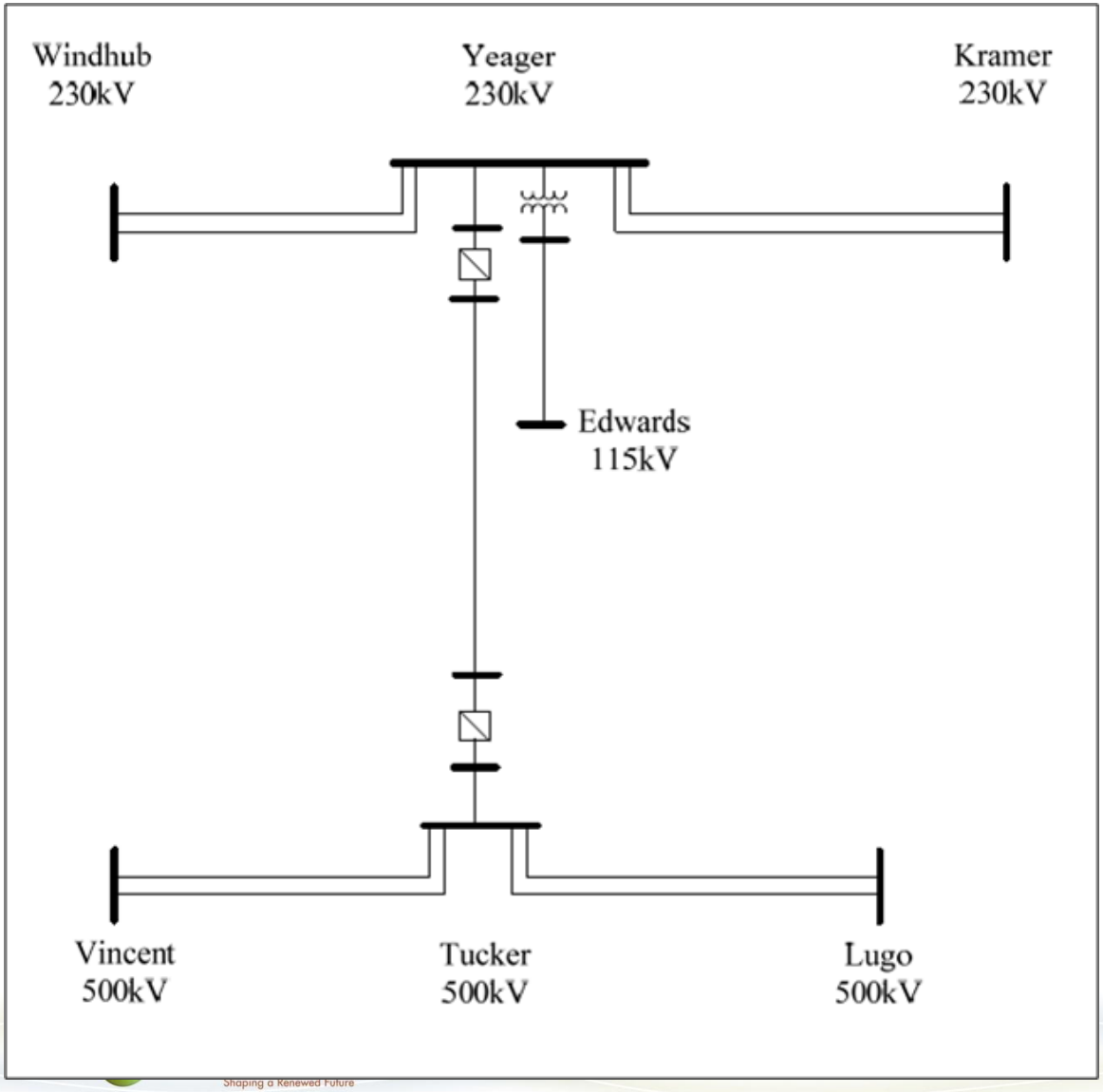
Background

- SCE application for CPCN for Coolwater-Lugo 230 kV transmission line (GIP-identified project) anticipated in 2013
- The CPUC has indicated that alternatives that support west Mohave renewable generation will need to be considered in upcoming CPCN proceedings
- In light of need to meaningfully discuss alternatives in the CPCN process, the ISO undertook to study alternatives in the 2012/2013 planning cycle
- AV Clearview Transmission Project has been previously suggested as a potential alternative in previous transmission planning cycles

AV Clearview Transmission Project Alternative overview

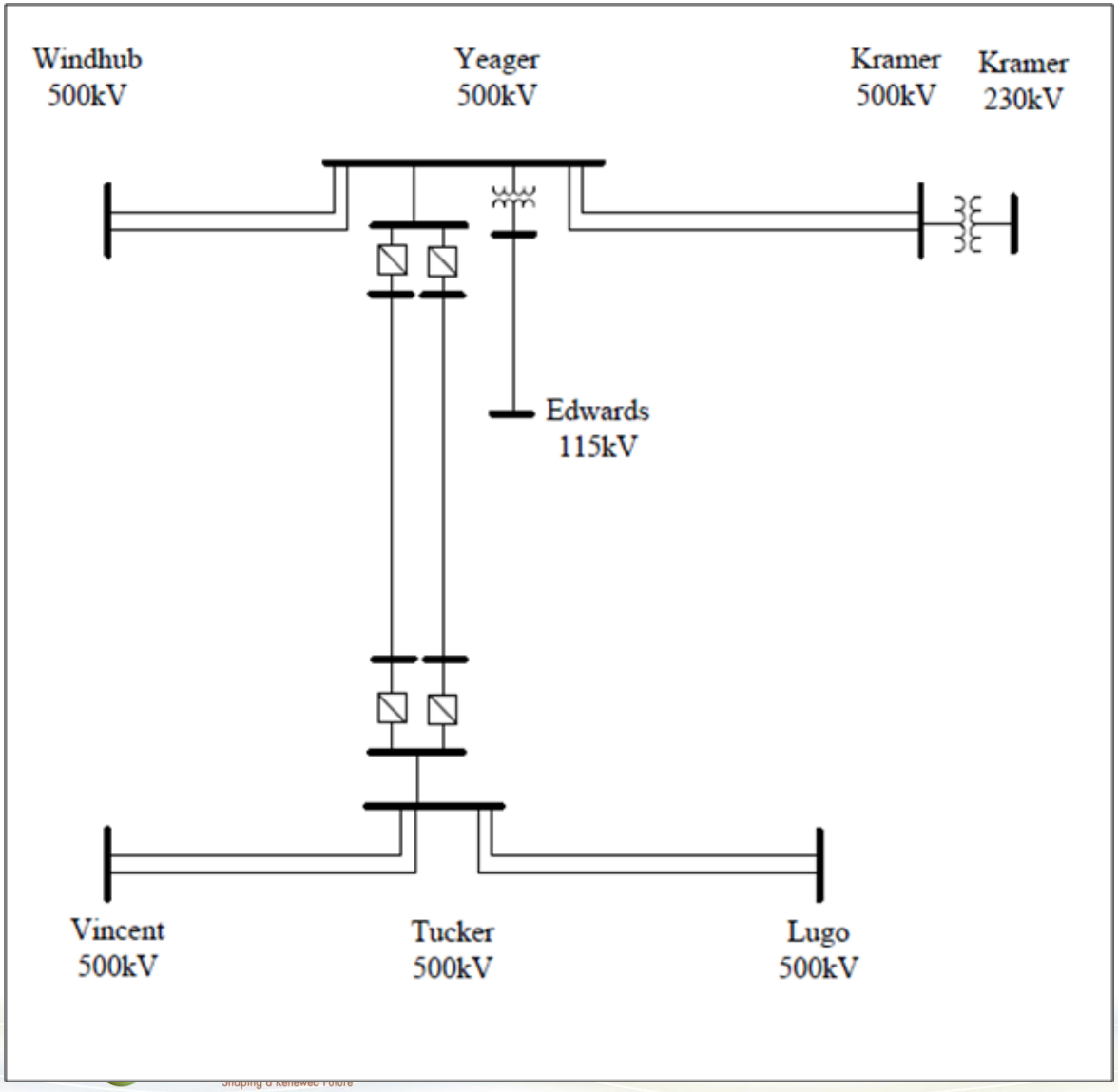
- Proposed by High Desert Power Authority
- Purpose is to connect eastern transmission and resources around Kramer area to the Tehachapi area
- Upon request, High Desert Power Authority provided the ISO with details of two options
  - Baseline Case
  - Expanded Case

AV Clearview Transmission Project Alternative – Baseline Case



- New 230 kV Yeager Substation
- New double circuit 230 kV from Windhub to Yeager
- New double circuit 230 kV from Yeager to Kramer
- New 230/115kV Step Down transformer bank at Yeager
- New single circuit 115kV from Yeager to SCE Edwards 115 kV substation
- New 500 kV Tucker Substation
- New 1000 MW capacity underground DC line between Yeager and Tucker Substation
- Loop Lugo-Vincent #1 and #2 Lines through Tucker Substation

AV Clearview Transmission Project Alternative – Expanded Case



- New **500** kV Yeager Substation
- New double circuit **500** kV from Windhub to Yeager
- New double circuit **500** kV from Yeager to Kramer
- New **500**/115kV Step Down transformer bank at Yeager
- New single circuit 115kV from Yeager to SCE Edwards 115 kV substation
- New 500 kV Tucker Substation
- New **2000** MW capacity underground DC line between Yeager and Tucker Substation
- Loop Lugo-Vincent #1 and #2 Lines through Tucker Substation

AV Clearview Transmission Project Alternative – Geographical Map

Cost estimates

- Cost of proposed AV Clearview Transmission Project Alternative
  - $750-800 million (Baseline case)
- Cost of proposed Coolwater-Lugo 230 kV transmission line
  - $480 million

Preliminary deliverability assessment results (Commercial Interest RPS portfolio)

- Approximately 750 MW of generation in the Kramer zone in the starting case
- AV Clearview Transmission Project Alternative
  - Baseline case
    - Need mitigation for Yeager-Edwards, Edwards-Holgate, Holgate-Kramer 115 kV overloads
    - With above mitigation, approximately 250 MW of additional generation in this area can be deliverable
  - Expanded case
    - Need mitigation for Yeager-Edwards, Edwards-Holgate, Holgate-Kramer 115 kV overloads
    - With above mitigation, approximately 1,250 MW of additional generation in this area can be deliverable

Preliminary production simulation study results (Commercial Interest RPS portfolio)

- The following transmission lines are congested with the addition of AV Clearview Transmission Project Alternative
  - Yeager-Edwards, Edwards-Holgate, Holgate-Kramer 115 kV
- There is no congestion identified with the addition of Coolwater-Lugo 230 kV transmission line
- The addition of AV Clearview Transmission Project Alternative does not increase the economic benefit in the CAISO system when compared to the Coolwater-Lugo 230 kV transmission line

Next steps

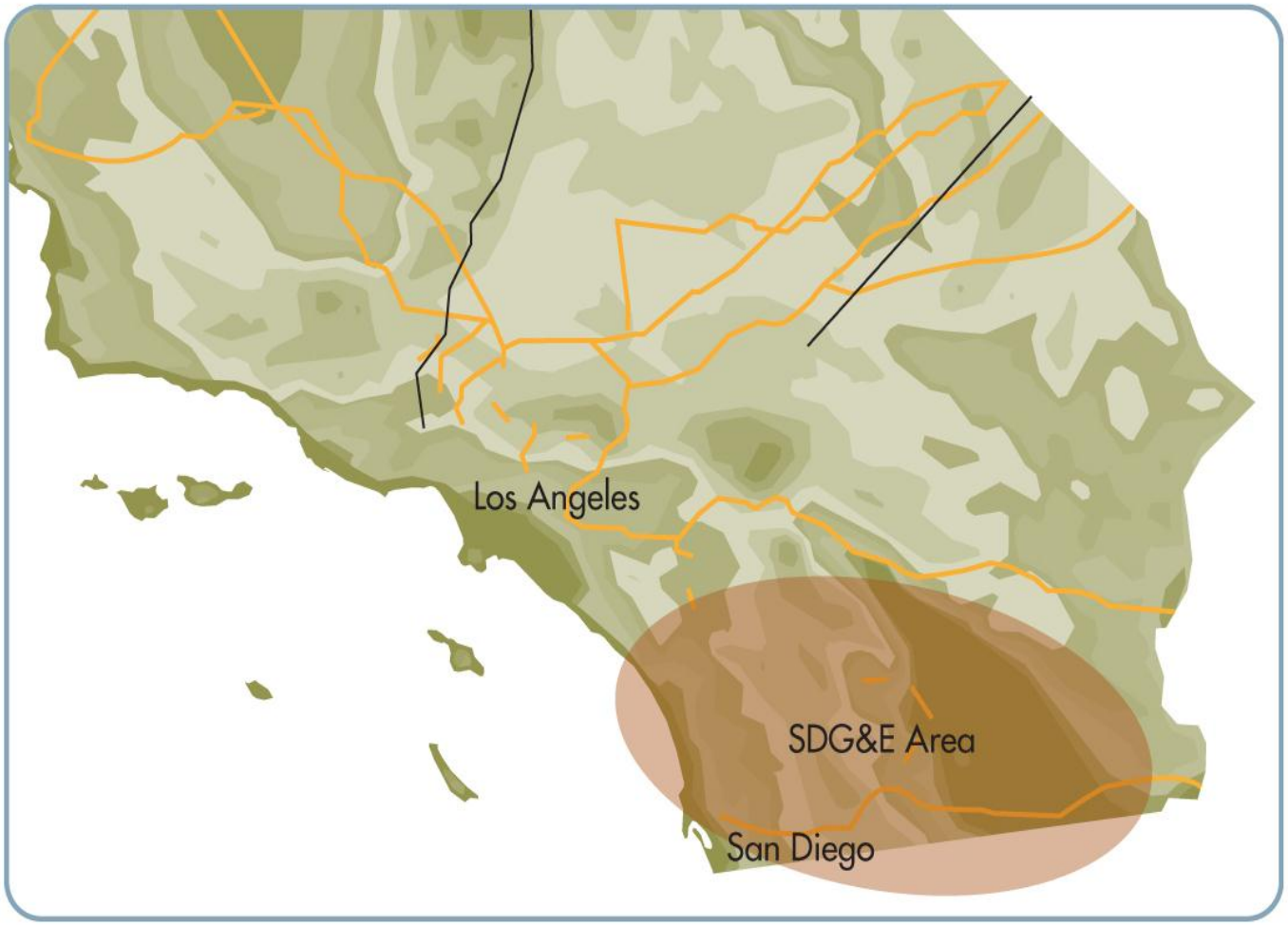
- Explore other operational benefits
- Refine benefit analysis

SDG&E Policy Driven Powerflow and Stability Results

Sushant Barave
Senior Regional Transmission Engineer

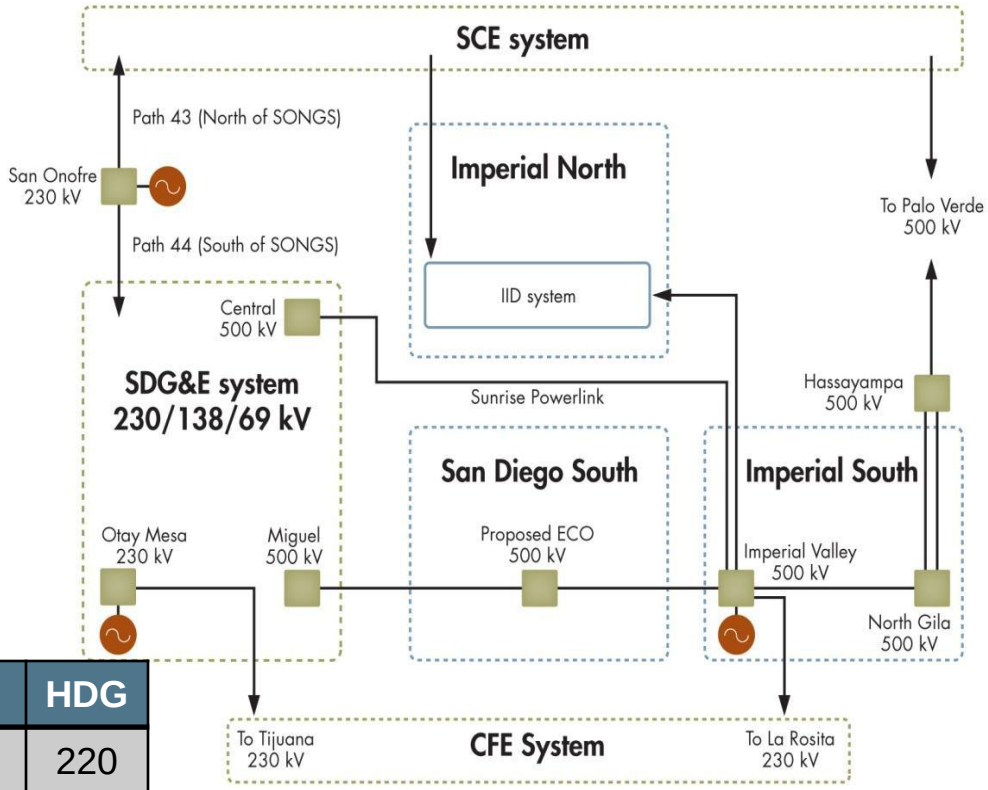
2012/2013 Transmission Planning Process Stakeholder Meeting
December 11, 2012

Study Area (SDG&E Service Area)



SDG&E Area Overview

- Overview
  - Service Area – from Southern Orange County to US – Mexico border
  - Generation – Over 3000 MW of Qualifying Capacity
  - Comprised of 69, 138, 230 and 500kV facilities
  - CREZs affecting San Diego area –

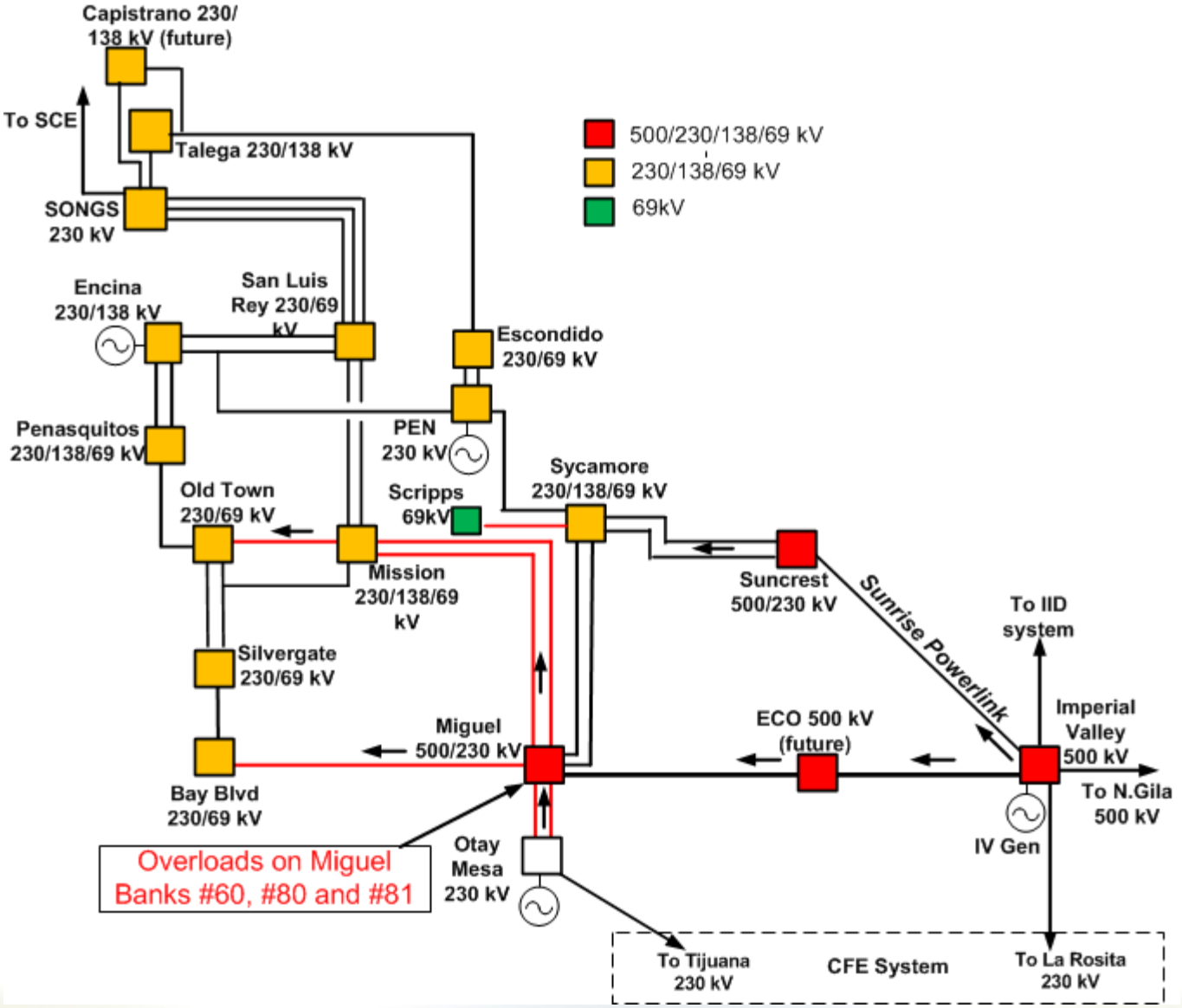


Zone	CC	CI	ENV	HDG
Imperial – SDGE	220	921	921	220
Imperial - IID	920	1219	1219	920
San Diego South	384	384	384	0
NonCREZ – SDGE	17	17	17	17
SDGE DGs	405	405	426	490

Overview of Identified Issues

- 11 overloads across all the portfolios
  - 2 overloads under category A condition
  - 6 overloads under category B condition
  - 3 overloads under common-mode category C condition
- Several buses with voltage >1.05 pu in off-peak cases
- Voltage Collapse under N-1-1 outage of Sunrise Power Link + Southwest Power Link

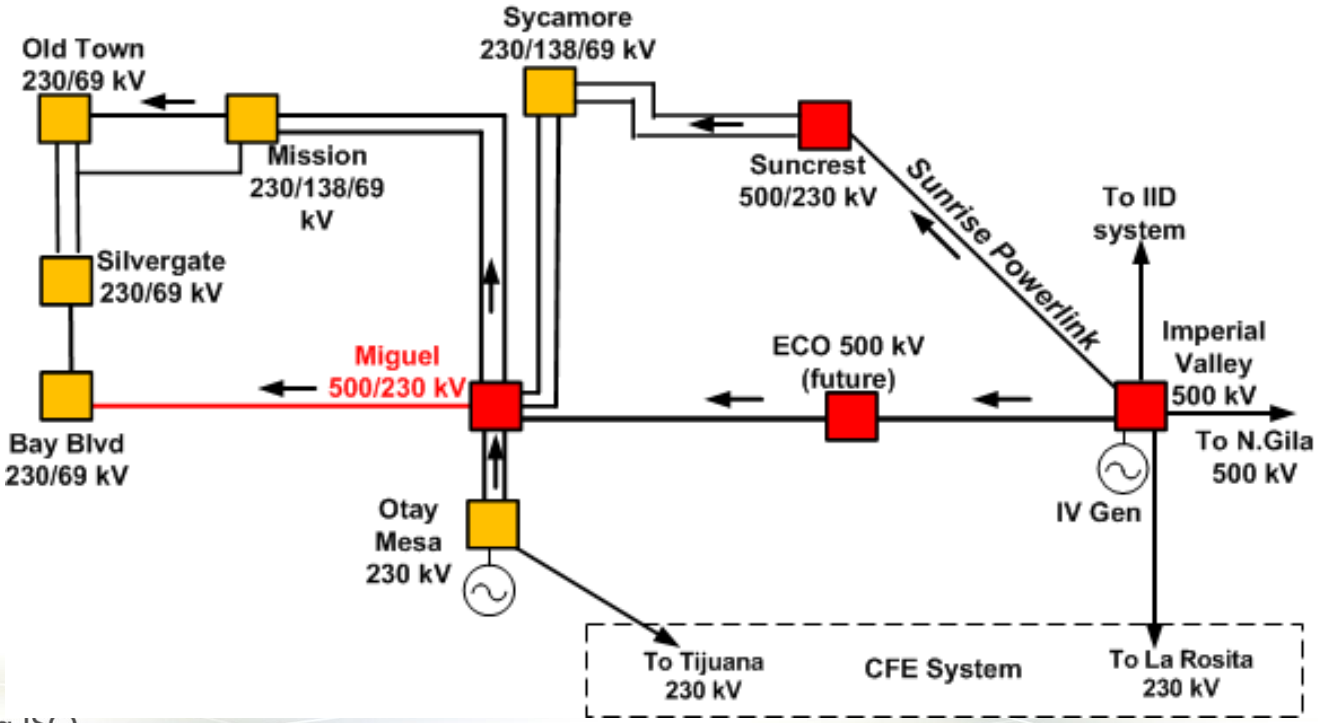
SDG&E area overloads



Thermal Overloads and Mitigations

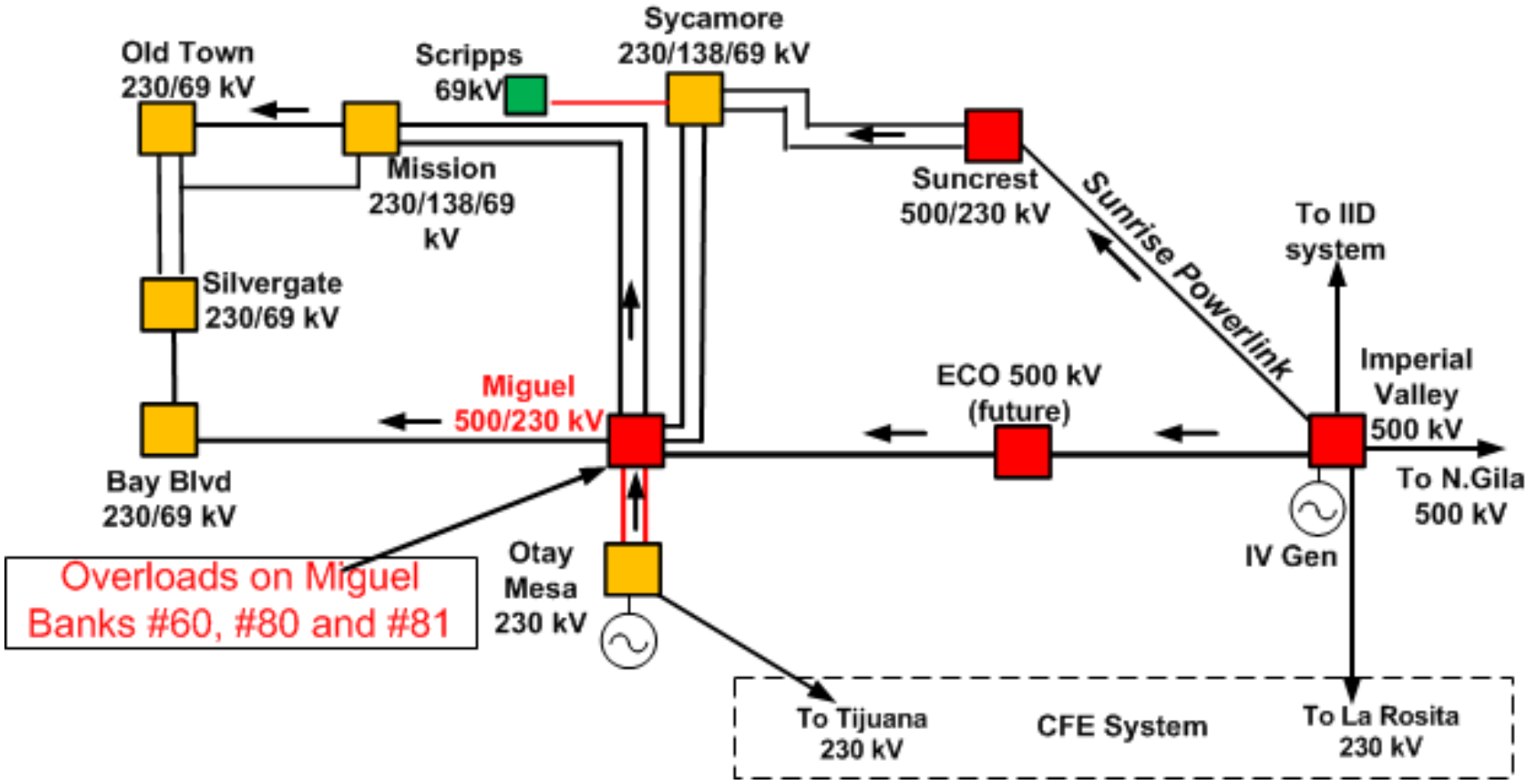
- 2 overloads under Category A condition

Overloaded Facility	Contingency	CC peak	CI peak	ENV peak	Mitigation
Miguel – Bay Blvd 230kV	None	107.7%	111.1%	102.1%	Upgrade OR congestion management in the DA and RT market (non-renewable resources contribute to congestion) OR a new SX-PQ 230kV line OR additional generation on 230kV North of Mission/Old Town area
Granite – Granite Tap 69kV	None	99.1%	100.3%	84.8%	Generation dispatch at El Cajon



Thermal Overloads and Mitigations

- 6 overloads under Category B condition



Thermal Overloads and Mitigations

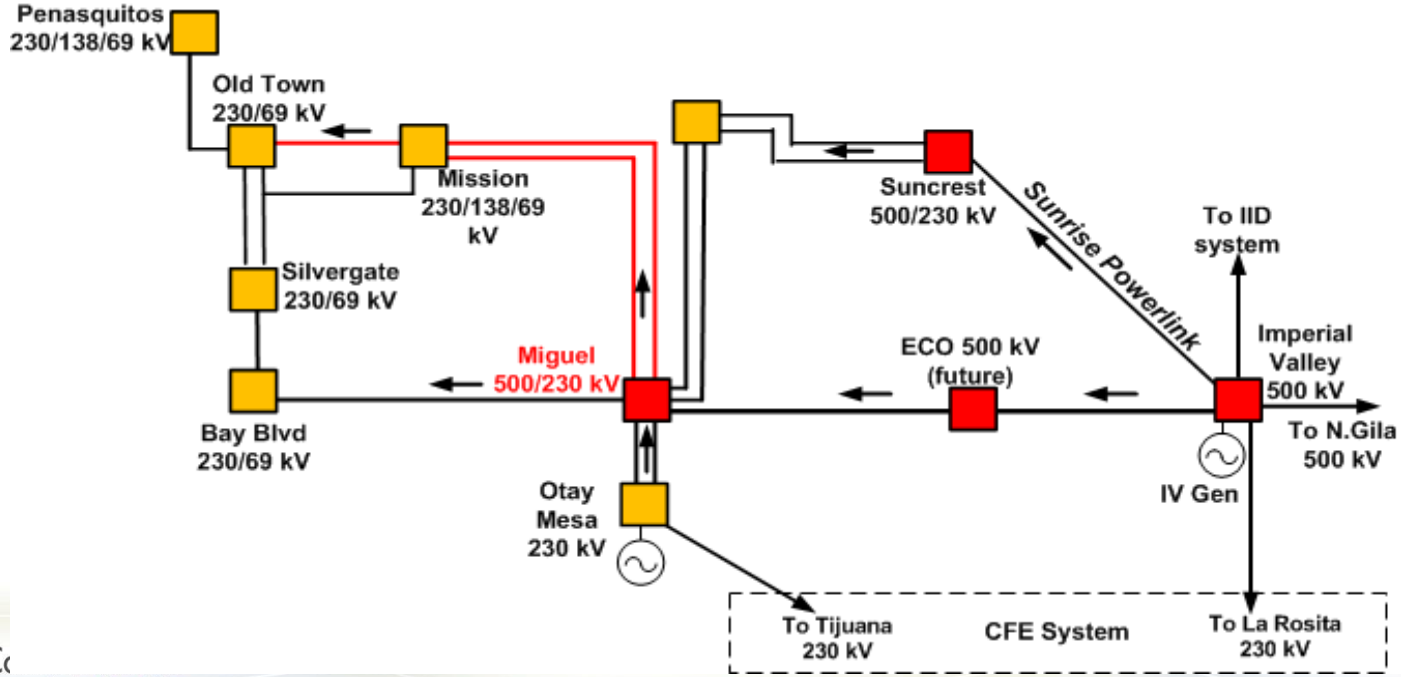
- 6 overloads under Category B condition

Overloaded Facility	Contingency	CC peak	CI peak	ENV peak	Mitigation
Otay Mesa – Miguel 230kV #1	Otay Mesa – Miguel 230kV #2	107.6%	110.6%	97.8%	Upgrade OR congestion management in the DA and RT market (non-renewable resources available) OR SPS to trip gen identified in GIP OR additional generation on 230kV North of Mission/Old Town area
Otay Mesa – Miguel 230kV #2	Otay Mesa – Miguel 230kV #1	107.7%	110.6%	97.9%	
Sycamore – Scripps 69kV	Bay Blvd – Miguel 230kV	97.9%	100.1%	95.9%	Upgrade OR a new SX-PQ 230kV line OR additional generation on 230kV North of Mission/Old Town area
Miguel 500/230 kV Bank #81	Miguel 500/230 Bank #80	98.6%	101.0%	98.1%	Upgrade OR congestion management in DA and RT market (non-renewable resources available) OR SPS to drop gen
Miguel 500/230kV Bank #80	Miguel 500/230 Bank #81	101.0%	103.5%	100.5%	
Miguel 230/138kV Bank #60	Miguel 230/138 Bank #61	101.4%	103.0%	97.8%	

Thermal Overloads and Mitigations

- 3 overloads under Category B condition

Overloaded Facility	Contingency	CC peak	CI peak	ENV peak	Mitigation
Miguel – Mission 230kV #1	Miguel Bus	98.1%	101.6%	93.5%	Upgrade OR congestion management in DA and RT market (non-renewable resources available) OR SPS to drop gen identified in GIP OR a new SX-PQ 230kV line OR additional generation on 230kV North of Mission/Old Town area
Miguel – Mission 230kV #2	Miguel Bus	97.6%	101.0%	93.0%	
Old Town – Mission 230kV	Silvergate – Otay Mesa 230kV #1 and #2	99.9%	103.6%	97.4%	Upgrade OR import more from the North and reduce imports form the East. OR a new SX-PQ 230kV line OR additional generation on 230kV North of Mission/Old Town area

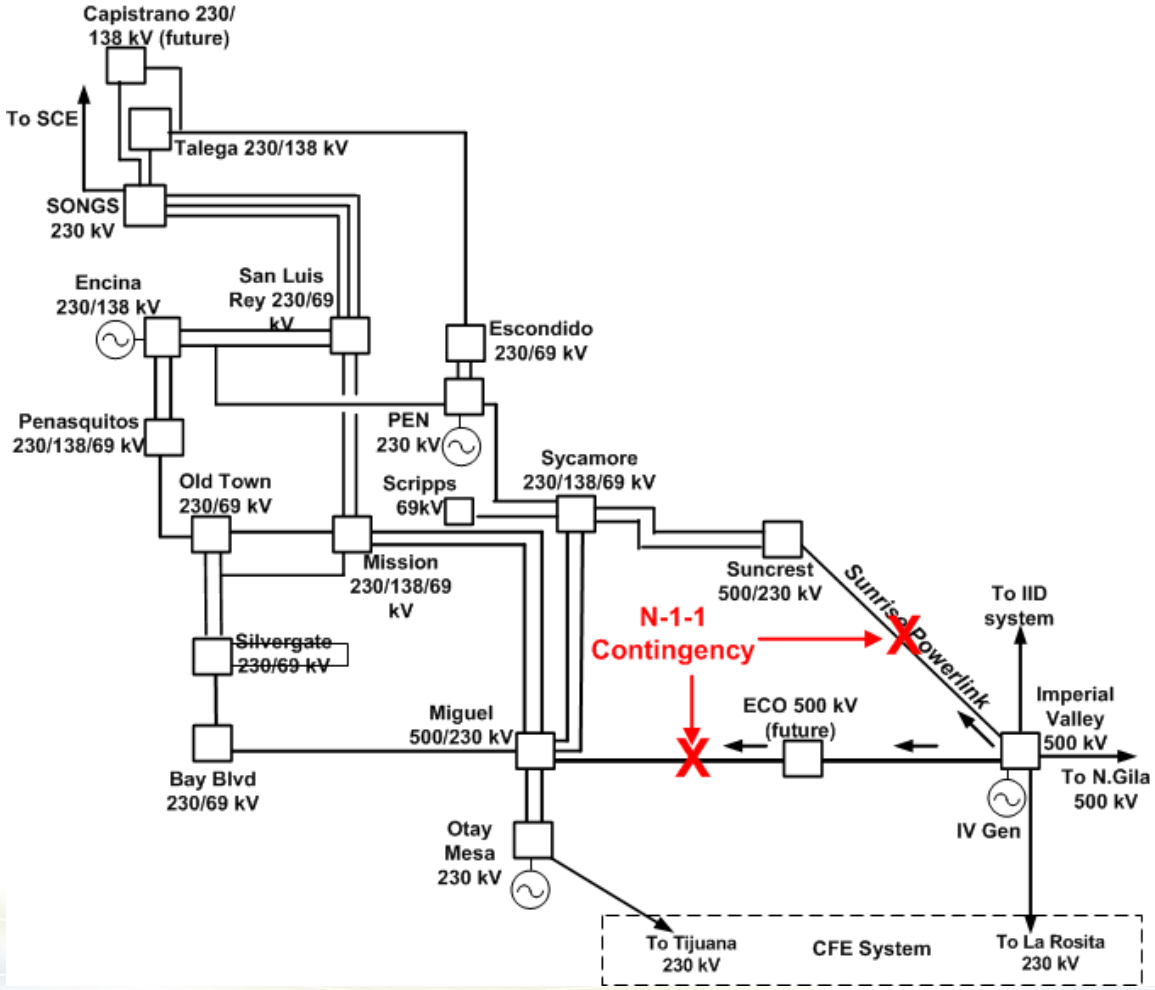


Voltage Issues and Mitigations

Substation	Contingency	CC off-peak	CI off-peak	ENV off-peak	HDG off-peak	Mitigation
ARTESN 69 kV	None	1.05	1.04	1.04	1.05	+/- 0.95 pf for generation in the area and * Voltage schedule adjustments / Tap adjustments across the system and/or * Dynamic voltage control devices
BOULEVRD 69 kV	None	1.07	1.07	1.07	1.10	
CHOLLAS 69 kV	None	1.04	1.04	1.04	1.05	
MIGUEL 138 kV	None	1.06	1.06	1.06	1.07	
POMERADO 69 kV	None	1.05	1.05	1.05	1.06	
POWAY 69 kV	None	1.05	1.05	1.05	1.05	
PRCTRVLY 138 kV	None	1.06	1.06	1.06	1.06	
R.CARMEL 69 kV	None	1.05	1.04	1.04	1.05	
SWEETWTR 69 kV	None	1.05	1.05	1.05	1.06	
SYCAMORE 69 kV	None	1.06	1.05	1.06	1.06	
TELECYN 138 kV	None	1.05	1.05	1.05	1.06	
SUNCREST 230 kV	None	1.06	1.05	1.05	1.06	
MIGUEL60 138 kV	None	1.06	1.05	1.06	1.06	
ML60 TAP 138 kV	None	1.05	1.05	1.06	1.06	
ECO 138 kV	None	1.05	1.05	1.05	1.07	
BOULEVRD 138 kV	None	1.04	1.05	1.05	1.07	

Voltage Collapse Issues and Mitigations

Contingency	Issue	Mitigation
Southwest Power Link (Miguel-ECO 500kV) + Sunrise Power Link (IV-Suncrest 500kV)	**Voltage Collapse**	IV gen drop and additional internal generation and/or dynamic reactive support within San Diego area.



Conclusions

- Thermal Issues
  - Overloads on the 230kV path from Miguel to Bay Blvd and Old Town area
    - Upgrade the limiting facilities
    - Congestion management in DA and RT market (non-renewable resources available)
    - SPS to drop gen identified in GIP
    - New Sycamore – Penasquitos 230kV line would mitigate some of these overloads
    - Additional generation on 230kV system North of Mission/Old Town area
- Voltage Issues
  - Voltage Collapse under N-1-1 condition
    - Trip IV gen post-contingency
    - Additional internal generation and/or dynamic reactive support
  - High voltages in the off-peak scenario
    - +/- 0.95 pf for generation in the area
    - Voltage schedule adjustments / Tap adjustments across the system
    - Dynamic voltage control devices

North PG&E Policy Driven Power flow and Stability Results

Rajeev Annaluru
Senior Regional Transmission Engineer

2012/2013 Transmission Planning Process Stakeholder Meeting
December 11-12, 2012

Studies Performed

- **Local Area Studies**
  - Thermal, voltage and transient stability studies for local areas
  - All Category, B, selected C and D contingencies
- **Bulk System Studies**
  - Post-transient and transient stability analysis for all four portfolios
  - Peak and off-peak conditions
  - All single and double 500 kV outages studied, large generation outages, three-phase faults with normal clearing, single-phase-to-ground faults with delayed clearing

Renewable Generation Assumptions in PG&E Area

Scenarios, year 2022

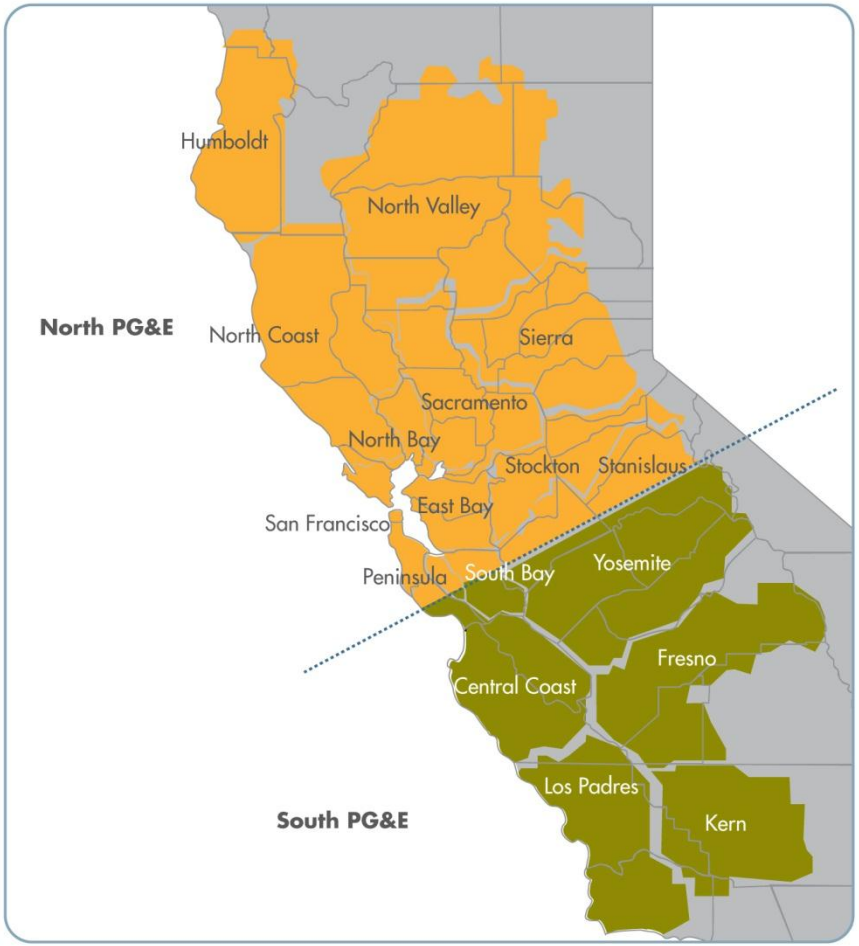
Portfolio	Capacity
Base	4728 MW
Cost Constrained	4686 MW
Environmental	5791 MW
High DG	6340 MW

Not all the generation is producing at nameplate capacity in the cases, but is producing at high range of expected simultaneous output.

North PG&E Area

Zones:

- Humboldt
- North Coast/North Bay
- Greater Bay Area – East Bay, South Bay, San Francisco, Peninsula
- North Valley
- Central Valley – Sacramento, Sierra, Stockton, Stanislaus
- Round Mtn and Solano CREZ



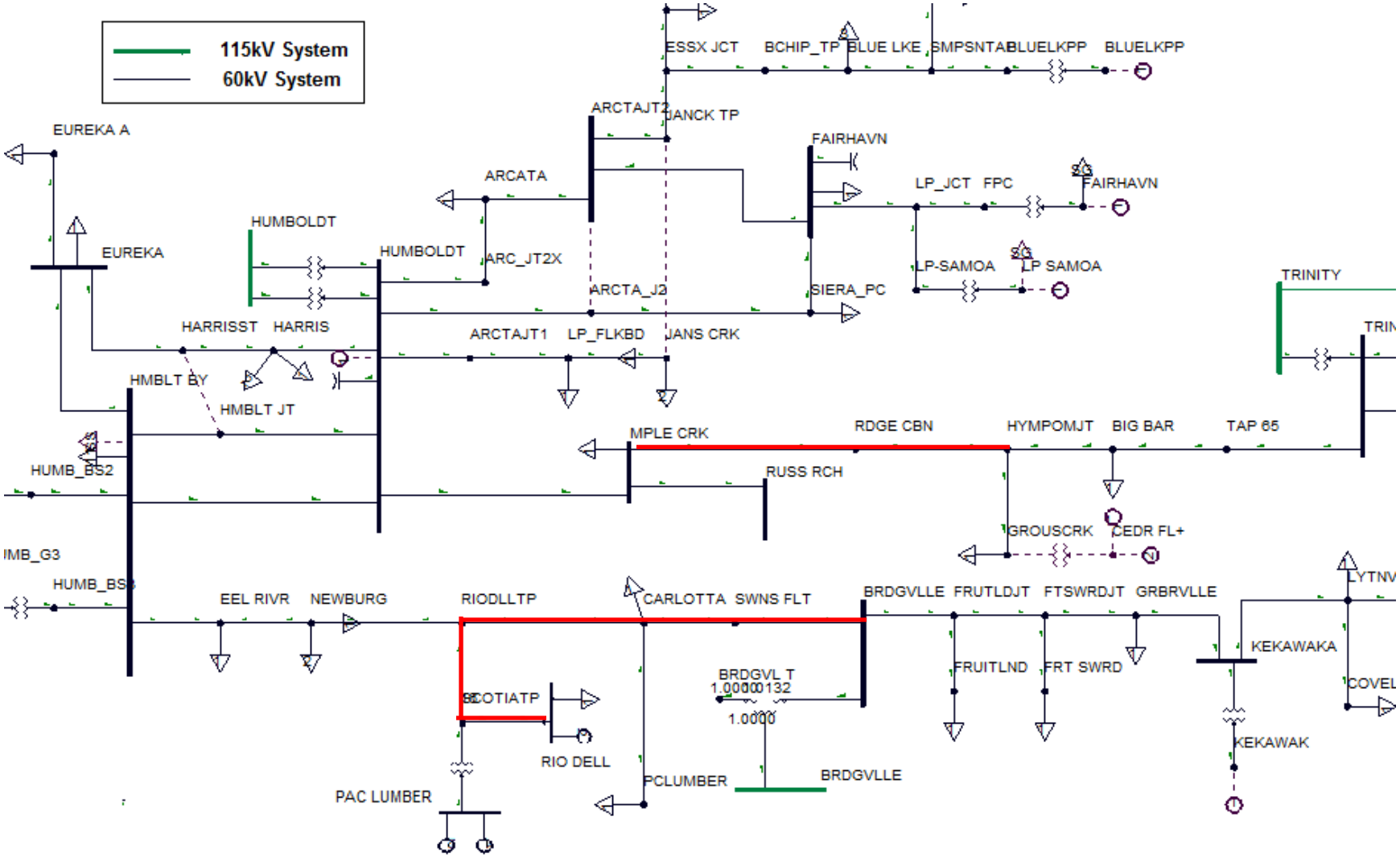
Humboldt Area – Summer Off-Peak Results

Thermal Overloads (Off-Peak)

North PG&E, Off-Peak Load 2022, Thermal Overloads								
Humboldt								
Overloaded Facility	Worst Contingency	Category	Category Description	Loading (%)				ISO Proposed Mitigation
				CI	CC	ENV	DG	
Maple Creek - Trinity 60kV line (Between Maple Creek - Ridge Cabin)	Bus fault at Humboldt 115kV	C	Bus	38.10%	102.10%	114.20%	56.00%	Dispatch Humboldt 60kV generation.
Maple Creek - Trinity 60kV line (Between Ridge Cabin - Hympom Jt)	Bus fault at Humboldt 115kV	C	Bus	37.80%	101.80%	113.80%	55.70%	
Rio Dell Jct-Bridgeville 60 kV between Rio Dell - Scotia Tap	Normal conditions	A	Normal Conditions	217.90%	9.00%	8.90%	4.80%	Reconductor the line. (Local issue. Will be addressed in the GIP)
Rio Dell Jct-Bridgeville 60 kV between Rio Dell - Carlotta	Humboldt - Riodell 60kV	B	L-1	185.10%	42.50%	42.50%	45.60%	
Rio Dell Jct-Bridgeville 60 kV between Carlotta-Swns Flat	Humboldt - Riodell 60kV	B	L-1	181%	39%	39%	43%	
Rio Dell Jct-Bridgeville 60 kV between Swns Flat - Bridgeville	Humboldt - Riodell 60kV	B	L-1	181%	39%	39%	42%	

Note: No other additional thermal or voltage issues were identified in Summer peak cases

Study Results, Humboldt Area, Off-peak load



North Coast and North Bay Areas

No Thermal or Voltage issues were identified

North Valley Area – Summer Peak Results

- **Thermal Overloads**

North PG&E, Peak Load 2022, Thermal Overloads							
North Valley Area							
Overloaded Facility	Worst Contingency	Category	Category Description	Loading (%)			Potential Mitigation
				CI	CC	ENV	
Cottonwood-Panorama 115 kV Line	Base system (n-0)	A	N-0	100%	100%	97%	Congestion management. Reduce generation from existing Simpson Power.
Trinity-Keswick 60 kV Line	Trinity-Cottonwood 115 kV Line	B	L-1	21%	24%	103%	Re-rate. If re-rate is not feasible, SPS to trip generator at Trinity 115 kV.
Keswick-Cascade 60 kV Line	Trinity-Cottonwood 115 kV Line	B	L-1	12%	15%	107%	Re-rate. If re-rate is not feasible, SPS to trip generator at Trinity 115 kV.
Trinity-Keswick 60 kV Line	COTTONWOOD BUS PARALLEL BKR STUCK 115KV	C2	Stuck-Brk	28%	33%	154%	SPS to trip generator at Trinity 115 kV
Keswick-Cascade 60 kV Line	COTTONWOOD BUS PARALLEL BKR STUCK 115KV	C2	Stuck-Brk	18%	23%	166%	SPS to trip generator at Trinity 115 kV
Delevan-Cortina 230 kV Line	Delevan-Vaca Dixon No.2 230 kV Line and Delevan-Vaca Dixon No.3 230 kV Line	C5	DCTL	104%	104%	100%	SPS to curtail Colusa generation.

- **No additional voltage concerns identified**

North Valley Area – Summer Off-peak Results

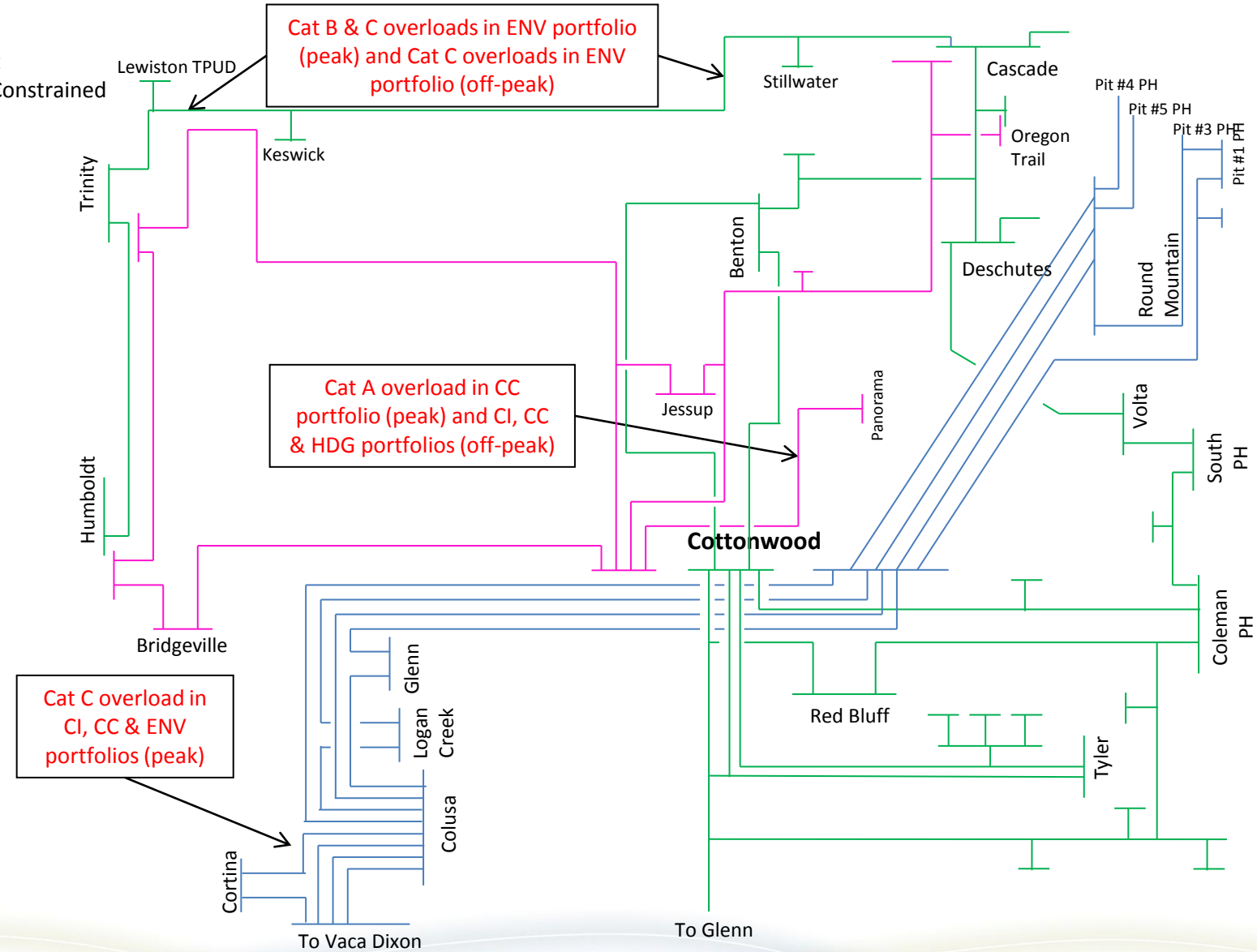
- **Thermal Overloads**

North PG&E, Off-peak Load 2022, Thermal Overloads								
North Valley Area								
Overloaded Facility	Worst Contingency	Category	Category Description	Loading (%)				Potential Mitigation
				CI	CC	ENV	DG	
Cottonwood-Panorama 115 kV Line	Base system (n-0)	A	N-0	110%	109%	100%	116%	Congestion management. Reduce generation from existing Simpson Power.
Trinity-Keswick 60 kV Line	COTTONWOOD BUS PARALLEL BKR STUCK 115KV	C2	Stuck-Brk	<100%	64%	32%	133%	Pre-dispatch existing Humboldt area generation.
Keswick-Cascade 60 kV Line	COTTONWOOD BUS PARALLEL BKR STUCK 115KV	C2	Stuck-Brk	<100%	79%	41%	157%	Pre-dispatch existing Humboldt area generation.

- **No additional voltage concerns identified**

North Valley Area – Results

CC – Cost Constrained
CI – Commercial Interest
ENV – Environmentally Constrained
HDG – High DG



Central Valley Area – Summer Peak Results

- **Thermal Overloads**

North PG&E, Peak Load 2022, Thermal Overloads							
Central Valley Area							
Overloaded Facility	Worst Contingency	Category	Category Description	Loading (%)			Potential Mitigation
				CI	CC	ENV	
Stockton 'A' 60 kV Line No. 1	Base system (n-0)	A	N-0	120%	118%	46%	Localized concern. Should be addressed in GIP.
Stockton 'A' - Weber 60 kV Line No. 3	Base system (n-0)	A	N-0	113%	114%	68%	Localized concern. Should be addressed in GIP.
Tesla - Salado - Manteca 115 kV Line	Base system (n-0)	A	N-0	18%	115%	62%	Localized concern. Should be addressed in GIP.
Tesla - Salado 115 kV Line No. 1	Tesla - Salado - Manteca 115 kV Line	B	L-1	8%	130%	65%	Localized concern. Should be addressed in GIP.
Tesla - Salado - Manteca 115 kV Line	Tesla - Salado 115 kV Line No. 1	B	L-1	9%	142%	69%	Localized concern. Should be addressed in GIP.
Drum - Higgins 115 kV Line	Drum-Rio Oso No. 1 115 kV Line & Drum-Rio Oso No. 2 115 kV Line	C	DCTL	100%	99%	101%	Congestion management. Curtail Drum area generation.
Table Mountain - Pease 60 kV Line	Palermo-Pease 115 kV Line & Pease-Rio Oso 115 kV Line	C	DCTL	Diverge	Diverge	Diverge	Pre-dispatch existing YCEC generation.
Tesla - Schulte 115 kV Line No. 2	BUS FAULT AT 33540 TESLA 115.00 Bus 2	C	Bus	146%	132%	137%	Pre-dispatch existing GWF Tracy units.
Bellota-Riverbank-Melones 115 kV Line	TESLA 115 kV Bus 1 and Bus 2 - CB 102 Failure	C	Stuck Bkr	Diverge	Diverge	Diverge	Pre-dispatch existing GWF Tracy units
Tesla - Salado 115 kV Line No. 1	Schulte-Kasson-Manteca 115 kV Line & Tesla-Salado-Manteca 115 kV Line	C	DCTL	8%	130%	65%	Localized concern. Should be addressed in GIP.

Central Valley Area – Summer Peak Results

- **Voltage Deviation**

North PG&E, Peak Load 2022, Voltage Deviation, negative- voltage goes down, positive - voltage goes up							
Central Valley Area							
Substation	Worst Contingency	Category	Category Description	Post Contingency Voltage Deviation (%)			Potential Mitigation
				CI	CC	ENV	
Bogue 115 kV	Bogue - Rio Oso 115 kV Line	B	L-1	-0.05	-0.03	-0.06	Pre-dispatch existing FREC unit
Placerville 115 kV area	Missouri Flat - Gold Hill 115 kV No. 2 Line	B	L-1	-0.06	-0.06	-0.03	Pre-dispatch existing Eldorado PH.

Central Valley Area – Summer Off-Peak Results

- **Thermal Overloads**

North PG&E, Off-Peak Load 2022, Thermal Overloads								
Central Valley Area								
Overloaded Facility	Worst Contingency	Category	Category Description	Loading (%)				Potential Mitigation
				CI	CC	ENV	DG	
Stockton 'A' 60 kV Line No. 1	Base system (n-0)	A	N-0	147%	147%	60%	148%	Localized concern. Should be addressed in GIP.
Tesla - Salado 115 kV Line No. 1	Base system (n-0)	A	N-0	32%	102%	82%	51%	Localized concern. Should be addressed in GIP.
Tesla - Salado - Manteca 115 kV Line	Base system (n-0)	A	N-0	30%	114%	89%	39%	Localized concern. Should be addressed in GIP.
Drum - Rio Oso 115 kV No. 2 Line	Higgins - Bell 115 kV Line	B	L-1	103%	102%	103%	109%	Existing ISO operating procedure.
Drum - Rio Oso 115 kV No. 1 Line	Higgins - Bell 115 kV Line	B	L-1	102%	101%	102%	111%	Existing ISO operating procedure.
Table Mountain - Pease 60 kV Line	Pease 115/60 kV Transformer No. 2	B	T-1	86%	86%	86%	117%	Second Pease 115/60 kV transformer (TPP project).
Tesla - Salado 115 kV Line No. 1	Tesla - Salado - Manteca 115 kV Line	B	L-1	44%	145%	122%	63%	Localized concern. Should be addressed in GIP.
Tesla - Salado - Manteca 115 kV Line	Tesla - Salado 115 kV Line No. 1	B	L-1	46%	160%	125%	66%	Localized concern. Should be addressed in GIP.
Higgins - Bell 115 kV Line	GOLDHILL 230 kV Bus 1 and 2 - CB 202 Failure	C	Stuck Bkr	101%	101%	101%	23%	New Lincoln-Placer 115 kV line (TPP project)
Drum - Higgins 115 kV Line	Drum-Rio Oso No. 1 115 kV Line & Drum-Rio Oso No. 2 115 kV Line	C	DCTL	119%	122%	123%	126%	Congestion management. Curtail Drum area generation.
Table Mountain - Pease 60 kV Line	Palermo-Pease 115 kV Line & Pease-Rio Oso 115 kV Line	C	DCTL	67%	67%	67%	105%	Second Pease 115/60 kV transformer (TPP project).
Bellota-Riverbank-Melones 115 kV Line	TESLA 115 kV Bus 1 and Bus 2 - CB 102 Failure	C	Stuck Bkr	3%	76%	67%	138%	Add sectionalizing breaker at Tesla 115 kV
Tesla - Salado 115 kV Line No. 1	Schulte-Kasson-Manteca 115 kV Line & Tesla-Salado-Manteca 115 kV Line	C	DCTL	44%	145%	122%	63%	Localized concern. Should be addressed in GIP.

Central Valley Area – Summer Off-Peak Results

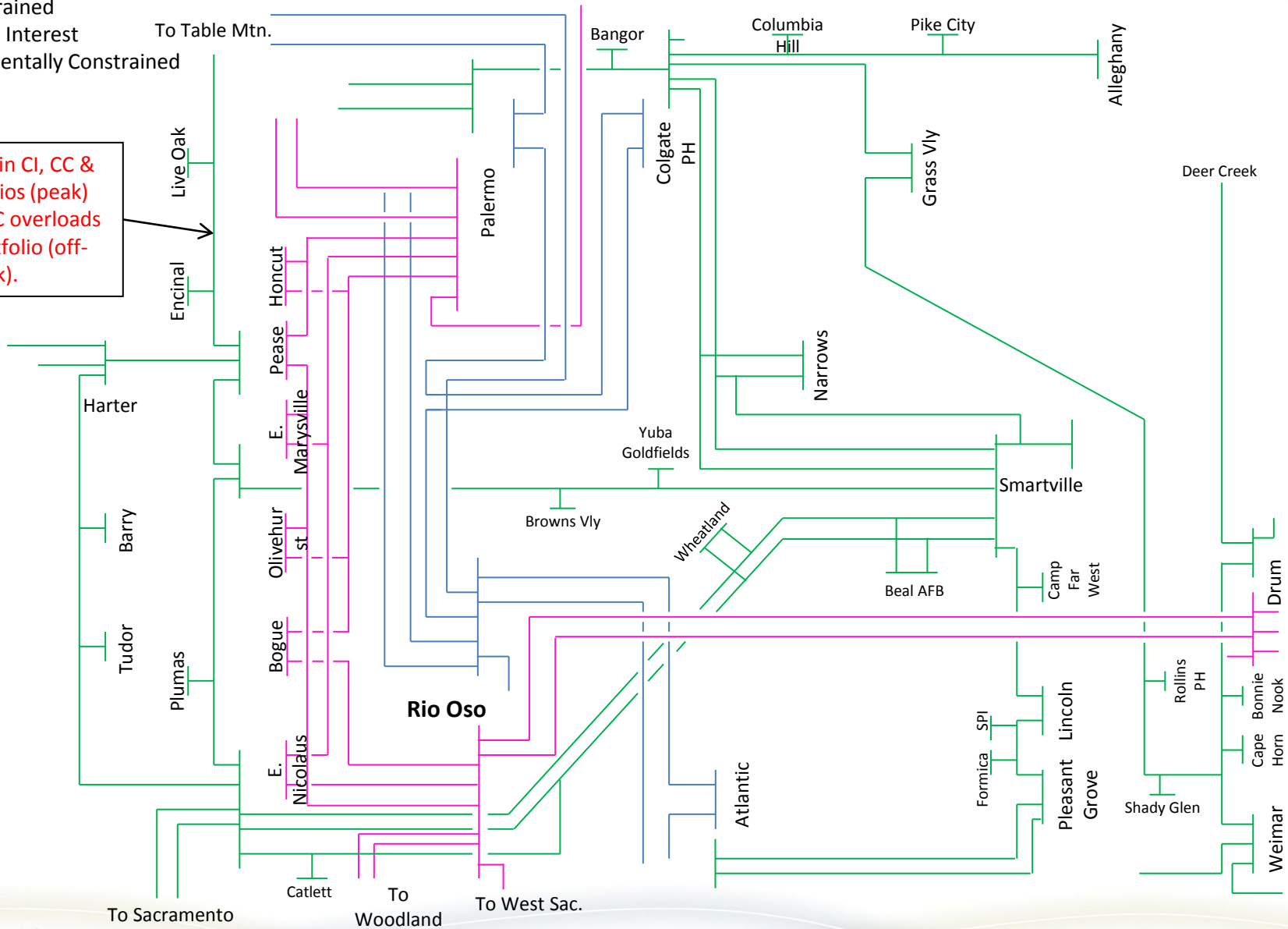
- **High Voltage**

North PG&E, Off-Peak Load 2022, Voltage Concerns								
Central Valley Area								
Substation	Worst Contingency	Category	Category Description	Min. Post Contingency Voltage (PU)				Potential Mitigation
				CI	CC	ENV	DG	
Drum area 115/60 kV area	Base system (n-0)	A	N-0	1.05	1.05	1.05	1.05	Reduce Drum area generation
Stockton 115/60 kV area	Base system (n-0)	A	N-0	1.06	1.06	1.06	1.06	0.95 PF reactive capability for DG in the area
Stanislaus 115 kV area	Base system (n-0)	A	N-0	1.06	1.06	1.06	1.06	0.95 PF reactive capability for DG in the area

Central Valley Area (North Sierra) – Results

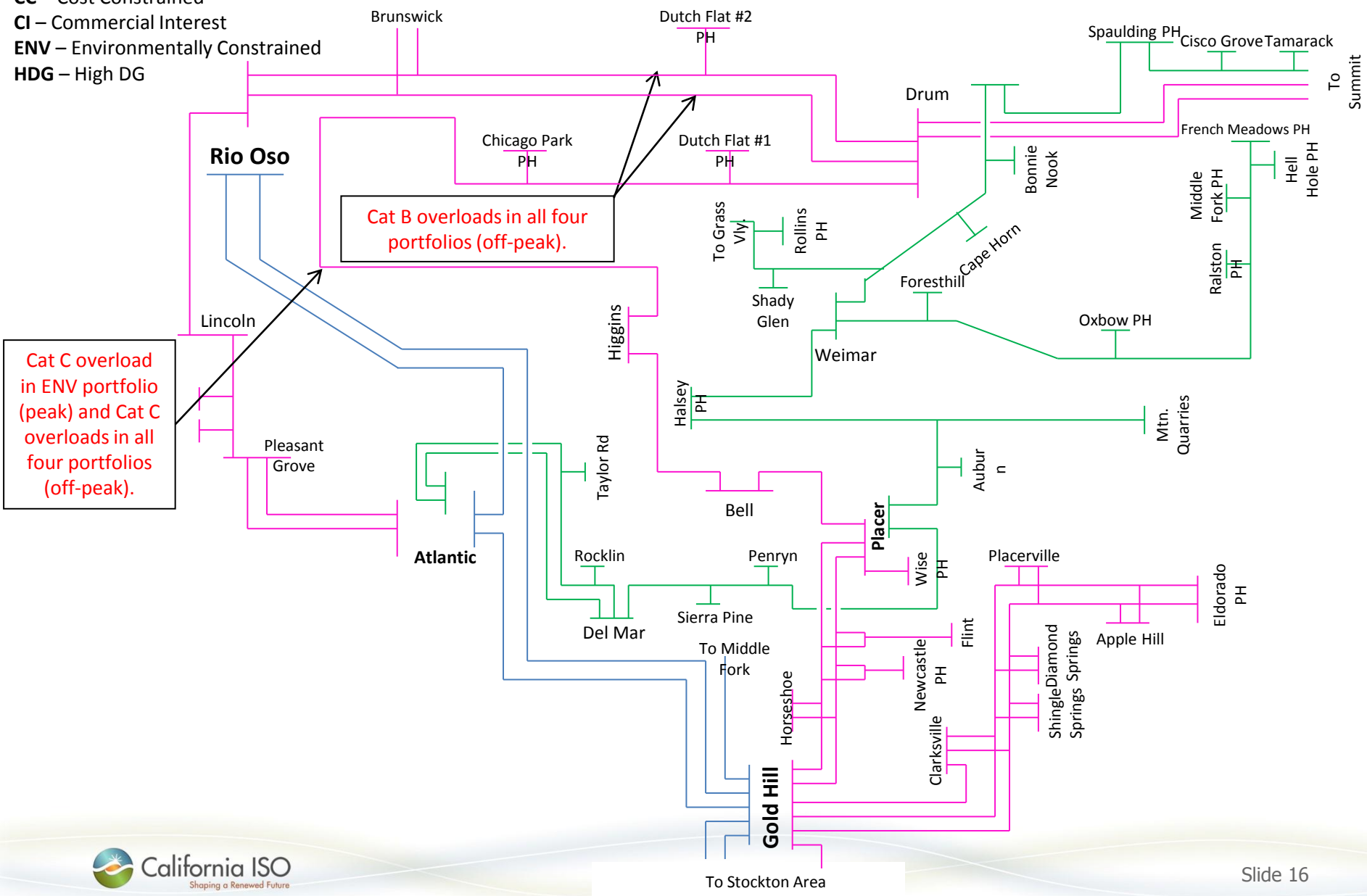
CC – Cost Constrained
CI – Commercial Interest
ENV – Environmentally Constrained
HDG – High DG

Divergence in CI, CC & ENV portfolios (peak) and Cat B & C overloads in HDG portfolio (off-peak).



Central Valley Area (South Sierra) – Results

CC – Cost Constrained
CI – Commercial Interest
ENV – Environmentally Constrained
HDG – High DG



Central Valley Area (Stockton) – Results

CC – Cost Constrained
CI – Commercial Interest
ENV – Environmentally Constrained
HDG – High DG

Cat A overload in CI & CC portfolios (peak)

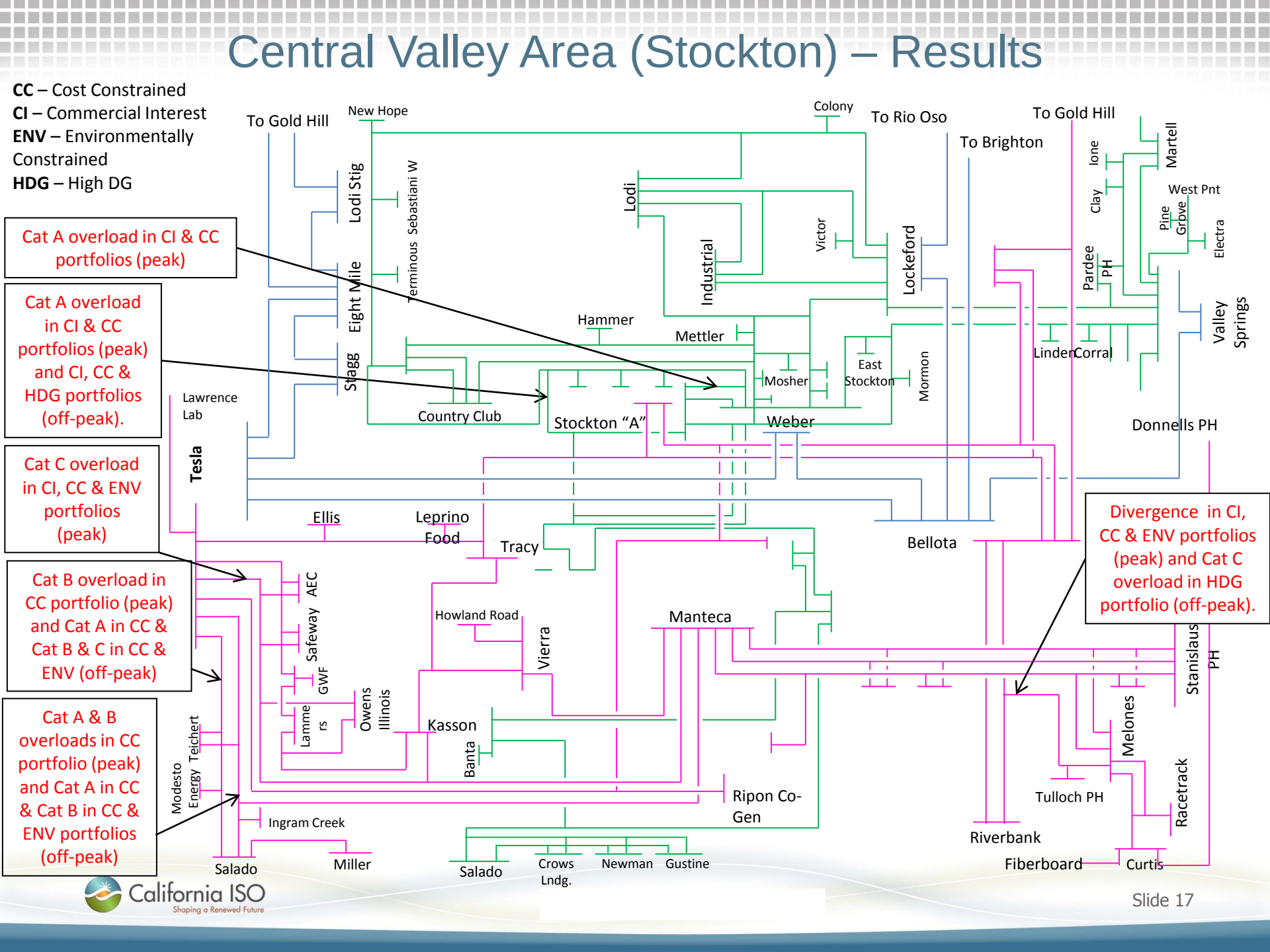
Cat A overload in CI & CC portfolios (peak) and CI, CC & HDG portfolios (off-peak).

Cat C overload in CI, CC & ENV portfolios (peak)

Cat B overload in CC portfolio (peak) and Cat A in CC & Cat B & C in CC & ENV (off-peak)

Cat A & B overloads in CC portfolio (peak) and Cat A in CC & Cat B in CC & ENV portfolios (off-peak)

Divergence in CI, CC & ENV portfolios (peak) and Cat C overload in HDG portfolio (off-peak).



Greater Bay Area – Summer Peak Results

- **Thermal Overloads**

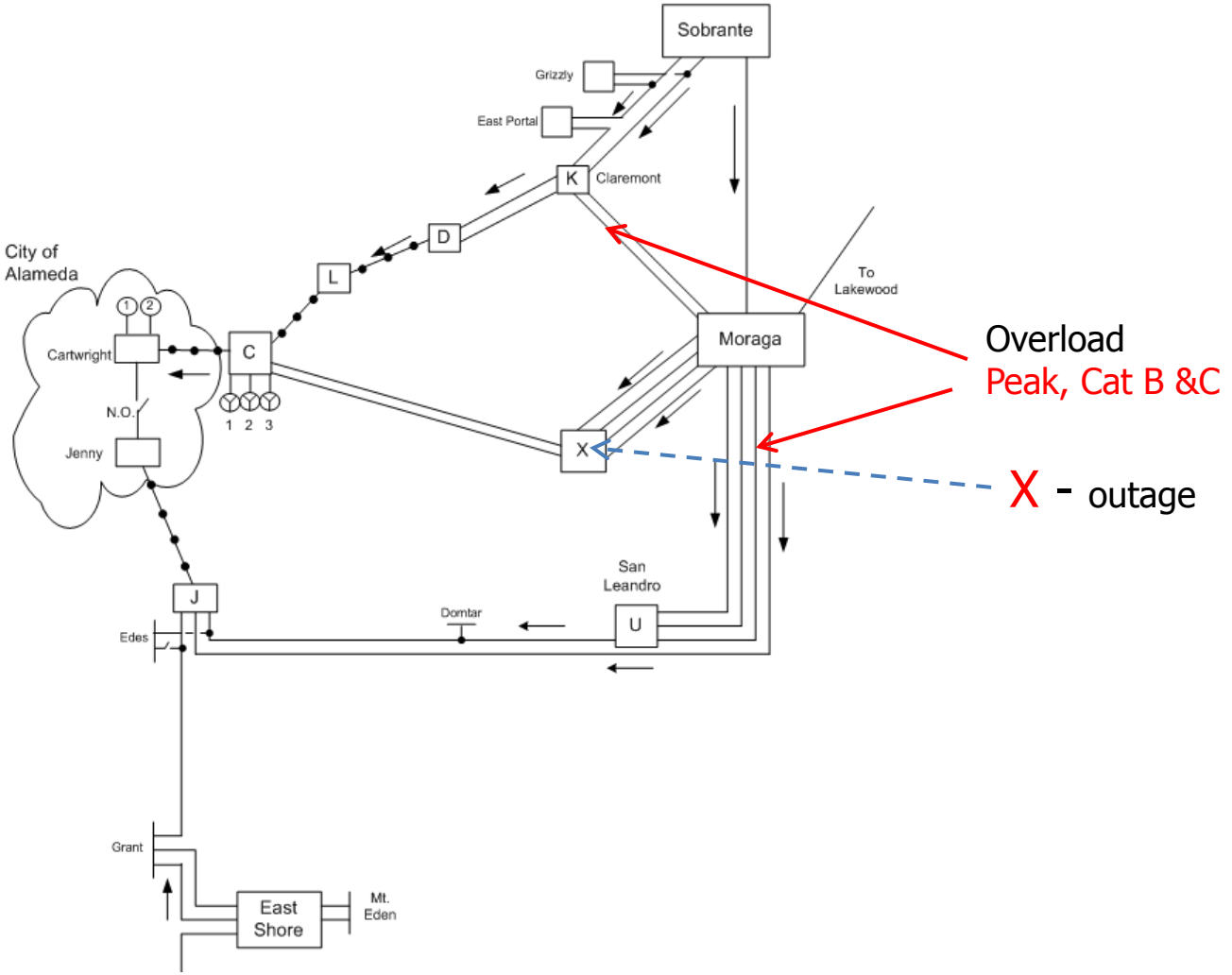
OVERLOADED FACILITY	CATEGORY	WORST CONTIGENCY	PORTFOLIO	LOADING	MITIGATION
Metcalf - Morgan Hill 115kV Line	B	Metcalf-Llagas 115 kV Line	CI & ENV	102% - 120%	Pre-dispatch Gilroy Gen for mitigation
	C1	BUS FAULT AT 35642 Metcalf 2D 115.00	CI & ENV	134% - 138%	
	C2	CB FAULT AT METCALF SUB 115 CB502	CI & ENV	120% - 123%	
LLAGAS - Morgan Hill 115kV Line	B	Metcalf-Morgan Hill 115 kV Line	CI & ENV	142% - 146%	Pre-dispatch Gilroy Gen for mitigation
	C1	LLAGAS - MORGN J2 115kV Line	CI & ENV	145% - 149%	
	C2	CB FAULT AT METCALF SUB 115 CB492	CI & ENV	135% - 139%	
Metcalf 230/115kV Bank 1	C2	CB FAULT AT METCALF SUB 115 CB492	CI, CC & ENV	161% - 165%	Pre-dispatch LECEF for mitigation
Metcalf 230/115kV Bank 4	C2	CB FAULT AT METCALF SUB 115 CB502	CI, CC & ENV	133% - 136%	
Station D - Station L 115kV Line 1	C2	CB FAULT AT 32790 Station X 115 CB372	CI, CC & ENV	132% - 133%	Pre-dispatch Oakland Gen to mitigate

Greater Bay Area – Summer Peak Results

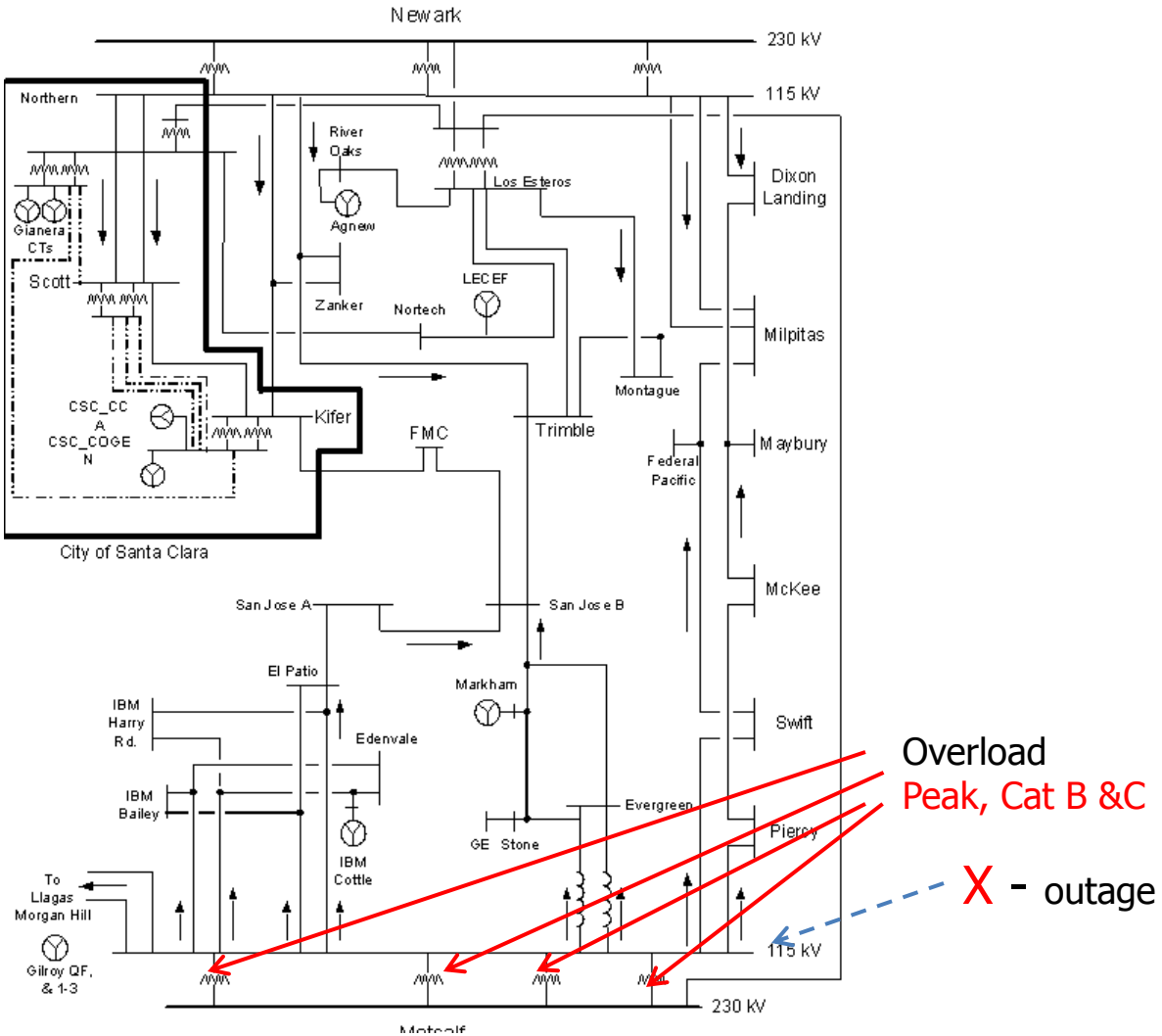
- **Thermal Overloads**

OVERLOADED FACILITY	CATEGORY	WORST CONTIGENCY	PORTFOLIO	LOADING	MITIGATION
Moraga - Station X 115kV Line 1	C2	CB FAULT AT 32780 CLARMNT 115 CB122	CI, CC & ENV	120% - 124%	Pre-dispatch Oakland Gen to mitigate
Moraga - Station X 115kV Line 2			CI, CC & ENV	120% - 124%	
Moraga - Station X 115kV Line 3			CI, CC & ENV	120% - 124%	
Moraga - Station X 115kV Line 1	C1	BUS FAULT AT 32790 Station X 115.00 Bus #1	CI, CC & ENV	123% - 130%	
Moraga - Station X 115kV Line 4	C2	CB FAULT AT 32780 CLARMNT 115 CB122	CI, CC & ENV	122% - 130%	
Moraga - CLARMNT 115kV Line 1	C2	CB FAULT AT 32790 Station X 115 CB372	CI, CC & ENV	110% - 125%	Pre-dispatch Oakland Gen to mitigate
Moraga - CLARMNT 115kV Line 2			CI, CC & ENV	110% - 125%	
OAK C115 - Station X 115kV Line 2	C2	CB FAULT AT 32780 CLARMNT 115 CB122	CI, CC & ENV	120% - 121%	Pre-dispatch Oakland Gen to mitigate
PITSBURG - LMEC 115kV Line 1	C2	CB FAULT AT 32950 PITSBURG 115 CB222	CI, CC & ENV	121%	Decrease LMEC Generation
PITSBURG - LMEC 115kV Line 2	C2	CB FAULT AT 32950 PITSBURG 115 CB212	CI, CC & ENV	108%	
Moraga 230/115kV Bank 3	C2	CB FAULT AT 33020 Moraga 115 CB502	CI, CC & ENV	113%	Pre-dispatch Pittsburg & LMEC Generation

Greater Bay Area – diagram



Greater Bay Area – diagram



Greater Bay Area – Summer Peak Results

- **Voltage Concerns , high voltage**
  - None
- **Voltage Concerns , low voltage**
  - San Jose, Morgan Hill & Llagas Area 115 kV (Cat B, C1 & C2 /Commercial Interest, CC & Environmental)
    - Mitigation – Pre-dispatch Gilroy Gen for voltage support
- **Voltage (Drop) Deviation**
  - San Jose, Morgan Hill & Llagas Area 115 kV (Cat B, C1 & C2 /Commercial Interest, CC & Environmental)
    - Mitigation – Pre-dispatch Gilroy Gen for voltage support

Greater Bay Area – Summer Off-Peak Results

- **Thermal Overloads**

OVERLOADED FACILITY	CATEGORY	WORST CONTIGENCY	PORTFOLIO	LOADING	MITIGATION
TRIMBLE - San Jose B 115kV Line	C5	Los Esteros - Trimble & Los Esteros - Montague 115 Kv	CI, CC & ENV	102% - 120%	reconductor

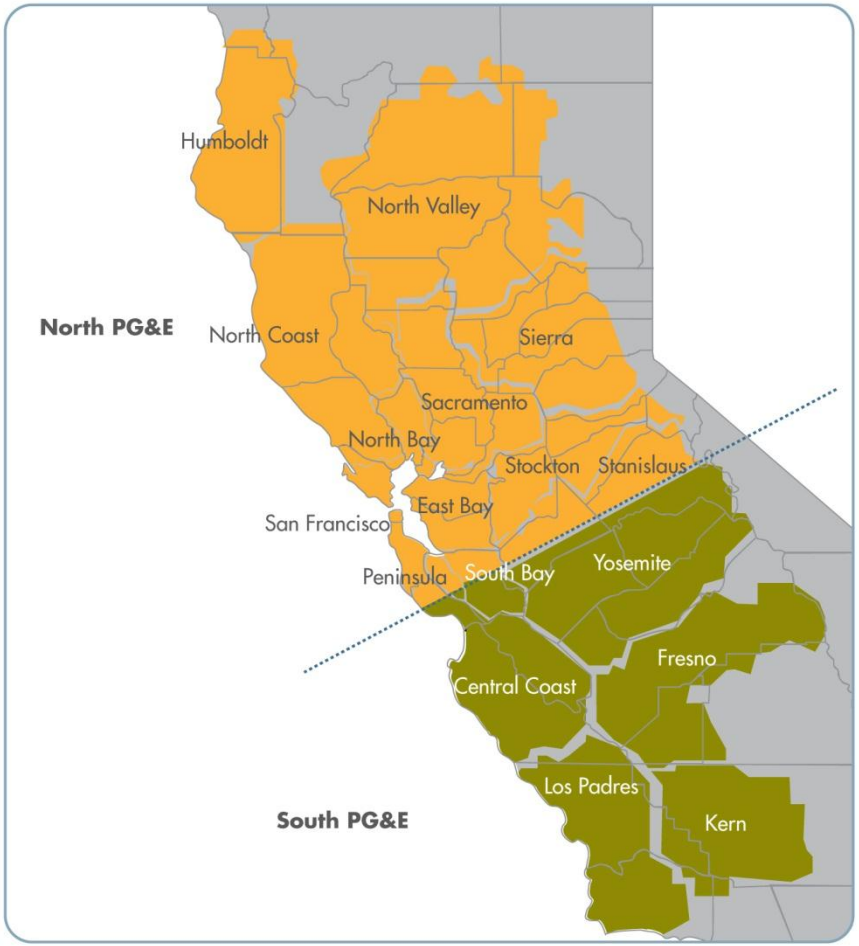
Greater Bay Area – Off Peak Results

- **Thermal Overloads**
  - None
- **Voltage Concerns, low voltage**
  - Mission Area 230 kV low voltage (Cat B & C5 / Commercial Interest & CC Portfolio)
    - Mitigation - boost voltage support from Russell City Gen
- **Voltage (Drop) Deviation**
  - Mission Area 230 kV voltage drop (Cat B & C5 / Commercial Interest & CC Portfolio)
    - Mitigation - boost voltage support from Russell City Gen

South PG&E Area

Zones:

- Fresno
- Yosemite
- Kern
- Central coast & Los Padres



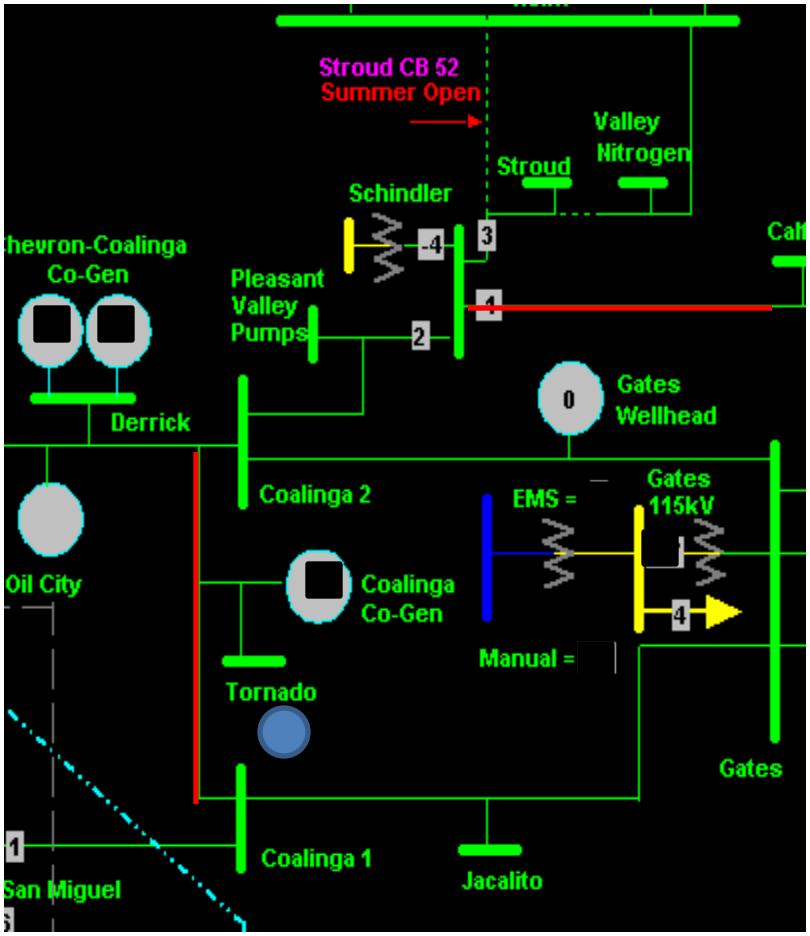
Fresno and Kern Peak Results

ID	Overloaded Facility Name	Worst Contingency	Category	Category Description	Facility Loading by Portfolio (%)			ISO Recommended Solution
					Cost	Comm'l	Enviro	
					peak	peak	peak	
Fres-Peak-T-01	Wilson-Le Grand 115kV	Bus Fault at Mendota 115kV	C1	Bus	100%	130%	135%	Reconductor Wilson-Le Grand 115kV
Fres-Peak-T-02	Dairyland-Le Grand 115kV	Bus Fault at Mendota 115kV	C1	Bus	87%	114%	111%	Reconductor Dairyland-Le Grand 115kV
Fres-Peak-T-03	Schindler-Huron-Gates 70kV	CB102 Failure at Panoche 115kV	C2	Breaker	147%	147%	160%	Sectionalize 115kV bus at Panoche
Fres-Peak-T-04	Coalinga-Coalinga #1 70kV	CB102 Failure at Panoche 115kV	C2	Breaker	104%	104%	109%	Sectionalize 115kV bus at Panoche
Fres-Peak-T-05	Schindler-Coalinga #2 70kV	CB102 Failure at Panoche 115kV	C2	Breaker	119%	119%	128%	Sectionalize 115kV bus at Panoche
Fres-Peak-T-06	Borden-Gregg #1 230kV	CB102 Failure at Herndon 115kV	C2	Breaker	100%	101%	98%	Sectionalize 115kV bus at Panoche
Fres-Peak-T-07	Borden-Gregg #1 230kV	CB202 Failure at Herndon 230kV	C2	Breaker	N/A	N/A	112%	Sectionalize 230kV bus at Herndon
Fres-Peak-T-08	Manchester-Airways-Sanger 115kV	CB202 Failure at Herndon 230kV	C2	Breaker	N/A	N/A	112%	Sectionalize 230kV bus at Herndon
Fres-Peak-T-09	Schindler-Huron-Gates 70kV	Panoche-Schindler #1 & #2 115kV	C5	L-2	177%	177%	190%	SPS to DEC renewables in area
Fres-Peak-T-10	Schindler-Coalinga #2 70kV	Panoche-Schindler #1 & #2 115kV	C5	L-2	114%	114%	119%	SPS to DEC renewables in area
Fres-Peak-T-11	Wilson-Le Grand 115kV	Borden-Gregg #1 & #2 230kV	C5	L-2	99%	99%	103%	Reconductor Wilson-Le Grand 115kV
Kern-Peak-T-01	None							

Fresno and Kern Off Peak Results

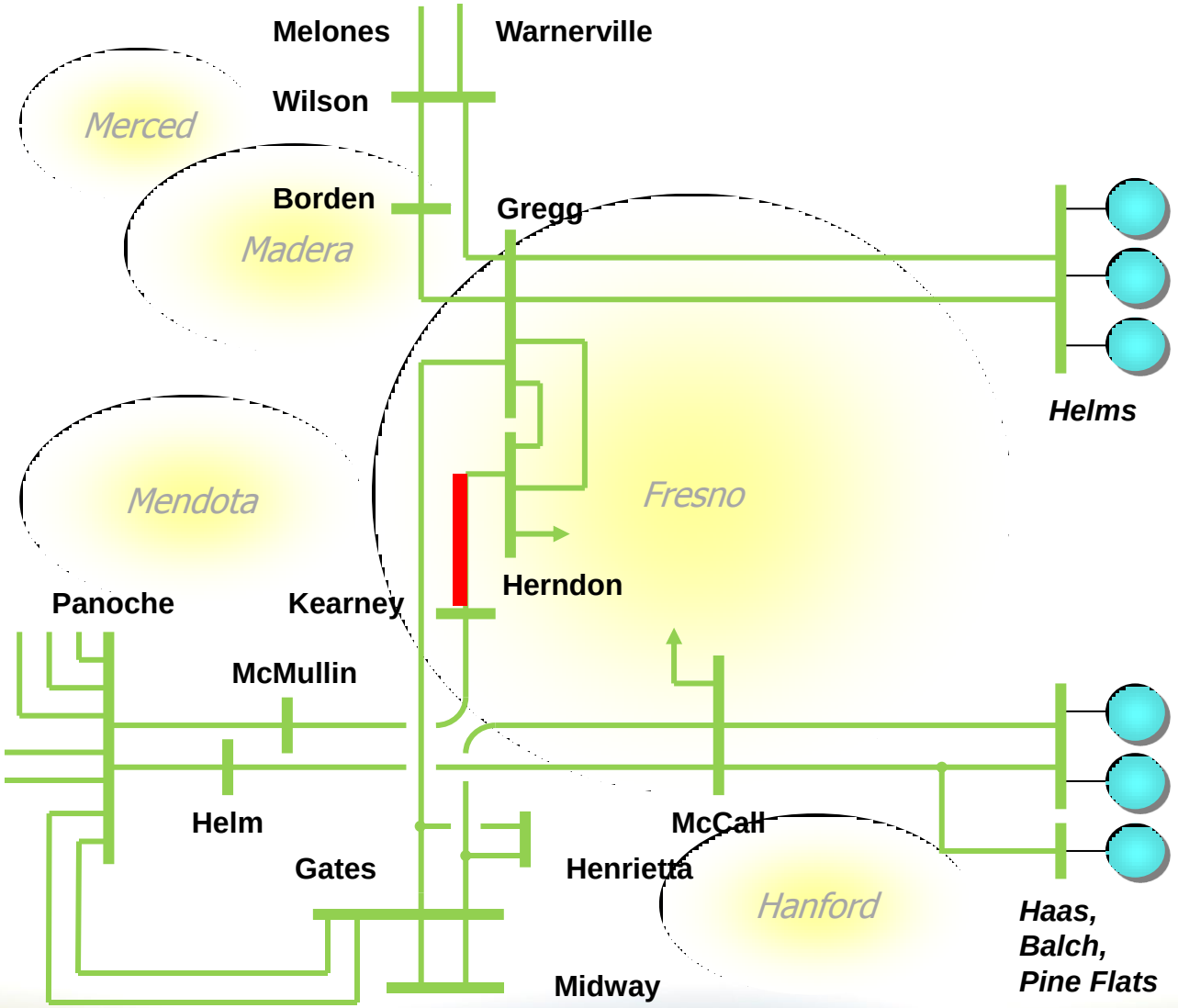
ID	Overloaded Facility Name	Worst Contingency	Category	Category Desc.	Facility Loading by Portfolio (%)				ISO Recommended Solution
					Cost	Comm'l	Enviro	DG	
					Off Peak	Off Peak	Off Peak	Off Peak	
Fres-OffPk-T-01	Exchequer-Le Grand 115kV	Bus Fault at Merced 70kV	C1	Bus	94.0%	93.0%	93.0%	104.0%	Exchequer SPS already in place
Fres-OffPk-T-02	Exchequer-Le Grand 115kV	Bus Fault at Merced Falls 70kV	C1	Bus	94.0%	93.0%	93.0%	103.0%	Exchequer SPS already in place
Fres-OffPk-T-03	Exchequer-Le Grand 115kV	Bus Fault at Merced 115kV	C1	Bus	93.0%	93.0%	93.0%	105.0%	Exchequer SPS already in place
Fres-OffPk-T-04	Wilson-Le Grand 115kV	Bus Fault at Mendota 115kV	C1	Bus	77.0%	100.0%	101.0%	147.0%	Reconductor Wilson-Le Grand 115kV
Fres-OffPk-T-05	Merced Falls-Exchequer 70kV	Bus Fault at Le Grand 115kV	C1	Bus	N/A	N/A	330.0%	217.0%	Exchequer SPS already in place
Fres-OffPk-T-06	Schindler-Huron-Gates 70kV	CB202 Failure at Panoche 230kV	C2	Breaker	N/A	N/A	N/A	116.2%	SPS to DEC renewable in area
Fres-OffPk-T-07	Schindler-Huron-Gates 70kV	CB102 Failure at Panoche 115kV	C2	Breaker	N/A	N/A	N/A	184.8%	SPS to DEC renewable in area
Fres-OffPk-T-08	Kearney-Herndon 230kV	Gates-Gregg 230kV & Gates-McCall 230kV	C5	L-2	N/A	105.0%	N/A	N/A	Reconductor Kearney-Herndon 230kV
Fres-OffPk-T-09	Manchester-Airways-Sanger 115kV	Herndon-Kearney 230kV & Gates-Gregg 230kV	C5	L-2	121.0%	124.0%	119.0%	90.0%	Reconductor Herndon-McCall 115kV system or upgrade to 230kV
Fres-OffPk-T-10	Manchester-Airways-Sanger 115kV	Panoche-Kearney 230kV & Gates-Gregg 230kV	C5	L-2	124.0%	127.0%	123.0%	93.0%	Reconductor Herndon-McCall 115kV system or upgrade to 230kV
Kern-OffPk-T-01	None								

Fresno Area 70 kV Overload Summary-Peak/Offpeak

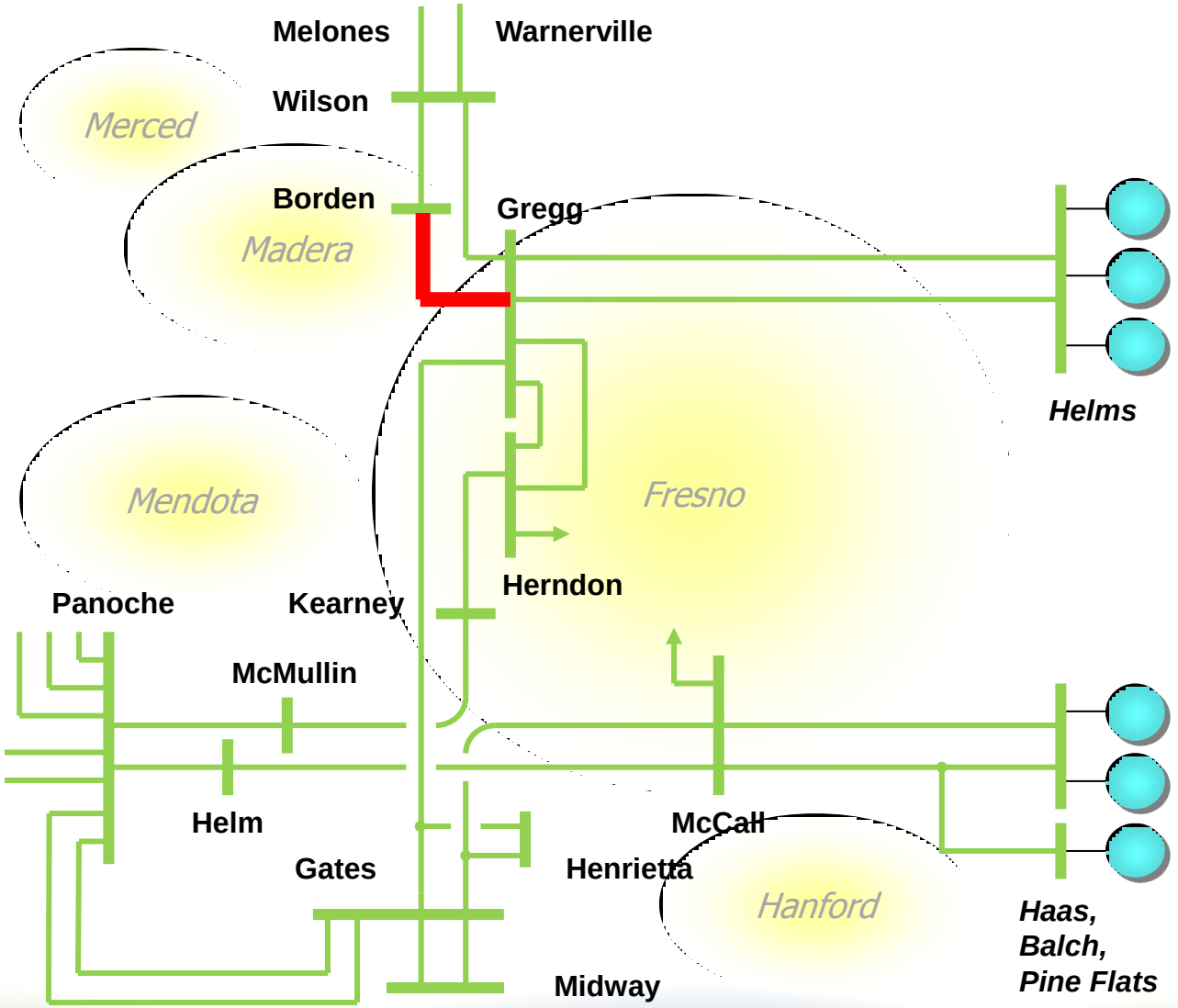


Renewable Generation

Fresno Area 230/115 kV Overload Summary-Off Peak



Fresno Area 230/115 kV Overload Summary-Peak



Fresno Area 230kV & 115kV Mitigation Summary

- Category A overload
  - None
- Category B & C overloads (Peak)
  - Dairyland-Le Grand-Wilson 115kV (C1)
    - Portfolios : All
    - Reconductor two weak 115kV paths from Panoche to Wilson
  - Borden-Gregg #1 230kV (C2)
    - Portfolios : All
    - Sectionalize Herndon 230kV bus and Herndon 115kV bus

Fresno Area 230kV & 115kV Mitigation Summary

- Category B & C overloads (Off-Peak)
  - Kearney-Herndon 230 kV line (C5)
    - Portfolios : Commercial Interest
    - Reconductor Line
  - Manchester-Airways-Sanger 115kV line (C5)
    - Portfolios : Cost, Comm'l, & Enviro
    - Mitigation : Reconductor Herndon-Sanger 115kV path
  - Wilson-Le Grand 115kV (C1)
    - Portfolios : Comm'l, Enviro, & HDG
    - Mitigation : Reconductor the line

Kern Area Mitigation Summary

- Category A, B & C overloads
  - None

Fresno & Kern Off Peak Voltage Results & Mitigation

ID	Substation	Worst Contingency	Category	Category Desc.	Per Unit Voltage by Portfolio				ISO Recommended Solution
					Cost	Comm'l	Enviro	DG	
					Off Peak	Off Peak	Off Peak	Off Peak	
Fres-OffPk-V-01	Reedley 70kV area	Base Case	A	N-0	1.063	1.063	1.064	1.074	
Fres-OffPk-V-02	Kerckhoff 2 PH 115kV area	Base Case	A	N-0	1.064	1.065	1.067	1.073	
Fres-OffPk-V-03	Los Banos 70kV area (Livingston Jct Bus)	Base Case	A	N-0	1.005	1.034	1.041	1.082	
Fres-OffPk-V-04	Borden 70kV system (Borden 70kV bus)	Borden-Gregg #1 & #2 230kV	C5	L-2	1.147	1.147	1.134	1.142	SPS to drop RPS generation post-contingency
Kern-OffPk-V-01	Chevron Lost Hills 70kV	Base Case	A	N-0	0.939	0.948	0.951	0.946	

Fresno & Kern Peak Voltage Results & Mitigation

ID	Substation	Worst Contingency	Category	Category Description	Per Unit Voltage by Portfolio			ISO Recommended Solution
					Cost	Comm'l	Enviro	
					peak	peak	peak	
Fres-Peak-V-01	Bonita 70kV	Base System	A	N-0	0.944	0.976	0.959	
Fres-Peak-V-02	Fresno Waste Water 70kV tap	Base System	A	N-0	1.058	1.06	1.057	
Fres-Peak-V-03	Mariposa 70kV	Bus Fault at Exchequer 115kV	C1	Bus	0.887	0.954	0.898	Add voltage support at Mariposa 70kV
Fres-Peak-V-04	Bonita 70kV	Bus Fault at Le Grand 115kV	C1	Bus	0.839	0.874	0.853	Add reactive support at Merced 70kV
Fres-Peak-V-05	Merced 70kV	Bus Fault at Le Grand 115kV	C1	Bus	0.896	0.928	0.897	Add reactive support at Merced 70kV
Fres-Peak-V-06	Oakhurst 115kV	Bus Fault at Kerckhoff 2 115kV	C1	Bus	0.844	0.836	0.870	Add reactive support at Oakhurst 115kV
Fres-Peak-V-07	Bonita 70kV	CB102 Failure at Wilson 115kV	C2	Breaker	0.884	0.908	0.901	Add reactive support at Merced 70kV
Fres-Peak-V-08	Herndon-McCall 115kV system (Manchester bus)	CB202 Failure at Herndon 230kV	C2	Breaker	N/A	N/A	0.864	Add reactive support on Herndon-McCall 115kV system
Fres-Peak-V-09	Borden 70kV	Borden-Gregg #1 & #2 230kV	C5	L-2	1.115	1.105	1.11	Add reactive support at Borden 70kV
Kern-Peak-V-01	Chevron Lost Hills 70kV	Base System	A	N-0	0.947	0.953	0.947	
Kern-Peak-V-02	System Wide	Base System	A	N-0	~1.05	~1.05	~1.05	

Fresno - Kern Peak & Off Peak Voltage Conclusions

- On Peak Voltage Concerns
  - TPP Low voltage conditions get worse
    - Mitigation – Rely on TPP proposed mitigation.
  - High voltage problems for Normal conditions (N-0)
    - Mitigation- Require .95 lead lag reactive power capability from renewable gens.
  - Voltage deviations
    - Mitigation- Rely in TPP proposed mitigation/ Require .95 lead lag reactive power capability from renewable gens.
- Off Peak Voltage concerns
  - High voltage problems for Normal conditions (N-0)
    - Mitigation- Require .95 lead lag reactive power capability from renewable gens.
  - Voltage deviations
    - Mitigation- Require .95 lead lag reactive power capability from renewable gens

Central Coast & Los Padres Area – Summer Peak Results

- **Thermal Overloads - Peak**

PG&E Central Coast & Los Padres, 2022 Peak Load Study Conditions								
Thermal Overloads								
Overloaded Facility	Worst Contingency	Category	Category Description	Loading (%)				Potential Mitigation
				CI	CC	ENV	HDG	
Morro Bay-Solar SS 230 kV #1 Line	CB Fault at Morro Bay Sub 230 kV CB622	C2	CB	112.7%	110.9%	110.8%	-	Reconductor /SPS
San Luis Obispo-Carrizo 115 kV #1 Line	Morro Bay-SolarSS 230 kV Line #1 & 2	C5	DCTL	120.8%	119.0%	121.4%	-	Reconductor /SPS

Central Coast & Los Padres Area – Summer Peak Results

- **Voltage Concerns - Peak**

PG&E Central Coast & Los Padres, 2022 Peak Load Study Conditions								
Voltage Concerns								
Substation	Worst Contingency	Category	Category Description	Voltage (PU)				Potential Mitigation
				CI	CC	ENV	HDG	
TT2286 115 kV	Bus 1 Fault at Mesa 115 kV	C1	Bus	0.83	0.85	0.83	-	Install reactive support/drop load
TT2286 115 kV	CB Fault at Morro Bay Sub 230 kV CB622	C2	CB	0.79	0.83	0.81	-	Install reactive support/drop load
TT2286 115 kV	Morro Bay-SolarSS 230 kV Line #1 & 2	C5	DCTL	0.82	0.84	0.84	-	Install reactive support/drop load
TT2284 115 kV	Bus 1 Fault at Mesa 115 kV	C1	Bus	0.83	0.85	0.83	-	Install reactive support/drop load
TT2284 115 kV	CB Fault at Morro Bay Sub 230 kV CB622	C2	CB	0.79	0.83	0.81	-	Install reactive support/drop load
TT2284 115 kV	Morro Bay-SolarSS 230 kV Line #1 & 2	C5	DCTL	0.82	0.84	0.84	-	Install reactive support/drop load

Central Coast & Los Padres Area – Summer Peak Results

- **Voltage Deviation - Peak**

PG&E Central Coast & Los Padres, 2022 Peak Load Study Conditions								
Voltage Deviation								
Overloaded Facility	Worst Contingency	Category	Category Description	Post Contingency Voltage Deviation (%)				Potential Mitigation
				CI	CC	ENV	HDG	
TT2286 115 kV	Bus 1 Fault at Mesa 115 kV	C1	Bus	-13.1%	-12.5%	-12.9%	-	Install reactive support/drop load
TT2286 115 kV	CB Fault at Morro Bay Sub 230 kV CB622	C2	CB	-16.3%	-14.1%	-15.2%	-	Install reactive support/drop load
TT2286 115 kV	Morro Bay-SolarSS 230 kV Line #1 & 2	C5	DCTL	-13.9%	-13.6%	-12.5%	-	Install reactive support/drop load
TT2284 115 kV	Bus 1 Fault at Mesa 115 kV	C1	Bus	-13.1%	-12.5%	-12.9%	-	Install reactive support/drop load
TT2284 115 kV	CB Fault at Morro Bay Sub 230 kV CB622	C2	CB	-16.4%	-14.1%	-15.2%	-	Install reactive support/drop load
TT2284 115 kV	Morro Bay-SolarSS 230 kV Line #1 & 2	C5	DCTL	-14.0%	-13.6%	-12.5%	-	Install reactive support/drop load

Central Coast & Los Padres Area–Summer Off Peak Results

Thermal Overload – Off Peak

PG&E Central Coast & Los Padres, 2022 Off-Peak Load Study Conditions								
Thermal Overload (%)								
Overloaded Facility	Worst Contingency	Category	Category Description	Loading (%)				Potential Mitigation
				CI	CC	ENV	HDG	
Morro Bay-Solar SS 230 kV #1 Line	Midway-Caliente SS 230 kV Line #1 & 2	C5	DCTL	106.0%	106.4%	107.2%	99.9%	Reconductor/SPS
Morro Bay-Solar SS 230 kV #2 Line	Midway-Caliente SS 230 kV Line #1 & 2	C5	DCTL	106.0%	106.4%	107.2%	99.9%	Reconductor/SPS

Voltage Concerns – Off Peak

PG&E Central Coast & Los Padres, 2022 Off-Peak Load Study Conditions								
Voltage Concerns								
Substation	Worst Contingency	Category	Category Description	Voltage (PU)				Potential Mitigation
				CI	CC	ENV	HDG	
TT2286 115 kV	Mesa-Divide #1 and #2 115 kV Lines	C5	DCTL	0.71	0.72	0.72	0.8	Install reactive support/drop load
TT2284 115 kV	Mesa-Divide #1 and #2 115 kV Lines	C5	DCTL	0.71	0.72	0.72	0.8	Install reactive support/drop load

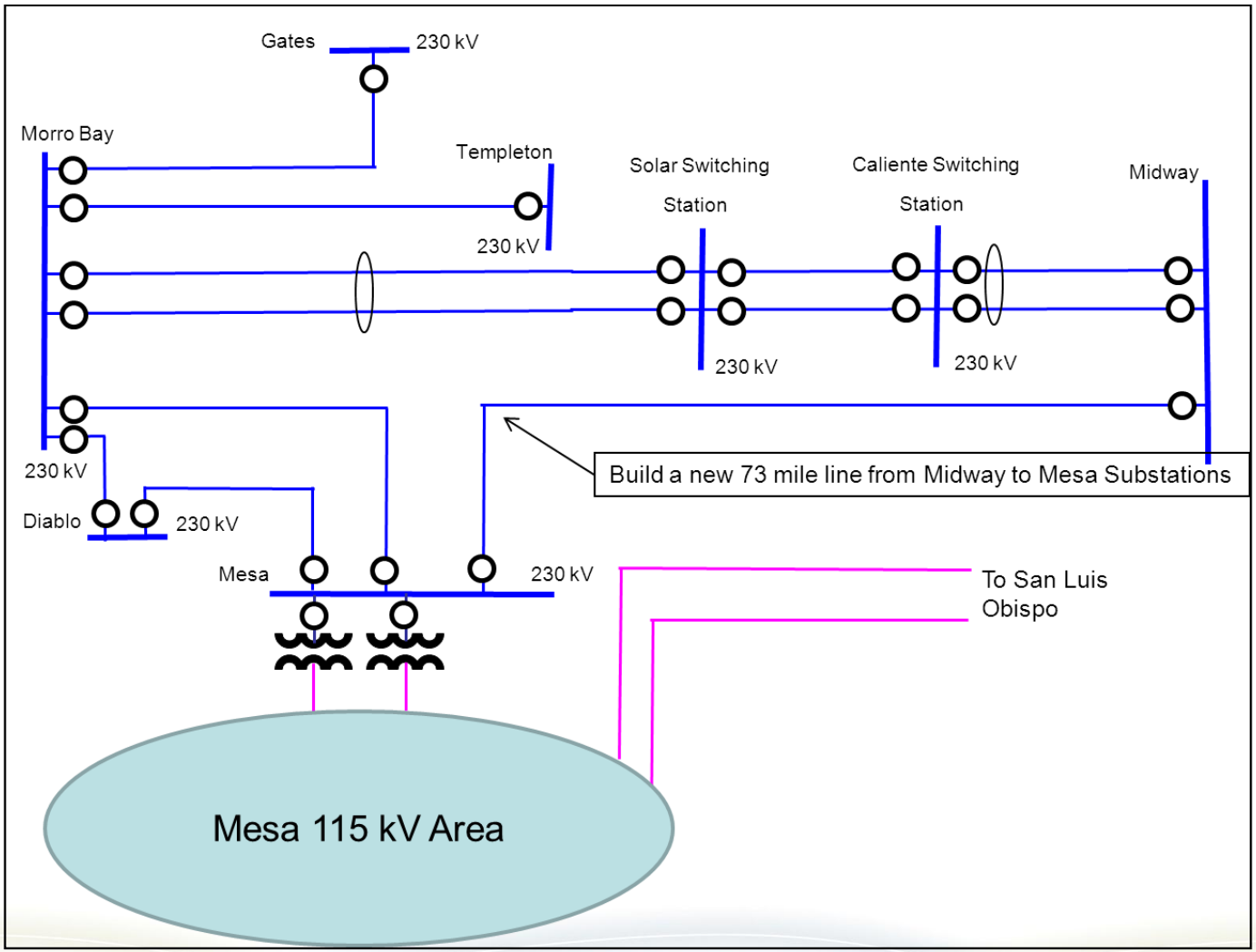
Voltage Deviation Concerns – Off Peak

PG&E Central Coast & Los Padres, 2022 Off-Peak Load Conditions								
Voltage Deviation (%)								
Overloaded Facility	Worst Contingency	Category	Category Description	Post Contingency Voltage Deviation (%)				Potential Mitigation
				CI	CC	ENV	HDG	
TT2286 115 kV	Mesa-Divide #1 and #2 115 kV Lines	C5	DCTL	-27.3%	-26.8%	-25.8%	-20.7%	Install reactive support/drop load
TT2284 115 kV	Mesa-Divide #1 and #2 115 kV Lines	C5	DCTL	-27.3%	-26.8%	-25.8%	-20.7%	Install reactive support/drop load

Central Coast & Los Padres Area Conclusions

- Thermal Overloads
  - Two new Category C (C5 and C2) facility overloads were identified for the peak conditions
    - Mitigation – Reconductor or SPS.
  - Two new Category C (DCTL) facility overloads were identified for the off-peak conditions
    - Mitigation- Reconductor or SPS
- Voltage concerns
  - The newly modeled RPS substations (TT2284 and TT2286) connecting to Manville and Lompoc 115 kV subs experience Category C low voltages under both peak and off-peak conditions
    - Mitigation- Renewables need to provide .95 Lead/Lag power factor capability, drop load or install reactive support.
  - Voltage deviations
    - RPS substations (TT2284 and TT2286) experience voltage deviations outside criteria requirements

Central Coast & Los Padres Area 230 and 115 kV Facility Overload Summary



PG&E Area – Bulk System

- **Bulk System Studies**
  - Post-transient and transient stability analysis for all four portfolios
  - Peak and off-peak conditions
  - All single and double 500 kV outages studied, large generation outages, three-phase faults with normal clearing, single-phase-to-ground faults with delayed clearing

Thermal Overloads, Bulk System North PG&E – Peak

Overloaded Facility	Contingency	Category	Category Description	Loading (%)			Potential Mitigation Solutions
				Comm Interest	Cost	Environ	
DELEVAN-CORTINA 230 #1	Olinda-Tracy 500 kV	B	L-1	99.0%	99.1%	95.0%	trip Colusa generation or upgrade the line
	ROUND MT-TABLE MT 500 #1 and 2	C	L-2	103.7%	102.1%	99.0%	
	Table Mtn 500 kV stuck brk	C	BRK	95.6%	95.6%	<95%	
	Tesla 500 kV stuck brk	C	BRK	96.4%	96.1%	<95%	
	Vaca Dix 500 kV stuck brk # 732	C	BRK	98.4%	97.8%	<95%	
NRS 400 -SRS 115 #1	Tesla-Metcalf 500 kV	B	L-1	99.8%	98.3%	104.0%	upgrade the line, overloads with lower voltage outages

Thermal Overloads, Bulk System North PG&E – Off Peak

Overloaded Facility	Contingency	Category	Category Description	Loading (%)				Potential Mitigation Solutions
				Comm Interest	Cost	Environ	High DG	
TABLE MTN 500/230kV transformer	normal conditions	A	base case	<95%	<95%	<95%	98.7%	Congestion mangmnt if overload, reduce Feather River gen
	Round Mtn 500/230 kV transformer	B	T-1	<95%	<95%	<95%	101.9%	Trip Hyatt generation or limit Table Mtn 500/230 transformer flow
	MALIN-ROUND MT 500 # 1 and 2	C	L-2	<95%	<95%	<95%	101.0%	
	ROUND MT-TABLE MT 500 # 1 and 2	C	L-2	<95%	<95%	<95%	101.6%	
ROUND MTN 500/230 kV transformer	Olinda 500/230 kV transformer	B	T-1	107.4%	110.1%	114.9%	<95%	Trip Colusa generation, or don't dispatch Colusa off -peak
	Captain Jack -Olinda 500 kV	B	L-1	<95%	<95%	100.4%	<95%	
OLINDA 500/230 kV transformer	Round Mtn 500/230 kV transformer	B	T-1	104.9%	108.4%	113.2%	<95%	Trip Colusa generation, or don't dispatch Colusa off -peak
	MALIN-ROUND MT 500 # 1 and 2	C	L-2	<95%	<95%	103.5%	<95%	
RIO OSO- BRIGHTON 230 #1	Table Mtn 500/230 kV transformer (no SPS)	B	T-1	102.7%	104.2%	103.4%	125.2%	No overload w/SPS, but transient stability violations Mitigation: Modify SPS or Limit the flow on Table Mountain transformer to < 870 MW
RIO OSO -LOCKFORD 230 #1		B	T-1	<95%	<95%	<95%	106.8%	
ATLANTC - GOLDHILL 230.0 #1		B	T-1	97.2%	99.8%	97.9%	118.0%	

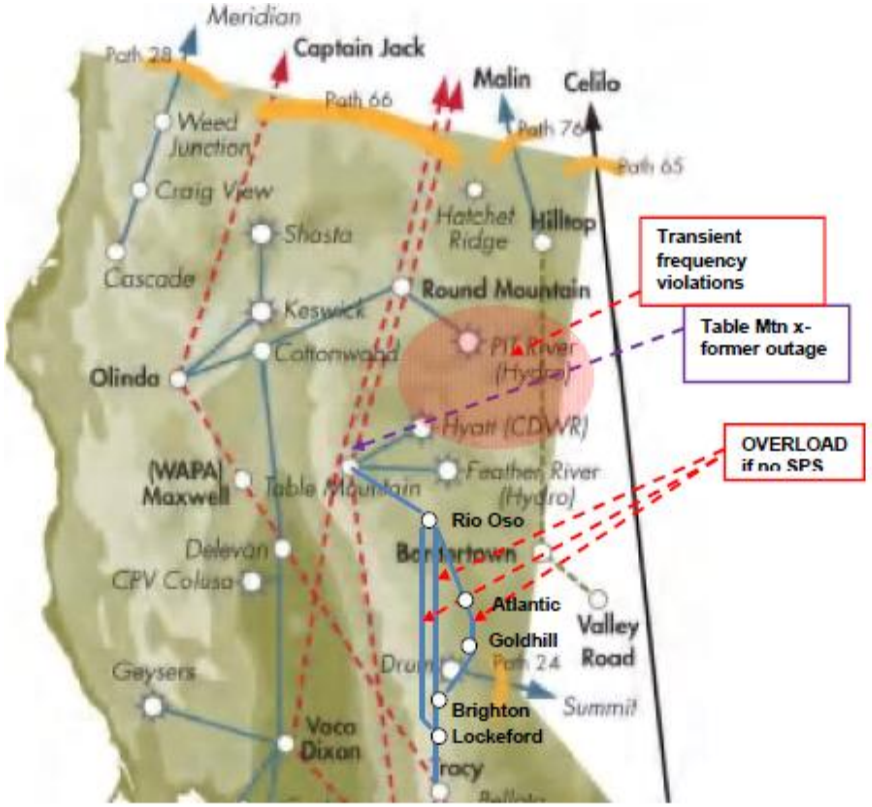
Table Mountain 500/230 kV Transformer Outage Off-Peak

Concerns

- Existing SPS to trip Hyatt and Thermalito generation
- Overload if SPS not applied
- Large transient frequency dip with SPS

Mitigation

- Modify SPS - trip Colgate, Poe, Butt Vly, Honey Lake, Win&AMD gen instead of Hyatt and Thermalito
- Limit Table Mtn x-former 230-to-500 kV flow to under 870 MW



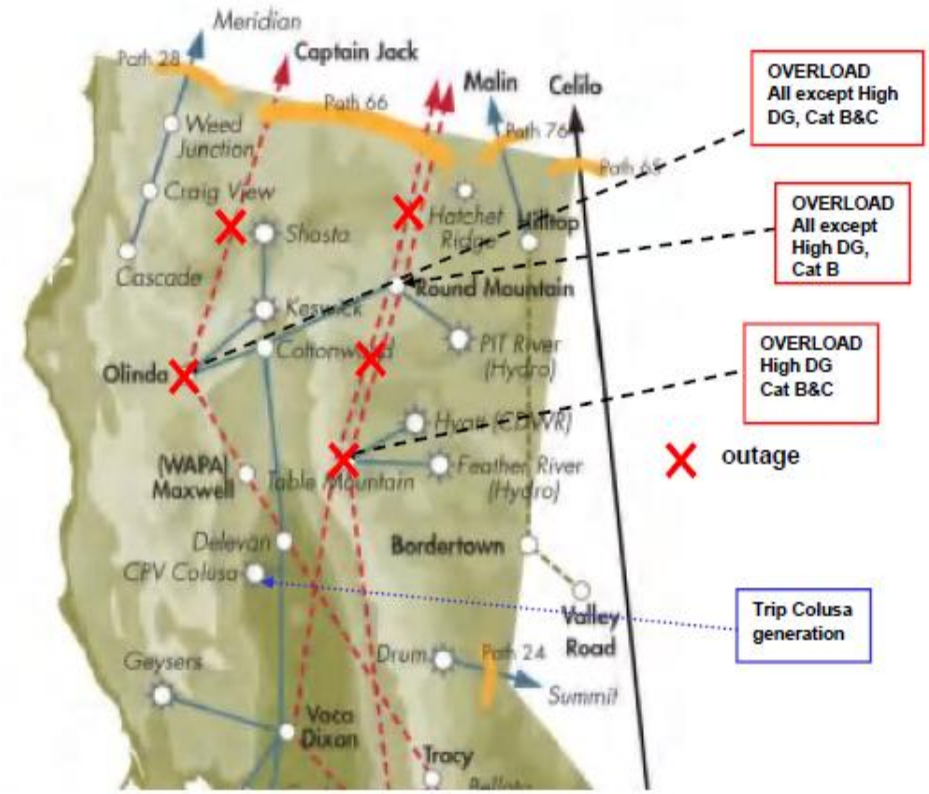
500/230 kV Transformer Overloads in North PG&E, Off-Peak

Concerns

- Table Mtn 500/230 kV overloads in High DG with Cat B&C
- Olinda and Round Mtn 500/230 kV overload in all other scenarios with ENV being the most critical

Mitigation

- Limit Table Mtn transformer 230-to-500 kV flow to under 870 MW
- Modify existing Colusa SPS to monitor transformer outages and to trip Colusa units also for Round Mtn transformer overload



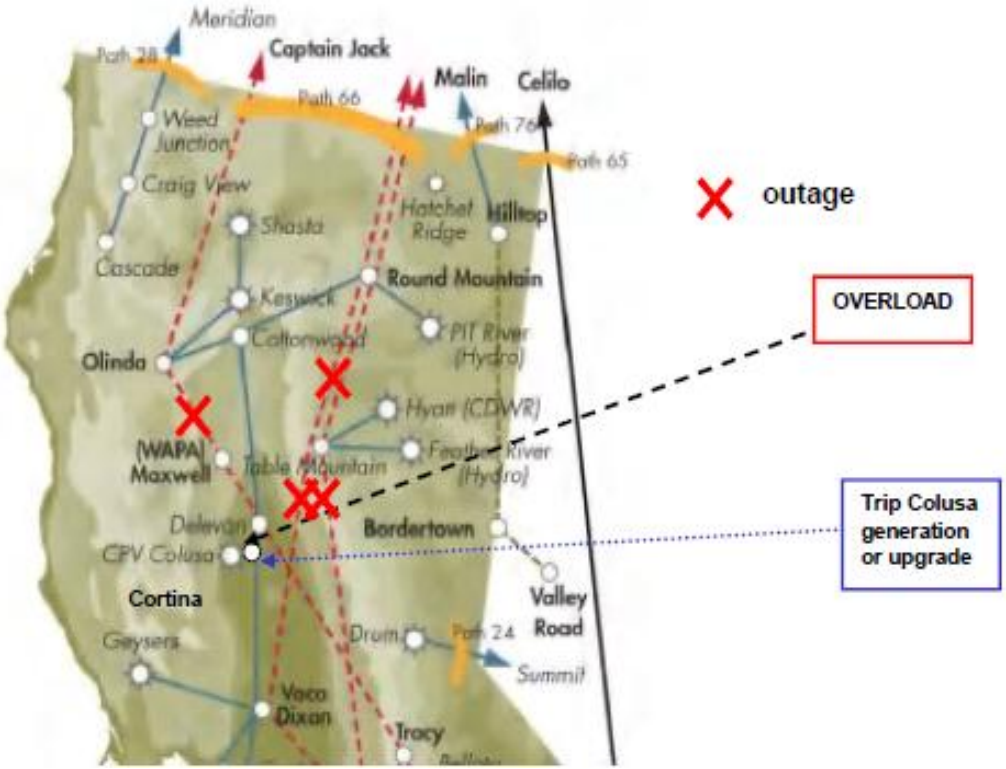
Delevan-Cortina 230 kV Line Overload, Peak Conditions

Concerns

- Up to 99% loading with Olinda-Tracy outage
- Category C overloads
- CI and CC scenarios are the most critical

Mitigation

- Trip Colusa generation or upgrade the line



Transient and Voltage Stability, Bulk System North PG&E

- Transient stability violations with Table Mtn 500/230 kV outage off-peak with SPS, all scenarios
- Large voltage deviations with Table Mtn 500/230 kV outage off-peak if no SPS is applied in High DG
- Wind generators that don't have Low Voltage Ride Through capability may trip with 3-phase faults in Bird Landing-Altamont area – same as in the Reliability Studies

Thermal Overloads, Bulk System South PG&E - Peak

Overloaded Facility	Contingency	Category	Category Description	Loading (%)			Potential Mitigation Solutions
				Comm Interest	Cost	Environ	
WESTLEY -TT22105 230 #1 (also off-peak)	Moss Landg-Los Banos 500	B	L-1	<95%	<95%	96.4%	trip renewable gen connected to Moss Lng-Panoche 230 kV
	Moss Landing 500/230 kV	B	T-1	<95%	<95%	95.3%	
	MALIN-ROUND MT 500 # 1 and 2	C	L-2	101.9%	<95%	100.6%	trip renewable gen connected to Westley-Los Banos or upgrade the line (LGIP)
	ROUND MT-TABLE MT 500 #1 and 2	C	L-2	98.9%	<95%	102.7%	
	DLO 500 kV South of Table Mtn	C	L-2	95.2%	<95%	102.7%	
	Moss Landing 500kV stuck brk	C	L-2	<95%	<95%	96.4%	
MOSSLND2 - TT22113 230 #2 (also off-peak)	Moss Landg-Los Banos 500	B	L-1	<95%	<95%	98.2%	trip renewable gen connected to Moss Lng-Panoche 230 kV
	Moss Landing 500/230 kV	B	T-1	<95%	<95%	102.6%	

Thermal Overloads, Bulk System South PG&E – Off peak

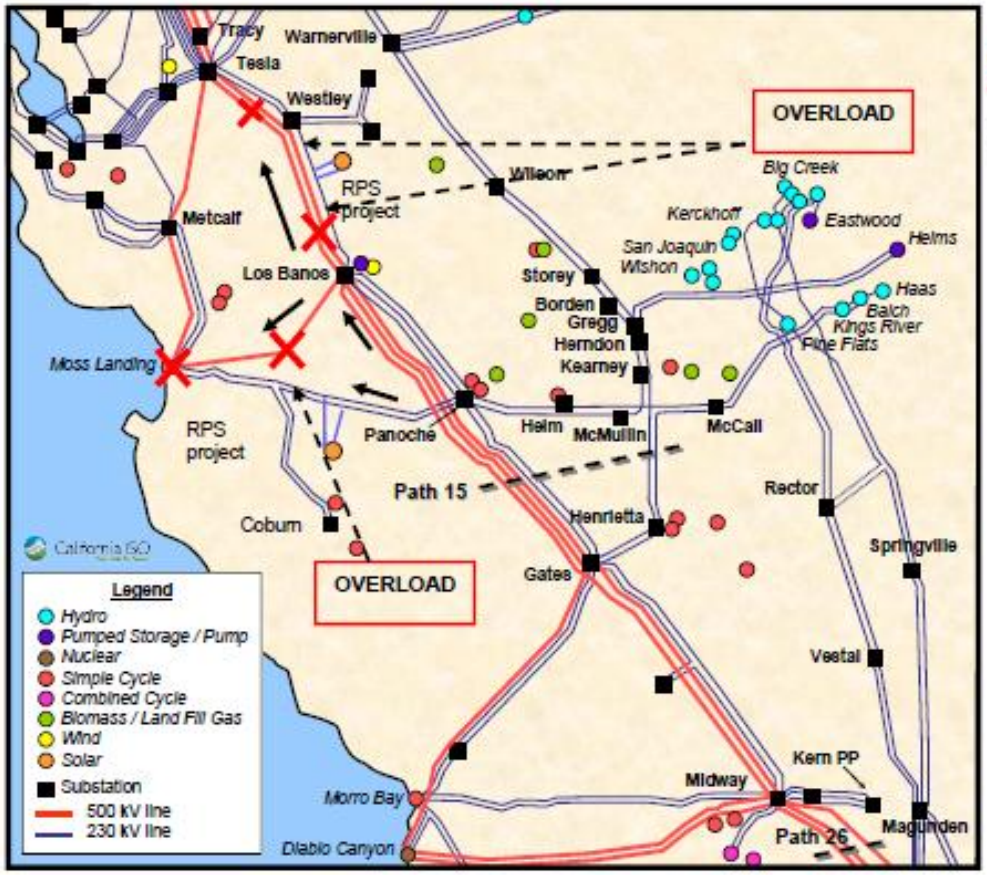
Overloaded Facility	Contingency	Category	Category Description	Loading (%)				Potential Mitigation Solutions
				Comm Interest	Cost	Environ	High DG	
GATES-MIDWAY 500	normal conditions	A	base case	99.1%	<95%	<95%	<95%	congestion management if overload
MOSSLND2 - TT22113 230 #2 (also peak)	Moss Landing-Los Banos 500 kV	B	L-1	96.6%	<95%	<95%	<95%	trip renewable gen connected to Moss Lng-Panoche 230 kV if overload
	Moss Landing 500/230 kV	B	T-1	98.8%	<95%	<95%	<95%	
WESTLEY- TT22105 230 #1 (also peak)	Tesla-Los Banos 500 kV	B	L-1	98.5%	<95%	<95%	<95%	trip renewable gen connected to Westley-Los Banos or line upgrade (LGIP)
	500 kV double outage north of Los Banos	C	L-2	135.3%	117.7%	129.3%	<95%	add tripping of renewable gen at Midway, Los Banos and Southern Cal to SPS or upgrade the line (in CI case, gen trip not enough)
	500 kV double outage south of Tracy	C	L-2	96.3%	<95%	<95%	<95%	
	Los Banos CB#832	C	BRK	96.4%	<95%	<95%	<95%	
LOSBANOS - TT22105 230 #1	500 kV double outage north of Los Banos	C	L-2	127.8%	117.8%	121.9%	<95%	add tripping of renewable gen at Midway, Los Banos and Southern Cal to SPS or upgrade the line
PANOCHE - GATES 230 #1 &2	Gates-Gregg & Gates-Mc Call 230 kV (Switch station)	C	L-2	98.9%	<95%	<95%	<95%	trip one Helms pump
KEARNEY - HERNDON 230 #1		C	L-2	102.4%	98.4%	96.4%	<95%	
GATES - MIDWAY 230.0 #1	500 kV double outage north of Midway	C	L-2	129.4%	118.0%	120.7%	<95%	add tripping renewables at Midway and all Helms pumps to SPS and/or use 30 min rating, above 30 min rating in CI
ARCO - MIDWAY 230.0 #1	500 kV double outage north of Midway	C	L-2	114.8%	105.4%	107.6%	<95%	

230 kV Line Overload in Central California

- The new project will upgrade the section to Westley (in LGIP)

Mitigation of the Los Banos-RPS interconnection section

- Line upgrade or
- Modify RAS for North of Los Banos 500 kV double outage to trip more generation in the south

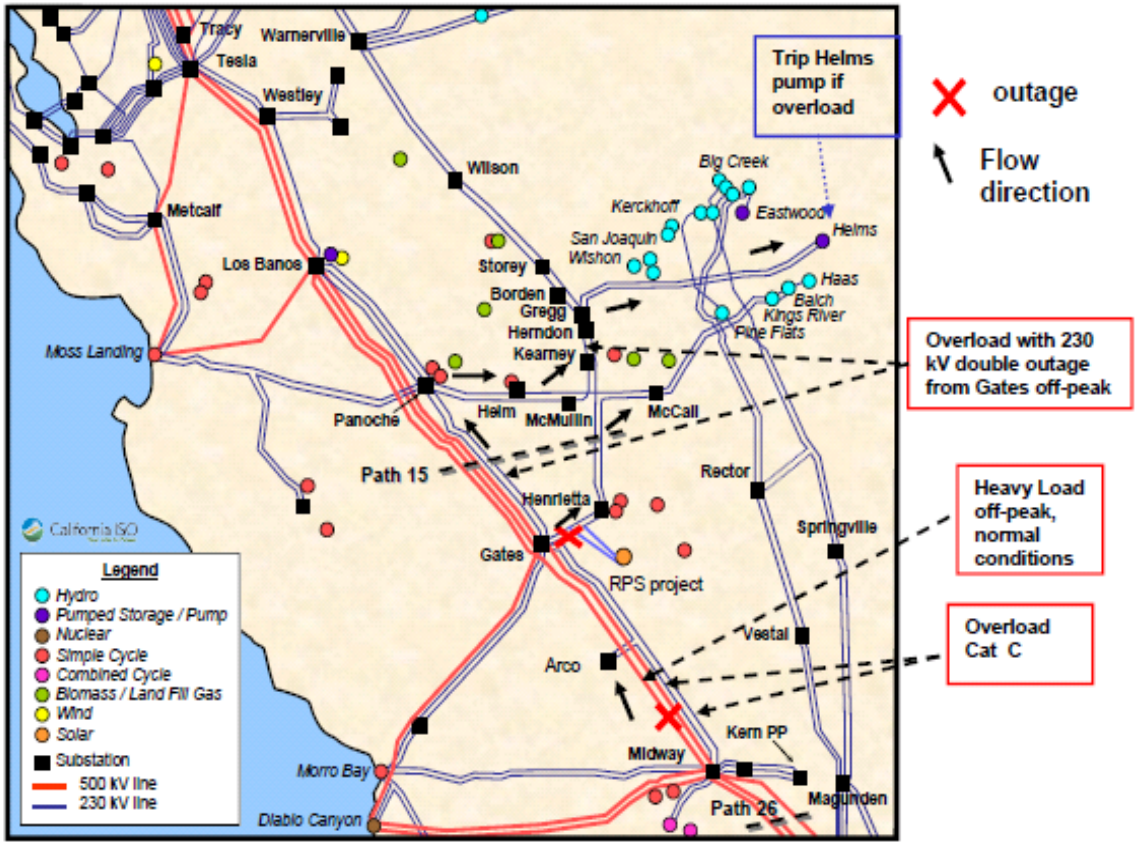


Moss Landing-new RPS section mitigation – install SPS to trip the RPS project if overloads

230 kV Line Overload in Southern PG&E (off-peak)

Mitigation

- Panoche-Gates 230 kV # 1 and 2 and Kearney-Herndon 230 kV – trip one Helms pump
- Gates-Midway and Arco-Midway 230 kV lines – use 30 min emergency rating and add tripping renewables at Midway and all Helms pumps to RAS for North of Midway 500 kV double outage



33% RPS Sensitivity Case Assessment Modeling a High Out of State Import Scenario

Yi Zhang
Senior Regional Transmission Engineer

2012/2013 Transmission Planning Process Stakeholder Meeting
Policy-Driven & Economic Study Preliminary Results

December 11, 2012

Portfolio summary

- Examine effects on the high voltage 500 kV system within California
- Conducted as a sensitivity analysis for informational purposes only
- Removed 3000 MW renewable generation the Commercial Interest portfolio, starting from the bottom of the portfolio's supply curve
- Added 3000 MW generation connected to El Dorado 500 kV bus

Basecase development

- Started from the peak load basecase for Commercial Interest portfolio
- Added 3000 MW renewable generation production at El Dorado
- Adjusted path flows to be within the limits

Path	Flow
West of River	10950
East of River	4187
COI	4800
PDCI	3100
Path 26	-796

Simulation results

Contingencies	Violations	Notes
El Dorado – Lugo and Mohave – Lugo 500 kV line N-2 outage	Victorville – Lugo 500 kV line overload	130% of emergency rating
El Dorado – Lugo and Mohave – Lugo 500 kV line N-2 outage	El Dorado – McCullough 500 kV line overload	139% of emergency rating
El Dorado – Lugo and El Dorado – Mohave 500 kV line N-2 outage	Victorville – Lugo 500 kV line overload	131% of emergency rating
El Dorado – Lugo and El Dorado – Mohave 500 kV line N-2 outage	El Dorado – McCullough 500 kV line overload	140% of emergency rating
Red Bluff – Devers 500 kV #1 and #2 lines N-2 outage	Victorville – Lugo 500 kV line overload	107% of emergency rating
Colorado River – Red Bluff 500 kV #1 and #2 lines N-2 outage	Victorville – Lugo 500 kV line overload	100% of emergency rating
Loss of 3000 MW at El Dorado simultaneously	Case diverged	Mainly caused by voltage instability in NW

Potential Mitigations East of Eldorado

Option 1

- Build a new 500 kV line from El Dorado to Rancho Vista
- Switch-in the second series caps on El Dorado – Lugo and Mohave – Lugo 500 kV lines and upgrade the series cap and line rating to 3800/4000 amps (normal/emergency)
- Relocate El Dorado – Mohave 500 kV line to make El Dorado – Lugo and El Dorado – Mohave a N-1-1 contingency

Option 2

- Convert Mead-Adelanto 500 kV line to DC

Northwest Voltage Instability

- Also identified in GIP Cluster 4, Phase 1 study
- Issue has also been identified in WECC project review groups
- ISO is participating in WECC project review groups to ensure resolution of this issue

Policy Driven Planning Deliverability Assessment Assumptions

Songzhe Zhu
Lead Regional Transmission Engineer

2012/2013 Transmission Planning Process Stakeholder Meeting
December 11-12, 2012

Overview

- Deliverability assessment is performed for the base portfolio.
- Generation dispatch and imports different from the power flow studies
- Same transmission model and loads as in the power flow studies

Objectives of Base Portfolio Deliverability Assessment

- Determine deliverability of the Target Maximum Import Capability
- Determine deliverability of renewable resources inside CAISO BAA
- Identify transmission upgrades to support full deliverability of the renewable resources and Target MIC

Import Assumptions

- 1500 MW total import from IID between IID-SCE branch group and IID-SDGE branch group.
- Maximum summer peak simultaneous historical import schedules on other import branch groups.
- Historically unused Existing Transmission Contracts are modeled by equivalent generators at the tie point.

Generation Assumptions

- Deliverability assessment is performed for generating resources in the base portfolio.
- Generation capacity tested for deliverability
  - Existing non-intermittent resources: most recent summer peak NQC
  - New non-intermittent resources: installed capacity in the base portfolio
  - Intermittent resources: 50% (low level) and 20% (high level) exceedance during summer peak load hours

Policy Driven Planning Deliverability Assessment Results – SCE Area

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Lead Regional Transmission Engineer

Sushant Barave
Senior Regional Transmission Engineer

2012/2013 Transmission Planning Process Stakeholder Meeting
December 11-12, 2012

Overview of renewable zones in SCE area

Renewable Zone	Base Portfolio MW
DG-SCA Muni	112
Distributed Solar - SCE	487
El Dorado	750
Kramer	765
Mountain Pass	665
Nevada C	142
NonCREZ	107
Palm Springs	198
Riverside East	1506
San Bernardino - Lucerne	106
Tehachapi	3395

Deliverability Assessment Results for SCE Area

Overloaded Facility	Contingency	Flow	Undeliverable Renewable Zone	Mitigation
Inyo 115kV phase shifter	Base Case	152%	Nevada C	Upgrade Inyo phase shifter
Control - Inyo 115kV No. 1	Base Case	106%	Kramer (Control)	
Lugo - Kramer 230kV No. 1	Base Case	115%	Nevada C	Coolwater - Lugo 230kV line or AV Clearview project
Lugo - Kramer 230kV No. 2	Base Case	115%	Kramer	
Kramer 230/115kV No. 1	Lugo - Kramer 230kV No. 1 & No. 2	108%	Kramer (Coolwater)	

Deliverability Assessment Results for SCE Area (Cont.)

Overloaded Facility	Contingency	Flow	Undeliverable Renewable Zone	Mitigation
Coolwater - Dunn Siding Loop 115 kV No. 1	Base Case	222%	Kramer (Coolwater 115kV) Mountain Pass	Reconductor Coolwater - Dunnsiding loop 115kV line
Tortilla - Coolwater - SEGS2 115kV No. 1 Kramer - Coolwater 115kV No. 1 Kramer 230/115kV No. 1	Kramer - Coolwater 115kV No. 1 Tortilla - Coolwater - SESG2 115 kV No. 1 Kramer - Victor - Roadway 115kV No. 1 & No. 2	119% 119% 102%	Kramer Lucerne Mountain Pass	SPS to trip generation

Deliverability Assessment Results for SCE Area (Cont.)

Overloaded Facility	Contingency	Flow	Undeliverable Renewable Zone	Mitigation
Lugo - Eldorado 500kV No. 1	Lugo - Victorville 500kV No. 1	110%	Mountain Pass	Lugo - Eldorado series cap and terminal equipment upgrade
	Red Bluff - Colorado River No. 1 & 2	110%	Eldorado	
	Devers - Red Bluff 500kV No. 1 & 2	114%	Riverside East	
Mccullough - Victorville 500kV No. 1	Base Case	101%	Tehachapi (230kV)	
Mccullough - Victorville 500kV No. 2	Base Case	100%	Nevada C	
Lugo - Victorville 500kV No. 1	Devers - Red Bluff 500kV No. 1 & 2	106%	Kramer (Control)	
	Red Bluff - Colorado River No. 1 & 2	102%	SDGE	

Deliverability Assessment Results for SCE Area (Cont.)

Overloaded Facility	Contingency	Flow	Undeliverable Renewable Zone	Mitigation
Lugo - Victorville 500kV No. 1	Lugo - Eldorado 500kV No. 1 & Eldorado - Mohave 500kV No. 1	115%	Eldorado Tehachapi (230kV) Nevada C SDGE	Re-route Lugo - Eldorado line
Pahrump 230/138kV No.1	Bob Tap – Crazy Eye 230kV No. 1 Bob Tap – Mead 230kV No. 1 and Bob Tap – Eldorado 230kV No. 1	101% 102%	Eldorado (VEA)	SPS to trip generation

Policy Driven Planning Deliverability Assessment Results – SDG&E Area

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Regional Transmission Engineer

2012/2013 Transmission Planning Process Stakeholder Meeting
December 11-12, 2012

Overview of renewable zones that impact San Diego area

Renewable Zone	CI Portfolio MW
Arizona	550
San Diego South	384
Baja	100
Imperial-SDGE	921
Imperial-IID	1219
Non-CREZ	17
DG-SDGE	405
Total	**3,596**

Violations caused by Borrego area generation

Overloaded Facility	Contingency	Flow	Undeliverable Renewable Zone	Mitigation
Borrego-Narrows 69 kV	Base Case	142%	Non CREZ, DG-Borrego	Localized concern to be addressed through GIP
Narrows-Warners 69 kV	Base Case	116%	Non CREZ, DG-Borrego	Localized concern to be addressed through GIP

Violations caused by multiple zones

Overloaded Facility	Contingency	Flow	Undeliverable Renewable Zone	Mitigation
Penasquitos-Old Town 230 kV	Base Case	107%	Arizona, Baja, San Diego South, Imperial, DG-SDGE	Upgrade line or New Sycamore-Penasquitos 230 kV line
Miguel-Bay Boulevard 230 kV	Base Case	125%	Arizona, Baja, San Diego South, Imperial, DG-SDGE	Upgrade line (identified as a DNU in C3C4 Ph II)
Miguel-Bay Boulevard 230 kV	Miguel-Mission 230 kV #1	111%	Arizona, Baja, San Diego South, Imperial, DG-SDGE	New Sycamore-Penasquitos 230 kV line or SPS to trip generation
Miguel-Bay Boulevard 230 kV	Miguel-Mission 230 kV #2	111%	Arizona, Baja, San Diego South, Imperial, DG-SDGE	New Sycamore-Penasquitos 230 kV line or SPS to trip generation

Violations caused by multiple zones

Overloaded Facility	Contingency	Flow	Undeliverable Renewable Zone	Mitigation
Miguel-Bay Boulevard 230 kV	Miguel-Mission 230 kV #1 & Miguel-Mission 230 kV #2	133%	Arizona, Baja, San Diego South, Imperial, DG-SDGE	New Sycamore-Penasquitos 230 kV line and SPS to trip generation
Miguel-Bay Boulevard 230 kV	Palomar-Sycamore 230 kV & Encina-San Luis Rey-Palomar 230 kV	106%	Arizona, Baja, San Diego South, Imperial, DG-SDGE	New Sycamore-Penasquitos 230 kV line or SPS to trip generation
Miguel-Bay Boulevard 230 kV	Palomar-Sycamore 230 kV & Artesian-Sycamore 69 kV	106%	Arizona, Baja, San Diego South, Imperial, DG-SDGE	New Sycamore-Penasquitos 230 kV line or SPS to trip generation
Miguel-Bay Boulevard 230 kV	Palomar-Sycamore 230 kV & Batiquitos-Shadowridge 138 kV	105%	Arizona, Baja, San Diego South, Imperial, DG-SDGE	New Sycamore-Penasquitos 230 kV line or SPS to trip generation

Violations caused by multiple zones

Overloaded Facility	Contingency	Flow	Undeliverable Renewable Zone	Mitigation
Miguel-Mission 230 kV #1	Miguel-Bay Boulevard 230 kV	103%	Arizona, Baja, San Diego South, Imperial, DG-SDGE	New Sycamore-Penasquitos 230 kV line or SPS to trip generation
Miguel-Mission 230 kV #2	Miguel-Bay Boulevard 230 kV	103%	Arizona, Baja, San Diego South, Imperial, DG-SDGE	New Sycamore-Penasquitos 230 kV line or SPS to trip generation
Miguel-Mission 230 kV #1	Miguel-Bay Boulevard 230 kV & Telecanyon-Grant Hill 138 kV	114%	Arizona, Baja, San Diego South, Imperial, DG-SDGE	New Sycamore-Penasquitos 230 kV line or SPS to trip generation
Miguel-Mission 230 kV #2	Miguel-Bay Boulevard 230 kV & Telecanyon-Grant Hill 138 kV	114%	Arizona, Baja, San Diego South, Imperial, DG-SDGE	New Sycamore-Penasquitos 230 kV line or SPS to trip generation

Violations caused by multiple zones

Overloaded Facility	Contingency	Flow	Undeliverable Renewable Zone	Mitigation
Mission-Old Town 230 kV #1	Miguel-Bay Boulevard 230 kV	108%	Arizona, Baja, San Diego South, Imperial, DG-SDGE	New Sycamore-Penasquitos 230 kV line or SPS to trip generation
Silvergate-Bay Boulevard 230 kV #1	Miguel-Mission 230 kV #1 & Miguel-Mission 230 kV #2	108%	Arizona, Baja, San Diego South, Imperial, DG-SDGE	New Sycamore-Penasquitos 230 kV line or SPS to trip generation
Sweetwater-Sweetwater Tap 69 kV	Silvergate-Bay Boulevard 230 kV	123%	DG-SDGE	Upgrade line or New Sycamore-Penasquitos 230 kV line

Violations caused by multiple zones

Overloaded Facility	Contingency	Flow	Undeliverable Renewable Zone	Mitigation
Escondido-San Marcos 69 kV	Encina-San Luis Rey 230 kV & Encina-San Luis Rey-Palomar 230 kV	106%	Non CREZ, DG-SDGE	Upgrade line or New Sycamore-Penasquitos 230 kV line
Escondido-San Marcos 69 kV	Encina-San Luis Rey-Palomar 230 kV & Encina-Penasquitos 230 kV	106%	Non CREZ, DG-SDGE	Upgrade line or New Sycamore-Penasquitos 230 kV line
Escondido-San Marcos 69 kV	Encina-San Luis Rey-Palomar 230 kV & Batiquitos-Shadowridge 138 kV	105%	Non CREZ, DG-SDGE	Upgrade line or New Sycamore-Penasquitos 230 kV line

Violations caused by multiple zones

Overloaded Facility	Contingency	Flow	Undeliverable Renewable Zone	Mitigation
Miguel 500/230 kV #1	Miguel 500/230 kV #2	124%	Arizona, Baja, San Diego South, Imperial	Third Miguel 500/230 kV transformer
Miguel 500/230 kV #2	Miguel 500/230 kV #1	121%	Arizona, Baja, San Diego South, Imperial	Third Miguel 500/230 kV transformer
Miguel-ECO 500 kV	Sycamore-Suncrest 230 kV #1 & Sycamore-Suncrest 230 kV #2	101%	Arizona, Baja, San Diego South, Imperial	SPS to trip generation
Miguel-ECO 500 kV	Suncrest-Ocotillo 500 kV	101%	Arizona, Baja, San Diego South, Imperial	SPS to trip generation

Violations caused by multiple zones

Overloaded Facility	Contingency	Flow	Undeliverable Renewable Zone	Mitigation
Otay Mesa-Tijuana 230 kV	Miguel-ECO 500 kV	134%	Arizona, Baja, San Diego South, Imperial	SPS to trip generation and CFE cross trip
Imperial Valley-ROA 230 kV	Miguel-ECO 500 kV	119%	Arizona, Baja, San Diego South, Imperial	SPS to trip generation and CFE cross trip

Sensitivity study – remove Product 2 generation and assume Encina Repower

- Remove the following units
  - Existing Encina units 1-5 and GT (964 MW total)
  - Product 2 generation (308 MW at Otay Mesa 230 kV and 100 MW at Carlton Hills 138 kV)
- Added the following units
  - 520 MW at Encina (260 MW at 230 kV and 260 MW at 138 kV)

Sensitivity study results

- The following results are not affected
  - Borrego area constraints still remain and need to be mitigated
- Multiple overloads are eliminated
- Some overloads remain, but with reduced loadings (shown in next slides)

Sensitivity study results

Overloaded Facility	Contingency	Flow	Undeliverable Renewable Zone	Mitigation
Miguel-Bay Boulevard 230 kV	Base Case	116%	Arizona, Baja, San Diego South, Imperial, DG-SDGE	Upgrade line (identified as a DNU in C3C4 Ph II)
Miguel-Bay Boulevard 230 kV	Miguel-Mission 230 kV #1	103%	Arizona, Baja, San Diego South, Imperial, DG-SDGE	SPS to trip generation
Miguel-Bay Boulevard 230 kV	Miguel-Mission 230 kV #2	103%	Arizona, Baja, San Diego South, Imperial, DG-SDGE	SPS to trip generation
Miguel-Bay Boulevard 230 kV	Miguel-Mission 230 kV #1 & Miguel-Mission 230 kV #2	123%	Arizona, Baja, San Diego South, Imperial, DG-SDGE	SPS to trip new and existing generation or New Sycamore-Penasquitos 230 kV line

Sensitivity study results

Overloaded Facility	Contingency	Flow	Undeliverable Renewable Zone	Mitigation
Miguel-Mission 230 kV #1	Miguel-Bay Boulevard 230 kV & Telecanyon-Grant Hill 138 kV	105%	Arizona, Baja, San Diego South, Imperial, DG-SDGE	SPS to trip generation
Miguel-Mission 230 kV #2	Miguel-Bay Boulevard 230 kV & Telecanyon-Grant Hill 138 kV	104%	Arizona, Baja, San Diego South, Imperial, DG-SDGE	SPS to trip generation
Sweetwater-Sweetwater Tap 69 kV	Silvergate-Bay Boulevard 230 kV	112%	DG-SDGE	Upgrade line or New Sycamore-Penasquitos 230 kV line
Escondido-San Marcos 69 kV	Encina-San Luis Rey 230 kV & Encina-San Luis Rey-Palomar 230 kV	102%	Non CREZ, DG-SDGE	Upgrade line or New Sycamore-Penasquitos 230 kV line

Sensitivity study results

Overloaded Facility	Contingency	Flow	Undeliverable Renewable Zone	Mitigation
Miguel 500/230 kV #1	Miguel 500/230 kV #2	128%	Arizona, Baja, San Diego South, Imperial	Third Miguel 500/230 kV transformer
Miguel 500/230 kV #2	Miguel 500/230 kV #1	124%	Arizona, Baja, San Diego South, Imperial	Third Miguel 500/230 kV transformer
Miguel-ECO 500 kV	Sycamore-Suncrest 230 kV #1 & Sycamore-Suncrest 230 kV #2	104%	Arizona, Baja, San Diego South, Imperial	SPS to trip generation
Miguel-ECO 500 kV	Imperial Valley-Ocotillo 500 kV	101%	Arizona, Baja, San Diego South, Imperial	SPS to trip generation

Sensitivity study results

Overloaded Facility	Contingency	Flow	Undeliverable Renewable Zone	Mitigation
Otay Mesa-Tijuana 230 kV	Miguel-ECO 500 kV	132%	Arizona, Baja, San Diego South, Imperial	SPS to trip generation and CFE cross trip
Imperial Valley-ROA 230 kV	Miguel-ECO 500 kV	117%	Arizona, Baja, San Diego South, Imperial	SPS to trip generation and CFE cross trip

Policy Driven Planning Deliverability Assessment Results – PG&E Area

Binaya Shrestha
Senior Regional Transmission Engineer

Abhishek Singh
Senior Regional Transmission Engineer

2012/2013 Transmission Planning Process Stakeholder Meeting
December 11-12, 2012

Overview of renewable zones that impact PG&E area

Renewable Zone	Base Portfolio MW
Carrizo South	900
Central Valley North	208
Los Banos	370
Merced	65
Solano	505
Westlands	1500
Non CREZ – North Valley	7
Non CREZ – North Coast	15
Non CREZ – Central Valley	101
Non CREZ – Central Coast / Los Padres	3
Non CREZ – Greater Bay Area	7
Greater Bay Area DG	182
Central Coast / Los Padres Area DG	126
Greater Fresno Area DG	739
Total	**4,728**

Violations caused by Renewable in PG&E North Area

Overloaded Facility	Contingency	Flow	Undeliverable Zone	Mitigation
Stockton 'A' 60 kV line #1	Normal	110%	Central Valley North	Localized concern. Should be addressed by GIP.
Stockton 'A'-Weber 60 kV line #3	Normal	107%	Central Valley North	Localized concern. Should be addressed by GIP.
Trimble-San Jose 'B' 115 kV line	Los Esteros - Trimble & Los Esteros - Montague 115 kV	105%	Greater Bay Area DG	Localized concern. Should be addressed by GIP.

Violations caused by Renewable in PG&E North Area

Overloaded Facility	Contingency	Flow	Undeliverable Zone	Mitigation
Cayetano-USWP-JRW 230 kV line	Contra Costa-Moraga Nos. 1&2 230 kV lines	102%	Solano CREZ	Recondutor or SPS

Violations caused by Renewable in PGE South Area

Overloaded Facility	Contingency	Flow	Undeliverable Zone	Mitigation
Bellota-Warnerville 230 kV line	Normal	120%	Greater Fresno Area DG, Central Valley North, Merced, Westlands	Upgrade will be needed for more than 1300 MW of generation in impacted zone.
Los Banos-Westley 230 kV line	Normal	108%	Central Coast/Los Padres Area DG, Greater Fresno Area DG, Los Banos, Merced, Westlands	Localized concern. Should be addressed by GIP.
Wilson-Le Grand 115 kV line	Normal	103%	Greater Fresno Area DG, Merced, Westlands	Recondctor. Upgrade also identified in GIP.

Violations caused by Renewable in PGE South Area

Overloaded Facility	Contingency	Flow	Undeliverable Zone	Mitigation
Panoche-Schindler 115 kV line #2 (Cheney Tap-Panoche)	Normal	132%	Greater Fresno Area DG, Westlands	Localized concern. Should be addressed by GIP.
Schindler-Huron-Gates 70 kV line (Huron Jct-Calflax)	Normal	112%	Greater Fresno Area DG, Westlands	Localized concern. Should be addressed by GIP.
Arco-Carneras 70 kV line	Normal	101%	Greater Fresno Area DG, Westlands	Localized concern. Should be addressed by GIP.

Violations caused by Renewable in PGE South Area

Overloaded Facility	Contingency	Flow	Undeliverable Zone	Mitigation
Moss Landing-Panoche 230 kV line (Moss Landing-TT22113)	Moss Landing - Coburn & Coburn - Panoche 230 kV Lines	101%	Central Coast/Los Padres Area DG, Greater Fresno Area DG, Los Banos , Merced, Westlands	Localized concern. Should be addressed by GIP.
Panoche-Schindler 115 kV line #1 (Westlands-Schindler)	Gates 230/70 kV Transformer #5	114%	Greater Fresno Area DG, Westlands	Localized concern. Should be addressed by GIP.
Panoche-Schindler 115 kV line #2 (Cheney Tap-Schindler)	Panoche - Schindler #1 115 kV Line	123%	Greater Fresno Area DG, Westlands	Localized concern. Should be addressed by GIP.

Violations caused by Renewable in PGE South Area

Overloaded Facility	Contingency	Flow	Undeliverable Zone	Mitigation
Wilson-Oro Loma 115 kV line (Oro Loma-El Nido)	Herndon - Kearney & Gates-Gregg 230 kV Lines	101%	Greater Fresno Area DG, Merced, Westlands	Localized concern. Should be addressed by GIP.
Gates 230/70 kV Bank #5	Panoche - Schindler #1 & #2 115 kV Lines	114%	Greater Fresno Area DG, Westlands	Localized concern. Should be addressed by GIP.
Coalinga1-Coalinga2 70 kV line (Coalnga1-Tornado)	Panoche - Schindler #1 115 kV Line	110%	Greater Fresno Area DG, Westlands	Localized concern. Should be addressed by GIP.

Violations caused by Renewable in PGE South Area

Overloaded Facility	Contingency	Flow	Undeliverable Zone	Mitigation
Gates-Coalinga2 70 kV line (Gates Tap-Gates)	Gates 230/70 kV Transformer #5	104%	Greater Fresno Area DG, Westlands	Localized concern. Should be addressed by GIP.
Schindler-Huron-Gates 70 kV line (Calflax-Schindler)	Gates 230/70 kV Transformer #5	110%	Greater Fresno Area DG, Westlands	Localized concern. Should be addressed by GIP.
Schindler-Huron-Gates 70 kV line (Huron-Huron Jct)	Panoche - Schindler #1 & #2 115 kV Lines	120%	Greater Fresno Area DG, Westlands	Localized concern. Should be addressed by GIP.

Violations caused by Renewable in PGE South Area

Overloaded Facility	Contingency	Flow	Undeliverable Zone	Mitigation
Schindler-Coalinga #2 70 kV line (Schindler-Pleasant Valley)	Panoche - Schindler #1 115 kV Line	114%	Greater Fresno Area DG, Westlands	Localized concern. Should be addressed by GIP.
Coalinga1-San Miguel 70 kV line	Gates 230/70 kV Transformer #5	119%	Greater Fresno Area DG, Westlands	Localized concern. Should be addressed by GIP.

Opening

Tom Cuccia
Senior Stakeholder Engagement and Policy Specialist

2012/2013 Transmission Planning Process Stakeholder Meeting
December 11-12, 2012

December 11th Agenda

Topic	Presenter
Opening	Tom Cuccia
Introduction	Neil Millar
Overview	Robert Sparks
Preliminary 33% RPS Results	ISO Regional Transmission Engineers
Deliverability Assessment	ISO Regional Transmission Engineers

December 12th Agenda

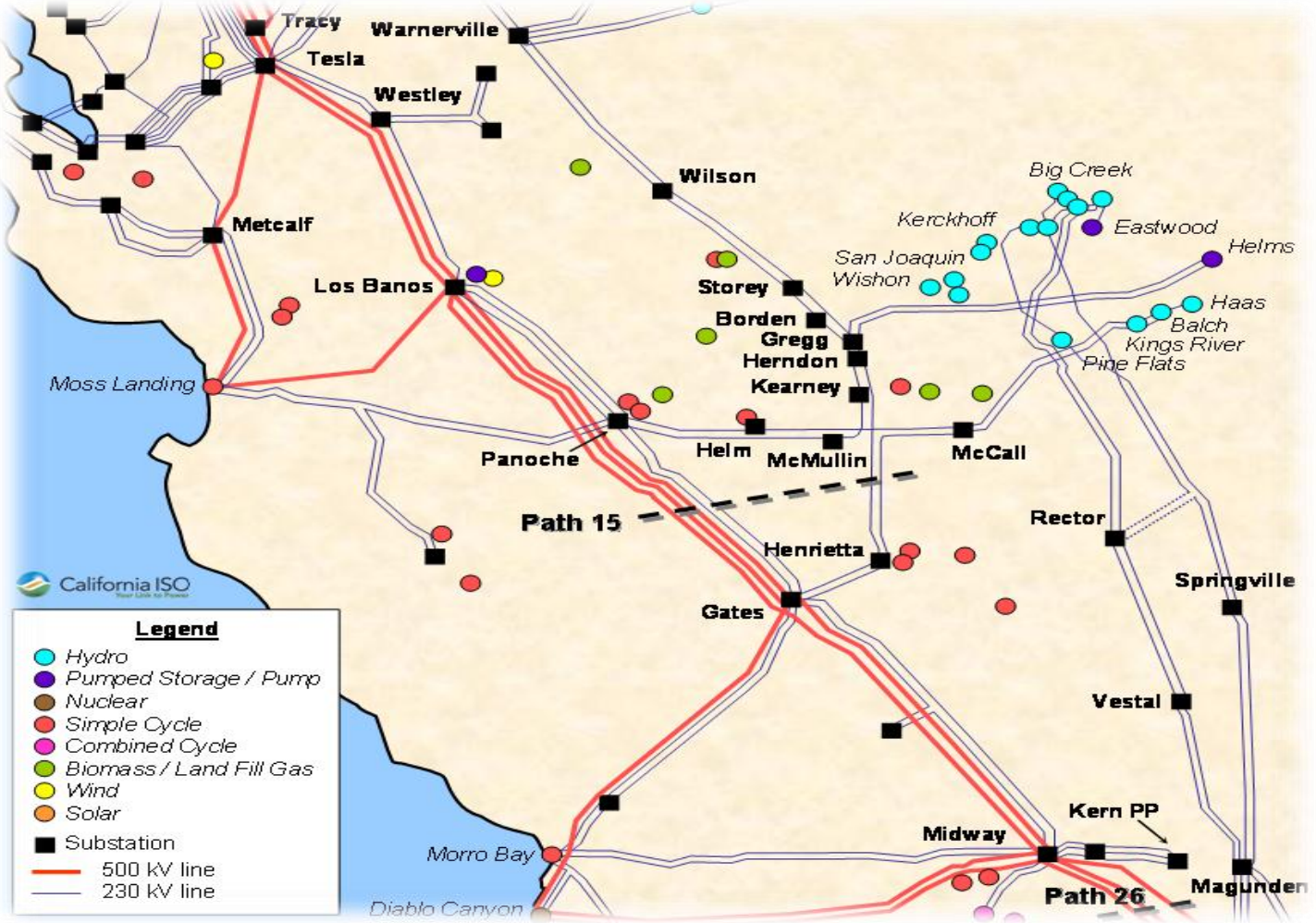
Topic	Presenter
Opening	Tom Cuccia
Central CA Study	Jeff Billinton
Economic Planning Study	Xiaobo Wang

Central California Study

Jeff Billinton
Manager Regional Transmission North

2012/2013 Transmission Planning Process Stakeholder Meeting
December 11-12, 2012

Central Valley Study Area



Central Valley Study Area Assessment Cases

- The study used:
  - All assessment cases related to the Bulk and Fresno/Kern areas
  - Four 2017 scenarios – per addendum to study plan
  - Four 2022 scenarios – per addendum to study plan
- Results:
  - See Bulk as well as and Fresno and Kern assessment
  - 2017 scenarios – *results presented earlier in the year*
  - 2022 scenarios – *results presented here*
  - Only additional or more severe concerns compared to the ones reported in the 2012-2013 Transmission Plan Reliability Assessment studies are discussed

2022 Summer Peak – Dry Hydro Scenario

- Base case parameters:
  - Derived from 2022 Summer Peak Commercial Interest (CI) case
  - Northern Cal Hydro – dry year historical data
  - Path 15 stressed close to maximum per dry year historical data for peak hours (620 MW North-to-South)
  - Path 66 stressed at maximum per dry year historical data for peak hours (4700 MW North-to-South)
  - North of Los Banos at 200 MW North-to-South flow
  - Helms generating with three units
  - About 520 MW of Fresno area peakers on-line
- Results:
  - North of Los Banos not a limiting concern
  - LCR studies to be performed at a later date

2022 Summer Peak – Dry Hydro Scenario Study Results Southern PG&E System

Potential Problems

- Several 70 and 115 kV overloads
- Loss of 230 kV bus tie breakers at Panoche, Gates and Mc Call
- Loss of 230 kV bus sectionalizing breaker at Gates

Due to low hydro in the Fresno area.

Potential Mitigation

- Add additional tie and sectionalizing breakers
- Change to Breaker And a Half design
- New SPS to trip renewables in the area

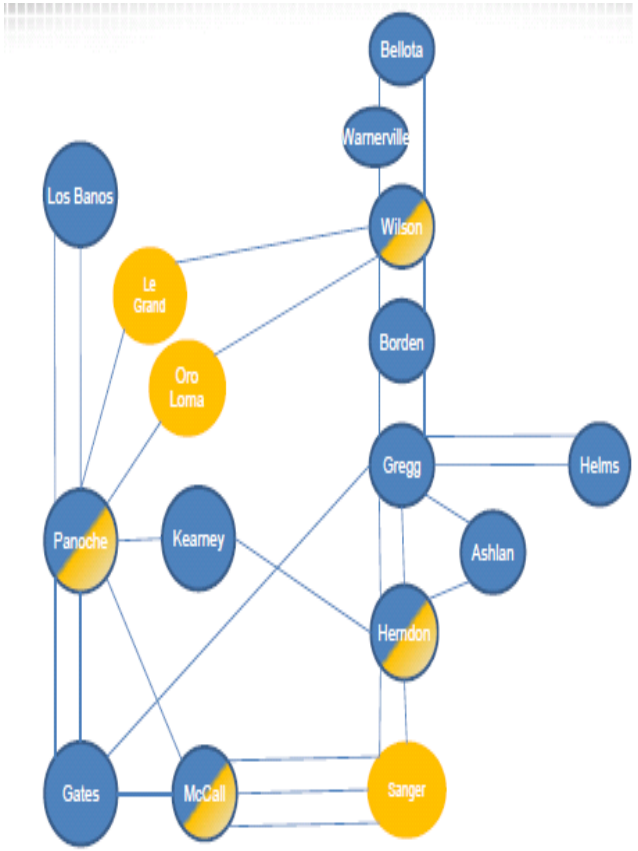
2022 Summer Partial Peak – Dry Hydro Scenario

- Base case parameters:
  - Derived from 2022 Summer Peak Commercial Interest (CI) case
  - Northern Cal Hydro – dry year historical data
  - Path 15 modeled at maximum per dry year historical data for partial peak hours (60 MW South-to-North)
  - Path 66 stressed at maximum per dry year historical data for partial peak hours (4350 MW North-to-South)
  - North of Los Banos flow modeled at 1216 MW North-to-South
  - Helms and Fresno area peakers are off-line
- Results:
  - Normal overload on Warnerville-Wilson 230 kV line
  - Multiple overloads under contingency conditions

2022 Summer Partial Peak – Dry Hydro Scenario Study Results

- Warnerville-Wilson 230 kV line – Cat. A, B & C
- Kearney-Herndon 230 kV line – Cat. B & C
- Wilson-Borden 230 kV line – Cat. C
- Wilson-Gregg 230 kV line – Cat. C
- Gates-Gregg 230 kV line – Cat. C
- Gates 500/230 kV bank – Cat. C
- Henrietta 230/115 kV bank – Cat. C
- Mc Call 230/115 kV bank – Cat. C
- Chowchilla-Kerckhoff #2 115 kV line – Cat. C
- Wilson-Oro Loma 115 kV line – Cat. C
- Sanger-Mc Call #3 115 kV line – Cat. C
- Barton-Herndon 115 kV line – Cat. C
- Manchester-Herndon 115 kV line – Cat. C
- GWF-Kingsburg 115 kV line – Cat. C
- GWF-Henrietta 115 kV line – Cat. C
- Oro Loma 115/70 kV bank – Cat. C
- Los Banos-Canal-Oro Loma 70 kV line – Cat. C
- Voltage collapse for DCTL Gates-Gregg & Gates – Mc Call

Caused by low hydro generation in Fresno (with Helms and peakers off-line)



Potential Mitigation: Congestion management

Further mitigation under review

2022 Fall/Winter Off-Peak – Dry Hydro Scenario

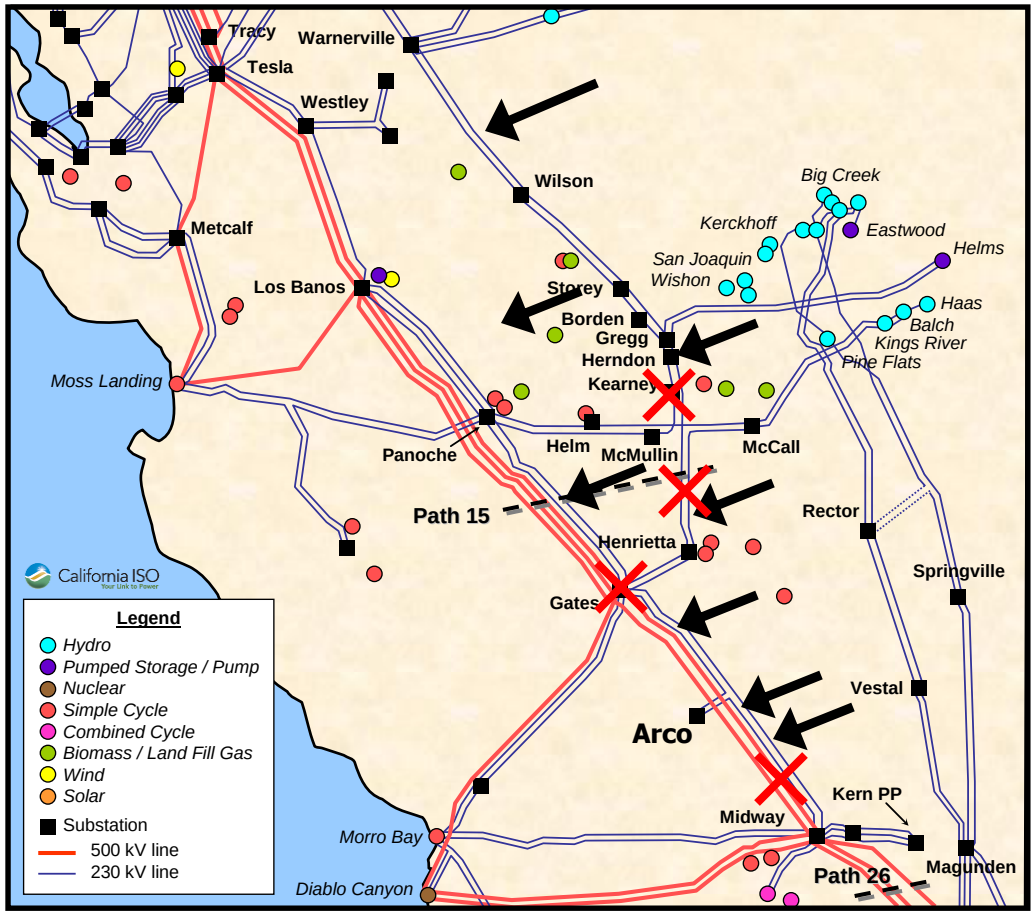
- Base case parameters:
  - Derived from 2022 Summer Peak Commercial Interest (CI) case
  - Northern Cal Hydro – dry year historical data
  - Path 15 stressed at maximum (5400 MW South-to-North)
  - Path 66 modeled according dry year historical data for off-peak hours (1140 MW South-to-North)
  - PDCI at 1850 MW South-to-North
  - Helms pumping with two pumps
  - Fresno area peakers off-line
- Results:
  - Emergency overloads on 230 kV in Central California

2022 Fall/Winter Off-Peak – Dry Hydro Scenario Study Results

- Gates-Midway 230 kV line – Cat B & C
- Westley-Los Banos 230 kV line – Category B & C
- Kerney-Herndon 230 kV line – Category B & C
- Panoche-Gates #1 & #2 230 kV lines – Category C
- Warnerville-Wilson 230 kV – Cat. C
- Gates-Gregg 230 kV line – Cat. C
- Arco-Midway 230 kV line – Cat. C
- Arco-Gates 230 kV line – Cat. C
- Wilson-Oro Loma 115 kV line – Category C
- Manchester-Airways-Sanger 115 kV lines – Category C

Potential Mitigation:

- Congestion management including Path 15 flow reduction
- Further mitigation under review



outage

overload

2022 Spring Off-Peak – Wet Hydro Scenario

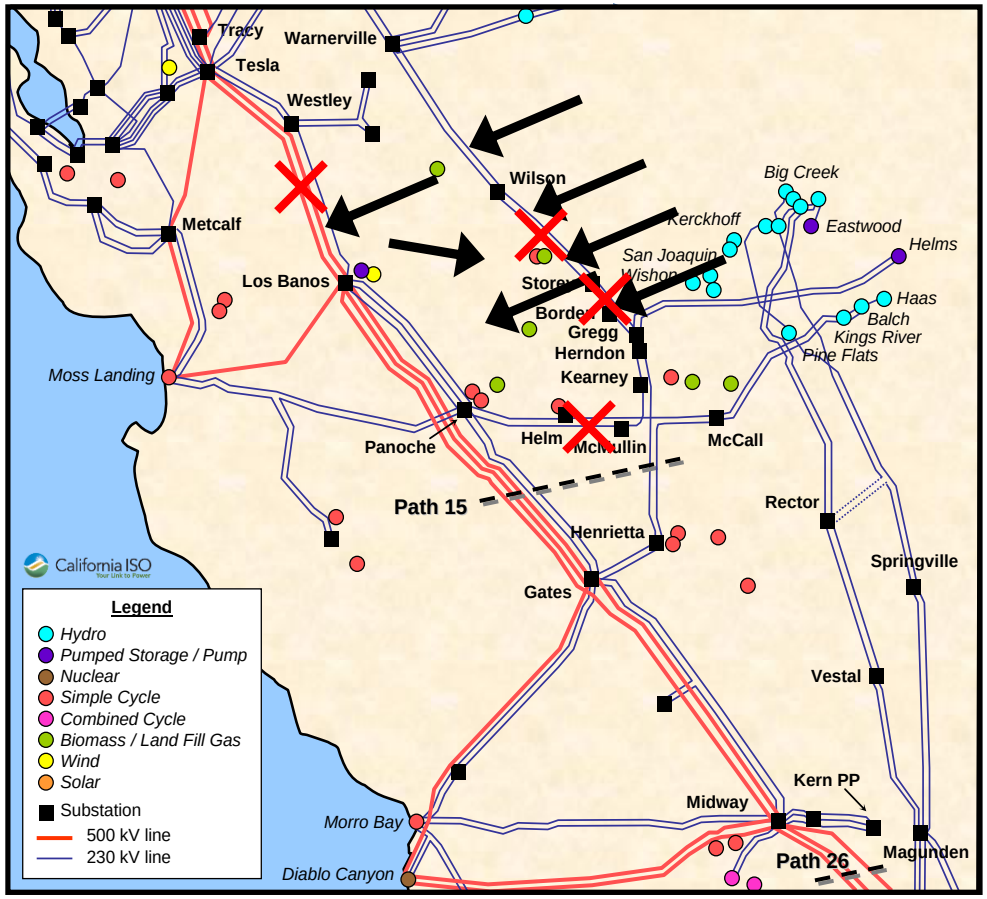
- Base case parameters:
  - Derived from 2022 Summer Peak Commercial Interest (CI) case
  - Northern Cal Hydro – wet year historical data
  - Path 15 below the max historical data for a wet year during off-peak hours (3200 MW South-to-North)
  - Path 66 at the max historical data for a wet year during off-peak hours (950 MW South-to-North)
  - PDCI at 1850 MW South-to-North
  - Helms generating with three units
  - Fresno area peakers off-line
- Results:
  - Warnerville-Wilson 230 kV line limits the Fresno resource output as well as Path 15 flows

2022 Spring Off-Peak – Wet Hydro Scenario Study Results

- Warnerville-Wilson 230 kV line Category A (100% loading) B & C
- Westley-Los Banos 230 kV line overload Category B & C
- Wilson-Borden 230 kV line overload Category B & C
- Wilson-Gregg 230 kV line overload Category B & C
- Borden-Gregg 230 kV line overload Category B & C
- Wilson-Le Grand 115 kV line overload Category C
- Oro Loma 115/70 kV bank overload Category C

Potential Mitigation:

- Congestion management including Path 15 flow reduction
- Further mitigation under review



outage

overload

Preliminary economic assessment

- Base case parameters:
  - 2017 Assumed half on Net Short met by renewables
  - 2022 Commercial Interest (CI) – base portfolio
  - Northern Cal Hydro – average year
  - CEC 1-in-2 load forecast
  - Natural Gas – MPR prices
  - AB 32 GHG emission taxes – CPUC 2011 MPR
  - Transmission additions as well as resource additions and retirements - per unified study assumptions
- Draft Results:
  - About 250 hours of congestion

Potential Mitigating Solutions

- Congestion Management
  - Use more extensively peakers and Helms in resource mode
- Transmission Development Alternatives
  - Loop lines in Bellota-Gregg corridor in different substations
  - Convert substations to BAH design
  - Reconductor Bellota-Gregg corridor
  - New single or double 230 kV lines into Gregg (from Gates, Panoche or Los Banos)
  - Loop major 230 kV ties into a new substation at Raisin City Jct.
  - New 500 kV line between Midway-Fresno and Fresno-Tesla

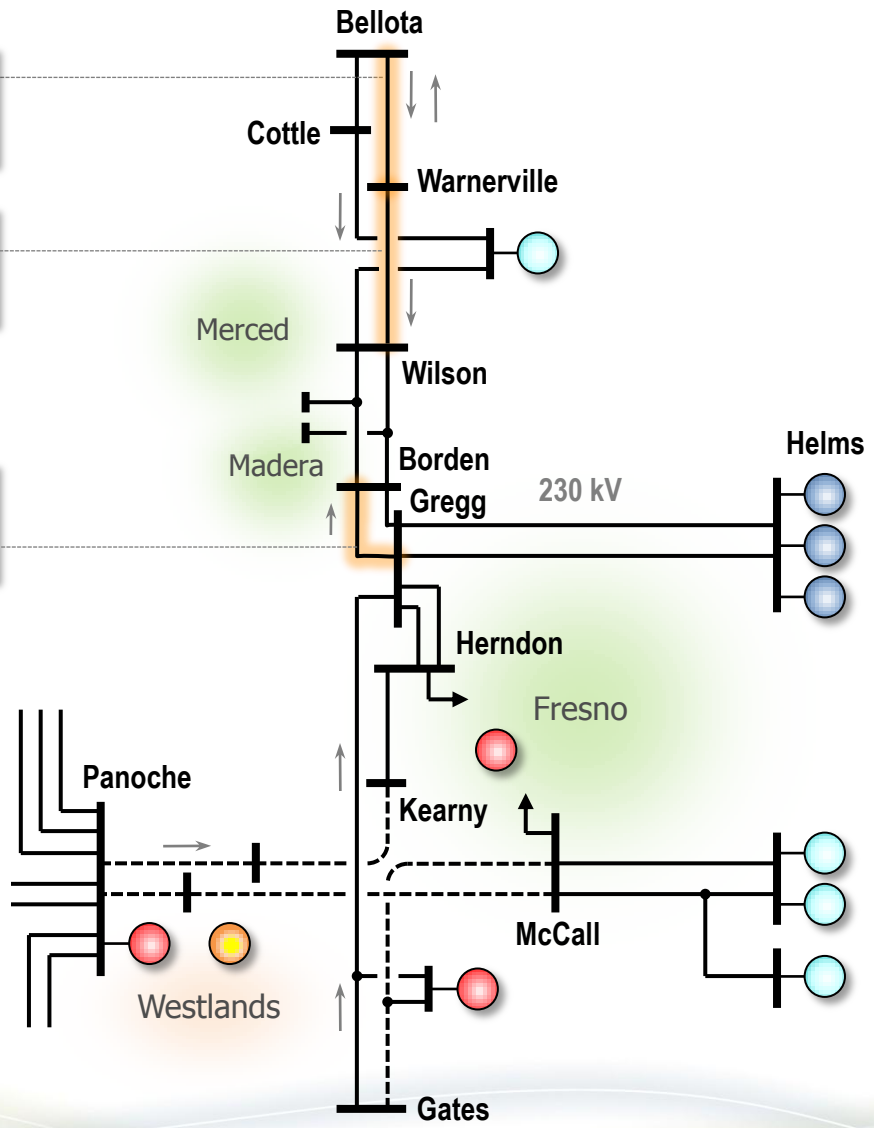
Simulated congestion

Congestion hours

2017	2022
23	11

2017	2022
64	131

2017	2022
-	111



Legend:

- Thermal
- Hydro
- Pumped storage
- Solar

Fresno Reliability Transmission Projects
Network upgrades of the existing 230 kV system
Approved in the ISO 2009/2010 Transmission Plan
Under construction

Next Steps

- Finalize economic analysis
  - Assessment of economic benefits
  - Assessment of economic comparison of alternatives
- Sensitivity assessment to renewable generation dispatch and development in Fresno area
- Helms water analysis for reliability need:
  - Assessing water availability for generation to maintain Fresno area reliability based on projected pumping capability due to transmission limitations.
- Other sensitivity analysis
- Flexible generation requirements

Remaining assessment activities

Reliability Assessment Activity	Date:
Present 2017 results at the stakeholder meeting	Sept 26-27 2012
Present 2022 results at the stakeholder meeting	Dec 11-12 2012
Post study results	December 19 2012
Economic Assessment Activity	**Date:**
Present results at the stakeholder meeting	Dec 11-12 2012
Post economic study results	Jan 31 2013
Overall Activity	**Date:**
Draft Plan for Stakeholder Comment	Jan 31 2013

Economic Planning Studies – Preliminary Results

Xiaobo Wang, PhD
Regional Transmission Engineering Lead

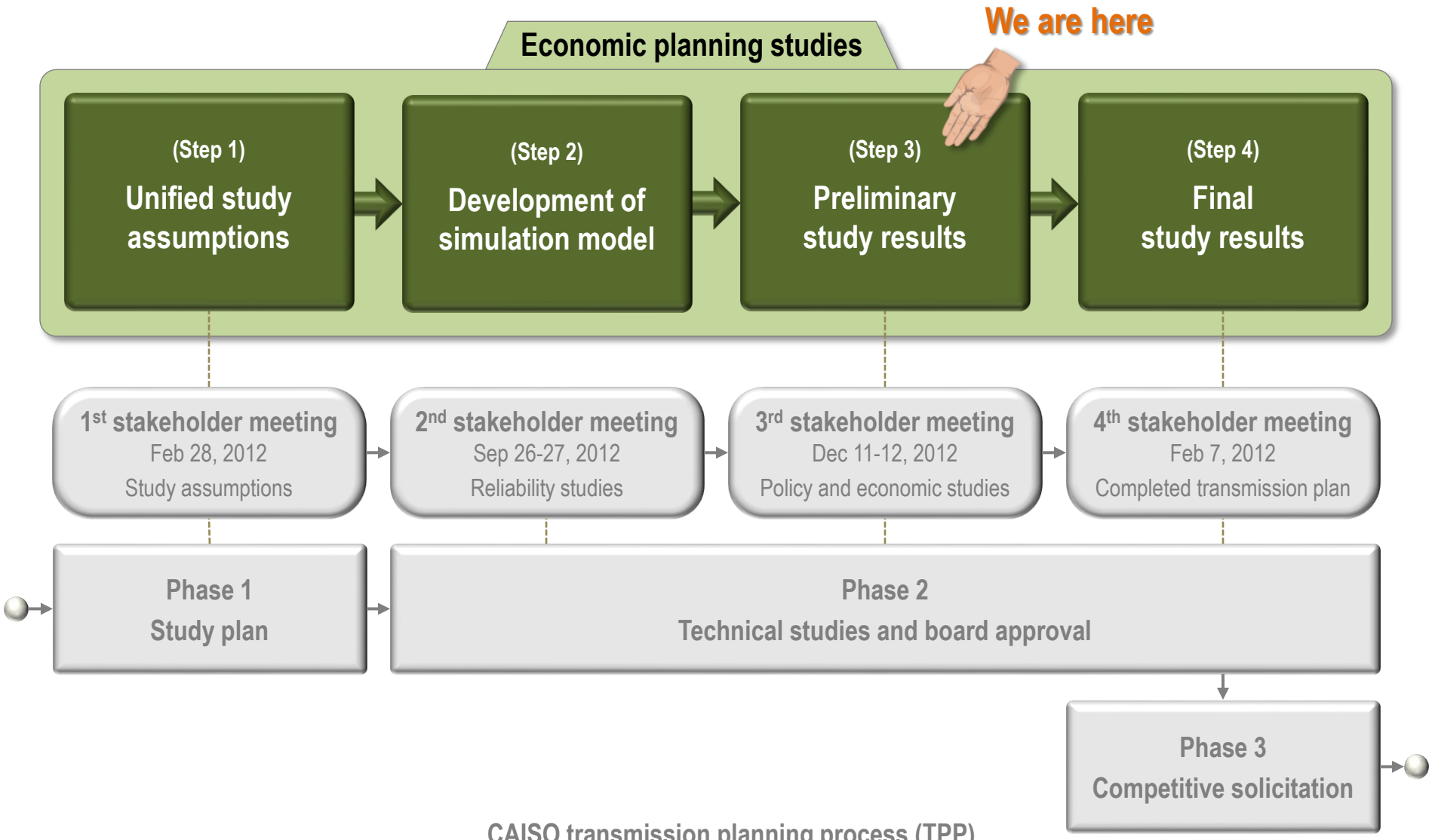
2012/2013 Transmission Planning Process Stakeholder Meeting
December 11-12, 2012

This presentation is organized as follows

Process, methodology and study assumptions	**9 slides**
System overview	**1**
Economic planning studies	**1**
Study 1: Path 26 Northern - Southern CA (P26)	**4**
Study 2: Los Banos North (LBN)	**1**
Study 3: Central California Area (CCA)	**1**
Study 4: Pacific Northwest - California (NWC)	**1**
Study 5: Desert Southwest - California (SWC)	**4**
Summary	**3**

Table of Contents

Steps of economic planning studies

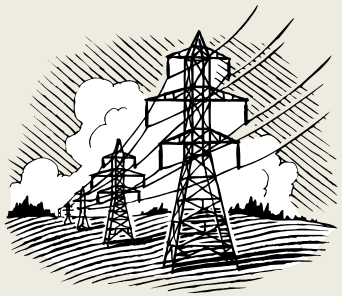


Economic planning studies

Technical approach

Engineering analysis
Power system simulation

Transmission loadings with and without proposed network upgrades



Benefit in year 2017

Benefit in year 2022

Economic evaluation
Cost-benefit analysis

Total benefit – Total cost = Net benefit

In order for a proposed network upgrade to qualify as an economic project, the study has to demonstrate a positive net benefit for the ISO ratepayers

Given multiple alternatives, the most economic solution is the alternative that has the largest net benefit

Database and simulation tools

Extensive analysis throughout 8760 hours

Identifies congestion based on security-constrained unit commitment (SCUC) and security-constrained economic dispatch (SCED)

Database size: 4,000 MB

Production simulation

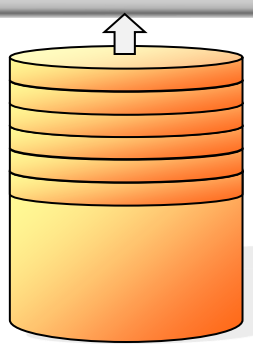


ABB GridView™
Version 8.3c dated 28-Nov-2012

CAISO modeling additions
Implemented more than 260 sets of modeling improvements

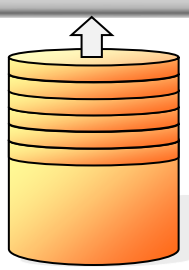
WECC TEPPC product simulation database
Dataset "2022 PC1" dated 2-May-2012

Intensive analysis for selected hours

Identifies thermal overload and voltage deviation based on stressed system conditions, e.g. peak load under certain generation dispatch patterns

Database size: 12 MB

Power flow computation



GE PSLF™
Version 18.0_01 dated 24-Oct-2011

CAISO modeling additions

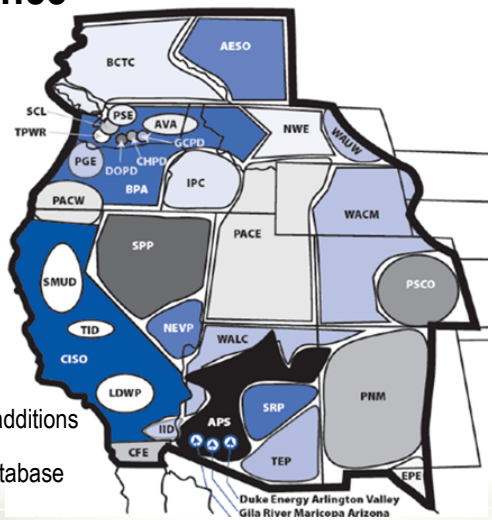
WECC PCC power flow base cases

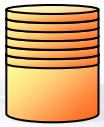
TEPPC = Transmission Expansion Planning Policy Committee
PCC = Planning Coordination Committee

CAISO modeling additions

Essential ~~Important~~ enhancements to the TEPPC production simulation database

a. Network upgrades approved in recent ISO Transmission Plans (230 kV and above)
b. Enforcement of all 500 kV transformer limits and 345 kV branch limits in WECC
c. Enforcement of all 230 kV branch limits and some 115 kV line limits in California
d. Modeling of what-if contingencies in the CA 500 kV and 230 kV transmission system
e. Load distribution patterns of spring, autumn and winter in addition to summer
f. Winter ratings of California transmission lines in addition to summer ratings ★
g. Dynamic transmission limits on Path 15 and Path 26 based on operating procedures
h. Unit commitment operating procedures in Southern California
i. Transmission-constrained pumped-storage operations with water-level control
j. Assumptions on California once-through-cooling generation compliance
k. California 33% RPS net short portfolios
l. California GHG emission model based on AB32 ★
m. Representation of BAAs, i.e. control areas, in the WECC system ★
n. Inter-BAA hurdle rates model ★
o. Dynamic resources in the ISO market ★
p. Flexible reserve requirements defined by the ISO ★
q. Inclusion of VEA system in the ISO control area ★



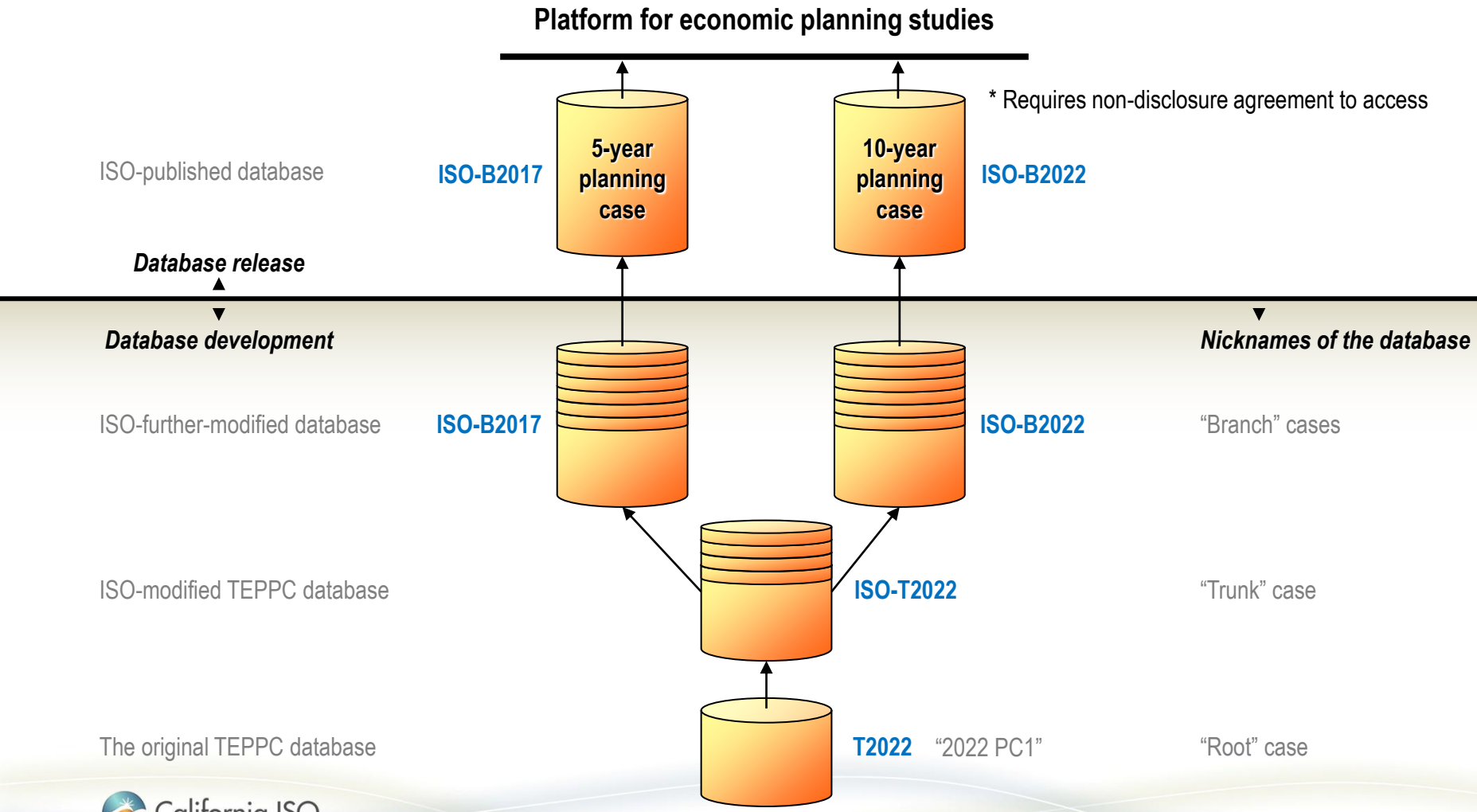


★ New modeling features introduced in this planning cycle

Base cases developed

Production simulation database

Beta release "DB121130" has been posted on the ISO *Market Participant Portal*, which is an ISO website requiring *Non-Disclosure Agreement (NDA)* to get access

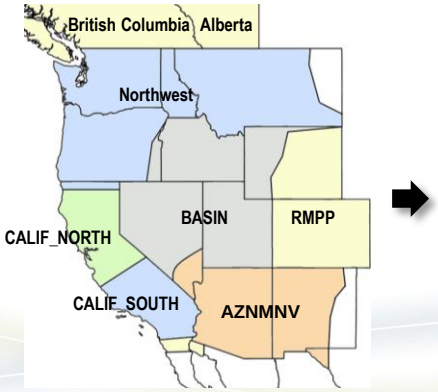


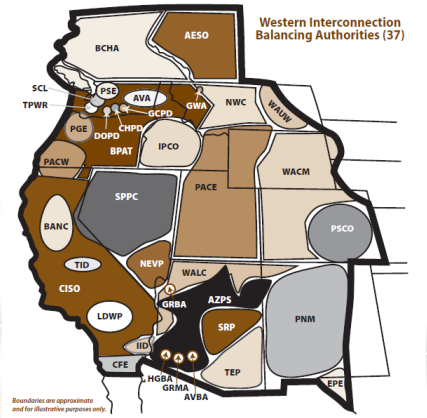
Data and assumptions

System topology and reserve allocation

In comparison:

#	Category	CAISO database	TEPPC database
1	Load area	Same as TEPPC model except VEA area added (40 load areas)	TEPPC model (39 load areas)
2	BAA	WECC EIM Phase 2 Study [Note] (31 BAAs)	TEPPC model (8 geographic areas)
3	Inter-BAA hurdle rates	WECC EIM Phase 2 Study [Note] (60 hurdle interfaces)	TEPPC model (13 hurdle interfaces)
4	Reserve sharing groups	WECC EIM Phase 2 Study [Note] (5 reserve sharing groups)	Not available
5	Flexible reserve requirements in California	CAISO-computed reserve requirements corresponding to the CPUC-defined RPS portfolios of March-2012	NREL-computed flexible reserve requirements
6	Flexible reserve requirements in other states	Same as TEPPC database with minor updates to the Southwest reserve sharing group	NREL-computed flexible reserve requirements





Acronyms:
BAA = Balancing authority area
CPUC = California Public Utility Commission
EIM = Energy imbalance market
NREL = National Renewable Energy Lab
RPS = Renewable Portfolio Standard

Note:
The "EIM Phase 2 Study" was a WECC study conducted by E3 and ABB in 2011

Data and assumptions (cont'd)

Load and resources

In comparison:

#	Category	CAISO database	TEPPC database
1	Load in California	CEC demand forecast published in September 2012	LRS 2011 CEC Feb 2012
2	Load in other states	WECC LRS 2012 load data	LRS 2011
3	Natural gas price reference	EIA forecast of Henry Hub price in AEO 2012	AEO 2011
4	Natural gas price allocation	MPR prices used in the ISO 2011 renewable integration study	NPCC 6th Power Plan
5	AB32 GHG emission taxes	CPUC 2011 MPR	Not available
6	Renewables	CPUC RPS 33% portfolios[1] of March 2012	CPUC portfolio[2] in 2011
7	Thermal generation additions	Same as TEPPC with minor updates	TEPPC model
8	OTC generation compliance	ISO 2012-2013 Transmission Plan - unified study assumptions	Similar

Acronyms:
AB = Assembly Bill
AEO = Annual Energy Outlook
CEC = California Energy Commission
CPUC = California Public Utility Commission
EIA = U.S. Energy Information Administration
GHG = Greenhouse gas
LRS = Load and Resources Subcommittee
MPR = Market Price Referent
NPCC = Northwest Power and Conservation Council
OTC = Once-through cooling
RPS = Renewable Portfolio Standard
TEPPC = Transmission Expansion Planning Policy Committee

Note:
[1] "CI", "CC", "EC" and "HD" portfolios defined by CPUC in March 2012
[2] The "Modified CC" portfolio defined by CPUC in 2011

Data and assumptions (cont'd)

Transmission

#	Project	Utility Area	Status	Op. Year
1	Contra Costa Substation Switch Replacement	PG&E	Pre-approval in TP2012	2015
2	Gregg – Herndon No.2 230 kV Line CB Upgrade	PG&E	Pre-approval in TP2012	2015
3	Kearney 230/70 kV Transformer Addition	PG&E	Pre-approval in TP2012	2015
4	Midway – Wheeler Ridge 230 kV Capacity Increase	PG&E	Pre-approval in TP2012	2018
5	Northern Fresno 115 kV Area Reinforcement	PG&E	*Placeholder assumption*	2018
6	Raisin City 230 kV station and new 230 kV lines	PG&E	*Placeholder assumption*	2020
7	Barren Ridge Renewable Transmission Project	LADWP	Approved	2017
8	West of Devers 230 kV reconductoring	SCE	ISO LGIA signed	2017
9	Cool Water – Lugo 500 kV line	SCE	*Placeholder assumption*	2018
10	Upgrade Inyo 115 kV phase shifter	SCE	*Placeholder assumption*	2017
11	Add solar G-1 to Los Banos 500 kV RAS scheme	PG&E	*Placeholder assumption*	2018

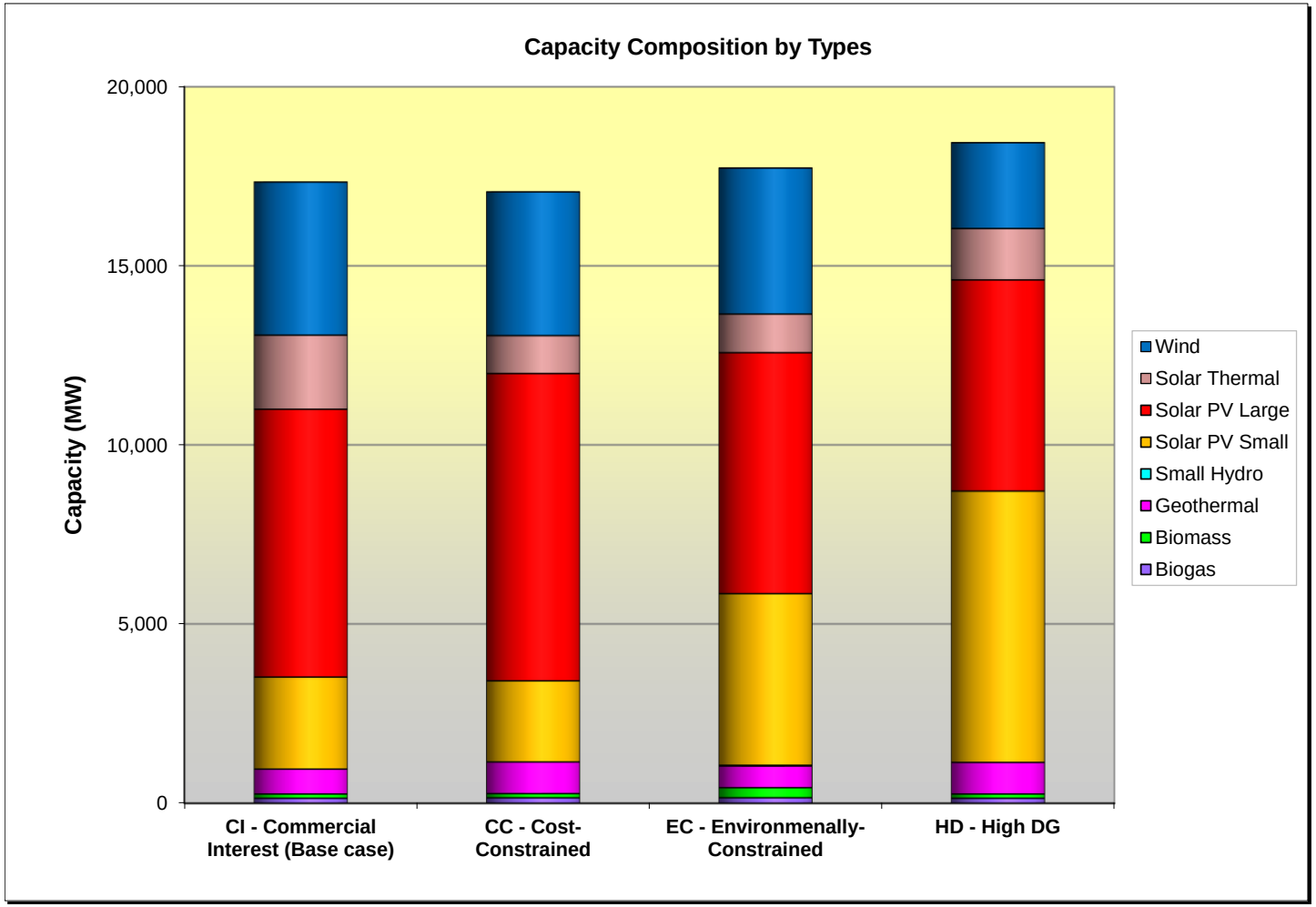
[Note]

Economic planning studies start from a feasible system that meets reliability standards and policy requirements
In order to establish a feasible system, the above-listed network upgrades are modeled in the base case
However, the above tables does *not* imply that those network upgrades will be approved and constructed

The "*placeholder assumptions*" correspond to not-yet-determined network upgrades in some problematic areas
In absence of the determinations, production simulation has to make *assumptions* and put *placeholder* upgrades in order to establish a feasible database by meeting the reliability standards and policy requirements

California 33% RPS net-short scenarios

Data defined by CPUC and CEC in March 2012



For the four California RPS portfolios, 1261 proxy renewable generators are represented in a nodal transmission model
Of those 1261 proxy generators, 313 are central-station generators and 948 are distributed generators

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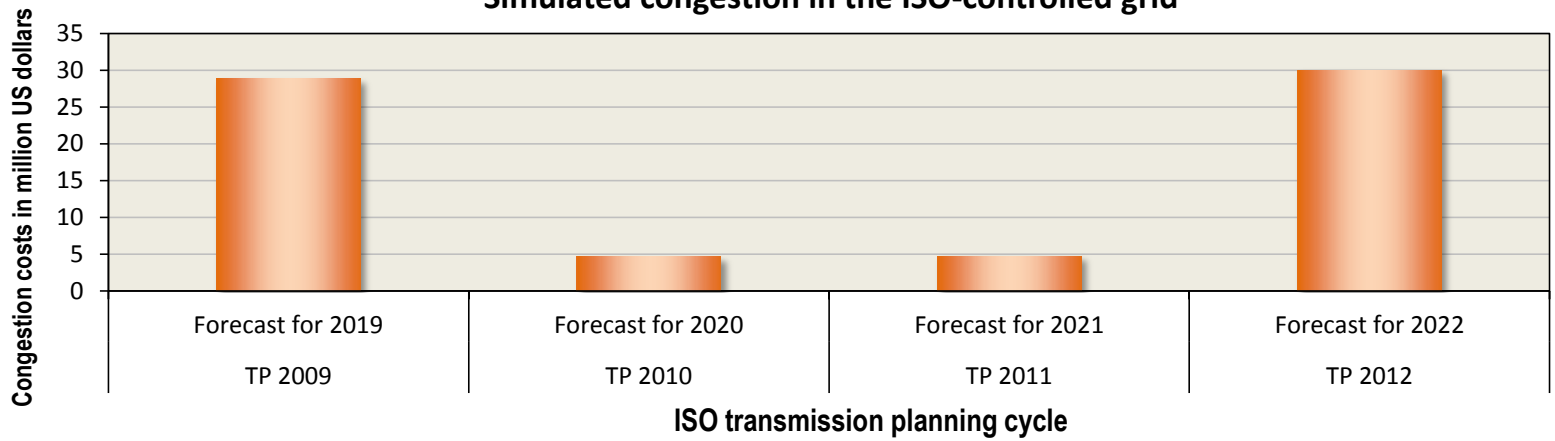
Overview of congestion

Trends of simulated congestion in recent year studies

Economic planning studies

aka congestion analysis



[INote] While congestion cost indicates congestion severity, it does *not* translate to the economic benefit of congestion relief directly

Some driving factors behind the simulated congestion

	TP 2009	TP 2010	TP 2011	TP 2012
CEC demand forecast (1-in-2 peak / annual energy)	**72 GW / 347 TWh** (Est.2020 load, CEC Nov-2007)	**69 GW / 327 TWh** (2020 load, CEC Dec-2009)		**68 GW / 315 TWh** (2020 load, CEC Sep-2012)
CPUC RPS 33% (Net short energy)	**75 TWh** (2009 to 2020, CPUC 2009)	**54 TWh** (2010 to 2020, CPUC 2010)	**54 TWh** (2011 to 2021, CPUC 2011)	**45 TWh** (2012 to 2022, CPUC Mar-2012)
CAISO database (Base cases)	**ISO "B2014, B2019"** (DB100105)	**ISO "B2015, B2020"** (DB110217)	**ISO "B2016, B2021"** (DB120120)	**ISO "B2017, B2022"** (To be published)
WECC database (Reference case)	**TEPPC "2017 PC4A"** (DB081110)		**TEPPC "2020 PC0"** (DB101122)	**TEPPC "2022 PC1"** (DB120502)

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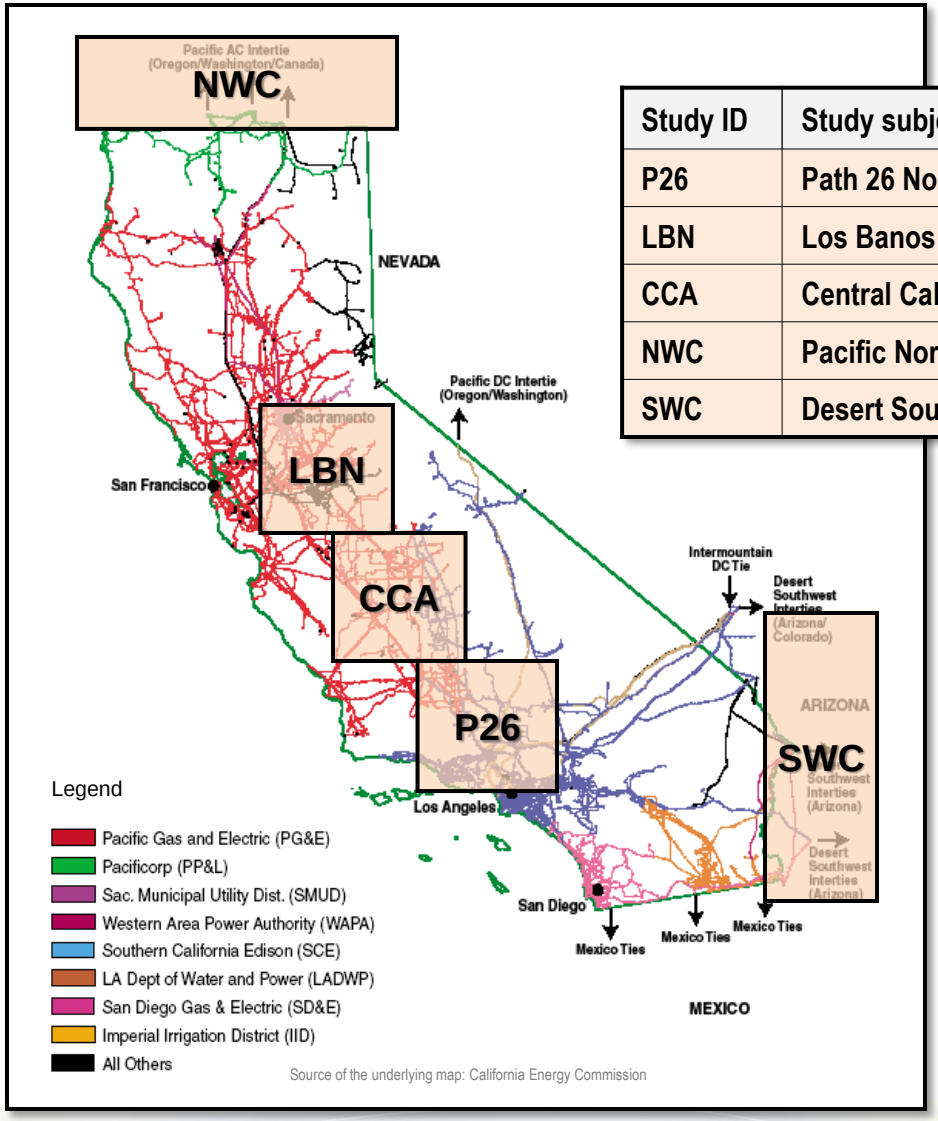
Overview of the economic planning studies

Study subjects and locations of the subjects



Study ID	Study subject
P26	Path 26 Northern - Southern CA
LBN	Los Banos North
CCA	Central California Area
NWC	Pacific Northwest - California
SWC	Desert Southwest - California

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Simulation results

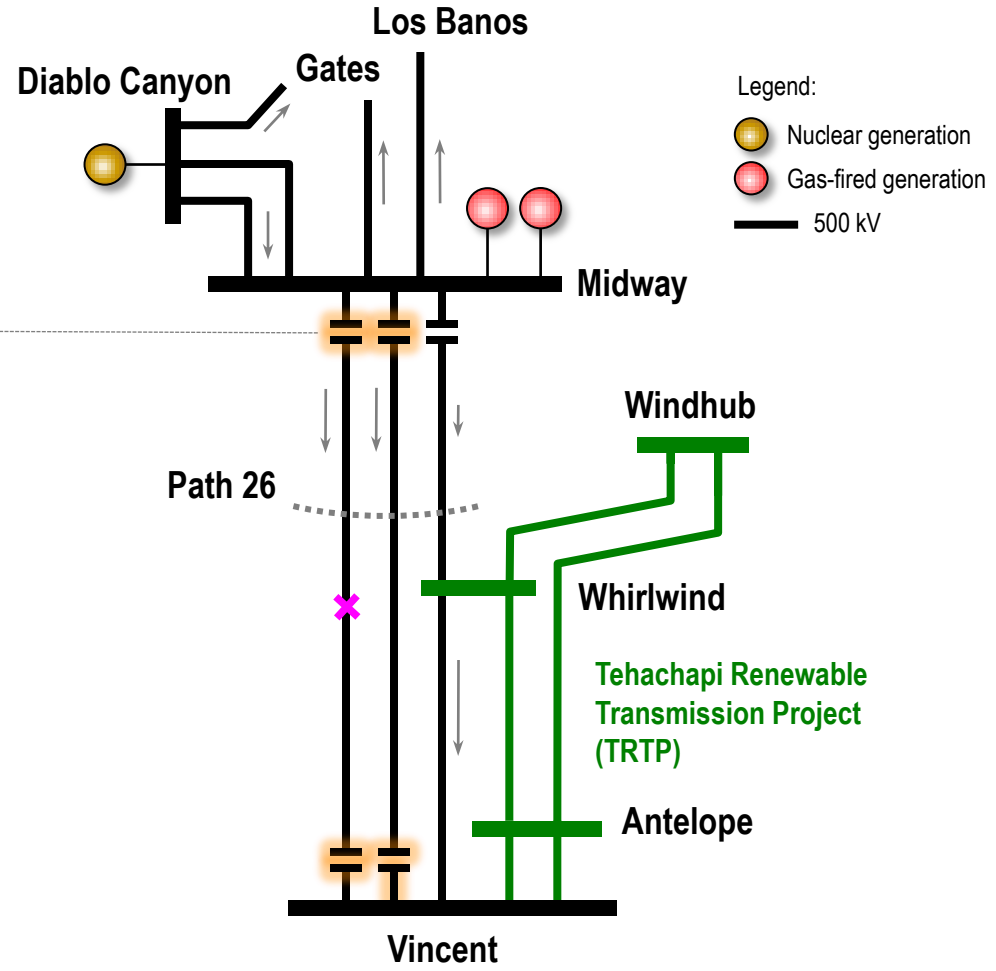
Congestion on Path 26 and Midway – Vincent 500 kV lines #1 and #2

Limiting constraints:
Midway – Vincent 500 kV #1 and #2 lines subject to L-1 on Path 26

Congestion hours

2017	2022
1568	1050

Limiting elements:
Series capacitors on the two lines



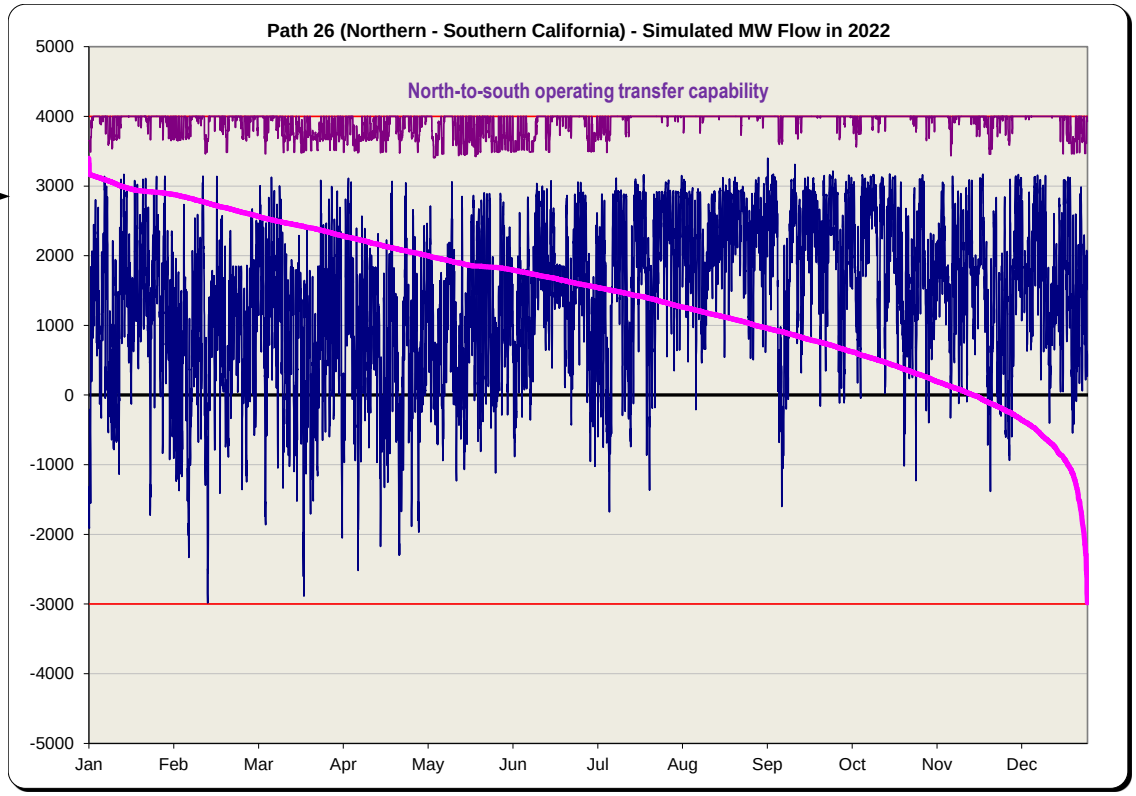
Comment:
The new Whirlwind 500 kV station is looped into the Midway – Vincent #3 line
Generation injection into Whirlwind pushes power flow towards #1 and #2 lines, making them more prone to congestion

Implications of the L-1 binding constraints:
Path 26 operational limit can often be much lower than the 4000 MW rating

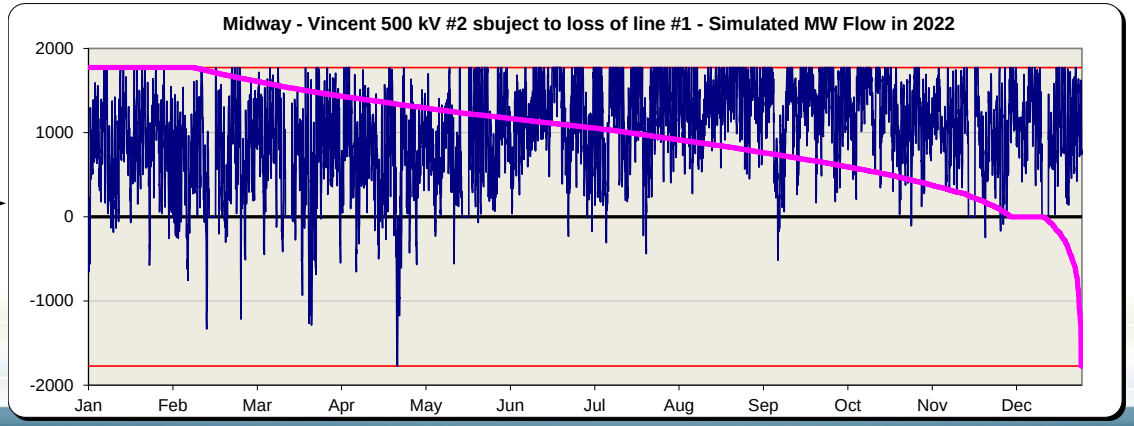
Simulation results

Power flow on Path 26 in 2022

Path 26 path flow under normal condition



Midway – Vincent 500 kV Line #1 flow under L-1 contingency

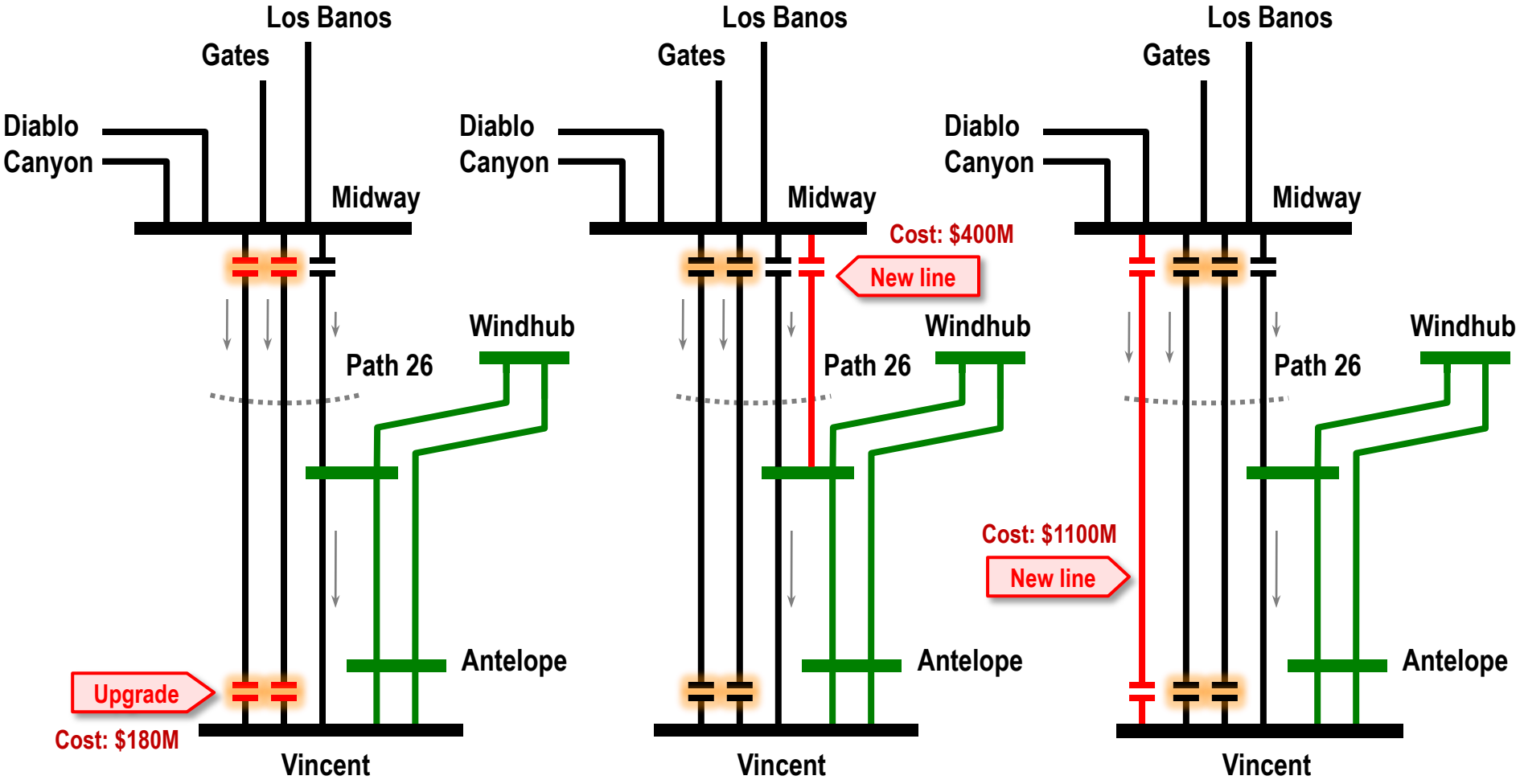


Observation 1:
Before path rating and operating transfer limits are reached, #1 and #2 line are already congested

Observation 2:
The congestion is predominantly from north to south, but can also be in the opposite direction

Economic assessment of Path 26 congestion relief

Three alternatives studied



Preliminary results and observations:

All alternatives have small dollar benefits due to canceled north-south benefits and reduced congestion revenue

As a result, none of the alternatives delivers a positive net benefit

Nevertheless, Alternative 1 is the most cost-effective solution

Summary on the Path 26 study

Comments

Path 26 operational limit will often be significantly lower than the 4000 MW path rating when the new Whirlwind 500 kV substation is looped into the Midway – Vincent line #3

The most limiting conditions are L-1 situations on Path 26 lines
The most limiting elements are the series capacitors on Midway – Vincent #1 and #2 lines

---

Path 26 congestion has been top-ranked in the ISO studies for four consecutive years
However, studies have not found significant economic benefit to relieve this congestion
The reason is that north and south LMP changes result in canceled dollars benefits

Path 26 congestion is not only a forecasted congestion but also an operations reality
The congestion happens in the ISO market

Path 26 is perhaps the most important link in the California transmission system
Any disruptions on Path 26 jeopardize system reliability and market integrity

It has been a challenge to find economic justification to relieve this congestion bottleneck
In this situation, shall also explore other justifications, such as policy and reliability needs

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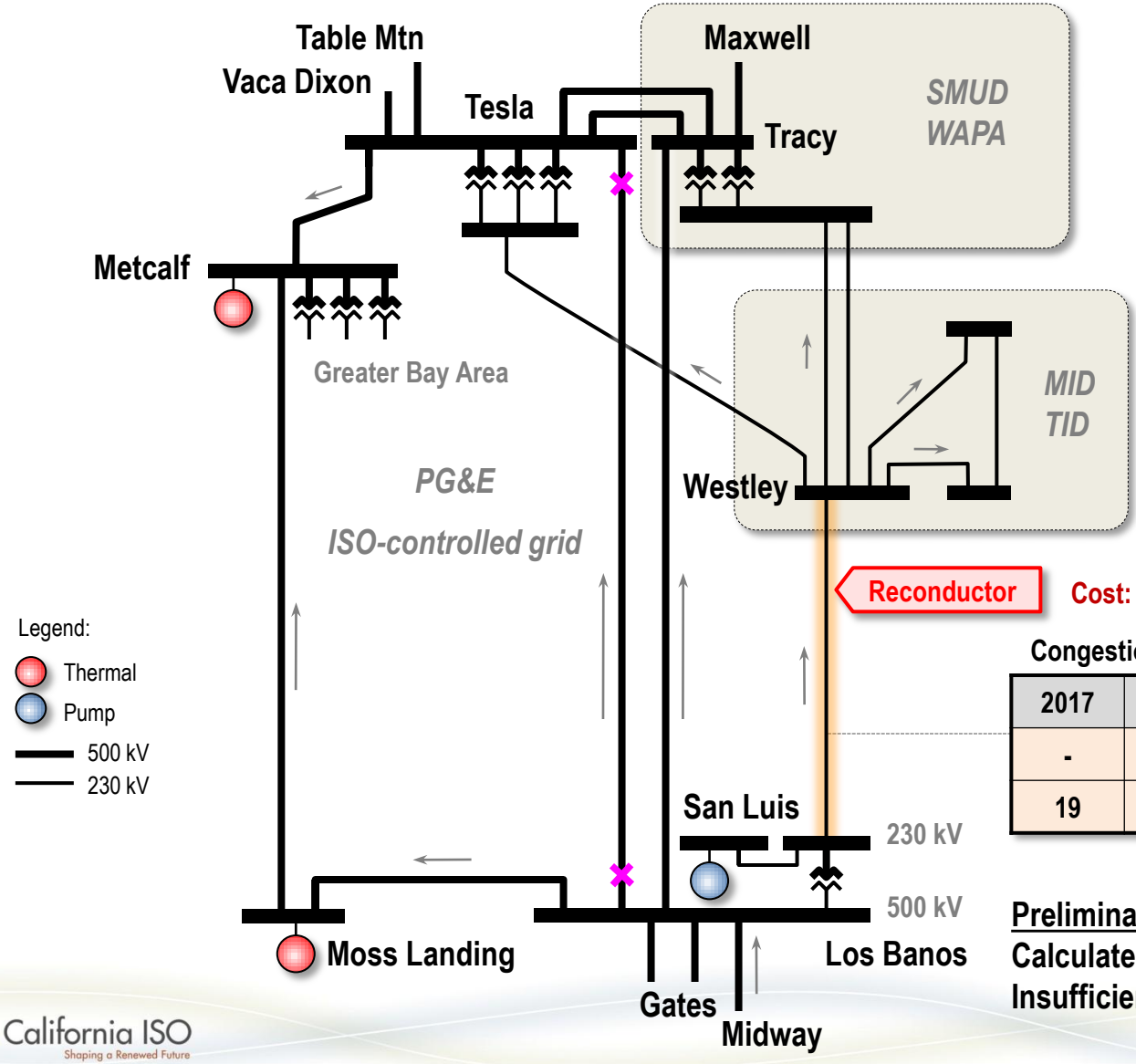
Los Banos North (LBN)

Economic assessment



Preliminary result and observations:
Calculated benefit is less than the cost
Insufficient economic justification

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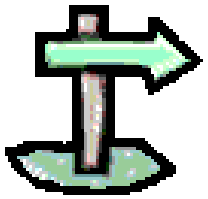

For this study subject, please see relevant slides in the "Central California Study" presentation

General information about the "Central California Study"

In the Central California area, reliability-driven upgrades are being proposed and studied to address the need mainly in the Greater Fresno Area (GFA)

The Central California Study is a comprehensive analysis where both reliability and economic assessments are made

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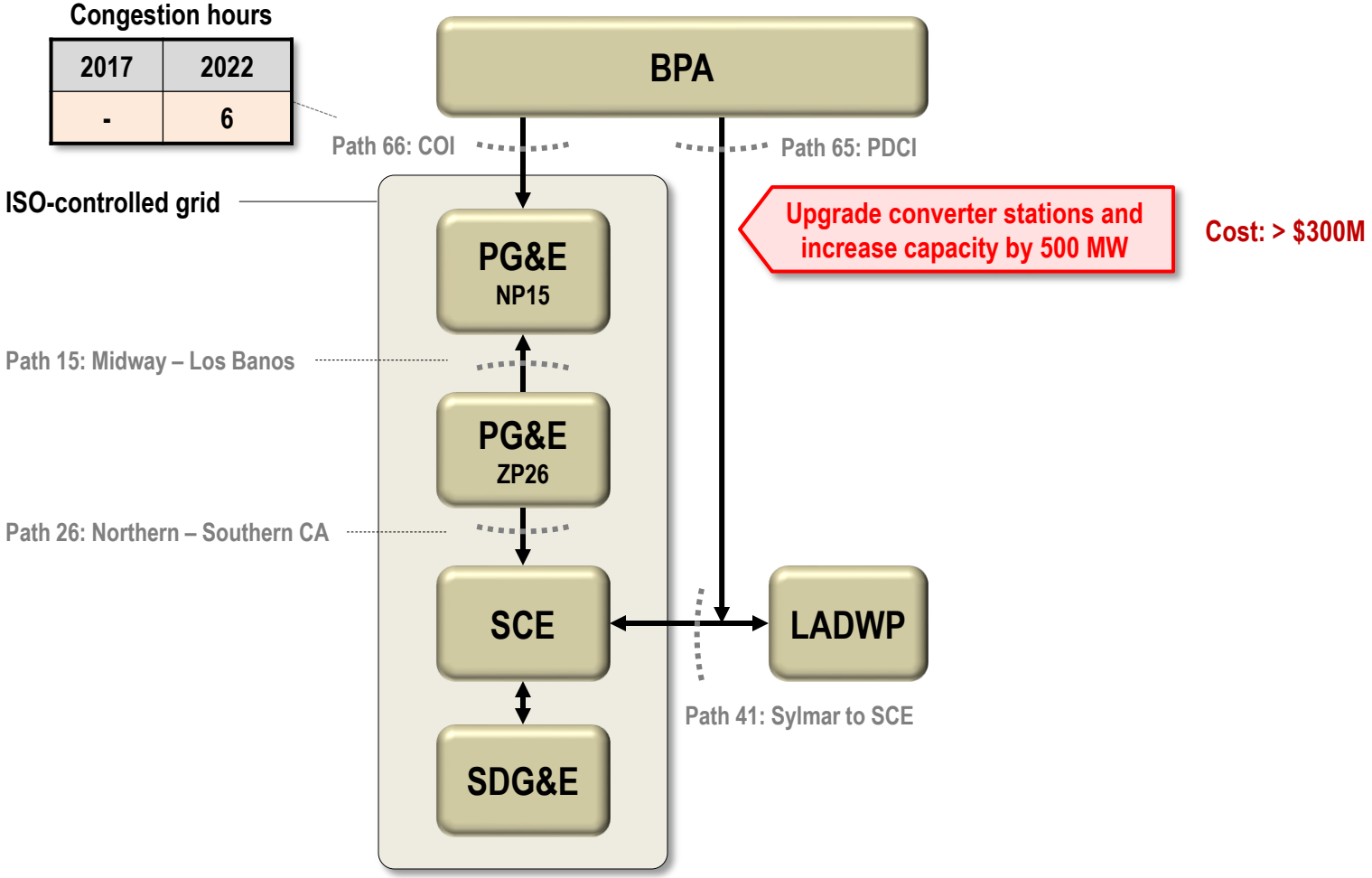
Pacific Northwest – California transmission interface

Analysis of PDCI upgrade

Congestion hours

2017	2022
-	6



Preliminary findings:

- Energy benefits: Insignificant
- Capacity benefit on system RA: Limited because of downstream constraints
- Capacity benefit on LCR: Negative because of aggravated downstream constraints

More detailed modeling and analysis will be conducted

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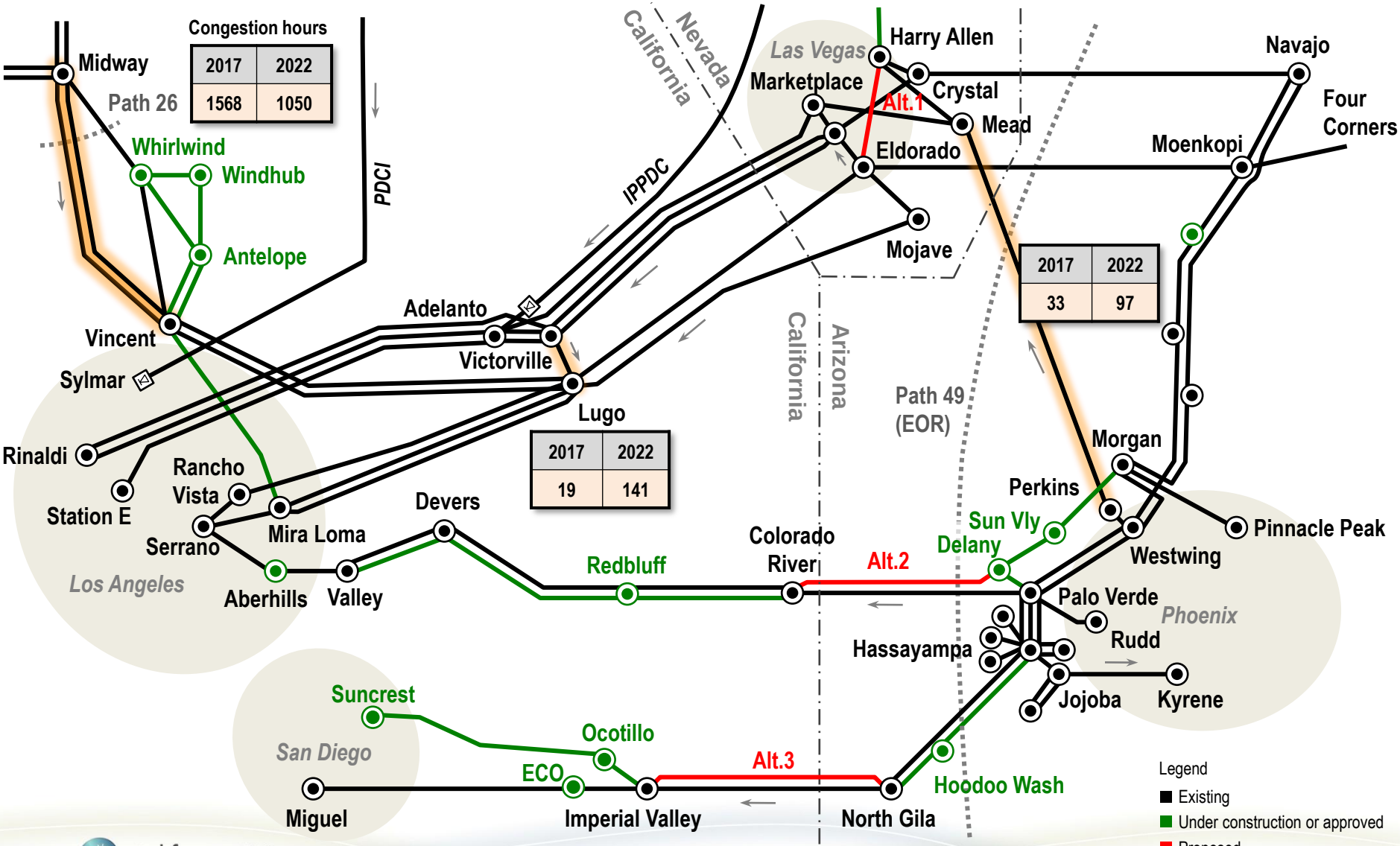
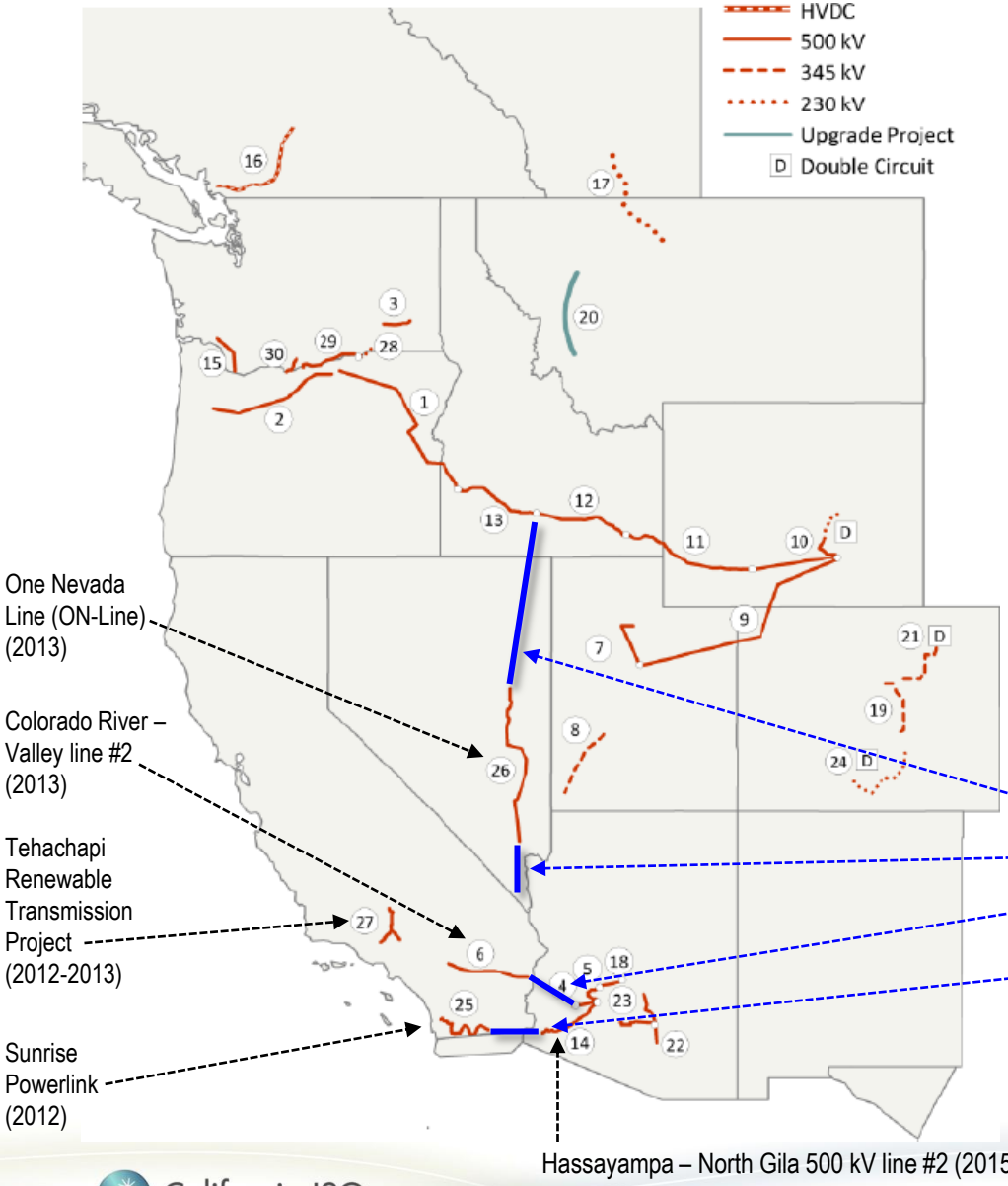
Desert Southwest – California transmission interface

Alternatives studied



[Note] This map shows 500 kV transmission system in Southern California and adjacent areas in AZ and NV

In a bigger picture – Alternatives studied



The **red** lines represent approved new transmission projects that are modeled in the TEPPC database

The **blue** lines represent proposed new transmission lines that are analyzed in this economic planning study

Proposed alternatives under this economic study		
1a	Midpoint – Robinson Summit 500 kV line	~275 miles
1	Harry Allen – Eldorado 500 kV line	~60 miles
2	Delany – Colorado River 500 kV line	~110 miles
3	North Gila – Imperial Valley 500 kV line #2	~80 miles

Source of the underlying map: "Common Case Transmission Assumptions", WECC SPG Coordination Group, Feb 2012

Economic assessment

Preliminary results

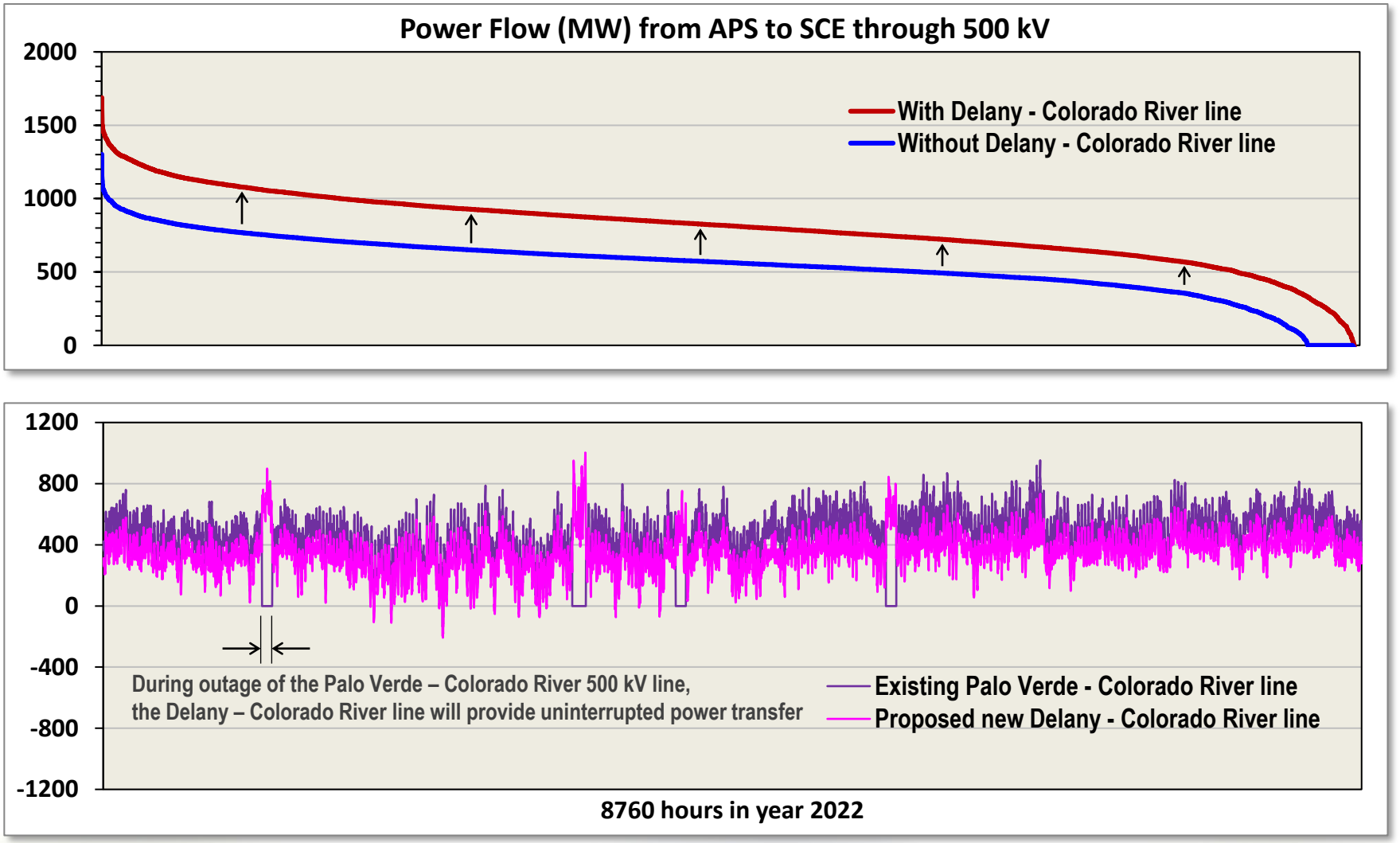
Alt	Description	In territory	Capital cost	Benefit
1	Harry Allen – Eldorado 500 kV line (~60 miles)	NV (100%)	$240M	~$150M
1a	Midpoint – Robinson Summit 500 kV line (~275 miles)	ID (20%) and NV (80%)	$540M	< 0
1b	Alternative 1a and 1	ID (10%) and NV (90%)	$780M	~$100M
2	Delany – Colorado River 500 kV line (~110 miles)	CA (10%) and AZ (90%)	$325M	~$1000M
3	North Gila – Imperial Valley 500 kV line #2 (~80 miles)	CA (90%) and AZ (10%)	$490M	~$200M

Observation:

In comparison of the alternatives, the Delany – Colorado River 500 kV line delivers the largest economic benefit

Power flow from APS to SCE via 500 kV

Performance of Alternative 2 (Delany – Colorado River 500 kV line)



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Summary of preliminary results

Evaluation of economic benefits to the ISO ratepayers

ID	Proposed congestion mitigation measures			Economic assessment		
	Alt	Transmission Facilities	Op.Yr	Benefit	Cost	Comment
P26	1	Upgrade series caps on Midway – Vincent 500 kV lines #1 & #2	2017	~ 0	$180M	Appears uneconomic
	2	Build Midway – Whirlwind 500 kV line #2	2017	~ 0	$400M	Appears uneconomic
	3	Build Midway – Vincent 500 kV #4	2017	~ 0	$1100M	Appears uneconomic
LBN	1	Re-conductor Los Banos – Westley 230 kV line	2017	~ 0	$45M	Appears uneconomic
CCA	-	See *Central California Study*	2020	-	-	See *Central California Study*
NWC	1	Increase PDCI capacity by 500 MW	2017	~ 0	> $300M	Appears uneconomic
SWC	1	Harry Allen – Eldorado 500 kV line	2017	~150M	$240M	Appears uneconomic
	1a	Midpoint – Robinson Summit 500 kV line	2017	< 0	$540M	Uneconomic
	1b	Alternatives 1a plus 1	2017	~100M	$780M	Uneconomic
	2	Delany – Colorado River 500 kV line	2017	~$1000M	$325M	Appears economic
	3	North Gila – Imperial Valley 500 kV line #2	2017	~$200M	$490M	Appears uneconomic

Note:
The US dollars are in year 2012 values
The benefits and costs are valued at the proposed operation year
The "benefit" is the total economic benefit determined by the economic planning study
The "cost" is the total capital cost

Exclamation:
The current results are preliminary and subject to change. Going forward, when further modeling enhancements are made and open issues are resolved, it is possible that some results may differ significantly from the preliminary findings

Open issues and uncertainties

- Reliability and policy-driven network upgrades still being studied and finalized
- Economic values of RA capacity that is imported from out-of-state
- Implications of imported capacity backfilling on transmission delivering renewables
- Uncertainties of generation fleet requirements for renewable integration

Next steps

- Address open issues mentioned in the last slide
- Complete further modeling enhancements and finalize the database
- Conduct sensitivity analysis for alternatives appearing to be economic

- Final results will be presented in the 4th stakeholder meeting in February 2013
- Finalized database will be published at completion of the *ISO Transmission Plan*

Thanks!

Your questions and comments are welcome

For written comments, please send to

RegionalTransmission@caiso.com

Acknowledgements of ISO teamwork

Database development and study execution by Xiaobo Wang, Luba Kravchuk, and Binaya Shrestha
Modeling supports and data advisories from June Xie, Chengrui Cai, and Frank Chen

Wrap-Up

Jeff Billinton
Manager, Regional Transmission - North

2012/2013 Transmission Planning Process Stakeholder Meeting
December 11-12, 2012

Next Steps

Date	Milestone
December 12 – December 27	Stakeholder comments to be submitted to regionaltransmission@caiso.com
January 31, 2013	2012/2013 Draft Transmission Plan posted
February 2013	Stakeholder Meeting on contents of draft Transmission Plan