California ISO

Agenda
Reliability Assessment and Study Updates

Isabella Nicosia
Associate Stakeholder Affairs and Policy Specialist

2019-2020 Transmission Planning Process Stakeholder Meeting
September 25-26, 2019

2019-2020 Transmission Planning Process Stakeholder Meeting – Day 1 (September 25) Agenda

Topic	Presenter
Introduction	Isabella Nicosia
Overview	Jeff Billinton
Key Issues	Neil Millar
Reliability Assessment - North	RTN - Engineers
Reliability Assessment - South	RTS - Engineers
Policy Assessment - Update	Sushant Barave
Economic Assessment - Update	Yi Zhang
Economic Assessment – LCR Areas (Continuation of 2018-2019 Transmission Plan)	Catalin Micsa
Next Steps	Isabella Nicosia

2019-2020 Transmission Planning Process Stakeholder Meeting – Day 2 (September 26) Agenda

Topic	Presenter
GridLiance Proposed Reliability Solutions	GridLiance
VEA Proposed Reliability Solutions	VEA
SDG&E Proposed Reliability Solutions	SDG&E
SCE Proposed Reliability Solutions	SCE
PG&E Proposed Reliability Solutions	PG&E
Wrap-up and Next Steps	Isabella Nicosia

Introduction and Overview
Preliminary Reliability Assessment Results

Jeff Billinton
Sr. Manager, Regional Transmission - North

2019-2020 Transmission Planning Process Stakeholder Meeting
September 25-26, 2019

2019-2020 Transmission Planning Process

December 2018 | April 2019 | March 2020

Phase 1 – Develop detailed study plan

State and federal policy

CEC - Demand forecasts

CPUC - Resource forecasts and common assumptions with procurement processes

Other issues or concerns

Phase 2 - Sequential technical studies

- Reliability analysis
- Renewable (policy-driven) analysis
- Economic analysis

Publish comprehensive transmission plan with recommended projects

Phase 3 Procurement

ISO Board for approval of transmission plan

The reliability assessment is a key component of the overall 2019-2020 Transmission Plan Study Plan

- Reliability Assessment to identify reliability-driven needs
  - CPUC IRP default portfolio used for reliability assessment
  - Load forecast based on California Energy Demand Revised Forecast 2018-2030 adopted by California Energy Commission (CEC) on January 9, 2019
- This is foundational to other aspects of the plan, which continues to evolve in each cycle:
  - Policy Assessment
  - Economic Planning Study to identify economically-driven elements
  - Interregional Transmission Planning Process (new section)
  - Other Studies
    - Local Capacity Requirements (near term, mid term, long term)
    - Long-term Congestion Revenue Rights
    - Frequency Response

2019-2020 Ten Year Reliability Assessment To Date

- Preliminary study results were posted on August 16
  - Based on assumptions identified in 2019-2020 Study Plan
  - Satisfy requirements of:
    - NERC Reliability Standards
    - WECC Regional Criteria
    - ISO Planning Standards
- Transmission request window (reliability driven projects) opened on August 16
  - PTO proposed mitigations submitted to ISO by September 16

2019-2020 Ten Year Reliability Assessment going forward

- Comments on Stakeholder Meeting due October 10
- Request Window closes October 15
  - Request Window is for alternatives to reliability assessment
- ISO recommended projects:
  - For management approval of reliability projects less than $50 million will be presented at November stakeholder session
  - For Board of Governor approval of reliability projects over $50 will be included in draft plan to be issued for stakeholder comments by January 31, 2020
- Purpose of today's stakeholder meeting
  - Review the results of the reliability analysis
  - Set stage for stakeholder feedback on potential mitigations

Critical Energy Infrastructure Information

- The ISO is constantly re-evaluating its CEII practices to ensure they remain sufficient going forward.
- Continuing with steps established in previous years:
  - Continuing to not post extreme event contingency discussions in general - only shared on an exception basis where mitigations are being considered:
    - Details on secure web site
    - Summaries on public site
  - Continuing to migrate previous planning cycles material to the secure website.
- One “bulk system” presentation has also been posted on the secure site.

2019-2020 Transmission Plan Milestones

- Draft Study Plan posted on February 21
- Stakeholder meeting on Draft Study Plan on February 28
- Comments to be submitted by March 14
- Final Study Plan to be posted on April 3
- Preliminary reliability study results to be posted on August 16
- Stakeholder meeting on September 25 and 26
- Comments to be submitted by October 10
- Request window closes October 15
- Preliminary policy and economic study results on November 18
- Comments to be submitted by December 2
- Draft transmission plan to be posted on January 31, 2019
- Stakeholder meeting in February
- Comments to be submitted within two weeks after stakeholder meeting
- Revised draft for approval at March Board of Governor meeting

Study Information

- Stakeholder comments to be submitted by October 10
  - Stakeholder comments are to include potential alternatives for economic LCR assessment
  - Stakeholders requested to submit comments to: regionaltransmission@caiso.com
  - Stakeholder comments are to be submitted within two weeks after stakeholder meetings
  - ISO will post comments and responses on website

Key Issues for the 2019-2020 Transmission Plan
Transmission Planning Process

Neil Millar
Executive Director, Infrastructure Development

2019-2020 Transmission Planning Process Stakeholder Meeting
September 25-26, 2019

Key Issues in 2019-2020 Transmission Plan Cycle

- Reliability
  - Initial results being presented are based on revised criteria for non-Bulk Electric System under ISO operational control
  - Using CPUC Reliability and Policy Base Case RPS portfolio
- Policy Assessment
  - Base RPS portfolio and sensitivities have been provided for 2019-2020 transmission planning process from the CPUC/CEC
    - Base portfolio also used for reliability analysis
    - Sensitivity 1 allows out-of-state on existing transmission only
    - Sensitivity 2 allows up to 4250 MW of new out-of-state wind on new transmission
  - Establishes planning framework for current RPS goals for 2030
  - These studies are using the ***existing*** deliverability methodology

Key Issues (continued)

- Preparation for economic study results are underway
  - Several modeling issues are being discussed today, providing an early opportunity for stakeholder feedback
  - Selection of economic studies for 2019-2020 Transmission Plan have NOT been made yet
  - Economic assessment of reduction or elimination of gas-fired generation in local capacity areas not studied last year will be completed this year:
    - LCR areas and sub-areas that were not assessed as a part of the 2018-2019 Transmission Plan will be assessed as an extension of 2018-2019 Transmission Plan
    - We will review the needs from the 10 year local capacity technical study in the 2018-2019 Transmission Plan for those remaining areas and sub-areas
    - Mitigation alternatives are not being presented today:
      - » Potential alternatives in the identified areas and sub-areas only can be submitted with stakeholder comments by October 10
    - Recommended LCR criteria changes will be taken into consideration when considering potential alternatives

Key Issues (continued)

- Interregional transmission planning process being documented in a separate chapter in this cycle and going forward.
  - Interregional projects submitted into the two year process last year were be addressed as per tariff-defined processes
  - No interregional projects are being carried forward into the second year of study
  - The ISO is not planning additional “special study” efforts at this time focusing on out-of-state renewables – the intra-ISO impacts of out-of-state renewables are already being examined as an RPS portfolio sensitivity

Other Issues

- No new special studies planned for this cycle
  - Policy sensitivities are already considering a range of future renewable generation development options
  - Several ongoing issues are expected to be documented in the special study section
    - ISO's support and input for CPUC proceeding re Aliso Canyon
    - Reporting on the status of CPUC Integrated Resource Planning process and system adequacy of supply issue
- With the "SATA" initiative on hold pending resolution of merchant storage dispatch, to the extent storage is considered, it will be considered as it was in the 2018-2019 cycle
- Need to be mindful of the ongoing complaint at FERC regarding the ISO's transmission planning process

PG&E
Preliminary Reliability Assessment Results

Jeff Billinton
Sr. Manager, Regional Transmission – North

2019-2020 Transmission Planning Process Stakeholder Meeting
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ISO Planning Standards

Applicability of Reliability Standards to non-Bulk Electric System Facilities under ISO Operational Control

- In planning for identified non-BES facilities, according to NERC Bulk Electric System definition and WECC BES Inclusion and Exclusion Guidelines, that have been turned over to the ISO operational control, the ISO will apply the NUC-001 Nuclear Plant Interface Requirements (NPIRs) for Diablo Canyon Power Plant, the approved WECC Regional Criteria and NERC Transmission Planning (TPL) standard TPL-001-4 categories P0, P1 and P3 contingencies taken on the non-BES equipment. All other NERC Transmission Planning (TPL) standard TPL-001-4 categories of contingencies taken on non-BES equipment may be evaluated for risk and consequences and may be used for project justification in conjunction with reduction in load outage exposure, through a benefit to cost ratio (BCR) under standard 5 section 4 herein.

Bulk Electric System – Inclusion Guidelines

- NERC Inclusions (I1 to I4)
- WECC Inclusion Guideline

Contingency Category	Impact on non-BES Element due to contingency of BES element	Impact on BES Element due to contingency of non-BES element
Single-contingency (P1)	Flow increase > 10% & subsequent flow > 90% of applicable rating	Flow increase > 10%

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Bulk Electric System - Inclusion <100 kV Facilities Assumptions

- Assessment is performed using following 2019-2020 TPP base cases:
  - 2029 local area Summer peak
  - 2029 winter peak
  - 2029 Spring off-peak

- Contingency used:
  - All local area P1 (includes generating resources and reactive devices)

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Bulk Electric System
Inclusion of <100 kV Facilities

S. No.	Area	<100 kV Facilities that met BES Inclusion Criteria
1	Humboldt	HUMBOLDT BAY-RIO DELL JCT 60kV
2	Humboldt	BRIDGEVILLE-GARBERVILLE 60kV
3	Humboldt	HMBLT BY-HARRIS 60kV
4	Humboldt	RIO DELL JCT-BRIDGEVILLE 60kV
5	NCNB	EGLE RCK 115/60kV TB 1
6	NCNB	HPLND JT 115/60kV TB 2
7	NCNB	KONOCTI-EAGLE ROCK 60kV
8	NCNB	MENDOCNO 115/60kV TB 3
9	NCNB	FULTON-HOPLAND 60kV
10	NCNB	WINDSOR-FTCH MTN 60kV
11	NVLY	CASCADE-BENTON-DESCHUTES 60kV
12	NVLY	CASCADE - OREGNTRL 60.0 kV
13	NVLY	WNTU PMS - LOMS JCT 60.0 kV
14	GBA	CHRISTIE-FRANKLIN #2 60kV
15	GBA	CLY LND 115/60kV TB 1
16	GBA	CLY LND2 115/60kV TB 2
17	GBA	EVRGRN 1 115/60kV TB 1
18	GBA	LIVERMORE-LAS POSITAS 60kV
19	GBA	LS PSTAS 230/60kV TB 4
20	CVLY	SALADO-CROWCREEK SS 60KV
21	CVLY	PEASE-E.MRYSVE 60KV
22	CVLY	ATLANTC 230/60KV TB 1
23	GFA	EXCHEQUR 70/115kV TB 1
24	GFA	GATES 230/70kV TB 5
25	GFA	GWF-HENRIETTA 70kV
26	GFA	MERCED 115/70kV TB 2
27	GFA	MERCED-MERCED FALLS 70kV
28	Kern	TAFT A-MARICOPA-CADET 70kV

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Greater Bay Area
Preliminary Reliability Assessment Results

Binaya Shrestha
Regional Transmission Engineer Lead

2019-2020 Transmission Planning Process Stakeholder Meeting
September 25-26, 2019

Greater Bay Area

- Service areas cover Alameda, Contra Costa, Santa Clara, San Mateo and San Francisco counties.
- Supply sources: Vaca Dixon, Tesla and Metcalf
- Comprised of 60, 115 & 230 & 500 kV transmission facilities.
- For ease of conducting the performance evaluation, the Greater Bay Area is divided into Seven sub-areas:
  - San Francisco
  - San Jose
  - Peninsula
  - Mission
  - East Bay
  - Diablo
  - De Anza

Load and Load Modifier Assumptions - Greater Bay Area

S. No.	Base Case	Scenario Type	Description	Gross Load (MW)	AAEE (MW)	BTM-PV		Net Load (MW)	Demand Response	
						Installed (MW)	Output (MW)		Total (MW)	D2 (MW)
1	GBA-2021-SP	Baseline	2021 summer peak load conditions. Peak load time - hours ending 18:00.	9,003	148	1,571	158	8,697	134	76
2	GBA-2021-WP	Baseline	2021 winter peak load conditions. Peak load time - hours ending 19:00.	7,850	148	1,571	0	7,702	134	76
3	GBA-2021-SpOP	Baseline	2021 spring off-peak load conditions. Off-peak load time - hours ending 13:00.	6,007	112	1,571	1256	4,639	134	76
4	GBA-2021-SP-HiRenew	Sensitivity	2021 summer peak load conditions with hi-renewable dispatch sensitivity	6,007	112	1,571	1256	4,639	134	76
5	GBA-2024-SP	Baseline	2024 summer peak load conditions. Peak load time - hours ending 18:00.	9,284	276	2,055	206	8,802	134	76
6	GBA-2024-WP	Baseline	2024 winter peak load conditions. Peak load time - hours ending 19:00.	8,401	273	2,055	0	8,128	134	76
7	GBA-2024-SpOP	Baseline	2024 spring off-peak load conditions. Off-peak load time - hours ending 13:00.	6,370	207	2,055	1665	4,498	134	76
8	GBA-2024-SP-Hi-CEC	Sensitivity	2024 summer peak load conditions with hi-CEC load forecast sensitivity	9,284	0	2,055	206	9,078	134	76
9	GBA-2024-SpOP-HiRenew	Sensitivity	2024 spring off-peak load conditions with hi renewable dispatch sensitivity	6,370	207	2,055	1665	4,498	134	76
10	GBA-2029-SP	Baseline	2029 summer peak load conditions. Peak load time - hours ending 18:00.	9,634	502	2,788	0	9,132	134	76
11	GBA-2029-WP	Baseline	2029 winter peak load conditions. Peak load time - hours ending 19:00.	8,404	372	2,788	0	8,032	134	76
12	GBA-2029-SP-QF	Sensitivity	2029 summer peak load conditions with QF retirement sensitivity	9,634	502	2,788	0	9,132	134	76
13	GBA-2029-SVP	Sensitivity	2029 summer peak load conditions with high SVP load sensitivity	9,634	502	2,788	0	9,132	134	76

Generation Assumptions - Greater Bay Area

S. No.	Base Case	Scenario Type	Description	Battery Storage (MW)	Solar		Wind		Hydro		Thermal	
					Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)
1	GBA-2021-SP	Baseline	2021 summer peak load conditions. Peak load time - hours ending 18:00.	80	20	2	221	98	0	0	7,838	5,149
2	GBA-2021-WP	Baseline	2021 winter peak load conditions. Peak load time - hours ending 19:00.	80	20	0	221	35	0	0	7,838	4,925
3	GBA-2021-SpOP	Baseline	2021 spring off-peak load conditions. Off-peak load time - hours ending 13:00.	80	20	20	221	119	0	0	7,838	1,373
4	GBA-2021-SP-HiRenew	Sensitivity	2021 summer peak load conditions with hi-renewable dispatch sensitivity	80	20	20	221	173	0	0	7,838	1,666
5	GBA-2024-SP	Baseline	2024 summer peak load conditions. Peak load time - hours ending 18:00.	80	20	2	221	76	0	0	7,838	5,497
6	GBA-2024-WP	Baseline	2024 winter peak load conditions. Peak load time - hours ending 19:00.	80	20	0	221	16	0	0	7,838	5,460
7	GBA-2024-SpOP	Baseline	2024 spring off-peak load conditions. Off-peak load time - hours ending 13:00.	80	20	19	221	4	0	0	7,838	1,345
8	GBA-2024-SP-Hi-CEC	Sensitivity	2024 summer peak load conditions with hi-CEC load forecast sensitivity	80	20	2	221	76	0	0	7,838	5,497
9	GBA-2024-SpOP-HiRenew	Sensitivity	2024 spring off-peak load conditions with hi renewable dispatch sensitivity	80	20	19	221	109	0	0	7,838	845
10	GBA-2029-SP	Baseline	2029 summer peak load conditions. Peak load time - hours ending 18:00.	80	20	0	221	39	0	0	7,838	4,837
11	GBA-2029-WP	Baseline	2029 winter peak load conditions. Peak load time - hours ending 19:00.	80	20	0	281	76	0	0	7,838	5,820
12	GBA-2029-SP-QF	Sensitivity	2029 summer peak load conditions with QF retirement sensitivity	80	20	0	221	39	0	0	7,838	4,837
13	GBA-2029-SVP	Sensitivity	2029 summer peak load conditions with high SVP load sensitivity	80	20	0	221	39	0	0	7,838	4,837

Note: Includes PG&E load only. DR and storage are modeled offline in starting base cases.

Previously approved transmission projects modelled in base cases

Project Name	Division	First Year Modeled
East Shore-Oakland J 115 kV Reconductoring Project	East Bay	2021
North Tower 115 kV Looping Project	East Bay	2024
Oakland Clean Energy Initiative Project	East Bay	2024
Christie-Sobrante 115 kV Line Reconductor	East Bay	2024
Moraga-Sobrante 115 kV Line Reconductor	East Bay	2024
Pittsburg 230/115 kV Transformer Capacity Increase	Diablo	2021
Martin 230 kV Bus Extension	San Francisco	2024
South of San Mateo Capacity Increase (revised scope)	Peninsula	2021 2029
Ravenswood – Cooley Landing 115 kV Line Reconductor	Peninsula	2021
Cooley Landing-Palo Alto and Ravenswood-Cooley Landing 115 kV Rerate	Peninsula	2021
Jefferson 230 kV Bus Upgrade	Peninsula	2024
Ravenswood 230/115 kV Transformer #1 Limiting Facility Upgrade	Peninsula	2021
Moraga-Castro Valley 230 kV Line Capacity Increase Project	Mission	2021
Monta Vista 230 kV Bus Upgrade	De Anza	2021
Newark-Lawrence 115 kV Line Upgrade	De Anza	2021
Los Esteros 230 kV Substation Shunt Reactor	San Jose	2021
Newark-Milipitas #1 115 kV Line Upgrade	San Jose	2021
Trimble-San Jose B 115 kV Line Upgrade	San Jose	2021
San Jose-Trimble 115 kV Series Reactor	San Jose	2021
Morgan Hill Area Reinforcement (revised scope)	San Jose	2024
Metcalf-Piercy & Swift and Newark-Dixon Landing 115 kV Upgrade	San Jose	2024

Reliability assessment preliminary results summary

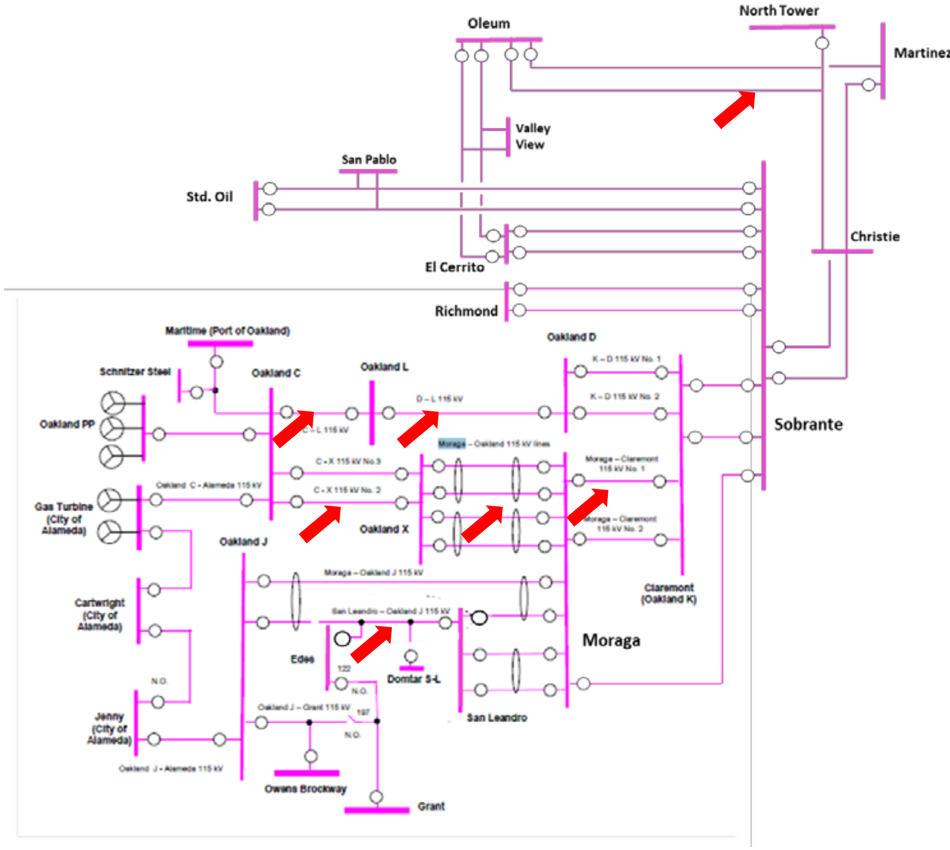
East Bay Division – Results Summary

<u>Observations</u>

- Near-term overloads on Oleum-Christie 115kV line.
- Some long-term issues identified in Northern Oakland area.

<u>Approved and Potential Mitigations</u>

- North Tower 115 kV Looping and Christie-Sobrante 115 kV Line Reconductor projects mitigate overloads in Oleum/Christie system.
- Dispatching OCEI battery helps, but doesn't mitigate all identified overloads. Dispatching Alameda CT will help. OCEI portfolio might also need to increase to meet projected demand increase. The overall East Bay area load appears higher than historical recorded. Need to check loads at stations served by the overloaded lines.
- No new mitigation required at this time.



East Bay Division – Results Summary cont'd

<u>Moraga-Sobrante 115 kV reconductoring project</u>

- The Moraga-Sobrante 115 kV reconductoring project was approved in 2018-2019 TPP cycle for potential overloads on the line driven by P2 contingencies at Moraga and Sobrante 230 kV stations.
- The Moraga-Sobrante 115 kV reconductoring project will be put on hold for following reasons:
  - 2019-2020 TPP reliability assessment identified no need for the project due to change in the East Bay division load forecast and distribution.
  - Moraga 230 kV bus upgrade as potential mitigation alternative to address this constraint as well as constrains identified in Mission division.

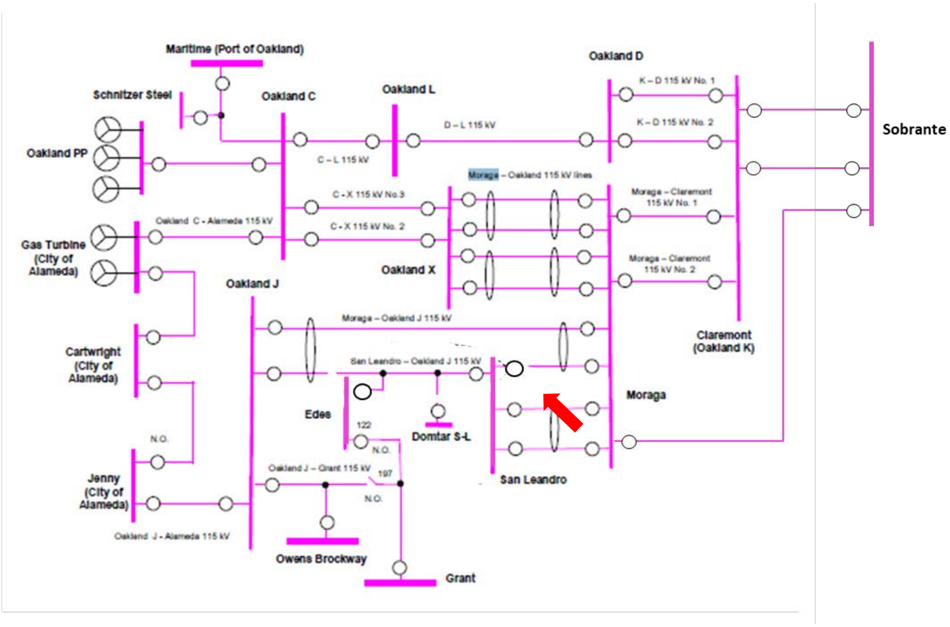
Diablo Division – Results Summary

<u>Observations</u>

- P2 at Moraga 115 kV and P6 overloads observed on Moraga-San Leandro 115 kV lines.

<u>Approved and Potential Mitigations</u>

- P2 overloads are mitigated in long-term by Moraga 115 kV bus upgrade part of OCEI.
- The overall Oakland area load appears higher than historical recorded. Need to check loads at stations served by the overloaded lines.
- The overloads in the interim will be mitigated by modification of the existing Moraga-Oakland J SPS (ISD: April 2021).
- Continue to assess and monitor load forecast in the area.



San Francisco Division – Results Summary

Observations

- No overloads observed.

Potential Mitigations

- No new upgrade expected.

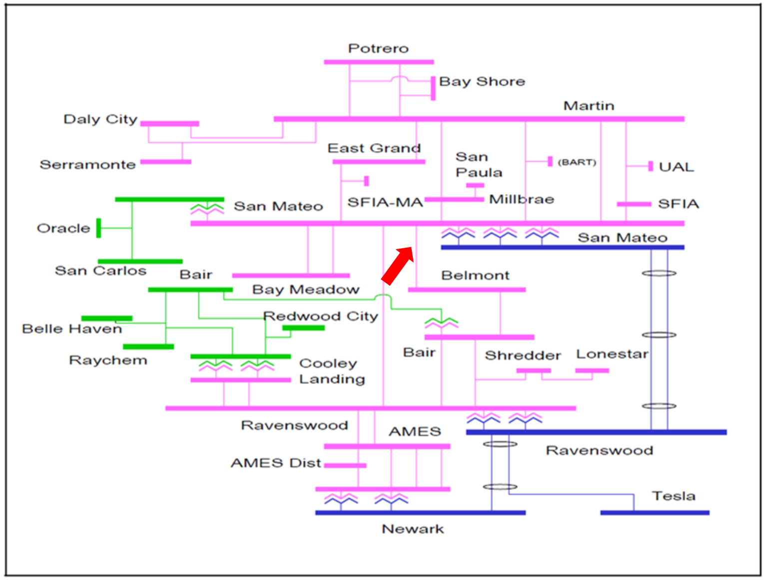
Peninsula Division – Results Summary

<u>Observations</u>

- Long-term P6 overload identified on San Mateo-Belmont 115 kV line.

<u>Potential Mitigations</u>

- Continue to monitor future load forecast.
- No new upgrade expected.



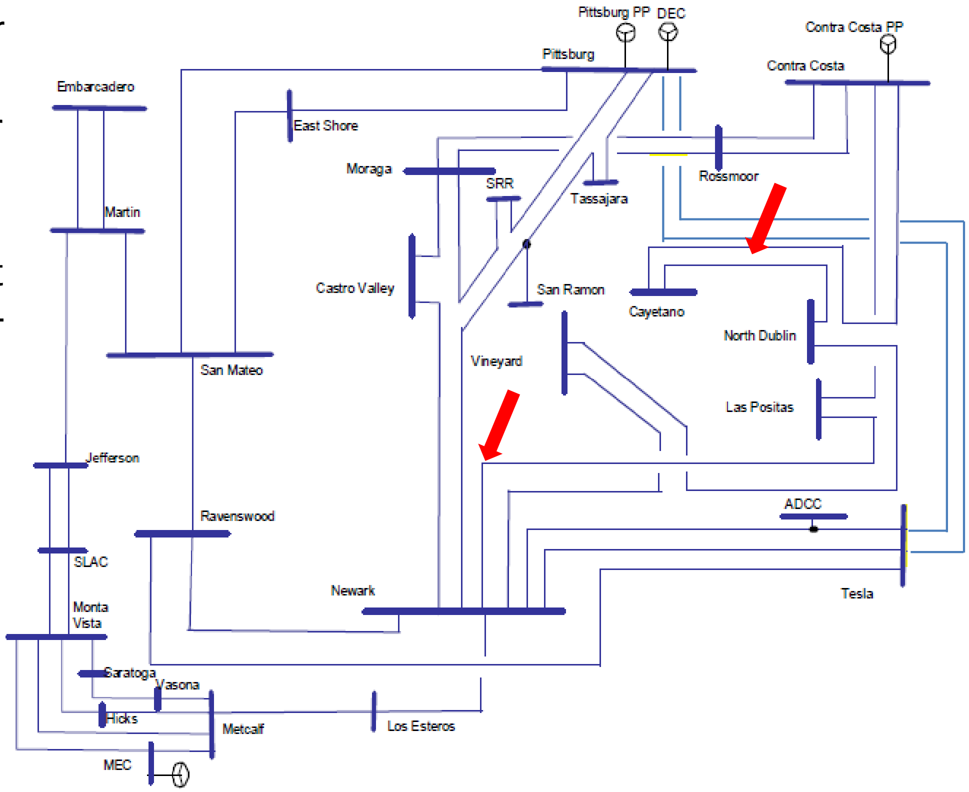
Mission Division – Results Summary

Observations

- E. Shore 230/115 kV bank #1 overload for P2 contingency at E. Shore 230 kV.
- Newark 230/115 kV bank #11 overload for P2 contingency at Newark 230. kV.
- 230 kV lines between Contra Costa and Newark overloads for P2 contingencies at Moraga and Contra Costa 230 kV in near-term and P6/P7 in long-term.

Potential Mitigations

- E. Shore, Contra Costa, Moraga and Newark 230 kV bus upgrade or reconfiguration.
- Continue to monitor future load forecast for P6/P7 driven long-term overloads on 230 kV lines between Contra Costa and Newark.



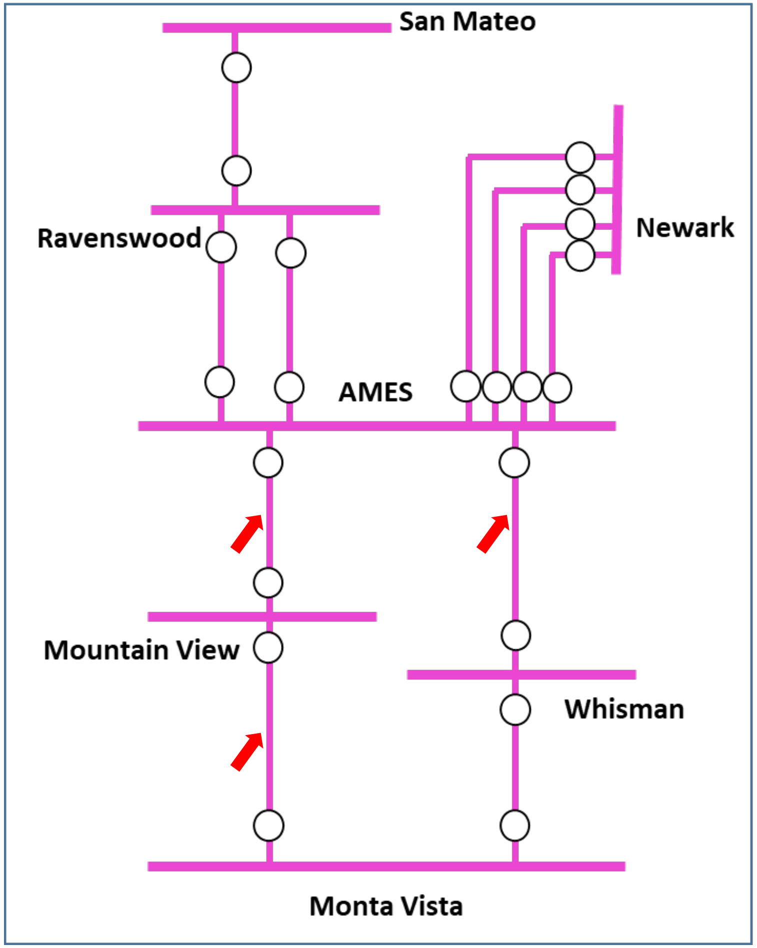
De Anza Division – Results Summary

Observations

- Ames-Mountain View-Whisman 115 kV line overload for P5 contingency at Monta Vista 115 kV.
- Long-term P1 overload on Monta Vista-Wolfe 115 kV Line.
- Long-term P6 overloads on Mountain View-Monta Vista and Newark-Applied Materials 115kV lines.

Potential Mitigations

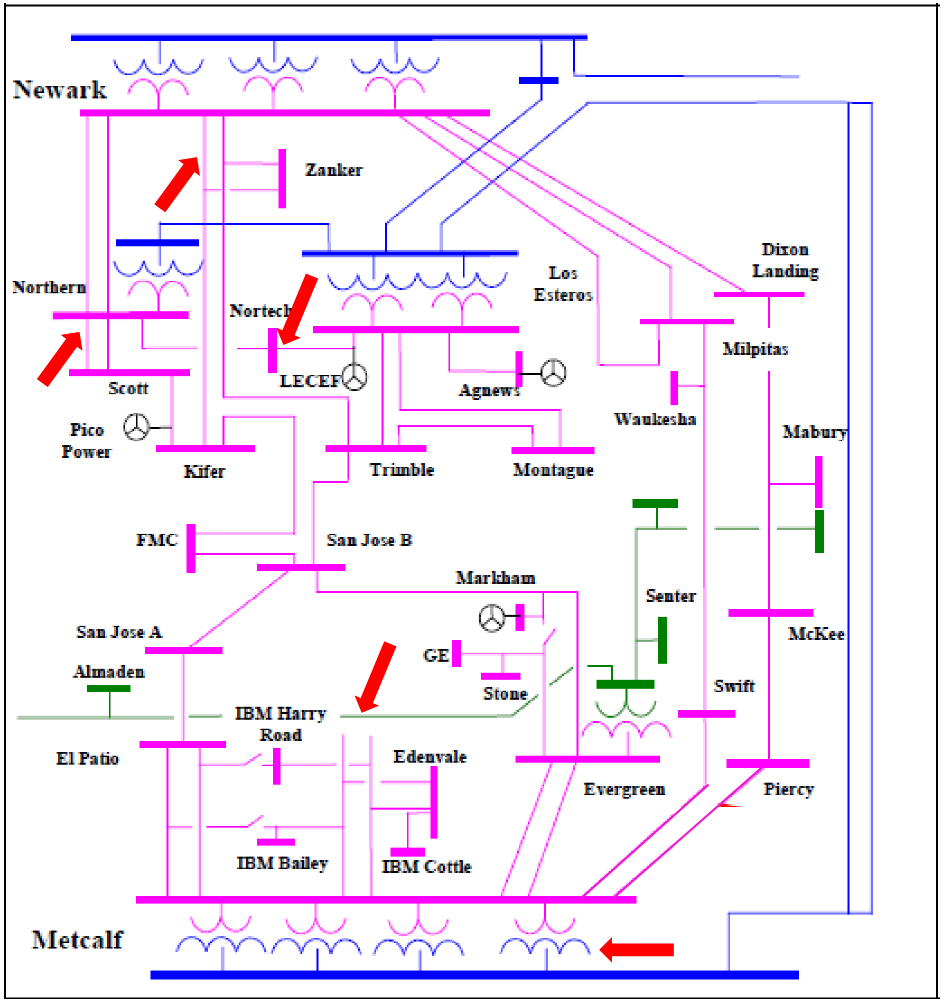
- Protection upgrade for P5 contingency driven overloads.
- Continue to monitor future load forecast for P6 driven long-term overloads.



San Jose Division – Results Summary

Observations
- P1 overload on Evergreen-Almaden 60 kV Line.
- Newark-Kifer 115 kV line overload for NRS P2 contingency.
- NRS-Scott 115 kV lines overload for P6 contingency.
- P2/P6 overloads starting 2024 on San Jose area 115 kV Lines.
- Long-term P2 overloads on Metcalf 500/230 kV and 230/115 kV banks.

Potential Mitigations
- Disable automatic load pickup at Los Gatos.
- SVP NRS breaker upgrade project.
- SPV area generation redispatch following first contingency.
- The overall San Jose division load appears higher than historical recorded. Need to check loads at stations served by the overloaded lines.
- Continue to assess and monitor load forecast in the area.



Greater Bay Area – Voltage Results Summary

<u>Observations</u>

- Large number of substations with high voltages observed in near-term off-peak cases.
- 2029 off-peak case shows significantly low number of substations with high voltages.
- Real-time case also shows low number of substations with high voltages concentrated in few buses in San Jose area.

<u>Potential Mitigations</u>

- No mitigation will be proposed for high voltages at this time.

Sensitivity Study Assessment

- Below is the list of facility overloads identified in sensitivity scenario(s) only.

Overloaded Facility	Category	2024 High CEC	2021 Summer Peak High Renew	2024 Off-Peak High Renew	2029 QF Retirement	2029 High SVP Forecast
FMC-San Jose 'B' 115 kV Line	P2, P6					√
Kifer-Duane 115 kV Line	P6					√
Lawrence - Monta Vista 115 kV	P2					√
Los Esteros-Metcalf 230 kV Line	P2, P6					√
Los Esteros-Montague 115 kV Line	P6					√
Metcalf 500/230 kV Trans No. 11	P6					√
Metcalf-El Patio No. 1 115 kV Line	P2, P3, P6, P7					√
Metcalf-Evergreen No. 1 115 kV Line	P6					√
Metcalf-Evergreen No. 2 115 kV Line	P2, P6					√
Metcalf-Hicks 230 kV Line	P2, P7					√
Monta Vista 230/115 kV Trans No. 2	P6					√
Monta Vista 230/115 kV Trans No. 3	P2, P6					√
Monta Vista 230/115 kV Trans No. 4	P6					√
Monta Vista-Hicks 230 kV Line	P2, P7					√
MOSSLNSW-LASAGUILASS #2 230KV	P6					√
Newark-Newark Dist 230kV section	P6					√
Newark-Trimble 115kV Line	P5, P6, P7					√
Nortech-NRS 115 kV Line	P1, P2, P6					√
NRS 230/115kV TB 1	P3, P5, P6					√
San Jose B bus tie	P6					√
San Jose 'B'-Stone-Evergreen 115 kV Line	P7					√
Saratoga-Vasona 230 kV Line	P7					√
Scott-Duane 115 kV Line	P2					√
Sobrante-El Cerrito STA G #2 115kV Line	P2				√	
Trimble-San Jose 'B' 115 kV Line	P2					√

Summary of Potential New Upgrades

Division	Potential Upgrade
East Bay	None required at this time.
Diablo	None required at this time.
San Francisco	None required at this time.
Penninsula	None required at this time.
Mission	E. Shore, Newark, Moraga and Contra Costa 230 kV bus upgrade or reconfiguration.
De Anza	Protection upgrade
San Jose	None required at this time.
Voltage Mitigation	None required at this time.

North Coast North Bay Area
Preliminary Reliability Assessment

Bryan Fong
Senior Regional Transmission Engineer

2019-2020 Transmission Planning Process Stakeholder Meeting
September 25-26, 2019

North Coast and North Bay Areas

- 10,000 sq. mile area located north of the Bay Area and south of Humboldt
- Counties include:
  - Sonoma, Mendocino, Lake, Marin and part of Napa and Sonoma counties – 10,000 sq. miles
- Cities include:
  - Laytonville, Petaluma, San Rafael, Novato, Benicia, Vallejo
- Transmission facilities: 60kV, 115kV and 230 kV

Load and Load Modifier Assumptions – NCNB Area

S. No.	Study Case	Scenario Type	Description	Gross Load (MW)	AAEE (MW)	BTM-PV		Net Load (MW)	Demand Response	
						Installed (MW)	Output (MW)		Total (MW)	D2 (MW)
1	NCNB-2021-SP	Baseline	2021 summer peak load conditions. Peak load time - hours between 18:00 and 19:00.	1,483	25	416	0	1,458	18	7
2	NCNB-2024-SP	Baseline	2024 summer peak load conditions. Peak load time - hours between 18:00 and 19:00.	1,519	47	498	0	1,472	18	7
3	NCNB-2029-SP	Baseline	2029 summer peak load conditions. Peak load time - hours between 18:00 and 19:00.	1,594	87	615	0	1,507	18	7
4	NCNB-2021-SOP	Baseline	2021 spring off-peak load conditions. Off-peak load time – weekend morning.	864	19	416	333	512	18	7
5	NCNB-2024-SOP	Baseline	2024 spring off-peak load conditions. Off-peak load time – weekend morning.	917	36	498	403	478	18	7
6	NCNB-2021-WP	Baseline	2021 winter peak load conditions. Peak load time - hours between 18:00 and 19:00.	1,480	25	416	0	1,455	18	7
7	NCNB-2024-WP	Baseline	2024 winter peak load conditions. Peak load time - hours between 18:00 and 19:00.	1,518	47	498	0	1,471	18	7
8	NCNB-2029-WP	Baseline	2029 winter peak load conditions. Peak load time - hours between 18:00 and 19:00.	1,595	64	615	0	1,531	18	7
9	NCNB-2024HS-SP	Sensitivity	2024 summer peak load conditions with hi-CEC load forecast sensitivity	1,519	0	498	0	1,519	18	7
10	NCNB-2021-HR	Sensitivity	2021 summer peak load conditions with hi renewable dispatch sensitivity	1,502	32	416	412	1,058	18	7
11	NCNB-2024-HR	Sensitivity	2024 summer peak load conditions with hi renewable dispatch sensitivity	917	36	498	493	389	18	7
12	NCNB-2029-QF	Sensitivity	2027 summer peak load conditions with QF retirement sensitivity	1,594	87	615	0	1,507	18	7

Note:
Includes PG&E load only.
DR and storage are modeled offline in starting base cases.

Generation Assumptions – NCNB Area

S. No.	Study Case	Scenario Type	Description	Battery Storage (MW)	Solar		Wind		Hydro		Thermal	
					Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)
1	NCNB-2021-SP	Baseline	2021 summer peak load conditions. Peak load time - hours between 18:00 and 19:00.	0	0	0	0	0	25	12	1,534	809
2	NCNB-2024-SP	Baseline	2024 summer peak load conditions. Peak load time - hours between 18:00 and 19:00.	0	0	0	0	0	25	12	1,534	759
3	NCNB-2029-SP	Baseline	2029 summer peak load conditions. Peak load time - hours between 18:00 and 19:00.	0	0	0	0	0	25	12	1,534	759
4	NCNB-2021-SOP	Baseline	2021 spring off-peak load conditions. Off-peak load time – weekend morning.	0	0	0	0	0	25	6	1,534	702
5	NCNB-2024-SOP	Baseline	2024 spring off-peak load conditions. Off-peak load time – weekend morning.	0	0	0	0	0	25	4	1,534	702
6	NCNB-2021-WP	Baseline	2021 winter peak load conditions. Peak load time - hours between 18:00 and 19:00.	0	0	0	0	0	25	12	1,534	728
7	NCNB-2024-WP	Baseline	2024 winter peak load conditions. Peak load time - hours between 18:00 and 19:00.	0	0	0	0	0	25	12	1,534	756
8	NCNB-2029-WP	Baseline	2029 winter peak load conditions. Peak load time - hours between 18:00 and 19:00.	0	0	0	0	0	25	17	1,534	806
9	NCNB-2024HS-SP	Sensitivity	2024 summer peak load conditions with hi-CEC load forecast sensitivity	0	0	0	0	0	25	12	1,534	753
10	NCNB-2021-HR	Sensitivity	2021 summer peak load conditions with hi renewable dispatch sensitivity	0	0	0	0	0	25	12	1,534	778
11	NCNB-2024-HR	Sensitivity	2024 summer peak load conditions with hi renewable dispatch sensitivity	0	0	0	0	0	25	4	1,534	702
12	NCNB-2029-QF	Sensitivity	2027 summer peak load conditions with QF retirement sensitivity	0	0	0	0	0	25	12	1,534	759

Previously approved transmission projects modelled in base cases

Project Name	Expected ISD
Fulton-Fitch Mountain 60kV Line Reconductor	20-Mar
Clear Lake 60kV System Reinforcement	22-Feb
Ignacio Area Upgrade	23-Dec
Lakeville 60kV Area Reinforcement	21-Dec
Vaca-Lakeville 230kV Corridor Series Compensation	21-Apr

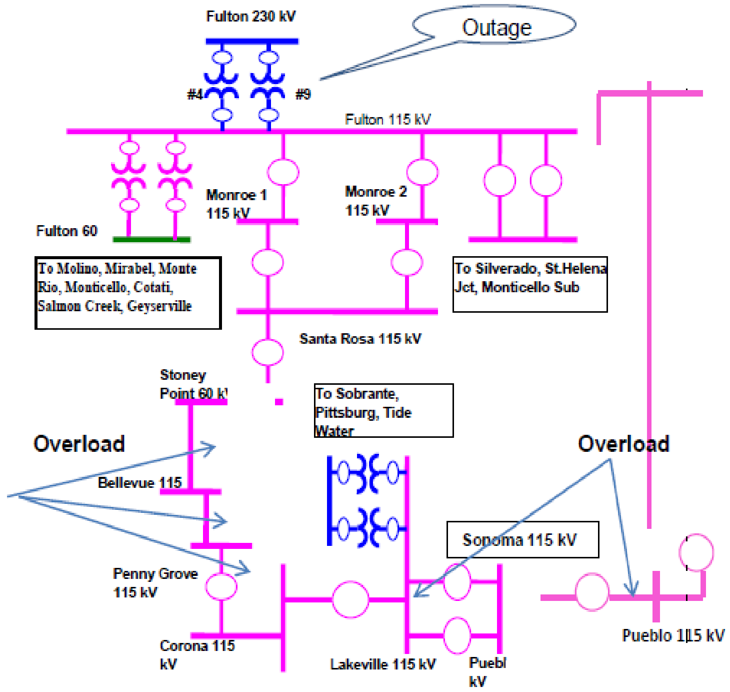
NCNB – Results Summary

Observations

- P1, P2 overload in the Clear Lake area
- P1, P2, P3, P6 & P7 Overloads in the Lakeville and Ignacio areas
- P2, P5, P6 & P7 Overloads in the Fulton and Hopland areas

Approved Mitigations

- P1, P2 overload in the Clear Lake area disappear after 2024 due to Clear Lake - Hopland is reconductored by 2022 (per Clear Lake Revised Scope)
- P1, P2, P3, P6 & P7 Overloads in the Lakeville and Ignacio areas disappear after 2024 due to Ignacio Area Reinforcement
- P2, P5, P6 & P7 Overloads in the Fulton and Hopland areas disappear after 2024 due to open line between Cotati and Petaluma setup per Lakeville 60kV Area Reinforcement (Fulton 230/115 kV Bank alternative in place after 2024 and action plan in the meantime)



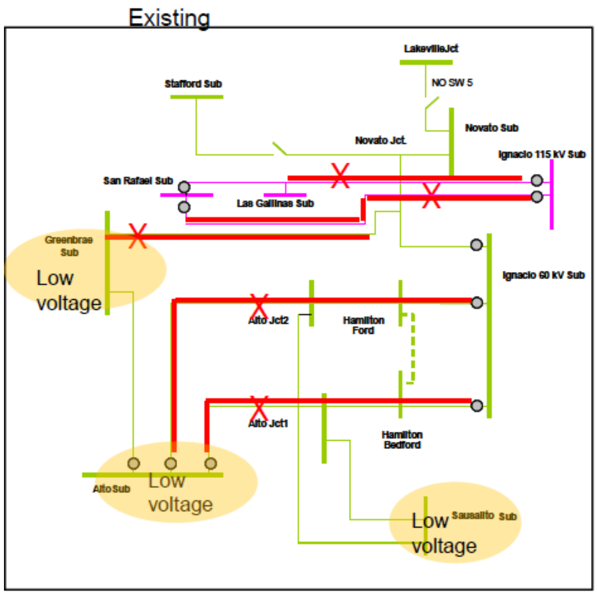
NCNB – Results Summary

Observations

- P1, P2, P3, P6 & P7 Overloads in the Lakeville and Ignacio areas in 2021 case
- P0, P1, P2, P3, P6 & P7 Overloads in the Tulucay-NAPA #2 60 kV line
- P0 overload – Fitch MTN JCt #2- Healdsburg #2 Tap 60kV Line
- P1, P2 & P3 Overloads in the Upper Lake areas

Approved and Potential Mitigations

- P1, P2, P3 & P6 Overloads of Ignacio – San Rafael 115kV Line addressed after 2024 due to Ignacio Area Reinforcement
- Upgrade limiting element on Fitch MTN JCt #2- Healdsburg #2 Tap (Expanding the previously approved Fulton-Fitch MTN project)
- Upgrade limiting element on Tulucay-NAPA#2 60 kV line,
- Load in Upper Lakes area higher than historical recorded, continue to monitor.



NCNB Area – Voltage Results Summary

Observations

- Few numbers of substations with high voltages observed in near-term off-peak cases.
- 2029 off-peak case shows significantly fewer substations with high voltages.

Potential Mitigations

- No mitigation will be proposed for high voltages at this time. Continue to monitor voltages

Sensitivity Study Assessment

- Below is the list of facility overloads identified in sensitivity scenario(s) only.

Overloaded Facility	Category	2024 SP High CEC Forecast	2021 Summer Peak High Renew	2024 Off-Peak High Renew	2029 QF Retirement
Mendocino - Upper Lake 60 kV Line	P1 & P2	√			

Summary of Potential New Upgrades

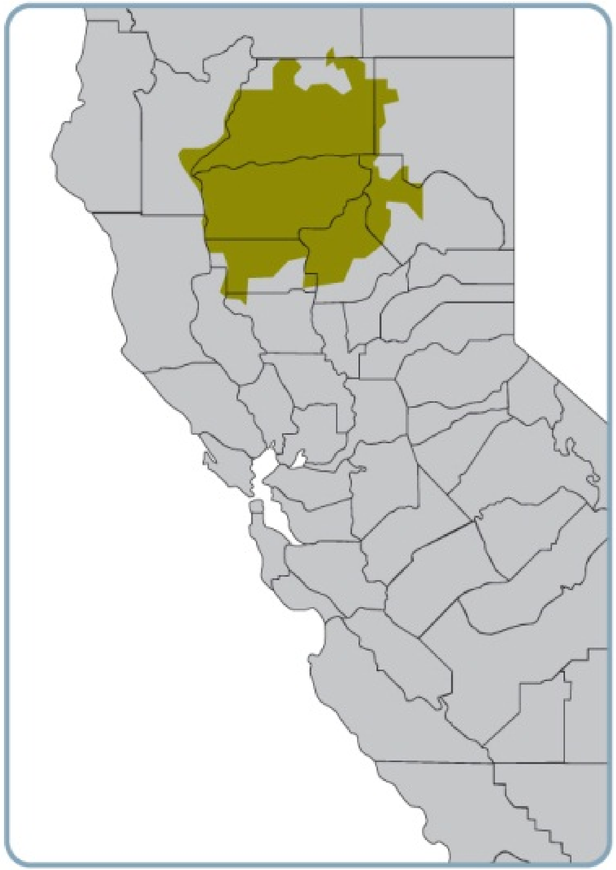
Area	Expected Upgrade
Fitch MTN: Remove Limiting Element	Remove any limiting element on Fitch MTN JCt #2- Healdsburg #2 Tap to match the largest conductor rating of 1126 AMPS for summer emergency (Expanding the previously approved Fulton-Fitch MTN project)
Tulucay-NAPA 2 : Remove Limiting Element	Remove any limiting element on Tulucay-NAPA #2 60 kV line, to match the conductor rating of 1126 AMPS for summer emergency.

North Valley Area
Preliminary Reliability Assessment Results

Ebrahim Rahimi
Lead Regional Transmission Engineer

2019-2020 Transmission Planning Process Stakeholder Meeting
September 25-26, 2019

North Valley Area



- North Valley Area located in the NE corner of PG&E system
- Major cities: Chico, Redding, Red Bluff, Paradise
- Comprised of 60, 115 & 230 & 500 kV transmission facilities.
- Supply sources include Table Mountain, Cottonwood, and Palermo

Load and Load Modifier Assumptions – North Valley Area

Study Case	Scenario Type	Description	Gross Load (MW)	AAEE (MW)	BTM-PV		Net Load (MW)	Demand Response	
					Installed (MW)	Output (MW)		Total (MW)	D2 (MW)
NVLY-2021-SP	Baseline	2021 summer peak load conditions. Peak load time - hours ending 19:00.	897	10	299	0	888	17	7
NVLY-2024-SP	Baseline	2024 summer peak load conditions. Peak load time - hours ending 19:00.	938	18	370	0	920	17	7
NVLY-2029-SP	Baseline	2029 summer peak load conditions. Peak load time - hours ending 19:00.	981	33	463	0	948	17	7
NVLY-2021-SOP	Baseline	2021 spring off-peak load conditions. Off-peak load time – hours ending 13:00.	349	7	299	349	102	17	7
NVLY-2024-SOP	Baseline	2024 spring off-peak load conditions. Off-peak load time – hours ending 13:00.	382	14	370	300	68	17	7
NVLY-2024-SP-HiCEC	Sensitivity	2024 summer peak load conditions with hi-CEC load forecast sensitivity	938	0	370	0	938	17	7
NVLY-2024-SOP-HiRene	Sensitivity	2024 spring off-peak load conditions with hi renewable dispatch sensitivity	382	14	370	367	2	17	7
NVLY-2021-SP-HiRenew	Sensitivity	2021 summer peak load conditions with hi-renewable dispatch sensitivity	882	13	299	296	573	17	7
NVLY-2029-SP-QF	Sensitivity	2029 summer peak load conditions with QF retirement sensitivity	981	33	463	0	948	17	7

Note:

DR and storage are modeled offline in sarting base cases.

Generation Assumptions – North Valley Area

Study Case	Scenario Type	Description	Battery Storage (MW)	Solar		Wind		Hydro		Thermal	
				Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)
NVLY-2021-SP	Baseline	2021 summer peak load conditions. Peak load time - hours ending 19:00.	0	0	0	103	68	1,798	1,288	1,072	759
NVLY-2024-SP	Baseline	2024 summer peak load conditions. Peak load time - hours ending 19:00.	0	0	0	103	0	1,774	1,436	1,072	570
NVLY-2029-SP	Baseline	2029 summer peak load conditions. Peak load time - hours ending 19:00.	0	0	0	103	68	1,798	1,153	1,072	408
NVLY-2021-SOP	Baseline	2021 spring off-peak load conditions. Off-peak load time – hours ending 13:00.	0	0	0	103	59	1,774	1,290	1,072	234
NVLY-2024-SOP	Baseline	2024 spring off-peak load conditions. Off-peak load time – hours ending 13:00.	0	0	0	103	3	1,774	1,291	1,072	323
NVLY-2024-SP-HiCEC	Sensitivity	2024 summer peak load conditions with hi-CEC load forecast sensitivity	0	0	0	103	0	1,774	1,443	1,072	565
NVLY-2024-SOP-HiRene	Sensitivity	2024 spring off-peak load conditions with hi renewable dispatch sensitivity	0	0	0	103	69	1,774	1,005	1,072	325
NVLY-2021-SP-HiRenew	Sensitivity	2021 summer peak load conditions with hi-renewable dispatch sensitivity	0	0	0	103	86	1,798	1,568	1,072	416
NVLY-2029-SP-QF	Sensitivity	2029 summer peak load conditions with QF retirement sensitivity	0	0	0	103	68	1,798	1,152	1,072	408

Note:
DR and storage are modeled offline in sarting base cases.

North Valley – Approved Projects

Approved Project	Expected ISD	First Year Modelled
Glen 230/60 kV Transformer No. 1 Replacement	May-20	2021
Delevan 230 kV Substation Shunt Reactor	Aug-20	2021
Cottonwood 230/115 kV Transformer replacement	Nov-21	2024
Cascade 115/60 kV No. 2 Transformer Project	Jan-22	2024
Tyler 60 kV Shunt Capacitor	Dec-22	2024
Cottonwood 115 kV Bus Sectionalizing Breaker	Dec-22	2024
Red Bluff-Coleman 60 kV Line Upgrade	Jul-23	2024

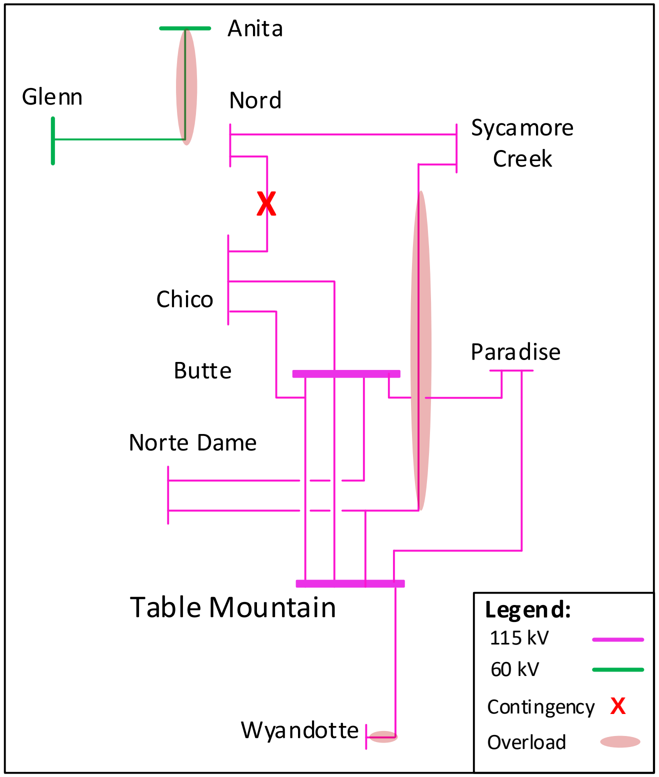
North Valley – Results Summary

Observations

- There are overloads in the long term under different contingencies:
  - Table Mountain – Sycamore 115 kV line for P1
  - Wyandotte 115 kV substation jumber for P0
  - Geln #3 60 kV line from Anita to Chico JCT under P0
- P2-4 at Cottonwood 60 kV and Table Mountain 230 kV and 115 kV causes overload or the solution diverges.

Potential Mitigations

- The load forecast has increased for later years. The ISO will continue to monitor the load forecast.
- Load power factor at Anita substation is under review.
- Substation upgrade or SPS to address P2-4 issue at Cottonwood and Table Mountain substation.



North Valley Area – Voltage Results Summary

Observations

- Large number of substations with high voltages observed in off-peak planning base cases as well as the real time cases.

- Low voltages were also observed in small pockets.

Potential Mitigations

- No mitigation will be proposed for voltage issues at this time.

Sensitivity Study Assessment

- Below is the list of facility overloads identified in sensitivity scenario(s) only.

Overloaded Facility	Category	2024 SP High CEC Forecast	2021 SP Heavy Renewable & Min Gas Gen	2024 SpOP Hi Renew & Min Gas Gen	2029 Retirement of QF Generations
Cottonwood - Round Mountain 230 kV Line	P6		✓		
Cascade – Benton - Deschutes 60 kV Line	P2		✓	✓	
Glen #3 60 kV Line	P0	✓			

Summary of Potential New Upgrades

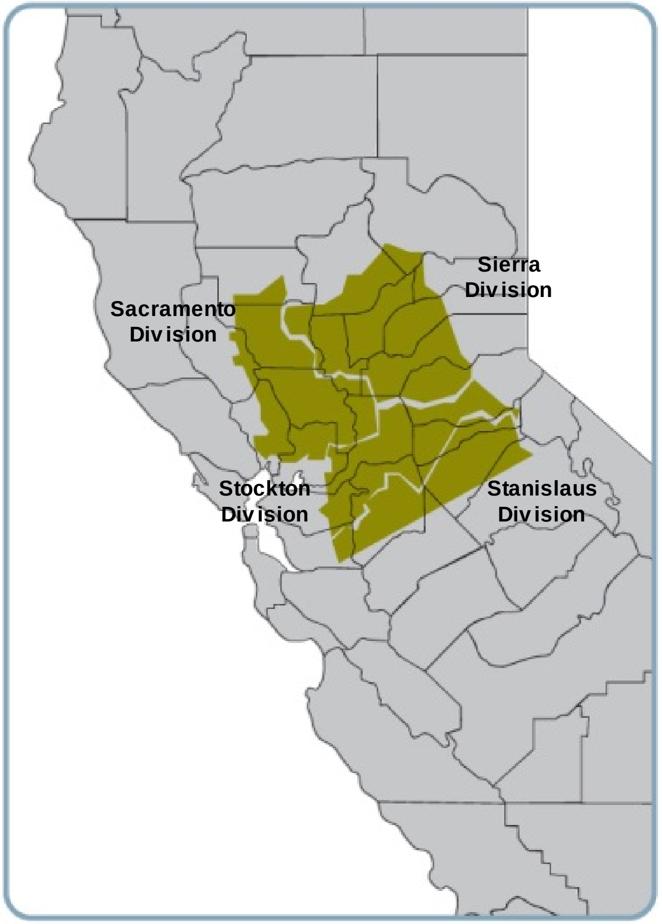
- No new reliability upgrade is recommended for North Valley area in this planning cycle.

Central Valley Area
Preliminary Reliability Assessment Results

Ebrahim Rahimi
Lead Regional Transmission Engineer

2019-2020 Transmission Planning Process Stakeholder Meeting
September 25-26, 2019

Central Valley Area



- The Central Valley Area covers the central part of the Sacramento Valley.
- The area is divided into four divisions:
  - Sacramento
  - Sierra
  - Stockton
  - Stanislaus
- Comprised of 60, 115 & 230 & 500 kV transmission facilities.
- Supply sources include Vaca Dixon, Rio Oso, Gold Hill, Atlantic, Brighton, Lockeford, Bellota

Load and Load Modifier Assumptions – Central Valley Area

Base Case	Scenario Type	Description	Gross Load (MW)	AAEE (MW)	BTM-PV		Net Load (MW)	Demand Response	
					Installed (MW)	Output (MW)		Total (MW)	D2 (MW)
CVLY-2021-SP	Baseline	2021 summer peak load conditions. Peak load time - hours ending 19:00.	4,174	56	1,340	0	4,117	91	40
CVLY-2024-SP	Baseline	2024 summer peak load conditions. Peak load time - hours ending 19:00.	4,364	106	1,697	0	4,258	92	40
CVLY-2029-SP	Baseline	2029 summer peak load conditions. Peak load time - hours ending 19:00.	4,625	192	2,164	0	4,434	92	40
CVLY-2021-SpOP	Baseline	2021 spring off-peak load conditions. Off-peak load time - hours ending 13:00.	1,728	43	1,340	1072	613	91	40
CVLY-2024-SpOP	Baseline	2024 spring off-peak load conditions. Off-peak load time - hours ending 13:00.	1,852	79	1,697	1374	399	92	40
CVLY-2024-SP-Hi-CEC	Sensitivity	2024 summer peak load conditions with hi-CEC load forecast sensitivity	4,364	0	1,697	0	4,364	92	40
CVLY-2024-SpOP-HiRenew	Sensitivity	2024 spring off-peak load conditions with hi renewable dispatch sensitivity	1,852	79	1,697	1680	93	92	40
CVLY-2021-SP-HiRenew	Sensitivity	2021 summer peak load conditions with hi-renewable dispatch sensitivity	4,285	72	1,338	1325	2,888	91	40
CVLY-2029-SP-QF	Sensitivity	2029 summer peak load conditions with QF retirement sensitivity	4,625	192	2,164	0	4,433	92	40

Note:
Includes PG&E load only.
DR and storage are modeled offline in starting base cases.

Generation Assumptions – Central Valley Area

Base Case	Scenario Type	Description	Battery Storage (MW)	Solar		Wind		Hydro		Thermal	
				Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)
CVLY-2021-SP	Baseline	2021 summer peak load conditions. Peak load time - hours ending 19:00.	0	38	1	1185	774	1427	1368	1,281	971
CVLY-2024-SP	Baseline	2024 summer peak load conditions. Peak load time - hours ending 19:00.	0	38	1	1079	704	1401	1355	1,275	981
CVLY-2029-SP	Baseline	2029 summer peak load conditions. Peak load time - hours ending 19:00.	0	38	1	1079	704	1427	1181	1,275	903
CVLY-2021-SpOP	Baseline	2021 spring off-peak load conditions. Off-peak load time - hours ending 13:00.	0	38	35	1185	668	1401	1048	1,281	440
CVLY-2024-SpOP	Baseline	2024 spring off-peak load conditions. Off-peak load time - hours ending 13:00.	0	38	34	1079	27	1401	945	1,275	504
CVLY-2024-SP-Hi-CEC	Sensitivity	2024 summer peak load conditions with hi-CEC load forecast sensitivity	0	38	1	1079	704	1401	1377	1,275	1,005
CVLY-2024-SpOP-HiRenew	Sensitivity	2024 spring off-peak load conditions with hi renewable dispatch sensitivity	0	38	35	1079	715	1404	851	1,275	450
CVLY-2021-SP-HiRenew	Sensitivity	2021 summer peak load conditions with hi-renewable dispatch sensitivity	0	38	35	1185	959	1427	1139	1,281	346
CVLY-2029-SP-QF	Sensitivity	2029 summer peak load conditions with QF retirement sensitivity	0	38	1	1079	650	1427	1217	1,275	882

Note:
Includes PG&E load only.
DR and storage are modeled offline in starting base cases.

Central Valley – Approved Projects

Approved Project	Expected ISD	First Year Modelled
Stockton A-Weber 60 kV Line Nos. 1 and 2 Reconductor	Sep-19	2021
West Point-Valley Springs 60 kV Line Reinforcement	Mar-20	2021
Pease 115/60 kV Transformer Addition	Mar-20	2021
Mosher Transmission Project	Mar-21	2021
Vaca-Davis Area Reinforcement	Feb-22	2024
Rio Oso 230/115 kV Transformer Upgrades	Jun-22	2024
Rio Oso Area 230 kV Voltage Support	Sep-22	2024
South of Palermo 115 kV Reinforcement Project	Nov-22	2024
East Marysville 115/60 kV	Dec-22	2024
Vierra 115 kV Looping Project	Jan-23	2024
Tesla 230 kV Bus Series Reactor	Dec-23	2024
Gold Hill 230/115 kV Transformer Addition	Dec-24	2029
Lockeford-Lodi Area 230 kV Development	Jul-25	2029

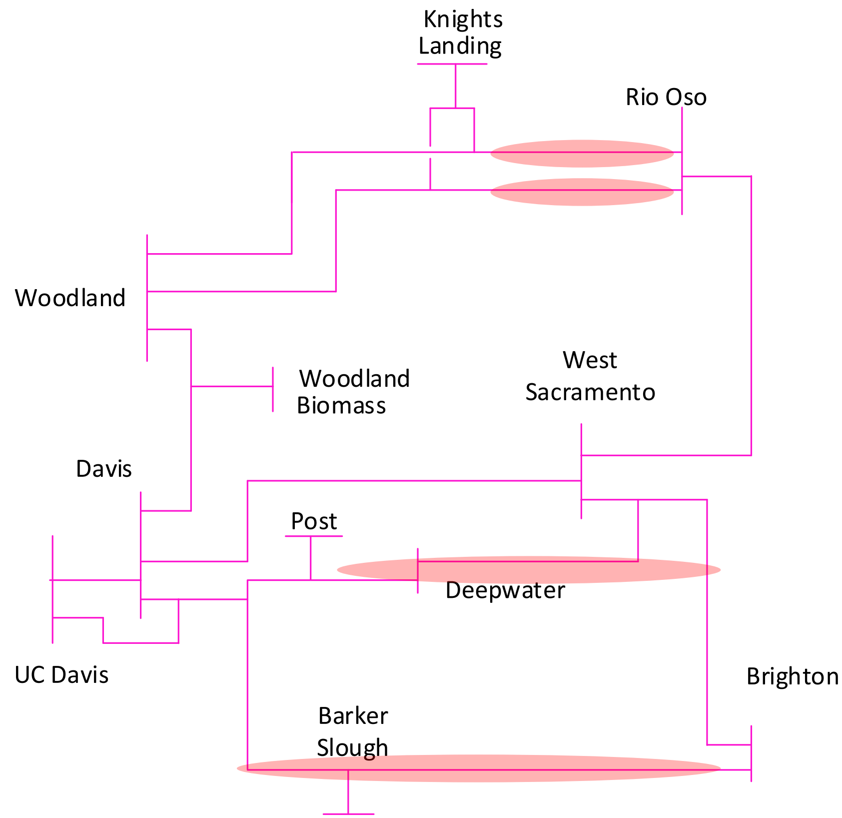
Sacramento Division – Results Summary

Observations

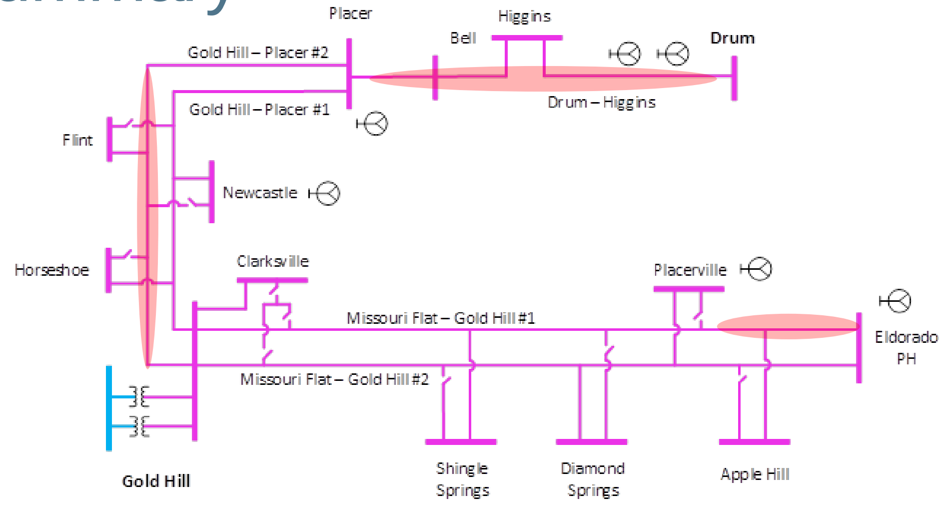
- There are P2, P6 and P7 overloads in the 115 kV network between Rio Oso, Brighton and Davis substations in the long term.
- P2-3 and P2-4 contingency at Rio Oso 115KV cause overload in the long term
- Arbuckle – Wilkins 60 kV line overlods under P0

Approved and Potential Mitigation

- The load power factor in the Wilkins area is under review
- Continue to monitor long term overloads on the 115 kV system
- Substation upgarde or SPS had been recommended to address P2 issues at Rio Oso 115 kV

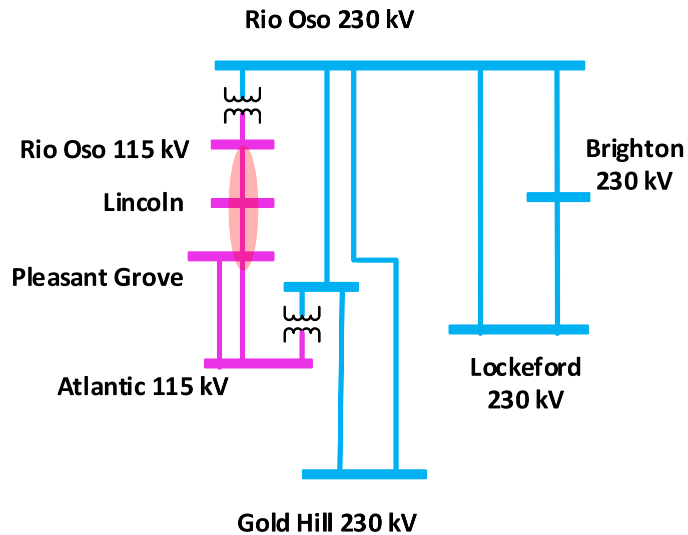


Sierra Division – Results Summary



Observations

- P2-4 at Gold Hill 230 bus causes voltage collapse in the Drum to Gold Hill 115 kV system.
- Rio Oso – Lincoln 115 kV line overloads for P7 of Rio Oso – Atlantic and Rio Oso – Gold Hill 230 kV lines in the long term
- P6 and P7 contingency of Placer – Gold Hill #1 and #2 115 kV lines overload the Drum – Higgins 115 kV line in the long term.
- There is P0 overload on Yuba City Cogen 60 kV tap
- The P2-1 on Missouri Flat – Gold Hill #1 causes overload in the long term.



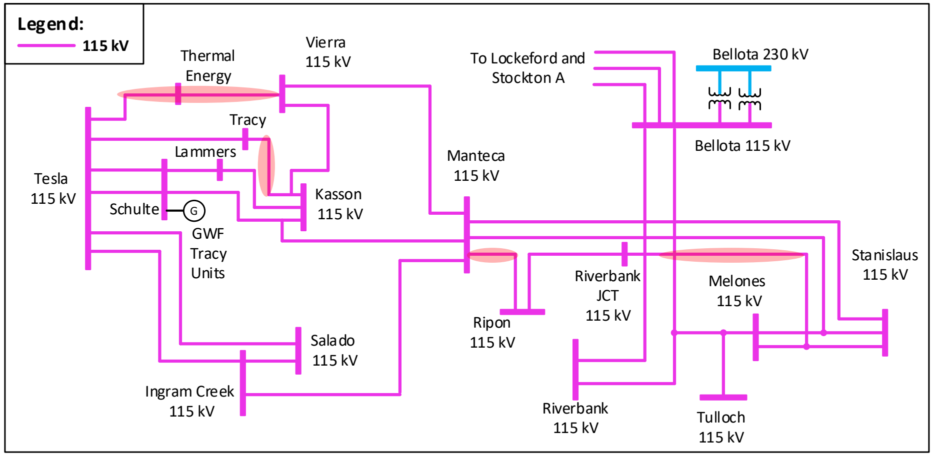
Approved and Potential Mitigation

- Substation upgrade or SPS to address P2-4 issue at Gold Hill 230 kV substation had been recommended.
- SPS to address P7 overload had been recommended on Rio Oso - Lincoln 115 kV line
- Rating of the Yuba City Cogen 60 kV tap line is under review
- Continue to monitor future forecast for the long term issues.

Stockton/Stanislaus Division – Results Summary

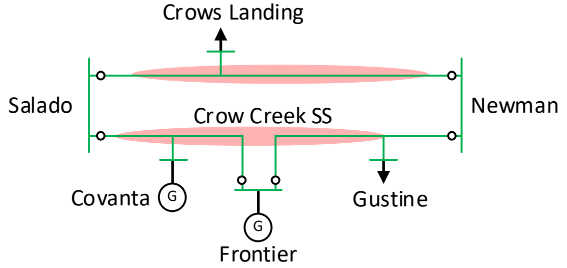
Observations

- P1 overload in the long term on Manteca – Ripon, Tracy – Kasson, Tesla – Vierra, and Stanislaus-Melones-Riverbank 115 kV lines in the long term.
- P1 overload on the Lockeford #1, Hammer – Country Club, and Salado – Newman 60 kV lines.
- P0 overload on the Manteca #1 and Rough & Ready 60 kV tap lines.
- P6 contingency of Schulte – Lammers and Schulte – Kasson – Manteca 115 kV lines overloads Tesla - Vierra and Manteca – Ripon 115 kV lines
- P2-4 at Bellota 230 kV and Tesla 115 kV buses may potentially cause voltage collapse.



Potential Mitigations

- Continue to monitor future load forecast.
- 60 kV Line ratings and the load forecast are under review
- Substation upgrade or SPS to address P2-4 issue at Bellota 230 kV and Tesla 115 kV substations.



Central Valley Area – Voltage Results Summary

Observations

- Large number of substations with high voltages observed in off-peak planning base cases as well as the real time cases.
- Low voltages were also observed in small pockets.

Potential Mitigations

- No mitigation will be proposed for voltage issues at this time.

Sensitivity Study Assessment

- Below is the list of facility overloads identified in sensitivity scenario(s) only.

Overloaded Facility	Category	2024 SP High CEC Forecast	2021 SP Heavy Renewable & Min Gas Gen	2024 SpOP Hi Renew & Min Gas Gen	2029 Retirement of QF Generations
Lambie – Birds Landing 230 kV Line	P2		✓		
Bellota – Warnerville 230 kV Line	P2		✓		
Cottle – Melones 230 kV Line	P2		✓		
Tesla – LLNL 115 kV	P2			✓	
Valley Springs #1 60 kV	P1				✓

Summary of Potential New Upgrades

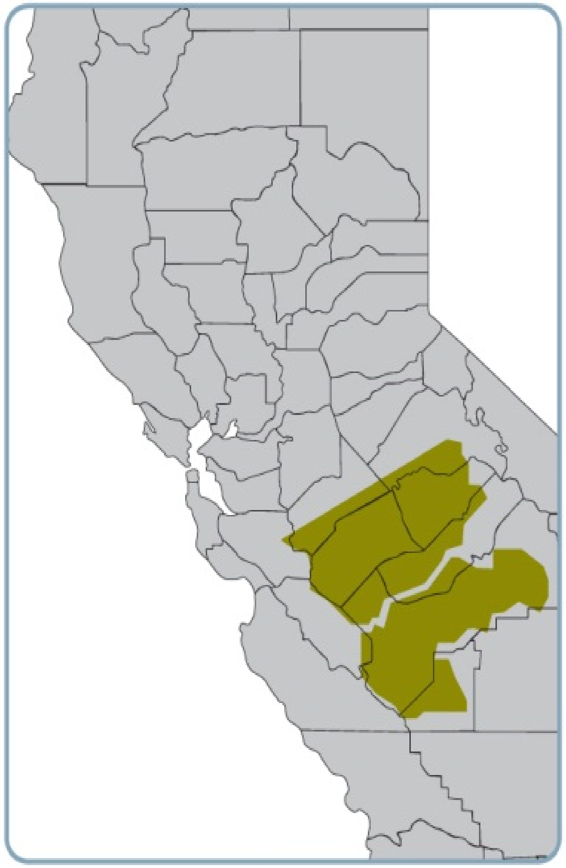
- Substation upgrades at:
  - Bellota 230 kV;
  - Rio Oso 115 kV; and
  - Tesla 115 kV

Greater Fresno Area
Preliminary Reliability Assessment

Vera Hart
Senior Regional Transmission Engineer

2019-2020 Transmission Planning Process Stakeholder Meeting
September 25-26, 2019

Greater Fresno Area



- Service areas cover Fresno, Kings, Tulare and Madera counties.
- Supply Source: Gates, Los Banos and Wilson
- Comprised of 70,115, 230 & 500 kV transmission facilities.

Load and Load Modifier Assumptions - Greater Fresno Area

S. No.	Base Case	Scenario Type	Description	Gross Load (MW)	AAEE (MW)	BTM-PV		Net Load (MW)	Demand Response	
						Installed (MW)	Output (MW)		Total (MW)	D2 (MW)
1	GFA-2021-SP	Baseline	2021 summer peak load conditions. Peak load time - hours ending 19:00.	3,150	42	1,226	0	3,108	56	14
2	GFA-2021-SpOP	Baseline	2021 spring off-peak load conditions. Off-peak load time - hours ending 13:00.	1,104	31	1,226	981	92	56	14
3	GFA-2021-SP-HiRenew	Sensitivity	2021 summer peak load conditions with hi-renewable dispatch sensitivity	3,289	52	1,224	1212	2,025	56	14
4	GFA-2024-SP	Baseline	2024 summer peak load conditions. Peak load time - hours ending 19:00.	3,386	78	1,557	0	3,308	56	14
5	GFA-2024-SpOP	Baseline	2024 spring off-peak load conditions. Off-peak load time - hours ending 13:00.	1,232	57	1,552	1257	(82)	56	14
6	GFA-2024-SP-Hi-CEC	Sensitivity	2024 summer peak load conditions with hi-CEC load forecast sensitivity	3,386	0	1,557	0	3,386	56	14
7	GFA-2024-SpOP-HiRenew	Sensitivity	2024 spring off-peak load conditions with hi renewable dispatch sensitivity	1,232	57	1,552	1537	(362)	56	14
8	GFA-2029-SP	Baseline	2029 summer peak load conditions. Peak load time - hours ending 19:00.	3,633	142	2,022	0	3,491	56	14
9	GFA-2029-SP-QF	Sensitivity	2029 summer peak load conditions with QF retirement sensitivity	3,633	142	2,022	0	3,491	56	14

Generation Assumptions - Greater Fresno Area

S. No.	Base Case	Scenario Type	Description	Battery Storage (MW)	Solar		Wind		Hydro		Thermal	
					Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)
1	GFA-2021-SP	Baseline	2021 summer peak load conditions. Peak load time - hours ending 19:00.	316	2610	0	13	9	1892	1800	1,480	1,195
2	GFA-2021-SpOP	Baseline	2021 spring off-peak load conditions. Off-peak load time - hours ending 13:00.	316	2610	2509	13	7	1892	-365	1,480	121
3	GFA-2021-SP-HiRenew	Sensitivity	2021 summer peak load conditions with hi-renewable dispatch sensitivity	316	2610	2582	13	11	1892	1484	1,480	301
4	GFA-2024-SP	Baseline	2024 summer peak load conditions. Peak load time - hours ending 19:00.	316	2610	0	13	9	1892	1800	1,480	1,192
5	GFA-2024-SpOP	Baseline	2024 spring off-peak load conditions. Off-peak load time - hours ending 13:00.	316	2610	2452	13	0	1892	-415	1,480	96
6	GFA-2024-SP-Hi-CEC	Sensitivity	2024 summer peak load conditions with hi-CEC load forecast sensitivity	316	2610	0	13	9	1892	1800	1,480	1,192
7	GFA-2024-SpOP-HiRenew	Sensitivity	2024 spring off-peak load conditions with hi renewable dispatch sensitivity	316	2610	2584	13	9	1892	-541	1,480	266
8	GFA-2029-SP	Baseline	2029 summer peak load conditions. Peak load time - hours ending 19:00.	316	2610	0	13	9	1892	1799	1,480	1,189
9	GFA-2029-SP-QF	Sensitivity	2029 summer peak load conditions with QF retirement sensitivity	316	2610	0	13	0	1892	1799	1,480	1,175

Previously approved transmission projects modelled in base cases

Project Name	Expected ISD
Oro Loma 70 kV Area Reinforcement	20-May
Reedley 70 kV Reinforcement (Renamed to Reedley 70 kV Area Reinforcement Projects Include Battery at Dinuba)	21-Dec
Wilson 115 kV Area Reinforcement	23-May
Wilson-Le Grand 115 kV line reconductoring	20-Apr
Panoche – Oro Loma 115 kV Line Reconductoring	21-Apr
Northern Fresno 115 kV Area Reinforcement	21-Mar
Bellota-Warnerville 230kV line Reconductoring	23-Dec
Herndon-Bullard 230kV Reconductoring Project	21-Jan
Gregg-Herndon #2 230 kV Line Circuit Breaker Upgrade	21-Jan

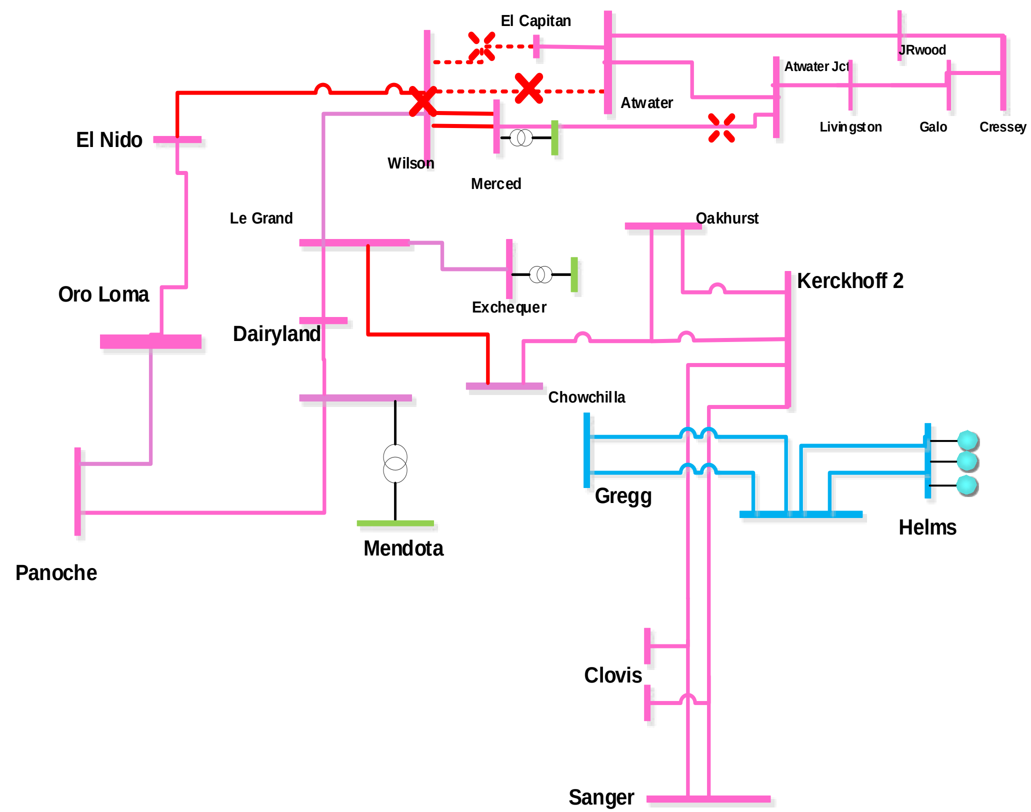
Wilson 115kV Area– Results Summary

<u>Observations</u>

1. P6 Overloads observed in the Wilson 115kV Area for all peak years
2. P2, P2-1 overloads on the Wilson-Oro Loma 115kV line in all peak years.
3. P5 (non-Redundant Relay protection) on the Gregg 230kV BAAH causing overloads in this area in 2029
4. Chowchilla-Legrand 115kV line overload for P2 in Off-peak cases
5. 115kV overloads near Panoche for P6 contingencies in the later years

<u>Potential Mitigations</u>

1. Expand Atwater SPS
   - To drop load post first contingency
   - Switching post first contingency
2. SPS or Reconductor Wilson-Oro Loma 115kV line
3. Protection upgrade
4. Redispatch Generation
5. Monitor future forecast



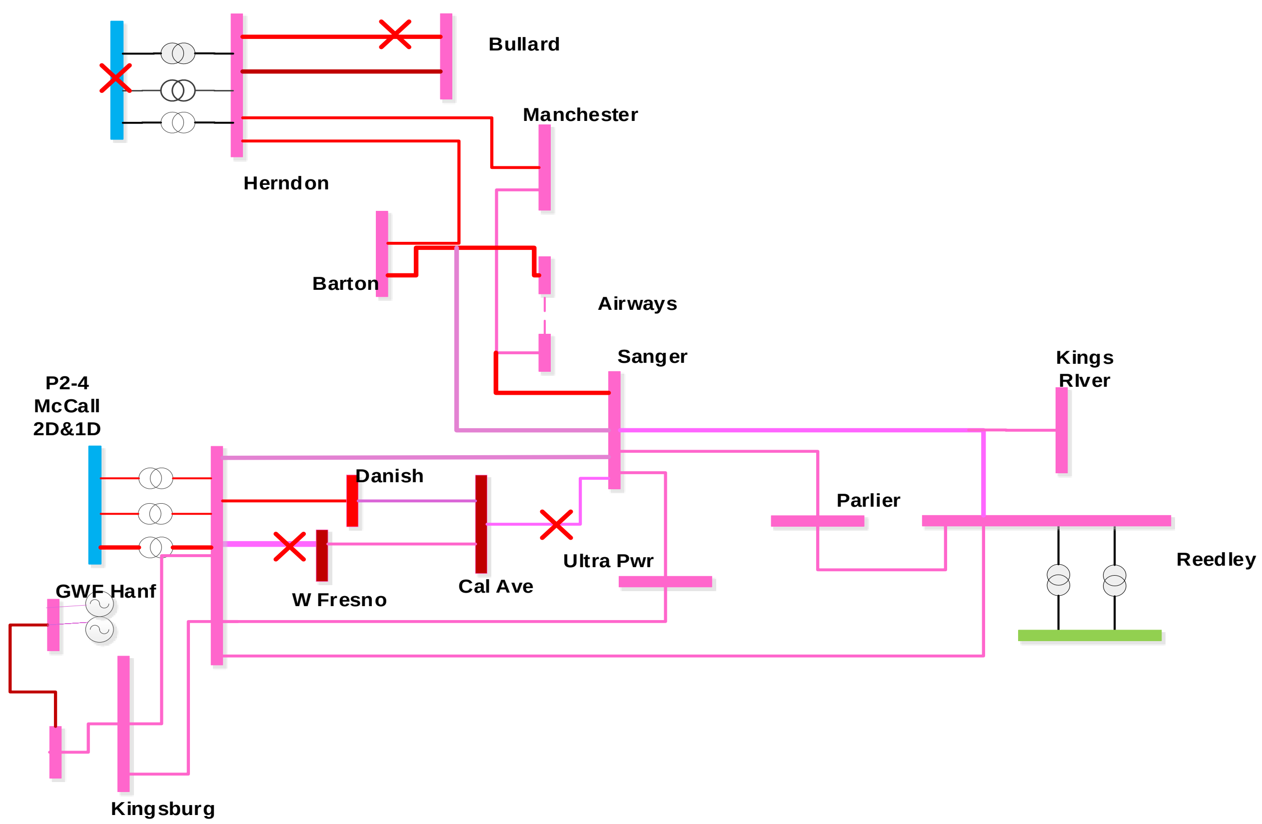
Fresno Area – Results- Herndon-McCall Area

Observations

1. P2 and P7 Overloads in the Spring Off-Peak cases in the McCall 115kV area near Barton due to Pumps
2. P2 and P6 Overloads in 2029 on McCall-Danish 115kV section for loss of McCall-West Fresno and Sanger to CalAve 115kV. Low voltage in the area
3. P5 Overloads near McCall due to Gregg 230kV BAAH
4. McCall 230/115kV Tb #3 overload in 2029 and Spring off-peak cases

Potential Mitigations

1. Drop Pumps
2. Monitor future forecast.
3. Install Redundant protection
4. Monitor Future forecast and Generation re-dispatch



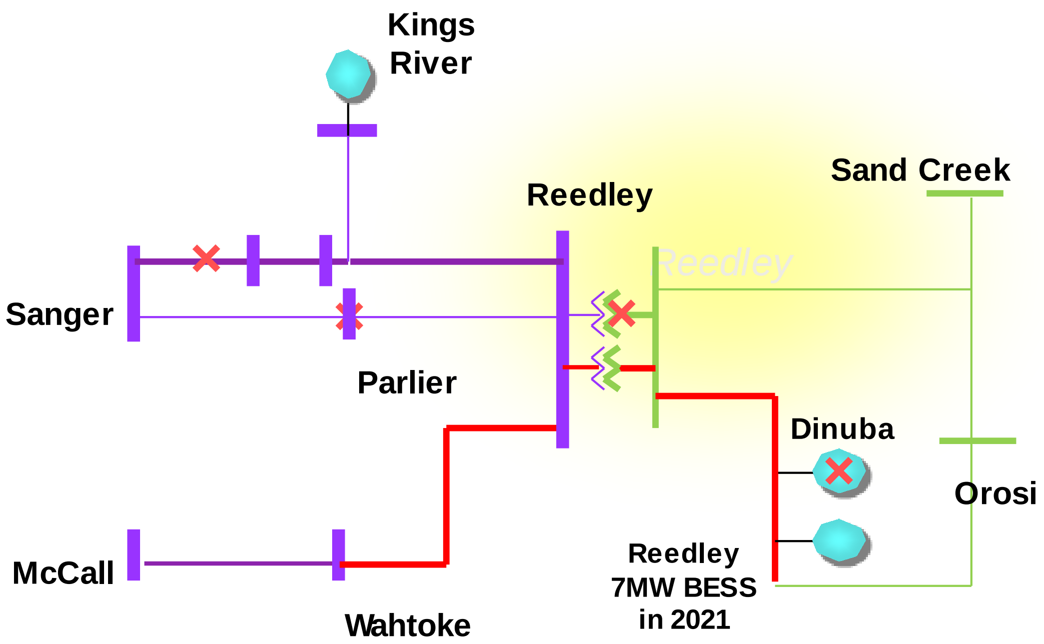
Fresno Area – Results-Reedley Area

Observations

1. Multiple 70kV overloads in the Dinuba area for P1, P2, P3, P6 contingencies in all years
2. Overloads and Low voltages in the Reedley 115kV area due to Wahtoke Load not being dropped for P6 Contingencies

Approved and Potential Mitigations

1. Dinuba BESS project mitigates near term issues.
   - Dinuba Battery is not sufficient for 2029 P1-P7 overloads
   - Dinuba Energy Gen NQC went from 8.3MW to 2.9MW is the driving factor for this issue
   - Will continue to monitor future load forecast
2. SPS to drop load at Wahtoke



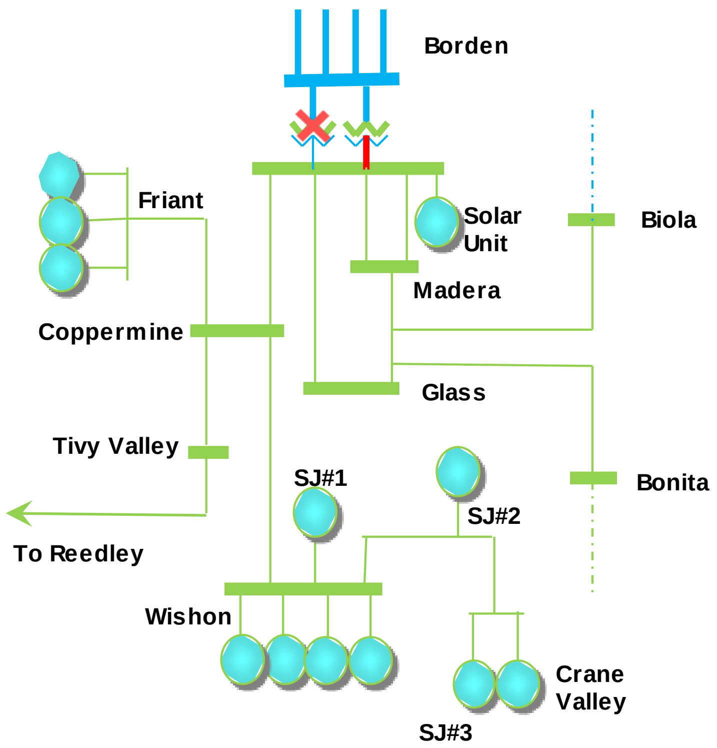
Fresno Area –Borden 70kV Results

<u>Observations</u>

1. P1, P3, P6 Contingencies causing overloads on Borden 230/70kV TB #1 in the summer peak years

<u>Potential Mitigations</u>

1. Upgrade Limiting equipment on the Borden 70kV TB #1



Fresno Area – Voltage Results Summary

Observations

- Real-time case shows high number of substations with high voltages including northern Fresno due to Wilson SVD not being in service yet. Those issues get resolved once the project is in
- Few numbers of substations in South-East Fresno with high voltages observed in near-term off-peak cases.
- 2029 off-peak case shows increasing number of substations with high voltages compared to 2021.

Potential Mitigations

- No mitigation will be proposed for high voltages at this time. Continue to monitor voltages in the future forecast

Sensitivity Study Assessment

- Below is the list of facility overloads identified in sensitivity scenario(s) only.

Overloaded Facility	Category	2024 High CEC	2021 Summer Peak High Renew min Gas	2024 Off-Peak High Renew	2029 QF Retirement
30500 BELLOTA 230 30515 WARNERVL 230 1	P2, P7		√	√	
30755 MOSSLNSW 230 30797 LASAGUILASS 230 2	P6		√	√	
30790 PANOCHE 230 30791 PNCHE 1M 230 1	P2		√	√	
34117 KETLMN T 70.0 34552 GATES 70.0 1	P0,P1			√	
34149 CHENYT 115 34158 PANOCHE2 115 1	P3,P6			√	
34149 CHENYT 115 34393 EXCELSIORSS 115 2	P6			√	
34150 NEWHALL 115 34154 DAIRYLND 115 1	P1,P2,P6		√	√	
34155 PANOCHE1 115 34350 KAMM 115 1	P6			√	
34156 MENDOTA 115 34153 GILLTAP 115 1	P1,P2, P6		√	√	
34157 PANOCHET 115 34155 PANOCHE1 115 1	P1,P2,P3,P5,P6,P7		√	√	
34157 PANOCHET 115 34156 MENDOTA 115 1	P1,P2,P3,P5,P6,P7		√	√	
34158 PANOCHE2 115 30790 PANOCHE 230 2	P1,P2		√	√	
34350 KAMM 115 34352 CANTUA 115 1	P6			√	
34352 CANTUA 115 34432 WESTLNDS 115 1	P6			√	
34370 MC CALL 115 34385 KINGS J1 115 1	P2,P6			√	
34385 KINGS J1 115 34417 KINGS J2 115 1	P6			√	
34417 KINGS J2 115 34418 KINGSBURGD 115 1	P6			√	
34418 KINGSBURGD 115 34419 KINGSBURGE 115 1	P3, P5, P6			√	
34418 KINGSBURGD 115 364621 JACKSONSWSTA 115 2	P6			√	
34419 KINGSBURGE 115 34423 GAURD J1 115 2	P7			√	
34419 KINGSBURGE 115 364621 JACKSONSWSTA 115 1	P6			√	
34423 GAURD J1 115 34370 MC CALL 115 2	P6			√	
34430 HENRETTA 115 30881 HENRIETA 230 3 1	P2,P5,P6,P7			√	
34430 HENRETTA 115 34519 LPRNJCTSS 115 1	P5,P6			√	
34432 WESTLNDS 115 34393 EXCELSIORSS 115 1	P6			√	

Summary of Potential New Upgrades

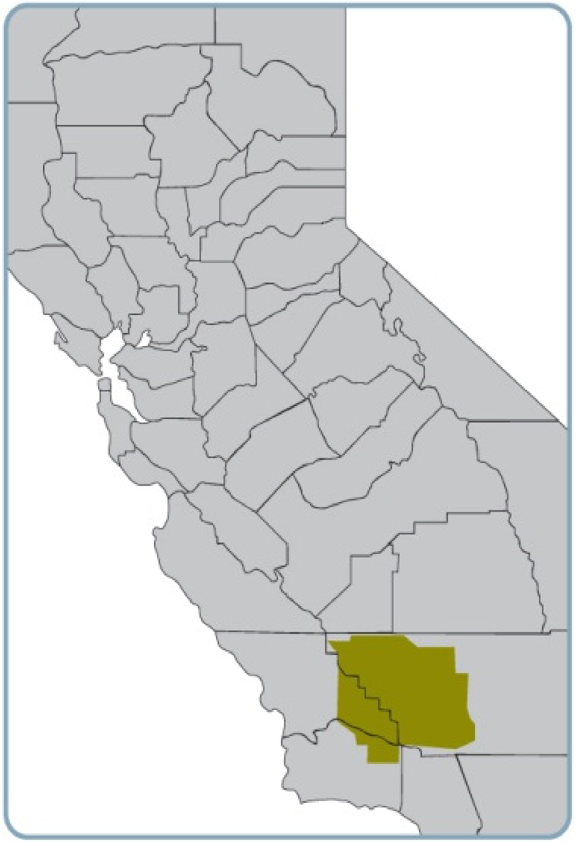
Area	Expected Upgrade
Wilson 115kV	Expand Atwater SPS
Wilson 115kV	Wilson-Oro Loma 115kV line Reconductor
Reedley 115kV	SPS to drop load at Wahtoke
Borden 70kV	Borden Transformer #1 Capacity increase
Gregg 230 kV	Gregg 230kV BAAH Bus protection upgrade

Kern Area
Preliminary Reliability Assessment Results

Abhishek Singh
Regional Transmission Engineer Lead

2019-2020 Transmission Planning Process Stakeholder Meeting
September 25-26, 2019

Kern Area



- Located south of the Yosemite-Fresno area and includes southern portion of the PG&E San Joaquin Division
- Major stations include Midway and Kern Power Plant
- Transmission system includes 60, 115 and 230 kV facilities.

Load and Load Modifier Assumptions - Kern Area

Study Case	Scenario Type	Description	Gross Load (MW)	AAEE (MW)	BTM-PV		Net Load (MW)	Demand Response	
					Installed (MW)	Output (MW)		Total (MW)	D2 (MW)
KERN-2021-SP	Baseline	2021 summer peak load conditions. Peak load time - hours ending 20:00.	1,987	23	512	0	1,965	65	49
KERN-2024-SP	Baseline	2024 summer peak load conditions. Peak load time - hours ending 20:00.	2,099	44	592	0	2,055	65	49
KERN-2029-SP	Baseline	2029 summer peak load conditions. Peak load time - hours ending 20:00.	2,238	82	732	0	2,157	66	49
KERN-2021-SOP	Baseline	2021 spring off-peak load conditions. Off-peak load time – hours ending 13:00.	1,016	17	512	410	589	65	49
KERN-2024-SOP	Baseline	2024 spring off-peak load conditions. Off-peak load time – hours ending 13:00.	1,079	32	592	479	568	65	49
KERN-2024-SP-HiCEC	Sensitivity	2024 summer peak load conditions with hi-CEC load forecast sensitivity	2,099	0	592	0	2,099	65	49
KERN-2024-SOP-HiRene	Sensitivity	2024 spring off-peak load conditions with hi renewable dispatch sensitivity	1,079	32	592	586	461	65	49
KERN-2021-SP-HiRenew	Sensitivity	2021 summer peak load conditions with hi-renewable dispatch sensitivity	1,981	29	512	507	1,445	65	49
KERN-2029-SP-QF	Sensitivity	2029 summer peak load conditions with QF retirement sensitivity	2,238	82	732	0	2,157	66	49

Generation Assumptions - Kern Area

Study Case	Scenario Type	Description	Battery Storage (MW)	Solar		Wind		Hydro		Thermal	
				Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)
KERN-2021-SP	Baseline	2021 summer peak load conditions. Peak load time - hours ending 20:00.	2	440	0	0	0	29	16	3,393	1,711
KERN-2024-SP	Baseline	2024 summer peak load conditions. Peak load time - hours ending 20:00.	2	440	0	0	0	29	16	3,383	1,712
KERN-2029-SP	Baseline	2029 summer peak load conditions. Peak load time - hours ending 20:00.	2	440	0	0	0	29	16	3,383	1,347
KERN-2021-SOP	Baseline	2021 spring off-peak load conditions. Off-peak load time – hours ending 13:00.	2	440	407	0	0	29	22	3,393	473
KERN-2024-SOP	Baseline	2024 spring off-peak load conditions. Off-peak load time – hours ending 13:00.	2	440	407	0	0	29	9	3,288	567
KERN-2024-SP-HiCEC	Sensitivity	2024 summer peak load conditions with hi-CEC load forecast sensitivity	2	440	0	0	0	29	16	3,383	1,712
KERN-2024-SOP-HiRene	Sensitivity	2024 spring off-peak load conditions with hi renewable dispatch sensitivity	2	440	407	0	0	29	21	3,288	717
KERN-2021-SP-HiRenew	Sensitivity	2021 summer peak load conditions with hi-renewable dispatch sensitivity	2	440	434	0	0	29	16	3,393	718
KERN-2029-SP-QF	Sensitivity	2029 summer peak load conditions with QF retirement sensitivity	2	440	0	0	0	29	11	3,383	1,346

Previously approved transmission projects modelled in base cases

Project Name	First Year Modeled
Wheeler Ridge Voltage Support	2021
Midway-Kern PP 230 kV #2 Line Project	2021 & 24 (Phase 1 and 2)
Kern PP 115 kV Area Reinforcement	2024
Wheeler Ridge Junction Substation	2024
Midway-Temblor 115 kV Line Reconductor and Voltage	2024
Midway-Kern PP 230 kV Line Nos. 1, 3 and 4 Capacity Increase Project	2024

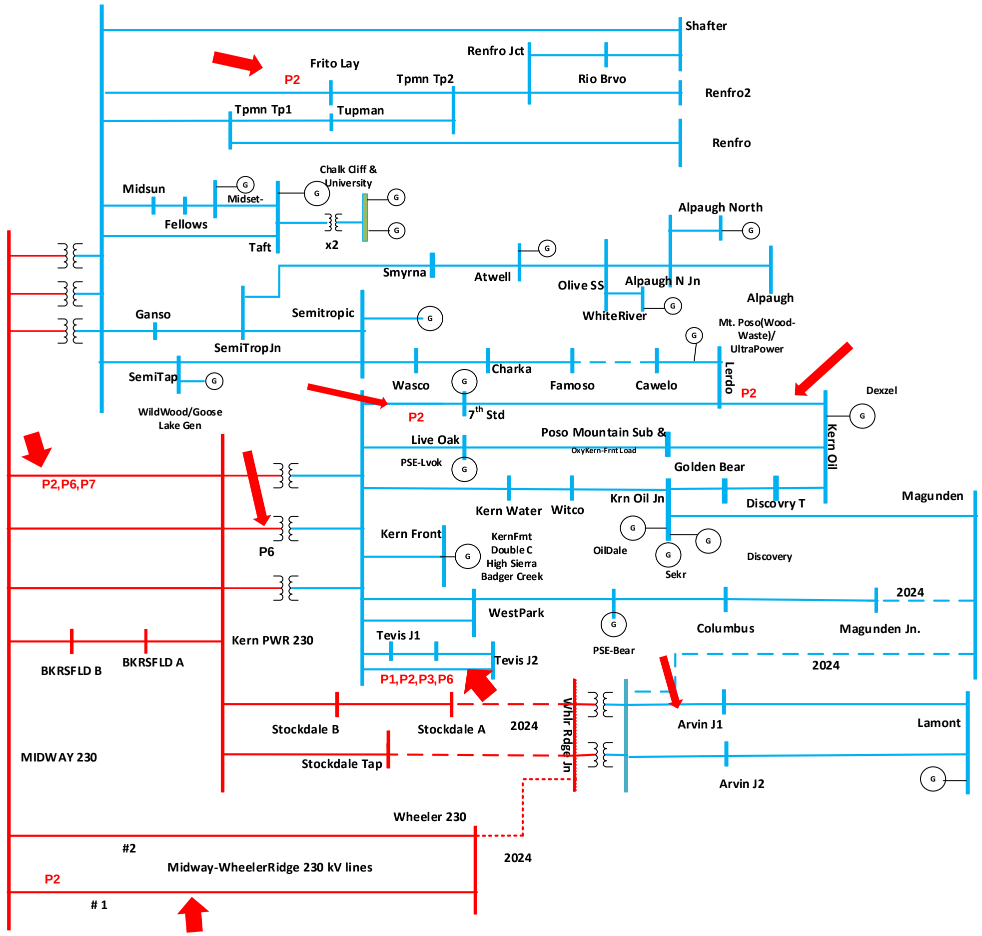
Kern 230 and 115 kV – Results Summary

Observations

- P2,P6, P7 near-term overloads on Midway-Kern PP 230 kV line # 1 in short term
- P6 long term overloads seen on Kern 230/115 kV banks
- P2 near-term overload on Midway-Wheeler ridge 230 kV lines
- P2 near-term overloads on Eastern Kern 115 kV lines

Approved and Potential Mitigations

- Continue to monitor future load forecast for P6 driven long-term overloads
- Short term issues are mitigated by the approved projects



![California ISO logo]

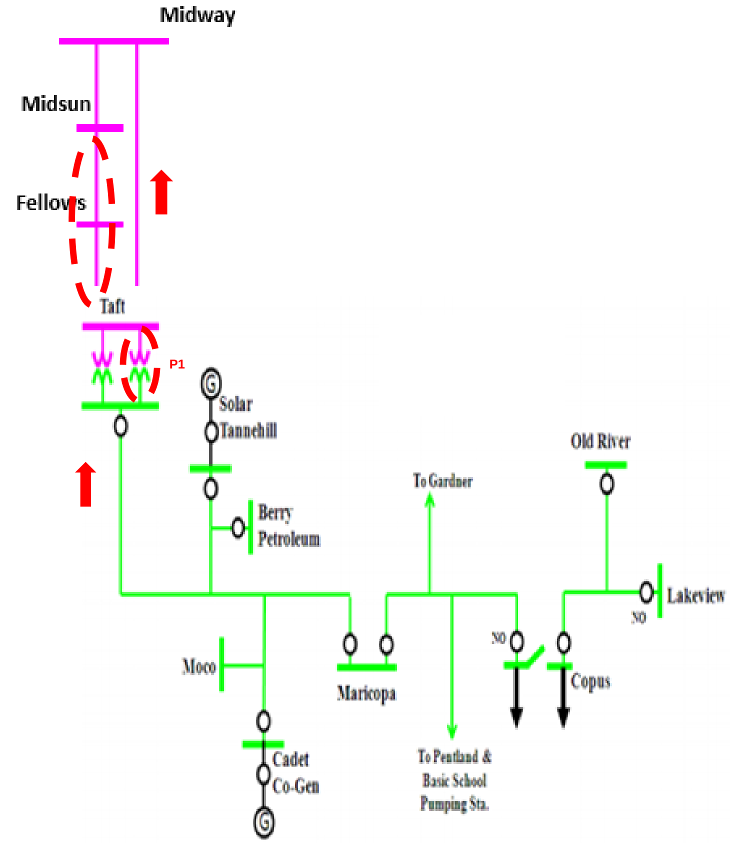
Kern 115 kV – Results Summary

<u>Observations</u>

- P1 long-term Overload observed On Taft 115/70 kV T/F bank # 2
- P1 contingencies resulting in loss of one of Midway-Taft lines results in overload on the other line for off-peak and sensitivities.

<u>Potential Mitigations</u>

- Monitor the long-term Bank overload.
- Rely on operating solutions including redispatch /Preferred Resource/upgrade for the 115 kV overloads



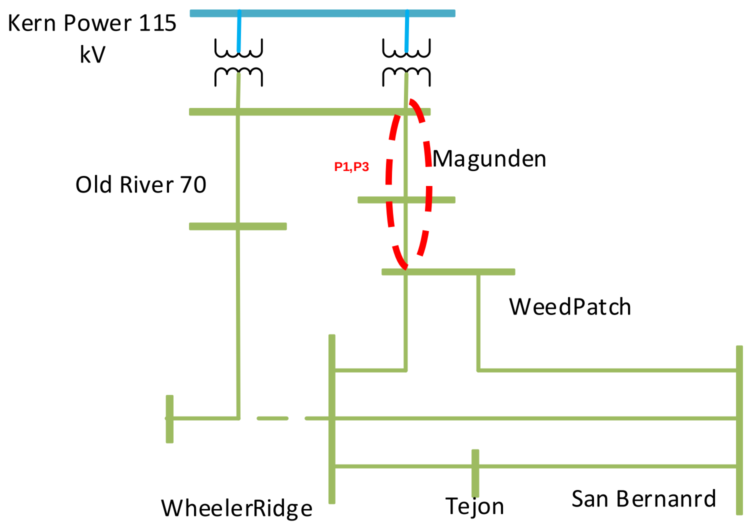
Kern 70 kV-Results Summary

Observations

- P1,P3 near-term Overload observed on 70 kV lines between Bakersfield and Weed patch 70 kV buses

Potential Mitigations

- Rely on Summer setup (Magunden CB 22) to open the connection between Bakersfield and Weedpatch 70 kV bus.



Kern Area – Voltage Results Summary

Observations

- Some substations with high voltages observed in near-term off-peak cases.
- 2029 off-peak case shows significantly low number of substations with high voltages.
- Real-time case also shows some substations with high voltages concentrated in few buses in Midway Semitropic 115 kV system

Potential Mitigations

- No mitigation will be proposed for high voltages at this time.

Sensitivity Study Assessment

- Below is the list of facility overloads identified in sensitivity scenario(s) only.

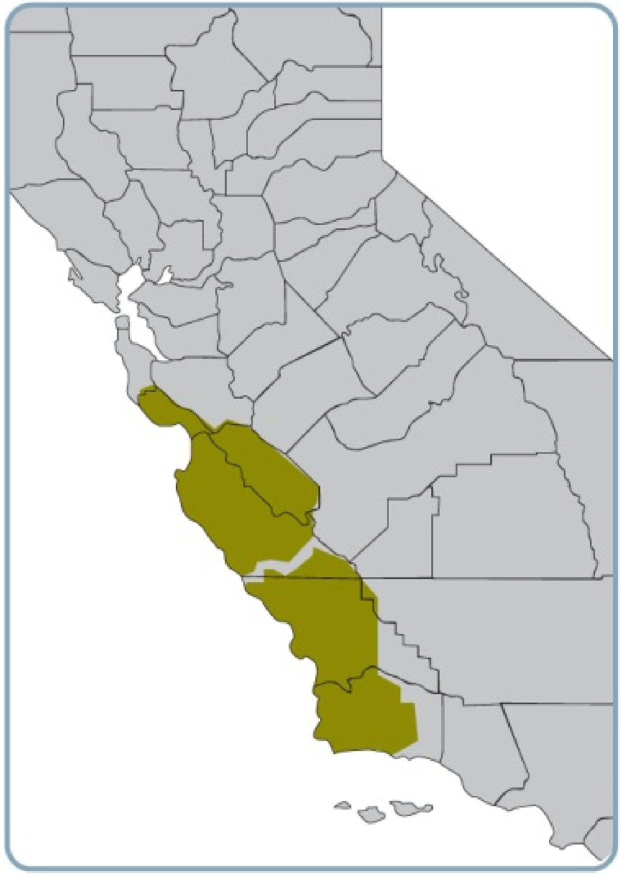
Overloaded Facility	Category	2024 High CEC	2021 Summer Peak High Renew	2024 Off-Peak High Renew	2029 QF Retirement	2029 High SVP Forecast
Taft-Q356Jn-Taft A 70 kV	P0, P2		√	√		
Blackwell-LostHill 70 kV	P0		√			
Lamont-Arvin Junction 115 kV	P6		√			

California ISO

Central Coast Los Padres Area
Preliminary Reliability Assessment Results

Lindsey Thomas
Regional Transmission Engineer
2019-2020 Transmission Planning Process Stakeholder Meeting
September 25-26, 2019

Central Coast/ Los Padres Area



- Central Coast is located south of the Greater Bay Area, it extends along the central coast from Santa Cruz to King City
- Major substations in Central Coast: Moss Landing, Green Valley, Paul Sweet, Salinas, Watsonville, Monterey, Soledad and Hollister
- Central Coast supply sources: Moss Landing, Panoche, King City and Monta Vista
- Central Coast transmission system includes 60, 115, 230 and 500 kV facilities

- Los Padres is located south of the Central Coast Division
- Major substations in Los Padres : Paso Robles, Atascadero, Morro Bay, San Luis Obispo, Mesa, Divide, Santa Maria and Sisquoc
- Key supply sources in Los Padres include Gates, Midway and Morro Bay
- Diablo Canyon nuclear power plant (2400 MW) is located in Los Padres but does not serve the area
- Los Padres transmission system includes 70, 115, 230 and 500 kV facilities

Load and Load Modifier Assumptions - CCLP Area

S. No.	Study Case	Scenario Type	Description	Gross Load (MW)	AAEE (MW)	BTM-PV		Net Load (MW)	Demand Response	
						Installed (MW)	Output (MW)		Total (MW)	D2 (MW)
1	CCLP-2021-SP	Baseline	2021 summer peak load conditions. Peak load time - hours ending 21:00.	1,231	30	397	0	1,201	30	16
2	CCLP-2024-SP	Baseline	2024 summer peak load conditions. Peak load time - hours ending 21:00.	1,282	56	454	0	1,226	30	16
3	CCLP-2029-SP	Baseline	2029 summer peak load conditions. Peak load time - hours ending 21:00.	1,360	103	550	0	1,257	30	16
4	CCLP-2021-SOP	Baseline	2021 spring off-peak load conditions. Off-peak load time – hours ending 13:00.	766	22	397	318	426	30	16
5	CCLP-2024-SOP	Baseline	2024 spring off-peak load conditions. Off-peak load time – hours ending 13:00.	830	42	454	368	420	30	16
6	CCLP-2021-WP	Baseline	2021 winter peak load conditions. Peak load time - hours ending 19:00.	1,133	30	397	0	1,104	30	16
7	CCLP-2024-WP	Baseline	2024 winter peak load conditions. Peak load time - hours ending 19:00.	1,270	55	453	0	1,214	30	16
8	CCLP-2029-WP	Baseline	2029 winter peak load conditions. Peak load time - hours ending 19:00.	1,262	76	550	0	1,185	30	16
9	CCLP-2024-SP-HiCEC	Sensitivity	2024 summer peak load conditions with hi-CEC load forecast sensitivity	1,282	0	454	0	1,282	30	16
10	CCLP-2024-SOP-HiRenew	Sensitivity	2024 spring off-peak load conditions with hi renewable dispatch sensitivity	830	42	454	450	338	30	16
11	CCLP-2021-SP-HiRenew	Sensitivity	2021 summer peak load conditions with hi-renewable dispatch sensitivity	1,215	38	397	393	784	30	16
12	CCLP-2029-SP-QF	Sensitivity	2029 summer peak load conditions with QF retirement sensitivity	1,360	103	550	0	1,257	30	16

Generation Assumptions - CCLP Area

S. No.	Study Case	Scenario Type	Description	Battery Storage (MW)	Solar		Wind		Hydro		Thermal	
					Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)
1	CCLP-2021-SP	Baseline	2021 summer peak load conditions. Peak load time - hours ending 21:00.	0	841	0	0	0	0	0	3,774	1,073
2	CCLP-2024-SP	Baseline	2024 summer peak load conditions. Peak load time - hours ending 21:00.	0	816	0	0	0	0	0	3,773	1,134
3	CCLP-2029-SP	Baseline	2029 summer peak load conditions. Peak load time - hours ending 21:00.	0	816	0	0	0	0	0	3,773	1,025
4	CCLP-2021-SOP	Baseline	2021 spring off-peak load conditions. Off-peak load time – hours ending 13:00.	0	841	841	0	0	0	0	3,774	269
5	CCLP-2024-SOP	Baseline	2024 spring off-peak load conditions. Off-peak load time – hours ending 13:00.	0	816	800	0	0	0	0	3,773	353
6	CCLP-2021-WP	Baseline	2021 winter peak load conditions. Peak load time - hours ending 19:00.	0	841	0	0	0	0	0	3,774	1,073
7	CCLP-2024-WP	Baseline	2024 winter peak load conditions. Peak load time - hours ending 19:00.	0	816	0	0	0	0	0	3,773	1,134
8	CCLP-2029-WP	Baseline	2029 winter peak load conditions. Peak load time - hours ending 19:00.	0	816	0	0	0	0	0	3,773	1,041
9	CCLP-2024-SP-HiCEC	Sensitivity	2024 summer peak load conditions with hi-CEC load forecast sensitivity	0	816	0	0	0	0	0	3,773	1,134
10	CCLP-2024-SOP-HiRenew	Sensitivity	2024 spring off-peak load conditions with hi renewable dispatch sensitivity	0	816	808	0	0	0	0	3,773	1,127
11	CCLP-2021-SP-HiRenew	Sensitivity	2021 summer peak load conditions with hi-renewable dispatch sensitivity	0	841	832	0	0	0	0	3,774	138
12	CCLP-2029-SP-QF	Sensitivity	2029 summer peak load conditions with QF retirement sensitivity	0	816	0	0	0	0	0	3,773	1,020

Previously approved transmission projects modelled in base cases

Project Name	First Year Modeled
Morgan Hill Area Reinforcement	2021
Coburn – Oil Fields 60kV System	2022
South of Mesa Upgrades	2023
Estrella Substation Project	2023

Previously approved transmission projects not modelled in base cases (on-hold)

Project Name	Division
North of Mesa Upgrades	320

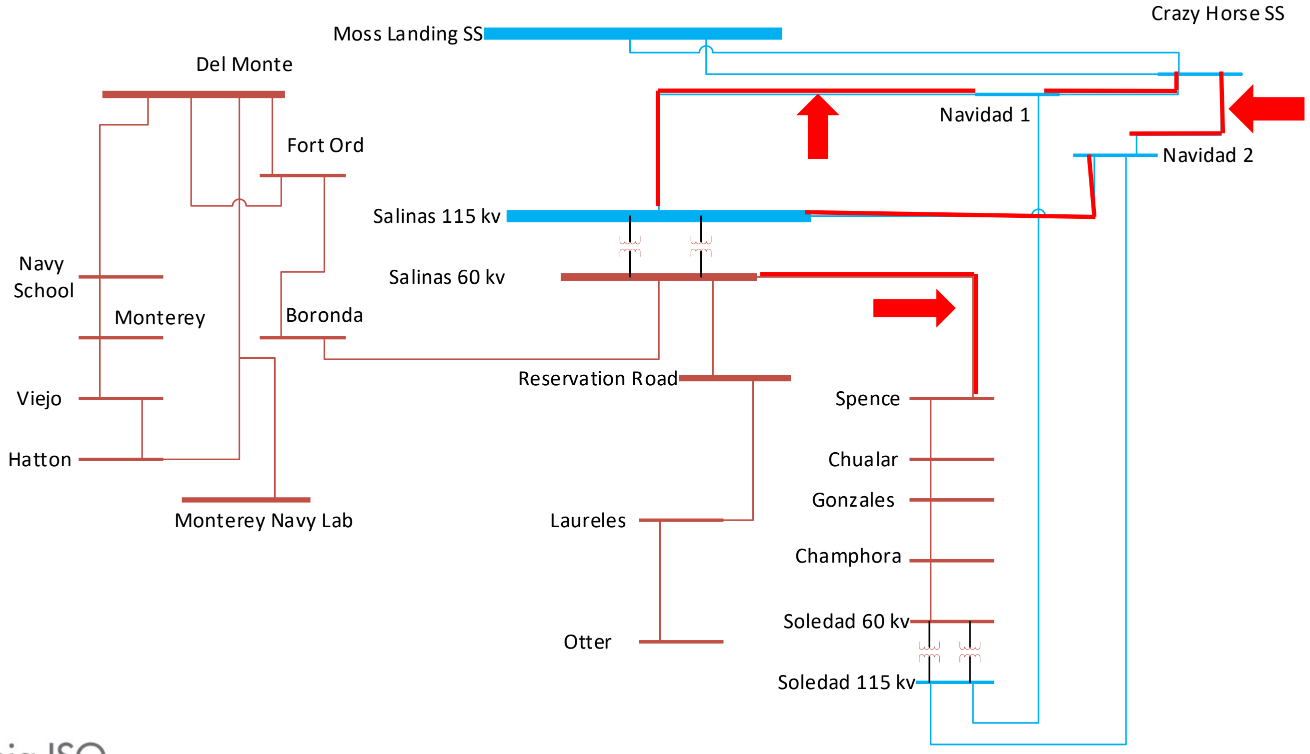
Central Coast – Results Summary

<u>Observations</u>

- Known P6 and P7 overloads in the Crazy Horse Salinas area.
- P1 and P3 on Salinas – Firestone #2 60 kV Line

<u>Potential Mitigations</u>

- RAS Identified in 2018-2019 TPP
- Possible rerate or reconductor



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Los Padres – Results Summary

<u>Observations</u>

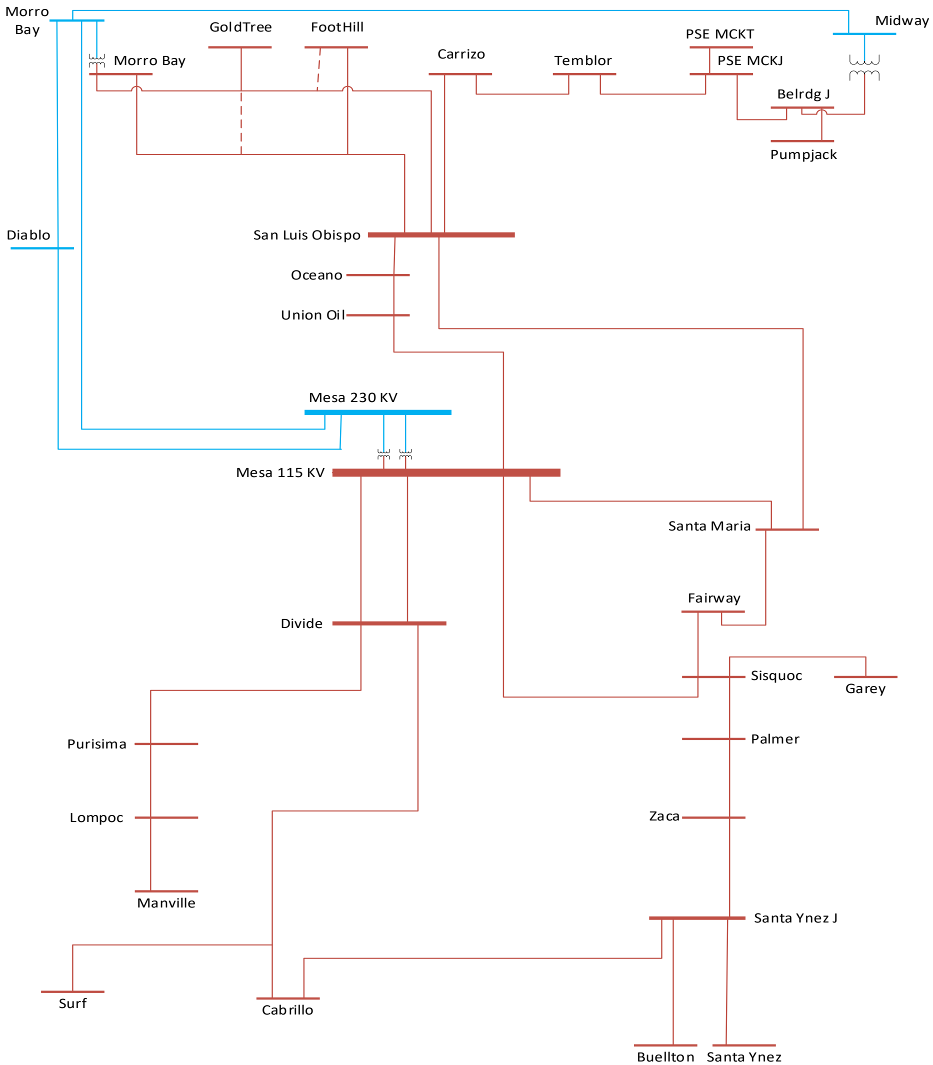
- P1 and P3 overloads on San Miguel – Coalinga 70kV Line, Paso Robles – Templeton 70 kV Line and San Miguel – Paso Robles 70 kV Line
- P2, P6 and P7 overloads in the Mesa area.

<u>Approved Mitigation</u>

- Estrella Substation Project
- South of Mesa Upgrades

<u>Potential Mitigation</u>

- North of Mesa Upgrades
  - Project on hold for further assessment in this planning cycle



CCLP Area – Voltage Results Summary

Observations

- Some substations with high voltages observed in real time off-peak case.
- 2021 winter case shows substations with voltages around 1.05.

Potential Mitigations

- No mitigation will be proposed for high voltages at this time.

Sensitivity Study Assessment

- Below is the list of facility overloads identified in sensitivity scenario(s) only.

Overloaded Facility	Category	2024 High CEC	2021 Summer Peak High Renew	2024 Off-Peak High Renew	2029 QF Retirement	2029 High SVP Forecast
30760 COBURN 230 36075 COBURN 60.0 1	P1, P2			√		
36260 SISQUOC 115 36286 PALMR 115 1	P6, P7		√			
36264 S.YNZ JT 115 36288 ZACA 115 1	P2, P6, P7		√			
36286 PALMR 115 36287 AECCEORTP 115 1	P6, P7		√			
36287 AECCEORTP 115 36288 ZACA 115 1	P2, P7		√			

California ISO

Humboldt Area
Preliminary Reliability Assessment Results

Lindsey Thomas
Regional Transmission Engineer

2019-2020 Transmission Planning Process Stakeholder Meeting

September 25-26, 2019

Humboldt Area

- 3000 sq. mile area located NW corner of PG&E service area
- Cities include
  - Eureka
  - Arcata
  - Garberville
- Transmission facilities: 115 kV from Cottonwood and 60 kV – from Mendocino

Load and Load Modifier Assumptions - Humboldt Area

S. No.	Study Case	Scenario Type	Description	Gross Load (MW)	AAEE (MW)	BTM-PV		Net Load (MW)	Demand Response	
						Installed (MW)	Output (MW)		Total (MW)	D2 (MW)
1	HMB-2021-SP	Baseline	2021 summer peak load conditions. Peak load time - hours between 20:00 and 21:00.	131	3	25	0	128	3	3
2	HMB-2024-SP	Baseline	2024 summer peak load conditions. Peak load time - hours between 20:00 and 21:00.	136	5	34	0	132	3	3
3	HMB-2029-SP	Baseline	2029 summer peak load conditions. Peak load time - hours between 20:00 and 21:00.	144	9	46	0	135	3	3
4	HMB-2029-SP-QF	Baseline	2029 summer peak load conditions. Peak load time - hours between 20:00 and 21:00.	144	9	46	0	135	3	3
5	HMB-2021-SOP	Baseline	2021 spring off-peak load conditions. Off-peak load time – weekend morning.	98	2	25	20	76	3	3
6	HMB-2024-SOP	Baseline	2024 spring off-peak load conditions. Off-peak load time – weekend morning.	105	3	34	27	75	3	3
7	HMB-2021-WP	Baseline	2021 winter peak load conditions. Peak load time - hours between 20:00 and 21:00.	167	3	25	0	164	3	3
8	HMB-2024-WP	Baseline	2024 winter peak load conditions. Peak load time - hours between 20:00 and 21:00.	175	5	34	0	171	3	3
9	HMB-2029-WP	Baseline	2029 winter peak load conditions. Peak load time - hours between 20:00 and 21:00.	184	6	46	0	178	3	3
10	HMB-2024HS-SP-P7	Sensitivity	2024 summer peak load conditions with hi-CEC load forecast sensitivity	136	0	34	0	136	3	3
11	HMB-2021-HR-P7	Sensitivity	2021 summer peak load conditions with hi renewable dispatch sensitivity	120	3	25	24	92	3	3
12	HMB-2024-HR-P7	Sensitivity	2024 summer peak load conditions with hi renewable dispatch sensitivity	105	3	34	33	68	3	3

Generation Assumptions - Humboldt Area

S. No.	Study Case	Scenario Type	Description	Battery Storage (MW)	Solar		Wind		Hydro		Thermal	
					Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)
1	HMB-2021-SP	Baseline	2021 summer peak load conditions. Peak load time - hours between 20:00 and 21:00.	0	0	0	0	0	5	0	259	172
2	HMB-2024-SP	Baseline	2024 summer peak load conditions. Peak load time - hours between 20:00 and 21:00.	0	0	0	0	0	5	0	259	187
3	HMB-2029-SP	Baseline	2029 summer peak load conditions. Peak load time - hours between 20:00 and 21:00.	0	0	0	0	0	5	0	259	187
4	HMB-2029-SP-QF	Baseline	2029 summer peak load conditions. Peak load time - hours between 20:00 and 21:00.	0	0	0	0	0	5	0	259	187
5	HMB-2021-SOP	Baseline	2021 spring off-peak load conditions. Off-peak load time – weekend morning.	0	0	0	0	0	5	0	259	15
6	HMB-2024-SOP	Baseline	2024 spring off-peak load conditions. Off-peak load time – weekend morning.	0	0	0	0	0	5	0	259	15
7	HMB-2021-WP	Baseline	2021 winter peak load conditions. Peak load time - hours between 20:00 and 21:00.	0	0	0	0	0	5	0	259	187
8	HMB-2024-WP	Baseline	2024 winter peak load conditions. Peak load time - hours between 20:00 and 21:00.	0	0	0	0	0	5	0	259	187
9	HMB-2029-WP	Baseline	2029 winter peak load conditions. Peak load time - hours between 20:00 and 21:00.	0	0	0	0	0	5	0	259	229
10	HMB-2024HS-SP-P7	Sensitivity	2024 summer peak load conditions with hi-CEC load forecast sensitivity	0	0	0	0	0	5	0	259	187
11	HMB-2021-HR-P7	Sensitivity	2021 summer peak load conditions with hi renewable dispatch sensitivity	0	0	0	0	0	5	0	259	187
12	HMB-2024-HR-P7	Sensitivity	2024 summer peak load conditions with hi renewable dispatch sensitivity	0	0	0	0	0	5	0	259	15

Previously approved transmission projects modelled in base cases

Project Name	First Year Modeled
Maple Creek Reactive Support	2020

Humboldt Area – Voltage Results Summary (high voltages)

Observations

- No Normal High Voltage observed

Potential Mitigations

- No mitigation will be proposed for high voltages at this time.

Sensitivity Study Assessment

- Below is the list of facility overloads identified in sensitivity scenario(s) only.

Overloaded Facility	Category	2024 High CEC	2021 Summer Peak High Renew	2024 Off-Peak High Renew	2029 QF Retirement
31110 BRDGVLLE 60.0 31120 FRUTLDJT 60.0 1 1	P1, P3		√		

PG&E Bulk System
Preliminary Reliability Assessment Results

Irina Green
Senior Advisor, Regional Transmission North

2019-2020 Transmission Planning Process Stakeholder Meeting
September 25-26, 2019

Posted on Market Participant Portal – Subject to Transmission Planning NDA

California ISO

SCE Metro Area
Preliminary Reliability Assessment Results

Nebiyu Yimer
Regional Transmission Engineer Lead

2019-2020 Transmission Planning Process Stakeholder Meeting
September 25-26, 2019

SCE Metro Area

- Includes Los Angeles, Orange, Ventura and Santa Barbara counties
- Comprised of 500 kV and 230 kV transmission facilities
- 1-in-10 summer peak net load of 17,866 MW in 2029
- Forecast load includes the impact of 4,300 MW of BTM PV and 1,252 MW of AAEE
- Generation capacity (NQC) approximately 4,700 MW in 2021 after 4000 MW (net) of scheduled retirements.

SCE Metro Area Study Scenarios

- Base scenarios

No.	Case	Description
B1	2021 Summer Peak	SCE Summer peak load time (9/7 HE 17 PPT)
B2	2024 Summer Peak	SCE Summer peak load time (9/3 HE 17 PPT)
B3-1	2028 Summer Peak	SCE Summer peak load time (9/4 HE 20 PPT)
B3-2	2028 Summer Peak	Consolidated CAISO summer peak (9/4 HE 20 PPT)
B4	2021 Spring Light Load	Spring minimum net load time (4/4 HE 13 PPT)
B5	2024 Spring Off-Peak	Spring shoulder load time (5/3 HE 21 PPT)

- Sensitivity scenarios

No	Case	Change From Base Assumption
S1	2024 Summer Peak	High CEC forecasted load
S2	2024 Spring Off-Peak	Heavy renewable output and minimum gas generation commitment
S3	2021 Summer Peak	Heavy renewable output and minimum gas generation commitment

Demand Side Assumptions

Scenario No.	Base Case	Gross Load (MW)	AAEE (MW)	BTM-PV		Net Load (MW)	Demand Response (installed)	
				Installed (MW)	Output (MW)		Fast (MW)	Slow (MW)
B1	2021 Summer Peak	19,220	334	2,249	974	17,911	266	376
B2	2024 Summer Peak	20,295	777	3,160	1,375	18,144	271	376
B3-1	2029 Summer Peak	19,117	1,252	4,299	0	17,866	271	376
B3-2	2029 CAISO Summer Peak	18,781	1,252	4,299	0	17,529	271	376
B4	2021 Spring Light Load	8,212	110	2,249	2,191	5,911	266	376
B5	2024 Spring Off-Peak	13,055	536	3,160	0	12,519	271	376
S1	2024 SP High CEC Load	21,484	777	3,160	1,375	19,332	271	376
S2	2024 SOP Heavy Renewable Output & Min. Gas Gen.	13,055	536	3,160	2,014	10,504	271	376
S3	2021 SP Heavy Renewable Output & Min. Gas Gen.	19,220	334	2,249	2,014	16,871	266	376

Note: DR and storage are modeled offline in starting base cases.

Supply Side Assumptions

No.	Base Case	Battery Storage (Installed) (MW)	Solar (Grid Connected)		Wind		Hydro		Thermal	
			Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	NQC (MW)	Dispatch (MW)
B1	2021 Summer Peak	423	225	126	0	0	0	0	4,616	3,781
B2	2024 Summer Peak	473	225	117	0	0	0	0	4,616	4,095
B3-1	2029 Summer Peak	473	225	0	0	0	0	0	4,231	3,891
B3-1	2029 CAISO Summer Peak	473	225	0	0	0	0	0	4,231	3,978
B4	2021 Spring Light Load	423	225	223	0	0	0	0	4,616	336
B5	2024 Spring Off-Peak	473	225	0	0	0	0	0	4,616	4,047
S1	2024 SP High CEC Load	473	225	117	0	0	0	0	4,616	4,371
S2	2024 SOP Heavy Renewable Output & Min. Gas Gen.	473	225	223	0	0	0	0	4,616	3,080
S3	2021 SP Heavy Renewable Output & Min. Gas Gen.	423	225	223	0	0	0	0	4,616	3,119

Note: DR and storage are modeled offline in starting base cases.

Previously approved transmission projects modelled in base cases

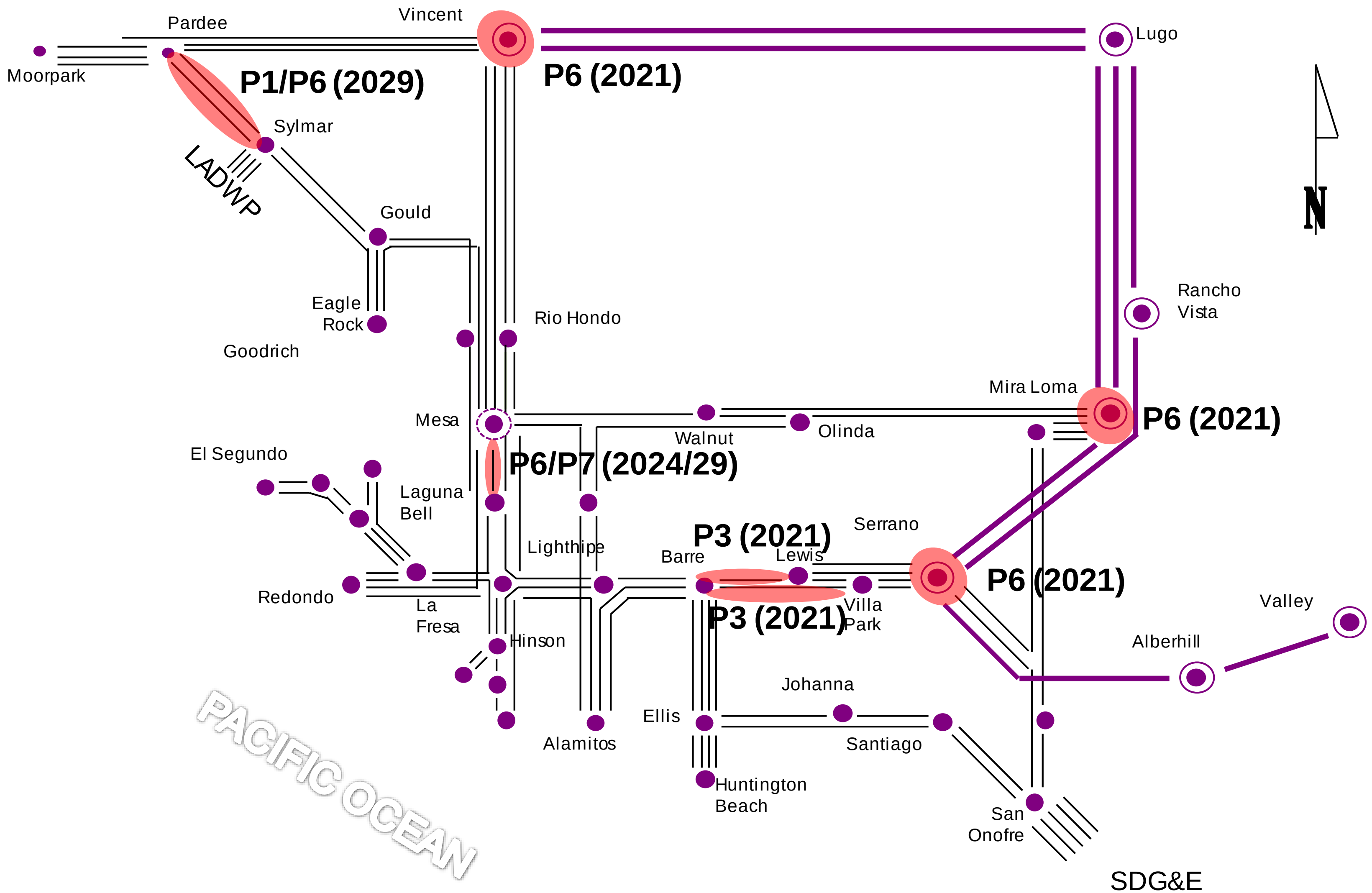
Project Name	ISD	First Year Modeled
Mesa 500 kV Substation	Mar. 2022	2024
Laguna Bell Corridor Upgrade	Dec. 2020	2021
Moorpark–Pardee No. 4 230 kV Circuit	Dec. 2020	2021
Wilderness 230/66 kV substation	Sept. 2024	2024
Alberhill 500 kV Substation	Sept. 2022	2024

Reliability assessment preliminary results summary

Base Scenario Results

Overloaded Facility	Worst Contingencies	Category	Loading (%)				Potential Mitigation Solutions
			B1 2021 Summer Peak	B2 2024 Summer Peak	B3 2029 Summer Peak	B4 CAISO 2029 Summer Peak	
Pardee - Sylmar 230 kV	Remaining Pardee - Sylmar 230 kV	P1	<100	<100	97	**129**	Increase line rating
	Remaining Pardee - Sylmar 230 kV & Victorville - Lugo 500 kV	P6	<100	<100	**123**	**170**	
Mesa - Laguna Bell 230 kV #1	Mesa - Lighthipe & Mesa–La Fresa /Mesa - Laguna Bell #2 230 kV lines	P6/P7	<100	**107**	**110**	<100	Re-dispatch resources, monitor economic impact
Serrano 500/230 kV Transformer	Two Serrano 500/230 kV Transformers	P6	**130**	<100	<100	<100	OP 7590
Vincent 500/230 kV Transformer #2 or #3	Vincent – Mira Loma 500 kV & Vincent 500/230 kV Transformer #3 or #2	P6	**109**	<100	<100	<100	OP 7550
Vincent 500/230 kV Transformer #1 or #4	Vincent – Mira Loma 500 kV & Vincent 500/230 kV Transformer #4 or #1	P6	**106**	<100	<100	<100	
Mira Loma 500/230 kV Transformer #4	Lugo - Rancho Vista & Mira Loma - Serrano 500 kV lines	P6	**129**	<100	<100	<100	OP 7580
Mira Loma 500/230 kV Transformer #1 or #2	Mira Loma - Serrano 500 kV & Mira Loma 500/230 kV Tr. #2 or #1	P6	**116**	<100	<100	<100	
Barre–Villa Park 230 kV	Huntington Beach RP Block & Barre–Lewis 230 kV	P3	**104**	<100	<100	<100	Re-dispatch resources
Barre–Lewis 230 kV	Huntington Beach RP Block & Barre–Villa Park 230 kV	P3	**104**	<100	<100	<100	Re-dispatch resources

Base Scenario Results – Cont'd



Slide 9

Sensitivity Assessment Results

- Facility overloads identified in sensitivity scenarios only

Overloaded Facility	Category	2024 SP High CEC Load	2024 SOP Heavy Ren. Output & Min Gas Gen. Commitment	2021 SP Heavy Ren. Output & Min Gas Gen. Commitment	Consolidated CAISO 2025 (1)
Ellis–Johanna 230 230 kV	P6		√		
Ellis–Santiago 230 kV	P6		√		
Mesa 230 kV Bus Tie	P6			√	
Pardee - Sylmar 230 kV	P1/P6				√

(1) The consolidated CAISO 2025 SP case was used for assessing the timing of the Pardee - Sylmar 230 kV constraint

- New low/high voltages identified in sensitivity scenarios only.

Substation	Category	2024 SP High CEC Load	2024 SOP Heavy Ren. Output & Min Gas Gen. Commitment	2021 SP Heavy Ren. Output & Min Gas Gen. Commitment
Goleta	P6	√		

Summary of Potential New Upgrades

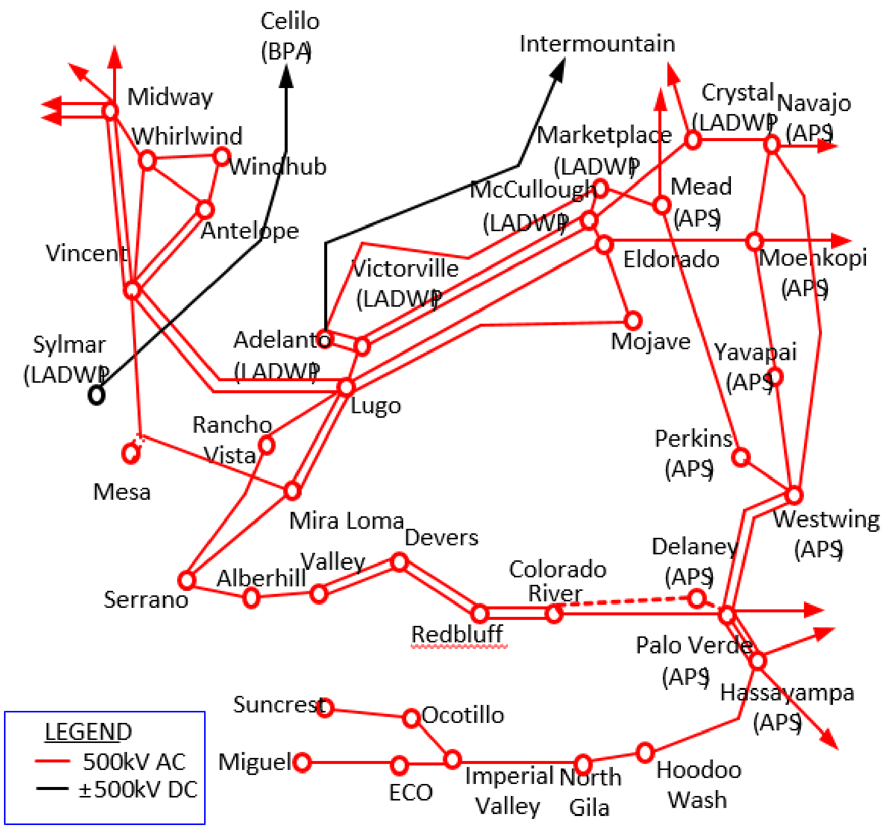
Concern	Potential Upgrade
- Severe thermal overload on Pardee - Sylmar 230 kV lines under P1 conditions - More severe thermal overload under P6 conditions	Increase the rating of Pardee - Sylmar 230 kV lines by summer of 2025.

SCE Bulk
Preliminary Reliability Assessment Results

Emily Hughes
Regional Transmission Engineer

2019-2020 Transmission Planning Process Stakeholder Meeting
September 25-26, 2019

SCE Bulk System



- SCE 500 kV system including interconnections with neighboring systems
- 1-in-5 summer peak net load of 23,089 MW in 2029
- Forecast 7,083 MW of BTM PV and 2,023 MW of AAEE by 2029
- 36,400 MW of existing generation

SCE Bulk Area Study Scenarios

- Base scenarios

No.	Case	Description
B1	2021 Summer Peak	1-in 5 summer peak load (9/7 HE 17 PPT)
B2	2024 Summer Peak	1-in 5 summer peak load (9/3 HE 17 PPT)
B3	2029 Summer Peak	Consolidated CAISO summer peak (9/4 HE 20 PPT)
B4	2021 Spring Light Load	Spring minimum net load time (4/4 HE 13 PPT)
B5	2024 Spring Off-Peak	Spring shoulder load time (5/3 HE 21 PPT)

- Sensitivity scenarios

No	Case	Change From Base Assumption
S1	2024 Summer Peak	High CEC forecasted load
S2	2024 Spring Off-Peak	Heavy renewable output and minimum gas generation commitment
S3	2021 Summer Peak	Heavy renewable output and minimum gas generation commitment

Load and Load Modifier Assumptions – SCE Bulk

S. No.	Study Case	Gross Load (MW)	AAEE (MW)	BTM-PV		Net Load (MW)	Demand Response	
				Installed (MW)	Output (MW)		Fast (MW)	Slow (MW)
B1	2021-Summer Peak	26,343	641	3,755	1,652	24,050	465	23
B2	2024-Summer Peak	27,722	1,336	5,123	2,254	24,132	465	23
B3	2029-Summer Peak	25,112	2,023	7,083	0	23,089	465	23
B4	2021-Spring Light Load	12,817	641	4,556	3,645	8,531	465	23
B5	2024-Spring Off-Peak	18,652	1,336	5,123	0	17,316	465	23
S1	2024-SP High CEC Load	29,291	1,336	5,123	2,254	25,701	465	23
S2	2024-SOP Heavy Renewable Output & Min. Gas Gen.	18,652	1,336	7,766	3,417	13,899	465	23
S3	2021-SP Heavy Renewable Output & Min. Gas Gen.	26,343	641	7,766	3,417	22,285	465	23

Note: DR and storage are modeled offline in starting base cases.

Generation Assumptions – SCE Bulk System

S. No.	Study Case	Battery Storage (MW)	Solar		Wind		Hydro		Thermal	
			Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)
B1	2021-Summer Peak	423	7,508	4,204	4,251	2,625	1,571	1,145	22,646	8,200
B2	2024-Summer Peak	473	7,508	3,904	4,233	1,524	1,591	1,300	23,160	8,488
B3	2029-Summer Peak	473	12,723	0	4,428	2,391	1,567	1,305	23,185	8,889
B4	2021-Spring Light Load	473	7,508	7,421	4,233	2,201	1,599	180	23,592	638
B5	2024-Spring Off-Peak	473	7,508	0	4,233	1,947	1,567	1,306	23,213	9,291
S1	2024-SP High CEC Load	473	7,508	3,904	4,233	1,524	1,591	1,300	23,160	9,745
S2	2024-SOP Heavy Renewable Output & Min. Gas Gen.	473	7,508	7,435	4,233	2,836	1,567	920	23,093	3,983
S3	2021-SP Heavy Renewable Output & Min. Gas Gen.	423	7,508	7,435	4,251	2,836	1,571	852	22,646	5,331

Note: DR and storage are modeled offline in starting base cases.

Previously approved transmission projects modelled in base cases

Project Name	ISD	First Year Modeled
Lugo – Victorville 500 kV Upgrade	Dec. 2021	2021
Delaney – Colorado River 500 kV Line	Dec. 2021	2021
Mesa 500 kV Substation	Mar. 2022	2024
Alberhill 500 kV Substation	Sept. 2022	2024

Reliability assessment preliminary results summary

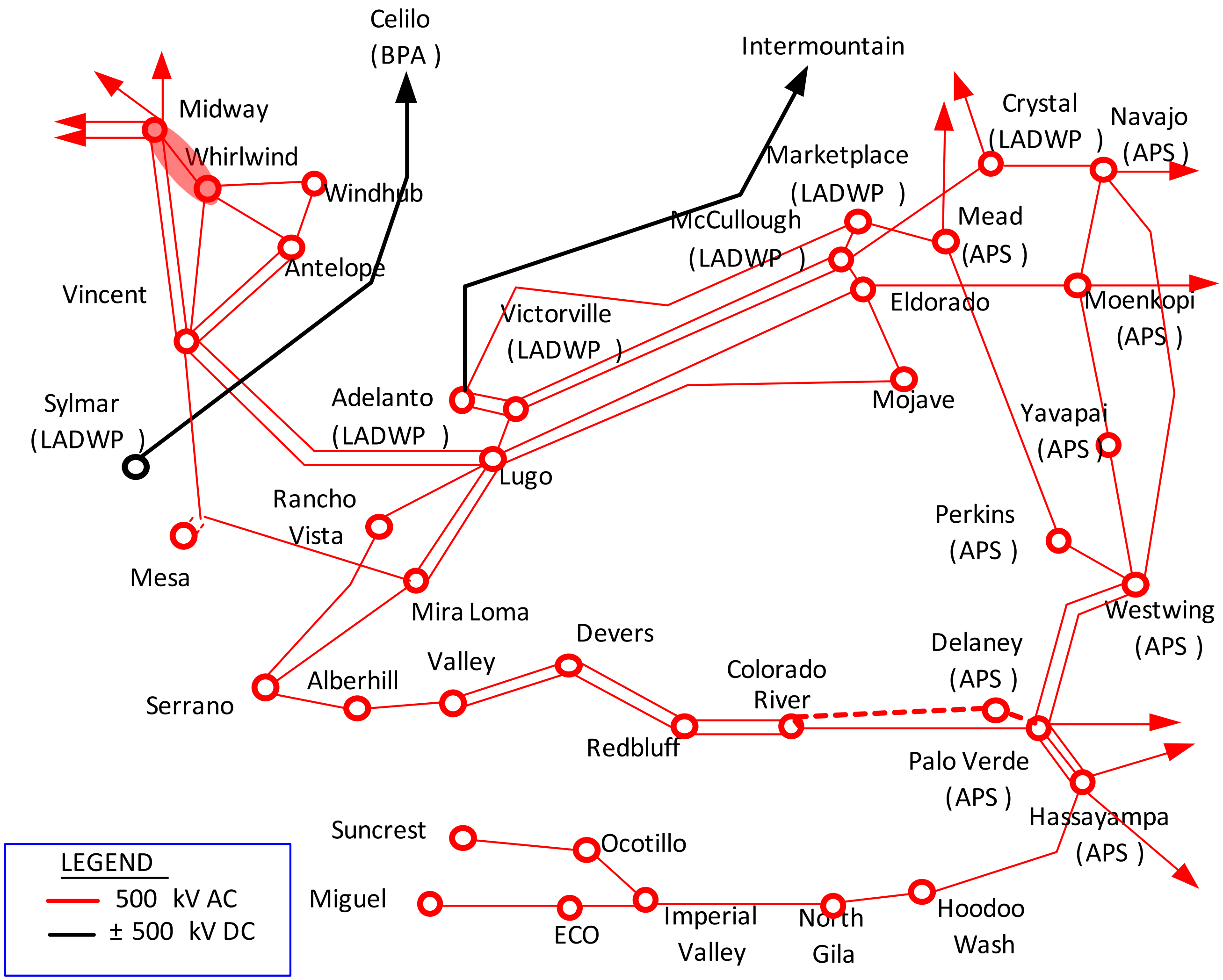
SCE Bulk System – Voltage Results Summary

Substation	Worst Contingency	Category	Loading %					Potential Mitigation Solutions
			2021 Summer Peak	2024 Summer Peak	2029 Summer Peak	2021 Spring Off-Peak	2024 Spring Off-Peak	
Midway_Vincent_22 500 kV	MIDWAY - WIRLWIND No. 3 and MIDWAY - VINCENT No. 1 500 kV lines	P6	**1.1721**	**1.1618**	>0.9 & <1.1	>0.9 & <1.1	>0.9 & <1.1	Midway-Vincent RAS, System adjustment after first contingency
Midway_Whirlwind_31 500 kV	MIDWAY - VINCENT No. 1 and MIDWAY - VINCENT No. 2 500 kV lines	P7	**1.1107**	**1.1046**	>0.9 & <1.1	>0.9 & <1.1	>0.9 & <1.1	Midway-Vincent RAS

Base Scenario Results

Overloaded Facility	Worst Contingency	Category	Loading %					Potential Mitigation Solutions
			2021 Summer Peak	2024 Summer Peak	2029 Summer Peak	2021 Spring Off-Peak	2024 Spring Off-Peak	
Midway_Vincent_12 - Vincent 500 kV	MIDWAY - WIRLWIND No. 3 and MIDWAY - VINCENT No. 2 500 kV lines	P6	**120**	**120**	<100	<100	<100	Midway-Vincent RAS, System adjustment after first contingency
Midway_Vincent_11 - Midway_Vincent_12 500 kV	MIDWAY - WIRLWIND No. 3 and MIDWAY - VINCENT No. 2 500 kV lines	P6	**126**	**125**	<100	<100	<100	Midway-Vincent RAS, System adjustment after first contingency
Midway_Vincent_21 - Midway_Vincent_22 500 kV	MIDWAY - WIRLWIND No. 3 and MIDWAY - VINCENT No. 1 500 kV lines	P6	**129**	**128**	<100	<100	<100	Midway-Vincent RAS, System adjustment after first contingency
Midway_Whirlwind_32 - Whirlwind 500 kV	MIDWAY - VINCENT No. 1 and MIDWAY - VINCENT No. 2 500 kV lines	P7	**172**	**171**	<100	<100	<100	Increase line rating
Midway_Whirlwind_31 - Midway_Whirlwind_32 500 kV	MIDWAY - VINCENT No. 1 and MIDWAY - VINCENT No. 2 500 kV lines	P7	**110**	**109**	<100	<100	<100	Midway-Vincent RAS
Midway-Midway_Vincent_21 500 kV	MIDWAY - WIRLWIND No. 3 and MIDWAY - VINCENT No. 1 500 kV lines	P6	**121**	**121**	<100	<100	<100	Midway-Vincent RAS, System adjustment after first contingency
Midway-Midway_Whirlwind_31 500 kV	MIDWAY - VINCENT No. 1 and MIDWAY - VINCENT No. 2 500 kV lines	P7	**118**	**117**	<100	<100	<100	Midway-Vincent RAS

SCE Bulk Thermal Overloads



Sensitivity Study Assessment

- Facility overloads identified in sensitivity scenarios only

Overloaded Facility	Category	2024 SP High CEC Load	2024 SOP Heavy Ren. Output & Min Gas Gen. Commitment	2021 SP Heavy Ren. Output & Min Gas Gen. Commitment
Antelope – Whirlwind 500 kV	P6			√

- Mitigation includes re-dispatch of resources after initial contingency

Summary of Potential New Upgrades

Concern	Potential Upgrade
- Severe thermal overload on Midway - Whirlwind 500 kV Line under P7 conditions	- Increase the line rating of Midway - Whirlwind 500 kV Line

Tehachapi and Big Creek Corridor Area
Preliminary Reliability Assessment Results

Emily Hughes
Regional Transmission Engineer

2019-2020 Transmission Planning Process Stakeholder Meeting
September 25-26, 2019

Tehachapi and Big Creek Corridor Area

- Comprises of 66kV, 230 kV, and 500kV transmission facilities.
- Over 6,500 MW of existing generation.
- Existing pumping load of 720 MW.
- Existing Hydro installed capacity of 1100 MW

Study Scenarios

- Base scenarios

No.	Case	Description
B1	2021 Summer Peak	SCE Summer peak load time (9/7 HE 17 PPT)
B2	2024 Summer Peak	SCE Summer peak load time (9/3 HE 17 PPT)
B3	2029 Summer Peak	SCE Summer peak load time (9/4 HE 20 PPT)
B4	2021 Spring Light Load	Spring minimum net load time (4/4 HE 13 PPT)
B5	2024 Spring Off-Peak	Spring shoulder load time (5/3 HE 21 PPT)

- Sensitivity scenarios

No	Case	Change From Base Assumption
S1	2024 Summer Peak	High CEC forecasted load
S2	2024 Spring Off-Peak	Heavy renewable output and minimum gas generation commitment
S3	2021 Summer Peak	Heavy renewable output and minimum gas generation commitment

Load and Load Modifier Assumptions

S. No.	Study Case	Gross Load (MW)	AAEE (MW)	BTM-PV		PLOAD	Net Load (MW)	Demand Response	
				Installed (MW)	Output (MW)			Fast (MW)	Slow (MW)
B1	2021-Summer Peak	3,160	20	418	184	3,140	2,956	115.3	19.9
B2	2024-Summer Peak	3,231	46	548	241	3,185	2,944	115.3	19.9
B3	2029-Summer Peak	2,978	73	784	0	2,905	2,905	115.3	19.9
B4	2021-Spring Light Load	980	20	491	393	960	567	115.3	19.9
B5	2024-Spring Off-Peak	1,543	46	548	0	1,497	1,497	115.3	19.9
S1	2024-SP High CEC Load	2,772	46	548	241	2,726	2,485	102.7	1.3
S2	2024-SOP Heavy Renewable Output & Min. Gas Gen.	2,389	46	868	382	2,343	1,961	102.7	1.3
S3	2021-SP Heavy Renewable Output & Min. Gas Gen.	2,543	20	868	382	2,523	2,141	102.7	1.3

Note: DR and storage are modeled offline in starting base cases.

Generation Assumptions

S. No.	Study Case	Battery Storage (MW)	Solar		Wind		Hydro		Thermal	
			Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)
B1	2021-Summer Peak	0	3,780	3,780	3,541	325	1,183	1,166	1,706	1,396
B2	2024-Summer Peak	0	3,780	3,746	3,523	189	1,179	1,166	1,706	1,444
B3	2029-Summer Peak	0	4,793	3,712	3,676	365	1,179	1,166	1,706	834
B4	2021-Spring Light Load	0	3,780	1,890	3,523	3,281	1,183	1,177	1,672	975
B5	2024-Spring Off-Peak	0	3,780	1,890	3,523	3,240	1,179	1,176	1,706	1,444
S1	2024-SP High CEC Load	0	3,780	1,965	3,523	1,268	1,179	1,076	1,706	1,366
S2	2024-SOP Heavy Renewable Output & Min. Gas Gen.	0	3,780	3,743	3,523	2,360	1,179	696	1,706	225
S3	2021-SP Heavy Renewable Output & Min. Gas Gen.	0	3,780	3,743	3,541	2,360	1,183	692	1,706	756

Note: DR and storage are modeled offline in starting base cases.

Previously approved transmission projects modelled in base cases

Project Name	ISD	First Year Modeled
Big Creek Corridor Rating Increase	June 2019	2021

Reliability assessment preliminary results summary

SCE Bulk System – Voltage Results Summary

Substation	Worst Contingency	Category	Loading %					Potential Mitigation Solutions
			2021 Summer Peak	2024 Summer Peak	2029 Summer Peak	2021 Spring Off-Peak	2024 Spring Off-Peak	
Springville 230 kV	VESTAL - RECTOR No. 1 and RECTOR - VESTAL No. 2 230 kV	P6	>0.9	>0.9	>0.9	**0.8822**	>0.9	System adjustment after first contingency

Base Scenario Results

Overloaded Facility	Worst Contingency	Category	Loading %					Potential Mitigation Solutions
			2021 Summer Peak	2024 Summer Peak	2029 Summer Peak	2021 Spring Off-Peak	2024 Spring Off-Peak	
Bailey - Pastoria 230 kV	PARDEE - WARNETAP 230 kV line	P1	<100	<100	<100	**102**	**105**	Modify Pastoria Energy RAS equation
	PARDEE-PASTORIA-WARNE 230 kV line	P1	<100	<100	<100	<100	**101**	Modify Pastoria Energy RAS equation
	PASTORIA - WARNETAP 230 kV line	P1	<100	<100	<100	<100	**101**	Modify Pastoria Energy RAS equation
Big Creek 2 - Big Creek 3 230 kV	BIG CRK1 - RECTOR No. 1 and BIG CRK8 - BIG CRK3 No. 1 230 kV lines	P6	**138**	**136**	**136**	**144**	**137**	Redispatch resources after initial contingency
Springville - Big Creek 4 230 kV	VESTAL - RECTOR No. 1 and RECTOR - VESTAL 230.0 No. 2	P6	<100	<100	<100	**106**	<100	Big Creek RAS- Generation Runback

Sensitivity Study Assessment

- Facility overloads identified in sensitivity scenarios only

Overloaded Facility	Category	2024 SP High CEC Load	2024 SOP Heavy Ren. Output & Min Gas Gen. Commitment	2021 SP Heavy Ren. Output & Min Gas Gen. Commitment
Magunden - Antelope 1 230 kV	P6			√

- Mitigation includes re-dispatch of resources after initial contingency

Summary of Potential New Upgrades

Concern	Potential Upgrade
- Thermal overloads on Bailey - Pastoria 230 kV lines under P1 conditions	- Modify Pastoria Energy RAS equation

SCE North of Lugo Area
Preliminary Reliability Assessment Results

Emily Hughes
Regional Transmission Engineer

2019-2020 Transmission Planning Process Stakeholder Meeting
September 25-26, 2019

SCE North of Lugo (NOL) Area

- Comprised of 55, 115 and 230 kV transmission facilities
- Total installed generation capacity in the area is over 2300 MW.
- The loads are mainly served from Control, Kramer and Victor substations. The area can be divided into following subareas:
  - North of Control
  - Kramer/North of Kramer/Cool Water
  - Victor

SCE NOL Area Study Scenarios

- Base scenarios

No.	Case	Description
B1	2021 Summer Peak	SCE Summer peak load time (9/7 HE 17 PPT)
B2	2024 Summer Peak	SCE Summer peak load time (9/3 HE 17 PPT)
B3	2028 Summer Peak	SCE Summer peak load time (9/4 HE 20 PPT)
B4	2021 Spring Light Load	Spring minimum net load time (4/4 HE 13 PPT)
B5	2024 Spring Off-Peak	Spring shoulder load time (5/3 HE 21 PPT)

- Sensitivity scenarios

No	Case	Change From Base Assumption
S1	2024 Summer Peak	High CEC forecasted load
S2	2024 Spring Off-Peak	Heavy renewable output and minimum gas generation commitment
S3	2021 Summer Peak	Heavy renewable output and minimum gas generation commitment

Load and Load Modifier Assumptions - NOL

S. No.	Base Case	Gross Load (MW)	AAEE (MW)	BTM-PV		Net Load (MW)	Demand Response	
				Installed (MW)	Output (MW)		Fast (MW)	Slow (MW)
B1	2021-Summer Peak	1,187	10	641	282	895	60.0	1.3
B2	2024-Summer Peak	1,284	24	839	369	891	60.0	1.3
B3	2029-Summer Peak	918	40	1,204	0	878	60.0	1.3
B4	2021-Spring Light Load	923	10	769	615	298	60.0	1.3
B5	2024-Spring Off-Peak	639	24	839	0	615	60.0	1.3
S1	2024-SP High CEC Load	1,343	24	839	369	950	60.0	1.3
S2	2024-SOP Heavy Renewable Output & Min. Gas Gen.	639	24	1,327	584	31	60.0	1.3
S3	2021-SP Heavy Renewable Output & Min. Gas Gen.	1,187	10	1,327	584	593	60.0	1.3

Note: DR and storage are modeled offline in starting base cases.

Generation Assumptions - NOL

S. No.	Base Case	Battery Storage (MW)	Solar		Wind		Hydro		Thermal	
			Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)
B1	2021-Summer Peak	0	878	791	0	0	74	54	1,738	1,238
B2	2024-Summer Peak	0	878	791	0	0	74	54	1,738	1,238
B3	2029-Summer Peak	0	1202	1,115	0	0	74	54	1,738	1,238
B4	2021-Spring Light Load	0	878	791	0	0	74	54	1,738	1,238
B5	2024-Spring Off-Peak	0	878	791	0	0	74	54	1,738	1,238
S1	2024-SP High CEC Load	0	878	456	0	0	74	28	1,738	525
S2	2024-SOP Heavy Renewable Output & Min. Gas Gen.	0	878	869	0	0	74	28	1,738	265
S3	2021-SP Heavy Renewable Output & Min. Gas Gen.	0	878	869	0	0	74	8	1,738	394

Note: DR and storage are modeled offline in starting base cases.

Reliability assessment preliminary results summary

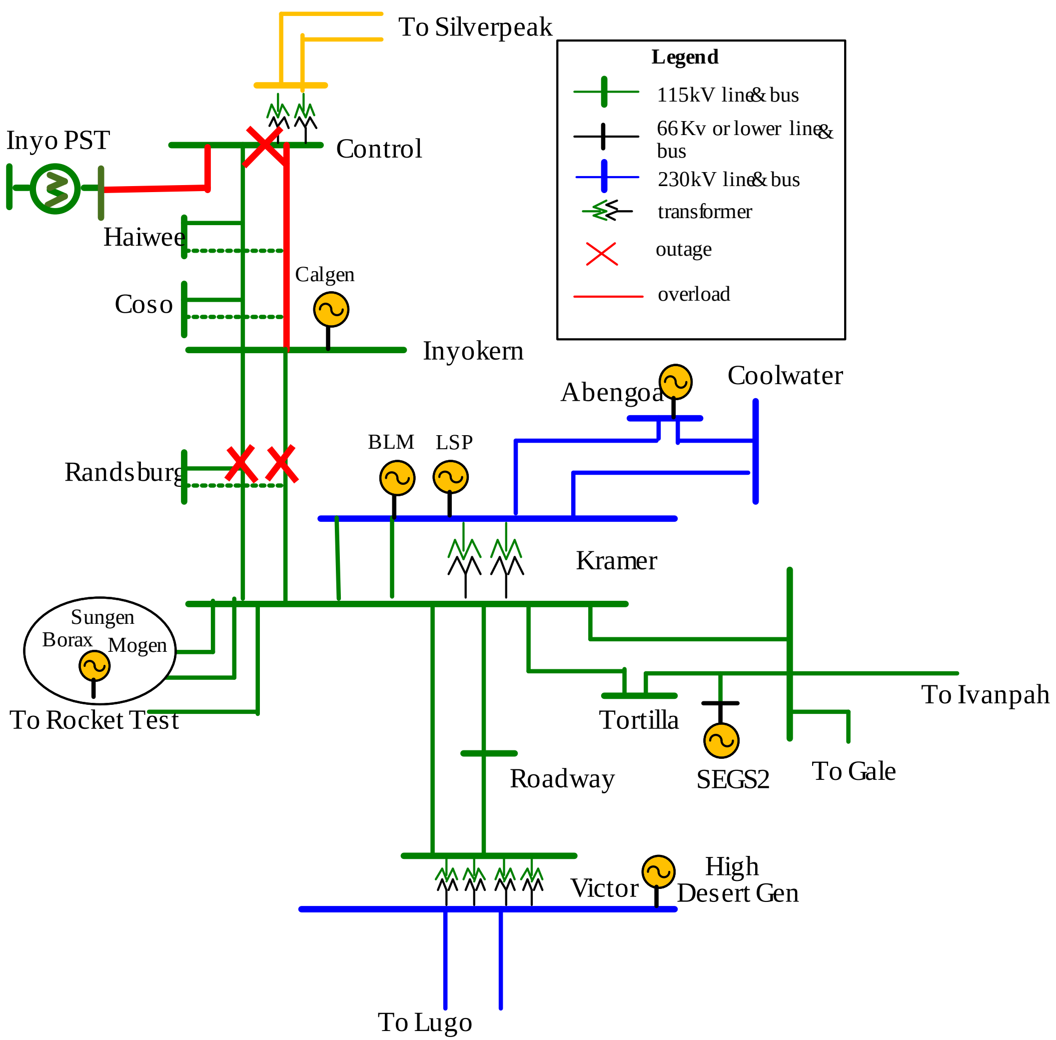
SCE NOL System – Voltage Results Summary

Substation	Worst Contingency	Category	Loading %					Potential Mitigation Solutions
			2021 Summer Peak	2024 Summer Peak	2029 Summer Peak	2021 Spring Off-Peak	2024 Spring Off-Peak	
Inyo 115kV	CONTROL - INYO 115.0 ck 1 and OXBOW B - CONTROL 115.0 ck 1	P6	1.1204	<1.1	1.1012	<1.1	1.1156	SCE voltage exception
	Control West Bus or Control East Bus	P2	1.1204	<1.1	1.1012	<1.1	1.1156	
Inyokern 115kV	INYOKERN - KRAMER 115.0 ck 1 and KRAMER-INYOKERN-RANDSB 115 ck 1	P6	Nonconv	>0.9	Nonconv	Nonconv	Nonconv	Operating Procedure 7690
	INYOKERN - KRAMER 115.0 ck 1 and CAL GEN - INYOKERN 115 ck 1	P6	0.8928	>0.9	>0.9	0.8839	0.8847	Install capacitor bank at Inyokern

Base Scenario Results

Overloaded Facility	Worst Contingency	Category	Loading %					Potential Mitigation Solutions
			2021 Summer Peak	2024 Summer Peak	2029 Summer Peak	2021 Spring Off-Peak	2024 Spring Off-Peak	
Control-Inyokern 115kV Line	Control EAST BUS	P2	<100	<100	<100	113.26	105.68	Bishop RAS; SCE Operating Procedure SOB-4
Control-Inyo 115kV Line	Inyokern - Kramer 115.0 ck 1 and Kramer-Inyokern -Randsburg 115 ck 1	P6	Nonconv	135.75%	Nonconv	Nonconv	Nonconv	Operating Procedure 7690

Base Scenario Results – continued



Sensitivity Study Assessment

- Facility overloads identified in sensitivity scenarios only

Overloaded Facility	Category	2024 SP High CEC Load	2024 SOP Heavy Ren. Output & Min Gas Gen. Commitment	2021 SP Heavy Ren. Output & Min Gas Gen. Commitment
Victor 230/115kV Transformer #3	P5	√		
The remaining Victor 230/115kV Transformer	P6	√		

Summary of Potential New Upgrades

Concern	Potential Upgrade
- Voltage overloads at Inyokern substation under P6 conditions	- Install capacitor bank at Inyokern

SCE East of Lugo Area
Preliminary Reliability Assessment Results

Emily Hughes
Regional Transmission Engineer

2019-2020 Transmission Planning Process Stakeholder Meeting
September 25-26, 2019

East of Lugo (EOL) Area

- Comprised of 115, 230 & 500 kV transmission facilities.
- Includes Eldorado, Mohave, Merchant, Ivanpah, CIMA, Pisgah Mountain Pass, Dunn Siding and Baker substations
- Total installed generation capacity is about 1800 MW. And over 70% of the total capacity is solar generation.
- The load is mostly served from CIMA 66kV substation.

SCE EOL Area Study Scenarios

- Base scenarios

No.	Case	Description
B1	2021 Summer Peak	SCE Summer peak load time (9/7 HE 17 PPT)
B2	2024 Summer Peak	SCE Summer peak load time (9/3 HE 17 PPT)
B3	2028 Summer Peak	SCE Summer peak load time (9/4 HE 20 PPT)
B4	2021 Spring Light Load	Spring minimum net load time (4/4 HE 13 PPT)
B5	2024 Spring Off-Peak	Spring shoulder load time (5/3 HE 21 PPT)

- Sensitivity scenarios

No	Case	Change From Base Assumption
S1	2024 Summer Peak	High CEC forecasted load
S2	2024 Spring Off-Peak	Heavy renewable output and minimum gas generation commitment
S3	2021 Summer Peak	Heavy renewable output and minimum gas generation commitment

Load and Load Modifier Assumptions – EOL

S. No.	Base Case	Gross Load (MW)	AAEE (MW)	BTM-PV		Net Load (MW)	Demand Response	
				Installed (MW)	Output (MW)		Fast (MW)	Slow (MW)
B1	2021-Summer Peak	3.44	0	0	0	3.44	0	0
B2	2024-Summer Peak	3.59	0	0	0	3.59	0	0
B3	2029-Summer Peak	3.20	0	0	0	3.20	0	0
B4	2021-Spring Light Load	1.47	0	0	0	1.47	0	0
B5	2024-Spring Off-Peak	2.29	0	0	0	2.29	0	0
S1	2024-SP High CEC Load	3.80	0	0	0	3.80	0	0
S2	2024-SOP Heavy Renewable Output & Min. Gas Gen.	2.29	0	0	0	2.29	0	0
S3	2021-SP Heavy Renewable Output & Min. Gas Gen.	3.44	0	0	0	3.44	0	0

Note: DR and storage are modeled offline in starting base cases.

Generation Assumptions – EOL

S. No.	Base Case	Battery Storage (MW)	Solar		Wind		Hydro		Thermal	
			Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)
B1	2021-Summer Peak	0	1254	702	0	0	0	0	525	419
B2	2024-Summer Peak	0	1254	652	0	0	0	0	525	419
B3	2029-Summer Peak	0	1254	0	0	0	0	0	525	418
B4	2021-Spring Light Load	0	1254	1241	0	0	0	0	525	0
B5	2024-Spring Off-Peak	0	1254	0	0	0	0	0	525	419
S1	2024-SP High CEC Load	0	1254	652	0	0	0	0	525	419
S2	2024-SOP Heavy Renewable Output & Min. Gas Gen.	0	1254	1241	0	0	0	0	525	0
S3	2021-SP Heavy Renewable Output & Min. Gas Gen.	0	1254	1241	0	0	0	0	525	0

Note: DR and storage are modeled offline in starting base cases.

Previously approved transmission projects modelled in base cases

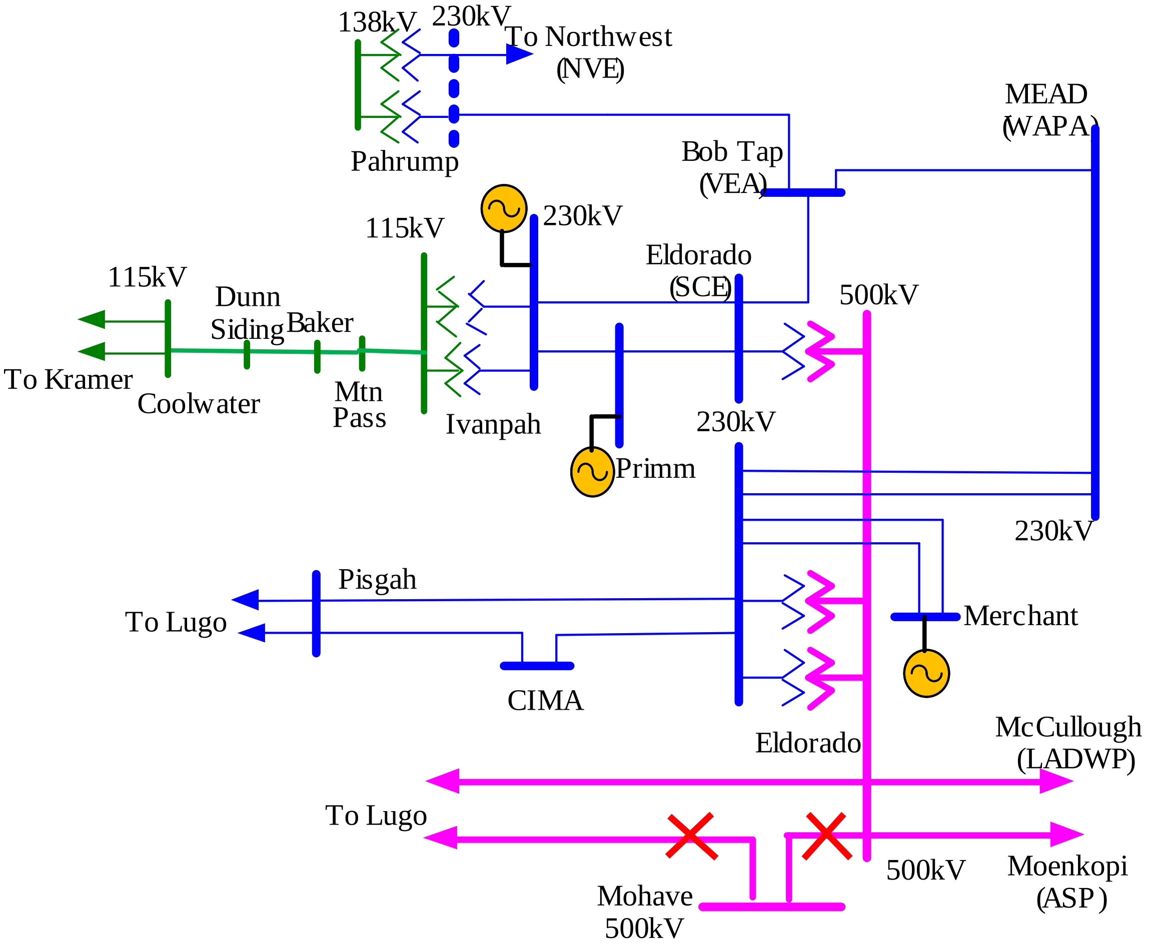
Project Name	ISD	First Year Modeled
Eldorado-Lugo Series Capacitor Upgrade	June 2021	2021
Lugo-Mohave Series Capacitor Upgrade	June 2021	2021
Calcite 230kV Substation	June 2021	2021
Lugo-Victorville 500kV Line Upgrade	June 2021	2021

Reliability assessment preliminary results summary

Base Scenario Results

Overloaded Facility	Worst Contingency	Category	Loading %					Potential Mitigation Solutions
			2021 Summer Peak	2024 Summer Peak	2029 Summer Peak	2021 Spring Off-Peak	2024 Spring Off-Peak	
System Diverge	Eldorado-Mohave & Lugo-Mohave 500kV	P6	Nconv	Nconv	Nconv	Nconv	Nconv	NVEnergy operating procedure

Base Scenario Results – continued



Summary of Potential New Upgrades

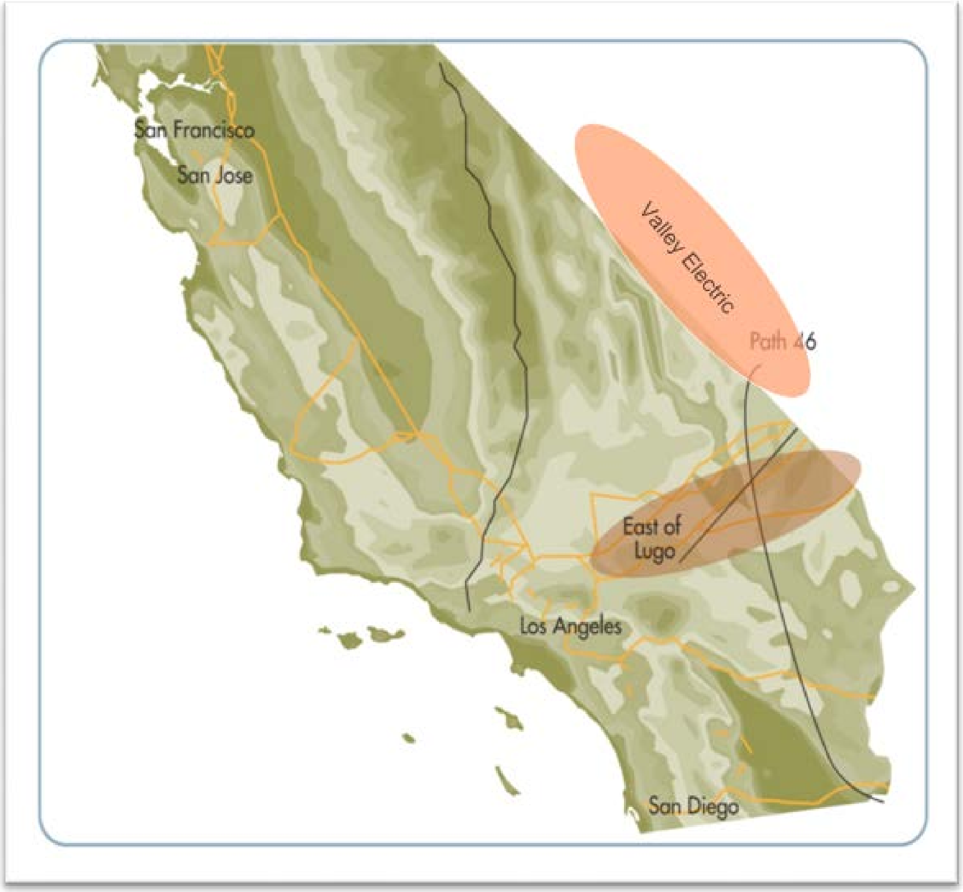
- No new upgrades

Valley Electric Association
Preliminary Reliability Assessment Results

Meng Zhang & Sushant Barave

2019-2020 Transmission Planning Process Stakeholder Meeting
September 25-26, 2019

Valley Electric Association (VEA) Area



- VEA system is comprised of 138 and 230 KV transmission facilities under ISO control
- Gridliance West (GLW) is the Transmission Owner for the 230 kV facilities in the VEA area
- Connects to WAPA's Mead 230kV substation, WAPA's Amargosa 138kV substation, NV Energy's Northwest 230kV substation and shares buses at Jackass 138kV and Mercury 138kV stations
- Approximately 115 MW of renewable generation is modeled in 2024.
- Forecasted 1-in-10 summer peak loads for 2021, 2024 and 2029 are 176 MW, 185 MW and 199 MW respectively.

VEA Study Scenarios

- Base scenarios

No.	Case	Description
B1	2021 Summer Peak	Summer peak load time (9/3 HE 16 PST)
B2	2024 Summer Peak	Summer peak load time (9/7 HE 16 PST)
B3	2029 Summer Peak	Summer peak load time (9/4 HE 19 PST)
B4	2021 Spring Off-Peak	Spring minimum net load time (4/4 HE 12 PST)
B5	2024 Spring Off-Peak	Spring shoulder load time (5/3 HE 20 PST)

- Sensitivity scenarios

No	Case	Change From Base Assumption
S1	2021 Summer Peak with high forecasted load	Load increase to reflect future load service requests
S2	2024 Summer Peak with high forecasted load	Load increase to reflect future load service requests
S3	2024 Off-peak with heavy renewable output	Model portfolio projects expected to be in-service by 2024

Demand Side Assumptions

Scenario No.	Case	Gross Load (MW)	AAEE (MW)	BTM-PV		Net Load (MW)	Demand Response	
				Installed (MW)	Output (MW)		Fast (MW)	Slow (MW)
B1	2021 Summer Peak	176	0	0	0	176	0	0
B2	2024 Summer Peak	185	0	0	0	185	0	0
B3	2029 Summer Peak	199	0	0	0	199	0	0
B4	2021 Spring light load	59	0	0	0	59	0	0
B5	2024 Spring Off-Peak	128	0	0	0	128	0	0
S1	2021 Summer Peak with high forecasted load	181	0	0	0	181	0	0
S2	2024 Summer Peak with high forecasted load	207	0	0	0	207	0	0
S3	2024 Off-peak with heavy renewable output	128	0	0	0	128	0	0

Supply Side Assumptions

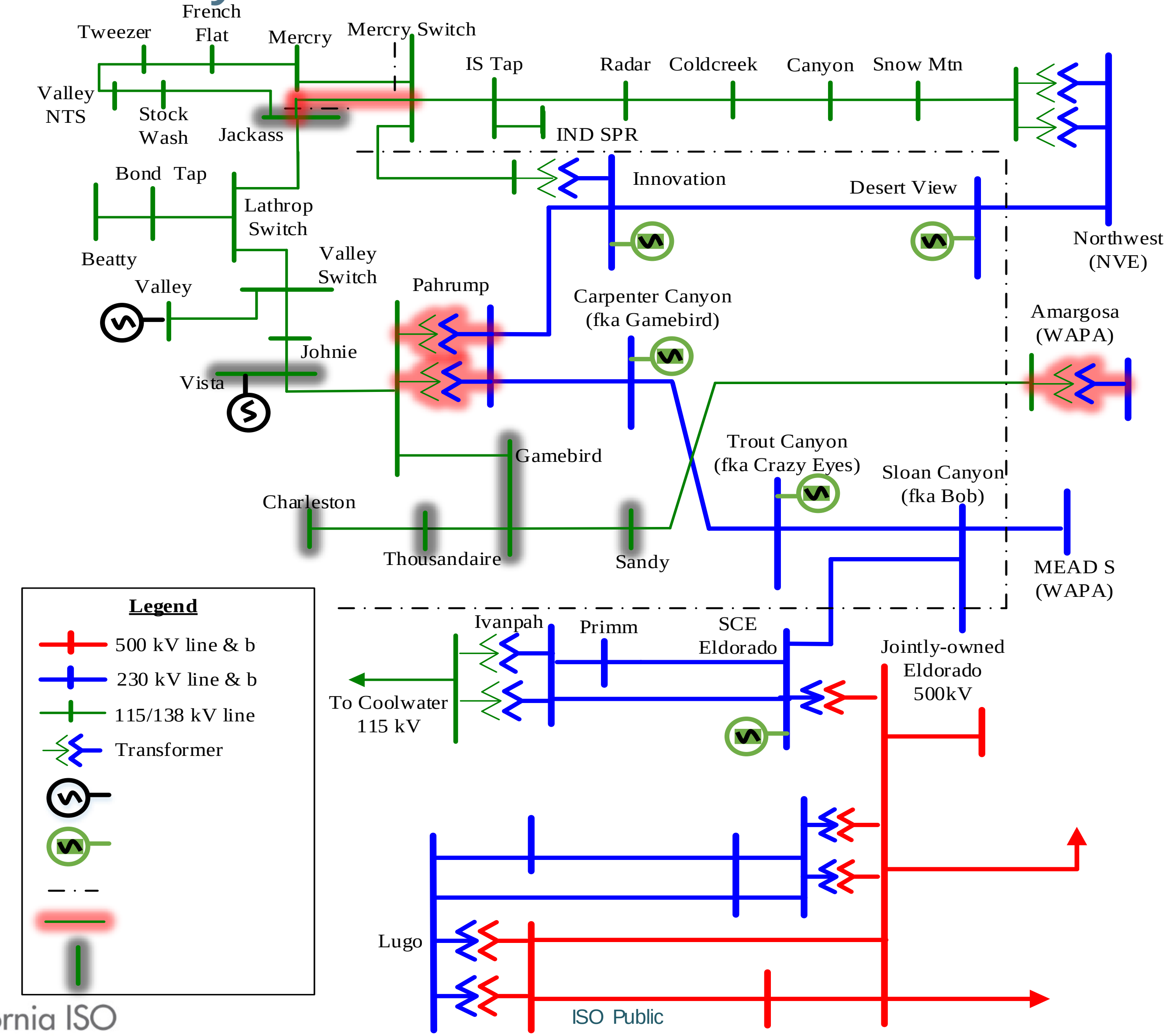
Scenario No.	Case	Installed Storage (MW)	Solar		Wind		Hydro		Thermal	
			Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)
B1	2021 Summer Peak	0	118.4	61.4	0	0	0	0	0	0
B2	2024 Summer Peak	0	118	66	0	0	0	0	0	0
B3	2029 Summer Peak	0	820	702	0	0	0	0	0	0
B4	2021 Spring light load	0	118	117	0	0	0	0	0	0
B5	2024 Spring Off-Peak	0	118	0	0	0	0	0	0	0
S1	2021 Summer Peak with high forecasted load	0	118	61	0	0	0	0	0	0
S2	2024 Summer Peak with high forecasted load	0	118	66	0	0	0	0	0	0
S3	2024 Off-Peak with heavy renewable output	0	820	811	0	0	0	0	0	0

Previously Approved Transmission Projects

No.	Transmission Projects	First Year Modeled	Description
1	Sloan Canyon 230kV Switching Station	2021	Build a new Sloan Canyon 230kV Switching Station and loop into existing Pahrump-Mead 230kV Line
2	Eldorado - Sloan Canyon 230kV Line	2021	New 230kV line between SCE's Eldorado 220kV substation and VEA's 230kV Bob switching station
3	Sloan Canyon - Mead 230kV Line Reconductoring	2021	Reconductor Sloan Canyon – Mead 230kV line for a higher rating.

Reliability Assessment Preliminary Results Summary

VEA-GLW system



Thermal Loading Results

Overloaded Facility	Contingency (All and Worst P6)	Category	Loading % (Baseline Scenarios)					Project & Potential Mitigation Solutions
			2021 Summer Peak	2024 Summer Peak	2029 Summer Peak	2021 Spring Off-Peak	2024 Spring Off-Peak	
Amargosa 230/138kV Transformer	Gamebird-Pahrump 138kV Line	P1	111	110	119	<100	<100	Option 1: New Gamebird Transformer Project Option 2: New Charleston-Vista 138kV Line Option 3: Amargosa transformer upgrade
	Pahrump-Gamebird & Pahrump-Vista 138kV lines; BKR PA222	P4	111	110	119	<100	<100	Option 1: New Gamebird Transformer Project Option 2: New Charleston-Vista 138kV Line Option 3: Amargosa transformer upgrade
	PAHRUMP 138/230kV Tran Bnk. 1 & PAHRUMP-GAMEBIRD 138; BKR PA232	P4	111	110	119	<100	<100	
	Northwest-Desert View & Pahrump-Sloan Canyon/Sloan Canyon-Trout Canyon 230kV lines	P6	108	109	172	<100	106	New Gamebird Transformer Project. Existing UVLS Option 3: Amargosa transformer upgrade
	Pahrump-Gamebird 138kV and Sloan Canyon-Mead 230kV lines	P7	111	110	119	<100	<100	Option 1: New Gamebird Transformer Project Option 2: New Charleston-Vista 138kV Line Option 3: Amargosa transformer upgrade
Pahrump 230/138kV Transformer No.1	Pahrump 230/138kV Transformer No.2	P1	<100	<100	102	<100	<100	New Gamebird Transformer Project
	Pahrump230/138kV Transformer No.2 & Vista-Johnnie-Valley TP 138kV lines	P6	<100	106	121	<100	<100	New Gamebird Transformer Project
Pahrump 230/138kV Transformer No.2	Pahrump 230/138kV Transformer No.1	P1	<100	<100	101	<100	<100	New Gamebird Transformer Project
	Pahrump230/138kV Transformer No.1 & Vista-Johnnie-Valley TP 138kV lines	P6	<100	106	120	<100	<100	New Gamebird Transformer Project

Thermal Loading Results (continued)

Overloaded Facility	Contingency (All and Worst P6)	Category	Loading % (Baseline Scenarios)					Project & Potential Mitigation Solutions
			2021 Summer Peak	2024 Summer Peak	2029 Summer Peak	2021 Spring Off-Peak	2024 Spring Off-Peak	
Jackass-Mercury SW 138kV Line	Pahrump-Vista 138kV line	P1	<100	<100	101	168	<100	Congestion management, RAS to curtail generation and line upgrade through GIDAP
	Vista-Johnnie-Valley TP 138kV line	P1	<100	<100	<100	156	<100	
	Stockade Wash-Jackass 138kV line	P1	<100	<100	<100	105	<100	
	Pahrump - Vista 138 & Pahrump – Gamebird 138; BKR PA222	P4	<100	<100	101	169	<100	Congestion management, RAS to curtail generation and line upgrade through GIDAP
	Pahrump 138/230kV Tran Bnk. 2 & Pahrump - Vista 138-kV Line; BKR PA212	P4	<100	<100	101	168	<100	
	Pahrump-Vista 138kV & Pahrump-Innovation 230kV lines	P7	<100	<100	101	168	<100	
	Vista-Johnnie-Valley TP 138kV & Pahrump-Innovation 230kV lines	P7	<100	<100	<100	156	<100	

Low/High Voltage Results

Substation	Contingency (All and Worst P6)	Category	Voltage PU (Baseline Scenarios)					Project & Potential Mitigation Solutions
			2021 Summer Peak	2024 Summer Peak	2029 Summer Peak	2021 Spring Off-Peak	2024 Spring Off-Peak	
Charleston-Thousandaire-Gamebird-Sandy 138kV buses	Pahrump-Gamebird 138kV line	P1	0.86	0.82	0.80	>0.9	0.89	Option 1: New Gamebird Transformer Project Option 2: New Charleston-Vista 138kV Line Option 3: Amargosa transformer upgrade and reactive support
Charleston-Thousandaire-Gamebird, Vista-Jackass138kV buses	Northwest-Desert View & Pahrump-Sloan Canyon/Sloan Canyon-Trout Canyon 230kV lines	P6	>0.9	0.90	0.67	>0.9	0.85	New Gamebird Transformer Project Existing UVLS. 2024OP High Renewable: Innovation RAS and Sloan Canyon RAS Option 3: Amargosa transformer upgrade and reactive support

Sensitivity Assessment Results

- Below is the list of facility overloads identified only in the sensitivity scenarios

Overloaded Facility	Contingency (All and Worst P6)	Category	Loading % (Sensitivity Scenarios) 2021 SP with Forecasted Load Addition	Loading % (Sensitivity Scenarios) 2024 SP with Forecasted Load Addition	Loading % (Sensitivity Scenarios) 2024 Summer OP Hi Renew & Min Gas Gen	Project & Potential Mitigation Solutions
Amargosa 230/138kV Transformer	Northwest-Desert View 230kV Line	P1	<100	<100	110	Sensitivity case only. Utilize Innovation RAS
	Trout Canyon-Sloan Canyon 230kV Line	P1	N/A	N/A	109	Sensitivity case only. Utilize Sloan Canyon RAS
Pahrump 230/138kV Transformer No.1	Pahrump 138/230kV Tran Bnk. 2 & Pahrump - Innovation 230; BKR PA122	P4	<100	<100	110	Sensitivity case only. Utilize Sloan Canyon RAS
Pahrump 230/138kV Transformer No.2	Pahrump 138/230kV Tran Bnk. 1 &Pahrump - Innovation 230; BKR PA132	P4	<100	<100	108	Sensitivity case only. Utilize Sloan Canyon RAS
Jackass-Mercury SW 138kV Line	Pahrump-Innovation 230kV line	P1	<100	<100	144	Sensitivity case only. Utilize Innovation RAS
	Sloan Canyon 230kV breaker	P4	<100	<100	130	Sensitivity case only. Utilize Sloan Canyon RAS
Pahrump-Carpenter Canyon 230kV Line	Trout Canyon-Sloan Canyon 230kV line	P1	N/A	N/A	137	Sensitivity case only. Utilize Sloan Canyon RAS
	Sloan Canyon 230kV breaker	P4	N/A	N/A	137	
	Trout Canyon-Sloan-Canyon 230kV & Valley TP-Lathrop SS 138kV lines	P6	N/A	N/A	139	
Trout Canyon-Sloan Canyon 230kV Line	Northwest-Desert View 230kV line	P1	N/A	N/A	120	Sensitivity case only. Utilize Innovation RAS
	Innovation-Desert View 230kV line	P1	N/A	N/A	108	
	Pahrump-Carpenter Canyon 230kV line	P1	N/A	N/A	137	Sensitivity case only. Utilize Sloan Canyon RAS
	Pahrump-Innovation 230 & Innovation – Desert View 230 & Innovation Transformer	P4	N/A	N/A	137	Sensitivity case only. Utilize Innovation RAS
	Pahrump 138/230kV Tran Bnk. 1 &Pahrump - Innovation 230; BKR PA132	P4	N/A	N/A	105	
	Pahrump 138/230kV Tran Bnk. 2 & Pahrump - Innovation 230; BKR PA122	P4	N/A	N/A	104	
	Pahrump-Carpenter Canyon 230kV & Gamebird-Sandy 138kV lines	P7	N/A	N/A	137	Sensitivity case only. Utilize Sloan Canyon RAS
Amargosa-Sandy-Gamebird 138kV Line	Carpenter Canyon-Trout Canyon & Northwest-Desert View 230kV lines	P6	N/A	N/A	102	Sensitivity case only. Utilize Innovation RAS and Sloan Canyon RAS
Innovation 230/138kV Transformer	Carpenter Canyon-Trout Canyon & Northwest-Desert View 230kV lines	P6	N/A	N/A	128	
Innovation-Desert View 230kV Line	Pahrump-Gamebird 138kV & Carpenter Canyon-Trout Canyon 230kV lines	P6	N/A	N/A	120	Sensitivity case only. Utilize Sloan Canyon RAS

Summary of Potential New Upgrades

Concern	Potential Upgrade
Amargosa 230/138kV transformer thermal overloading	Option 1: New Gamebird Transformer Project Option 2: New Charleston-Vista 138kV Line Option 3: Amargosa transformer upgrade with reactive support
Pahrump 230/138kV transformer #1 and #2 thermal overloading	
Jackass Flats – Mercury Switch 138 kV	
Low voltage issues at several 138 kV buses	

SCE Eastern Area
Preliminary Reliability Assessment Results

Charles Cheung
Senior Regional Transmission Engineer

2019-2020 Transmission Planning Process Stakeholder Meeting
September 25-26, 2019

SCE Eastern Area

- Includes the SCE owned transmission system in the Riverside County around and east of the Devers Substation
- Comprised of 500, 230 and 161 kV transmission facilities.
- Summer Peak net load of 4,473 MW in 2021

SCE Eastern Area Study Scenarios

- Base scenarios

No.	Case	Description
B1	2021 Summer Peak	Summer peak load time (9/7 HE 16 PST)
B2	2024 Summer Peak	Summer peak load time (9/3 HE 16 PST)
B3	2029 Summer Peak	Summer peak load time (9/4 HE 19 PST)
B4	2021 Spring Light Load	Spring minimum net load time (4/4 HE 12 PST)
B5	2024 Spring Off-Peak	Spring shoulder load time (5/3 HE 20 PST)

- Sensitivity scenarios

No	Case	Change From Base Assumption
S1	2024 Summer Peak	High CEC forecasted load
S2	2024 Spring Off-Peak	Heavy renewable output and minimum gas generation commitment
S3	2021 Summer Peak	Heavy renewable output and minimum gas generation commitment

Demand Side Assumptions

Scenario No.	Base Case	Gross Load (MW)	AAEE (MW)	BTM-PV		Net Load (MW)	Demand Response	
				Installed (MW)	Output (MW)		Fast	Slow
B1	2021 Summer Peak	4,938	101	827	364	4,473	63	23
B2	2024 Summer Peak	5,196	228	1,087	478	4,489	63	23
B3	2029 Summer Peak	4,800	347	1,439	0	4,453	63	23
B4	2021 Spring Light Load	2,397	101	827	776	1,520	63	23
B5	2024 Spring Off-Peak	3,296	228	1,087	0	3,068	63	23
S1	2021 SP High CEC Load	5,489	228	1,087	478	4,782	63	23
S2	2024 SOP Heavy Renewable Output & Min. Gas Gen.	3,296	228	1,087	753	2,315	63	23
S3	2021 SP Heavy Renewable Output & Min. Gas Gen.	4,938	101	827	753	4,084	63	23
Note:	*DR and storage are modeled offline in starting base cases.*							

Supply Side Assumptions

S. No.	Base Case	Battery Storage (MW)	Solar		Wind		Hydro		Thermal	
			Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)
B1	2021 Summer Peak	0	1527	855	710	441	0	0	3,771	3,141
B2	2024 Summer Peak	0	1527	794	710	256	0	0	3,771	2,665
B3	2029 Summer Peak	0	1527	0	710	384	0	0	3,771	3,373
B4	2021 Spring Light Load	0	1527	1512	710	369	0	0	3,771	91
B5	2024 Spring Off-Peak	0	1527	0	710	327	0	0	3,771	3,373
S1	2024 SP High CEC Load	0	1527	794	710	256	0	0	3,771	3,343
S2	2024 SOP High RPS	0	1527	1512	710	476	0	0	3,771	834
S3	2021 SP High RPS	0	1527	1512	710	476	0	0	3,771	1,687

Note: DR and storage are modeled offline in starting base cases.

Previously approved transmission projects modelled in base cases

Project Name	ISD	First Year Modeled
Alberhill 500 kV Substation	March 2022	2024
West of Devers Upgrade	Dec. 2021	2024

Changes in topology compared with last year's base cases

Changes	Rating before change	Rating after change	Cases affected
Eagle Mountain 5A bank 230/161/12 kV replaced by 3A bank 230/161 kV due to 5A bank failure	230/230 MVA	71/74 MVA	B1 2021SP, B4 2021LL, S3 2021SP

Reliability assessment preliminary results summary

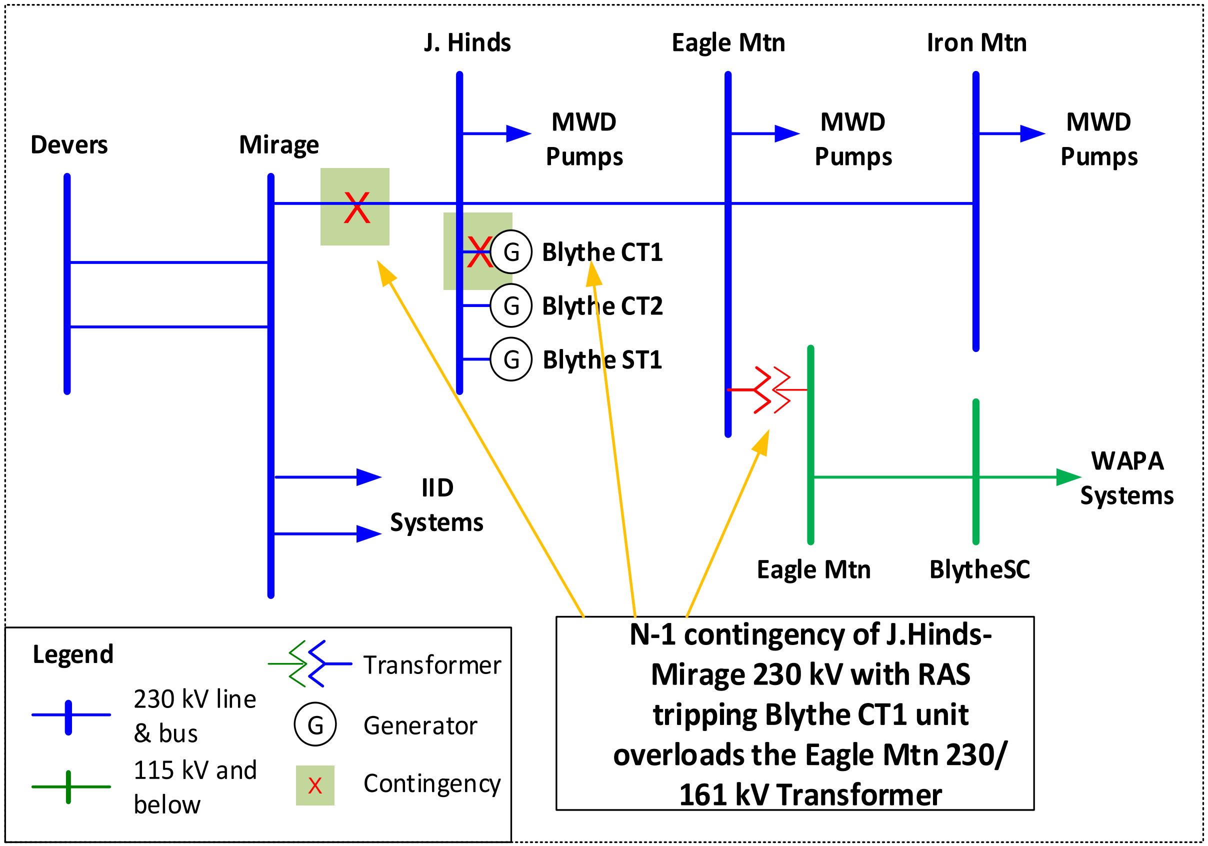
Thermal loading Results

Overloaded Facility	Contingencies	Category	Loading (%)			Potential Mitigation
			B1 2021 Summer Peak	B2 2024 Summer Peak	B3 2029 Summer Peak	
Eagle Mountain 230/161 kV Transformer	J.Hinds-Mirage 230 kV with 1 CT out	P1	**108**	<100	<100	1-hour rating, Generation Re-dispatch
	Eagle Mtn – Iron Mtn 230 kV AND J.Hinds-Mirage 230 kV with 1 CT out	P6	**239**	<100	<100	
Coachella Valley-Ramon 230 kV	Coachella Valley-Mirage 230 kV	P7	<100	<100	**110**	Modifying existing RAS to trip portfolio generation at IID
Ramon-Mirage 230 kV	Coachella Valley-Mirage 230 kV	P7	<100	<100	**127**	

Stability Results

Contingencies	Category	Transient Stability Performance					Potential Mitigation
		B1 2021 Summer Peak	B2 2024 Summer Peak	B3 2029 Summer Peak	B4 2021 Light Load	B5 2024 Off Peak	
3 Phase Fault at Mirage 230 kV, tripping Mirage-Ramon & Coachella Valley-Mirage 230 kV	P6	Unstable	Unstable	Unstable	Unstable	Unstable	Modifying existing RAS to trip generation at IID, further investigation
SLG Fault at Mirage 230 kV, tripping Mirage-Ramon & Coachella Valley-Mirage 230 kV	P7	Stable	Stable	Unstable	Unstable	Stable	

Eagle Mtn P1 Contingency Thermal Overload



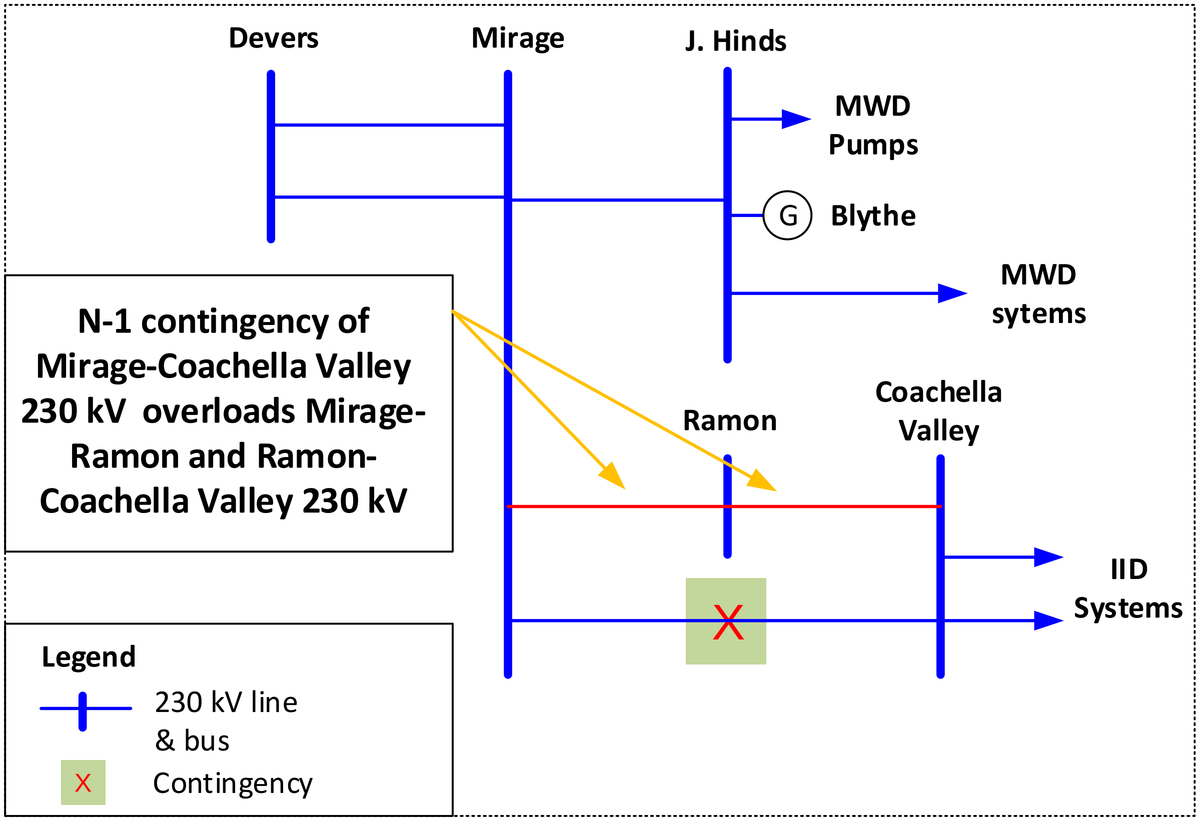
Thermal Overload:

- In the B1 2021 Peak case, N-1 thermal overload on Eagle Mtn 230/161 kV transformer after losing J.Hinds-Mirage 230 kV line

Mitigation:

- 1-hour rating of 105 MVA, Generation Re-dispatch

Path 42 P1 Contingency Thermal Overload



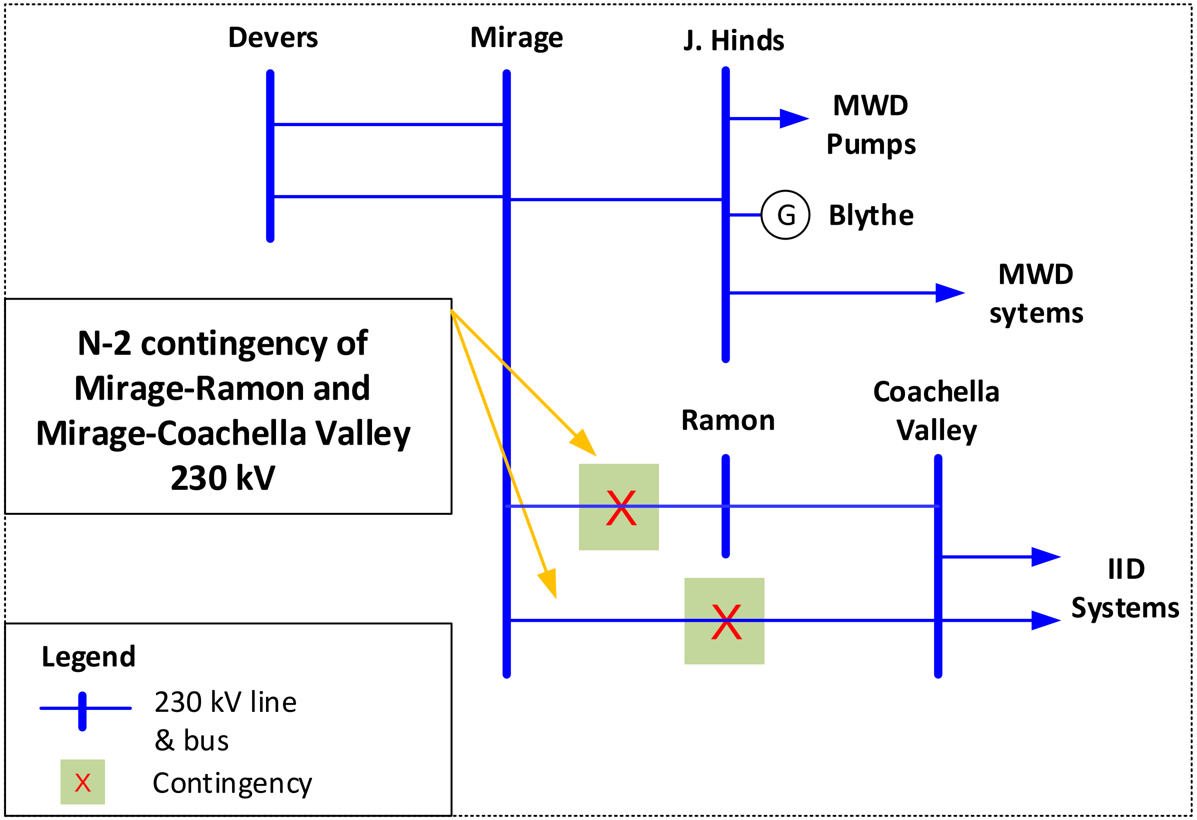
Thermal Overload:

- In the B3 2029 Peak case, N-1 thermal overload on Mirage-Ramon and Ramon-Coachella Valley 230 kV lines after losing Mirage-Coachella Valley 230 kV lines

Mitigation:

- Modify existing IID RAS to trip portfolio generation

Path 42 P6/7 Contingency Stability



Stability Issue:

- In all cases, unstable results under N-2 contingency of Mirage-Ramon and Mirage-Coachella Valley 230 kV lines

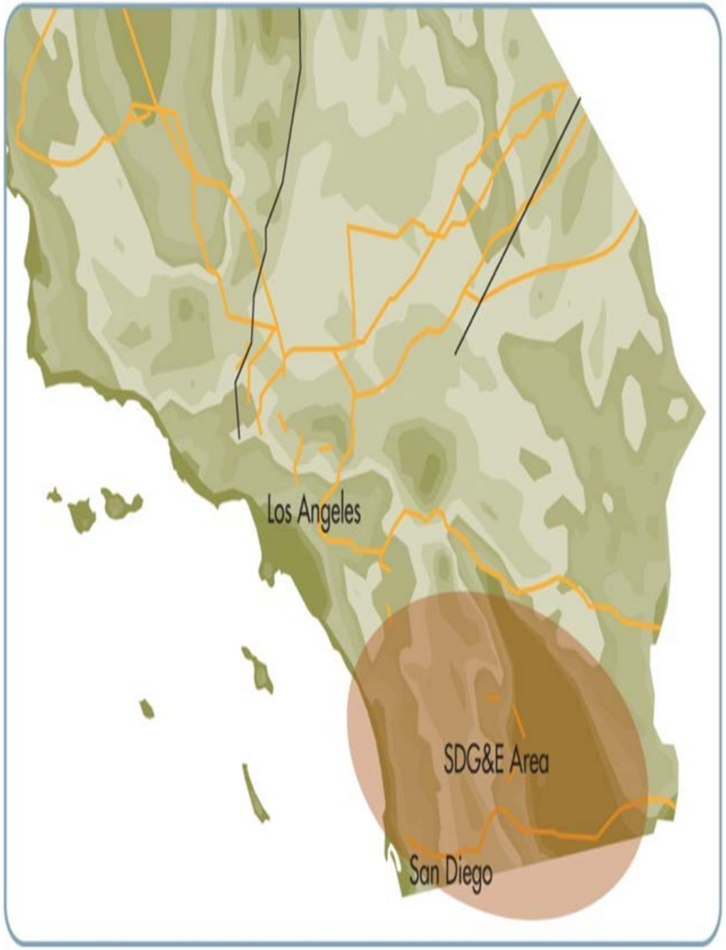
Mitigation:

- Modify existing IID RAS to trip portfolio generation
- Further investigation on composite load models

SDG&E Main System
Preliminary Reliability Assessment Results

Charles Cheung
Senior Regional Transmission Engineer
2019-2020 Transmission Planning Process Stakeholder Meeting
September 25-26, 2019

SDG&E Main Transmission System



- Covers San Diego, Imperial, and Southern Orange counties
- Comprised of 500 kV and 230 kV transmission facilities, along with its sub-transmission system 138/69 kV
- Net peak load of 4,550 MW with AAEE load reduction by 2021
- Generation of 6,183 MW installed capacity by 2021, of which 2,425 MW of renewable resources and 166 MW of battery storage are operational
- BTM-PV of 2,270 MW installed capacity, 322 MW of AAEE, and 40 MW of Demand Response, by 2029

Baseline Study Scenarios

No.	Case	Description
B1	2021 Summer Peak	Summer peak load time (9/1 HE 19 PST)
B2	2024 Summer Peak	Summer peak load time (9/4 HE 19 PST)
B3	2029 Summer Peak	Summer peak load time (9/5 HE 19 PST)
B4	2021 Spring Light Load	Spring minimum net load time (4/10 HE 13 PST)
B5	2024 Spring Off-Peak	Spring shoulder load time (5/3 HE 20 PST)

Sensitivity Study Scenarios

No	Case	Change From Base Assumption
S1	2024 Summer Peak	High CEC forecasted load
S2	2024 Spring Off-Peak	Heavy renewable output and minimum gas generation commitment
S3	2021 Summer Peak	Heavy renewable output and minimum gas generation commitment

Load and Load Reduction Assumptions

Scenario No.	Base Case	Gross Load (MW)	AAEE (MW)	BTM-PV		Net Load (MW)	Demand Response	
				Installed (MW)	Output (MW)		Fast	Slow
B1	2021 Summer Peak	4619	69	1520	0	4550	16	24
B2	2024 Summer Peak	4850	159	1748	0	4691	16	24
B3	2029 Summer Peak	5102	322	2270	0	4779	16	24
B4	2021 Spring Light Load	2390	19	1520	1201	1171	16	24
B5	2024 Spring Off-Peak	3379	110	1748	0	3270	16	24
S1	2021 SP High CEC Load	5266	159	1748	0	5107	16	24
S2	2024 SOP Heavy Renewable Output & Min. Gas Gen.	5051	110	1748	1678	3264	16	24
S3	2021 SP Heavy Renewable Output & Min. Gas Gen.	6045	69	1520	1459	4516	16	24
Note:	*DR and storage are modeled offline in starting base cases.*							

Generation Resources with 50% RPS

Base Case	Solar		Wind		Battery Storage		Geothermal		Thermal	
	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)
2021 Summer Peak	1499	0	926	0	166	0	0	0	3560	3484
2024 Summer Peak	1499	0	926	667	166	0	0	0	3560	2088
2029 Summer Peak	1499	0	926	204	166	0	32	32	3524	2190
2021 Spring Light Load	1499	1184	926	723	166	-166	0	0	3560	2
2024 Spring Off-Peak	1499	0	926	741	166	-166	0	0	3560	375
2024 SP High CEC Load	1499	0	926	667	166	0	0	0	3560	2099
2024 SOP High RPS	1499	1439	926	741	166	-166	0	0	3560	70
2021 SP High RPS	1499	1439	926	723	166	0	0	0	3560	957

Previously Approved Projects Modelled

Project Name	ISD	First Year Modeled
Imperial Valley Bank 80 Replacement	May 2019	2021
Southern Orange County Reliability Upgrade	Mar 2023	2024
2nd Miguel to Bay Boulevard 230 kV Circuit	Jul 2019	2021
Artesian 230 kV Expansion with 69 kV upgrades	Nov 2020	2021
2nd San Marcos-Escondido 69 kV circuit	Feb 2021	2021
2nd Pomerado-Poway 69 kV circuit	Mar 2021	2021
IID S-Line Upgrade	Dec 2021	2024

Reliability Assessment Results Summary

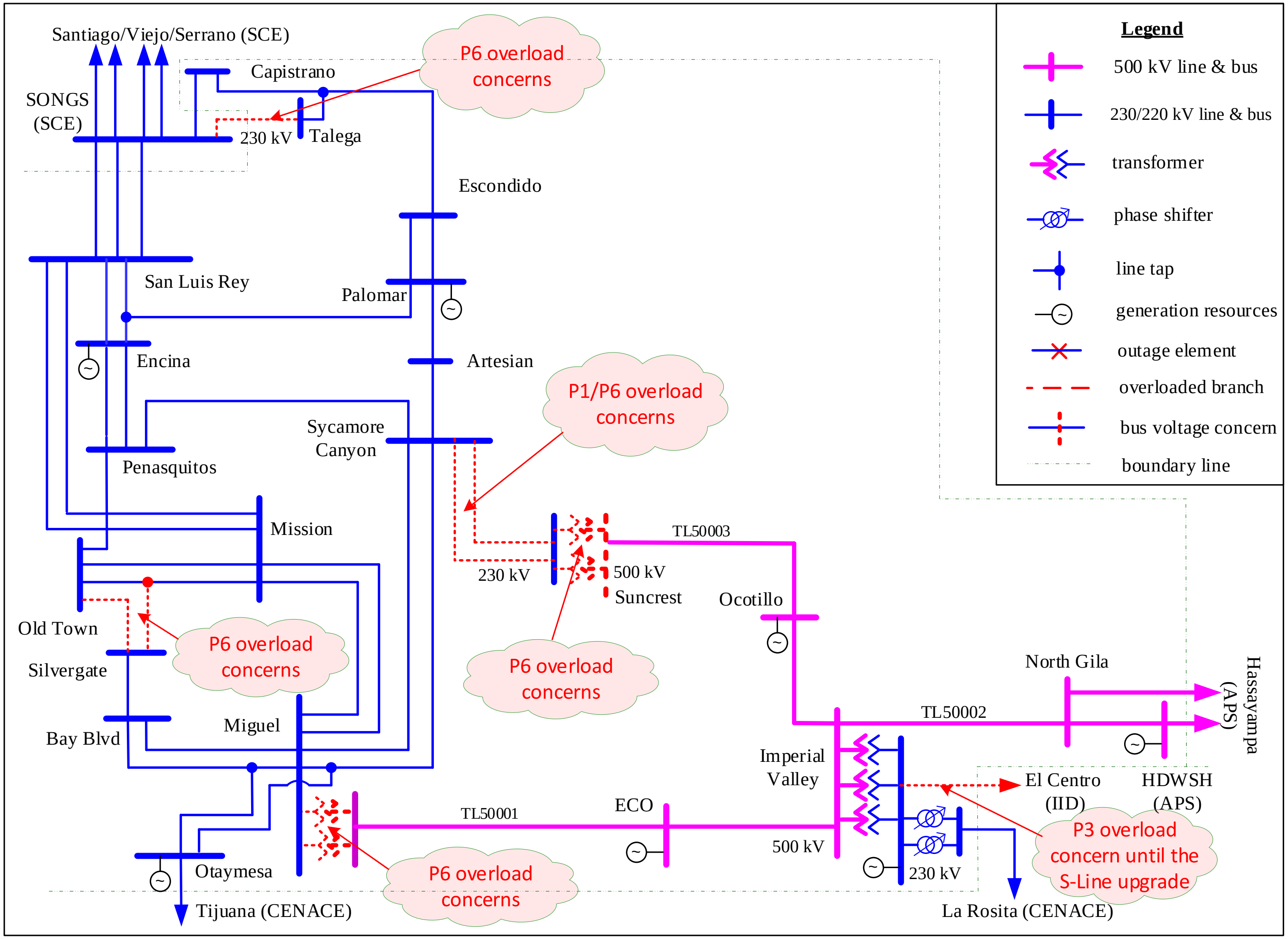
The assessment preliminarily identified:

- 2 transformer 500/230 kV overloaded for P6 outages
- 4 branches 230 kV overloaded for P1/P3/P4/P6 outages

Reliability Assessment Results Summary

Reliability Concern		Type of Concern	Baseline Scenario					Sensitivity Scenario		
ID	Element		B1-21SP	B2-24SP	B3-29SP	B4-21LL	B5-24OP	S1-24SP HLOAD	S2-24OP HRPS	S3-21SP HRPS
1	Talega-San Onofre 230 kV Line	Thermal		P6	P6			P6		
2	Silvergate-Old Town 230 kV Line	Thermal		P6				P6	P6	P6
3	Miguel BK80 and BK81	Thermal		P6	P6		P6	P6	P6	P6
4	Suncrest BK80 and BK81	Thermal	P6	P6	P6		P6	P6	P6	P6
5	Suncrest-Sycamore 230 kV Line	Thermal	P6	P6	P6		P6	P6	P6	P6
6	IID-S-Line 230 kV	Thermal	P1/P3/P4							

Reliability Assessment Results Summary

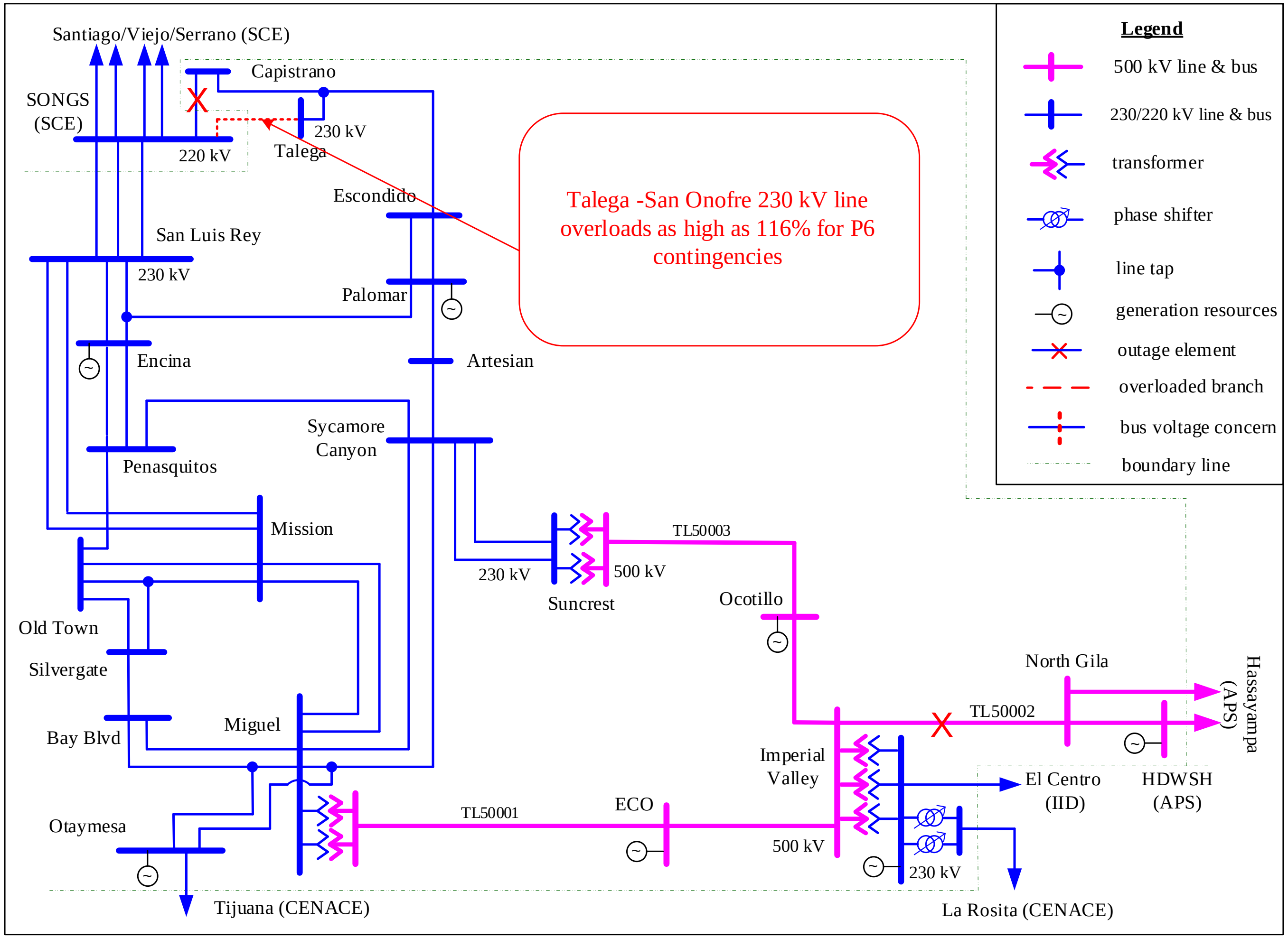


Mitigation Solutions Summary

- Rely on applicable short-term emergency rating that allow operational action after 2nd contingency to mitigate thermal overload concerns on:
  - No.1 Talega-San Onofre 230 kV Line
  - No.2 Silvergate-Old Town 230 kV path
  - No.3 Miguel BK80 and BK81
  - No.4 Suncrest BK80 and BK81
  - No.5 Suncrest-Sycamore 230 kV path
- Interim OP on the S-Line overload (No.6) until the S-Line upgrade

Detailed Discussions on the Identified Reliability Concerns and Mitigation Solutions

No.1 - Talega-San Onofre 230 kV Line



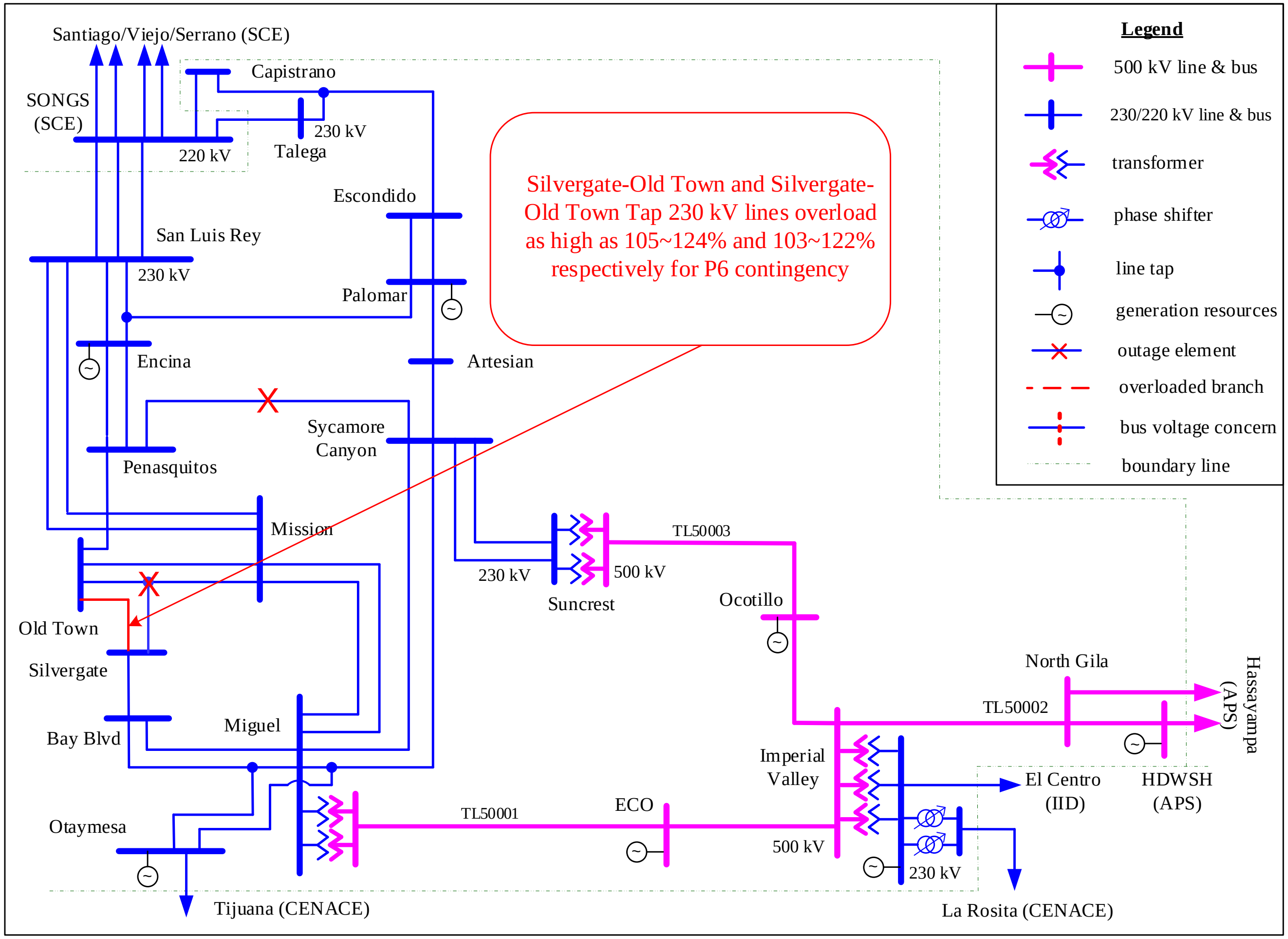
Reliability Concern

- Thermal overloads for P6 contingencies

Existing Mitigation

- OP to reduce reactive power output of the synchronous condensers at Talega and re-dispatch generation within 30 minutes after the 2nd contingency

No.2 - Silvergate-Old Town 230 kV path



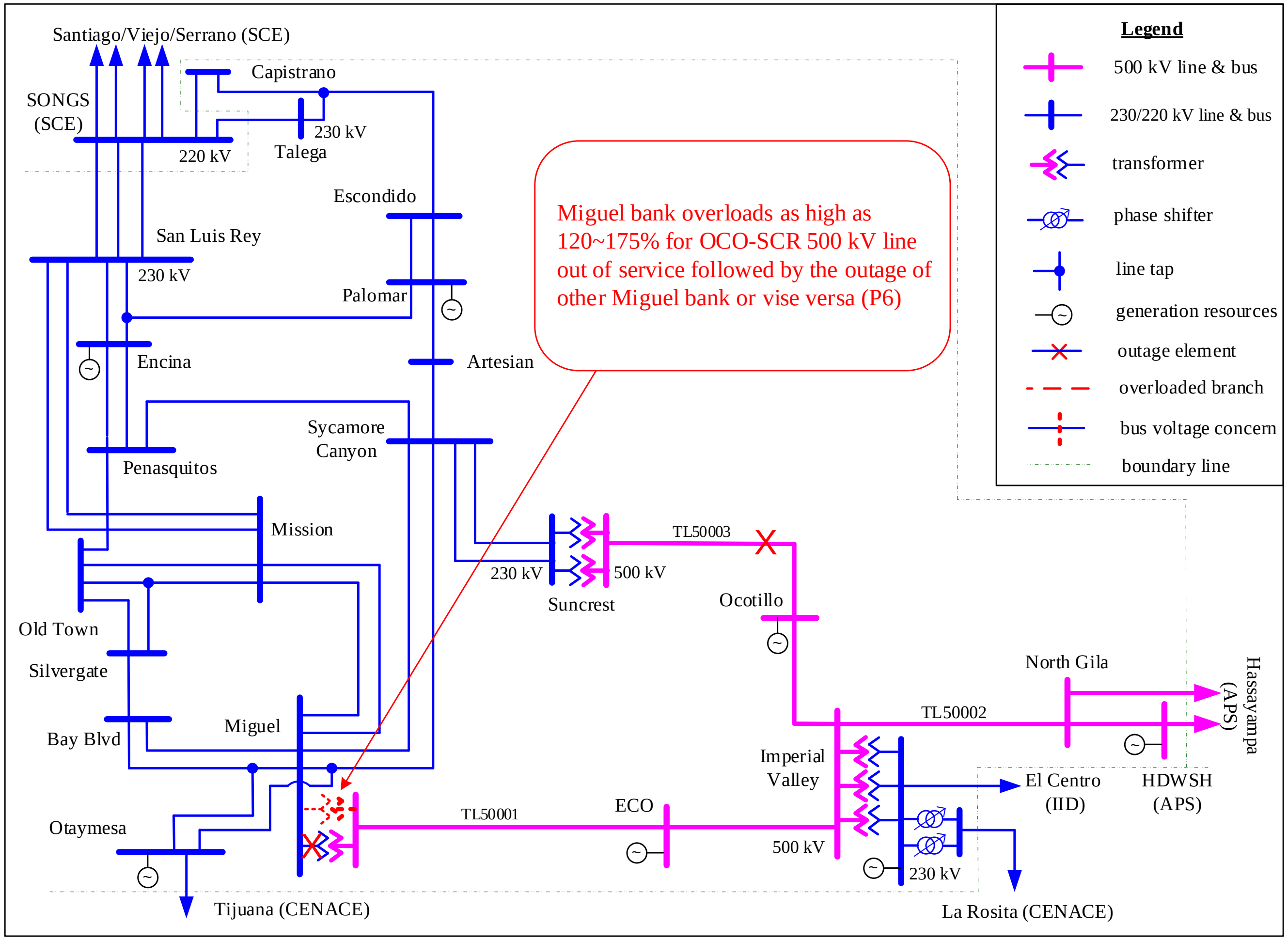
Reliability Concern

- Thermal overloads for P6 contingencies

Existing Mitigation

- OP to re-dispatch generation in the Otay Mesa and Pio Pico area after the 1st contingency
- Curtail CENACE import in the off-peak case

No.3 - Miguel BK80 and BK81



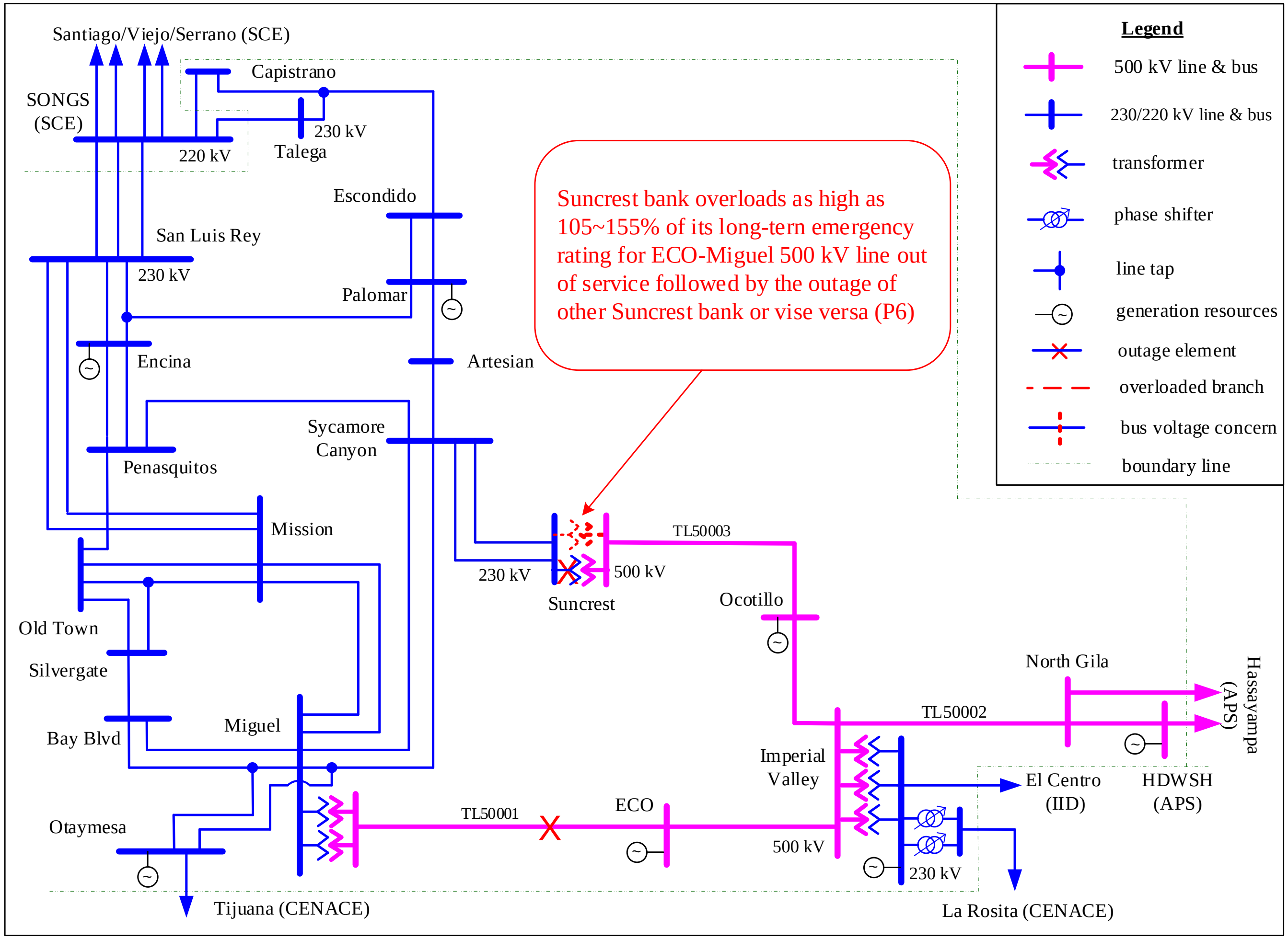
Reliability Concern

- Thermal overloads for P6 contingency

Existing Mitigation

- Market congestion management and operation procedure can be relied upon to redispatch generation resources including preferred resources and energy storage, curtail import, and adjust the IV phase shifters, along with existing Miguel BK 80 / BK 81 RAS.

No.4 - Suncrest BK80 and BK81



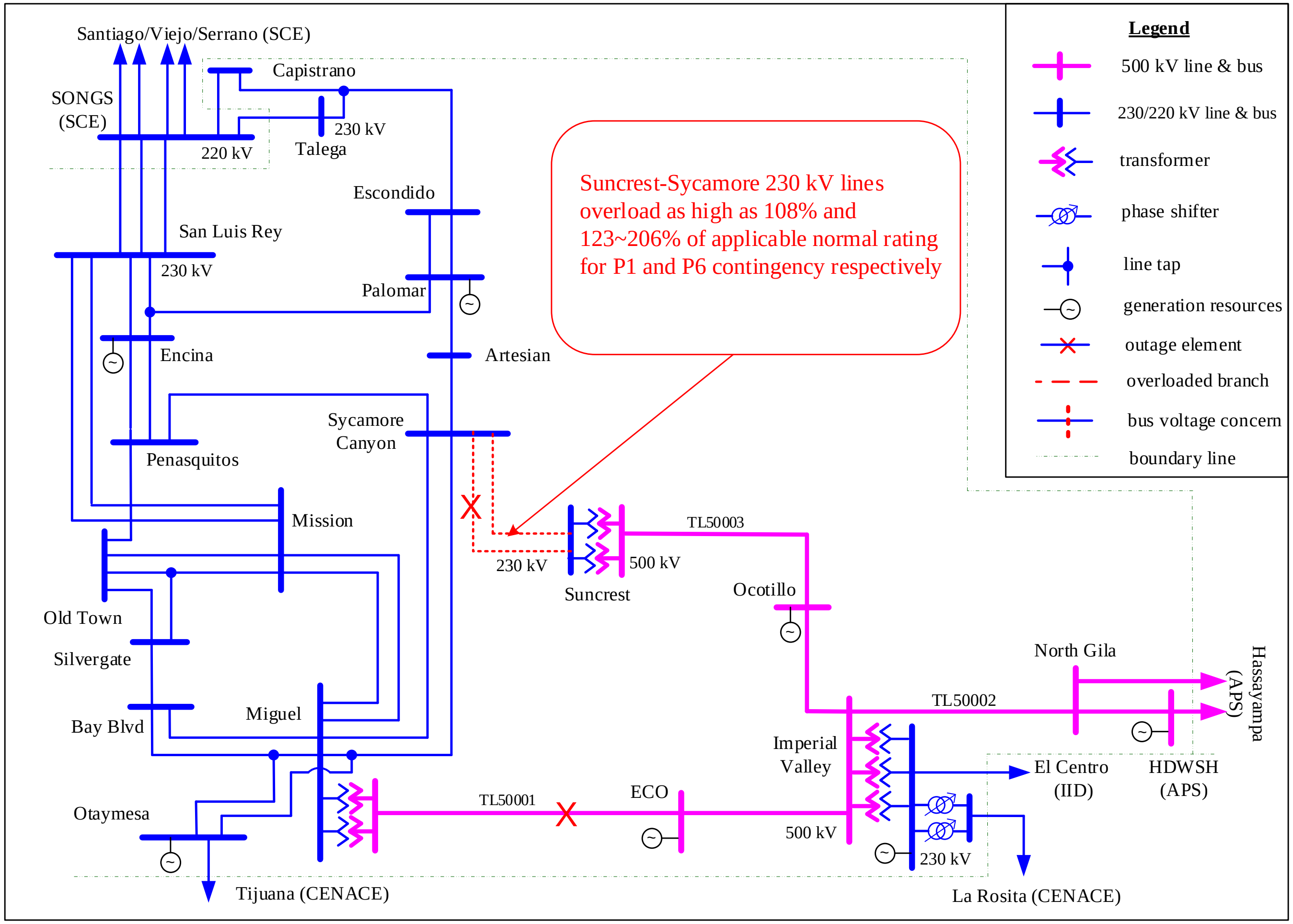
Reliability Concern

- Thermal overloads for P6 contingencies

Existing Mitigation

- Market congestion management and operation procedure can be relied upon to redispatch generation resources including preferred resources and energy storage, curtail import, and adjust the IV phase shifters

No.5 - Suncrest-Sycamore 230 kV path



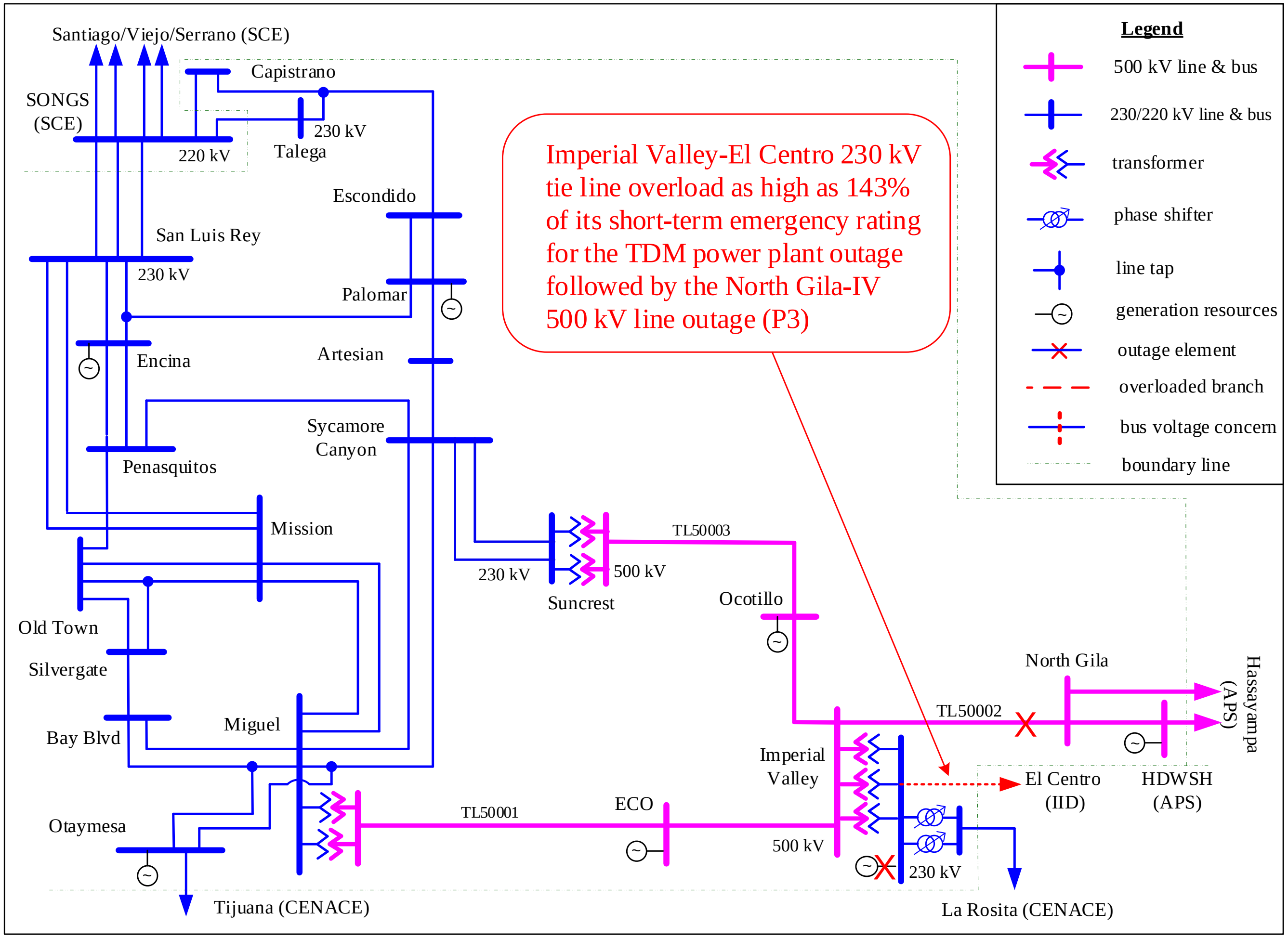
Reliability Concern

- Thermal overloads for P6 contingencies

Existing Mitigation

- Market congestion management, operation procedure, and the 30-minute short term emergency ratings of the lines can be relied upon to redispatch generation resources including preferred resources and energy storage, curtail import, adjust the IV phase shifters, along with existing TL23054/TL23055 RAS

No.6 - IID S-Line 230 kV tie line



Reliability Concern

- Thermal overload for P3 contingency

Mitigation

- Will be mitigated by the approved S-line upgrade project with estimated in-service date of December 2021. Existing ISO operation procedure can be used to eliminate the overload concern as an interim solution

San Diego Gas & Electric Area Sub-Transmission Preliminary Reliability Assessment Results

Charles Cheung
Senior Regional Transmission Engineer

2019-2020 Transmission Planning Process Stakeholder Meeting
September 25-26, 2019

SDGE Area Sub-Transmission Study Scenarios

- Base scenarios

No.	Case	Description
B1	2021 Summer Peak	Summer peak load time (9/1 HE 19 PST)
B2	2024 Summer Peak	Summer peak load time (9/4 HE 19 PST)
B3	2029 Summer Peak	Summer peak load time (9/5 HE 19 PST)
B4	2021 Spring Off-Peak	Spring minimum net load time (4/10 HE 13 PST)
B5	2024 Spring Off-Peak	Spring shoulder load time (5/3 HE 20 PST)

- Sensitivity scenarios

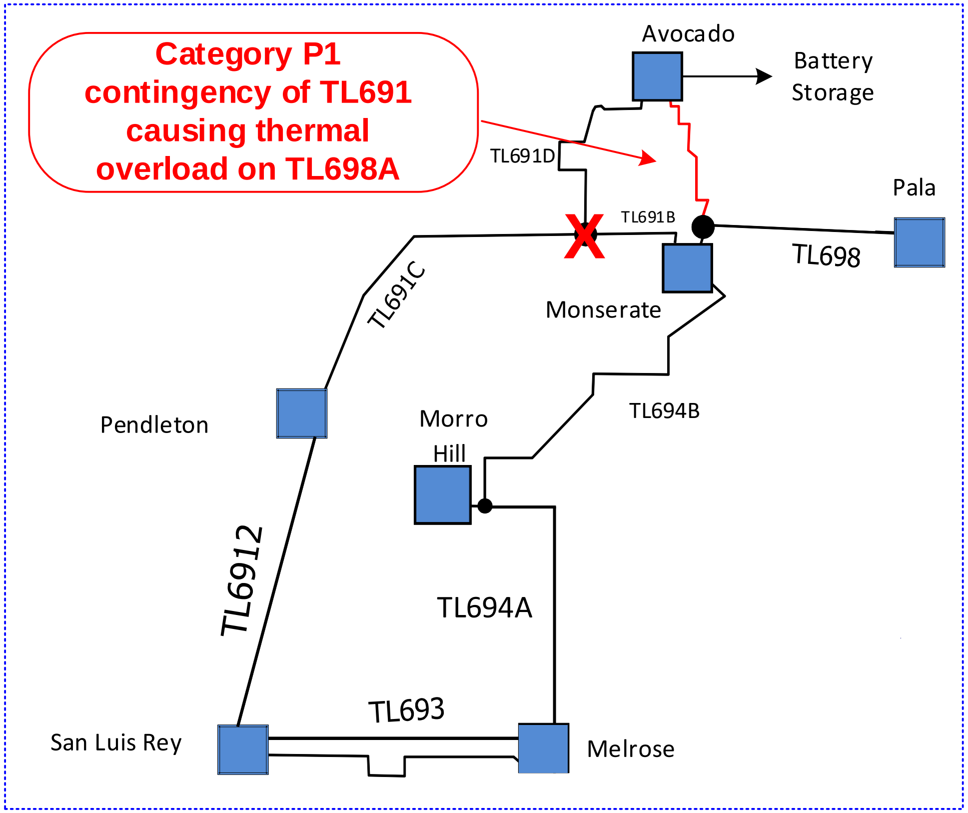
No	Case	Change From Base Assumption
S1	2024 Summer Peak	High CEC forecasted load
S2	2024 Spring Off-Peak	Heavy renewable output and minimum gas generation commitment
S3	2021 Summer Peak	Heavy renewable output and minimum gas generation commitment

Reliability assessment preliminary results summary

Thermal loading Off-Peak Results

Overloaded Facility	Contingencies	Category	Loading (%)			Potential Mitigation Solutions
			B4 2021 OP	B5 2024 OP	S2 2024 OP High RE	
Avocado-Avocado Tap 69 kV	Avocado-Monserate-Pala 69 kV	P1	**151**	**187**	**186**	Potential RAS to trip battery charging at Avocado
Avocado-Monserate Tap 69 kV	Avocado-Monserate-Pendleton 69 kV	P1	**151**	**191**	**190**	

Avocado Area P1/P2.1 Contingency Thermal Overload (1)



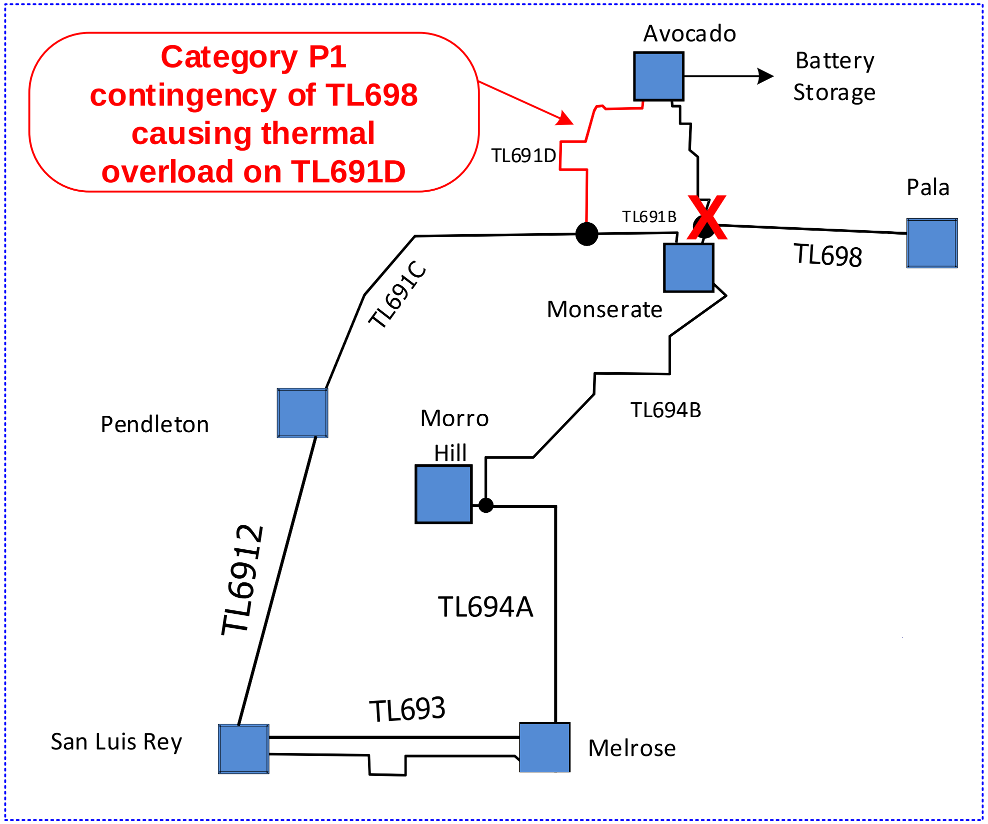
Thermal Overload:

- In the 2021 and 2024 Off-Peak case, N-1 thermal overload on TL698A (52 MVA) after losing TL691 or TL691D
- 70 MW of Battery at Avocado in charging mode

Mitigation:

- Potential RAS to trip battery charging

Avocado Area P1/P2.1 Contingency Thermal Overload (2)



Thermal Overload:

- In the 2021 and 2024 Off-Peak case, N-1 thermal overload on TL691D (52 MVA) after losing TL698 or TL698A or TL698B
- 70 MW of Battery at Avocado in charging mode

Mitigation:

- Potential RAS to trip battery charging

2019-2020 TPP Policy-driven Assessment

Sushant Barave
Regional Transmission Engineering Lead

2019-2020 Transmission Planning Process Stakeholder Meeting
September 25-26, 2019

Contents

- Policy-driven assessment context and objectives
- Methodology
- Key inputs and assumptions
- Next steps and timeline

California ISO

Contents

- Policy-driven assessment context and objectives
- Methodology
- Key inputs and assumptions
- Next steps and timeline

California ISO

Renewable portfolio development and the ISO transmission planning process (TPP)

- In accordance with the May 2010 memorandum of understanding between the ISO and the California Public Utilities Commission (CPUC), and in coordination with the California Energy Commission (CEC), the CPUC develops the resource portfolios to be used by the ISO in its annual transmission planning process (TPP).

- The ISO utilizes the portfolios transmitted by the CPUC in performing reliability, policy and economic assessments in the TPP, with a particular emphasis on identifying policy-driven transmission needs necessary to accommodate renewable generation.

Two key objectives of policy-driven assessment in 2019-2020 TPP

1. Evaluate transmission solutions needed to meet state, municipal, county or federal policy requirements or directives as specified in the Study Plan
   a. Capture reliability impacts
   b. Test the deliverability of resources selected to be full capacity deliverability status (FCDS)
   c. Analyze renewable curtailment data

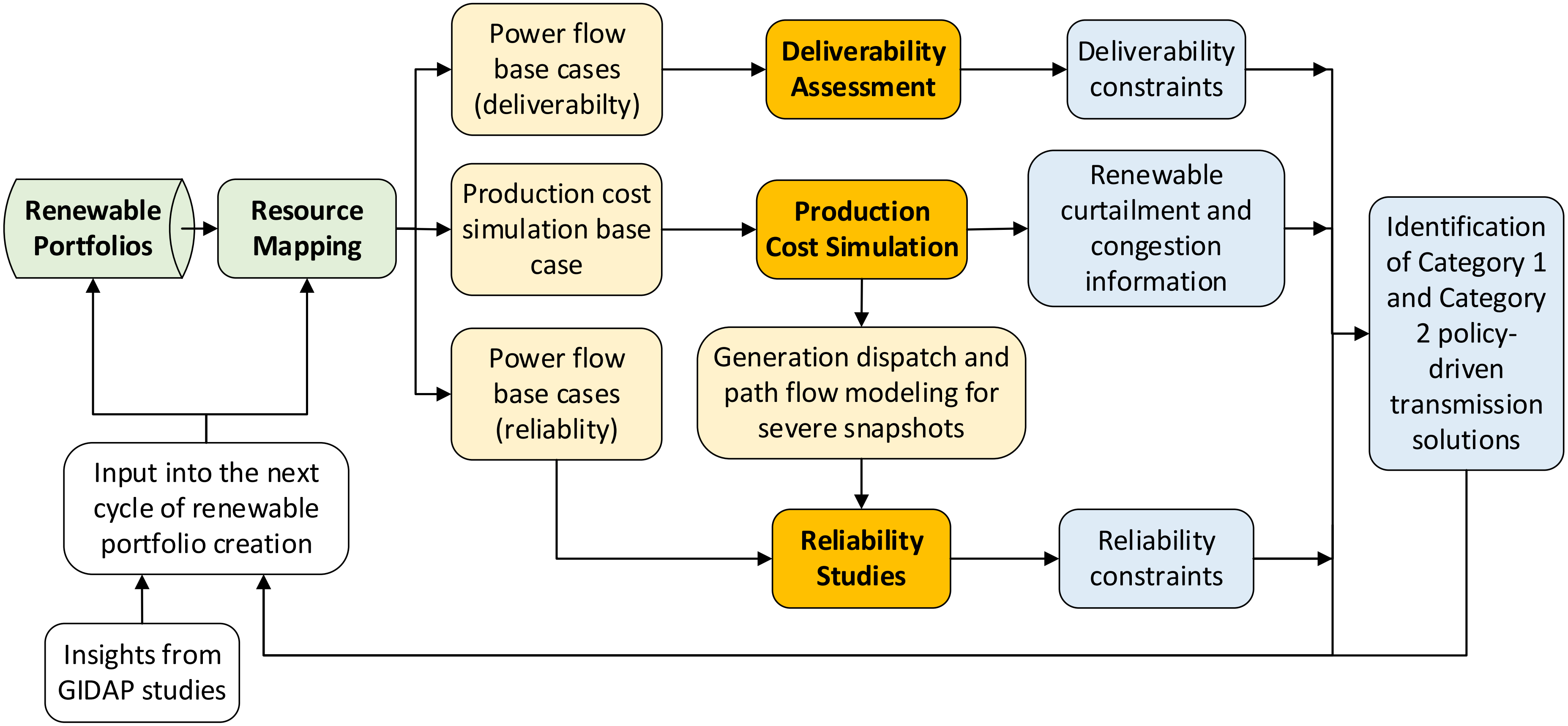
2. Test the transmission capability estimates used in CPUC's integrated resource planning (IRP) process and provide recommendations for the next cycle of portfolio creation

Contents

- Policy-driven assessment context and objectives
- Methodology
- Key inputs and assumptions
- Next steps and timeline

California ISO

Methodology includes technical studies, identification of policy-driven upgrades and input into the IRP



Contents

Key inputs and assumptions

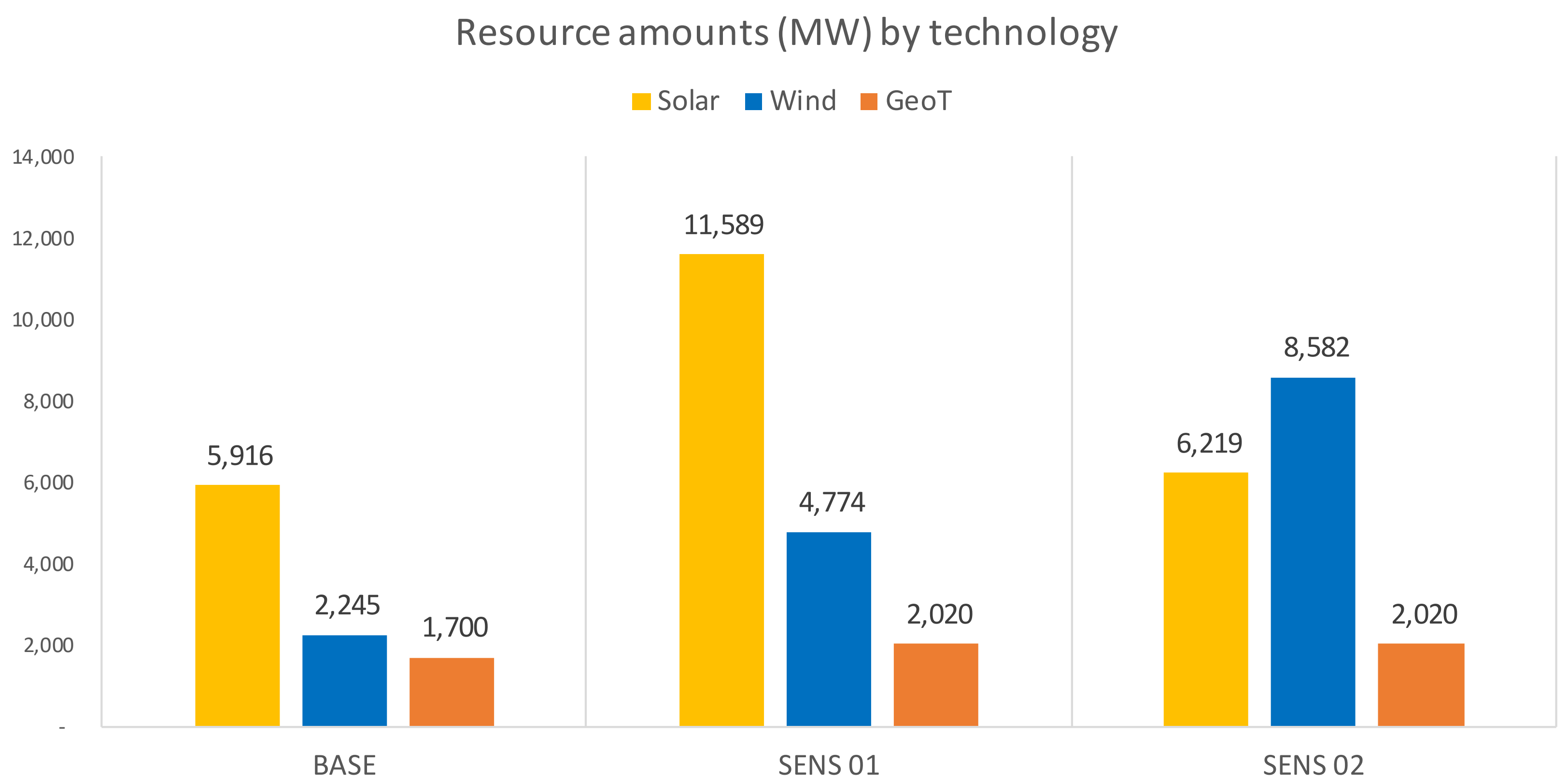
- Inputs
  - Renewable portfolios*
  - Resource mapping**

- Assumptions
  - Transmission
  - Load
  - Resource dispatch

* (https://www.cpuc.ca.gov/General.aspx?id=6442460548)

** https://efiling.energy.ca.gov/GetDocument.aspx?tn=227311&DocumentContentId=58171

Three portfolios with very different resource mix by technology and location

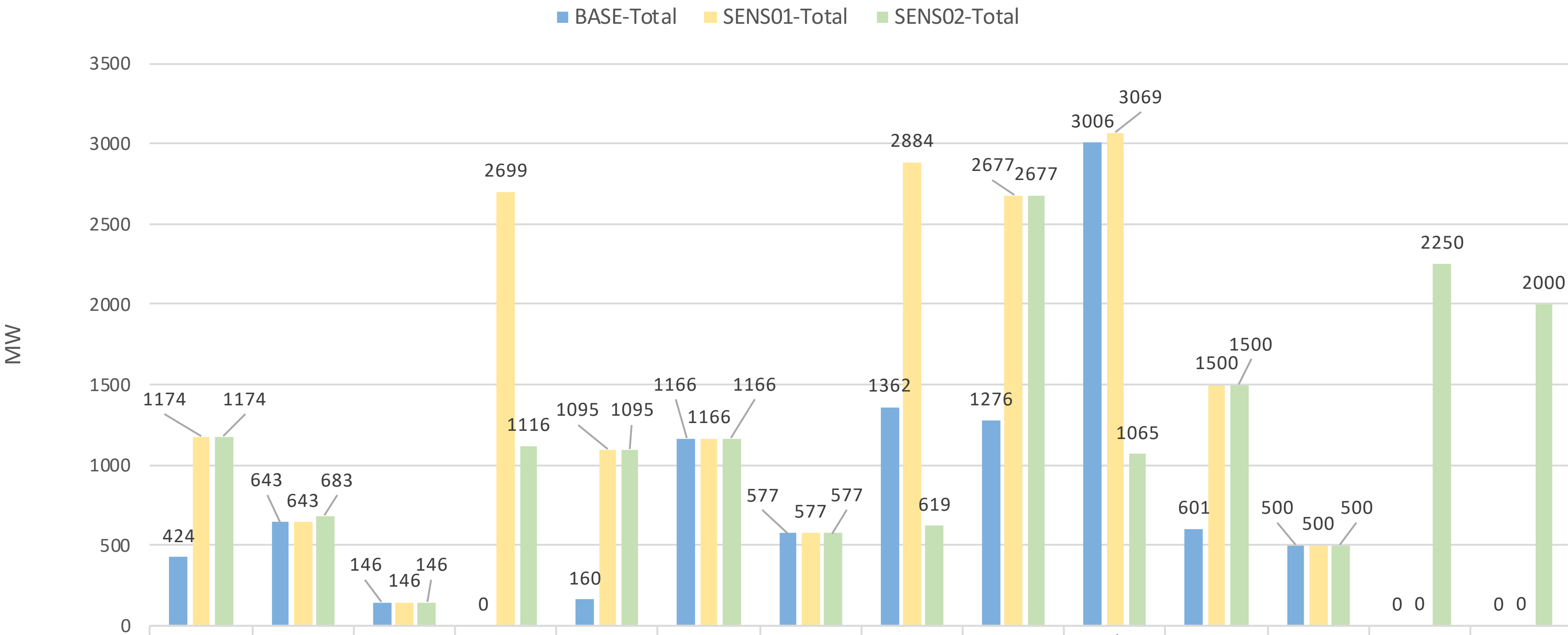


Reliability and policy-driven ***base portfolio*** (42 MMT GHG target)	Policy-driven ***sensitivity portfolio #1*** – In-state (32 MMT GHG target)	Policy-driven ***sensitivity portfolio #2*** – Out-of-state (32 MMT GHG target)

Total “generic” resource mix (EO + FC) in portfolios

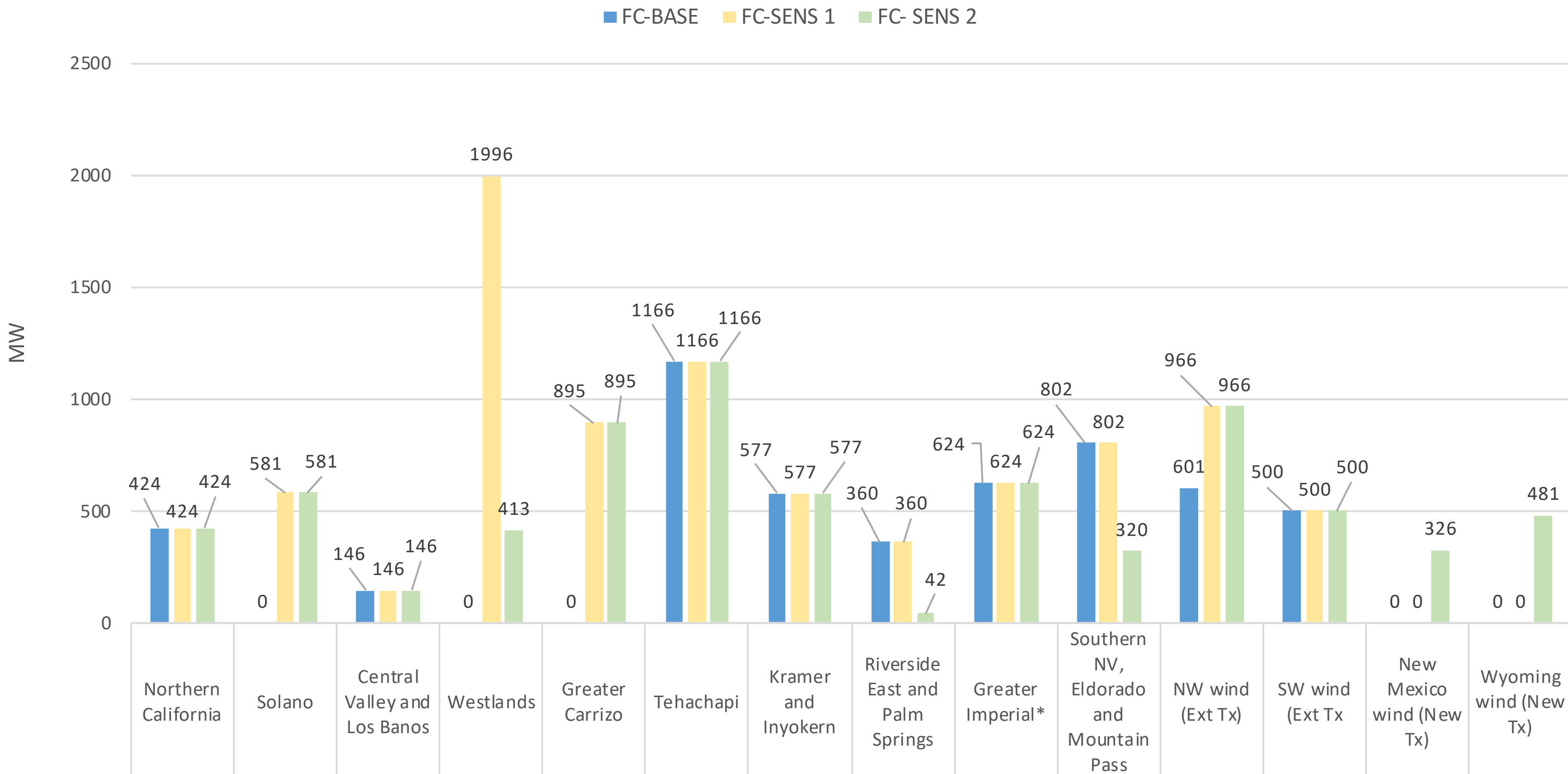
Renewable zone	PCM and snapshot study capacity (MW)												Deliverability study capacity (MW)		
	BASE				SENS 1				SENS 2				BASE	SENS 1	SENS 2
	Solar	Wind	GeoT	Total	Solar	Wind	GeoT	Total	Solar	Wind	GeoT	Total			
Northern California	0		424	424	750		424	1,174	750		424	1,174	424	424	424
Solano	0	643	0	643	0	643	0	643	40	643	0	683	0	581	581
Central Valley and Los Banos	0	146	0	146	0	146	0	146	0	146	0	146	146	146	146
Westlands	0	0	0	0	2,699	0	0	2,699	1,116	0	0	1,116	0	1,996	413
Greater Carrizo	0	160	0	160	0	1095	0	1,095	0	1095	0	1,095	0	895	895
Tehachapi	1,013	153	0	1,166	1,013	153	0	1,166	1,013	153	0	1,166	1,166	1,166	1,166
Kramer and Inyokern	577	0	0	577	577	0	0	577	577	0	0	577	577	577	577
Riverside East and Palm Springs	1,320	42	0	1,362	2,842	42	0	2,884	577	42		619	360	360	42
Greater Imperial*	0	0	1276	1276	1,401	0	1276	2,677	1,401	0	1,276	2,677	624	624	624
Southern CA desert and Southern NV	3,006	0	0	3,006	2,307	442	320	3,069	745	0	320	1,065	802	802	320
None (Distributed Wind)	0	0	0	0	0	253	0	253	0	253	0	253	0	253	253
NW_Ext_Tx (Northwest wind)	0	601	0	601	0	1500	0	1,500	0	1,500	0	1,500	601	966	966
SW_Ext_Tx (Southwest wind)	0	500	0	500	0	500	0	500	0	500	0	500	500	500	500
New Mexico wind (new Tx)	0	0	0	0	0	0	0	0	0	2,250	0	2,250	0	0	326
Wyoming wind (New Tx)	0	0	0	0	0	0	0	0	0	2,000	0	2,000	0	0	481
TOTALS	5,916	2,245	1,700	9,861	11,589	4,774	2,020	18,383	6,219	8,582	2,020	16,822	5,200	9,290	7,714

Total (FCDS + EODS) resource selection by location – Base vs. Sensitivity 1 vs. Sensitivity 2



	Northern California	Solano	Central Valley and Los Banos	Westlands	Greater Carrizo	Tehachapi	Kramer and Inyokern	Riverside East and Palm Springs	Greater Imperial*	Southern NV, Eldorado and Mountain Pass	NW wind (Ext Tx)	SW wind (Ext Tx	New Mexico wind (New Tx)	Wyoming wind (New Tx)
BASE-Total	424	643	146	0	160	1166	577	1362	1276	3006	601	500	0	0
SENS01-Total	1174	643	146	2699	1095	1166	577	2884	2677	3069	1500	500	0	0
SENS02-Total	1174	683	146	1116	1095	1166	577	619	2677	1065	1500	500	2250	2000

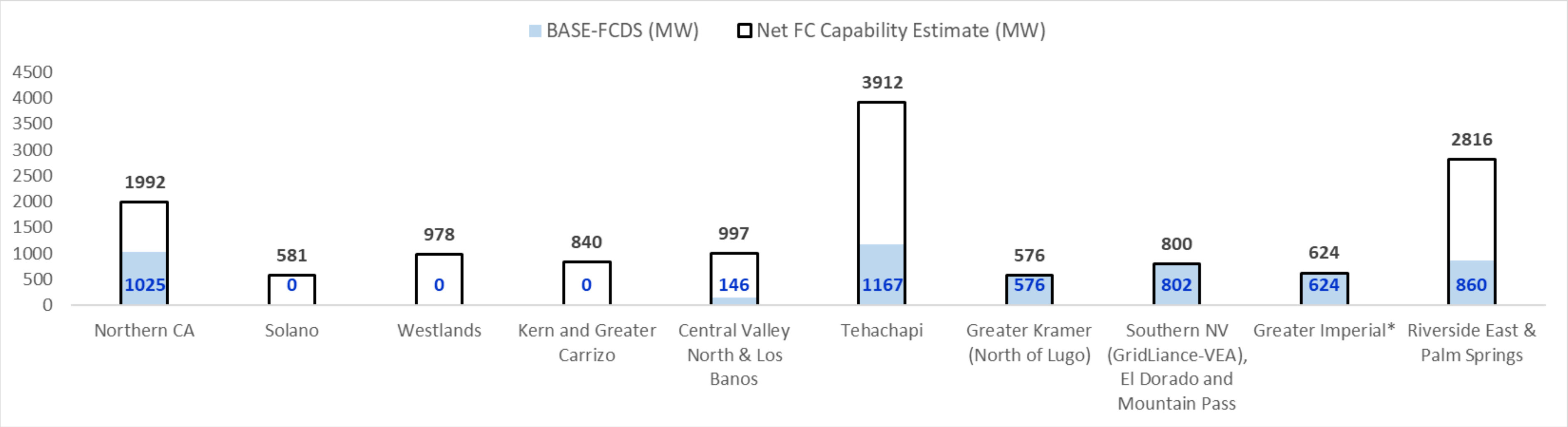
FCDS resource selection by location – Base vs. Sensitivity 1 vs. Sensitivity 2

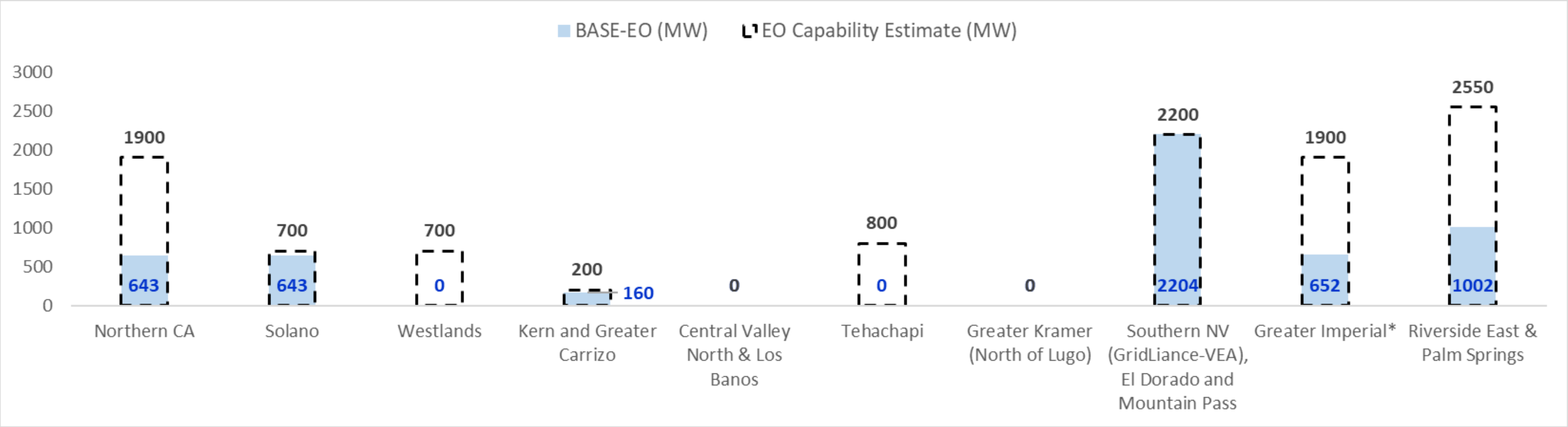


	Northern California	Solano	Central Valley and Los Banos	Westlands	Greater Carrizo	Tehachapi	Kramer and Inyokern	Riverside East and Palm Springs	Greater Imperial*	Southern NV, Eldorado and Mountain Pass	NW wind (Ext Tx)	SW wind (Ext Tx	New Mexico wind (New Tx)	Wyoming wind (New Tx)
FC-BASE	424	0	146	0	0	1166	577	360	624	802	601	500	0	0
FC-SENS 1	424	581	146	1996	895	1166	577	360	624	802	966	500	0	0
FC- SENS 2	424	581	146	413	895	1166	577	42	624	320	966	500	326	481

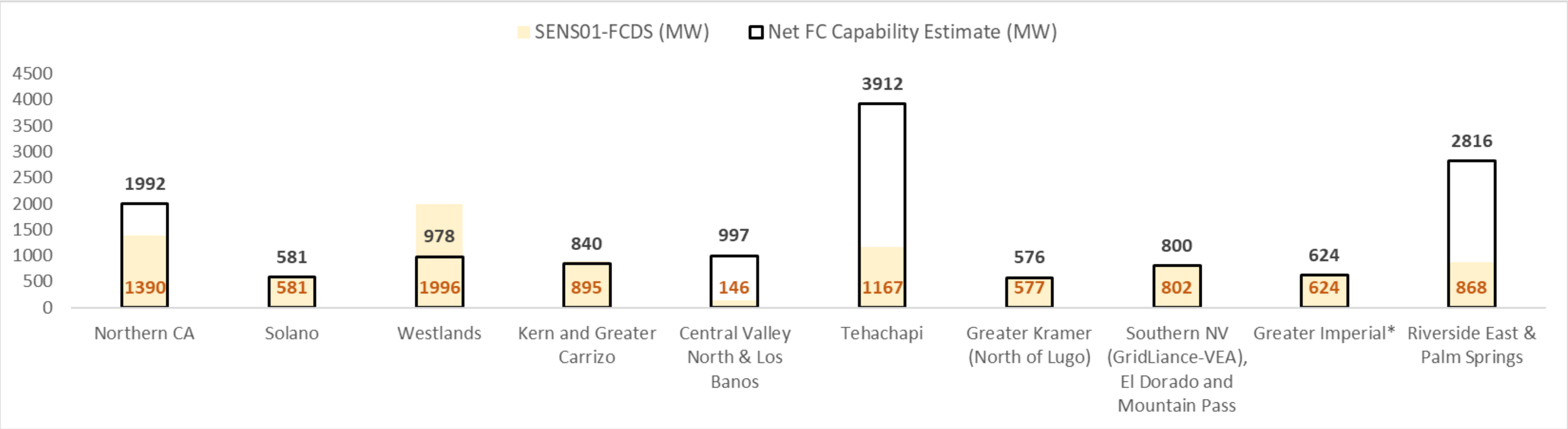
California ISO

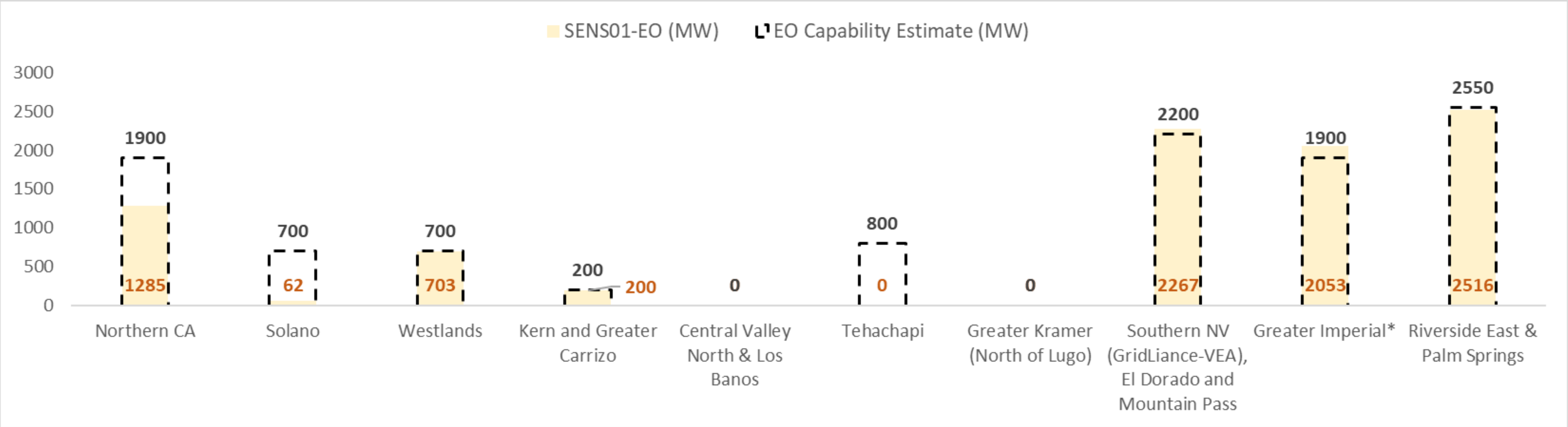
Utilization of the estimated transmission capability - base portfolio



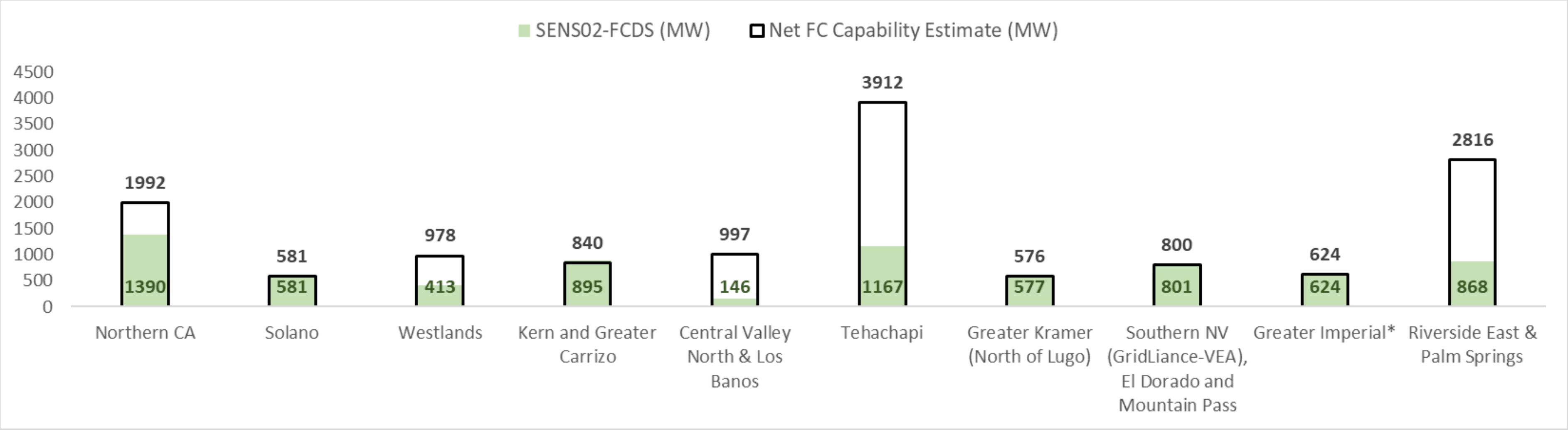


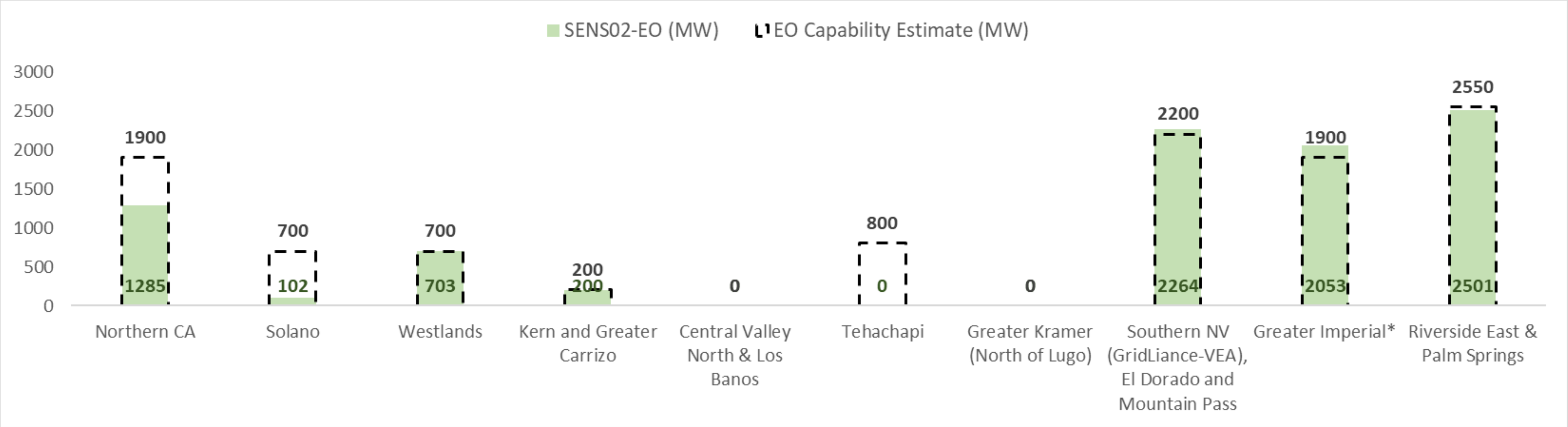
Utilization of the estimated transmission capability – Sensitivity portfolio 1





Utilization of the estimated transmission capability – Sensitivity portfolio 2





The ISO used the proposed resource mapping provided by the CEC staff and incorporated input received from relevant planning entities

- The portfolios are at a geographic scale that is too broad for transmission planning, which requires specific interconnection locations.
- CEC staff developed recommendations for allocating MW amounts to specific substations to achieve granularity that is sufficient for the ISO to utilize in its transmission studies.
- The ISO relied on specific information received from IID as part of the annual TPP base case coordination and made certain changes to the modeling locations recommended by the CEC.

Summary of modeling changes as a result of IID's input into TPP base case coordination

- The CEC staff had recommended the following mapping locations for geothermal resources in the base portfolio

MW Assignment	Substation	Notes
1052	Bannister	Imperial Irrigation District (IID)
160	El Centro	IID-CAISO Line S
32	Highline	IID

- Based on IID's input about the likely location for geothermal resource development based on their interconnection studies, the ISO will model these resources as follows -

MW Modeled	Substation	Notes
622	Bannister 230 kV (IID)	Based on modeling input from IID.
622	Hudson Ranch 230 kV (connecting to IID's Midway 230 kV)	Based on modeling input from IID.

Summary of transmission topology, load and dispatch assumptions

- Starting base cases
  - Year-10 base cases used for 2019-2020 TPP annual reliability assessment are used as a starting point
- Load assumption
  - The ISO will identify severe snapshots to be modeled based on high transmission system usage hours under high renewable dispatch in respective study areas, and the corresponding load levels were modeled.
- Transmission assumption
  - Same assumptions as the ISO Annual Reliability Assessments for NERC Compliance (all transmission projects approved by the ISO)
- Dispatch assumption
  - For reliability assessment, dispatch renewables based on the identified snapshot
  - For deliverability assessment, according to the deliverability methodology

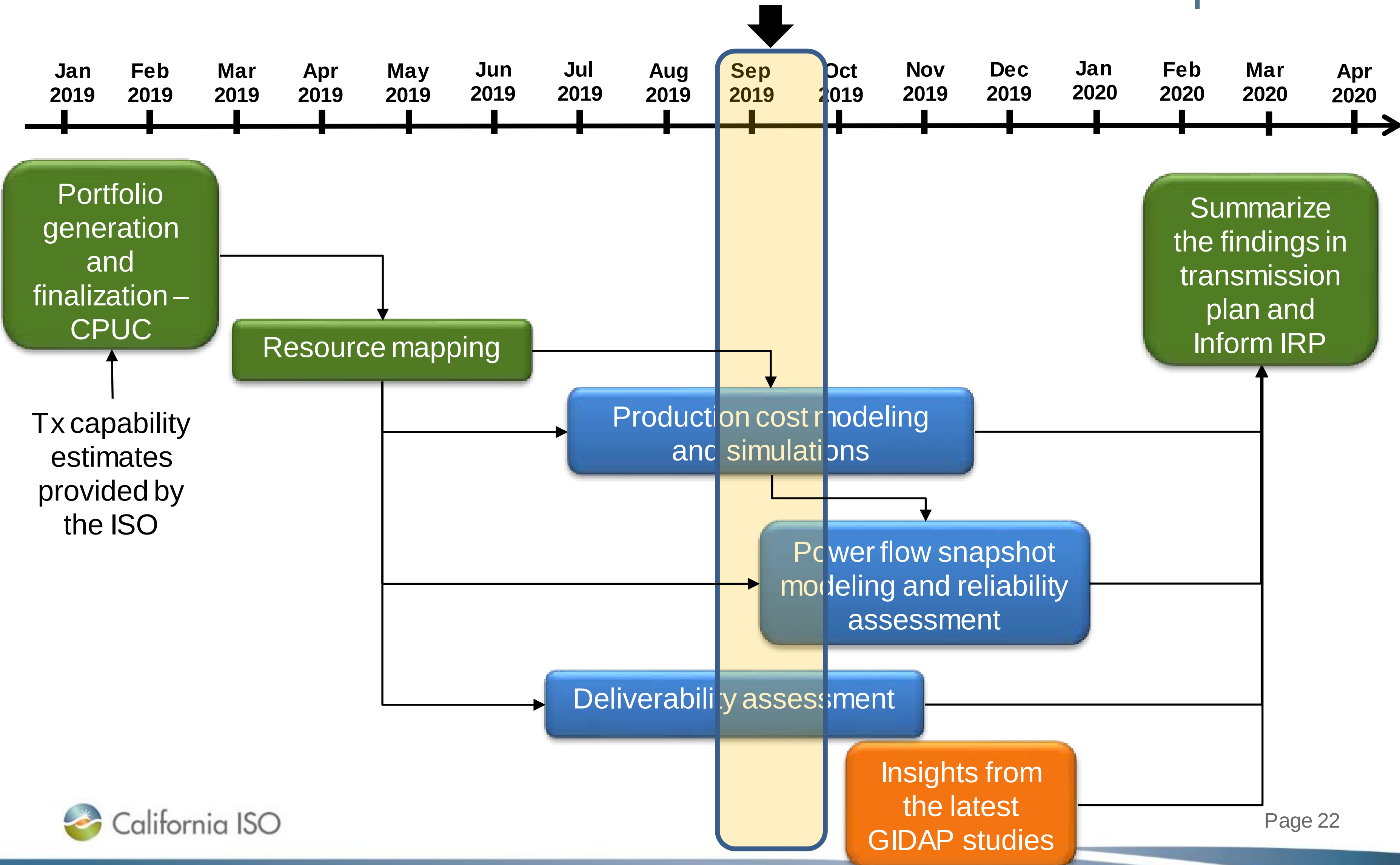
Contents

- Policy-driven assessment context and objectives
- Methodology
- Key inputs and assumptions
- Next steps and timeline

Next steps

- Finalize and present deliverability assessment results
- Capture and analyze renewable curtailment based on production cost simulation runs
- Select power flow snapshots for reliability assessment; model these snapshots and run contingency analyses

2019-2020 policy-driven assessment results and the latest GIDAP studies are used to inform the CPUC IRP process



California ISO

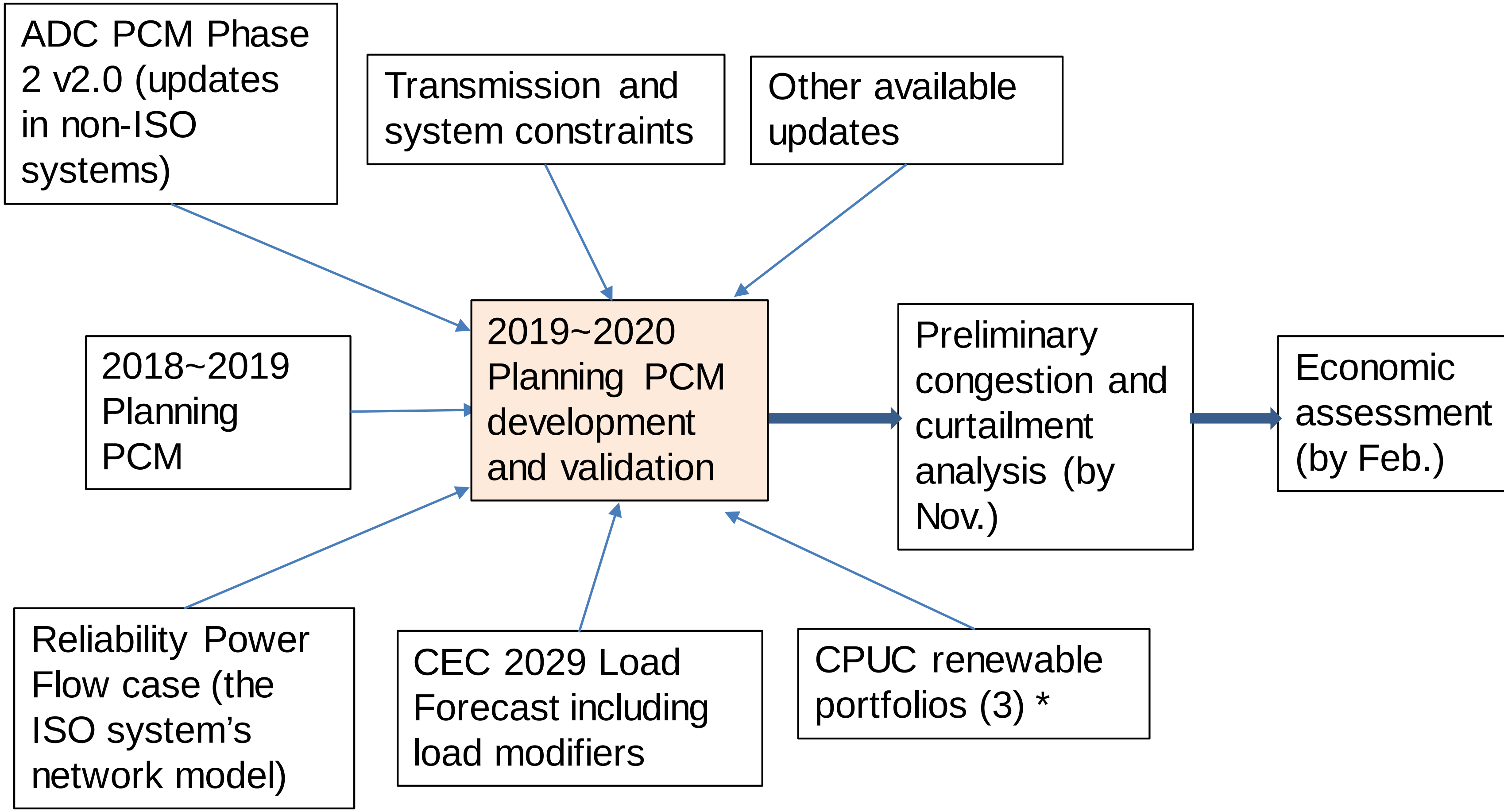
Economic Planning- Production cost model (PCM) development, Renewable curtailment and price model, and Battery cost model

Yi Zhang
Regional Transmission Engineering Lead

2019-2020 Transmission Planning Process Stakeholder Meeting
September 25-26, 2018

Planning PCM development update

Planning PCM development



* The base portfolio is for economic planning study; the sensitivity portfolios are for policy-driven study

Key system and transmission constraints

- ISO net export limit 2000 MW
- Scheduled outages and derates based on facility owners' submitted data and OASIS data
- Nomograms for major paths based on planning studies or operation procedures
- Contingencies and SPS
  - Critical contingencies identified in ISO's TPP, LCR, and GIP studies

Next steps

- Continue on database development
- Conduct production cost simulations and congestion analysis for
  - Economic assessment
  - Policy driven study
- Provide update in the next TPP Stakeholder Meeting

Renewable curtailment and price model

Renewable (wind and solar) model in production cost model (PCM)

- Renewables are modeled as resources with hourly profiles (hourly resources) and curtailment price (dispatch cost)
- Normally grid-connected renewables are modeled as curtailable hourly resources with negative curtailment price
  - Negative curtailment price is to mimic the negative price bid of renewables in the actual market operation to avoid curtailment

How was transmission (related) curtailment and system curtailment expected to be handled?

- Conceptually, transmission curtailment and system curtailment should be considered differently:
  - Transmission curtailment is supposed to be based on the generator shift factor (GSF) to the congested lines
  - System curtailment is supposed to be proportional to the actual generation output of all generators (renewable)
  - Note: transmission losses are modeled in the planning PCM, but the impact on curtailment is not as significant as the transmission and system constraints
- Separating these two types of curtailment in market operation or production cost simulation is difficult
  - Both ISO market and the current planning PCM simulation rely on post processing to identify transmission and system curtailments

Renewable dispatch (curtailment) price model

- Negative $25 used for the entire system in the WECC ADS PCM to represent tax credit of renewables
- CPUC ALJ 2017 recommended a three-tiers curtailment price based on cumulative curtailed energy over the year

Cumulative curtailed energy less than	Price
200GWh	-$15
12480 GWh	-$25
Floor (default)	-$300

- In ISO's and CPUC's 2018 studies, a revised hourly curtailment price profile was used

Hourly curtailment less than	Price
2000 MW	-$15
7000 MW	-$25
12000 MW	-$50
18000 MW	-$150
Floor (default)	-$300

Key concerns impacting renewable curtailment modeling – negative prices and curtailment order

- Rationale for solar or wind generators to remain on at negative prices, and negative prices beyond minus $20 to minus $25 do not seem to be supported by "fundamentals"

Price model	Multi-tier	-$25 flat	-$50 flat	-$100 flat	-$150 flat	-$300 flat
Curtailment (GWh)	10,154	10,360	10,293	9,672	9,406	8,340

- The order the renewable generators are curtailed is much more critical in nodal than zonal analysis
  - Location is critical for power flow and congestion results as well as tracking resources whose benefits accrue to ratepayers

Generation economic dispatch in production cost simulation

- Generation economic dispatch is based on the augment cost of generators, which is the dispatch cost plus the cost adders
- Dispatch cost for thermal generators
  - Fuel cost, minimum load cost, VOM, and startup cost
- Dispatch cost for renewables and hydro
  - Pre-determined dispatch cost, VOM
- Cost adder is calculated inside the optimization solver, and includes
  - The summation of shadow price of binding constraint times the generator shift factor (GSF)
  - Generator's contribution to transmission losses (but relatively small)

Dispatch approaches that work for thermal may not work for renewables - All generators are treated the same in the PCM economic dispatch

Thermal

- Thermal generators use individual incremental heat rates with relatively small step size
- Thermal generator can be just dispatched down to the next segment in the heat rate curve

Renewables

- Renewable generators use the same global price (flat or step profile with large step size)
- If a generator has larger GSF to a congestion, its cost adder normally is also higher, hence it is likely to be curtailed before other generators are curtailed
- Increased curtailment in one gen pocket may drive up the global curtailment price in other gen pockets

Compare PCM results and the actual market performance

What we observed in simulation results:

- When curtailment happens, individual renewable generators are sequentially curtailed all the way to zero, except for the last marginal unit that is only partially curtailed – the rest are untouched.
- There is no delineation between "system" and "transmission" curtailment – all curtail
- Non-ISO's constraints and wheeling charges impact ISO's generator dispatch

This differs from actual market performance:

- Generators may have different economic bid, which determines the curtailment order; and operators can adjust operation
- Non-ISO's constraints and wheeling are not explicitly modeled in, hence have limited impact on ISO's generator dispatch (outside the EIM time frame)

The current renewables curtailment model needs to be revisited for nodal analysis because:

- Issue (1) The step model affecting all renewables equally can create "cliffs" in pricing – a small system change may create a small reduction in curtailment, but change the curtailment price for all renewables, for example, from -50 to -25, having an exaggerated effect.
- Issue (2) The staged pricing based on the total amount of curtailment in each hour moves LMPs in different local congested areas for changes in unrelated areas.
- Issue (3) The sequential curtailment of individual units before "moving on" to the next unit is providing erratic results – minor system changes can affect cost adders that lead to selection of units to curtail

Potential enhancements for curtailment price model

- Option 1: use a single flat curtailment price
  - Partially resolves issue (1) (in the previous slide) since there is only one potential "cliff", so it would provide consistency for transmission economic assessment
  - Resolves issue (2), but does not resolve issue (3)
- Option 2: curtailment price model with high granularity location-wise and with smaller step size
  - Can resolve all three issues, but is not a practical option for implementation
  - Needs to define smaller areas, or down to unit level
  - Needs to query and analyze a lot of historical data, but using hard-coded price curves for all renewables, existing and future, is still not sufficient for future year study

Potential enhancements for curtailment price model (2)

- Option 3: model each renewable generator as several smaller generators (blocks) with “slightly” different curtailment prices
- Step size in price sufficient to mute impact of what should be inconsequential differences in generation shift factors and losses
  - Partially resolves issue (1), similar to Option 1
  - Resolves issues (2) and (3)
  - Needs to model more generators, simulation time will increase
  - Price of each block need to be defined
- This is the ISO’s current candidate option

Implementation of Option 3

- Applied to all wind or solar generators that locate inside the ISO or are scheduled to the ISO
- Each generator is modeled as five separate generators (blocks) with identical hourly profile, each block's Pmax is 20% of the Pmax of the actual generator
- Each block has different curtailment price around $-25
  - $-25 pivot and $1 step size were used, further refinement may be needed

Block	Price
1	$-23
2	$-24
3	$-25
4	$-26
5	$-27

Summary of renewable curtailment and price model

- Recommendation is to implement Option 3 (the multi-block renewable generator model) in the planning PCM in 2019~2020 planning cycle
  - The block model improved the curtailment results
  - The total curtailment did not change much, but the allocation changed
- Next step is to refine the curtailment price blocks and steps
  - Currently assumed $-25 curtailment price, 5 blocks for each renewables, and $1 step change for blocks

Consider replacement cost of batteries in ISO's planning PCM

The needs for enhancing the battery model in PCM

- Dispatchable energy of batteries needs to be modeled to be less than the energy capacity due to the depth of discharge (DoD, or cycle depth)
- Operation cost needs to be modeled to reflect the replacement cost
- Baseline assumptions for battery parameters
  - Only the energy capacity cost is considered in replacement cost
  - The 2025 forecast in the DOE report (DOE/Hydro Wires report, July 2019*) would be used, unless the forecast for future years, e.g. 2030, becomes available

* https://www.sandia.gov/ess-ssl/wp-content/uploads/2019/07/PNNL_mjp_Storage-Cost-and-Performance-Characterization-Report_Final.pdf

Battery (Li-ion) depth of discharge, cycle life, and operation cost

- Depth of discharge, or DoD
  - Normally not fully charged or discharged
  - Typical DoD: 80% (DOE report)
- Cycle life: 3500 cycles based on 80% DoD (DOE report)
- Calendar life: about 10 years depending on operation conditions (DOE report)
- Operation cost
  - Replacement cost needs to be considered in operation cost since battery's economic life is a function of number of cycles and DoD

Battery cost and cycle life predictions in the DOE report*

Table 4.3. Summary of compiled 2018 findings and 2025 predictions for cost and parameter ranges by technology type – BESS.[(a)]

Parameter	Sodium-Sulfur Battery		Li-Ion Battery		Lead Acid		Sodium Metal Halide		Zinc-Hybrid Cathode		Redox Flow Battery	
	2018	2025	2018	2025	2018	2025	2018	2025	2018	2025	2018	2025
Capital Cost – Energy Capacity ($/kWh)	400-1,000 **661**	(300-675) **(465)**	223-323 **271**	(156-203) **(189)**	120-291 **260**	(102-247) **(220)**	520-1,000 **700**	(364-630) **(482)**	265-265 **265**	(179-199) **(192)**	435-952 **555**	(326-643) **(393)**
Power Conversion System (PCS) ($/kW)	230-470 **350**	(184-329) **(211)**	230-470 **288**	(184-329) **(211)**	230-470 **350**	(184-329) **(211)**	230-470 **350**	(184-329) **(211)**	230-470 **350**	(184-329) **(211)**	230-470 **350**	(184-329) **(211)**
Balance of Plant (BOP) ($/kW)	80-120 **100**	(75-115) **(95)**	80-120 **100**	(75-115) **(95)**	80-120 **100**	(75-115) **(95)**	80-120 **100**	(75-115) **(95)**	80-120 **100**	(75-115) **(95)**	80-120 **100**	(75-115) **(95)**
Construction and Commissioning ($/kWh)	121-145 **133**	(115-138) **(127)**	92-110 **101**	(87-105) **(96)**	160-192 **176**	(152-182) **(167)**	105-126 **115**	(100-119) **(110)**	157-188 **173**	(149-179) **(164)**	173-207 **190**	(164-197) **(180)**
Total Project Cost ($/kW)	2,394-5,170 **3,626**	(1,919-3,696) **(2,674)**	1,570-2,322 **1,876**	(1,231-1,676) **(1,446)**	1,430-2,522 **2,194**	(1,275-2,160) **(1,854)**	2,810-5,094 **3,710**	(2,115-3,440) **(2,674)**	1,998-2,402 **2,202**	(1,571-1,956) **(1,730)**	2,742-5,226 **3,430**	(2,219-3,804) **(2,598)**
Total Project Cost ($/kWh)	599-1,293 **907**	(480-924) **(669)**	393-581 **469**	(308-419) **(362)**	358-631 **549**	(319-540) **(464)**	703-1,274 **928**	(529-860) **(669)**	500-601 **551**	(393-489) **(433)**	686-1,307 **858**	(555-951) **(650)**
O&M Fixed ($/kW-yr)	10	(8)	10	(8)	10	(8)	10	(8)	10	(8)	10	(8)
O&M Variable (cents/kWh)	0.03		0.03		0.03		0.03		0.03		0.03	
System Round-Trip Efficiency (RTE)	0.75		0.86		0.72		0.83		0.72		0.675	(0.7)
Annual RTE Degradation Factor	0.34%		0.50%		5.40%		0.35%		1.50%		0.40%	
Response Time (limited by PCS)	1 sec		1 sec		1 sec		1 sec		1 sec		1 sec	
Cycles at 80% Depth of Discharge	4,000		3,500		900		3,500		3,500		10,000	
Life (Years)	13.5		10		2.6	(3)	12.5		10		15	
MRL	9	(10)	9	(10)	9	(10)	7	(9)	6	(8)	8	(9)
TRL	8	(9)	8	(9)	8	(9)	6	(8)	5	(7)	7	(8)

(a) An E/P ratio of 4 hours was used for battery technologies when calculating total costs.
MRL = manufacturing readiness level; O&M = operations and maintenance; TRL = technology readiness level.

* https://www.sandia.gov/ess-ssl/wp-content/uploads/2019/07/PNNL_mjp_Storage-Cost-and-Performance-Characterization-Report_Final.pdf

Options to address the challenges in modeling battery cost in PCM

- Option 1: Incremental cost (quadratic or step-up function)
  - It is still a preliminary research work

- Option 2: flat average cost for each MWh
  - Proposed equation for calculating the replacement cost

$$Average\ Cost = \frac{Per\ unit\ replacement\ cost}{Cycle\ life * DoD * 2}$$

  - Example: parameter assumptions in the DOE report
    - Replacement cost: $189,000/MWh (the forecasted energy capacity cost in 2025)
    - Cycle life: 3500 cycles based on 80% DoD
    - Average cost is $33.75/MWh

Battery model Option 2 (average cost approach) - Case study

- Three cases were simulated to compare the impact of modeling battery replacement cost and DoD
  - (1) Base case (Batteries 100% DoD, $0 operation cost)
  - (2) Case 1 + Dispatchable energy of batteries is modeled as 80% of the actual energy capacity to reflect the 80% DoD
  - (3) Case 2 + $33.75/MWh operation cost for all batteries

Case	(1) Base case	(2) Battery 80% DoD $0 cost	(3) Battery 80% DoD and $33.75/MWh cost
WECC Production cost ($M)	15,228	15,234	15,325
WECC total curtailment (GWh)	13,441	13,620	13,950
Total ISO curtailment (GWh)	11,343	11,563	11,837
ISO Wind and Solar curtailment (GWh)	10,003	10,204	10,391
Total Battery market revenue ($M)	130	109	8

Summary and next steps of modeling battery replacement cost and depth of discharge in PCM

- Batteries (Li-ion) replacement cost and depth of discharge (DoD) impact the dispatch and need to be modeled in PCM. The ISO is proposing at this time:
  - To use the “average cost” approach for modeling the replacement cost
  - To use the 2025 predictions in the DOE report for the parameter assumptions (e.g. energy capacity cost, cycle life, and DoD)

- Further refinement to the approach and parameters of modeling these characteristics of batteries will be continued in future planning cycles

Economic Assessment of Local Capacity Areas Extension of 2018-2019 Transmission Plan

Catalin Micsa
Senior Advisor, Regional Transmission – North

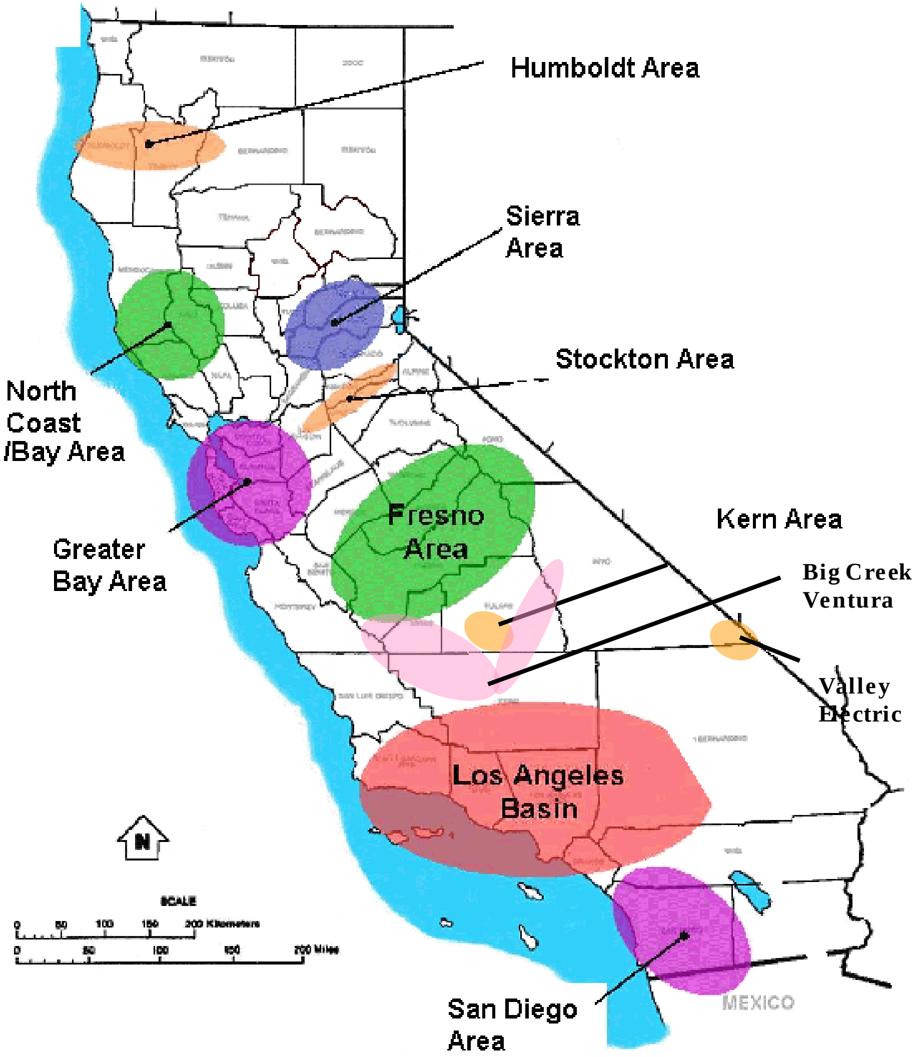
Stakeholder Meeting September 25, 2019

Continuation of economic study conducted as part of the 2018-2019 transmission planning cycle

- Identify potential transmission upgrades that would economically lower gas-fired generation capacity requirements in local capacity areas or sub-areas.

- Explore and assess alternatives – conventional transmission and preferred resources - to reduce or eliminate need for gas-fired generation in the remaining half of the existing areas and sub-areas.

LCR Areas within CAISO



LCR areas and subareas without need for studies (18)

LCR Areas / Subareas without requirements in 2028	LCR Areas / Subareas without the need to reduce requirements in 2028
Sierra - Placerville - Placer - Bogue - Drum-Rio Oso - South of Palermo	North Coast-North Bay - Eagle Rock - Fulton - Overall
Stockton - Lockeford	Fresno - Borden
Los Angeles Basin - West of Devers - Valley-Devers - Valley	Big Creek-Ventura - Rector - Vestal
San Diego-Imperial Valley - Mission - Esco - Miramar	

LCR areas and subareas already studied last year (23)

LCR Areas / Subareas
Sierra - Pease - South of Rio Oso - Overall
Greater Bay Area - Llagas - San Jose - South Bay-Moss Landing - Ames/Pittsburg/Oakland - Overall
Fresno - Hanford - Herndon - Reedley

LCR Areas / Subareas
Kern - Westpark - Kern Oil - Overall
Big Creek-Ventura - Santa Clara
Los Angeles Basin - Eastern LA Basin - Overall
San Diego–Imperial Valley - El Cajon - Border - Pala Inner - Pala Outer - San Diego - Overall

LCR areas and subareas to be studied this year (14-17)

LCR Areas / Subareas
Humboldt
Stockton - Stanislaus - Tesla-Bellota - Weber
Greater Bay Area - Llagas (Update) - Oakland - Contra Costa - Overall (Update as required)
Fresno - Coalinga - Overall

LCR Areas / Subareas
Kern - South Kern PP - Overall (if needed)
Big Creek-Ventura - Santa Clara (if new portfolio is approved) - Overall
Los Angeles Basin - El Nido - Western LA Basin - Overall (in conjunction with Western reduction)
San Diego–Imperial Valley - Overall (in conjunction with Western reduction)

Local Capacity Technical Study

- 10-year Local Capacity Technical Study conducted as part of 2018-2019 transmission planning process and used for this assessment
- Same economic reduction assumptions as documented in 2018-2019 Transmission Plan
- All technical documentation regarding study results, definition of areas and/or subareas, diagrams, loads and resources, hourly load profiles, requirements, effectiveness factors can be found in the Appendix G to the 2018-2019 Transmission Plan here: http://www.caiso.com/Documents/AppendixG-BoardApproved2018-2019TransmissionPlan.pdf

Project submittal

- Potential alternatives may be submitted to reduce or eliminate the gas-fired generation for LCR areas and sub-areas under study this year (areas identified on Slide 6)
- The continuation of the LCR reduction studies do not include currently proposed changes to the local capacity study criteria
  - Update of contingency category definition
  - Update for Bulk Electric System (BES) voltage level definition
  - Full alignment of LCT criteria with mandatory criteria
- In the future the update for BES voltage level definition may eliminate or reduce the need in certain non-BES sub-areas.

Schedule

- Present assessment and alternatives to reduce or eliminate gas fired generation in the remaining LCR areas and sub-areas (slide 6) at November 18, 2019 stakeholder meeting
- Update Appendix G of 2018-2019 Transmission Plan

Day 1 – Wrap-up
Reliability Assessment and Study Updates

Isabella Nicosia
Associate Stakeholder Affairs and Policy Specialist

2019-2020 Transmission Planning Process Stakeholder Meeting
September 25, 2019

2019-2020 Transmission Planning Process Stakeholder Meeting – Day 2 (September 26) Agenda

Topic	Presenter
GridLiance Proposed Reliability Solutions	GridLiance
VEA Proposed Reliability Solutions	VEA
SDG&E Proposed Reliability Solutions	SDG&E
SCE Proposed Reliability Solutions	SCE
PG&E Proposed Reliability Solutions	PG&E
Wrap-up and Next Steps	Isabella Nicosia