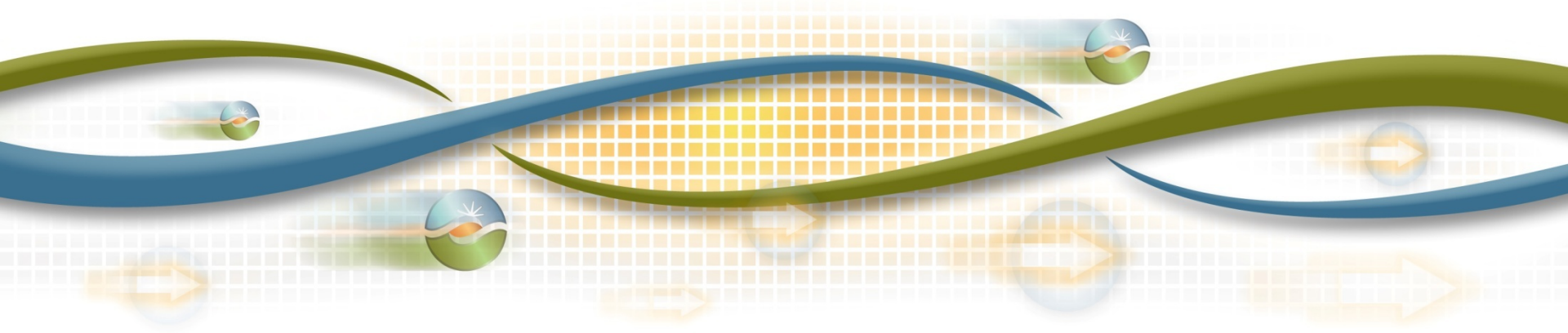
Agenda – Day 1 & 2
Preliminary Reliability Assessment Results

Kim Perez
Stakeholder Engagement and Policy Specialist

2017-2018 Transmission Planning Process Stakeholder Meeting
September 21-22, 2017



2017-2018 Transmission Planning Process Stakeholder Meeting - Agenda – Day 1

Topic	Presenter
Introduction	Kim Perez
Overview	Jeff Billinton
Key Issues	Neil Millar
Preliminary Reliability Results - North	ISO Regional Transmission Engineers
Preliminary Reliability Results – South	ISO Regional Transmission Engineers
Wrap-up & Next Steps	Kim Perez

2017-2018 Transmission Planning Process Stakeholder Meeting – Agenda – Day 2

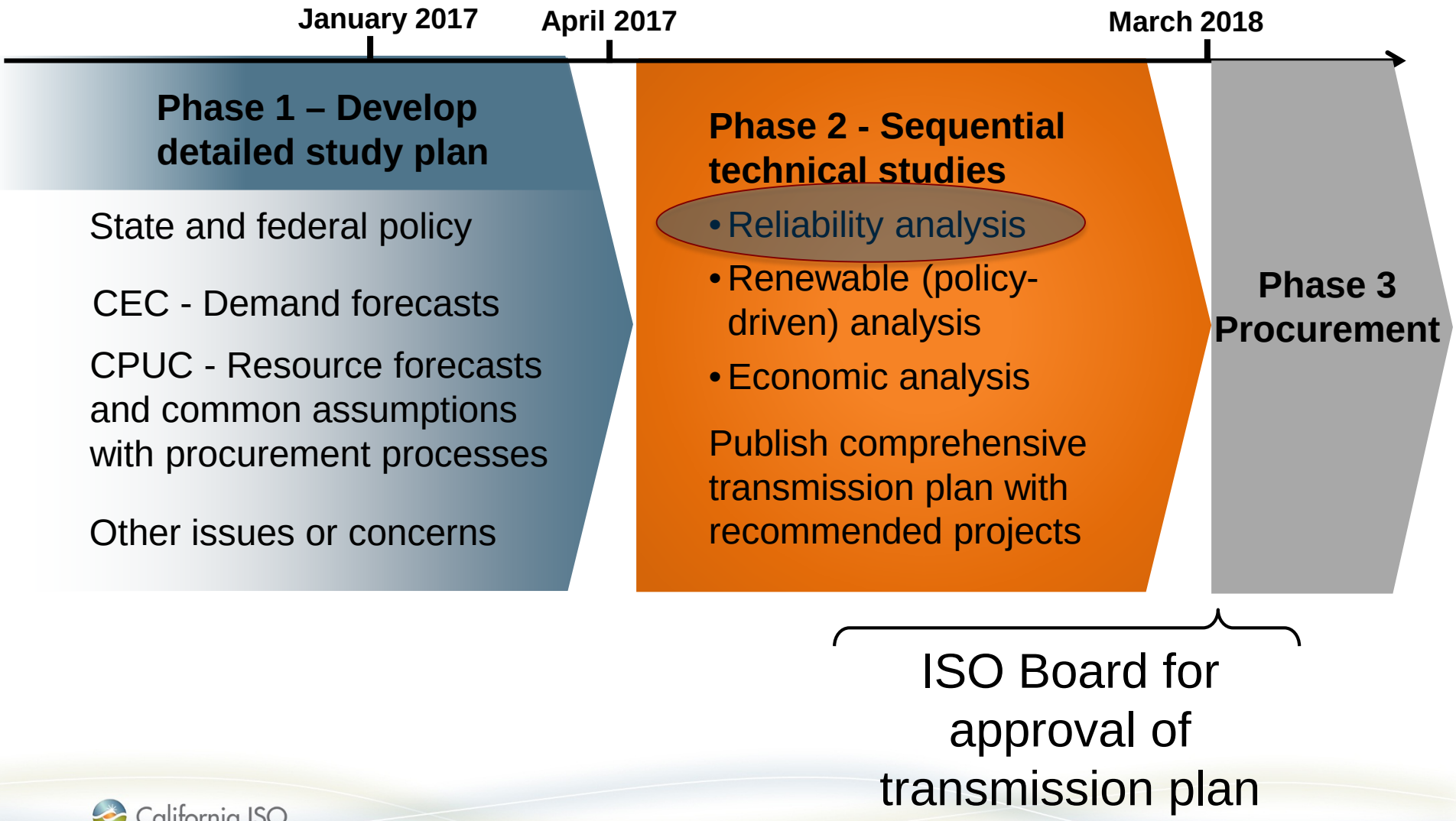
Topic	Presenter
Introduction	Kim Perez
SDG&E Proposed Reliability Solutions	SDG&E
VEA Proposed Reliability Solutions	VEA
GridLiance Proposed Reliability Solutions	GridLiance
PG&E Proposed Reliability Solutions	PG&E
Economic Study Assumptions	Yi Zhang
Special Studies updates	Sushant Barave/ Yi Zhang Shucheng Liu Irina Green
Next Steps	Kim Perez

Introduction and Overview
Preliminary Reliability Assessment Results

Jeff Billinton
Manager, Regional Transmission - North

2017-2018 Transmission Planning Process Stakeholder Meeting
September 21-22, 2017

2017-2018 Transmission Planning Process



2017-2018 Ten Year Reliability Assessment To Date

- Preliminary study results were posted on August 15
  - Based on assumptions identified in 2017-2018 Study Plan
  - Satisfy requirements of:
    - NERC Reliability Standards
    - WECC Regional Criteria
    - ISO Planning Standards
- Transmission request window (reliability driven projects) opened on August 15
  - PTO proposed mitigations submitted to ISO September 15

2017-2018 Ten Year Reliability Assessment going forward

- Comments on Stakeholder Meeting due October 6
- Request Window closes October 15
- 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, 2015

- 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 category D 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.

Key Issues influencing the 2017-2018 Study Plan
Transmission Planning Process

Neil Millar

Executive Director, Infrastructure Development

2017-2018 Transmission Planning Process Stakeholder Meeting

September 21, 2017

Coordination of input assumptions with California Energy Commission and Public Utilities Commission

- RPS portfolio direction for 2017-2018 transmission planning process was received from the CPUC/CEC
- As anticipated, the existing 33% RPS scenarios will continue to be used until direction is available on 50% RPS goals – likely 2018-2019
- Until then, no new policy-driven analysis is anticipated to be required
- Coordination on load forecasting and other modeling assumptions has continued as in the past
- The ISO is continuing to support the CPUC's IRP process

Selection of recommended reliability solutions, and consideration of non-conventional solutions

- Stakeholders have expressed interest in more discussion on the transmission plan on how reliability mitigations are selected and how preferred resources are assessed.
- More discussion will be included in the final plan
- Currently, we rely on judgment balancing environmental feasibility, cost, and technical performance in all selections
- Consideration of preferred resources takes into account previously established frameworks, but is evolving as we consider various applications
- Discussions of the Oakland area and the San Ysidro area will be particularly informative

Special study efforts from 2016-2017 are continuing into this year:

- Four special studies from last year are being updated this year:
  - Complete validation of updated generation models (extension of 2016-2017 efforts) *and update analysis in 2017-2018 TPP*
  - Complete the 50% RPS special study out of state analysis and coordination with the other western planning regions on interregional transmission project studies (extension of 2016-2017 efforts)
  - Complete large energy storage benefits analysis (extension of 2016-2017 efforts)
  - Continue to assess the ***system*** risks to reliability of economically driven early retirement of gas fired generation (now also an extension of the 2016-2017 efforts focusing on the Plexos analysis)

- Two special studies last year have migrated into regulatory processes:
  - Support gas-electric coordination issues through CPUC proceedings (regulatory process)
  - Further consideration of slow response resource characteristics for providing local resource adequacy (regulatory process)

The ISO Board has approved the proposal to remove the conceptual statewide plan requirement:

- Since 2010, the ISO has prepared and published the statewide plan as part of its annual planning process, initially developed to facilitate coordination with the California Transmission Planning Group (CTPG)
- Implementation of FERC Order No. 1000 has supplanted the need to develop the statewide plan
  - CTPG is no longer functioning and its members are focused on regional planning through Order 1000
  - The statewide plan no longer facilitates the coordination function it was intended to provide
  - ISO developing the plan on its own diverts resources away from Order 1000 activities
- After an ISO stakeholder process in May and June, the ISO Board approved the proposal on July 26.
- The change was filed with FERC on August 26 and we are awaiting a decision.

Western Planning Region Interregional coordination of data obligation and Anchor Data Set (ADS)

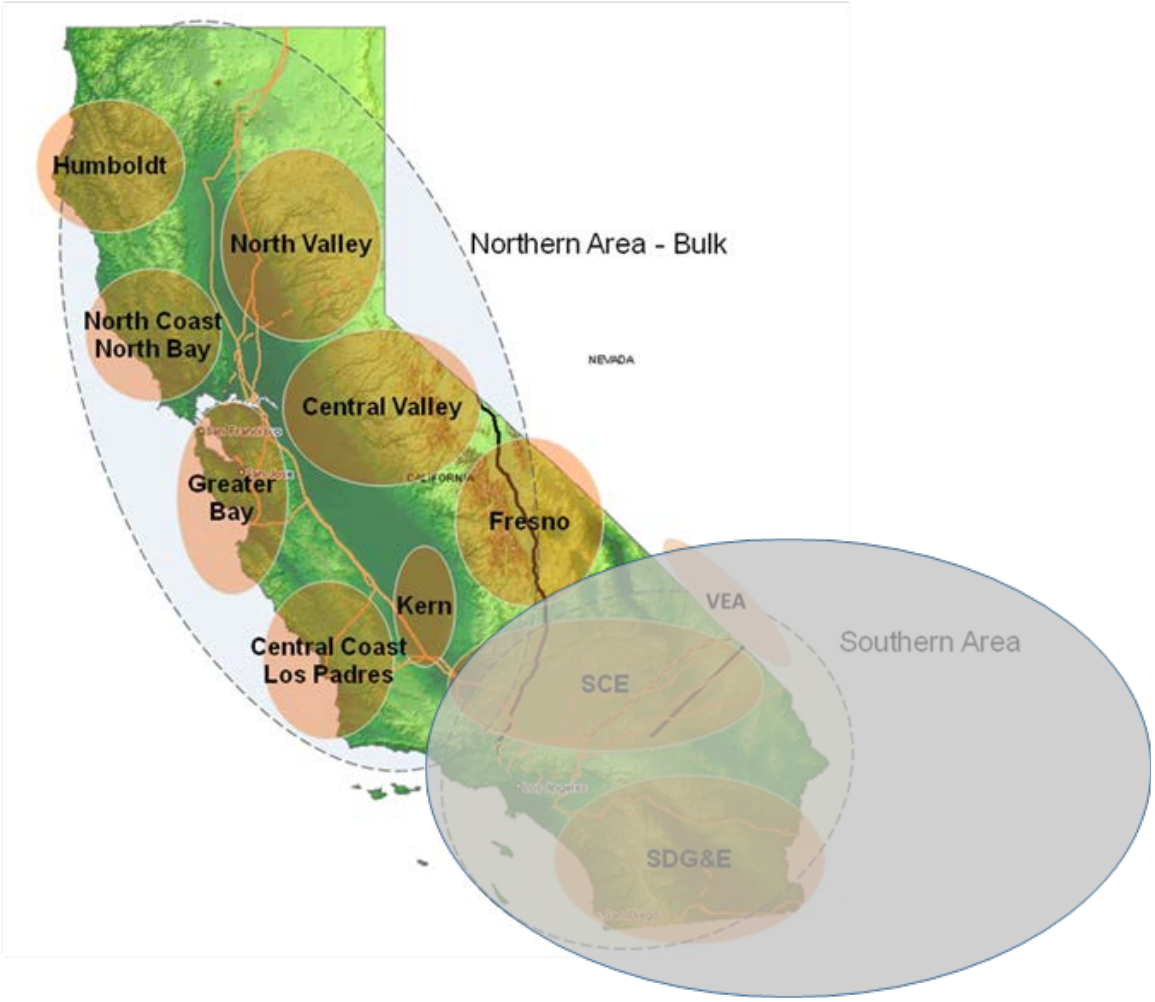
- WECC Board approved the creation of the ADS development process
  - "The ADS will include data used by the Western Planning Regions (WPR) to create regional plans that establish a common modeling foundation to be used by WECC, the WPRs and other stakeholders . . ."
- Western Planning Regions (WPR) and WECC collaborated on the development of the ADS Process Workflow
- WPRs coordinated their regional planning data to develop coordinated datasets for implementing the initial ADS
  - Coordinated 2026 power flow case provided to WECC in early August
  - Coordinated 2026 production cost model dataset provided to WECC middle of September
- Reliability Assessment Committee formed the ADS Task Force to provide guidance and recommendations on data process/protocols that will manage how WPR regional planning data is represented in the ADS
- Emerging concern will need to be managed that other non-WPR entities are seeking to "modify" the WPR data represented in the ADS

PG&E System - Overview
Preliminary Reliability Assessment Results

Binaya Shrestha
Regional Transmission Engineer Lead

2017-2018 Transmission Planning Process Stakeholder Meeting
September 21-22, 2017

PG&E Study Areas



Presentations

- **Northern Area – Bulk**

- **PG&E Local Areas:**
  - Humboldt area
  - North Coast and North Bay area
  - North Valley area
  - Central Valley area
  - Greater Bay area:
  - Greater Fresno area;
  - Kern area;
  - Central Coast and Los Padres areas

- **Voltage Assessment**

Modeling of Projects in Base Cases

- Each local area presentation will identify which previously approved projects were modelled in the base cases
- Previously approved projects not modelled in base cases
  - Started with projects on hold in 2016-2017 Transmission Plan
  - Additional projects were not modeled based on review of changes in assumptions and prior reliability assessment
  - Need and scope review conducted on not modelled projects
- Previously approved projects modelled in base cases
  - Projects modeled are still required to meet reliability needs

Local Area Presentation Layout

- Each local area presentation will have following layout:
  - Area introduction
  - Base case summary
  - Previously approved projects modeled in base cases
  - Previously approved projects not modeled in base cases
  - Summary of reliability needs identified in the area
  - Need and scope review of not modeled projects
  - Areas of additional mitigation requirement
  - Summary of sensitivity study assessment

Base case summary

Each local area presentation will include slide on base case summary with following information as modeled in the study database:

- Load & load modifier assumptions:
  - Gross load
  - Additional achievable energy efficiency
  - Behind-the-meter PV
  - Demand response
  - Net load
- Generation assumptions:
  - Battery storage
  - Solar
  - Wind
  - Thermal

Voltage Assessment

- System wide voltage assessment conducted
  - Voltage assessment will be presented as a separate presentation and not in local areas
- Review of voltage projects
  - Similar to the local area assessment the voltage project needs were reviewed

Greater Bay Area
Preliminary Reliability Assessment Results

Binaya Shrestha
Regional Transmission Engineer Lead

2017-2018 Transmission Planning Process Stakeholder Meeting
September 21-22, 2017

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

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)
GBA-2019-SP	Baseline	2019 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	8,583	239	1,011	336	8,008	161	73
GBA-2022-SP	Baseline	2022 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	8,809	389	1,303	441	7,980	161	73
GBA-2027-SP	Baseline	2027 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	9,251	669	2,145	734	7,848	161	73
GBA-2019-WP	Baseline	2019 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	8,128	245	1,011	0	7,883	161	73
GBA-2022-WP	Baseline	2022 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	8,335	402	1,303	0	7,933	161	73
GBA-2027-WP	Baseline	2027 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	8,748	708	2,145	0	8,040	161	73
GBA-2019-ML	Baseline	2019 spring light load conditions. Light load time - hours between 02:00 and 04:00.	4,644	164	1,011	0	4,480	161	73
GBA-2022-SOP	Baseline	2022 spring off-peak load conditions. Off-peak load time – weekend morning.	7,141	305	1,303	1,231	5,605	161	73
GBA-2022-SP-PS-AAEE	Sensitivity	2022 summer peak load conditions with peak-shift and AAEE sensitivity	8,902	0	1,303	169	8,732	161	73
GBA-2019-SP-PS	Sensitivity	2019 summer peak load conditions with peak-shift sensitivity	8,687	239	1,011	207	8,241	161	73
GBA-2027-SP-PS	Sensitivity	2027 summer peak load conditions with peak-shift sensitivity	9,290	669	2,145	197	8,424	161	73
GBA-2022-SP-HiRenew	Sensitivity	2022 summer peak load conditions with hi renewable dispatch sensitivity	8,759	339	1,303	441	7,980	161	73
GBA-2027-SP-QF	Sensitivity	2027 summer peak load conditions with QF retirement sensitivity	9,251	669	2,145	734	7,848	161	73

Note:

DR and storage are modeled offline in starting base cases.

Generation Assumptions - Greater Bay 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)
GBA-2019-SP	Baseline	2019 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	4	25	6	259	79	0	0	6,850	4,507
GBA-2022-SP	Baseline	2022 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	4	25	6	259	79	0	0	6,850	4,517
GBA-2027-SP	Baseline	2027 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	4	25	6	259	79	0	0	6,850	4,528
GBA-2019-WP	Baseline	2019 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	4	25	0	259	108	0	0	6,850	4,166
GBA-2022-WP	Baseline	2022 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	4	25	0	259	96	0	0	6,850	3,289
GBA-2027-WP	Baseline	2027 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	4	25	0	259	119	0	0	6,850	4,432
GBA-2019-ML	Baseline	2019 spring light load conditions. Light load time - hours between 02:00 and 04:00.	4	25	0	259	24	0	0	6,850	2,093
GBA-2022-SOP	Baseline	2022 spring off-peak load conditions. Off-peak load time – weekend morning.	4	25	25	259	238	0	0	6,850	1,189
GBA-2022-SP-PS-AAEE	Sensitivity	2022 summer peak load conditions with peak-shift and AAEE sensitivity	4	25	6	259	79	0	0	6,850	4,516
GBA-2019-SP-PS	Sensitivity	2019 summer peak load conditions with peak-shift sensitivity	4	25	6	259	79	0	0	6,850	4,401
GBA-2027-SP-PS	Sensitivity	2027 summer peak load conditions with peak-shift sensitivity	4	25	6	259	79	0	0	6,850	4,556
GBA-2022-SP-HiRenew	Sensitivity	2022 summer peak load conditions with hi renewable dispatch sensitivity	4	25	25	259	238	0	0	6,850	2,150
GBA-2027-SP-QF	Sensitivity	2027 summer peak load conditions with QF retirement sensitivity	4	25	6	259	79	0	0	6,850	4,530

Note:

DR and storage are modeled offline in starting base cases.

Previously Approved Transmission Projects Modelled in base cases

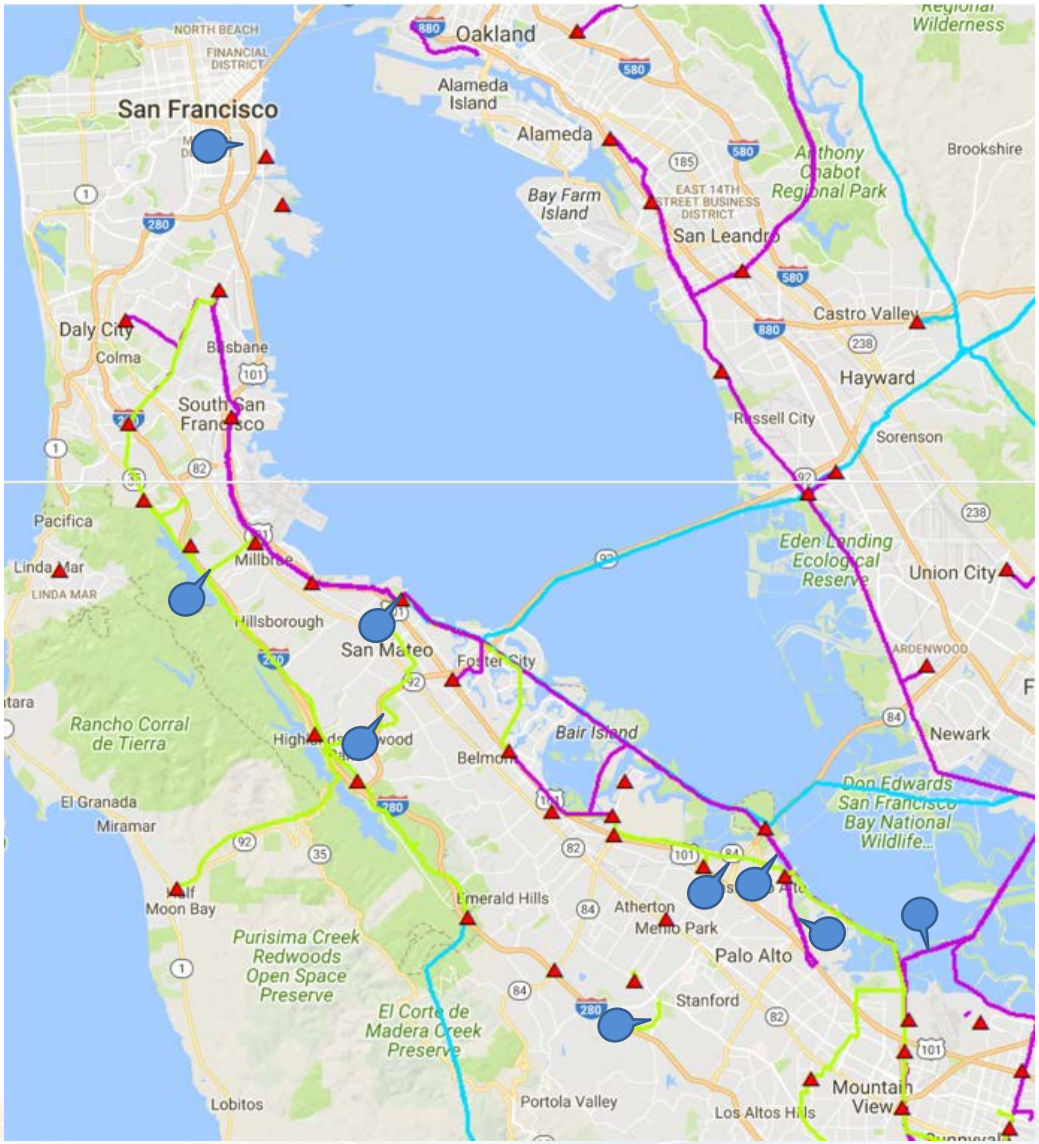
Project Name	First Year Modeled
Christie 115/60 kV Transformer No. 2	2019
Contra Costa Sub 230 kV Switch Replacement	2019
Cooley Landing 115/60 kV Transformer Capacity Upgrade	2019
NRS-Scott No. 1 115 kV Line Reconductor	2019
East Shore-Oakland J 115 kV Reconductoring Project	2022
Metcalf-Piercy & Swift and Newark-Dixon Landing 115 kV Upgrade	2022
Monte Vista 230 kV Bus Upgrade	2022
North Tower 115 kV Looping Project	2022
Pittsburg 230/115 kV Transformer Capacity Increase	2022
Martin 230 kV Bus Extension	2027

Previously Approved Transmission Projects Not modelled in base cases

Project Name	In-service Date
Metcalf-Evergreen 115 kV Line Reconductoring	May-19
Los Esteros 230 kV Substation Shunt Reactor	Sep-19
Ravenswood – Cooley Landing 115 kV Line Reconductor	Jan-21
Los Esteros-Montague 115 kV Substation Equipment Upgrade	Mar-21
Moraga-Castro Valley 230 kV Line Capacity Increase Project	Mar-21
Spring 230/115 kV substation near Morgan Hill	May-21
Evergreen-Mabury Conversion to 115 kV	Jun-21
San Mateo – Bair 60 kV Line Reconductor	May-23
South of San Mateo Capacity Increase	Feb-29
Jefferson - Stanford #2 60 kV Line	TBD

Summary of Reliability Needs Identified

SF / Peninsula



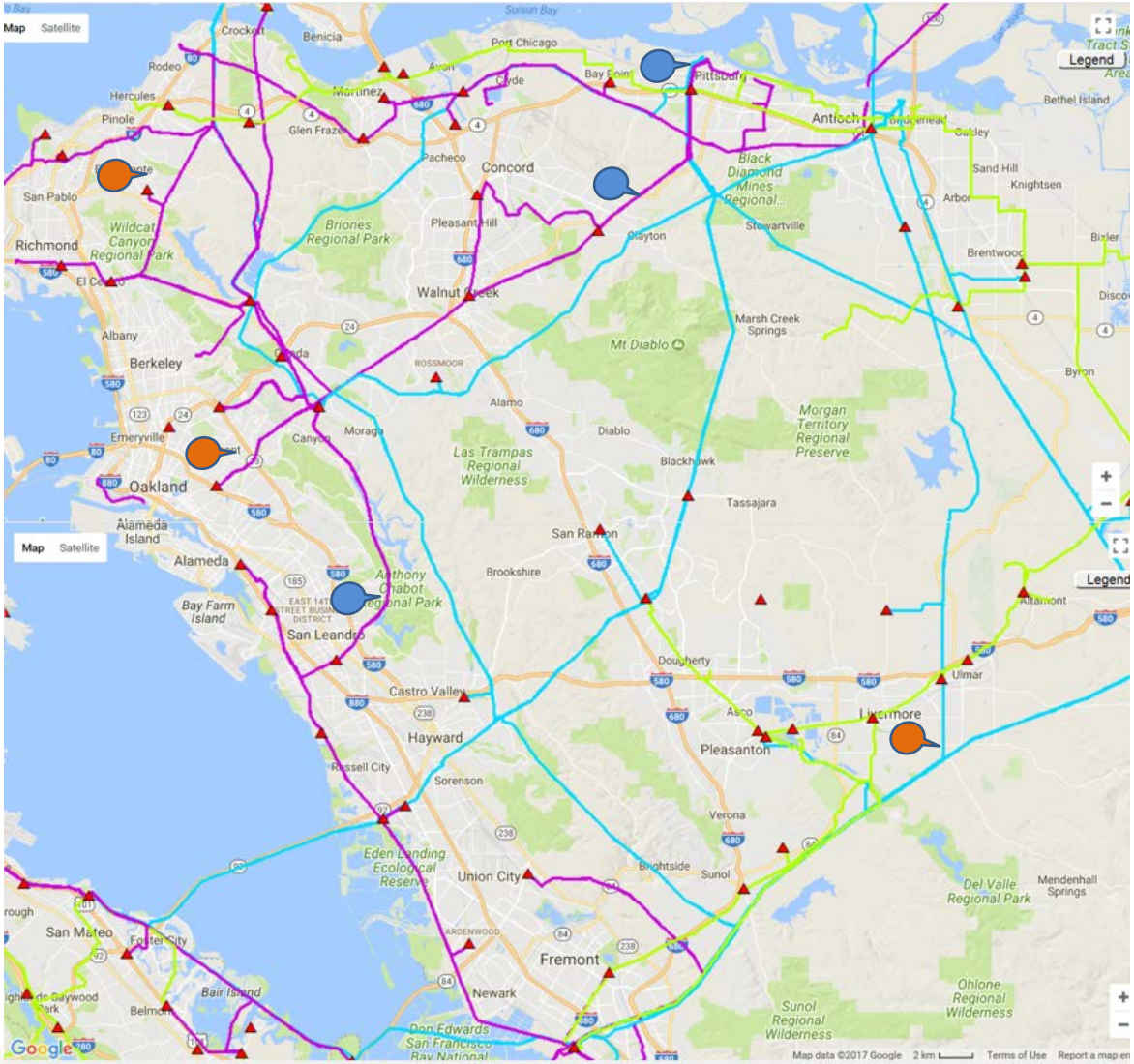
	Facility identified with thermal overload mitigated by previously approved project.
	Facility identified with thermal overload not mitigated by previously approved project.

High voltages observed mainly in 60 kV system in 2019 minimum load. Low voltages also observed in 60 kV system for loss of 230 kV source at Jefferson.

Map source: PG&E solar photovoltaic and renewable auction mechanism (PV RAM) project map

Summary of Reliability Needs Identified

East Bay / Diablo / Mission



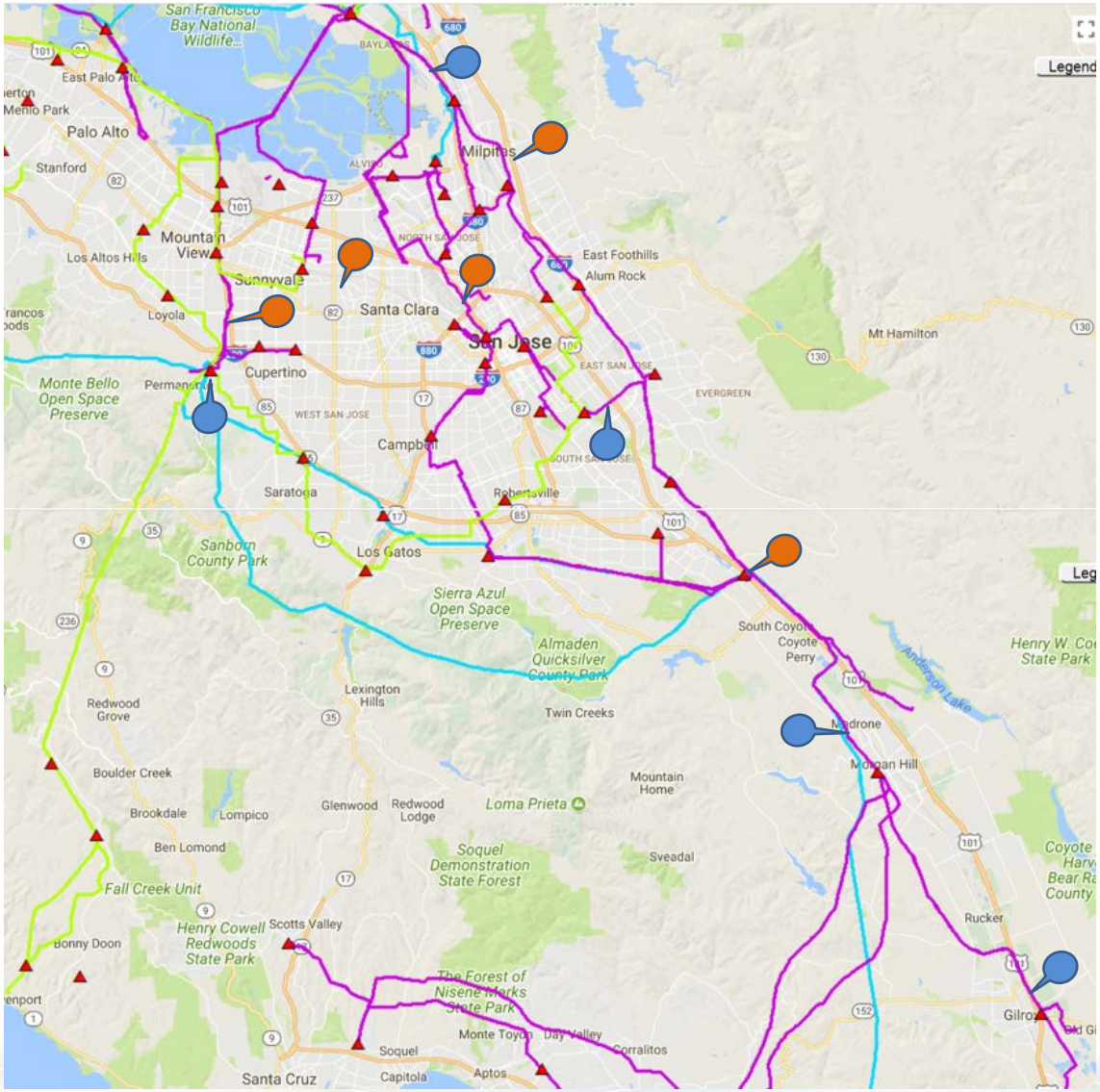
	Facility identified with thermal overload mitigated by previously approved project.
	Facility identified with thermal overload not mitigated by previously approved project.

High voltages observed mainly in sub-transmission (115 & 60 kV) system in 2019 minimum load, 2019 summer peak and 2022 off-peak cases.

Map source: PG&E solar photovoltaic and renewable auction mechanism (PV RAM) project map

Summary of Reliability Needs Identified

San Jose / De Anza



	Facility identified with thermal overload mitigated by previously approved project.
	Facility identified with thermal overload not mitigated by previously approved project.

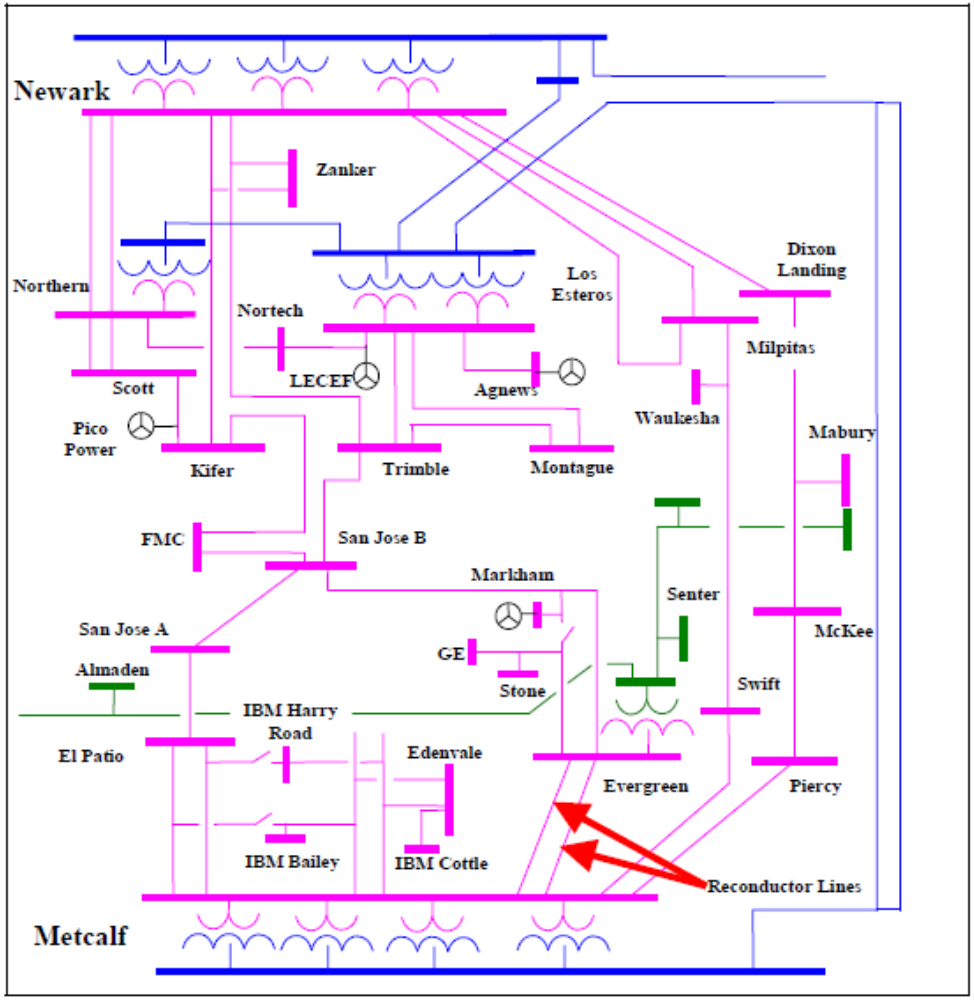
High voltages observed mainly in sub-transmission (115 & 60 kV) system in 2019 minimum load, 2019 summer peak and 2022 off-peak cases. Low voltage also observed in 60 kV system for Monta Vista 230 kV bus and breaker outages.

Map source: PG&E solar photovoltaic and renewable auction mechanism (PV RAM) project map

Assessment of previously approved projects not modeled in base cases

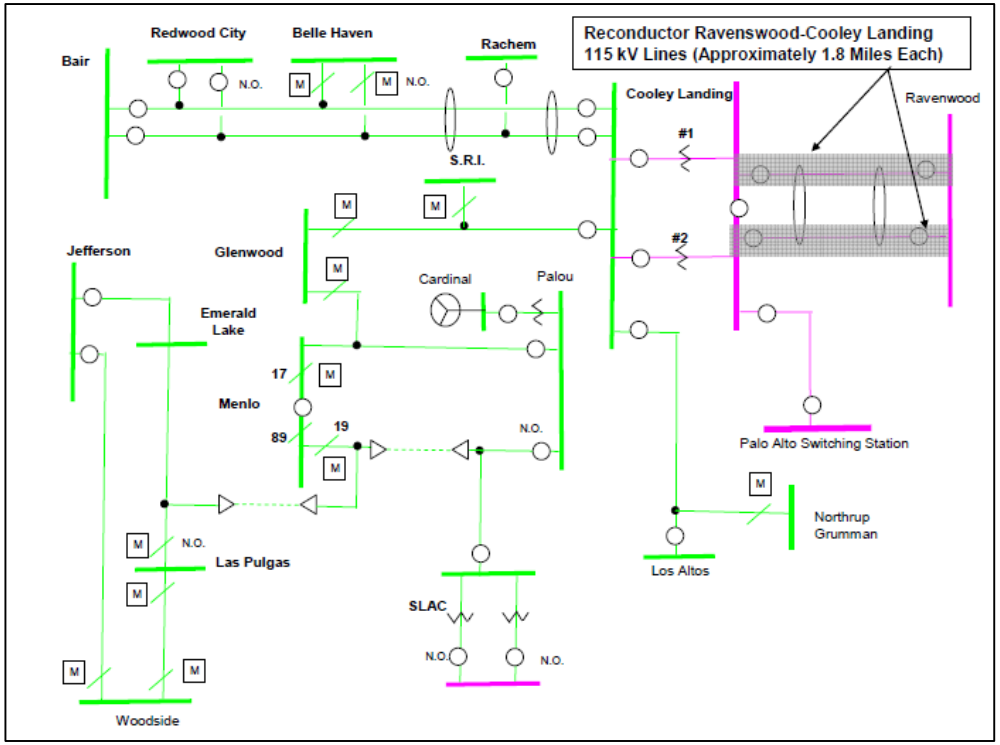
Metcalf-Evergreen 115 kV Line Reconductoring

- Original need
  - 2001 TPP: NERC Category P1 thermal overload.
- Reliability Assessment Need
  - NERC Categories P2 and P6 thermal overloads in multiple sensitivity scenarios including two peak-shift sensitivities.
- Mitigation still required {or not}
  - Mitigation required for reliability
  - Also needed in the Bay Area for LCR in San Jose sub-area.
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads. Under review for potential alternative solutions.
- Alternatives
  - Power flow control device
- Preliminary Conclusion
  - Original scope of reconductoring Metcalf-Evergreen 115 kV lines.



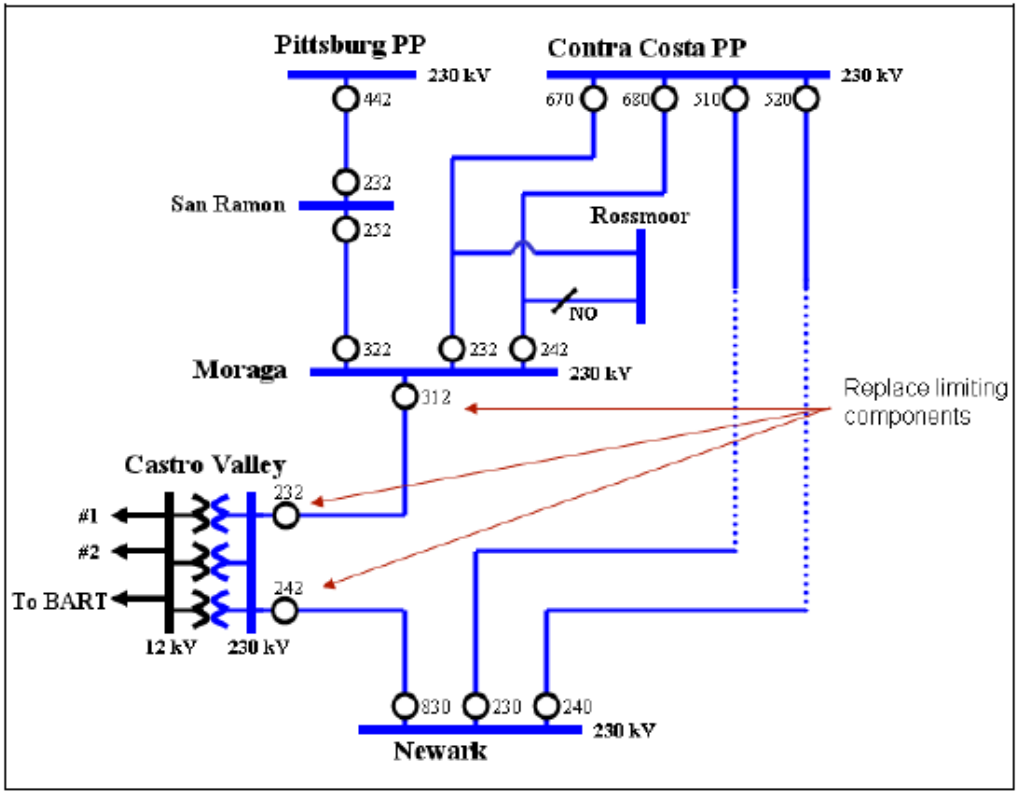
Ravenswood – Cooley Landing 115 kV Line Reconductor

- Original need
  - 2009 TPP: NERC Category P3 thermal overload.
- Reliability Assessment Need
  - NERC Category P2, P6 and P7 thermal overloads in baseline.
  - Overloads worsen in peak-shift and high CEC forecast sensitivities.
- Mitigation still required {or not}
  - Mitigation required for reliability
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads. Under review for potential alternative solutions due to potential interaction with south of San Mateo capacity increase project, San Mateo – Bair 60 kV line reconductor project and potential mitigation need for Palo Alto 115 kV lines.
- Alternatives
  - Cooley Landing 115 kV bus upgrade
  - New 115 kV source to Palo Alto
  - Normally close tie between Ames and Monta Vista 115 kV systems.
- Preliminary Conclusion
  - Original scope of reconductoring Ravenswood-Cooley Landing 115 kV lines.



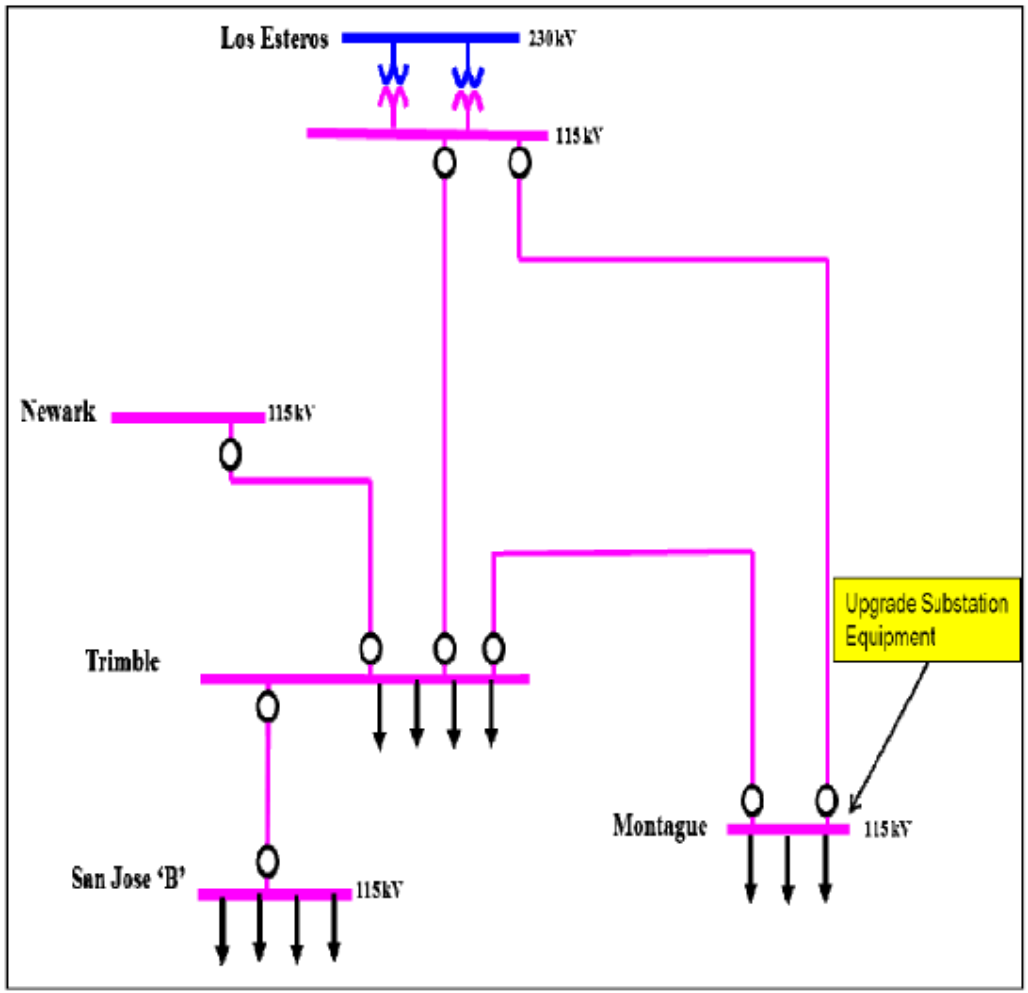
Moraga-Castro Valley 230 kV Line Capacity Increase Project

- Original need
  - 2010-2011 TPP: NERC Category P3 and P6 thermal overloads.
- Reliability Assessment Need
  - None.
- Mitigation still required {or not}
  - Mitigation not required for reliability
  - Mitigation not required for LCR
  - Needed for generation deliverability
- Review of current project to meet need
  - Not applicable
- Alternatives
  - Not applicable
- Preliminary Conclusion
  - Project needed for generation deliverability



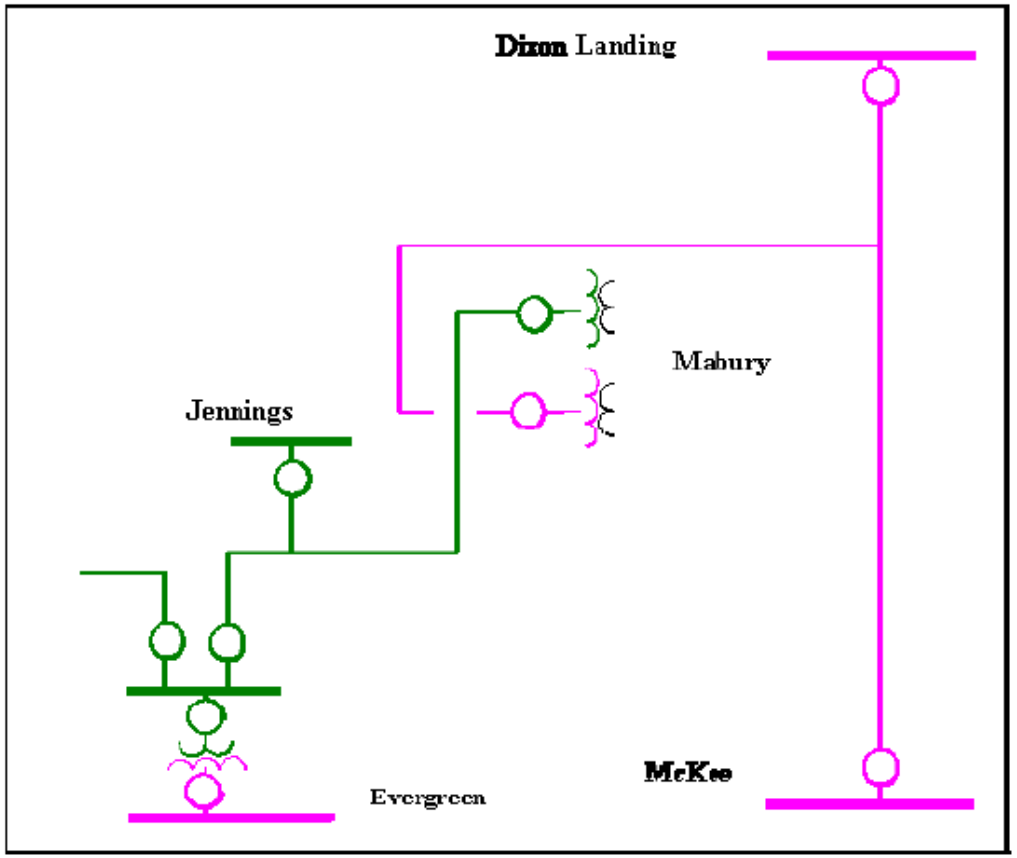
Los Esteros-Montague 115 kV Substation Equipment Upgrade

- Original need
  - 2012-2013 TPP: NERC Category P1 thermal overload.
- Reliability Assessment Need
  - NERC Category P6 thermal overload in high CEC forecast sensitivity.
- Mitigation still required {or not}
  - Mitigation not required for reliability
  - Mitigation not required for LCR
  - Mitigation not required for gen deliverability
- Review of current project to meet need
  - Not applicable
- Alternatives
  - Not applicable
- Preliminary Conclusion
  - Cancel



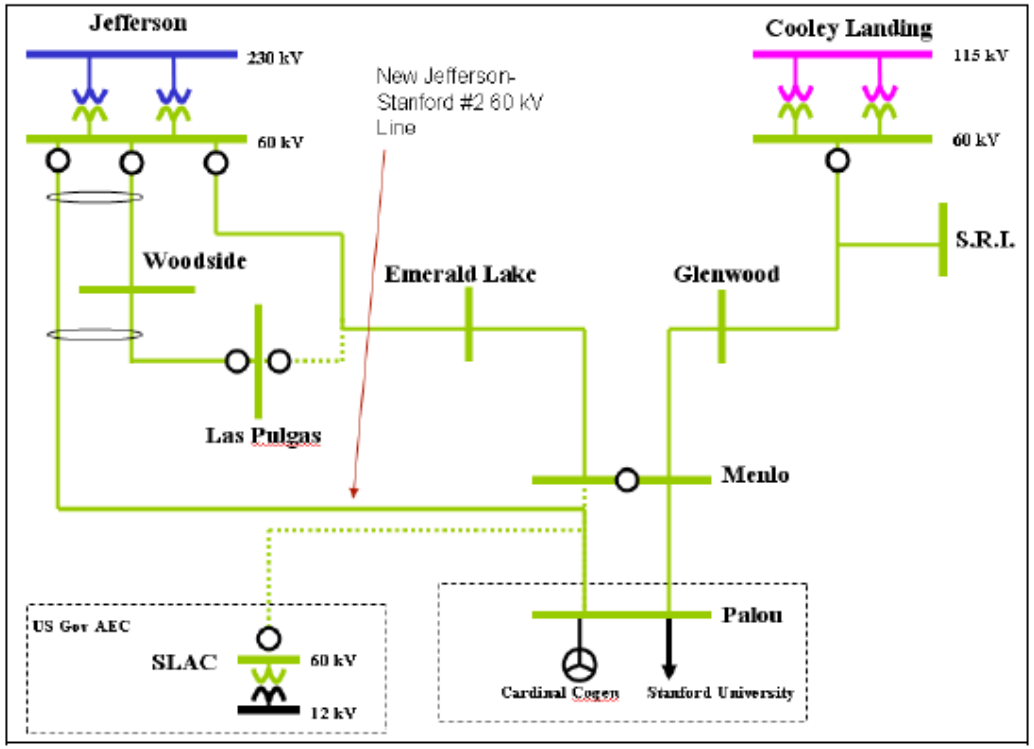
Evergreen-Mabury Conversion to 115 kV

- Original need
  - 2009 TPP: Reliability to customers served from Mabury Substation and NERC Category P1 thermal overload.
- Reliability Assessment Need
  - NERC Category P1, P2 and P7 thermal overloads in baseline in 2019 only.
  - Overloads worsen in 2019 peak-shift sensitivity.
- Mitigation still required {or not}
  - Mitigation not required for reliability with Metcalf - Piercy & Swift and Newark - Dixon Landing 115 kV Upgrade project
  - Mitigation not required for LCR
  - Mitigation not required for gen deliverability
- Review of current project to meet need
  - Metcalf - Piercy & Swift and Newark - Dixon Landing 115 kV Upgrade project mitigates identified needs.
- Alternatives
  - Replace 60 kV distribution bank with 115/60/12 kV distribution bank (reduced scope)
- Preliminary Conclusion
  - Reduced scope with BCR or cancel



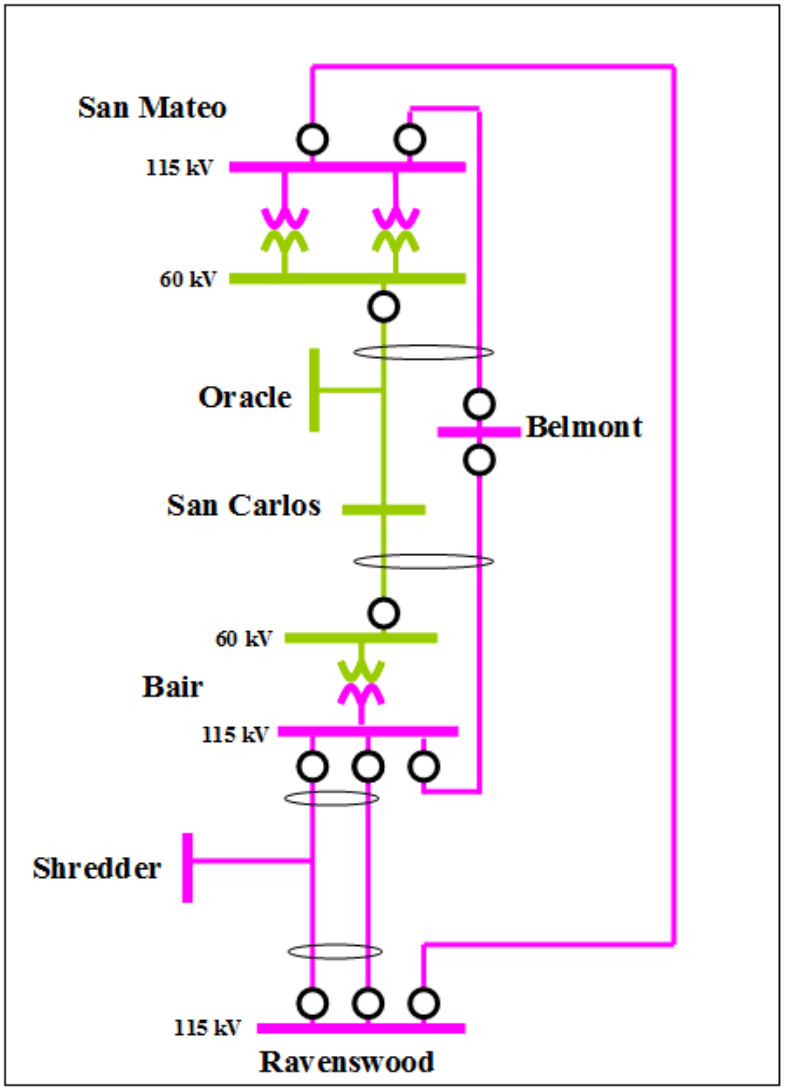
Jefferson - Stanford #2 60 kV Line

- Original need
  - 2010-2011 TPP: NERC Category P3 thermal overload.
- Reliability Assessment Need
  - NERC Category P2, P5, P6 and P7 thermal overloads in baseline.
  - Overloads worsen in peak-shift and high CEC forecast sensitivities..
- Mitigation still required {or not}
  - Mitigation required for reliability
- Review of current project to meet need
  - Current needs are driven by proposed interim system reconfiguration.
  - Project scope does mitigate original need.
- Alternatives
  - Not applicable
- Preliminary Conclusion
  - Remain on hold for further review of load uncertainty and interim system reconfiguration.



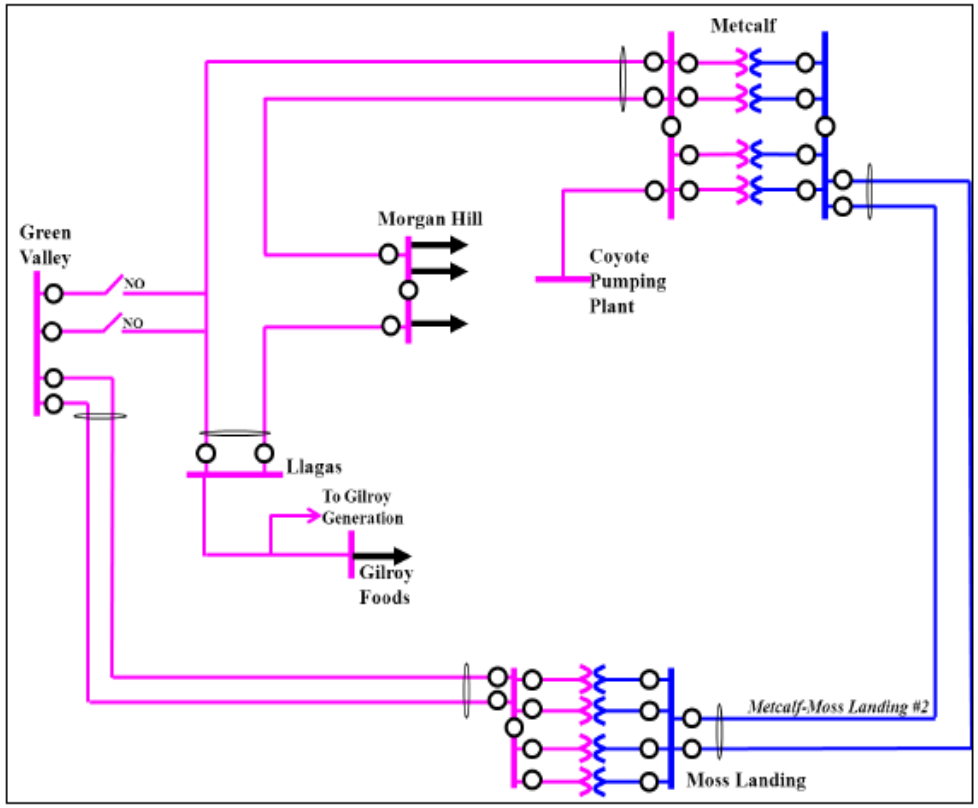
San Mateo – Bair 60 kV Line Reconductor

- Original need
  - 2009 TPP: NERC Category P1 thermal overload.
- Reliability Assessment Need
  - NERC Category P2 and P6 thermal overloads in baseline.
  - Overloads worsen in peak-shift and high CEC forecast sensitivities.
- Mitigation still required {or not}
  - Mitigation required for reliability
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads. Under review for potential alternative solutions due to potential interaction with Ravenswood-Cooley Landing 115 kV Reconductor project.
- Alternatives
  - Cooley Landing 115 kV bus upgrade
- Preliminary Conclusion
  - Further review.



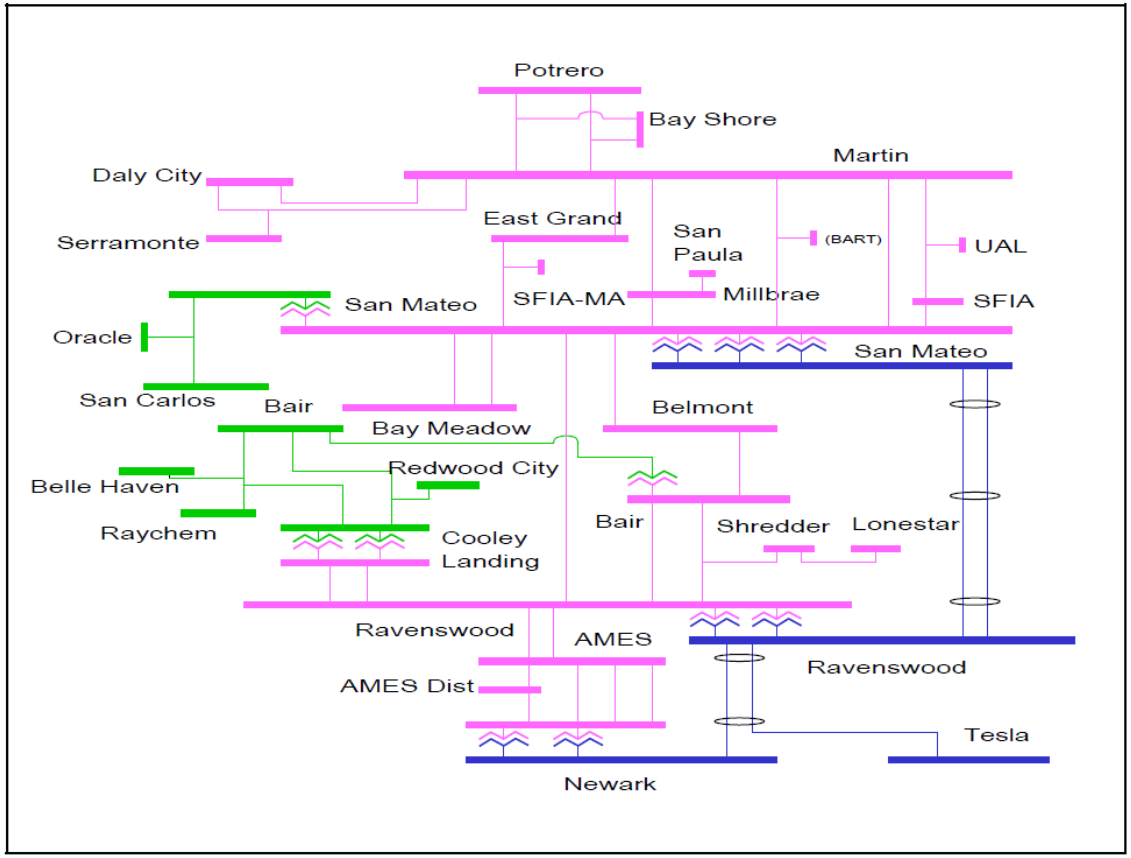
Morgan Hill Area Reinforcement (Spring)

- Original need
  - 2013-2014 TPP: NERC Category P6 thermal overload and low voltage.
  - Loss of close to 200 MW load and 300 MW of generation for NERC category P7 (DCTL) outage.
- Reliability Assessment Need
  - Similar to original
- Mitigation still required {or not}
  - Mitigation required for reliability
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads. Under review for potential alternative solutions.
- Alternatives
  - Reconductor Green Valley-Llagas 115 kV line and normally close ties with Green Valley 115 kV system.
  - Restructure Metcalf-Green Valley 115 kV line into Green Valley-Morgan Hill 115 kV. Keep the tie normally open and automatic closing for contingency on either side.
  - Morgan Hill-Gilroy-Coyote Reinforcement.
- Preliminary Conclusion
  - Further review



South of San Mateo Capacity Increase

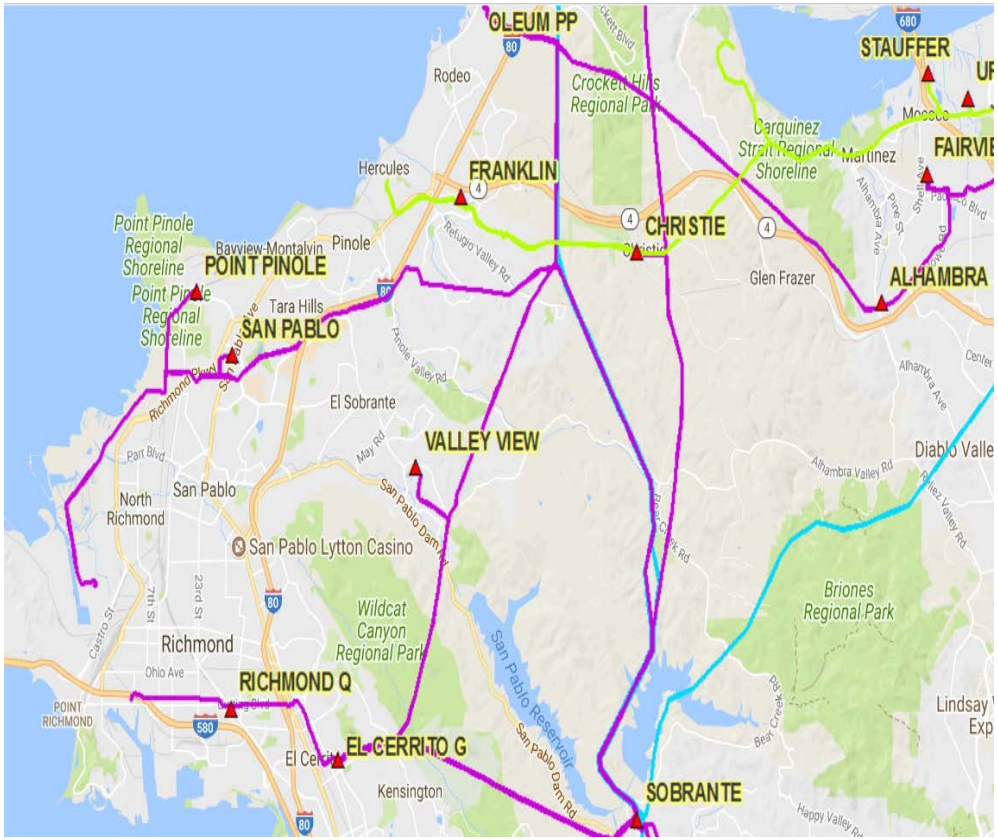
- Original need
  - 2007 TPP: Bay Area LCR
- Reliability Assessment Need
  - NERC Categories P6 thermal overloads in baseline winter scenario w/o SPS action and multiple sensitivity scenarios including two peak-shift sensitivities.
- Mitigation still required {or not}
  - Mitigation required for reliability
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads. Under review for potential alternative solutions due to feasibility and potential interaction with Ravenswood-Cooley Landing 115 kV Reconductor project.
- Alternatives
  - New 115 kV source to Palo Alto
  - Normally close tie between AMES and Monta Vista 115 kV systems.
- Preliminary Conclusion
  - Further review of normally closing tie between AMES and Monta Vista 115 kV systems alternative



Areas of additional mitigation requirement

Additional Mitigation Requirements
Oleum-Martinez 115 kV system

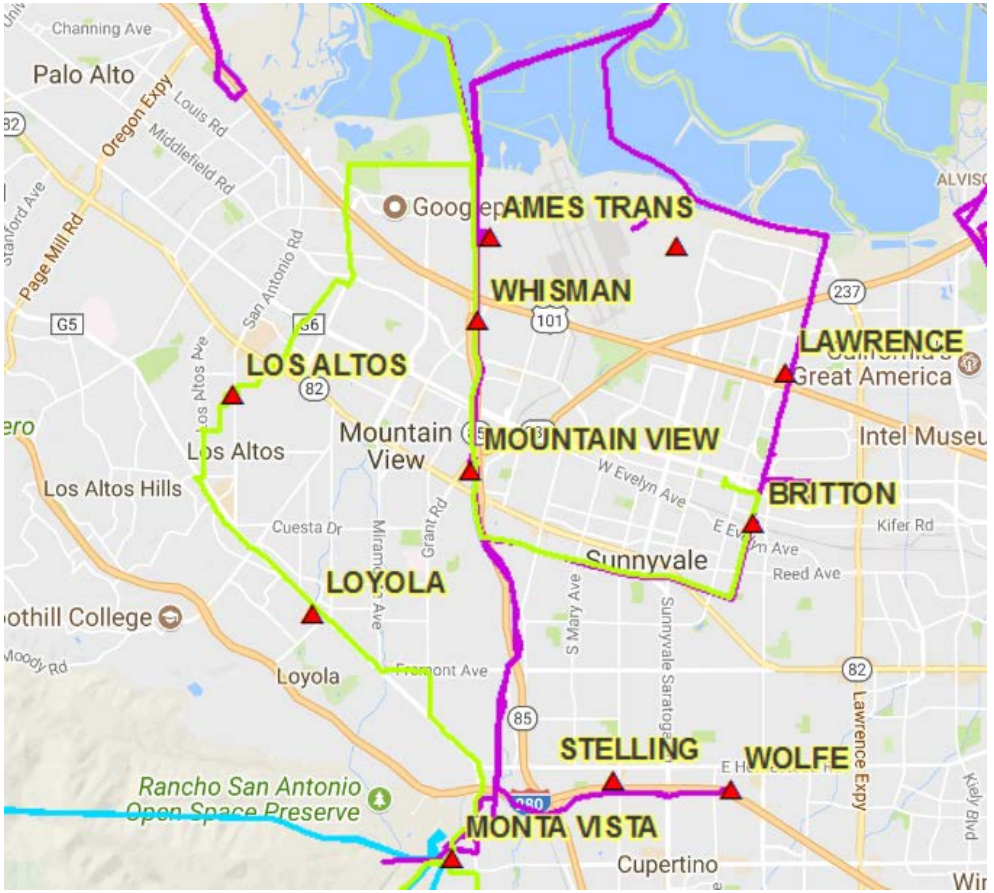
- Reliability Assessment Need
  - NERC Categories P2 and P7 thermal overloads in multiple facilities.
  - Overloads worsen in peak-shift and high CEC forecast sensitivities.
- Potential Alternatives
  - Substation upgrade at Sobrante 115 kV and Pittsburg 230 kV for P2 and rerate or preferred resource for P7
  - New 230 kV source to Oleum
- First Year of Need identified in Current Assessment
  - 2019
- Interim Mitigation
  - Action plan



Map source: PG&E solar photovoltaic and renewable auction mechanism (PV RAM) project map

Additional Mitigation Requirements
Monta Vista – Newark 115 kV Lines

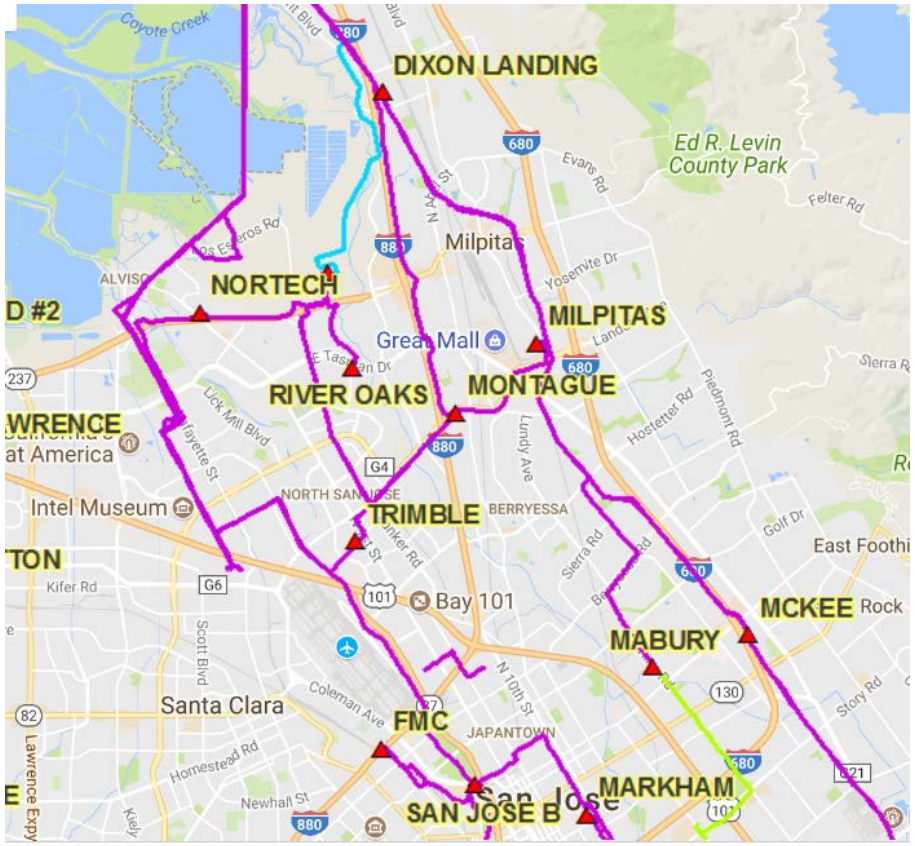
- Reliability Assessment Need
  - NERC Categories P6 and P7 thermal overloads in multiple facilities.
  - Overloads worsen in peak-shift and high CEC forecast sensitivities.
- Potential Alternatives
  - Preferred resource
  - Rerate
  - Reconductor
- First Year of Need identified in Current Assessment
  - 2019
- Interim Mitigation
  - Action plan



Map source: PG&E solar photovoltaic and renewable auction mechanism (PV RAM) project map

Additional Mitigation Requirements
Newark-Milpitas & Trimble-San Jose 'B‘ 115 kV Lines

- Reliability Assessment Need
  - NERC Categories P2, P6 and P7 thermal overloads in baseline.
  - Overloads worsen in peak-shift and high CEC forecast sensitivities.
- Potential Alternatives
  - Preferred resource
  - Rerate
  - Reconductor
- First Year of Need identified in Current Assessment
  - 2019
- Interim Mitigation
  - Action plan

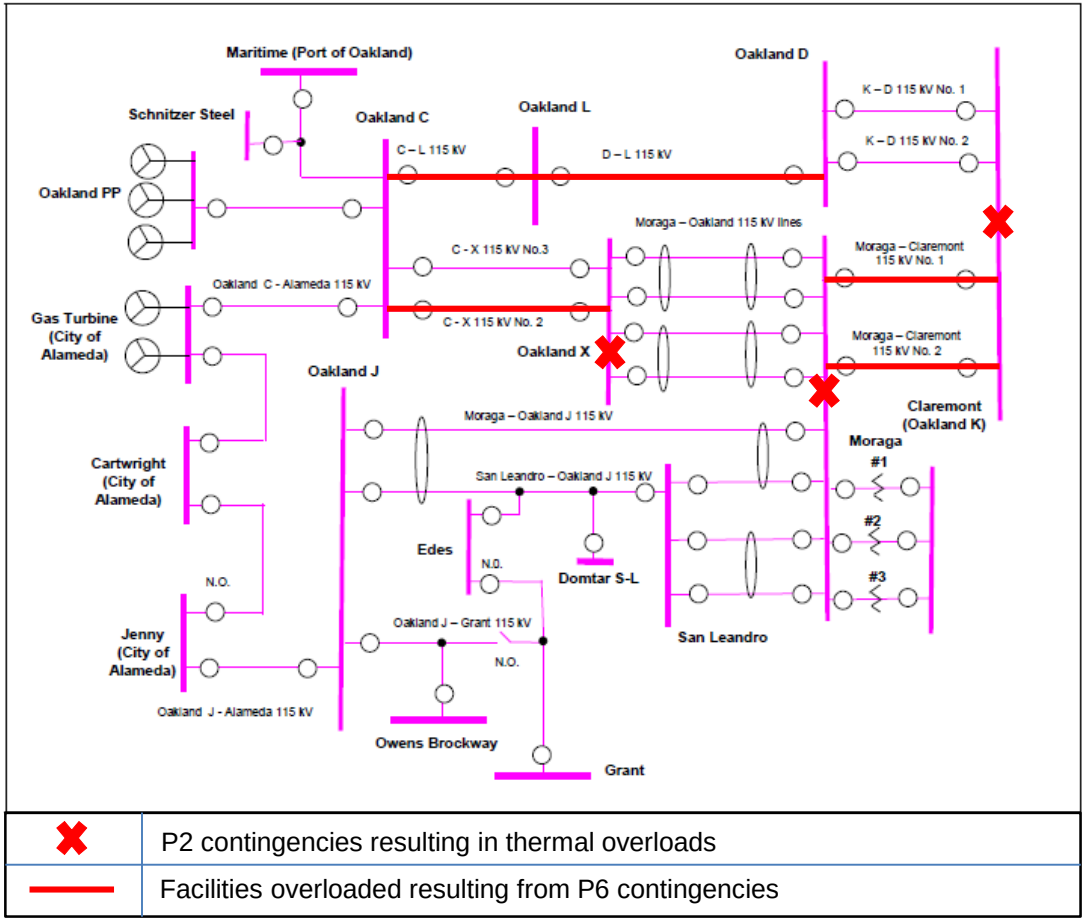


Map source: PG&E solar photovoltaic and renewable auction mechanism (PV RAM) project map

Additional Mitigation Requirements

East Bay Area Long-Term Need without Local Generation

- Reliability Assessment Need
  - NERC Categories P2 and P6 thermal overloads in multiple facilities.
  - Overloads worsen in peak-shift and high CEC forecast sensitivities.
- Potential Alternatives
  - Substation upgrade at Moraga 115 kV and Oakland X 115 kV for P2 and Alameda load transfer and preferred resource for P6
  - New 115 kV line to Maritime, Oakland C or Oakland D
  - New 230 kV source to vicinity of existing Oakland C
  - Generation repower
- First Year of Need identified in Current Assessment without local generation
  - 2019
- Interim Mitigation
  - Local generation
  - Existing SPS



Sensitivity Study Assessment

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

Overloaded Facility	Category	2022 SP High CEC Forecast	2019 SP Peak-Shift	2027 SP Peak-Shift	2022 SP Heavy Renewable & Min Gas Gen	2027 Retirement of QF Generations
Los Esteros-Montague 115 kV Line	P6	√				
Metcalf 230/115 kV Trans No. 3	P2	√	√	√		
Metcalf-El Patio No. 2 115 kV Line	P2	√		√		
Metcalf-Evergreen No. 1 115 kV Line	P2	√				
San Jose 'B'-Stone-Evergreen 115 kV Line	P2	√		√		
Stone-Evergreen-Metcalf 115kV Line	P2	√		√		
Stone-Evergreen-Metcalf 115kV Line	P6	√	√	√		
Monta Vista 230/115 kV Trans No. 2	P6	√		√		
Monta Vista 230/115 kV Trans No. 3	P6	√				
Monta Vista 230/115 kV Trans No. 4	P6	√		√		
Whisman-Monta Vista 115 kV Line	P6		√			
Las Positas-Newark 230kV Line	P2			√	√	√

Humboldt Area
Preliminary Reliability Assessment Results

Bryan Fong
Senior Regional Transmission Engineer

2017-2018 Transmission Planning Process Stakeholder Meeting
September 21-22, 2017

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

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)
HUMB-2019-SP	Baseline	2019 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	140	10	14	5	126	4	3
HUMB-2022-SP	Baseline	2022 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	145	17	19	6	122	4	3
HUMB-2027-SP	Baseline	2027 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	155	30	30	10	115	4	3
HUMB-2019-WP	Baseline	2019 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	151	10	14	0	141	4	3
HUMB-2022-WP	Baseline	2022 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	157	17	19	0	140	4	3
HUMB-2027-WP	Baseline	2027 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	171	31	30	0	140	4	3
HUMB-2019-ML	Baseline	2019 spring light load conditions. Light load time - hours between 02:00 and 04:00.	80	7	14	0	73	4	3
HUMB-2022-SOP	Baseline	2022 spring off-peak load conditions. Off-peak load time – weekend morning.	119	13	19	18	89	4	3
HUMB-2022-SP-PS-AAEE	Sensitivity	2022 summer peak load conditions with peak-shift and AAEE sensitivity	122	0	19	2	119	4	3
HUMB-2019-SP-PS	Sensitivity	2019 summer peak load conditions with peak-shift sensitivity	116	13	14	3	101	4	3
HUMB-2027-SP-PS	Sensitivity	2027 summer peak load conditions with peak-shift sensitivity	135	40	30	3	92	4	3
HUMB-2022-SP-HiRenew	Sensitivity	2022 summer peak load conditions with hi renewable dispatch sensitivity	134	14	19	19	101	4	3
HUMB-2027-SP-QF	Sensitivity	2027 summer peak load conditions with QF retirement sensitivity	171	31	30	0	140	4	3

Note:

DR and storage are modeled offline in starting base cases.

Generation Assumptions – Humboldt 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)
HUMB-2019-SP	Baseline	2019 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	0	0	0	0	0	0	0	264	125
HUMB-2022-SP	Baseline	2022 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	0	0	0	0	0	0	0	264	126
HUMB-2027-SP	Baseline	2027 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	0	0	0	0	0	0	0	264	110
HUMB-2019-WP	Baseline	2019 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	0	0	0	0	0	0	0	264	83
HUMB-2022-WP	Baseline	2022 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	0	0	0	0	0	0	0	264	166
HUMB-2027-WP	Baseline	2027 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	0	0	0	0	0	0	0	264	110
HUMB-2019-ML	Baseline	2019 spring light load conditions. Light load time - hours between 02:00 and 04:00.	0	0	0	0	0	0	0	264	164
HUMB-2022-SOP	Baseline	2022 spring off-peak load conditions. Off-peak load time – weekend morning.	0	0	0	0	0	0	0	264	154
HUMB-2022-SP-PS-AAEE	Sensitivity	2022 summer peak load conditions with peak-shift and AAEE sensitivity	0	0	0	0	0	0	0	264	207
HUMB-2019-SP-PS	Sensitivity	2019 summer peak load conditions with peak-shift sensitivity	0	0	0	0	0	0	0	264	207
HUMB-2027-SP-PS	Sensitivity	2027 summer peak load conditions with peak-shift sensitivity	0	0	0	0	0	0	0	264	207
HUMB-2022-SP-HiRenew	Sensitivity	2022 summer peak load conditions with hi renewable dispatch sensitivity	0	0	0	0	0	0	0	264	207
HUMB-2027-SP-QF	Sensitivity	2027 summer peak load conditions with QF retirement sensitivity	0	0	0	0	0	0	0	264	110

Note:

DR and storage are modeled offline in starting base cases.

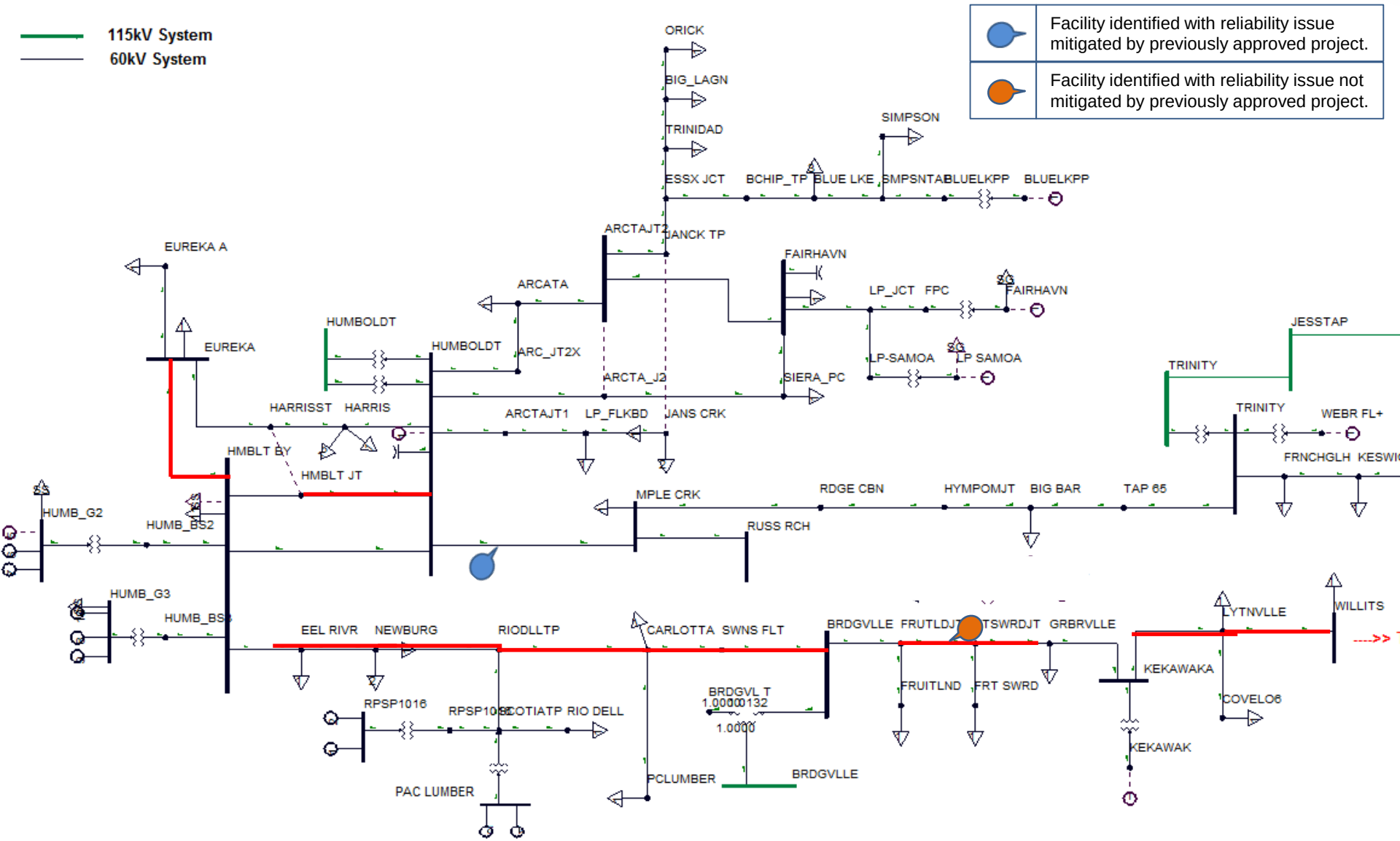
Previously Approved Transmission Projects Modelled in base cases

Project Name	First Year Modeled
Maple Creek Reactive Support (Install 10 Mvar SVC at Maple Creek Sub)	2022

Previously Approved Transmission Projects Not modelled in base cases

Project Name	In-service Date
New Bridgeville – Garberville No. 2 115 kV Line	Jan-24

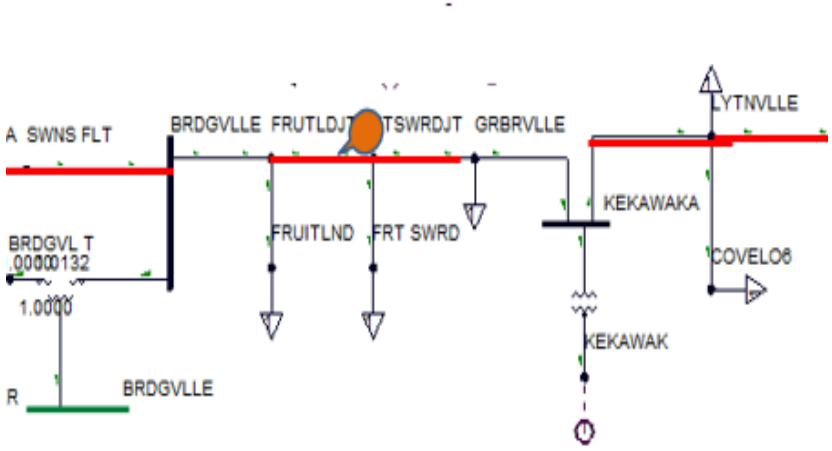
Humboldt Area – Results



Assessment of previously approved projects not modeled in base cases

New Bridgeville – Garberville No. 2 115 kV Line

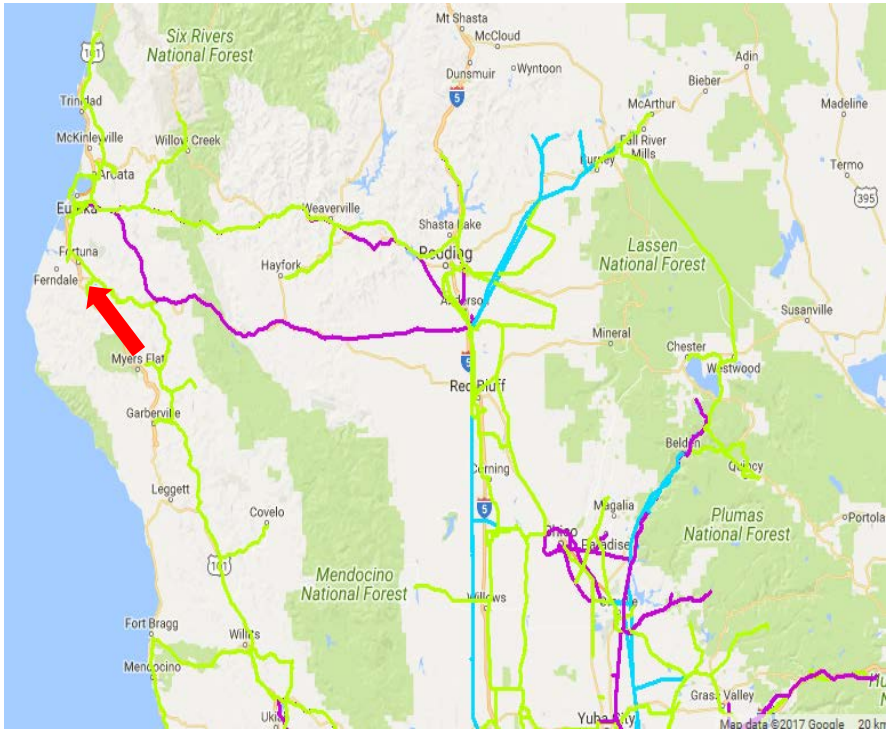
- Original need
  - NERC Category P1 and P2 thermal overload.
- Reliability Assessment Need
  - NERC Categories P1, P2, P3 and P6 thermal overloads in summer and winter baseline scenarios
  - Overloads worsen in two peak-shift sensitivities scenarios.
- Mitigation still required {or not}
  - Mitigation required for reliability
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads. Under review for potential alternative solutions.
- Alternatives
  - Re-dispatch generation at Humboldt Bay Power Plant. Rerate the Humboldt Bay – Rio Dell 60 kV Line and update limiting equipment on the line. Install a shunt capacitor at Bridgeville 60 kV substation
  - Re-dispatch generation at Humboldt Bay Power Plant. Re-conductor some sections of the Humboldt Bay – Rio Dell 60 kV Line and update limiting equipment on the line. Install a shunt capacitor at Bridgeville 60 kV substation
- Preliminary Conclusion
  - Further analysis required



Areas of additional mitigation requirement

Additional Mitigation Requirements
Carlotta – Rio Dell 60kV line

- Reliability Assessment Need
  - NERC Categories P2 and P6 voltage issues
  - Voltage issues worsen in peak-shift and high CEC forecast sensitivities.
- Potential Alternatives
  - Address voltage issues, Voltage support, UVLS and/ or SPS
- First Year of Need identified in Current Assessment
  - 2019
- Interim Mitigation
  - Action plan



Sensitivity Study Assessment

- There is no facility overloads identified in sensitivity scenario(s) only.

North Coast & North Bay Areas
Preliminary Reliability Assessment Results

Bryan Fong
Senior Regional Transmission Engineer

2017-2018 Transmission Planning Process Stakeholder Meeting
September 21-22, 2017

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

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)
NCNB-2019-SP	Baseline	2019 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	1,447	34	247	91	1,322	13	8
NCNB-2022-SP	Baseline	2022 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	1,479	54	336	113	1,311	13	8
NCNB-2027-SP	Baseline	2027 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	1,561	90	513	176	1,295	13	8
NCNB-2019-WP	Baseline	2019 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	1,533	35	247	0	1,497	13	8
NCNB-2022-WP	Baseline	2022 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	1,566	57	336	0	1,510	13	8
NCNB-2027-WP	Baseline	2027 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	1,654	98	513	0	1,557	13	8
NCNB-2019-ML	Baseline	2019 spring light load conditions. Light load time - hours between 02:00 and 04:00.	692	23	247	0	669	13	8
NCNB-2022-SOP	Baseline	2022 spring off-peak load conditions. Off-peak load time – weekend morning.	1,074	43	336	318	714	13	8
NCNB-2022-SP-PS-AAEE	Sensitivity	2022 summer peak load conditions with peak-shift and AAEE sensitivity	1,421	0	336	44	1,377	13	8
NCNB-2019-SP-PS	Sensitivity	2019 summer peak load conditions with peak-shift sensitivity	1,418	45	247	57	1,316	13	8
NCNB-2027-SP-PS	Sensitivity	2027 summer peak load conditions with peak-shift sensitivity	1,474	125	513	48	1,302	13	8
NCNB-2022-SP-HiRenew	Sensitivity	2022 summer peak load conditions with hi renewable dispatch sensitivity	1,390	47	336	336	1,007	13	8
NCNB-2027-SP-QF	Sensitivity	2027 summer peak load conditions with QF retirement sensitivity	1,561	90	513	176	1,295	13	8

Note:

DR and storage are modeled offline in starting base cases.

Generation Assumptions - NCNB Area

Base Case	Scenario Type	Description	Battery Storage (MW)	Solar		Geo-Thermal		Hydro		Thermal	
				Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)
NCNB-2019-SP	Baseline	2019 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	10	0	0	1367	689	153	19	254	123
NCNB-2022-SP	Baseline	2022 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	10	0	0	1367	689	153	38	254	123
NCNB-2027-SP	Baseline	2027 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	10	0	0	1367	689	153	38	254	123
NCNB-2019-WP	Baseline	2019 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	10	0	0	1367	689	153	22	254	123
NCNB-2022-WP	Baseline	2022 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	10	0	0	1367	689	153	38	254	123
NCNB-2027-WP	Baseline	2027 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	10	0	0	1367	689	153	21	254	123
NCNB-2019-ML	Baseline	2019 spring light load conditions. Light load time - hours between 02:00 and 04:00.	10	0	0	1367	689	153	36	254	123
NCNB-2022-SOP	Baseline	2022 spring off-peak load conditions. Off-peak load time – weekend morning.	10	0	0	1367	689	153	36	254	123
NCNB-2022-SP-PS-AAEE	Sensitivity	2022 summer peak load conditions with peak-shift and AAEE sensitivity	10	0	0	1367	689	153	38	254	123
NCNB-2019-SP-PS	Sensitivity	2019 summer peak load conditions with peak-shift sensitivity	10	0	0	1367	689	153	38	254	123
NCNB-2027-SP-PS	Sensitivity	2027 summer peak load conditions with peak-shift sensitivity	10	0	0	1367	689	153	38	254	123
NCNB-2022-SP-HiRenew	Sensitivity	2022 summer peak load conditions with hi renewable dispatch sensitivity	10	0	0	1367	689	153	36	254	123
NCNB-2027-SP-QF	Sensitivity	2027 summer peak load conditions with QF retirement sensitivity	10	0	0	1367	689	153	33	254	123

Note:

DR and storage are modeled offline in starting base cases.

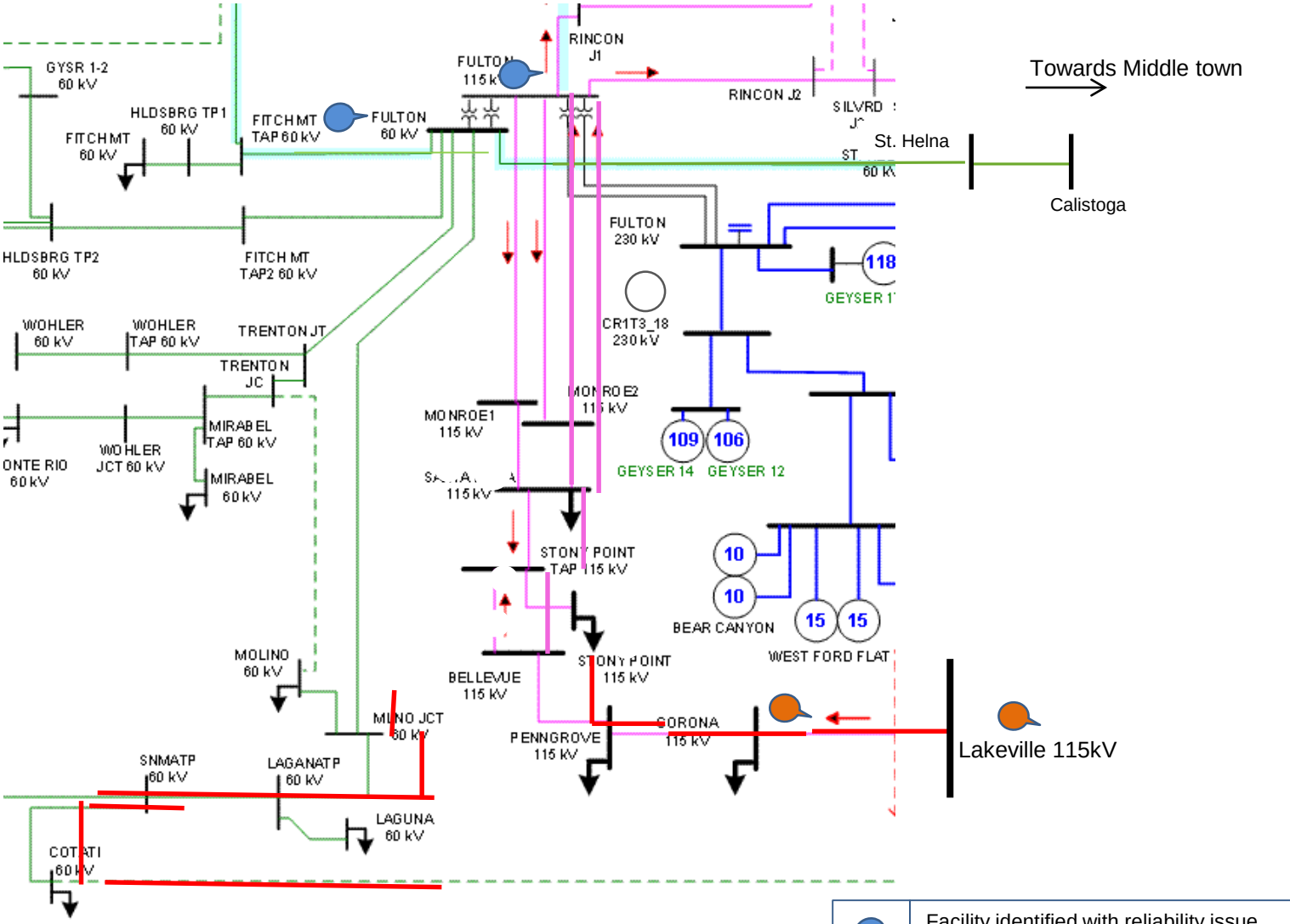
Previously Approved Transmission Projects Modelled in base cases

Project Name	First Year Modeled
Ignacio 230 kV Substation Shunt Reactor	2022

Previously Approved Transmission Projects Not modelled in base cases

Project Name	In-service Date
Fulton-Fitch Mountain 60 kV Line Reconductor (Fulton-Hopland 60 kV Line)	Aug-18
Fulton 230/115 kV Transformer	May-22
Clear Lake 60 kV System Reinforcement	Feb-23
Ignacio – Alto 60 kV Line Voltage Conversion	Mar-23
Napa – Tulucay No. 1 60 kV Line Upgrades	Jul-20

Summary of Reliability Needs Identified

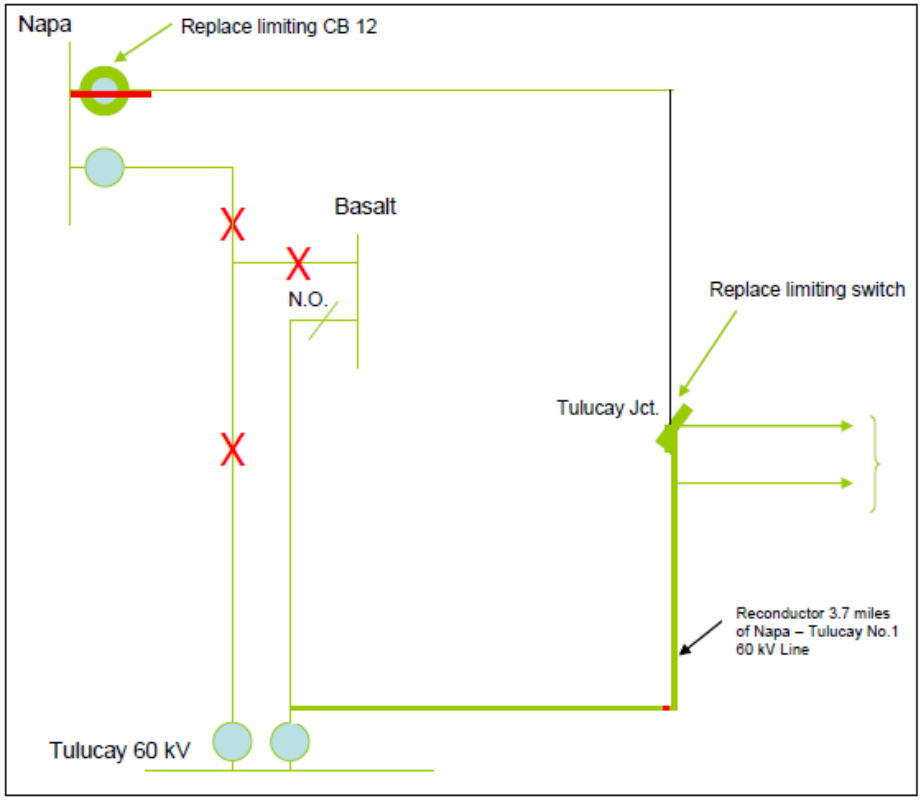


	Facility identified with reliability issue mitigated by previously approved project.
	Facility identified with reliability issue not mitigated by previously approved project.

Assessment of previously approved projects not modeled in base cases

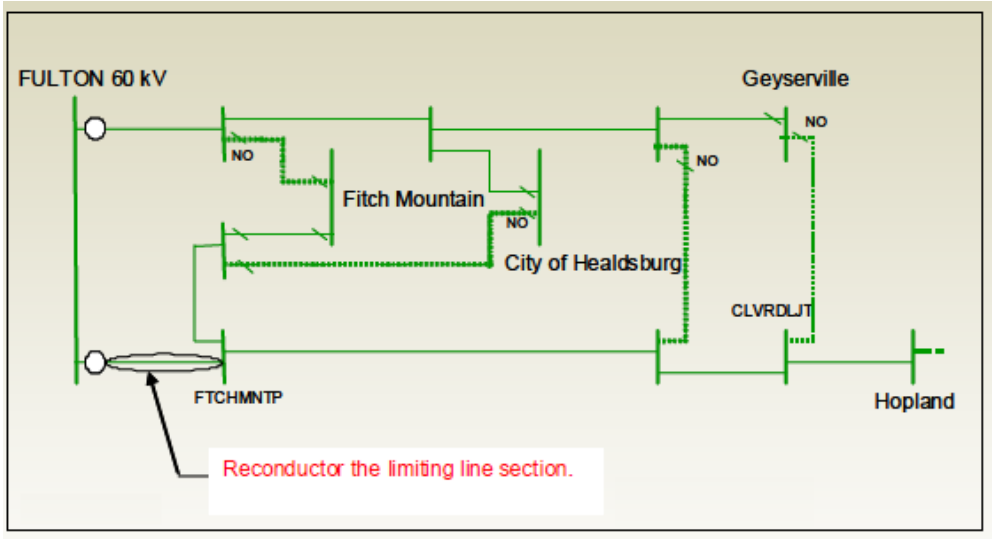
Napa – Tulucay No. 1 60 kV Line Upgrades

- Original need
  - NERC Category P2 thermal overload.
- Reliability Assessment Need
  - Need for Mitigation Not Identified
- Mitigation still required {or not}
  - Mitigation not required for reliability
  - Mitigation not required for LCR
  - Mitigation not required for deliverability
- Review of current project to meet need
  - N/A
- Alternatives
  - N/A
- Preliminary Conclusion
  - Cancel



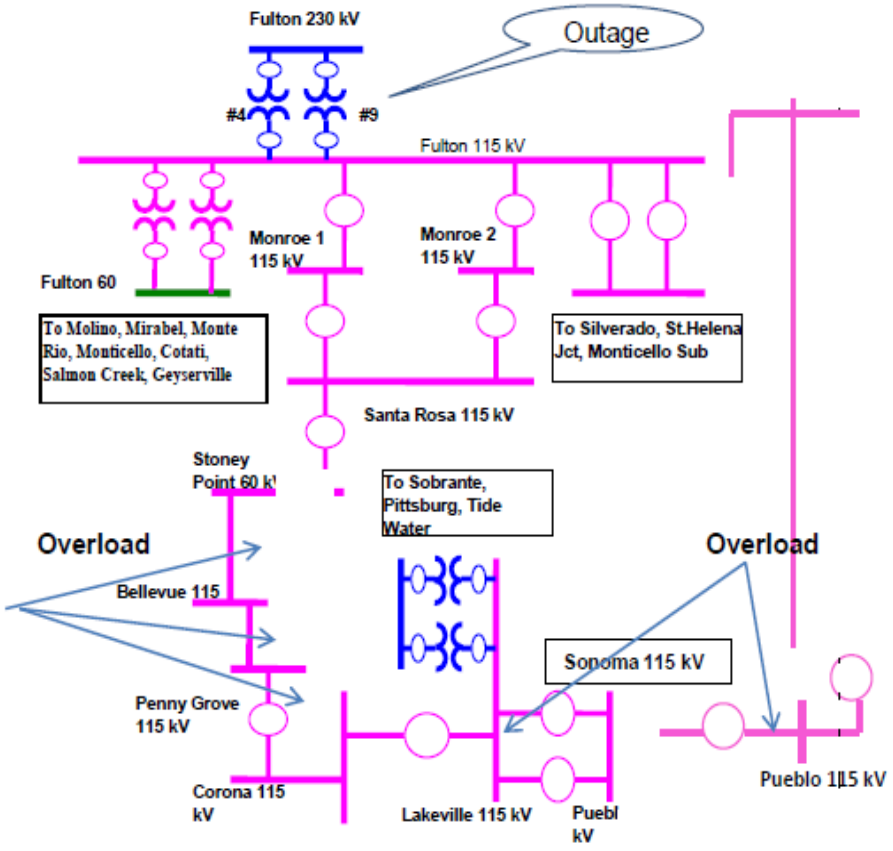
Fulton-Fitch Mountain 60 kV Line Reconductor (Fulton-Hopland 60 kV Line)

- Original need
  - NERC Category P1 and P2 thermal overload.
- Reliability Assessment Need
  - NERC Categories P1, P2 and P7 thermal overloads in baseline
  - P2 in multiple sensitivity scenarios including two peak-shift sensitivities.
- Mitigation still required {or not}
  - Mitigation required for reliability
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads. Under review for potential alternative solutions.
- Alternatives
  - Reconductor the Fulton – Hopland 60 kV line, Rerate a section and tap
- Preliminary Conclusion
  - Further analysis required



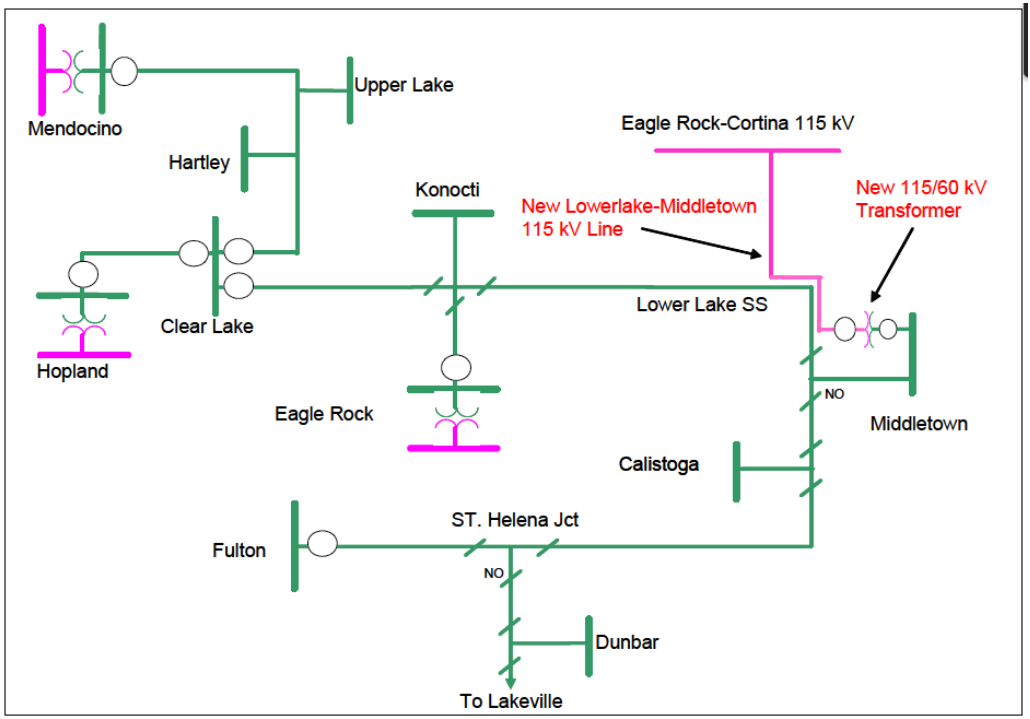
Fulton 230/115 kV Transformer

- Original need
  - NERC Category P6 thermal overload.
- Reliability Assessment Need
  - NERC Categories P1 P2, P3, P5 and P6 thermal overloads in baseline.
  - Overloads worsen in sensitivity scenarios including two peak-shift sensitivities.
- Mitigation still required {or not}
  - Mitigation required for reliability
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads. Under review for potential alternative solutions.
- Alternatives
  - Reconductor the line sections on the Lakeville #2 60 kV Line. Upgrade the capacity of the Petaluma A bus conductor with at least a summer emergency. Upgrade limiting equipment, including terminal equipment and disconnect switches
  - Open line between Cotati and Petaluma after first T-1 outage. (not applicable for P1 & P2)
- Preliminary Conclusion
  - Further analysis required



Clear Lake 60 kV System Reinforcement

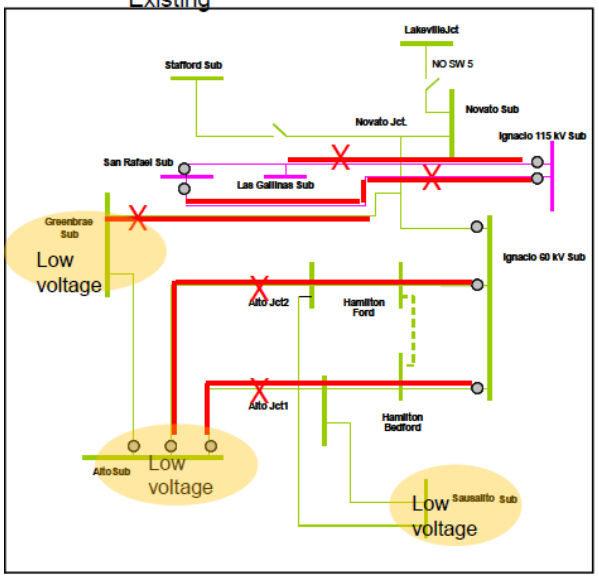
- Original need
  - NERC Category P1, P2, P3, P6 and P7 thermal overload.
- Reliability Assessment Need
  - NERC Categories P1 P2, P3 and P6 thermal overloads in baseline.
  - Overloads worsen in sensitivity scenarios including two peak-shift sensitivities.
- Mitigation still required {or not}
  - Mitigation required for reliability
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads. Under review for potential alternative solutions.
- Alternatives
  - Reconductor Clear Lake – Hopland 60 kV line and install a shunt capacitor at Middletown 60 kV substation along with the associated interconnecting equipment (i.e. circuit breaker).
  - Construct a 60 kV bus at Lower Lake and install a new 115/ 60 kV Transformer at Lower Lake and construct a new 60 kV line from the new 60 kV Lower Lake bus tap onto the Konocti – Middletown 60 kV Line
  - Add energy storage at Clear Lake 60 kV Substation
  - Add energy storage at Lower Lake 60 kV Substation
- Preliminary Conclusion
  - Further analysis required



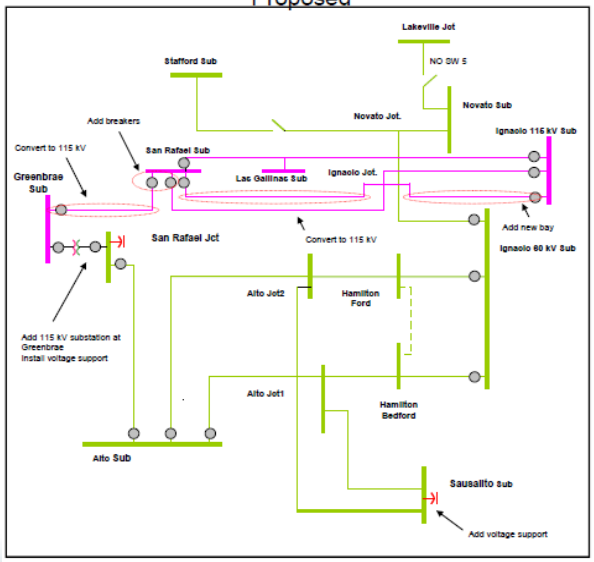
Ignacio – Alto 60 kV Line Voltage Conversion

- Original need
  - NERC Category P2 thermal overload.
- Reliability Assessment Need
  - NERC Categories P1, P2, P3, P6 and P7 thermal overloads and P2, P3, P6 and P7 in multiple sensitivity scenarios including two peak-shift sensitivities.
- Mitigation still required {or not}
  - Mitigation required for reliability
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads. Under review for potential alternative solutions.
- Alternatives
  - Reconductor Ignacio- San Rafael #1 115 kV Line and San Rafael Jct – Greenbrae line section of Ignacio – Alto 60 kV line as well as upgrade limiting equipment. Construct a 60 kV bus at San Rafael, install a new 115/ 60 kV Transformer at San Rafael and loop into the Ignacio – Alto 60 kV line. Reconductor Ignacio- San Rafael #3 115 kV Line and upgrade limiting equipment.
  - Reconductor Ignacio – Alto 60 kV Line and upgrade limiting equipment on line. Reconductor Ignacio- San Rafael #1 115 kV Line and upgrade limiting equipment on line. Add shunt capacitors at Greenbrae 60 kV Substation
  - Rerate Ignacio – Alto 60 kV Line and upgrade limiting equipment on line. Reconductor Ignacio- San Rafael #1 115 kV Line and upgrade limiting equipment on line. Add shunt capacitors at Greenbrae 60 kV Substation
- Preliminary Conclusion
  - Further analysis required

Existing



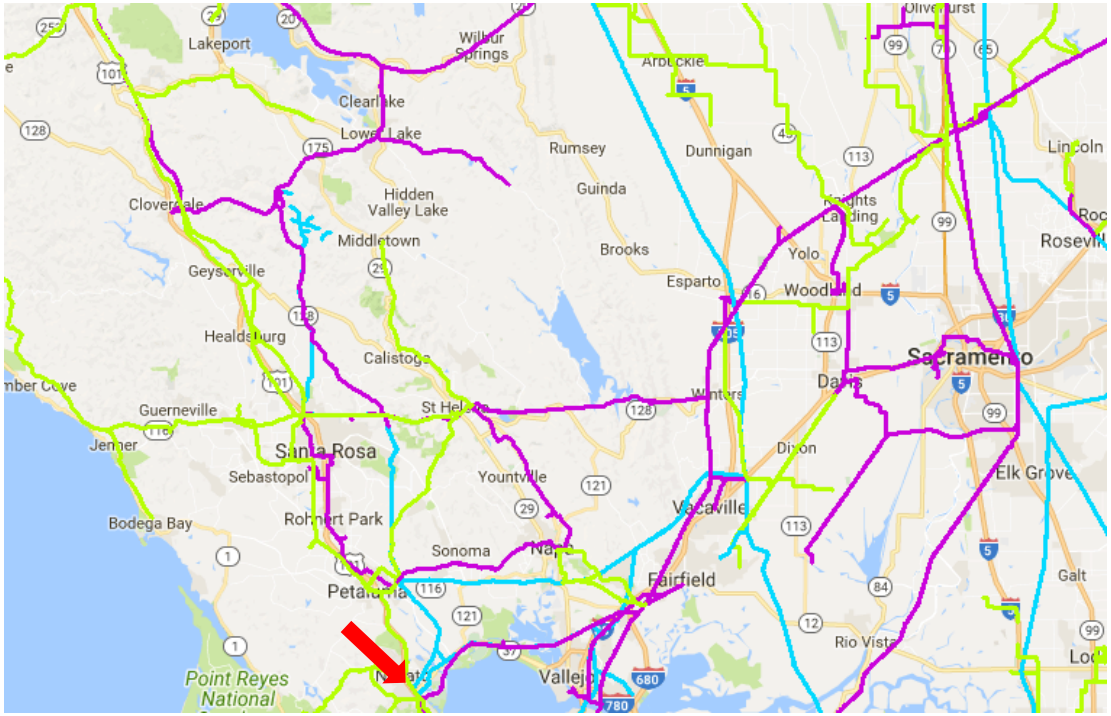
Proposed



Areas of additional mitigation requirement

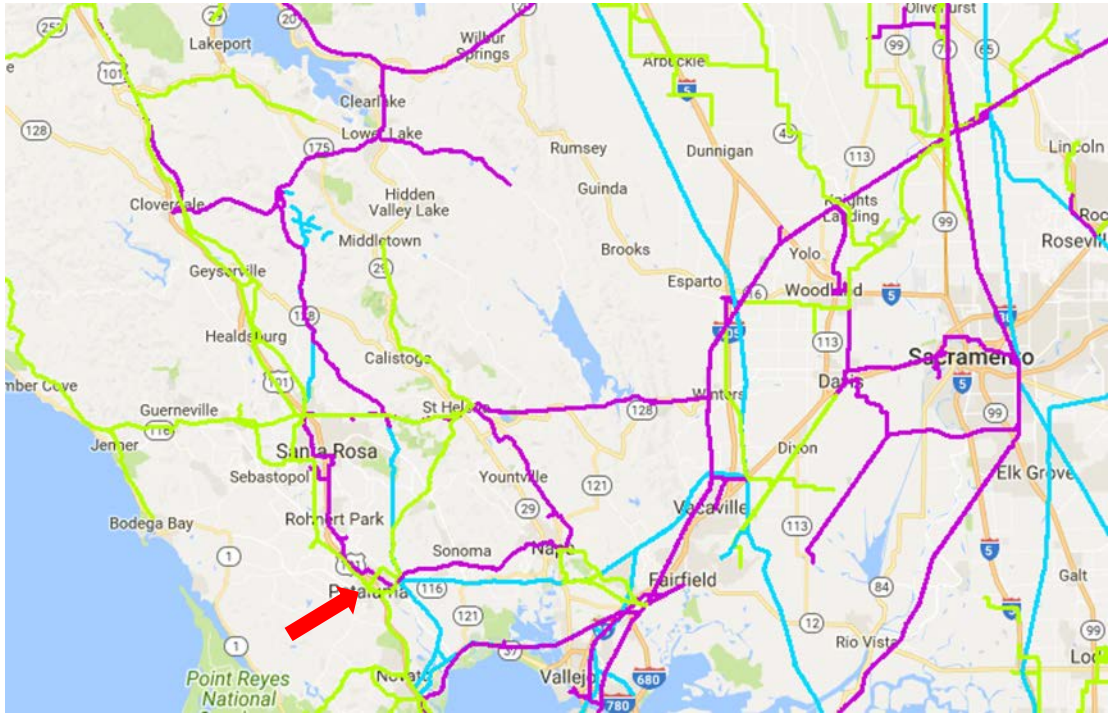
Additional Mitigation Requirements
Ignacio 230/115kV bank

- Reliability Assessment Need
  - NERC Categories P1 (2027 Winter Peak) thermal overload
- Potential Alternatives
  - Preferred resource
  - Rerate
  - Reconductor
- First Year of Need identified in Current Assessment
  - 2027
- Interim Mitigation
  - None
- Preliminary Conclusion
  - Continue to monitor as overload in 2027 case only



Additional Mitigation Requirements
Lakeville – Lakeville Junction 60 kV Line

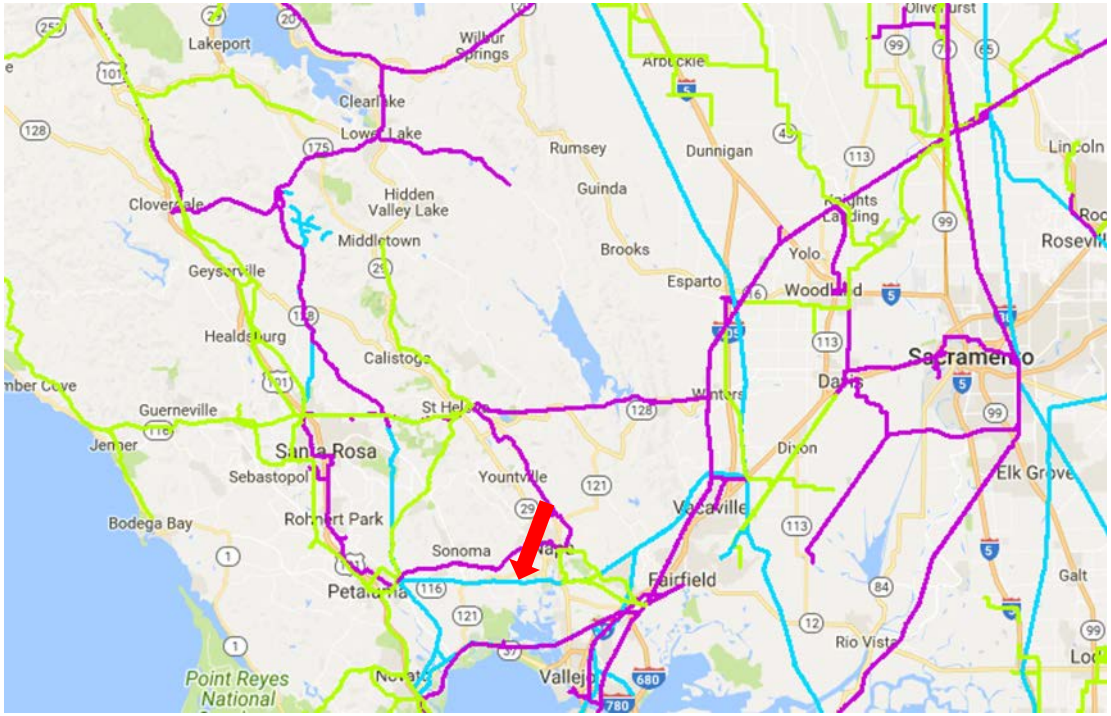
- Reliability Assessment Need
  - NERC Categories P1, P2 , P3, P5 & P6 thermal overload in winter baseline
  - Overloads worsen in Heavy Renewable & Min Gas Gen forecast sensitivities, peak-shift and high CEC forecast sensitivities
- Potential Alternatives
  - Preferred resource
  - Rerate
  - Reconductor
- First Year of Need identified in Current Assessment
  - 2019
- Interim Mitigation
  - Action plan



Additional Mitigation Requirements

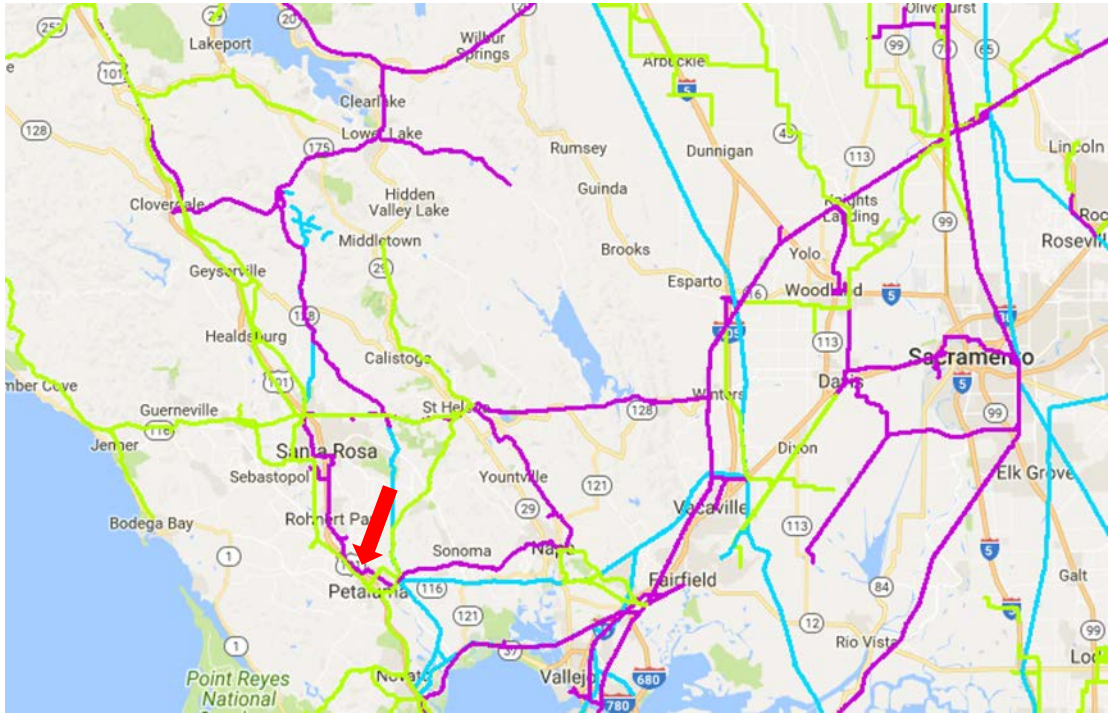
Lakeville – Vaca Dixon and Tulucay – Vaca Dixon 230 kV Lines

- Reliability Assessment Need
  - NERC Categories P2 and P6 thermal overloads in winter baseline
  - Overloads worsen in peak-shift and high CEC forecast sensitivities.
- Potential Alternatives
  - Substation upgrade
- First Year of Need identified in Current Assessment
  - 2019
- Interim Mitigation
  - Action plan



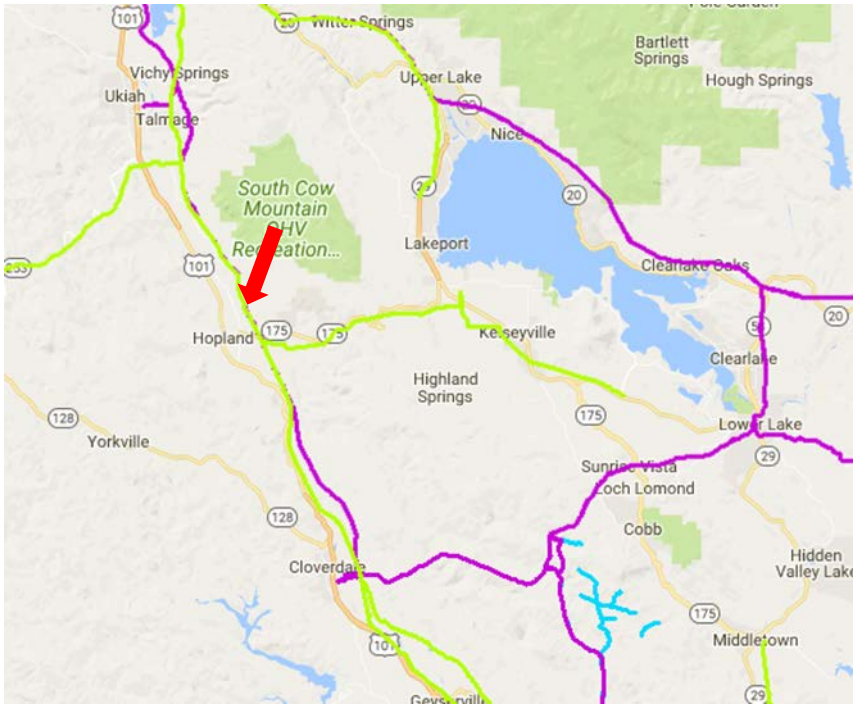
Additional Mitigation Requirements
Lakeville – Corona 115 kV

- Reliability Assessment Need
  - NERC Categories P2, P5, P6 and P7 thermal overloads in winter baseline
  - Overloads worsen peak-shift and high CEC forecast sensitivities.
- Potential Alternatives
  - Substation upgrade
- First Year of Need identified in Current Assessment
  - 2019
- Interim Mitigation
  - Action plan



Additional Mitigation Requirements
Philo Junction – Hopland Junction 60 kV

- Reliability Assessment Need
  - NERC Categories P2 voltage issues in winter baseline
  - No voltage issues in sensitivity cases
- Potential Alternatives
  - Address voltage issues, Voltage support, UVLS and/ or SPS
- First Year of Need identified in Current Assessment
  - 2019
- Interim Mitigation
  - Action plan



Sensitivity Study Assessment

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

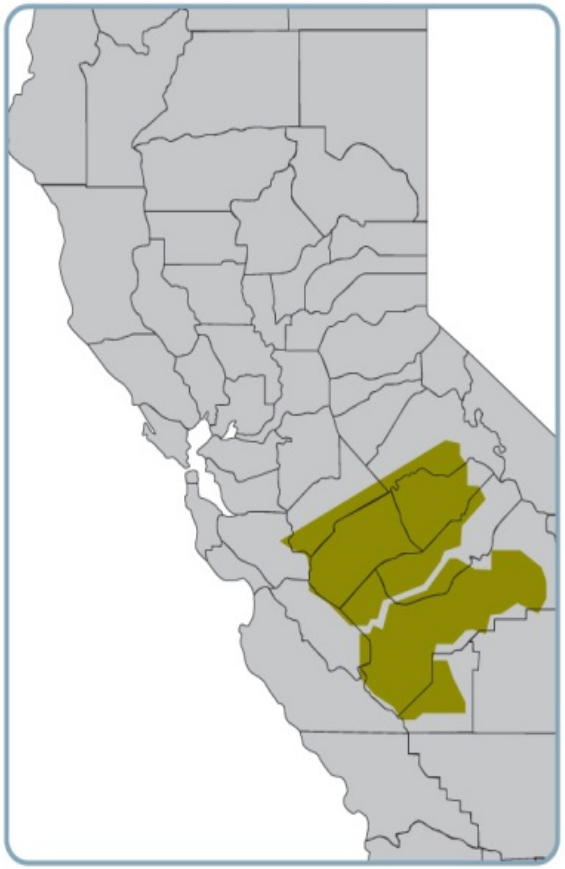
Overloaded Facility	Category	2022 SP High CEC Forecast	2019 SP Peak-Shift	2027 SP Peak-Shift	2022 SP Heavy Renewable & Min Gas Gen	2027 Retirement of QF Generations
32669 STAF_JCT 60.0 32673 TOCA_JCT 60.0 1 1	P2					√
31362 TRNTN JT 60.0 31378 FULTON 60.0 1 1	P3				√	
31364 MOLINO 60.0 31363 TRNTN_JC 60.0 1 1	P3				√	
31384 COTATI 60.0 31389 PETC_JCT 60.0 1 1	P3				√	
31397 WILLITSJ 60.0 31312 FRT BRGG 60.0 1 1	P3				√	
31366 MLNO JCT 60.0 31385 LAGUNATP 60.0 1 1	P5	√		√		
31378 FULTON 60.0 32650 ST.HELNA 60.0 1 1	P6	√				

Fresno Area
Preliminary Reliability Assessment Results

Abhishek Singh
Regional Transmission Engineer Lead

2017-2018 Transmission Planning Process Stakeholder Meeting
September 21-22, 2017

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- Fresno

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)
FRESNO-2019-SP	Baseline	2019 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	3,375	60	562	187	3,129	57	28
FRESNO-2022-SP	Baseline	2022 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	3,481	100	684	231	3,150	58	28
FRESNO-2027-SP	Baseline	2027 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	3,696	172	969	331	3,193	58	28
FRESNO-2019-SPR-LL	Baseline	2019 spring light load conditions. Light load time - hours between 02:00 and 04:00.	1,067	42	562	0	1,026	57	28
FRESNO-2022-SPR-OPK	Baseline	2022 spring off-peak load conditions. Off-peak load time – weekend morning.	1,535	82	687	649	803	58	27
FRESNO-2019-SP-PS	Sensitivity	2019 summer peak load conditions with peak-shift and AAEE sensitivity	3,350	60	562	115	3,174	57	28
FRESNO-2027-SP-PS	Sensitivity	2027 summer peak load conditions with peak-shift and AAEE sensitivity	3,684	172	969	89	3,423	58	28
FRESNO-2022-SP-HIGH CEC	Sensitivity	2022 summer peak load conditions with peak-shift and AAEE sensitivity	3,481	0	687	89	3,392	58	28
FRESNO-2022-SP-HIGH RENEW-MINGAS	Sensitivity	2022 summer peak load conditions with hi renewable dispatch sensitivity	3,074	87	687	687	2,300	58	28
FRESNO-2027-SP-QFRETIRE	Sensitivity	2027 summer peak load conditions with QF retirement sensitivity	3,696	172	969	331	3,312	58	28

Generation Assumptions- Fresno

Base Case	Scenario Type	Description	Storage (Battery+ Helms) (MW)	Solar		Hydro(No Helms)		Thermal	
				Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)
FRESNO-2019-SP	Baseline	2019 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	1257	1442	361	806	773	2928	1,253
FRESNO-2022-SP	Baseline	2022 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	1257	1618	404	806	773	2928	1,220
FRESNO-2027-SP	Baseline	2027 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	1257	1618	404	806	773	2928	1,254
FRESNO-2019-SPR-LL	Baseline	2019 spring light load conditions. Light load time - hours between 02:00 and 04:00.	45	1442	0	806	737	2928	399
FRESNO-2022-SPR-OPK	Baseline	2022 spring off-peak load conditions. Off-peak load time – weekend morning.	-865	1618	1598	806	509	2928	1,311
FRESNO-2019-SP-PS	Sensitivity	2019 summer peak load conditions with peak-shift and AAEE sensitivity	1257	1442	361	806	773	2928	1,251
FRESNO-2027-SP-PS	Sensitivity	2027 summer peak load conditions with peak-shift and AAEE sensitivity	1257	1618	404	806	772	2928	1,221
FRESNO-2022-SP-HIGH CEC	Sensitivity	2022 summer peak load conditions with peak-shift and AAEE sensitivity	1257	1618	405	806	772	2928	1,220
FRESNO-2022-SP-HIGH RENEW-MINGAS	Sensitivity	2022 summer peak load conditions with hi renewable dispatch sensitivity	1257	1618	1618	806	756	2928	356
FRESNO-2027-SP-QFRETIRE	Sensitivity	2027 summer peak load conditions with QF retirement sensitivity	1257	1618	404	806	773	2928	1,061

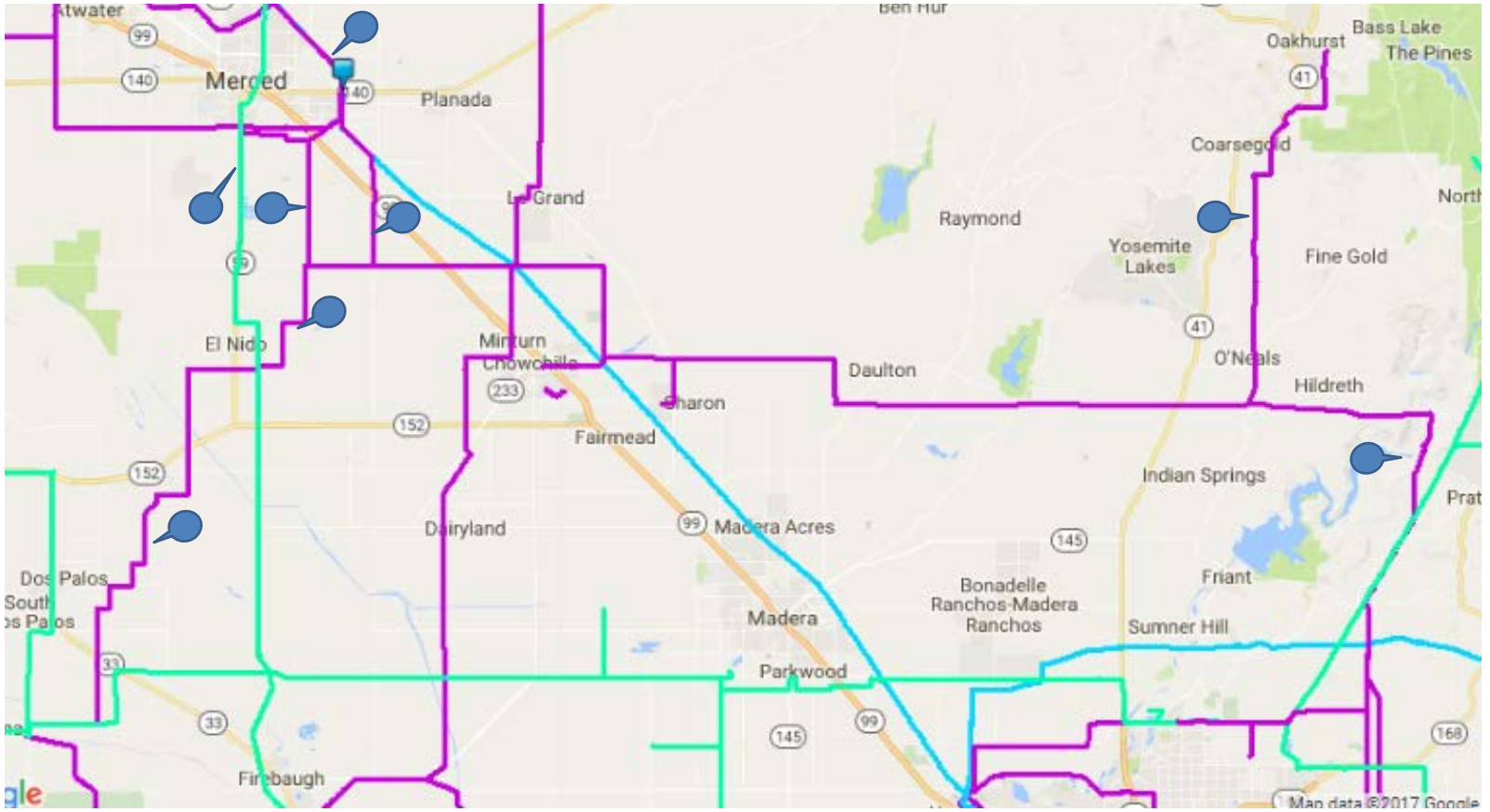
Previously Approved Transmission Projects Modelled in base cases

Project Name	First Year Modeled
Gregg - Herndon #2 230 kV Line Circuit Breaker Upgrade	2019
Los Banos - Livingston Jct - Canal 70 kV Switch Replacement	2019
Panoche-Oro Loma 115 kV Reconductoring	2022
Helm - Kerman 70 kV Line Reconductor	2019
Warnerville - Bellota 230 kV line reconductoring	2027
Wilson - Le Grand 115 kV line reconductoring	2022
Lemoore 70 kV Disconnect Switches Replacement	2019
Oakhurst/Coarsegold UVLS	2019
Series Reactor on Warnerville-Wilson 230 kV Line	2019

Previously Approved Transmission Projects Not modelled in base cases

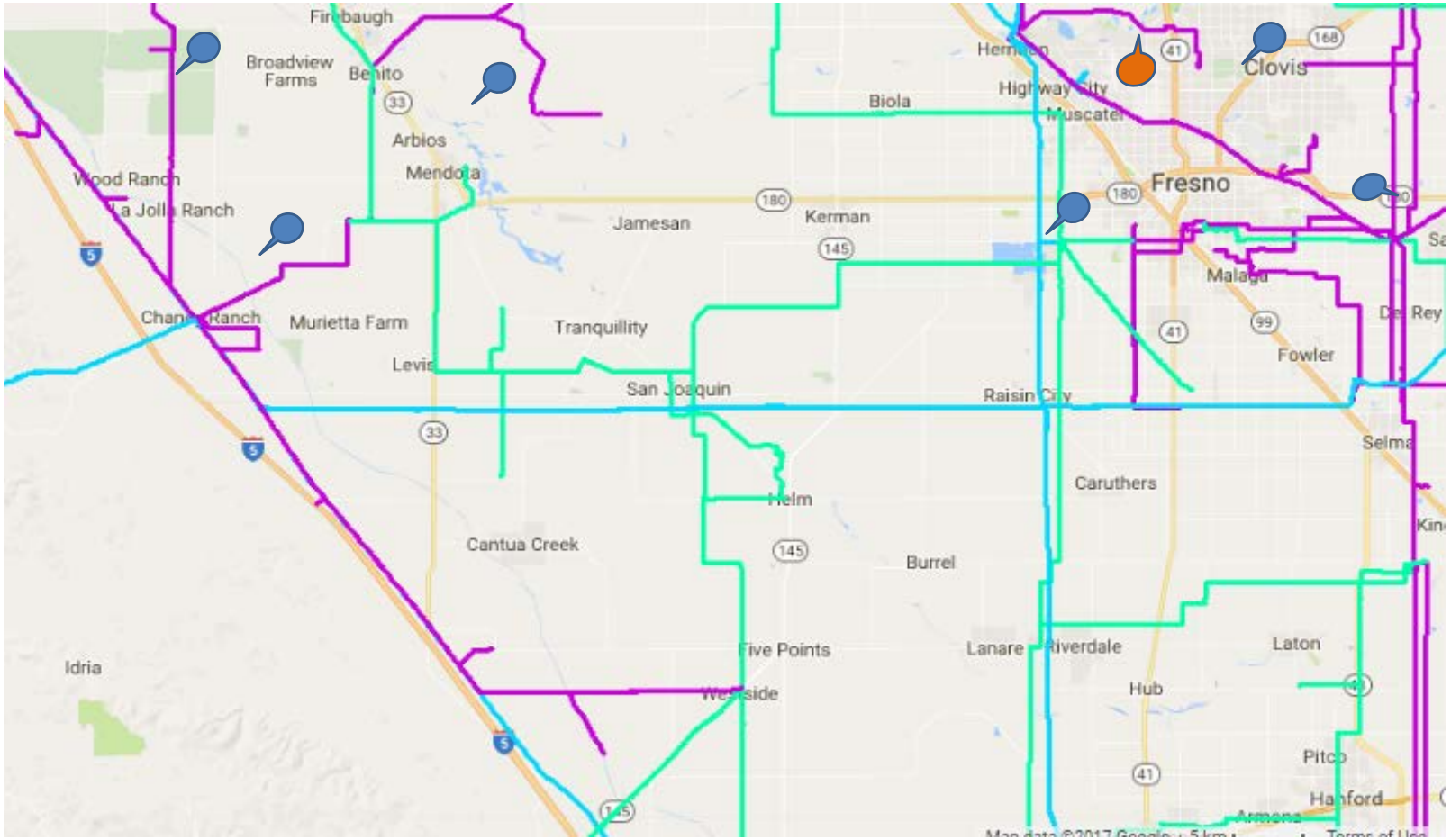
Project Name	Current In-Service date
Northern Fresno 115 kV Area Reinforcement	December -2022
Ashlan - Gregg and Ashlan - Herndon 230 kV Line Reconductor	May-2020
Caruthers - Kingsburg 70 kV Line Reconductor	April-2019
Kearney - Caruthers 70 kV Line Reconductor	April-2019
McCall - Reedley #2 115 kV Line	May-2022
Oro Loma - Mendota 115 kV Conversion Project	May-2019
Reedley 70 kV Reinforcement	Feb-2020
Reedley 115/70 kV Transformer No. 2 Replacement Project	May-2021
Reedley-Orosi 70 kV Line Reconductor	December-2018
Reedley-Dinuba 70 kV Line Reconductor	March-2019
Wilson 115 kV Area Reinforcement	March-2019
Oro Loma 70 kV Area Reinforcement	April-2023
Borden 230 kV Voltage Support	May-2019
Wilson Voltage Support	December-2019
Gates-Gregg 230 kV Line	December-2022
Gates No. 2 500/230 kV Transformer	December-2022
Kearney - Herndon 230kV Line Reconductor	March-2019

Summary of Reliability Needs Identified Northern Fresno



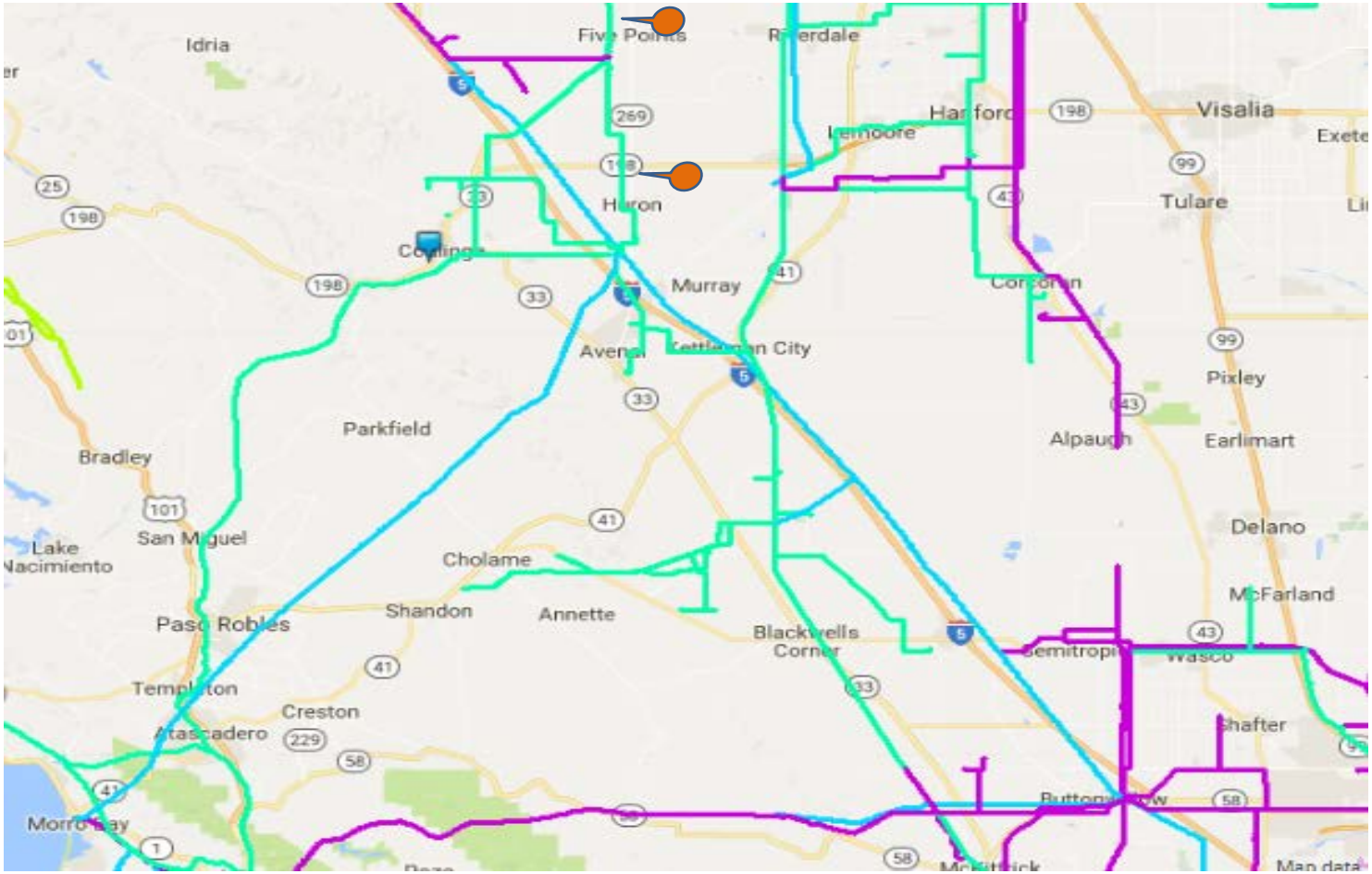
	Facility identified with reliability issue mitigated by previously approved project.
	Facility identified with reliability issue not mitigated by previously approved project.

Summary of Reliability Needs Identified Central Fresno



	Facility identified with reliability issue mitigated by previously approved project.
	Facility identified with reliability issue not mitigated by previously approved project.

Summary of Reliability Needs Identified Southern Fresno

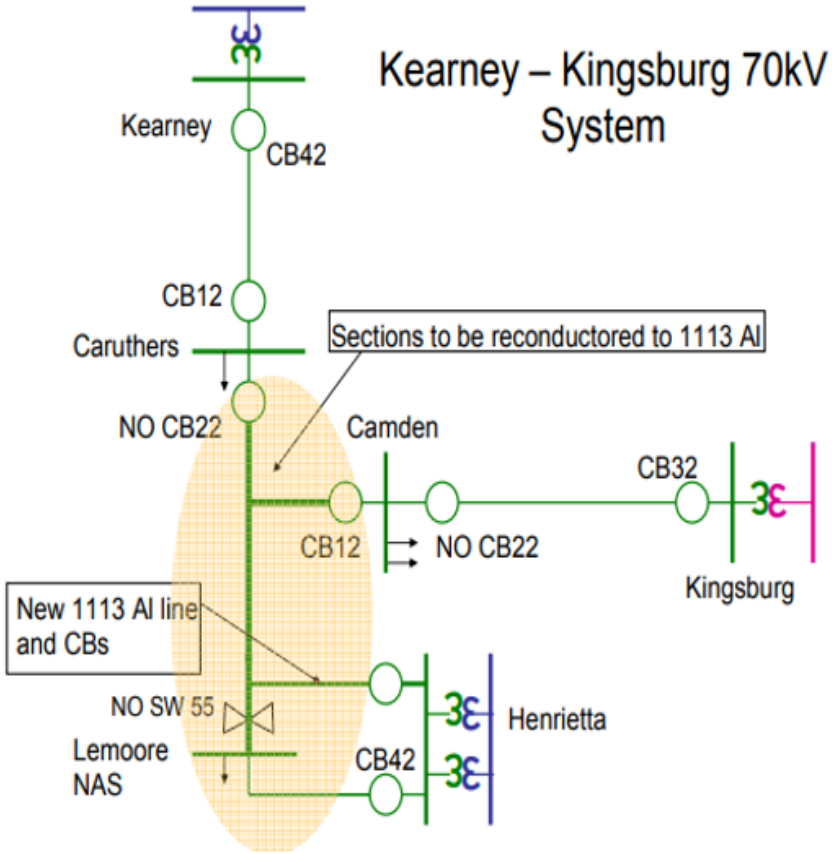


	Facility identified with reliability issue mitigated by previously approved project.
	Facility identified with reliability issue not mitigated by previously approved project.

Assessment of previously approved projects not modeled in base cases

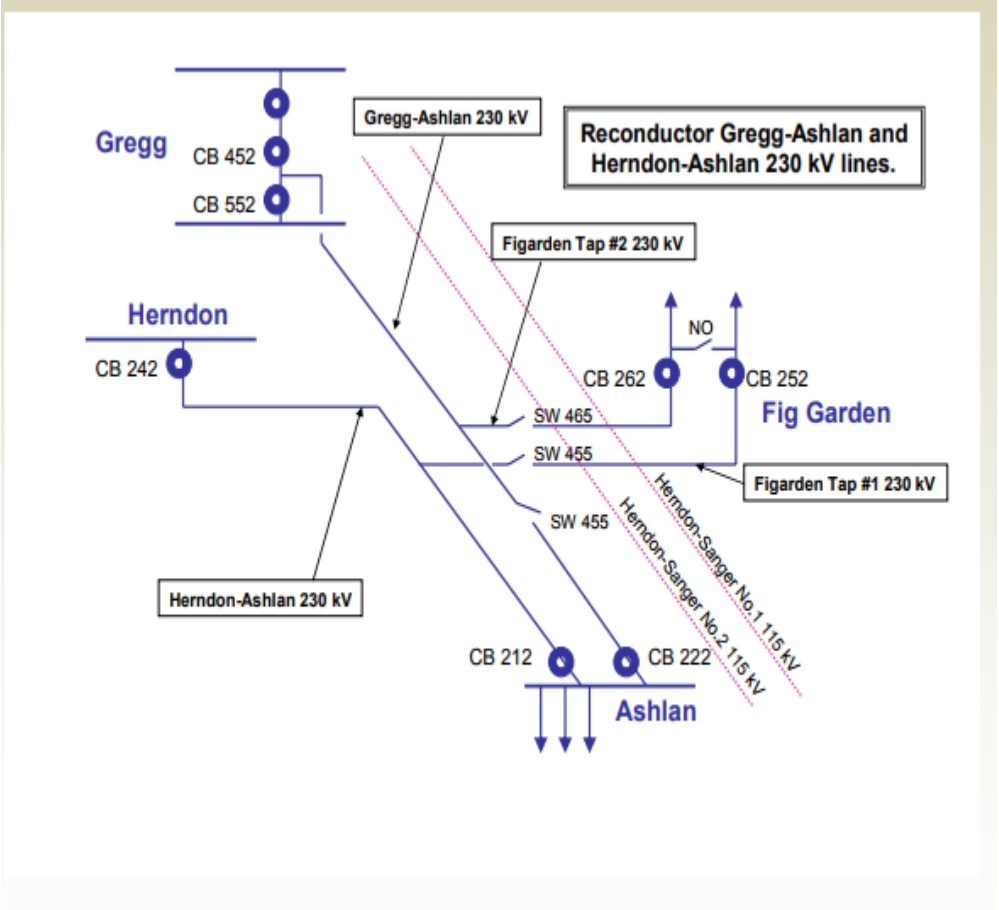
Caruthers - Kingsburg 70 kV Line Reconductor

- Original need
  - 2009 TPP: NERC Category P0
- Current Reliability Assessment Need
  - Not required
- Mitigation still required
  - Mitigation not required for reliability
  - Mitigation not required for generation deliverability
  - Mitigation not required for LCR
- Review of current project to meet need
  - Not Applicable
- Alternatives
  - None
- Preliminary Conclusion
  - Cancel the Project

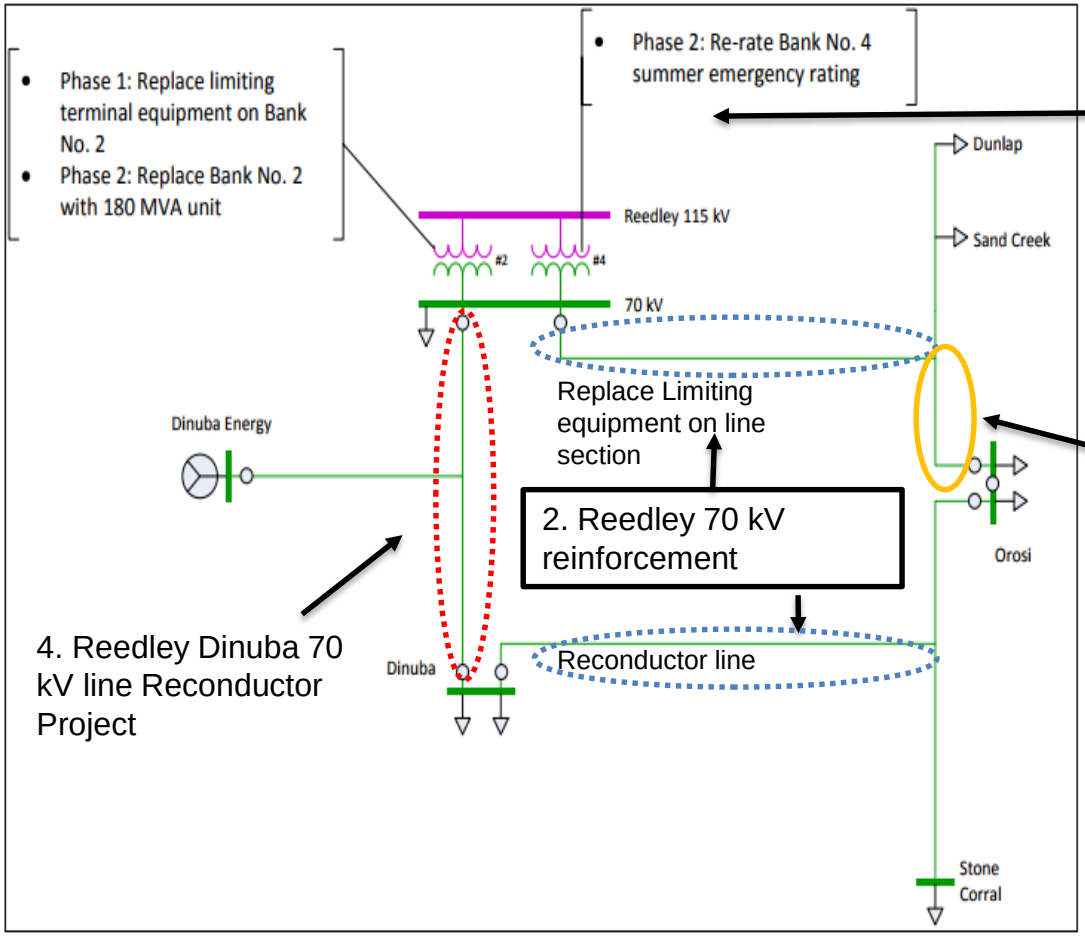


Ashlan - Gregg and Ashlan - Herndon 230 kV Line Reconductor

- Original need
  - NERC Category P7(Gregg-Herndon # 1 & # 2) thermal overload.
- Reliability Assessment Need
  - NERC Categories P6 (Gregg-Herndon # 1 & # 2) thermal overloads in baseline and multiple sensitivity scenarios (AAEE and 2027 Peak Shift) that can be mitigated by system adjustment and planned load shed.
- Mitigation still required {or not}
  - Mitigation not required for reliability
  - Mitigation not required for generation deliverability
  - Mitigation not required for LCR
- Review of current project to meet need
  - Not Applicable
- Alternatives
  - Not Applicable
- Preliminary Conclusion
  - Cancel the Project.



Reedley Area 70kV Reinforcement Projects



1.) Reedley 115/70 kV replacement project replaced bank # 2 and rerates bank # 4

3. Reedley Orosi 70 kV line Reconductor
- Install 20 MVARs of shunt caps at Dinuba Sub.

4. Reedley Dinuba 70 kV line Reconductor Project

Reedley 70 kV Area Reinforcement Projects

Project # 1- Reedley 115/70 kV Transformer # 2 Replacement Project

- Original need
  - 2013-14 TPP : NERC Category P3
- Current Reliability Assessment Need
  - No Overloads seen on the T/F bank # 2
- Mitigation still required
  - Mitigation not required for reliability
  - Mitigation not required for generation deliverability
  - Mitigation not required for LCR
- Review of current project to meet need
  - Not Applicable
- Alternatives
  - Not Applicable
- Preliminary Conclusion
  - Cancel the project.

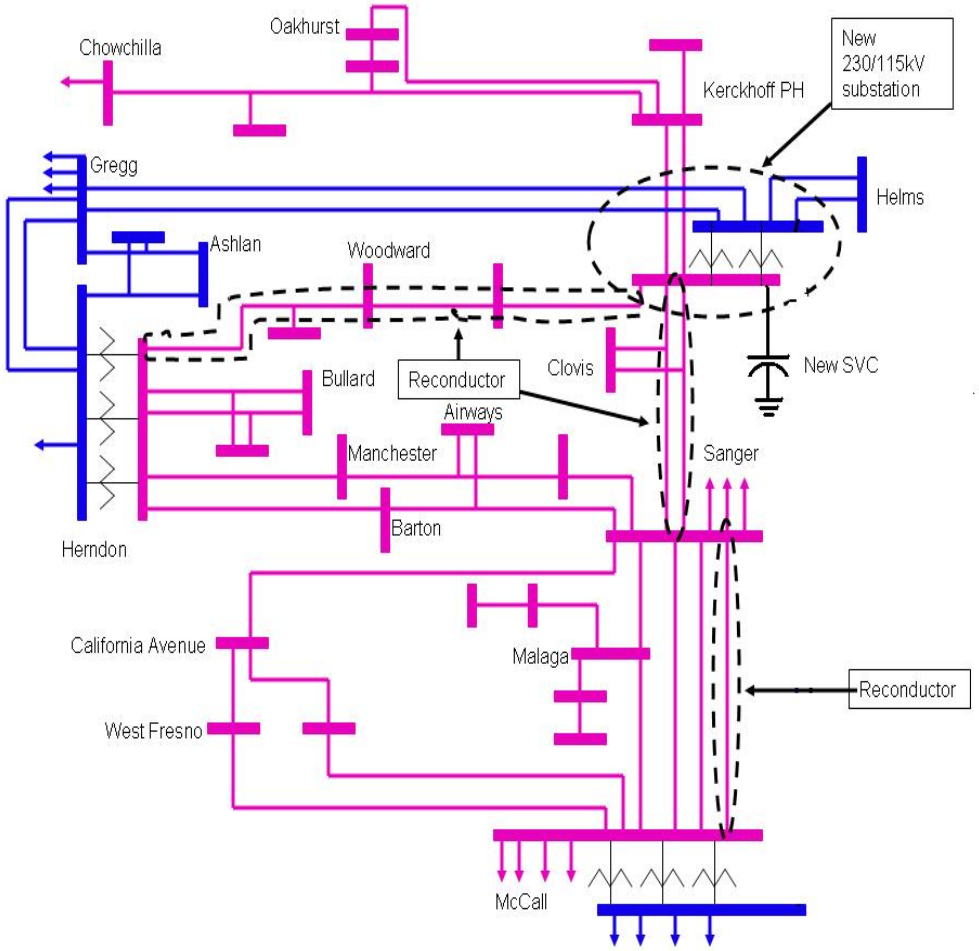
Reedley 70 kV Area Reinforcement Projects

Project # 2,3 & 4- Reconductor Projects in the Area.

- Original need
  - NERC Category P1
- Current Reliability Assessment Need
  - No Overloads seen due to the existing summer setup in the system.
- Mitigation still required
  - Mitigation not required with the existing summer setup.
- Review of current project to meet need
  - Current scope of approved project would potentially alleviate the overload in the absence of the summer setup.
- Alternatives
  - Extend summer setup for all the seasons.
  - Utilize Preferred Resources
- Preliminary Conclusion
  - Further Review Required.

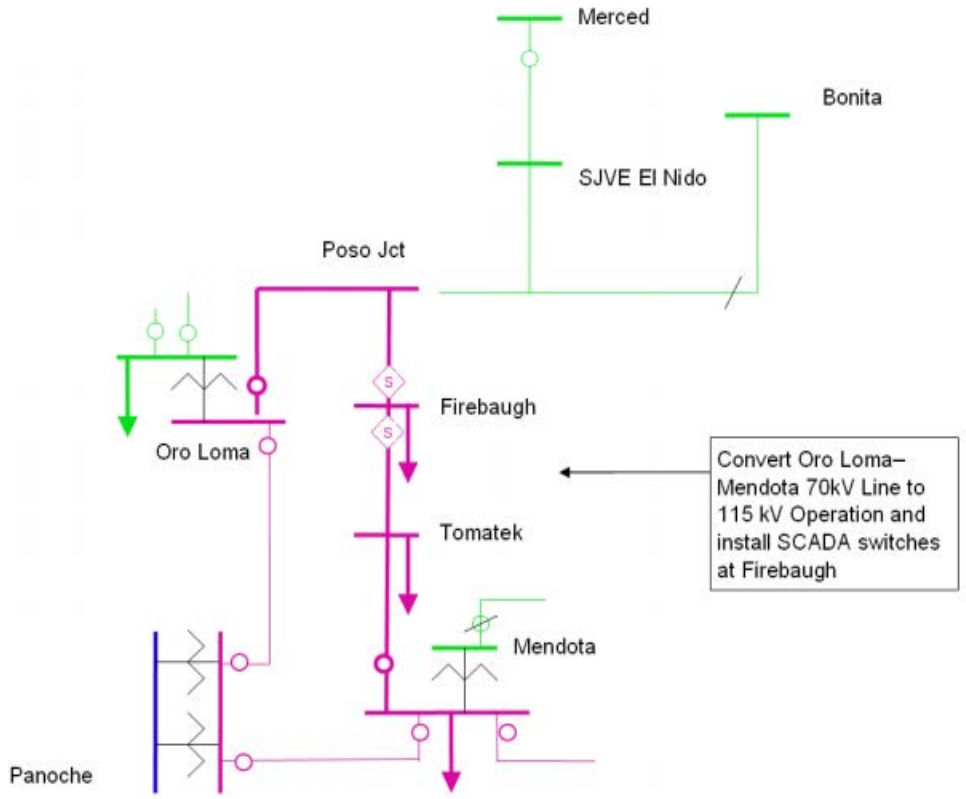
Northern Fresno 115 kV Area Reinforcement

- Original need
  - 2012-13 TPP: NERC Category P2, P6 &P7
- Current Reliability Assessment Need
  - NERC Categories P2 overloads (Bus Tie breaker fault) in the Peak baseline scenarios
  - Multiple overloads & non convergence issue in several sensitivity scenarios.
- Mitigation still required
  - Mitigation required for reliability
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads. Under review for potential alternative solutions..
- Alternatives
  - Proceed with sectionalizing Herndon and McCall buses
  - Evaluate Potential Reconductor and SPS options.
- Preliminary Conclusion
  - Revisit the scope of the original project



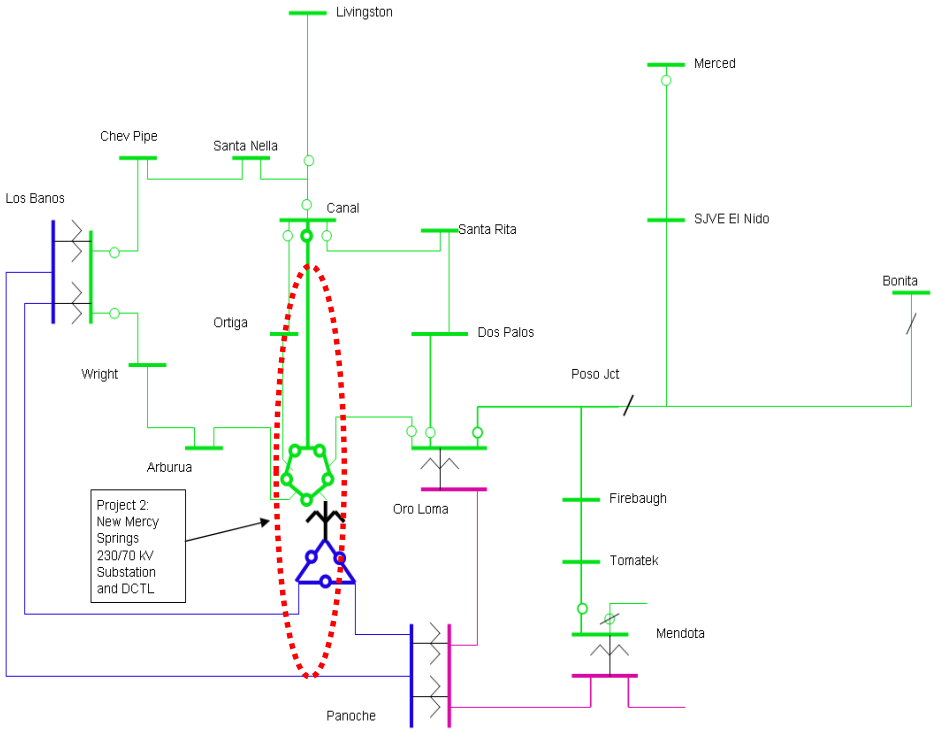
Oro Loma - Mendota 115 kV Conversion Project

- Original need
  - 2010-11 TPP: NERC Category P1 & P6 thermal overload.
- Reliability Assessment Need
  - NERC Category P6 thermal overloads in one baseline (2019 Spring Light load) scenario only.
- Mitigation still required {or not}
  - Not required with current summer setup
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads. Under review for potential alternative solutions due to potential interaction with Oro loma 70 kV area reinforcement project.
- Alternatives
  - Rely on Summer setup to mitigate overload
  - Reconductoring and bank replacement evaluation in conjunction with the Oro loma 70 kV reinforcement project.
- Preliminary Conclusion
  - Revisit the scope of original project.



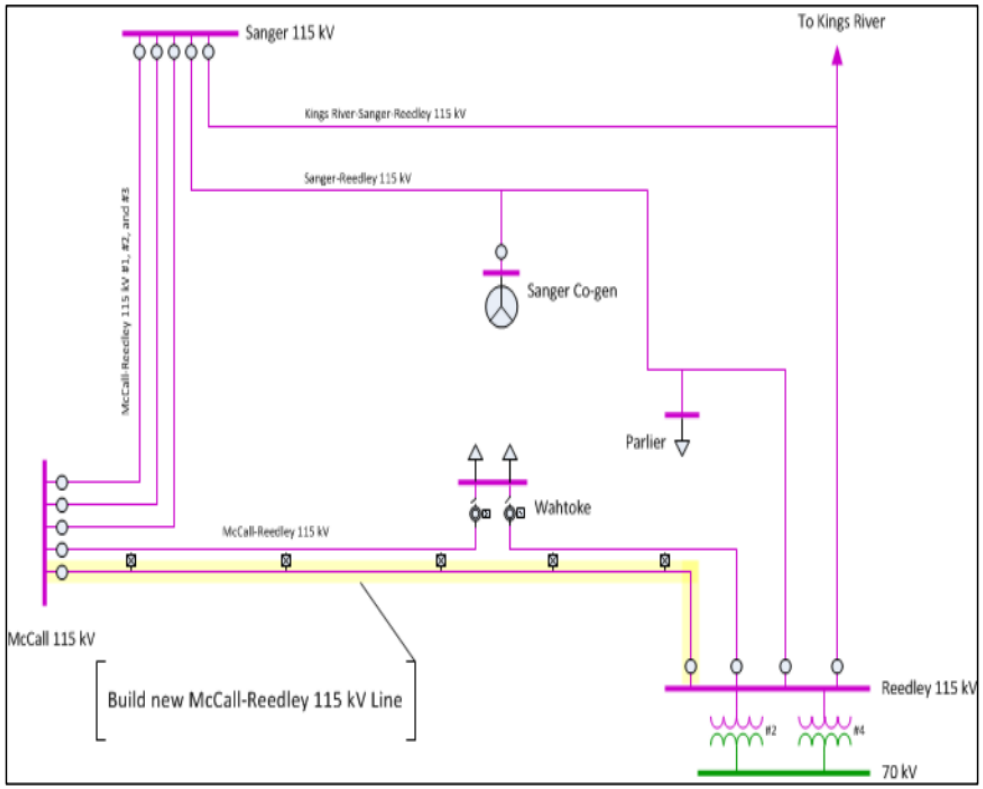
Oro Loma 70 kV Area Reinforcement

- Original need
  - 2010-11 TPP : NERC Category P6 thermal overloads.
- Reliability Assessment Need
  - NERC Categories P1,P2,P3 &P6 thermal overloads in baseline
  - NERC Categories P1,P2,P3,P6 & P7 thermal overloads in multiple sensitivity scenarios.
- Mitigation still required {or not}
  - Mitigation required for reliability
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads. Under review for potential alternative solutions due to potential interaction with the Oroloma-Mendota 115 kV conversion project.
- Alternatives
  - Remove existing summer setup and reconductor Los Banos-Canal and Mercy springs Canal 70 kV lines.
  - Remove existing summer setup and reconductor Los Banos-Canal, Mercy springs Canal and replace limiting equipment on Oroloma bank
- Preliminary Conclusion
  - Further analysis required



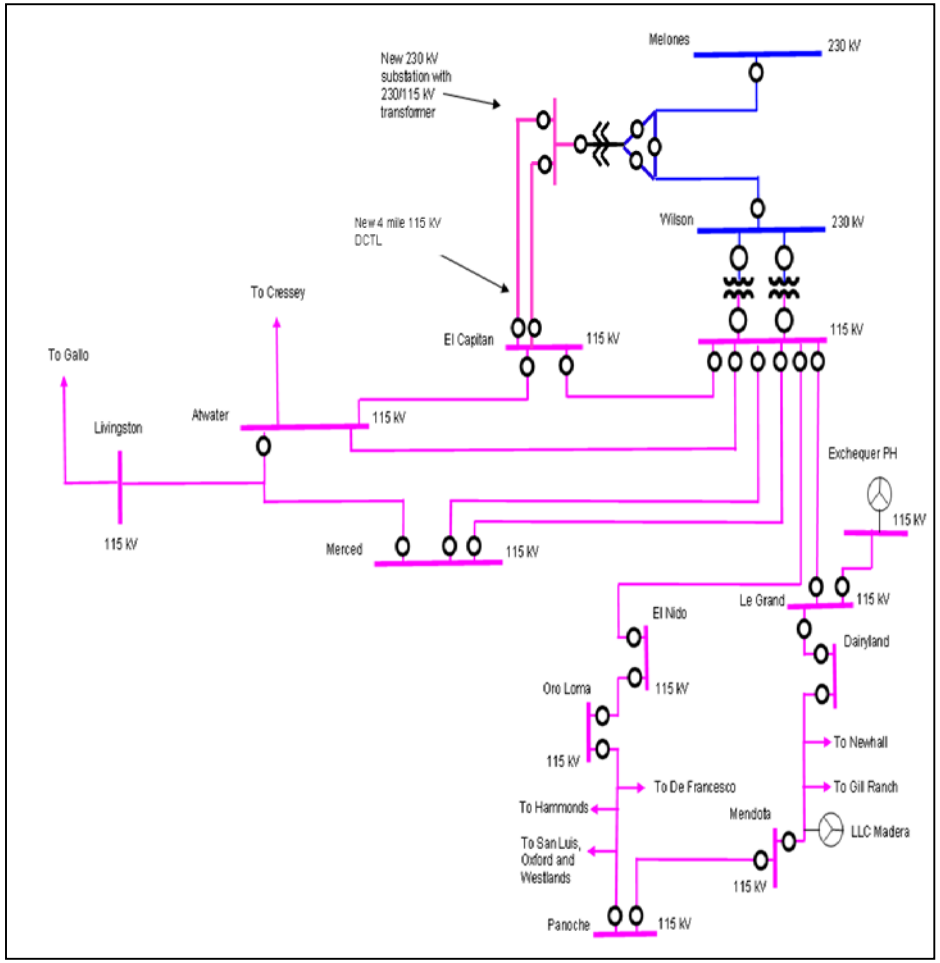
McCall - Reedley #2 115 kV Line

- Original need
  - 2013-14 TPP: NERC Category P6 & P7 thermal overload.
- Reliability Assessment Need
  - NERC Categories P6 thermal overloads in baseline
  - NERC Category P2 (QF sensitivity only) & P6 thermal overloads in multiple sensitivity scenarios.
- Mitigation still required {or not}
  - Mitigation required for reliability
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads. Under review for potential alternative solutions.
- Alternatives
  - SPS
  - Disable automatics and reconductor limiting sections.
- Preliminary Conclusion
  - Further analysis required



Wilson 115 kV Area Reinforcement

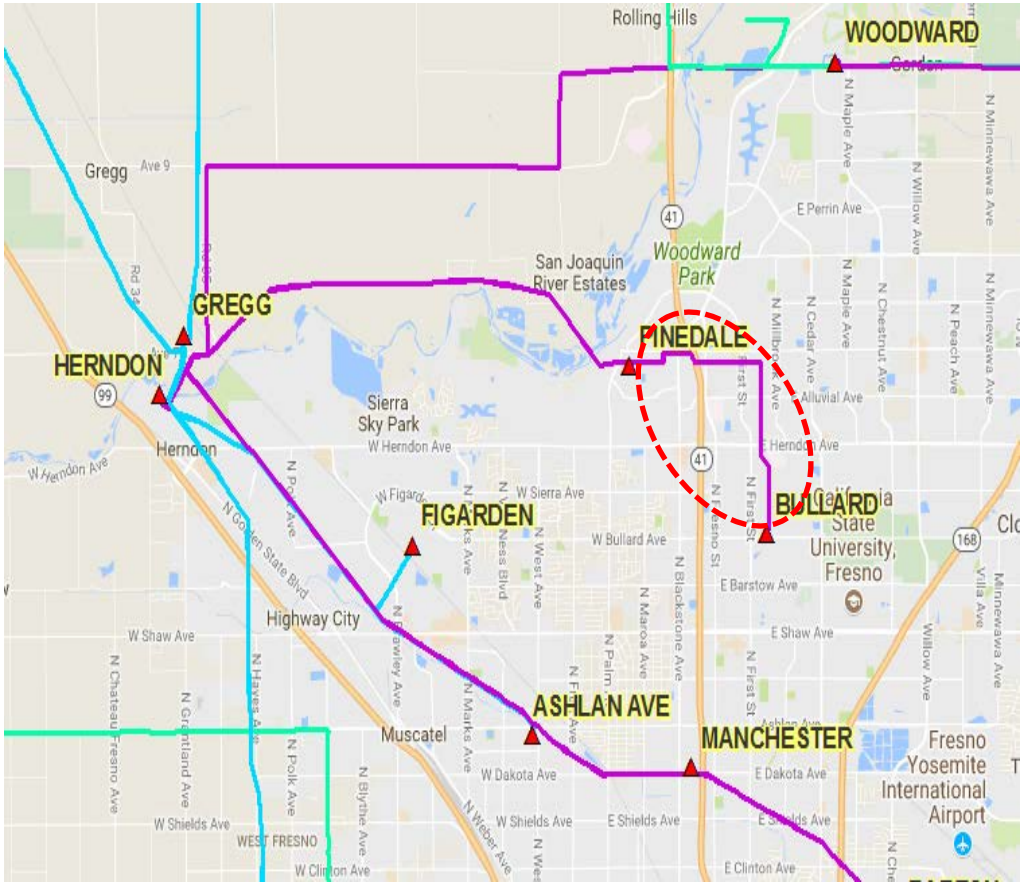
- Original need
  - 2010-11TPP: NERC P6 & P7 thermal overloads & voltage collapse.
- Reliability Assessment Need
  - NERC Categories P2 and P6 thermal overloads and voltage issues in baseline and multiple sensitivity scenarios.
- Mitigation still required {or not}
  - Mitigation required for reliability
- Review of current project to meet need
  - Under review for potential alternative solutions.
- Alternatives
  - Sectionalize Wilson 115 kV bus (P2) & rely on radializing the system following the first contingency.
  - Sectionalize Wilson 115 kV bus (P2) & install a third 230/115 kV transformer along with reconductor to mitigate P6 concerns.
- Preliminary Conclusion
  - Further analysis required



Areas of additional mitigation requirement

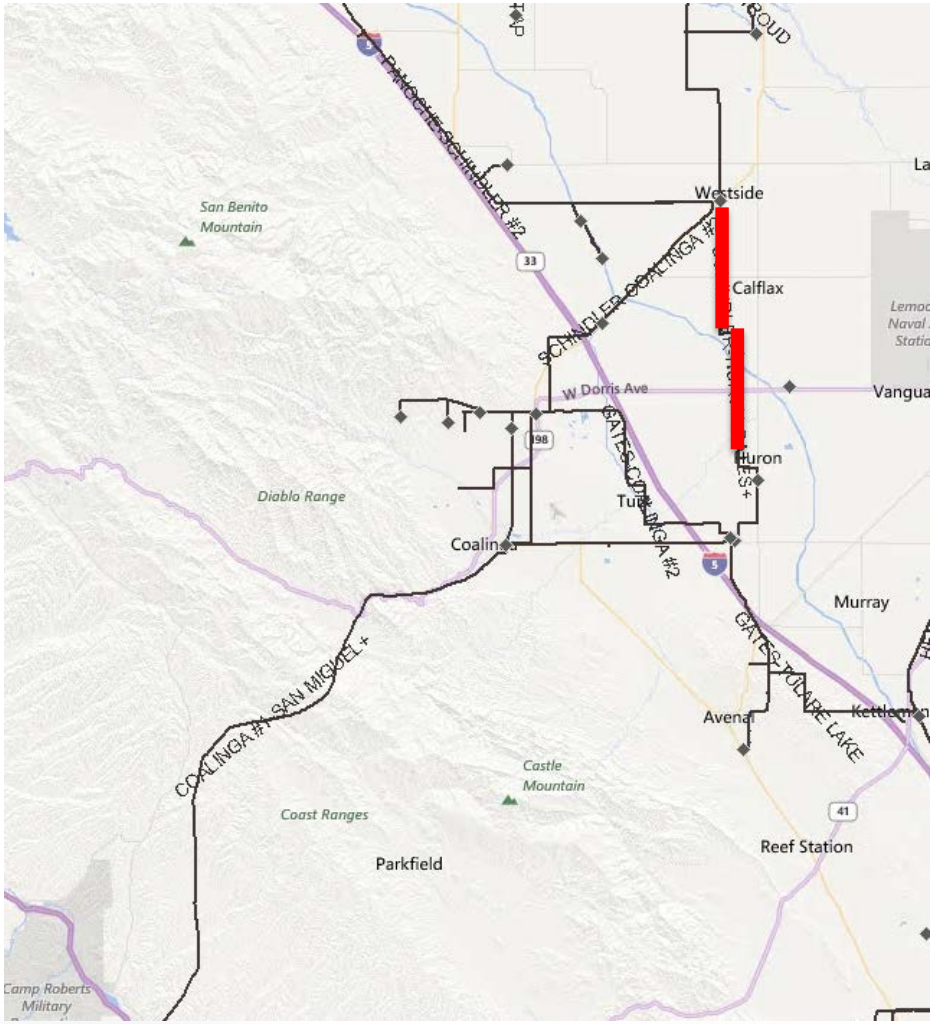
Additional Mitigation Requirements
HERNDON-BULLARD #2 115 kV – (From 7/38 To Bullard Sub)

- Reliability Assessment Need
  - NERC Categories P2-1 thermal overload in baseline and sensitivity scenarios.
  - Overloads worsen in 2027 peak-shift and high CEC forecast sensitivities.
- Potential Alternatives
  - SPS to drop load (~24 MW load drop in 2027 Peak shift scenario)
  - Use Preferred Resources to mitigate thermal overloads
  - Reconductoring the limiting sections.
- First Year of Need identified in Current Assessment
  - 2019
- Interim Mitigation
  - Action plan



Additional Mitigation Requirements
Coalinga 70 kV Area

- Reliability Assessment Need
  - NERC Categories P2 thermal overloads in the 2022 Spring Off-Peak scenario
    - SCHINDLER-HURON-GATES - From 9/2 To 16/12(HuronJ to Calflax line section)
    - SCHINDLER-HURON-GATES - From Schindler To 9/2 (Schindler to Five Point Switching Station)
- Potential Alternatives
  - Utilize Short Term rating of the limiting sections
  - SPS to drop generation.
- First Year of Need identified in Current Assessment
  - 2022 Spring Off-Peak
- Interim Mitigation
  - Action plan



Sensitivity Study Assessment

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

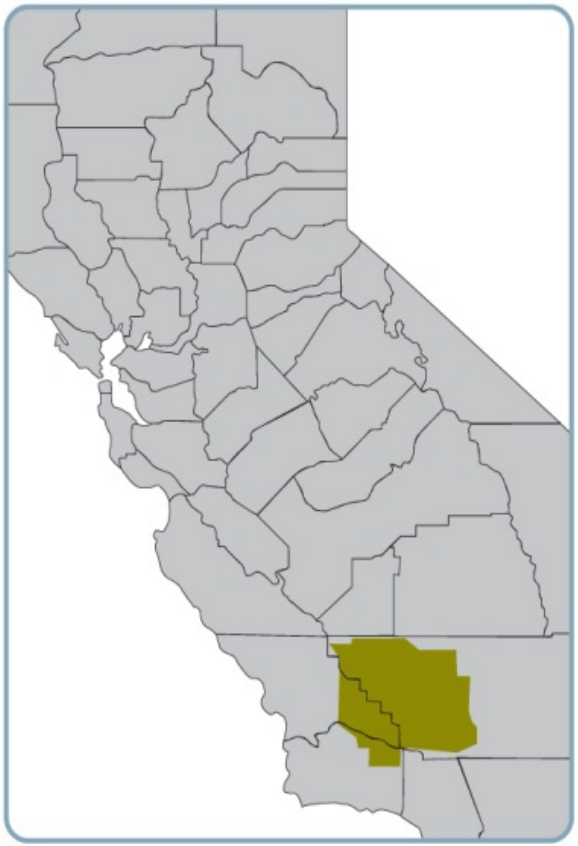
Overloaded Facility	Category	2022 SP High CEC Forecast	2019 SP Peak-Shift	2027 SP Peak-Shift	2022 SP Heavy Renewable & Min Gas Gen	2027 Retirement of QF Generations
34117 KETLMN T 70.0 34552 GATES 70.0 1 1	P0				√	
34567 FIVEPOINTSSS 70.0 34560 CALFLAX 70.0 1 1	P2				√	
30875 MC CALL 230 30878 MCCALL3M 115 3 1	P6					√
34105 CERTANJ1 115 34100 CHWCHLLA 115 1 1	P6					
34107 CERTANJ2 115 34101 CERTAN T 115 1 1	P6			√		
34107 CERTANJ2 115 34103 CHWCGNJT 115 1 1	P6			√		
34155 PANOCHE1 115 34350 KAMM 115 1 1	P6				√	
34240 GLASS 70.0 34256 BORDEN 70.0 1 1	P6	√		√		
34252 MADERA 70.0 34256 BORDEN 70.0 2 1	P6	√		√		
34256 BORDEN 70.0 34252 MADERA 70.0 1 1	P6	√		√		
34350 KAMM 115 34352 CANTUA 115 1 1	P6			√	√	
34352 CANTUA 115 34432 WESTLNDS 115 1 1	P6				√	
34561 Q526TP 70.0 34566 PLSNTVLY 70.0 1 1	P6					√
34562 SCHLNDLR 70.0 34561 Q526TP 70.0 1 1	P6				√	√
34562 SCHLNDLR 70.0 34567 FIVEPOINTSSS 70.0 1 1	P6				√	
36354 SAN MIGL 70.0 34574 COLNGA 1 70.0 1 1	P6	√			√	√

Kern Area
Preliminary Reliability Assessment Results

Abhishek Singh
Regional Transmission Engineer Lead

2017-2018 Transmission Planning Process Stakeholder Meeting
September 21-22, 2017

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

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)
Kern-2019-SP	Baseline	2019 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	1,948	30	255	85	1,833	76	56
Kern-2022-SP	Baseline	2022 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	2,065	50	273	98	1,917	77	58
Kern-2027-SP	Baseline	2027 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	2,190	85	401	137	1,967	77	58
Kern-2019-SPR-LL	Baseline	2019 spring light load conditions. Light load time - hours between 02:00 and 04:00.	726	21	255	0	705	76	56
Kern-2022-SPR-OPK	Baseline	2022 spring off-peak load conditions. Off-peak load time – weekend morning.	1,214	40	273	273	901	77	58
Kern-2019-SP-PS	Sensitivity	2019 summer peak load conditions with peak-shift and AAEE sensitivity	1,939	30	255	52	1,857	76	58
Kern-2027-SP-PS	Sensitivity	2022 summer peak load conditions with peak-shift and AAEE sensitivity	2,290	85	401	37	2,168	77	58
Kern-2022-SP-HIGH CEC	Sensitivity	2022 summer peak load conditions with peak-shift and AAEE sensitivity	2,095	0	273	38	2,058	77	58
Kern-2022-SP-HIGH RENEW-MINGAS	Sensitivity	2022 summer peak load conditions with hi renewable dispatch sensitivity	1,858	43	273	273	1,525	77	58
Kern-2027-SP-QFRETIRE	Sensitivity	2027 summer peak load conditions with QF retirement sensitivity	2,189	85	401	137	1,966	77	58

Generation Assumptions- Kern

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)
Kern-2019-SP	Baseline	2019 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	2	726	181	0	0	22	13	3,247	2,812
Kern-2022-SP	Baseline	2022 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	2	726	181	0	0	22	13	3,247	2,880
Kern-2027-SP	Baseline	2027 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	2	726	181	0	0	22	13	3,247	2,683
Kern-2019-SPR-LL	Baseline	2019 spring light load conditions. Light load time - hours between 02:00 and 04:00.	2	726	0	0	0	22	13	3,247	316
Kern-2022-SPR-OPK	Baseline	2022 spring off-peak load conditions. Off-peak load time – weekend morning.	2	726	665	0	0	22	13	3,247	2,641
Kern-2019-SP-PS	Sensitivity	2019 summer peak load conditions with peak-shift and AAEE sensitivity	2	726	181	0	0	22	13	3,247	2,715
Kern-2027-SP-PS	Sensitivity	2027 summer peak load conditions with peak-shift and AAEE sensitivity	2	726	181	0	0	22	13	3,247	2,887
Kern-2022-SP-HIGH CEC	Sensitivity	2022 summer peak load conditions with peak-shift and AAEE sensitivity	2	726	181	0	0	22	13	3,247	2,888
Kern-2022-SP-HIGH RENEW-MINGAS	Sensitivity	2022 summer peak load conditions with hi renewable dispatch sensitivity	2	726	726	0	0	22	13	3,247	551
Kern-2027-SP-QFRETIRE	Sensitivity	2027 summer peak load conditions with QF retirement sensitivity	2	726	181	0	0	22	13	3,247	2,565

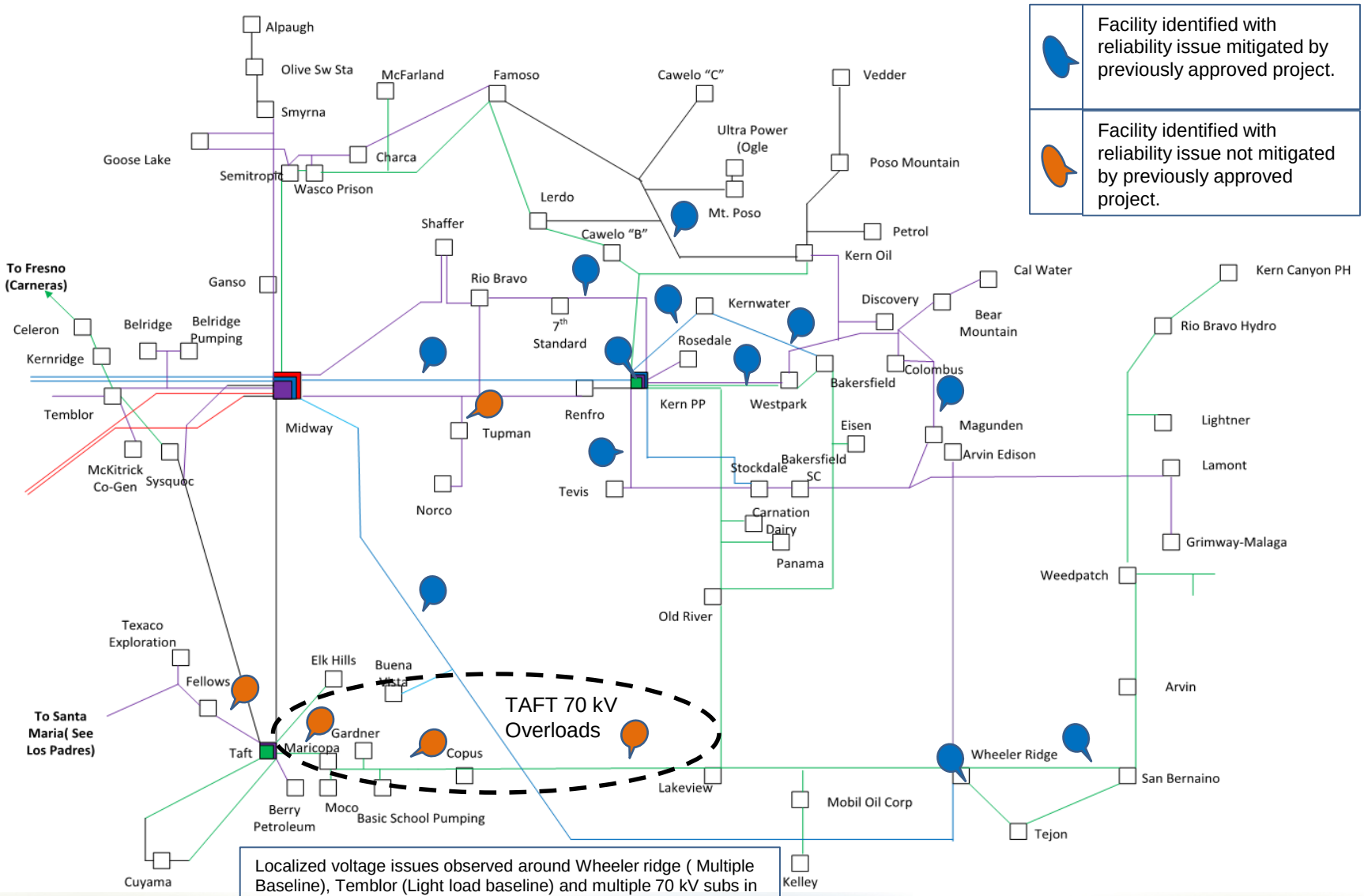
Previously Approved Transmission Projects Modelled in base cases

Project Name	2017-18 TPP Base case First Modeled year
Midway-Kern PP Nos. 1,3 and 4 230 kV Lines Capacity Increase	2022
Semitropic – Midway 115 kV Line Reconductor	2019
Kern PP 230 kV Area Reinforcement	2022
Midway – Kern PP #2 230 kV Line	2022
San Bernard – Tejon 70 kV Line Reconductor	2019

Previously Approved Transmission Projects Not modelled in base cases

Project Name	Current In-service date
Wheeler Ridge-Weedpatch 70 kV Line Reconductor	April-2019
Kern PP 115 kV Area Reinforcement	June-2020
Wheeler Ridge Junction Substation	May-2020
North East Kern Voltage Conversion Project	May-2025
Midway-Temblor 115 kV Line Reconductor and Voltage Support	April-2019
Wheeler Ridge Voltage Support	December-2020

Summary of reliability needs identified

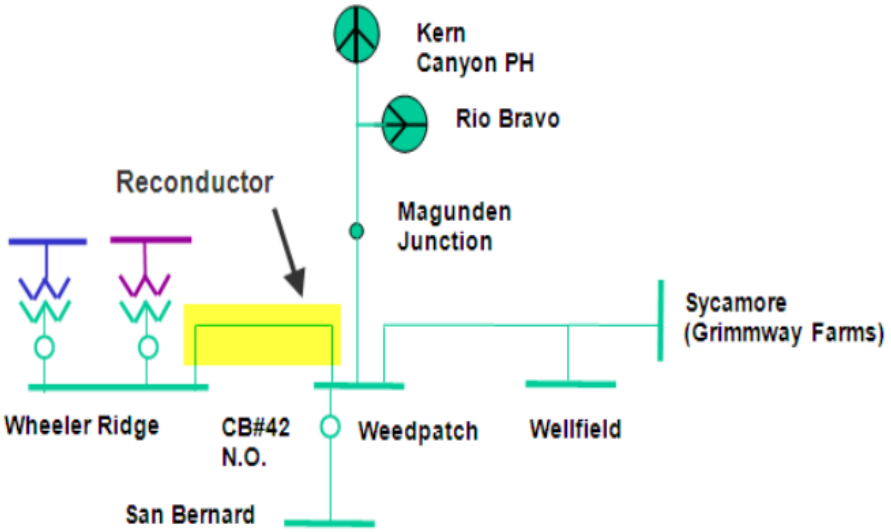


Localized voltage issues observed around Wheeler ridge (Multiple Baseline), Temblor (Light load baseline) and multiple 70 kV subs in 2019 case. Multiple 70 kV voltage issues go away in 2022 with the PF correction applied at the subs.

Assessment of previously approved projects not modeled in base cases

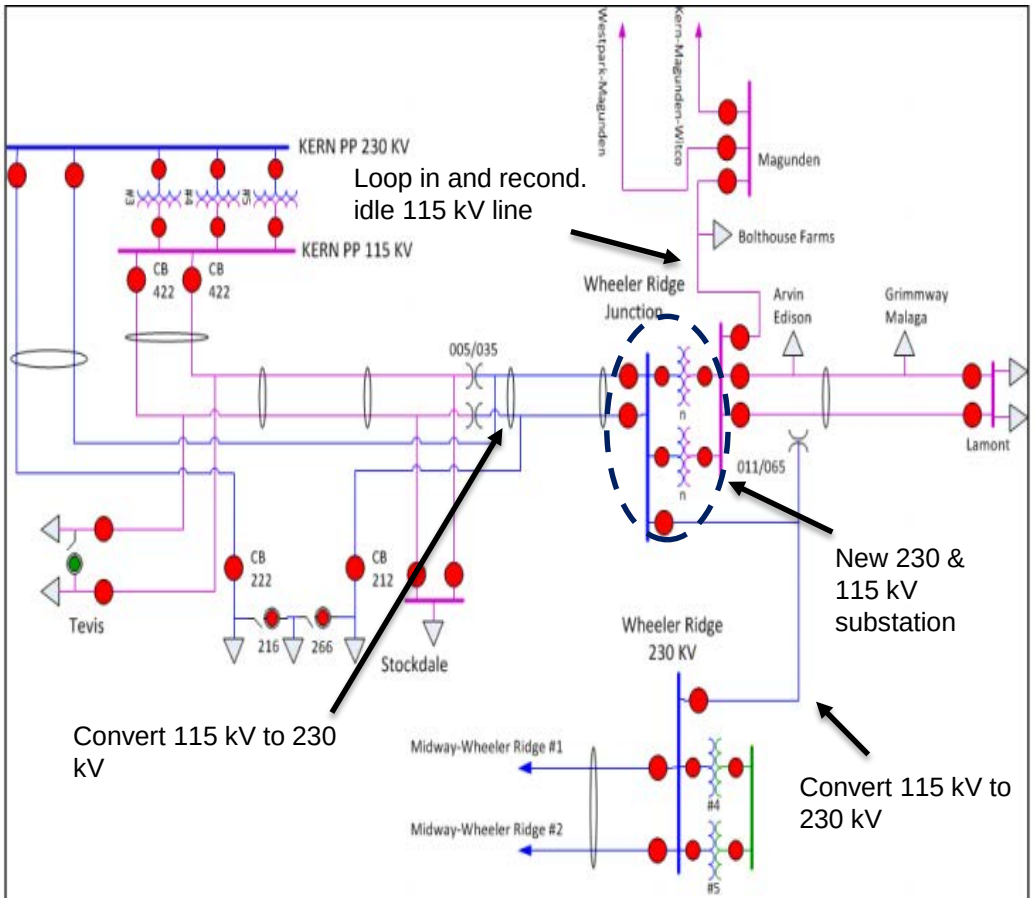
Wheeler Ridge-Weedpatch 70 kV Line Reconductor

- Original need
  - 2013-14 TPP: NERC Category P3 overloads
- Current Reliability Assessment Need
  - NERC Categories P3 overloads in baseline (2027 Peak) and several sensitivity scenarios.
- Mitigation still required
  - Mitigation required for reliability
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads.
- Alternatives
  - Not required.
- Preliminary Conclusion
  - Original scope of the project meets the reliability requirement. Monitor the overload as the need is seen in 2027



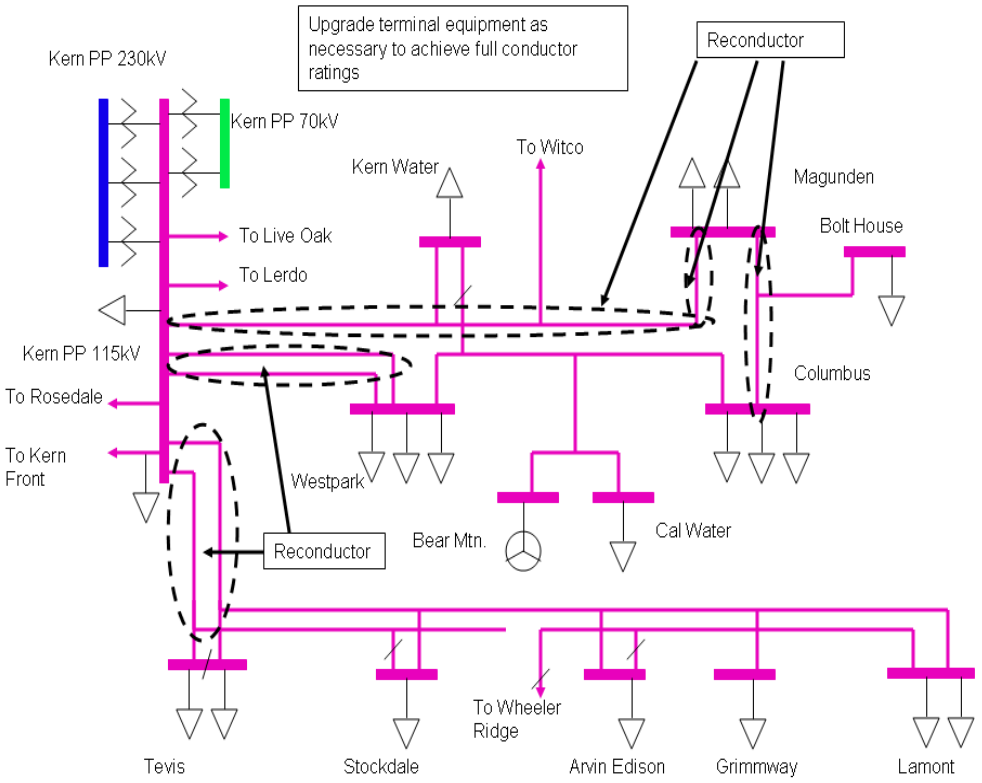
Wheeler Ridge Junction Station Project

- Original need
  - 2013-14 TPP :NERC Category P2,P3, &P6
- Current Reliability Assessment Need
  - NERC Categories P1,P2 &P6 overloads in baseline and sensitivity scenarios.
- Mitigation still required
  - Mitigation required for reliability
  - Mitigation required for generation interconnection.
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads. Under review for potential alternative solutions.
- Alternatives
  - Rerating/Reconductoring the limiting sections and SPS for some overloads.
  - Evaluate Project in conjunction with the Kern PP 115 kV reinforcement project.
  - 115 kV switching station at Wheeler ridge Junction.
- Preliminary Conclusion
  - Revisit the scope of the original project



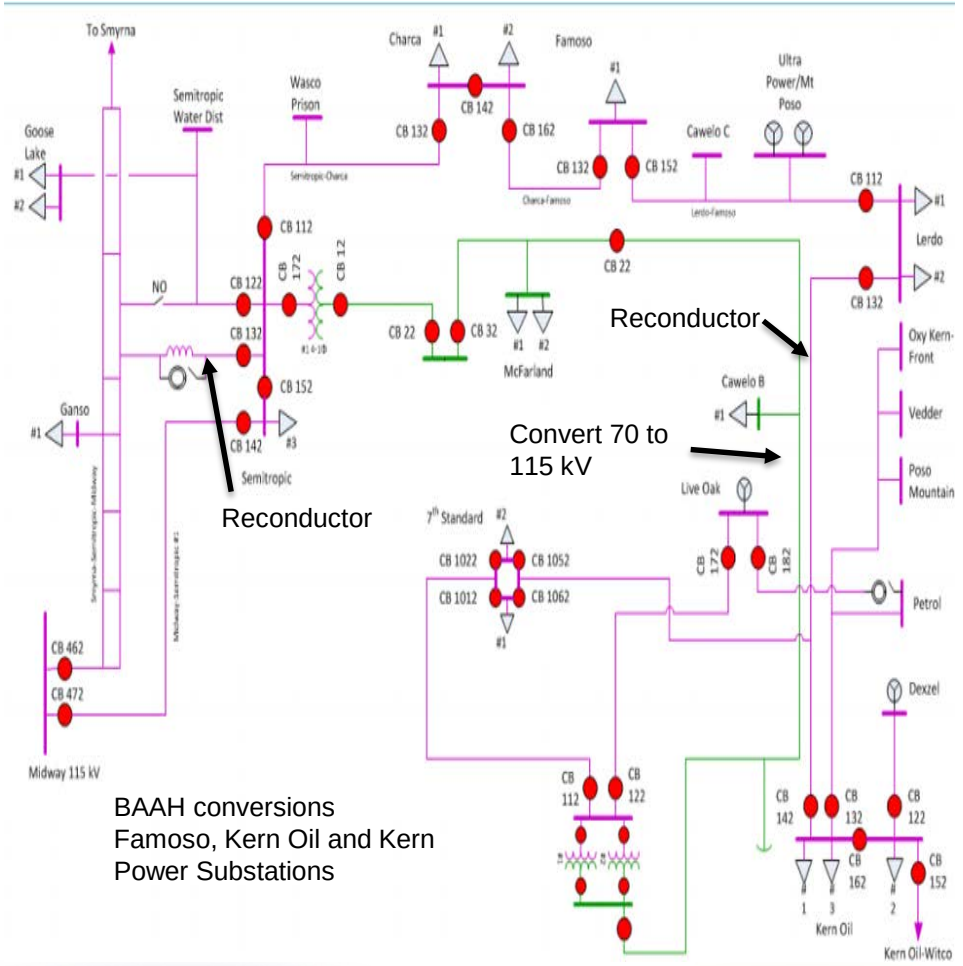
Kern PP 115 kV reinforcement project

- Original need
  - 2011-12 TPP:NERC Category P0, P1,P3,P6 & P7 overloads
- Current Reliability Assessment Need
  - NERC Category P2& P6 overloads for all years baseline scenario
  - Multiple P0,P1, P2,P3,P6 & P7 overloads seen in the sensitivity cases (QF sensitivity being the worst)
- Mitigation still required
  - Mitigation required for reliability
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads. Under review for potential alternative solutions.
- Alternatives
  - Re-conductor transmission lines and explore possible SPS options.
  - Evaluate Project in conjunction with the North East and Wheeler Ridge reinforcement project.
- Preliminary Conclusion
  - Revisit the scope of the original project



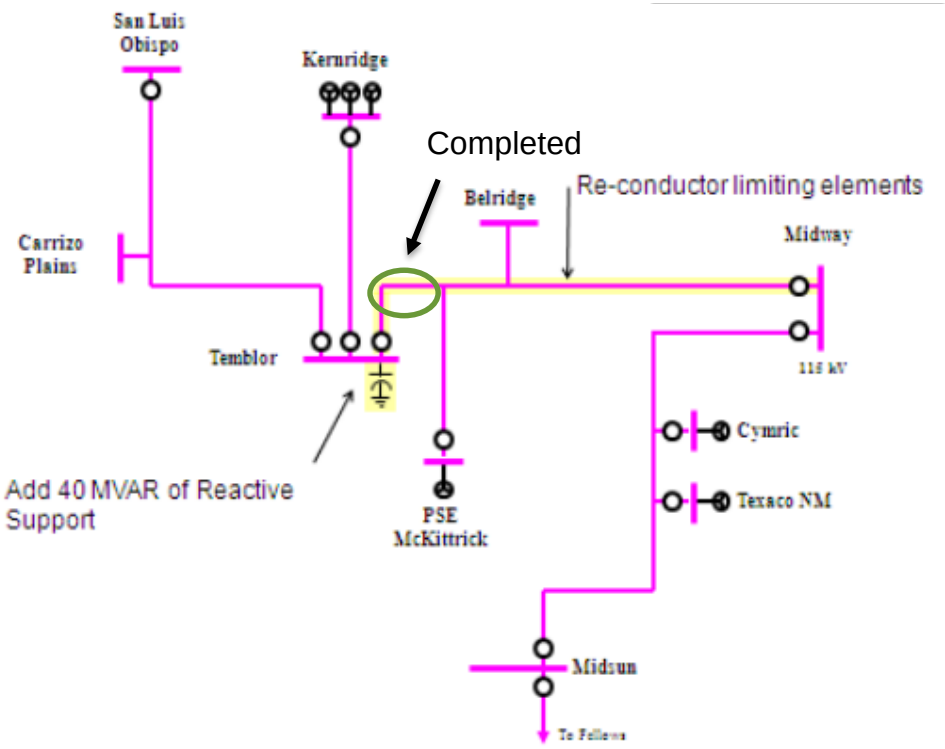
North East Kern 115 kV Voltage Conversion Project (Semitropic-Wasco-Famoso-Kern 70 kV project)

- Original need
  - 2014-15 TPP: NERC Category P1,P3 & P6 thermal overloads.
- Reliability Assessment Need
  - NERC Categories P2 & P6 thermal overloads in baseline and multiple sensitivity scenarios.
- Mitigation still required {or not}
  - Mitigation required for reliability
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads. Under review for potential alternative solutions.
- Alternatives
  - Re-conductor transmission lines and explore possible SPS options
  - Evaluate Project in conjunction with the Kern PP 115 kV reinforcement project
- Preliminary Conclusion
  - Revisit the scope of the original project



Midway-Temblor 115 kV line reconductor and voltage support

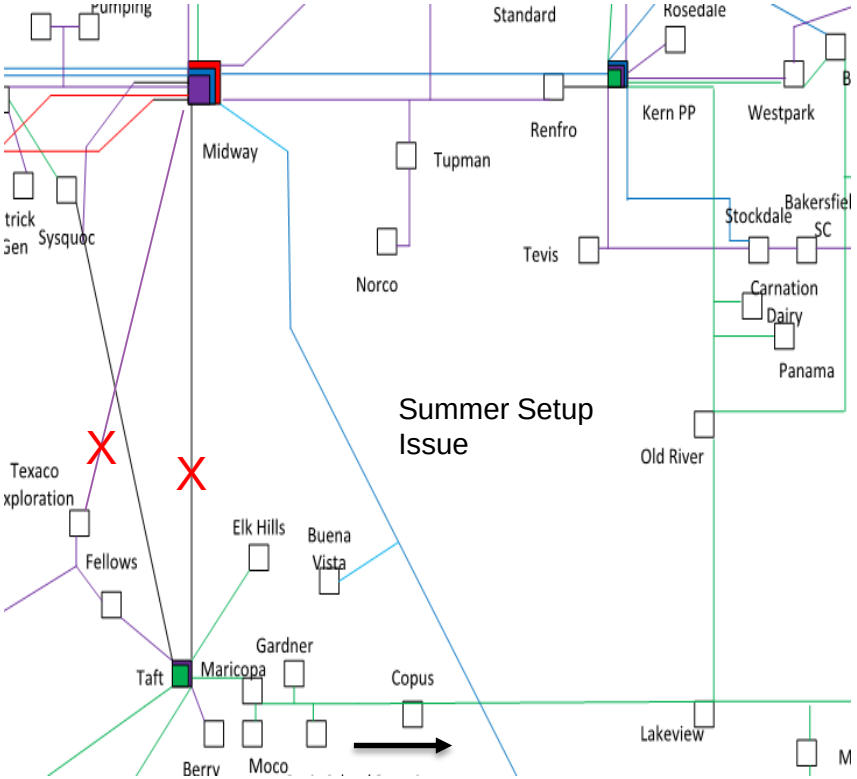
- Original need (2012-13 TPP)
  - NERC Category P1(Loss of generation) thermal overload on Midway-Temblor Line.
  - Low Voltage issues for P3 contingency in the area.
- Reliability Assessment Need
  - Original Overloads not seen in local studies.
  - Overloads seen in bulk Partial Peak 2027 analysis for P0, P1 & P6 500 kV contingencies.
  - Low Voltage observed in the 2019 Light load baseline study only.
- Mitigation still required {or not}
  - Mitigation required for reliability
- Review of current project to meet need
  - Phase 1 completed. (Temblor-Mckittrick Jn)
  - Phase 2 reconductor scope & voltage support under review for potential alternative solutions..
- Alternatives
  - Under Review
- Preliminary Conclusion
  - Revisit the scope of the original project



Areas of additional mitigation requirement

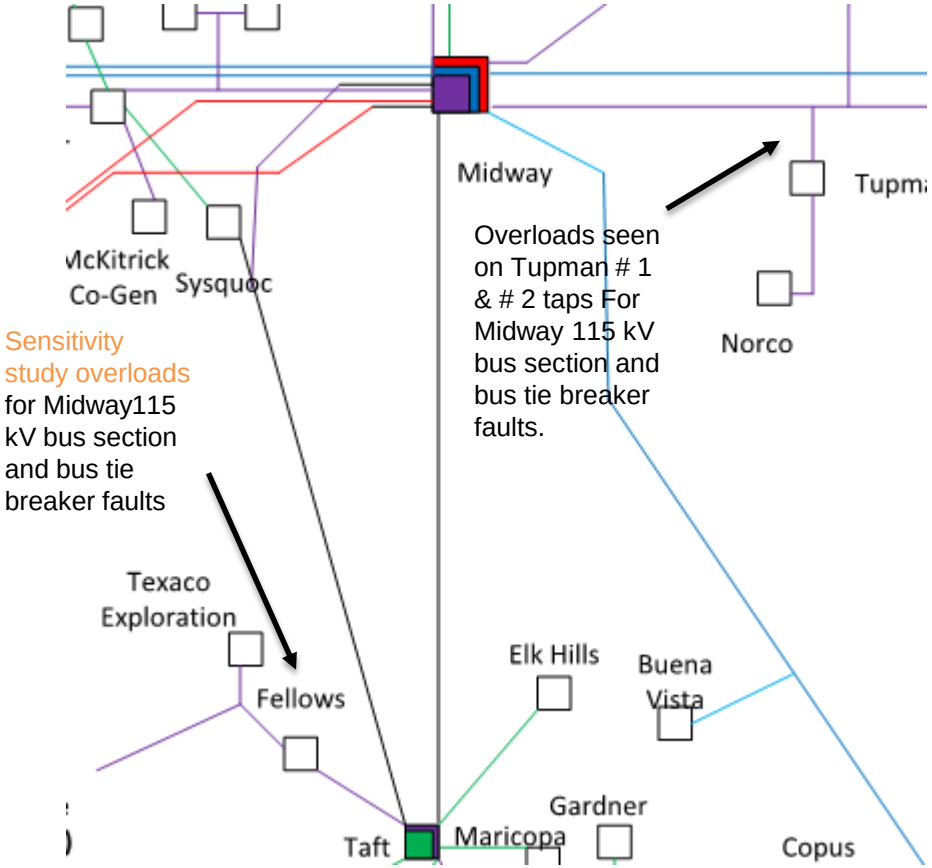
TAFT 70 kV Area Overloads

- Reliability Assessment Need
  - NERC Categories P6 thermal overloads
  - in one baseline scenario (2019 Spring Light Load).
- Potential Alternatives
  - Extend the summer setup to all the seasons
  - SPS
- First Year of Need identified in Current Assessment
  - 2019 Minimum Load Case
- Interim Mitigation
  - Extend the summer setup



Midway 115 kV Area Overloads

- Reliability Assessment Need
  - NERC Categories P2 thermal overloads on the Tupman taps in the baseline and multiple sensitivity scenarios.
  - NERC Categories P2 thermal overloads on multiple line sections between Taft and Fellows sub seen in the sensitivity scenarios only.
- Potential Alternatives
  - Sectionalizing Midway 115 kV bus section
  - Rerate/Reconductor the limiting sections.
  - SPS
- First Year of Need identified in Current Assessment
  - 2019
- Interim Mitigation
  - Action plan



Sensitivity Study Assessment

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

Overloaded Facility	Category	2022 SP High CEC Forecast	2019 SP Peak-Shift	2027 SP Peak-Shift	2022 SP Heavy Renewable & Min Gas Gen	2027 Retirement of QF Generations
30970 MIDWAY 230 30945 KERN PP 230 3 1	P6					√
30970 MIDWAY 230 30945 KERN PP 230 4 1	P2					√
34225 BELRDG J 115 34774 MIDWAY 115 1 1	P2				√	
34226 BELRDG J 115 34774 MIDWAY 115 1 1	P6				√	
34766 SHAFTER 115 34774 MIDWAY 115 1 1	P2			√		
34775 RENFRJCT 115 34760 RIO BRVO 115 1 1	P2			√		
34777 FELLOWSG 115 34800 SANTA FE SUB 115 1 1	P2				√	
34777 FELLOWSG 115 39070 AEVICTORYJT 115 1 1	P2				√	
34800 SANTA FE SUB 115 34802 MIDSET 115 1 1	P2				√	
34802 MIDSET 115 34776 TAFT 115 1 1	P2				√	

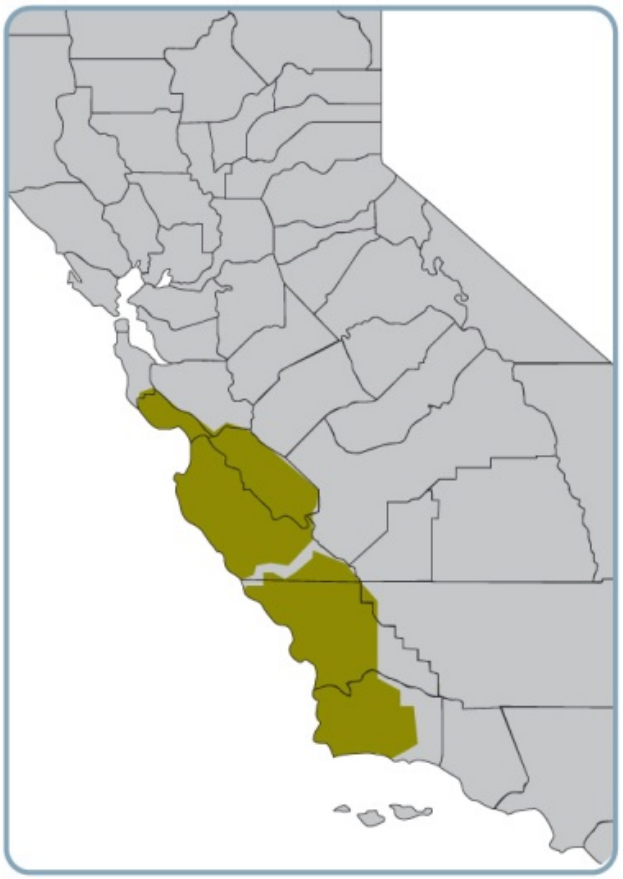
Central Coast and Los Padres Areas Preliminary Reliability Assessment Results

Ramesh Chakkapalli

2017-2018 Transmission Planning Process Stakeholder Meeting

September 21-22, 2017

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 Areas

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)
CCLP-2019-SP	Baseline	2019 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	1,351	33	223	75	1,243	28	16
CCLP-2022-SP	Baseline	2022 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	1,395	55	273	94	1,248	28	16
CCLP-2027-SP	Baseline	2027 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	1,502	89	456	160	1,253	28	16
CCLP-2019-WP	Baseline	2019 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	1,338	34	223	0	1,304	28	16
CCLP-2022-WP	Baseline	2022 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	1,382	54	273	0	1,325	28	16
CCLP-2027-WP	Baseline	2027 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	1,488	96	456	0	1,392	28	16
CCLP-2019-ML	Baseline	2019 spring light load conditions. Light load time - hours between 02:00 and 04:00.	693	23	223	0	668	28	16
CCLP-2022-SOP	Baseline	2022 spring off-peak load conditions. Off-peak load time – weekend morning.	1,072	42	273	259	771	28	16
CCLP-2022-SP-PS-AAEE	Sensitivity	2022 summer peak load conditions with peak-shift and AAEE sensitivity	1,380	0	273	37	1,343	28	16
CCLP-2019-SP-PS	Sensitivity	2019 summer peak load conditions with peak-shift sensitivity	1,340	33	223	47	1,260	28	16
CCLP-2027-SP-PS	Sensitivity	2027 summer peak load conditions with peak-shift sensitivity	1,484	90	456	44	1,350	28	16
CCLP-2022-SP-HiRenew	Sensitivity	2022 summer peak load conditions with hi renewable dispatch sensitivity	1,304	47	273	273	984	28	16
CCLP-2027-SP-QF	Sensitivity	2027 summer peak load conditions with QF retirement sensitivity	1,502	89	456	160	1,253	28	16

Note:

DR and storage are modeled offline in sarting base cases.

Generation Assumptions – CCLP Areas

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)
CCLP-2019-SP	Baseline	2019 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	0	1,105	276	0	0	0	0	249	162
CCLP-2022-SP	Baseline	2022 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	0	1,105	276	0	0	0	0	249	162
CCLP-2027-SP	Baseline	2027 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	0	1,105	276	0	0	0	0	249	162
CCLP-2019-WP	Baseline	2019 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	0	1,105	0	0	0	0	0	249	162
CCLP-2022-WP	Baseline	2022 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	0	1,105	0	0	0	0	0	249	162
CCLP-2027-WP	Baseline	2027 winter peak load conditions. Peak load time - hours between 16:00 and 18:00.	0	1,105	0	0	0	0	0	249	162
CCLP-2019-ML	Baseline	2019 spring light load conditions. Light load time - hours between 02:00 and 04:00.	0	1,105	0	0	0	0	0	249	162
CCLP-2022-SOP	Baseline	2022 spring off-peak load conditions. Off-peak load time – weekend morning.	0	1,105	870	0	0	0	0	249	162
CCLP-2022-SP-PS-AAEE	Sensitivity	2022 summer peak load conditions with peak-shift and AAEE sensitivity	0	1,105	276	0	0	0	0	249	162
CCLP-2019-SP-PS	Sensitivity	2019 summer peak load conditions with peak-shift sensitivity	0	1,105	276	0	0	0	0	249	162
CCLP-2027-SP-PS	Sensitivity	2027 summer peak load conditions with peak-shift sensitivity	0	1,105	276	0	0	0	0	249	162
CCLP-2022-SP-HiRenew	Sensitivity	2022 summer peak load conditions with hi renewable dispatch sensitivity	0	1,105	1,105	0	0	0	0	249	162
CCLP-2027-SP-QF	Sensitivity	2027 summer peak load conditions with QF retirement sensitivity	0	1,105	276	0	0	0	0	249	162
Note:											
DR and storage are modeled offline in sarting base cases.											

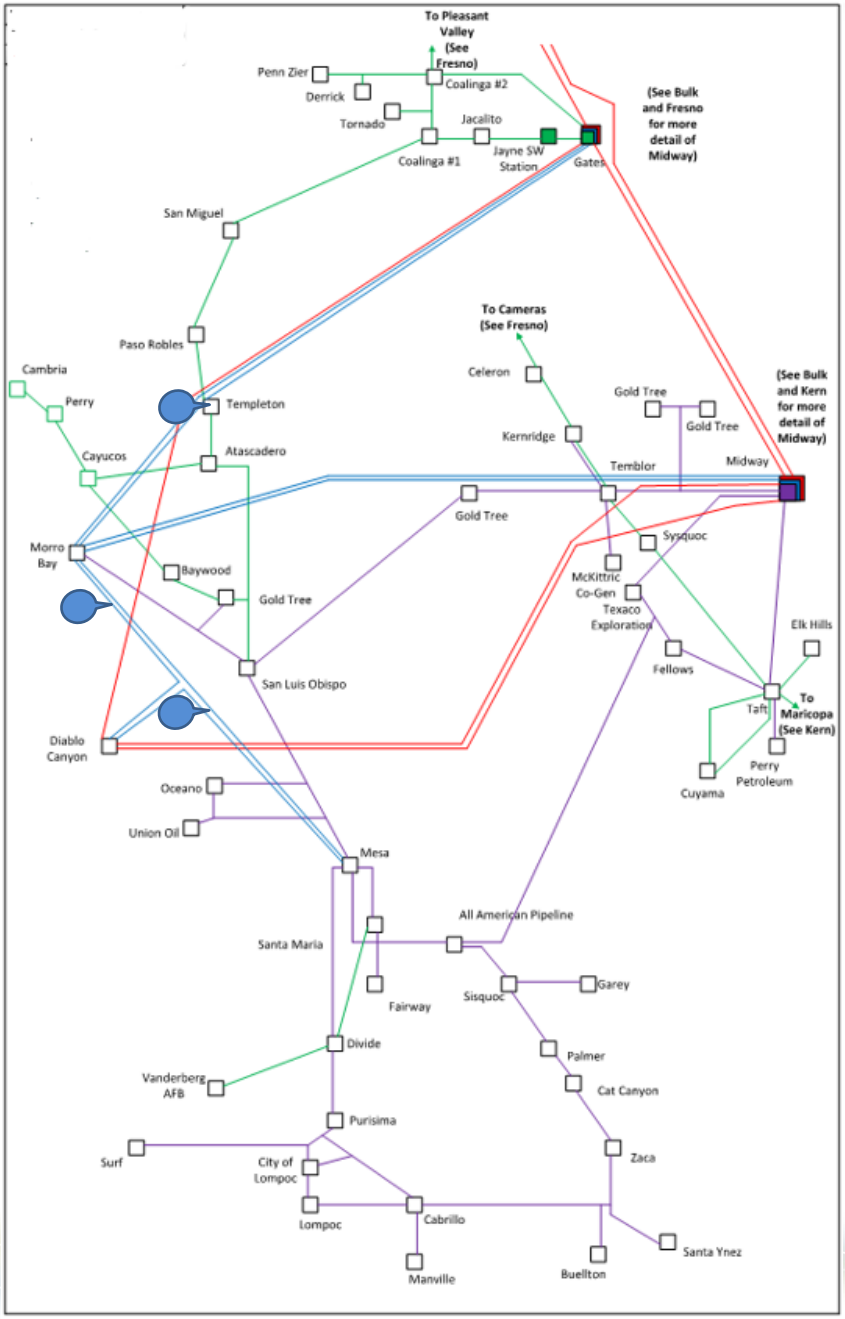
Previously Approved Transmission Projects Modelled in base cases

Project Name	First Year Modeled
Estrella Project	2019

Previously Approved Transmission Projects Not modelled in base cases

Project Name	In-Service Date
Watsonville Voltage Conversion Project	Jun-21
Midway-Andrew Project	Jun-25
Morro Bay 230/115 KV Transformer Project	Apr-19

Summary of Reliability Needs Identified

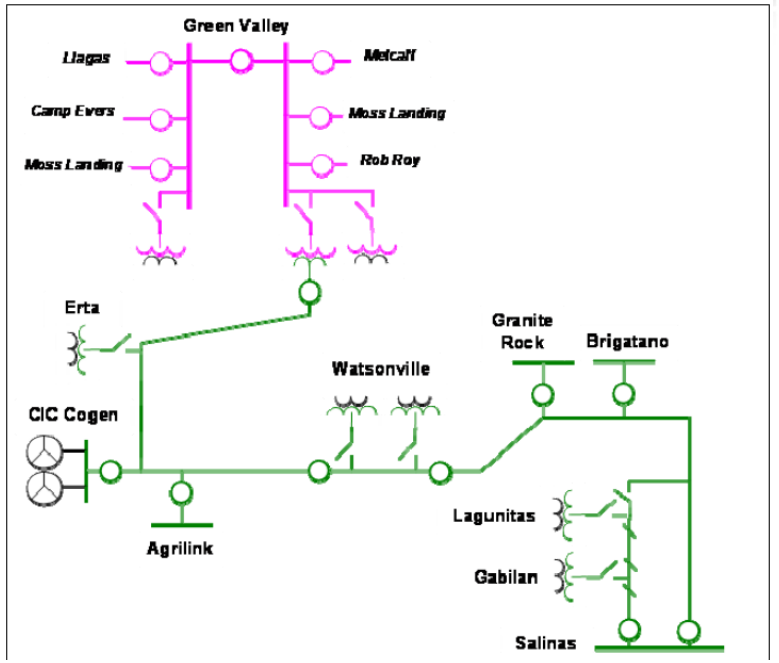


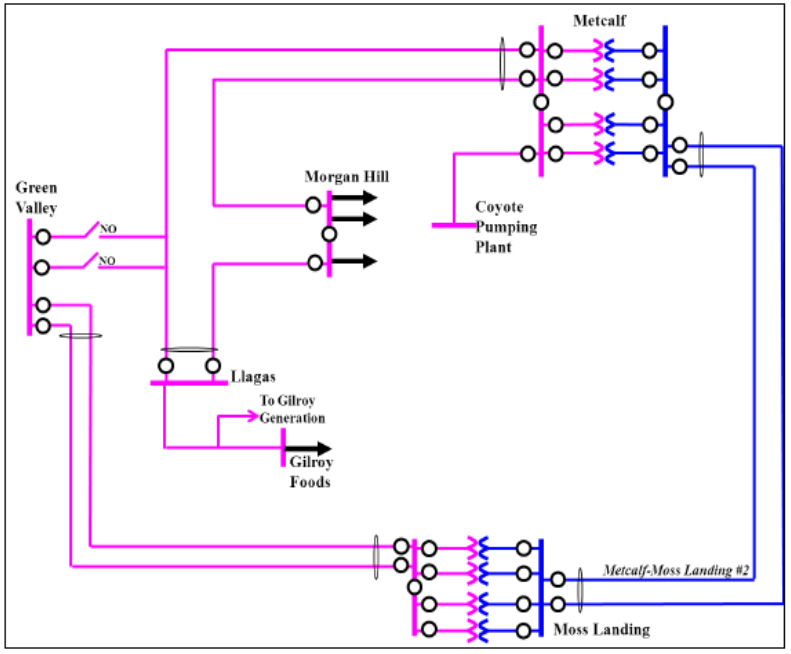
	Facility identified with reliability issue mitigated by previously approved project.
	Facility identified with reliability issue not mitigated by previously approved project.

Assessment of previously approved projects not modeled in base cases

Watsonville Voltage Conversion Project 60 KV to 115 KV

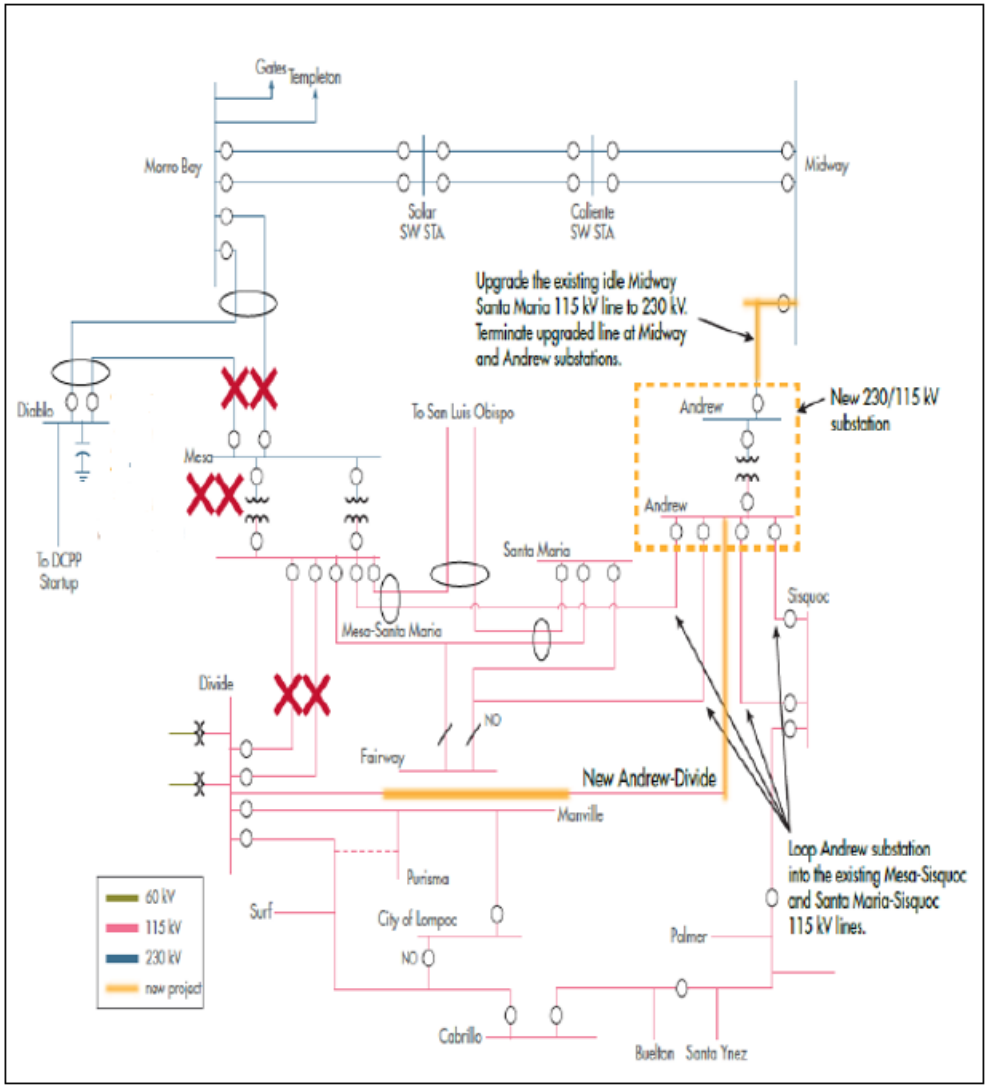
- Original need
  - NERC Category P6 thermal overloads and low voltages.
  - Loss of close to 200 MW load for NERC category P7 (DCTL) outage.
- Reliability Assessment Need
  - Similar to original
- Mitigation still required {or not}
  - Mitigation required for reliability
- Review of current project to meet need
  - Current scope of the project mitigates identified thermal overloads and voltage issues. Under review for potential alternative solutions.
- Alternatives
  - Reconductor Green Valley-Llagas 115 kV line and normally close ties with Green Valley 115 kV system.
  - Restructure Metcalf-Green Valley 115 kV line into Green Valley-Morgan Hill 115 kV. Keep the tie normally open and automatic closing for contingency on either side.
- Preliminary Conclusion
  - Further review





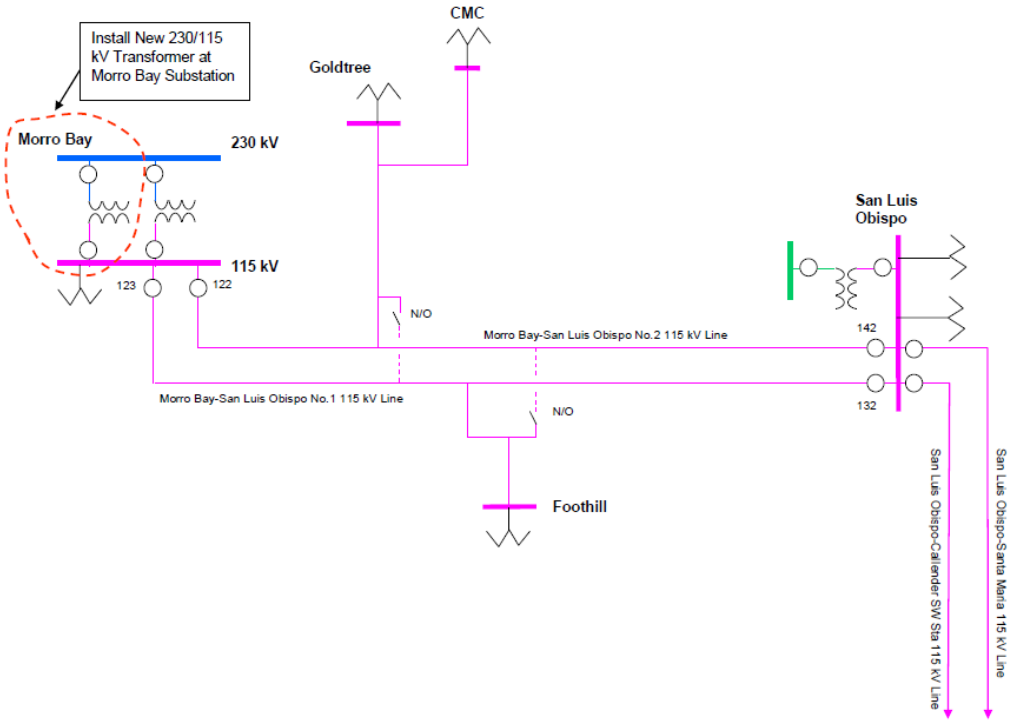
Midway-Andrew 230 KV project

- Original need
  - NERC Category P2,P6,P7 severe thermal overloads with voltage collapse
- Reliability Assessment Need
  - Similar to original
- Mitigation still required {or not}
  - Mitigation required for reliability
- Review of current project to meet need
  - Current scope of the project mitigates identified thermal overloads. Under review for potential alternative solutions.
- Alternatives
  - Re-purpose Diablo-Midway 500 KV #3 to 230 KV
    1. Loop in SLO-Santa Maria into Andrew Sub and loop in SLO-Sana Maria to Mesa. Re-conductor Sisquoc-Sana Ynez 115 KV
    2. Andrew-Divide 115 KV Line
    3. Loop in SLO-Santa Maria into Andrew Sub and loop in SLO-Sana Maria to Mesa. New Mesa-Divide-3 115 KV
    4. New 230 KV line to Mesa and new Mesa-Divide 115 KV line
    5. New 230 KV line to Mesa and Reconducor Sisquoc-Sana Ynez 115 KV
- Preliminary Conclusion
  - Further analysis required



Morro Bay 230/115 KV Transformer project

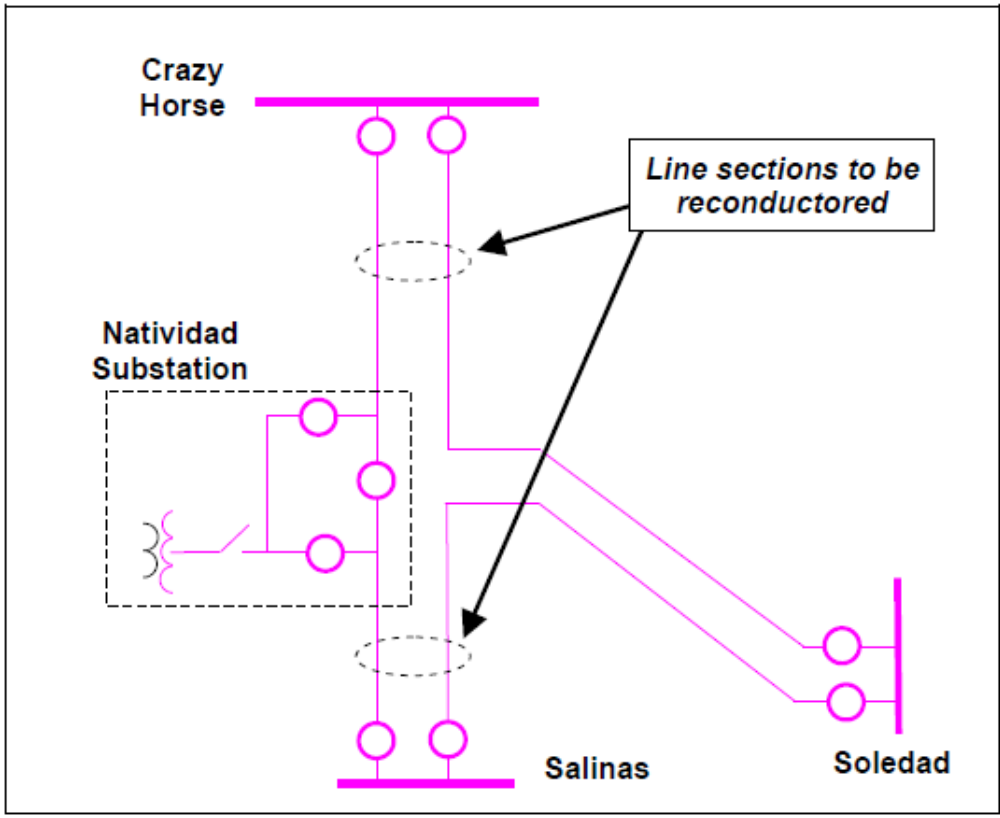
- Original need
  - NERC Category P2,P6,P7 thermal overloads
- Reliability Assessment Need
  - Similar to original
- Mitigation still required {or not}
  - Reevaluate the need with Midway-Andrew project
- Review of current project to meet need
  - Midway-Andrew project mitigates identified needs.
- Alternatives
  - Reconductor the Callander SW Station- San Luis Obispo and Callander SW Station-Mesa 115 KV lines.
- Preliminary Conclusion
  - Further Analysis with Midway-Andrew project



Areas of additional mitigation requirement

Additional Mitigation Requirements
Crazy Horse-Salinas 115 kV lines

- Reliability Assessment Need
  - NERC Category P5, P6, P7 thermal overloads.
- Potential Alternatives
  - Rerate
  - Reconductor
  - SPS
- First Year of Need identified in Current Assessment
  - 2019
- Interim Mitigation
  - Action plan



Additional Mitigation Requirements
Coburn-Oil fields 60 kV system

- Reliability Assessment Need
  - NERC Category P3, P1 causing low voltages in the local areas with potential for generation retirement in the area.
- Potential Alternatives
  - Shunt Capacitor
- First Year of Need identified in Current Assessment
  - 2019
- Interim Mitigation
  - Local generation

Map source: PG&E solar photovoltaic and renewable auction mechanism (PV RAM) project map

Sensitivity Study Assessment

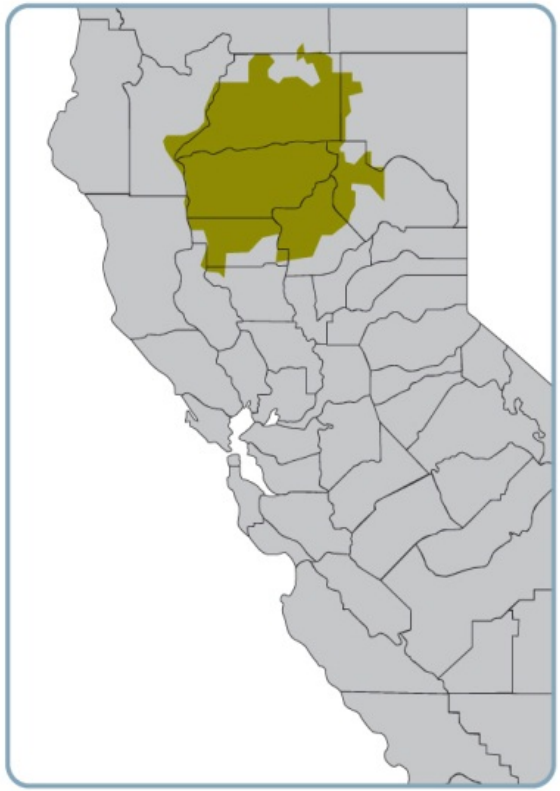
- No additional facility overloads identified in sensitivity scenario(s) only that were not in Base case scenarios.

North Valley Area
Preliminary Reliability Assessment Results

Ebrahim Rahimi
Lead Regional Transmission Engineer

2017-2018 Transmission Planning Process Stakeholder Meeting
September 21-22, 2017

North Valley Area



- 15,000 sq. miles NE corner of PG&E
- Cities: Chico, Redding, Red Bluff, Paradise
- Generation: Colusa is the largest generation facility (717 MW).
- Comprised of 60, 115, 230 & 500 kV transmission facilities.

Load and Load Modifier Assumptions – North 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)
NVLY-2019-SP	Baseline	2019 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	892	14	163	54	824	36	28
NVLY-2022-SP	Baseline	2022 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	924	23	188	63	838	36	28
NVLY-2027-SP	Baseline	2027 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	991	39	272	93	859	36	28
NVLY-2019-ML	Baseline	2019 spring light load conditions. Light load time - hours between 02:00 and 04:00.	271	10	163	0	261	36	28
NVLY-2022-SOP	Baseline	2022 spring off-peak load conditions. Off-peak load time – weekend morning.	419	19	188	177	223	36	28
NVLY-2019-SP-PS	Sensitivity	2019 summer peak load conditions with peak-shift sensitivity	883	14	163	33	835	36	28
NVLY-2027-SP-PS	Sensitivity	2027 summer peak load conditions with peak-shift sensitivity	998	39	272	25	934	36	28
NVLY-2022-SP-PS-AAEE	Sensitivity	2022 summer peak load conditions with peak-shift and AAEE sensitivity	915	0	188	24	891	36	28
NVLY-2022-SP-HiRenew	Sensitivity	2022 summer peak load conditions with hi renewable dispatch sensitivity	796	20	188	188	588	36	28
NVLY-2027-SP-QF	Sensitivity	2027 summer peak load conditions with QF retirement sensitivity	991	39	272	93	859	36	28

Note:

DR and storage are modeled offline in starting 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-2019-SP	Baseline	2019 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	0	0	0	103	34	1,774	1,662	1,065	511
NVLY-2022-SP	Baseline	2022 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	0	0	0	103	34	1,774	1,662	1,065	482
NVLY-2027-SP	Baseline	2027 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	0	0	0	103	34	1,774	1,662	1,065	384
NVLY-2019-ML	Baseline	2019 spring light load conditions. Light load time - hours between 02:00 and 04:00.	0	0	0	103	10	1,774	203	1,065	311
NVLY-2022-SOP	Baseline	2022 spring off-peak load conditions. Off-peak load time – weekend morning.	0	0	0	103	103	1,774	896	1,065	210
NVLY-2019-SP-PS	Sensitivity	2019 summer peak load conditions with peak-shift sensitivity	0	0	0	103	34	1,774	1,662	1,065	437
NVLY-2027-SP-PS	Sensitivity	2027 summer peak load conditions with peak-shift sensitivity	0	0	0	103	34	1,774	1,662	1,065	413
NVLY-2022-SP-PS-AAEE	Sensitivity	2022 summer peak load conditions with peak-shift and AAEE sensitivity	0	0	0	103	34	1,774	1,662	1,065	479
NVLY-2022-SP-HiRenew	Sensitivity	2022 summer peak load conditions with hi renewable dispatch sensitivity	0	0	0	103	103	1,774	1,618	1,065	285
NVLY-2027-SP-QF	Sensitivity	2027 summer peak load conditions with QF retirement sensitivity	0	0	0	103	34	1,774	1,647	1,065	399

Note:

DR and storage are modeled offline in starting base cases.

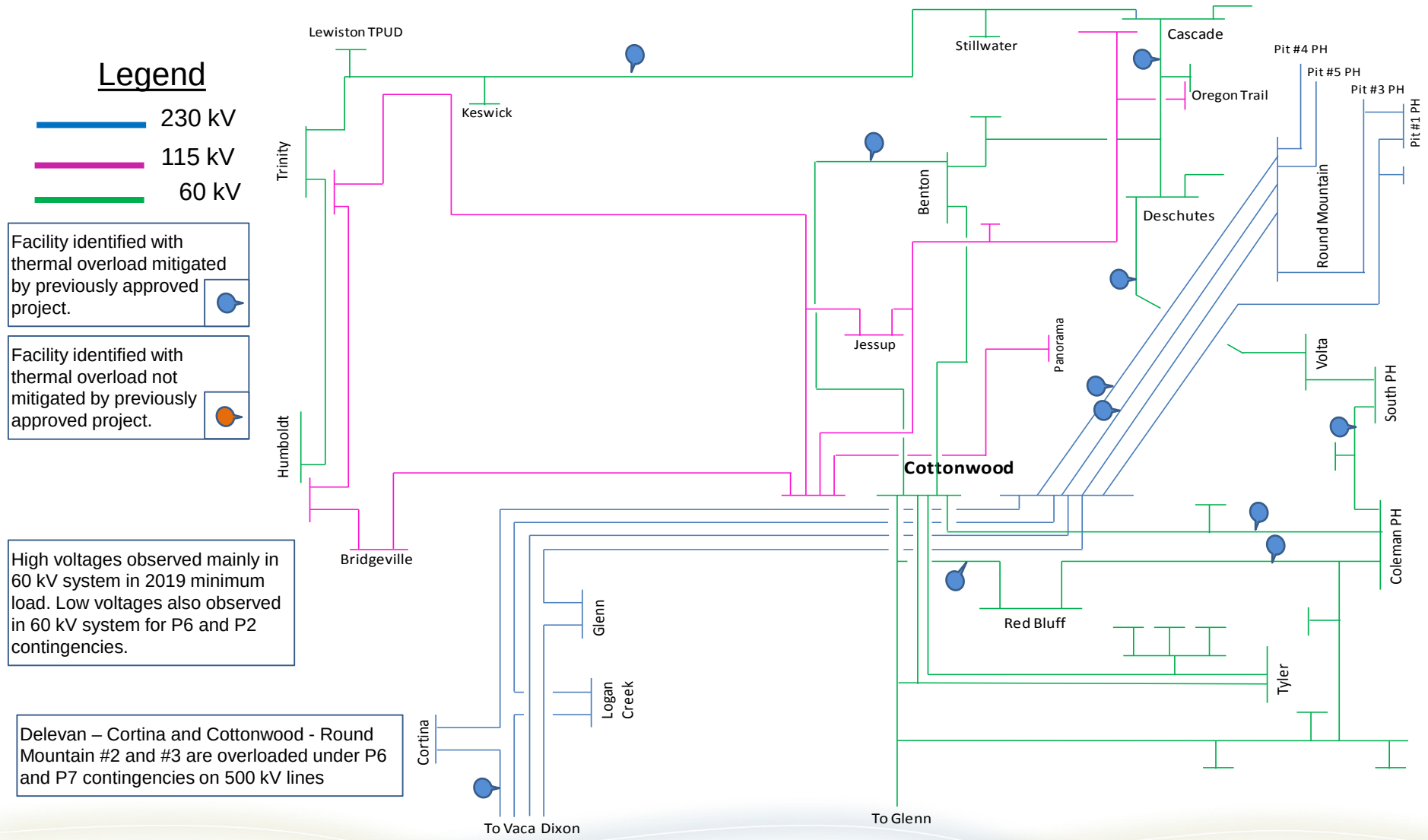
Previously Approved Transmission Projects Modelled in base cases

- None of the active projects were modelled in the base cases.
  - Delevan 230 kV and Cottonwood 115 kV shunt reactor projects were modelled in the case but were switched off. These projects are discussed in the Voltage Assessment presentation.

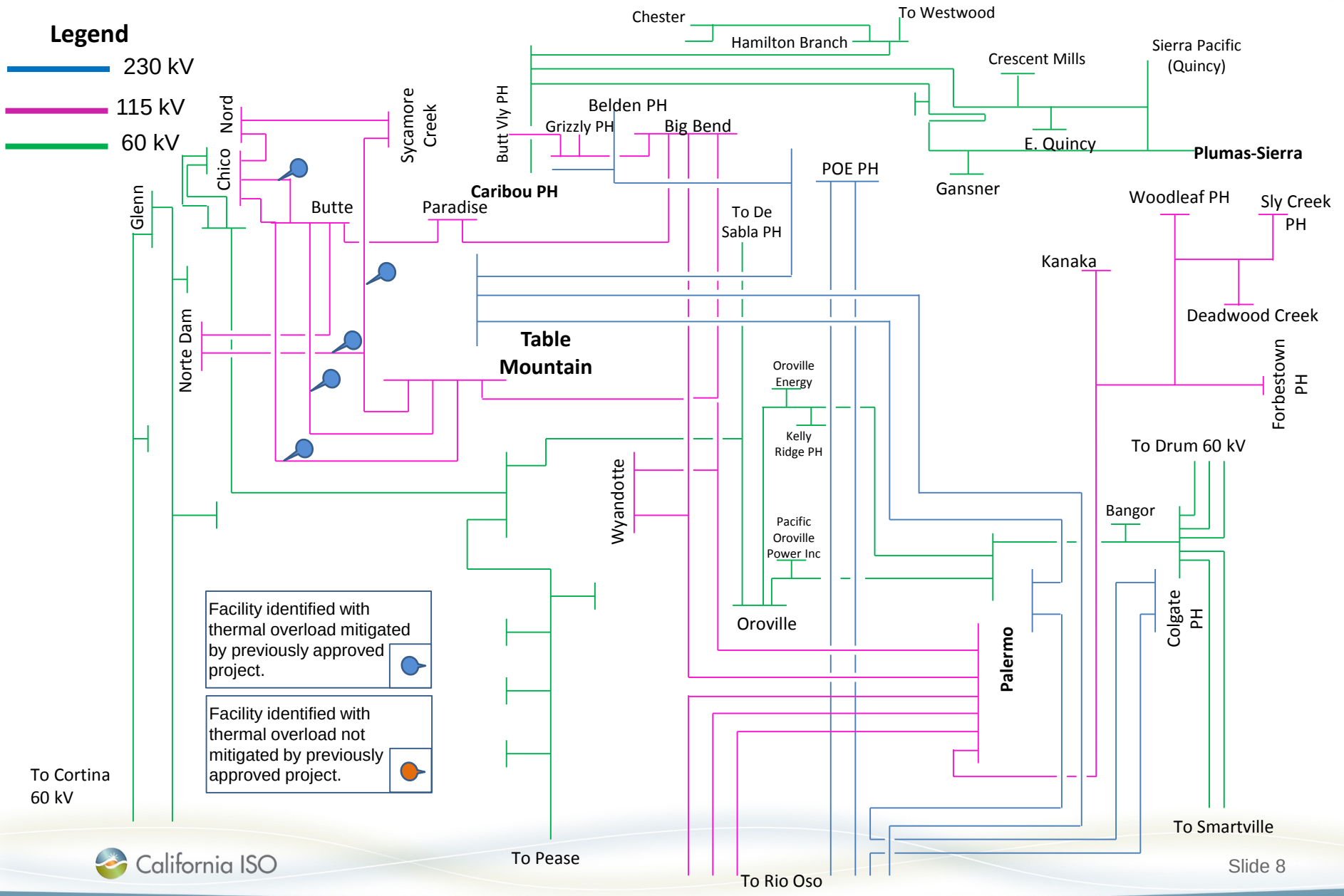
Previously Approved Transmission Projects Not modelled in the base cases

Project Name	Current ISD
Cascade 115/60 kV No2 Transformer Project and Cascade – Benton 60 kV Line Project	Jul-2019
Glenn #1 60 kV Reconductoring	Apr-2021
Glenn 230/60 kV Transformer No 1 Replacement	Jun-2019
Table Mountain – Sycamore 115 kV Line	Dec-2025
Cottonwood-Red Bluff No2 60 kV Line Project and Red Bluff Area 230/60 kV Substation Project	Apr-2024
Cottonwood 115 kV Substation Shunt Reactor	Nov-2019
Delevan 230 kV Substation Shunt Reactor	Nov-2019

North Valley Area – Results (1/2)



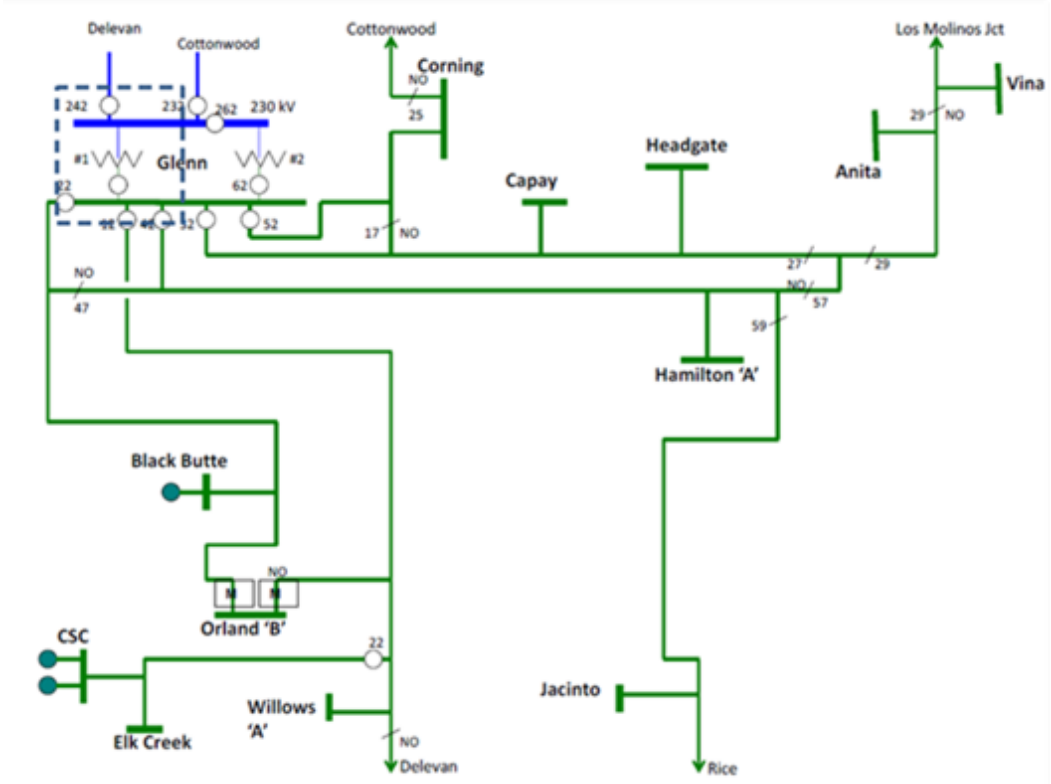
North Valley Area – Results (2/2)



Review of Previously Approved Transmission Projects Not Modelled in the Base Cases

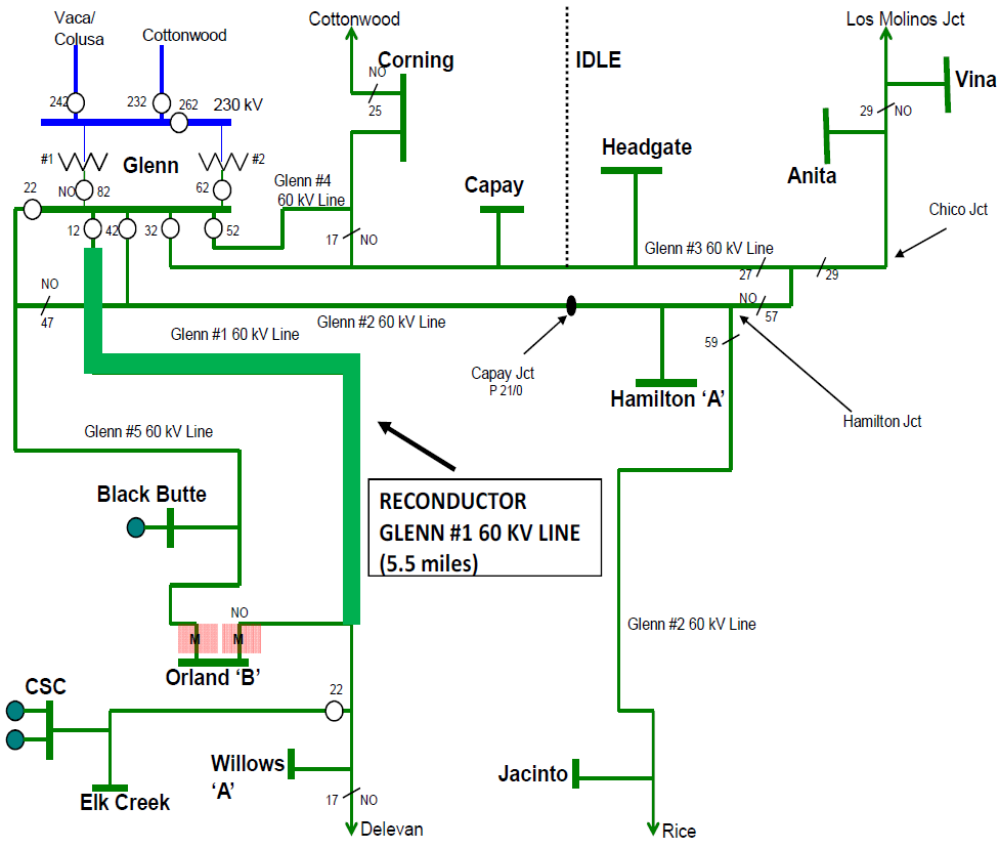
Glen 230/60 kV Transformer No. 1 Replacement

- Original need
  - 2013-2014 TPP: Planning for New Transmission vs. Involuntary Load Interruption Standard (BCR Project)
- Reliability Assessment Need
  - BCR Project
- Mitigation still required
  - BCR is greater than 1 (2.21)
- Review of current project to meet need
  - BCR Project
- Alternatives
  - Status quo
- Preliminary conclusion
  - Proceed with original scope



Glen #1 60 kV Reconductoring

- Original need
  - 2009 TPP: NERC Category P1 and P7 thermal overload.
- Reliability Assessment Need
  - No reliability issue was identified
- Mitigation is not required
  - Not Needed for reliability
  - Not needed for LCR
  - Not needed for generation deliverability
- Review of current project to meet the need
  - Not applicable
- Alternatives
  - Not applicable
- Preliminary conclusion
  - Cancel the project



Cascade 115/60 kV No. 2 Transformer Project and Cascade-Benton 60 kV Line Project

- Original need
  - 2010-2011 TPP: NERC P6 thermal overload and P1, P3, and P6 voltage issues.
- Reliability Assessment Need
  - NERC Categories P2 and P6 thermal overloads and voltage issues under base cases.
- Mitigation still required
  - Needed for reliability.
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads. Under review for potential alternative solutions.
- Alternatives
  - Install a new 115/60 kV Transformer and high side breaker at Cascade substation.
  - Install high side breaker at Cascade substation. Evaluate SPS for other contingencies.
- Preliminary Conclusion
  - Further analysis is required

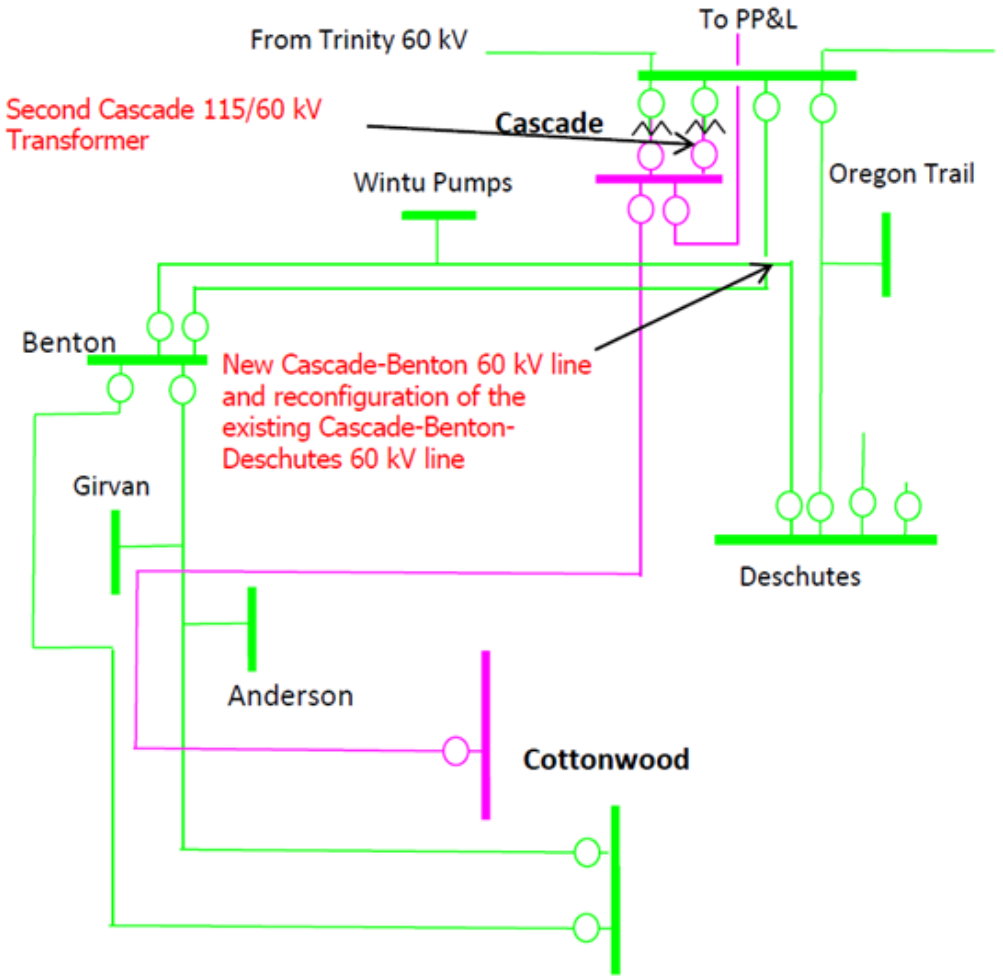
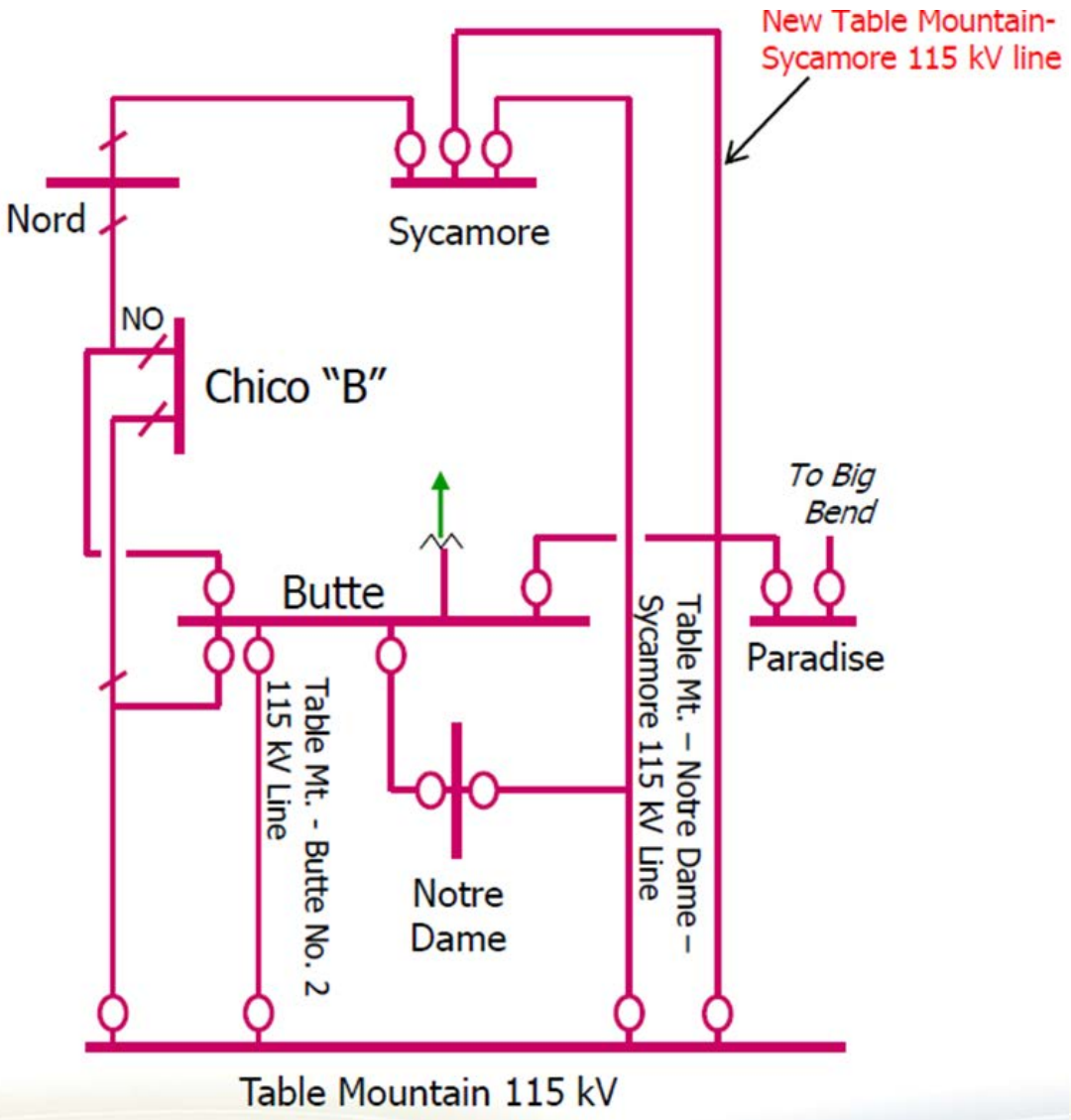


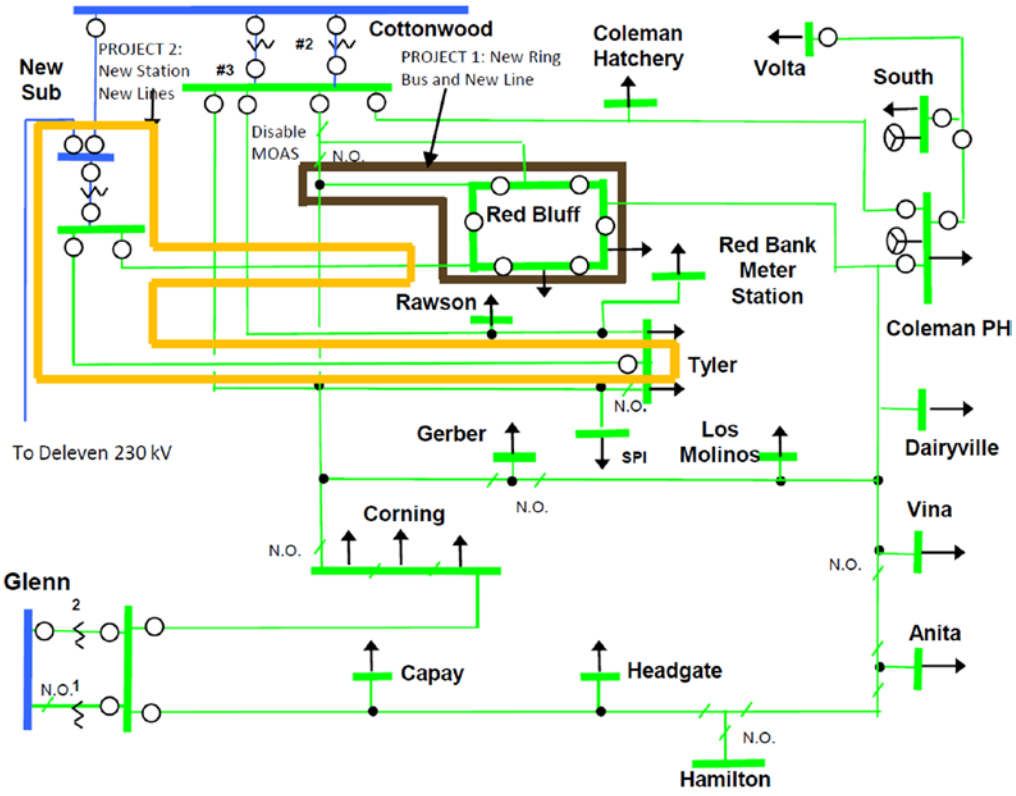
Table Mountain-Sycamore 115 kV Line

- Original need
  - 2010-2011 TPP: NERC Category P2, P6, P7 severe thermal overload.
- Reliability Assessment Need
  - NERC Categories P6 and P7 thermal overloads in the base case. P2 mostly in sensitivity.
- Mitigation still required
  - Needed for reliability.
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads but it is under review for potential alternative solutions with reduced scope.
- Alternatives
  - SPS
- Preliminary conclusion
  - Further analysis is required



Cottonwood-Red Bluff No. 2 60 kV Line Project and Red Bluff Area 230 kV Substation Project

- Original need
  - 2010-2011 TPP: NERC P1, P6 thermal overload and voltage issue.
- Reliability Assessment Need
  - NERC Categories P1, P2, P6 thermal overloads and voltage issues under base scenario.
- Mitigation still required
  - Needed to address reliability.
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads but it is under review for potential alternative solutions with reduced scope.
- Alternatives
  - Reconductor Coleman and Cottonwood to Red Bluff 60 kV lines plus bus breaker at Cottonwood
  - Energy storage
- Preliminary conclusion
  - Further analysis required



Additional Mitigation Requirements

- No need for new thermal mitigation measures was identified under base scenarios.
- There are high voltages at 115 kV and 60 kV system that could be addressed by load power factor correction. If power factor correction is not feasible or cost effective, voltage support at transmission level is required. This is discussed in detail in Voltage Assessment presentation.

Sensitivity Study Assessment

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

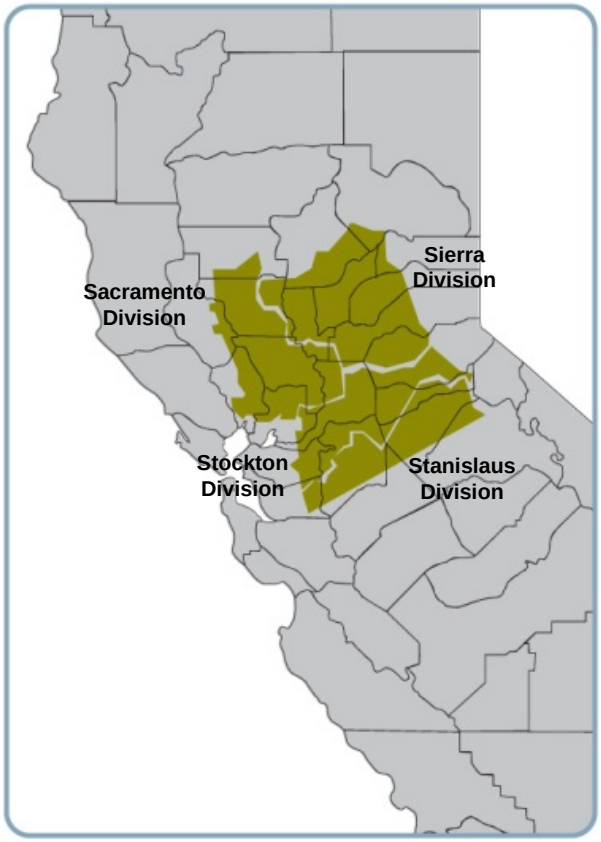
Overloaded Facility	Category	2019 SP Peak-Shift	2027 SP Peak-Shift	2022 SP High CEC Forecast	2022 SP Heavy Renewable & Min Gas Gen	2027 Retirement of QF Generations
OREGNTRL - SPI_AND 115 kV	P6		√	√		
COTWDPGE - JESSUPJ1 115 kV	P6		√	√		√
WYANDTTE - WYANDJT1 115 kV	P0		√			
BENTON - GIRVAN 60 kV	P6		√			
WNTU PMS - BENTON 60 kV	P2		√			
Glen #4 60 kV line	P0		√			

Central Valley Area
Preliminary Reliability Assessment Results

Ebrahim Rahimi
Lead Regional Transmission Engineer

2017-2018 Transmission Planning Process Stakeholder Meeting
September 21-22, 2017

Central Valley Area



- Includes the following divisions:
  - Sacramento
  - Sierra
  - Stockton
  - Stanislaus
- Transmission facilities: 60, 115, 230 and 500 kV.

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-2019-SP	Baseline	2019 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	3,865	96	688	229	3,540	101	59
CVLY-2022-SP	Baseline	2022 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	3,995	159	807	273	3,563	103	59
CVLY-2027-SP	Baseline	2027 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	4,246	272	1,162	398	3,577	104	59
CVLY-2019-ML	Baseline	2019 spring light load conditions. Light load time - hours between 02:00 and 04:00.	1,354	66	688	0	1,288	101	59
CVLY-2022-SOP	Baseline	2022 spring off-peak load conditions. Off-peak load time – weekend morning.	2,046	127	807	763	1,156	103	59
CVLY-2019-SP-PS	Sensitivity	2019 summer peak load conditions with peak-shift sensitivity	3,835	96	688	142	3,597	101	59
CVLY-2027-SP-PS	Sensitivity	2027 summer peak load conditions with peak-shift sensitivity	4,072	272	1,162	107	3,693	104	59
CVLY-2022-SP-PS-AAEE	Sensitivity	2022 summer peak load conditions with peak-shift and AAEE sensitivity	3,958	0	807	105	3,853	103	59
CVLY-2022-SP-HiRenew	Sensitivity	2022 summer peak load conditions with hi renewable dispatch sensitivity	3,433	138	807	807	2,488	103	59
CVLY-2027-SP-QF	Sensitivity	2027 summer peak load conditions with QF retirement sensitivity	4,246	272	1,162	398	3,577	104	59

Note:
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-2019-SP	Baseline	2019 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	34	46	12	1,376	454	1,389	1,101	1,501	1,188
CVLY-2022-SP	Baseline	2022 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	34	46	12	1,376	454	1,389	1,099	1,501	1,181
CVLY-2027-SP	Baseline	2027 summer peak load conditions. Peak load time - hours between 16:00 and 18:00.	34	46	12	1,376	454	1,389	1,095	1,501	1,171
CVLY-2019-ML	Baseline	2019 spring light load conditions. Light load time - hours between 02:00 and 04:00.	34	46	0	1,376	138	1,389	891	1,501	1,237
CVLY-2022-SOP	Baseline	2022 spring off-peak load conditions. Off-peak load time – weekend morning.	34	46	46	1,376	1,376	1,389	742	1,501	335
CVLY-2019-SP-PS	Sensitivity	2019 summer peak load conditions with peak-shift sensitivity	34	46	7	1,376	454	1,389	1,133	1,501	1,188
CVLY-2027-SP-PS	Sensitivity	2027 summer peak load conditions with peak-shift sensitivity	34	46	3	1,376	454	1,389	1,133	1,501	1,054
CVLY-2022-SP-PS-AAEE	Sensitivity	2022 summer peak load conditions with peak-shift and AAEE sensitivity	34	46	4	1,376	454	1,389	1,133	1,501	1,053
CVLY-2022-SP-HiRenew	Sensitivity	2022 summer peak load conditions with hi renewable dispatch sensitivity	34	46	46	1,376	1,376	1,389	1,091	1,501	305
CVLY-2027-SP-QF	Sensitivity	2027 summer peak load conditions with QF retirement sensitivity	34	46	12	1,376	454	1,389	1,085	1,501	1,181

Note:

DR and storage are modeled offline in starting base cases.

Previously Approved Transmission Projects Modelled in base cases

Project Name	Modelled Starting Year
West Point – Valley Springs 60 kV Line	2022
Stockton 'A' –Weber 60 kV Line Nos. 1 and 2 Reconductor	2022
Cortina No.3 60 kV Line Reconductoring Project	2019
Lodi-Eight Mile 230 kV Line (Reconductoring)	2022
South of Palermo 115 kV Reinforcement Project	2022
Rio Oso 230/115 kV Transformer Upgrades	2022
Missouri Flat – Gold Hill 115 kV Line (Reconductor)	2019 (Under construction)
Ripon 115 kV Line	2019 (Under construction)

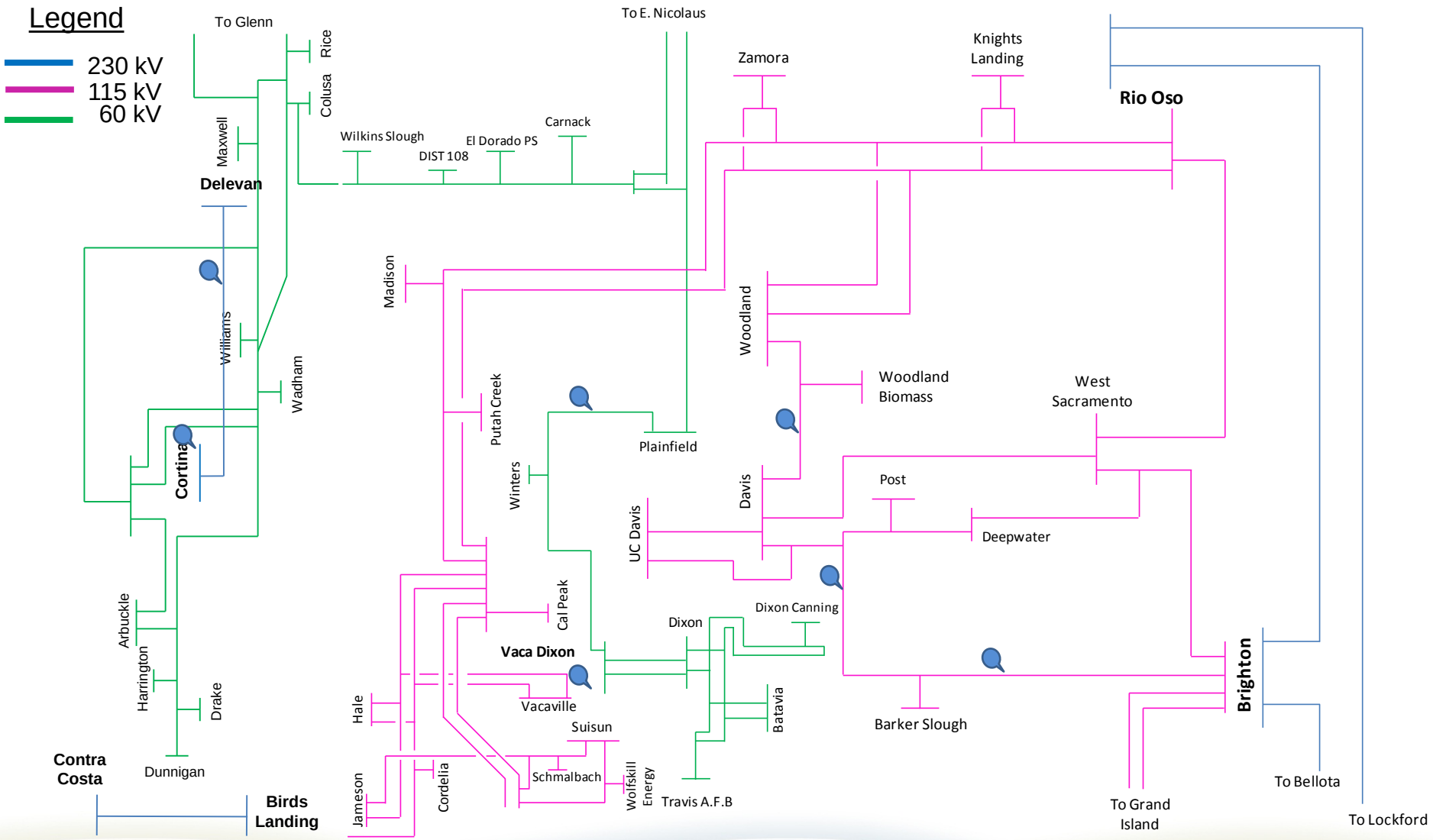
Previously Approved Transmission Projects Not modelled in base cases

Project Name	Current ISD
Pease 115/60 kV Transformer Addition and Bus Upgrade	Sep - 2019
Mosher Transmission Project	Dec - 2018
Rio Oso – Atlantic 230 kV Line Project	Dec - 2022
Vierra 115 kV Looping Project	Jun - 2023
Stagg – Hammer 60 kV Line	Aug - 2022
Vaca – Davis Voltage Conversion Project	Apr - 2025
Atlantic-Placer 115 kV Line	Dec - 2021
Lockeford-Lodi Area 230 kV Development	Dec - 2022

Sacramento Area

Facility identified with thermal overload mitigated by previously approved project.

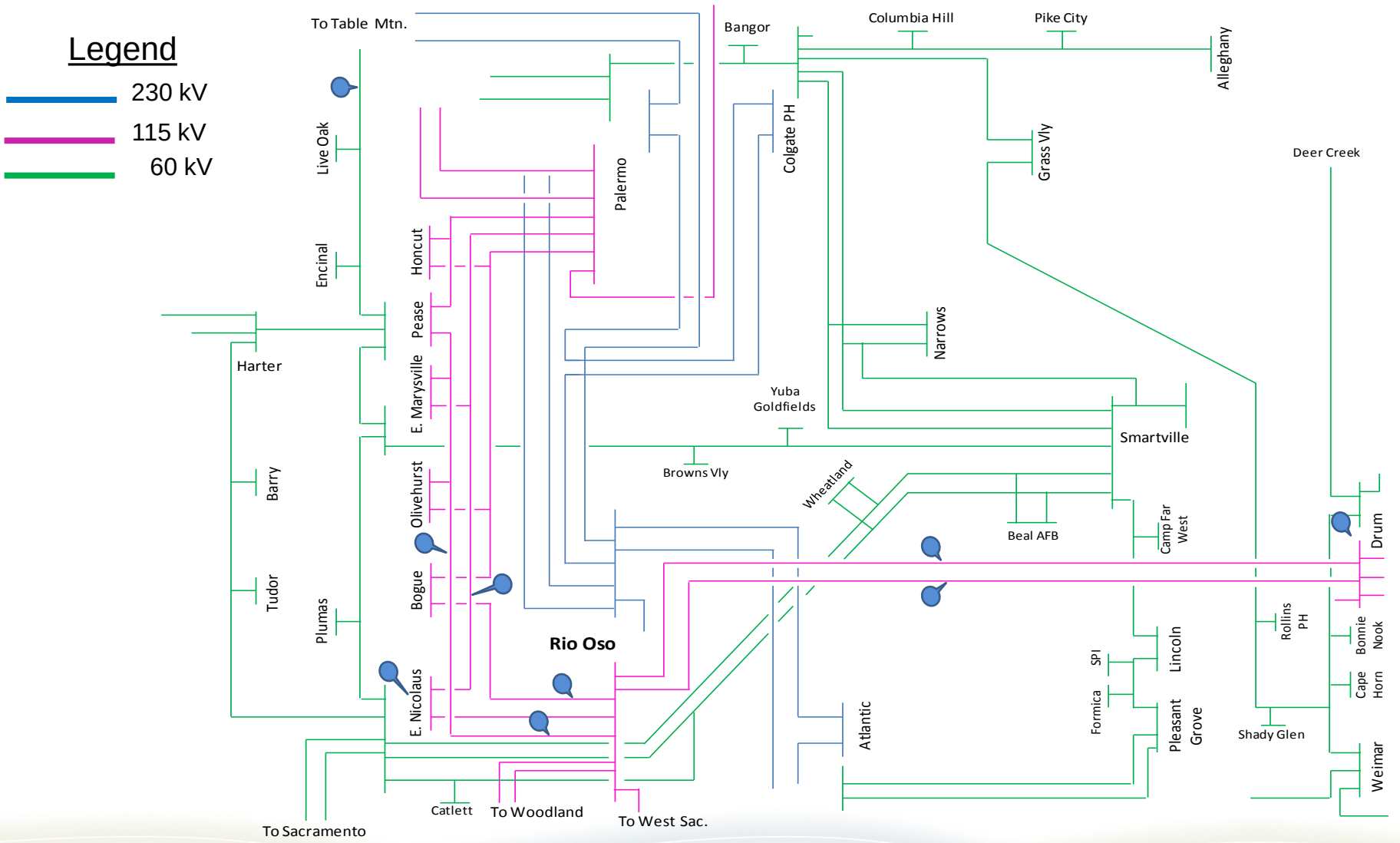
Facility identified with thermal overload not mitigated by previously approved project.



Sierra Area (1/2)

Facility identified with thermal overload mitigated by previously approved project.

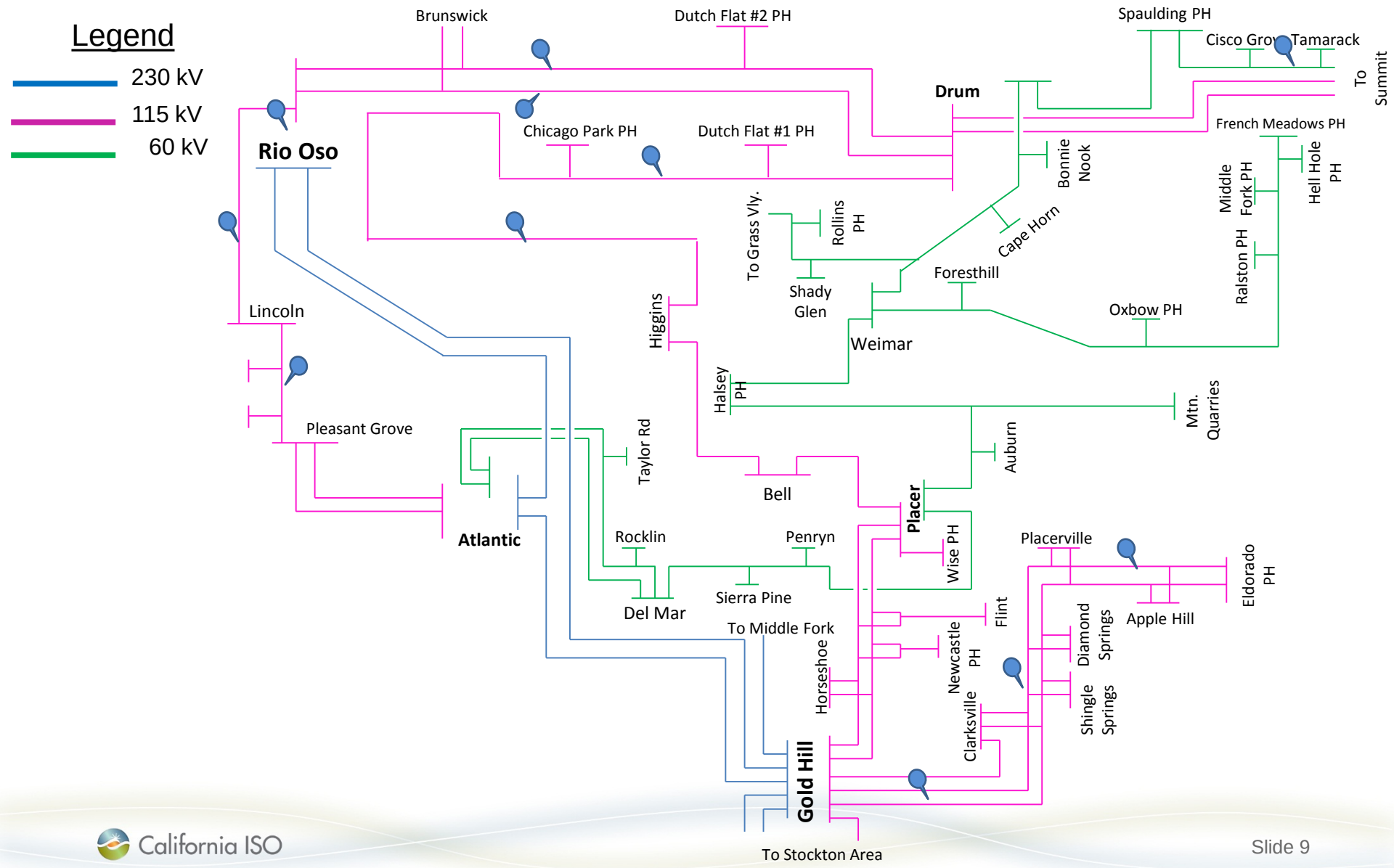
Facility identified with thermal overload not mitigated by previously approved project.



Sierra Area (2/2)

Facility identified with thermal overload mitigated by previously approved project.

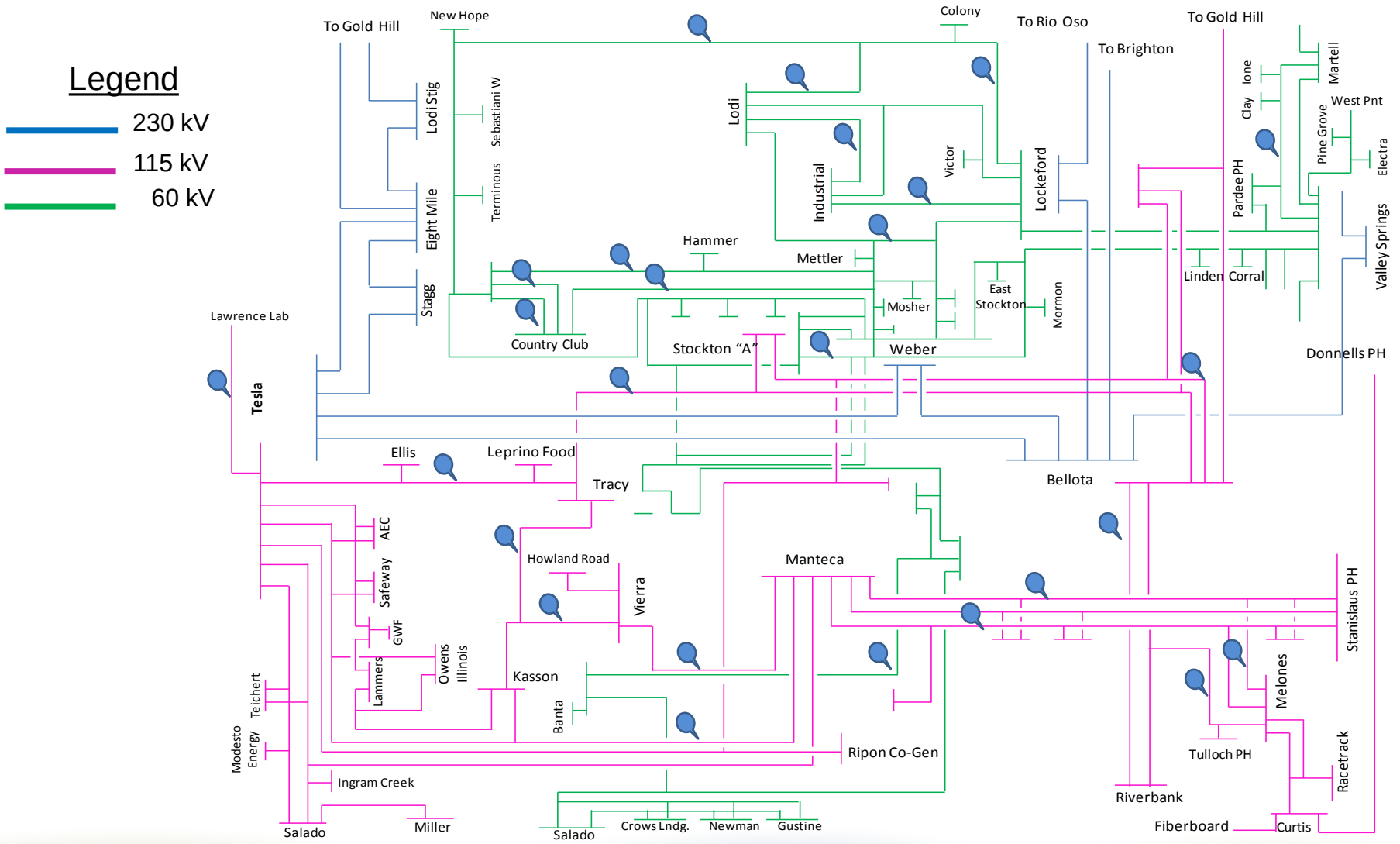
Facility identified with thermal overload not mitigated by previously approved project.



Stockton/Stanislaus Area

Facility identified with thermal overload mitigated by previously approved project.

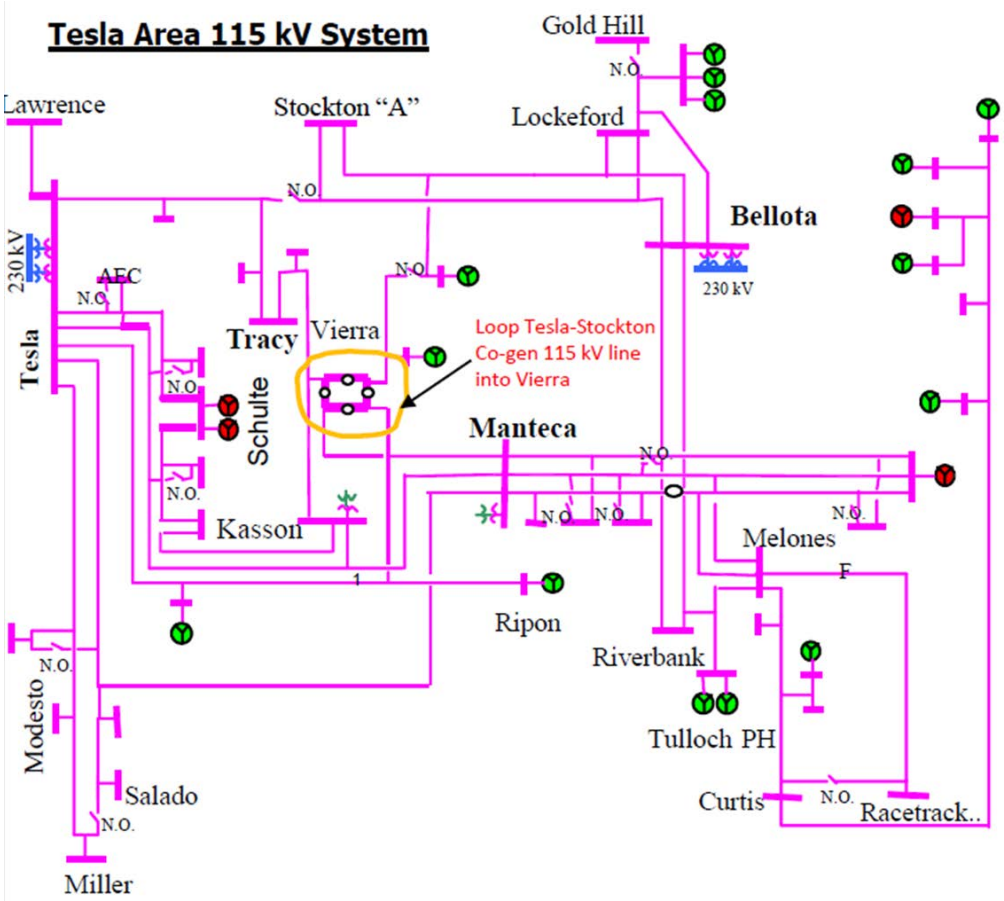
Facility identified with thermal overload not mitigated by previously approved project.



Review of Projects Not Modelled in The Base Cases

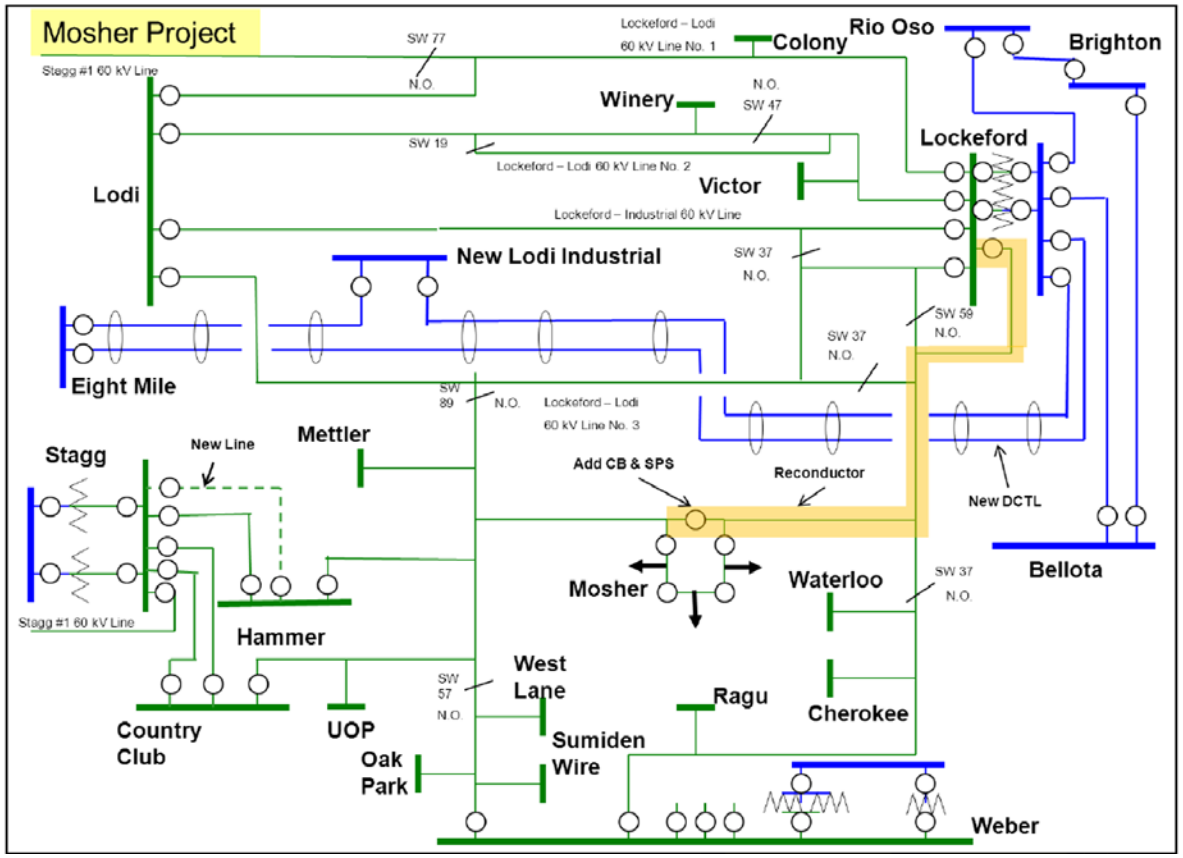
Vierra 115 kV Looping Project

- Original need
  - 2010-2011 TPP: NERC Category P3, P6 thermal overload.
- Reliability Assessment Need
  - NERC Categories P3 and P6 thermal overloads.
- Mitigation still required
  - Needed for reliability
  - Needed for LCR in Tesla-Bellota sub-area
- Review of current project to meet need
  - Not applicable.
- Alternatives
  - Not applicable.
- Preliminary conclusion
  - Proceed with the original scope of the project



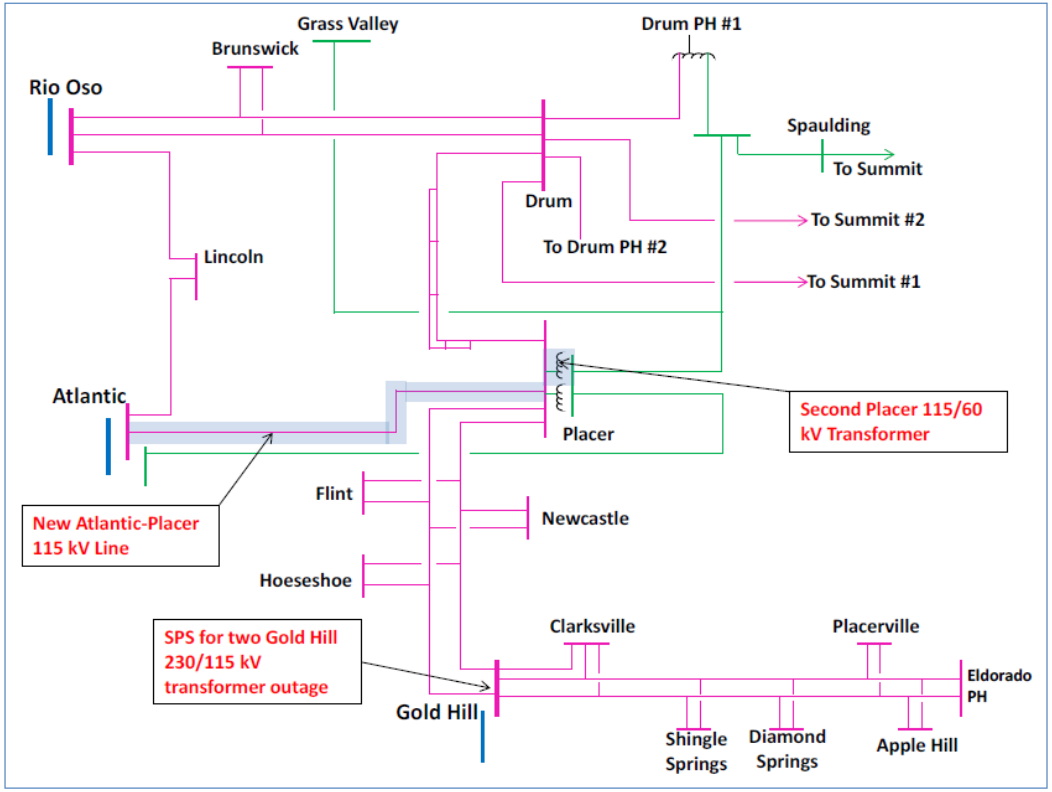
Mosher Transmission Project
Project Review

- Original need
  - 2013-2014 TPP: Planning for New Transmission vs. Involuntary Load Interruption Standard (BCR Project)
- Reliability Assessment Need
  - BCR project.
- Mitigation still required
  - BCR is greater than 1 (1.05) with reduced scope of single 715 AAC.
- Review of current project to meet need
  - BCR project.
- Alternatives
  - Single 715 AAC conductor
- Preliminary conclusion
  - Proceed with Single 715 AAC conductor.



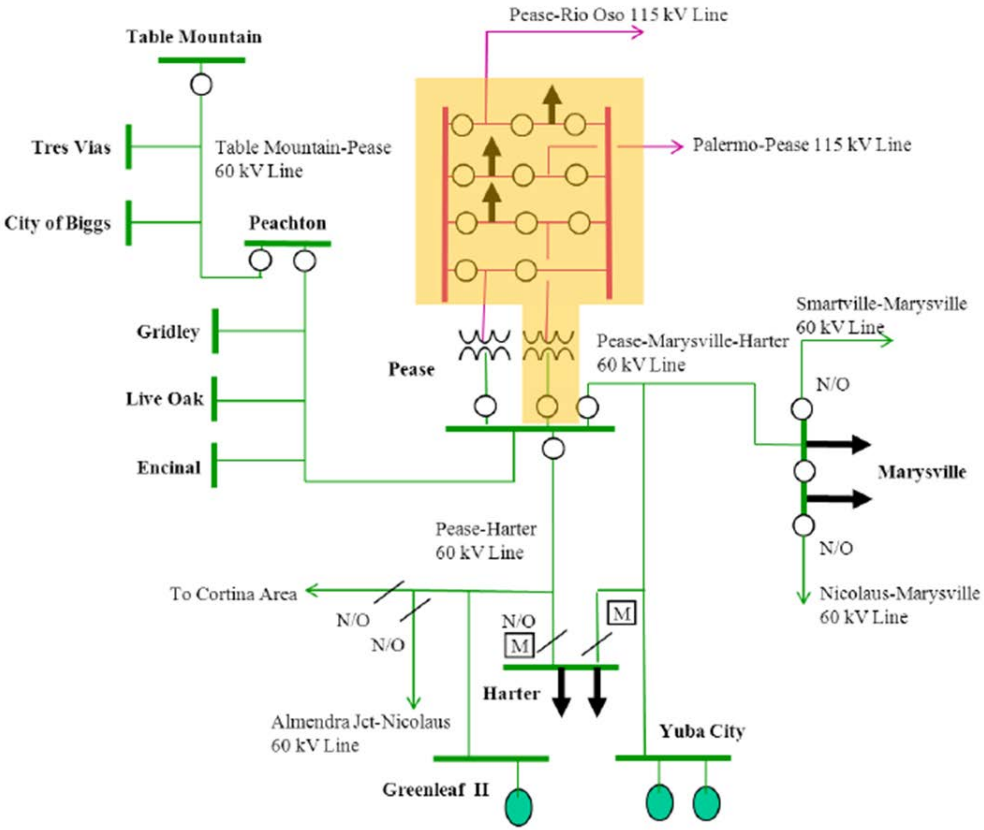
Atlantic-Placer Project Review

- Original need
  - 2012-2013 TPP studies identified NERC P0, P1, P2, P6, P7 overload and P1 voltage deviation, P6, P7 low voltage (voltage collapse.
- Reliability Assessment Need
  - NERC Categories P2, P6 thermal issue and voltage collapse under P6 and minor voltage issue under P7.
- Mitigation still required
  - Needed to address reliability issues.
- Review of current project to meet need
  - Current scope of approved project mitigates identified criteria violation. Under review for potential alternative solutions.
- Alternatives
  - Cancel the new line and keep the second Placer 115/60 kV transformer and keep SPS at Gold Hill
  - Cancel the line and the second transformer keep SPS at Gold Hill
- Preliminary conclusion
  - Further analysis required



Pease 115/60 kV Transformer Addition and Bus Upgrade Project Review

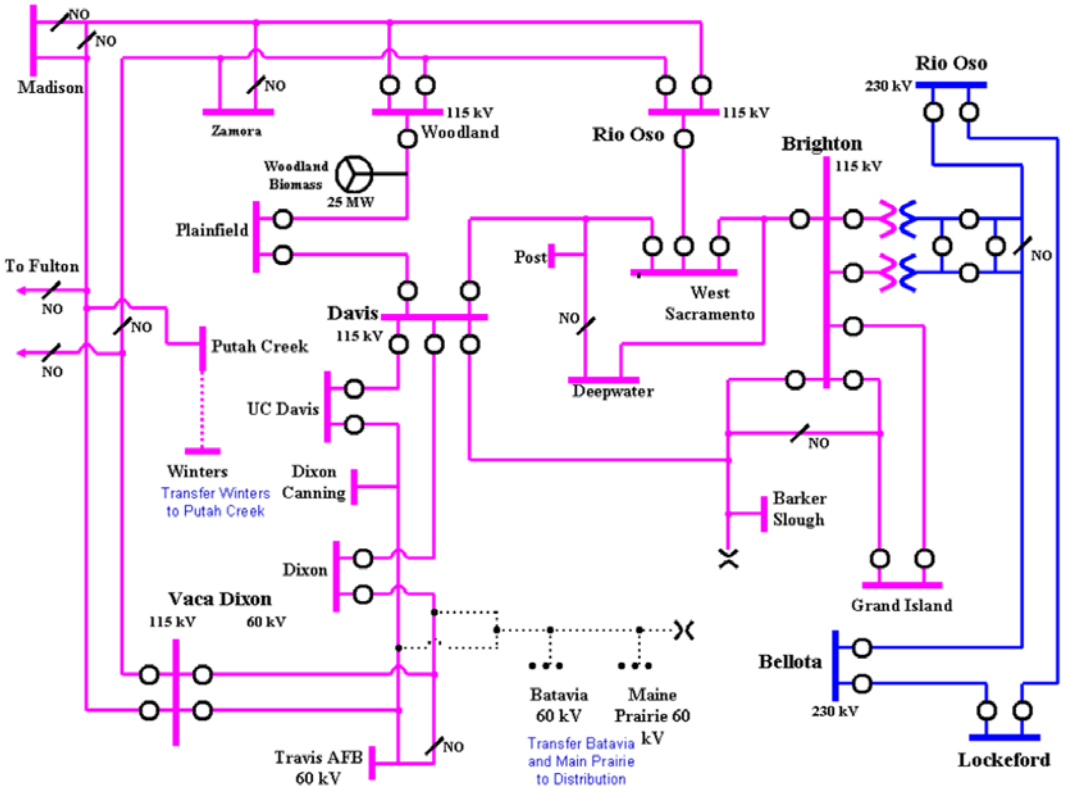
- Original need
  - 2012-2013 TPP: NERC Category P1, P3 overloads and voltage issues.
- Reliability Assessment Need
  - NERC Categories P3 and P6 thermal overloads.
- Mitigation still required
  - Needed to address reliability issues
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads. Under review for potential alternative solutions.
- Alternatives
  - Proceed with the bank and cancel the UVLS
  - Proceed with the UVLS and cancel the bank
- Preliminary conclusion
  - Further analysis required



Vaca – Davis Voltage Conversion Project

- Original need
  - 2010-2011 TPP: NERC Category P0 voltage issue, severe Category P1, P3 and P6 thermal issues, and Category P1, P3, and P6 voltage issues.
- Reliability Assessment Need
  - NERC Categories P1, P2, P6 under base case and P0 under sensitivity scenario in 2027
- Mitigation still required
  - Needed for reliability.
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads. Under review for potential alternative solutions.
- Alternatives

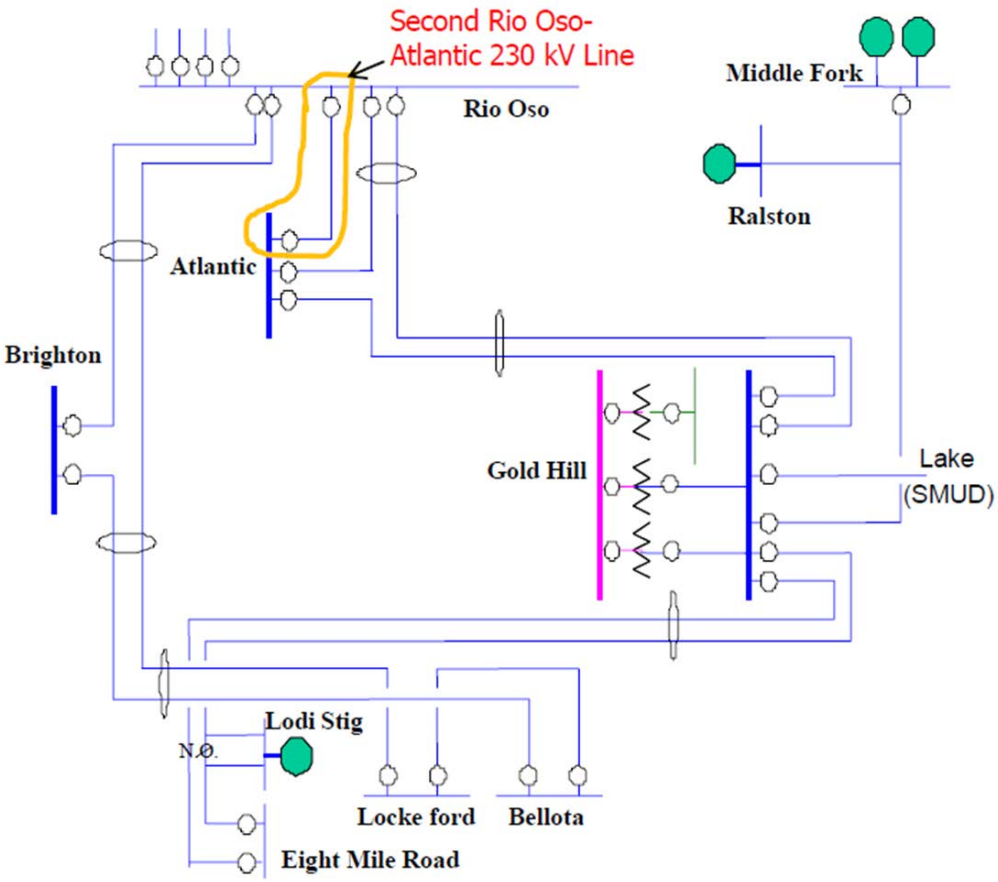
  A combination of the followings:
  - Re-rate or reconductor 115 kV lines around Davis
  - Energy storage at Davis and Plainfield
  - Re-conductor Vaca-Plainfield 60 kV line
- Preliminary conclusion
  - Further analysis required



- Original scope:
  - Reconductor and convert the two 60 kV lines to 115 kV operation. Reconductor/re-rate four other 115 kV.
  - Construct/convert four 115 kV switching station.
  - Transfer load
  - Replace Vaca Dixon 230/115 kV Nos. 2 and 2A Txs with a 420 MVA transformer.

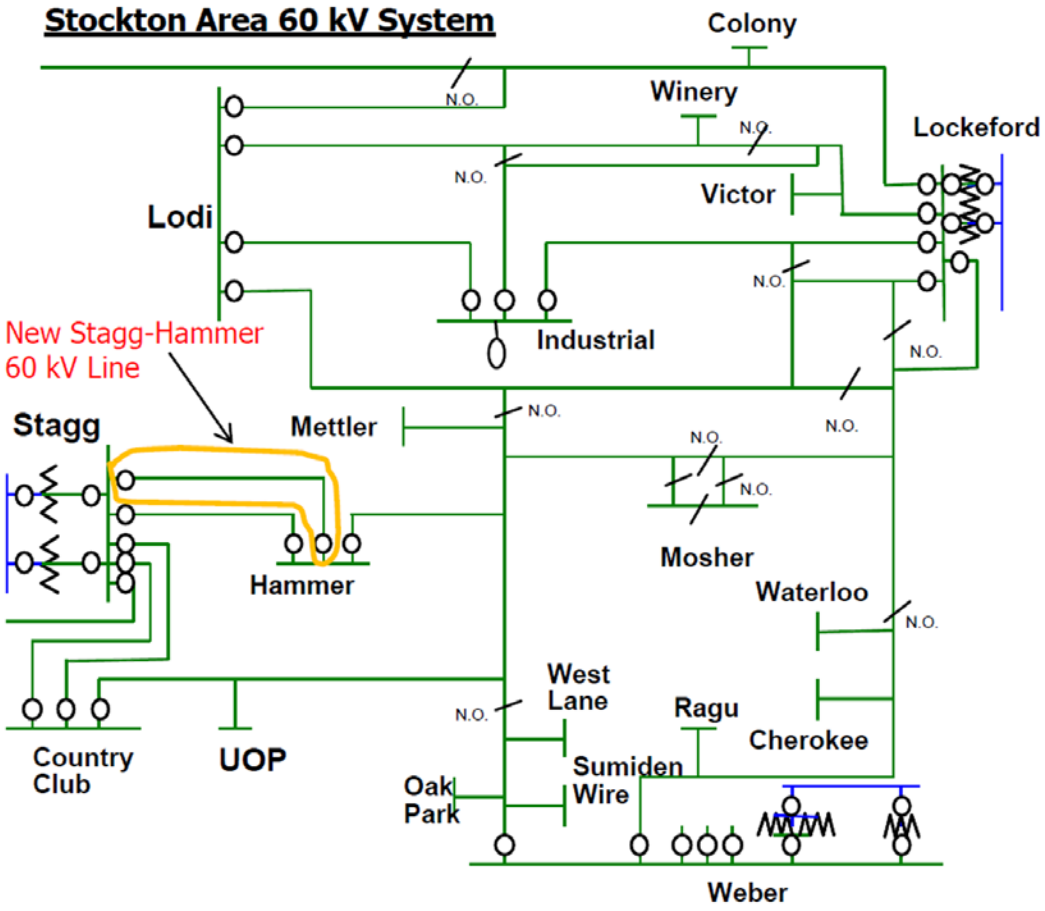
Rio Oso – Atlantic 230 kV Line Project

- Original need
  - 2010-2011 TPP: NERC Category P1 thermal overload.
- Reliability Assessment Need
  - NERC Categories P5-5, P6 and P7 thermal overloads.
- Mitigation still required
  - Needed to address reliability issues.
- Review of current project to meet need
  - The current need has shifted from a P1 overload to primarily P6 and P7 contingencies and as such while the current project would address the need review of Alternatives to address P6 and P7.
- Alternatives
  - For P5 contingency: protection upgrade (install redundant relay).
  - For P6: operational mitigation where after first contingency system is readjusted to radialize parts of the system to avoid overload.
  - Minor P7 issue in 2022 sensitivity scenario will be monitored.
- Preliminary conclusion
  - Further analysis required



Stagg – Hammer 60 kV Line

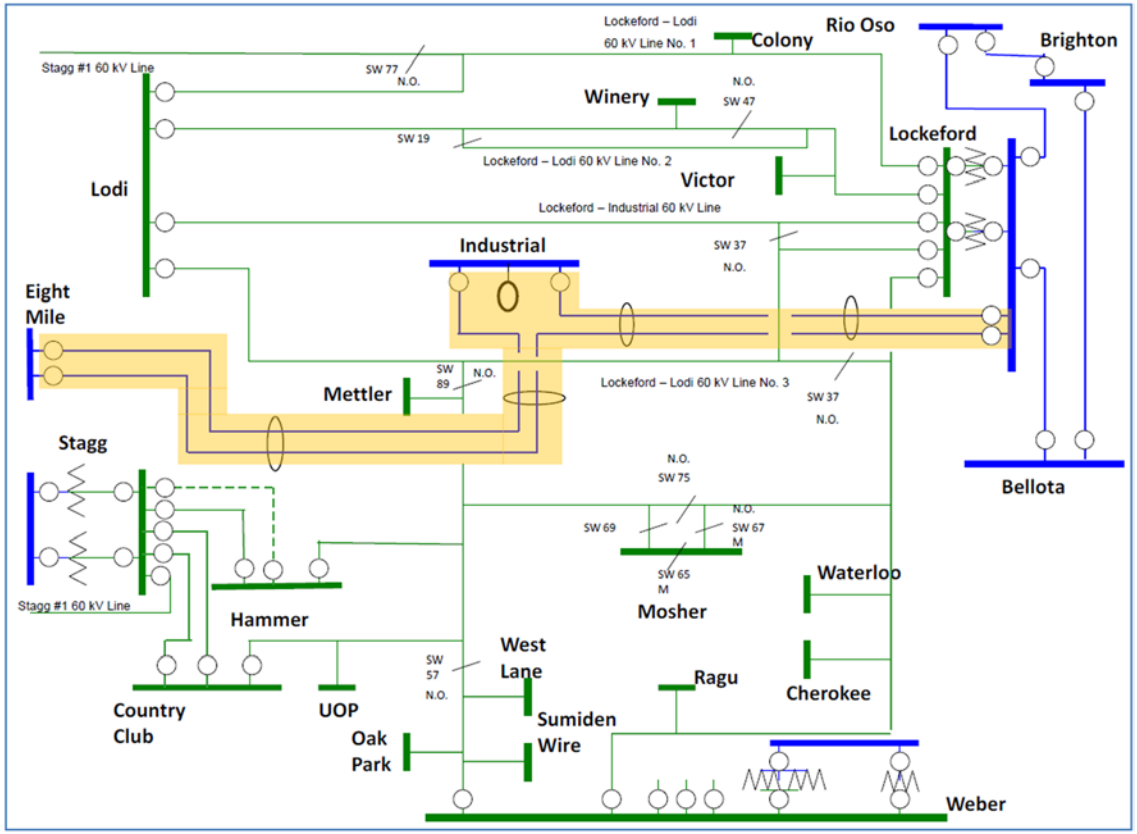
- Original need
  - 2010-2011 TPP: NERC Category P0 thermal overload.
- Reliability Assessment Need
  - NERC Categories P2, P6, P7 thermal overloads.
- Mitigation still required
  - Needed for reliability.
- Review of current project to meet need
  - Current scope of approved project mitigates identified thermal overloads. Under review for potential alternative solutions.
- Alternatives
  - Install Special Protection Scheme at Stagg 60 kV with communications and control actions at Mosher 60 kV
- Preliminary conclusion
  - Further analysis required



Lockeford-Lodi Area 230 kV Development

- Original need
  - NERC Category P1 thermal overload.
- Reliability Assessment Need
  - NERC Categories P6 thermal overloads and P1 voltage issues.
- Mitigation still required
  - Mitigation is needed for reliability.
- Review of current project to meet need
  - Current scope of approved project mitigates identified but the scope is under review for potential alternative or reduced scope solutions.
- Alternatives

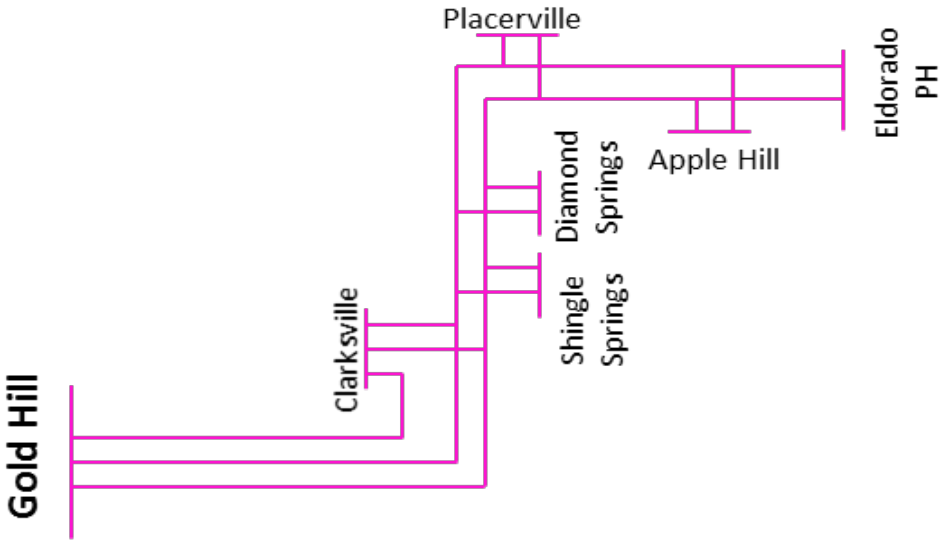
  A combinations of the following is being considered
  - Voltage support at Lockeford
  - Reinforcing 60 kV path between Lockeford and Lodi
  - 230 kV lines to supply Industrial
- Preliminary conclusion
  - Further analysis required



Areas of additional mitigation requirement

Additional Mitigation Requirements

- Reliability Assessment Need
  - NERC Categories P2-1 thermal overloads on the Gold Hill to Eldorado 115 kV lines
- Potential Alternatives
  - Rerate/Reconductor the limiting sections.
  - Preferred resources
- First Year of Need identified in Current Assessment
  - 2019
- Interim Mitigation
  - Action plan



- There are high voltages at 115 kV and 60 kV system that could be addressed by load power factor correction. If power factor correction is not feasible or cost effective, voltage support at transmission level is required. This is discussed in detail in Voltage Assessment presentation.

Sensitivity Study Assessment

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

Overloaded Facility	Category	2019 SP Peak-Shift	2027 SP Peak-Shift	2022 SP High CEC Forecast	2022 SP Heavy Renewable & Min Gas Gen	2027 Retirement of QF Generations
Rio Oso - Brighton 230 kV line	P2		√			√
Contra Costa PP - Birds Landing 230 kV line	P2				√	
Vaca - Plainfield 60 kV line	P0		√			
Rio Oso - West Sacramento 115 kV line	P6		√			
Placer - Bell 115 kV line	P2		√			
Higgins - Bell 115 kV line	P2		√			
Placerville - MIZOU_T1 115KV	P2-1			√		
Table Mountain - Pease 60 kV line	P3				√	√
Lincoln - Ulura JT 115 kV line	P6			√		
Hammer - Hammer Jct 60 kV line	P7		√	√		

Bulk and Regional Voltage Issues

Preliminary Reliability Assessment Results

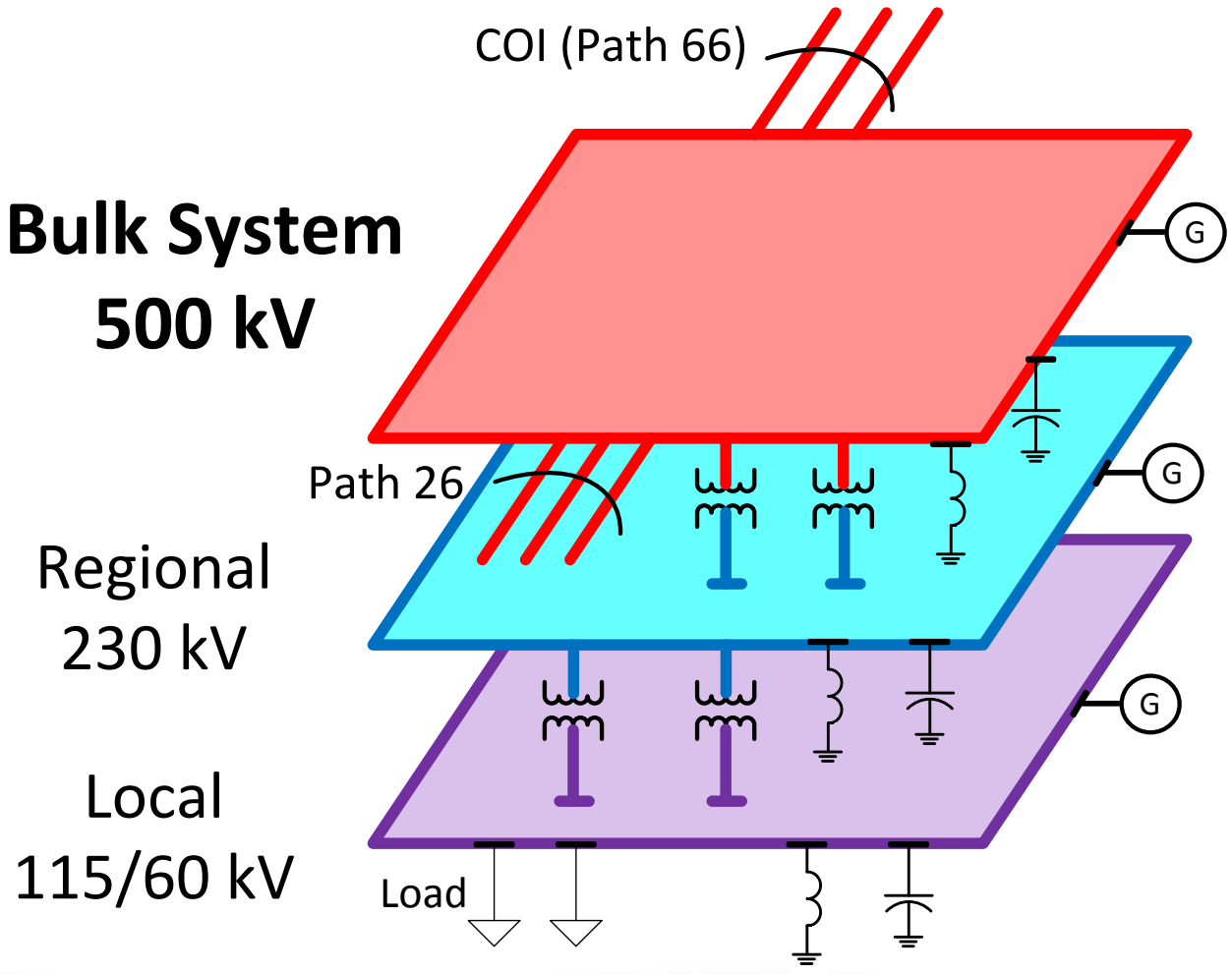
Ebrahim Rahimi
Lead Regional Transmission Engineer

2017-2018 Transmission Planning Process Stakeholder Meeting
September 21-22, 2017

Outline

- Review of voltage issues in PG&E system
- Operational and Planning Voltage Issues
- Load/gen/path flow conditions with more voltage issues
- Preliminary 2017-2018 TPP Voltage Assessment Results
- Preliminary conclusions on projects

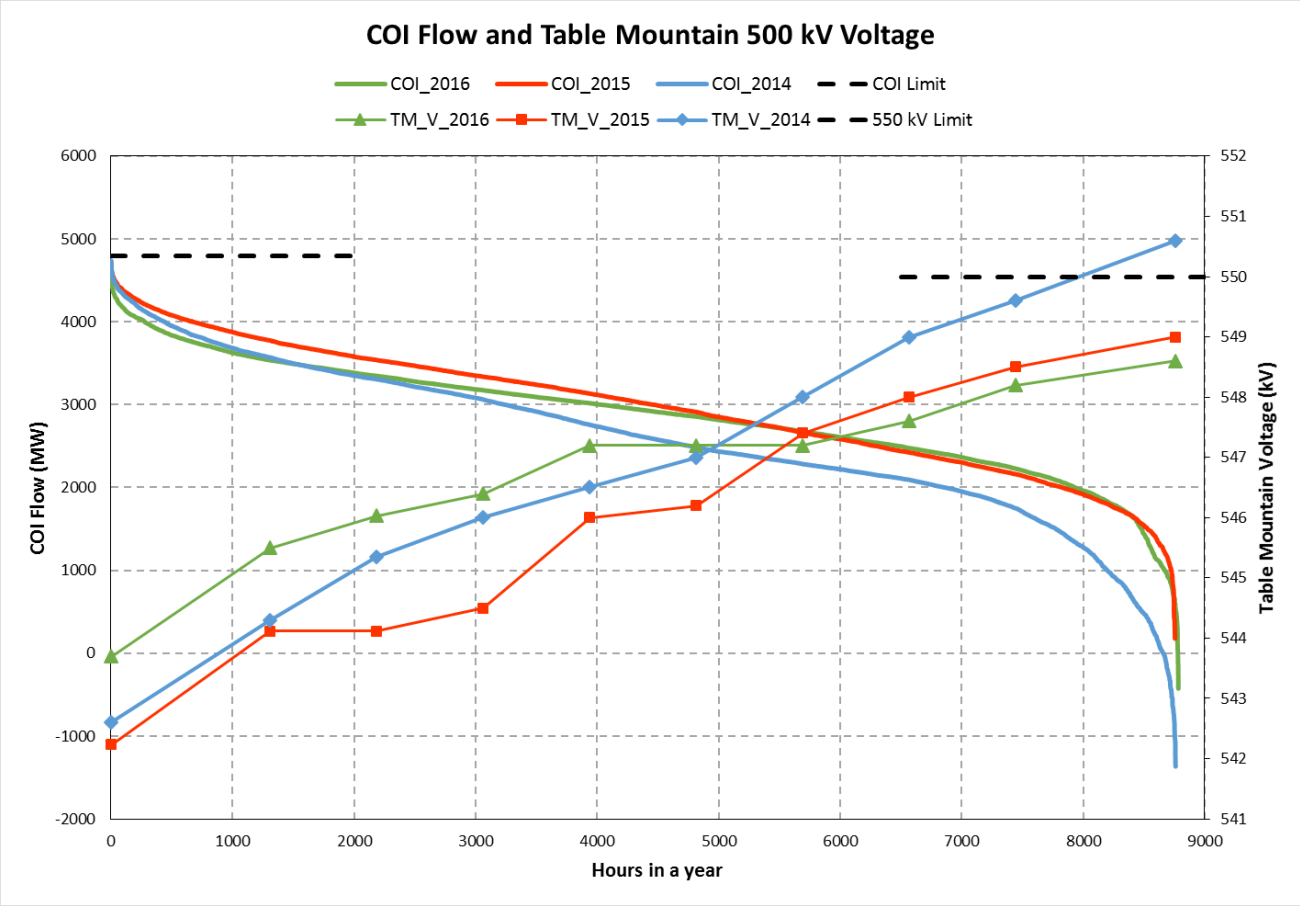
Bulk, Regional, and Local Networks in PG&E System



Analysis of existing voltage issues

Cause of voltage Issues on 500 kV system

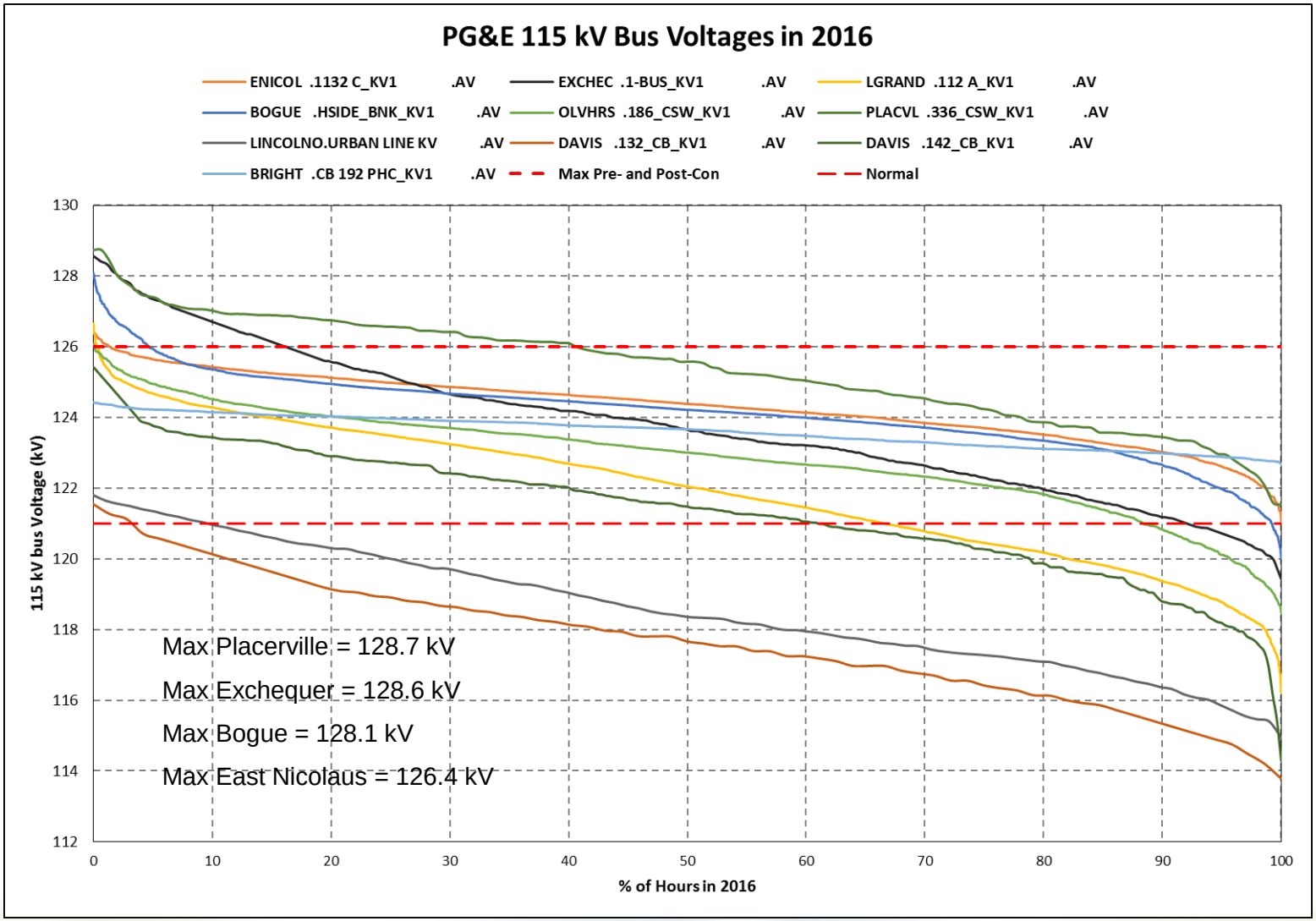
- A major contributor to high voltage on 500 kV appears to be related to low COI flow



Year	Hours with COI flow less than 2000 MW
2014	1894
2015	932
2016	850

- Data points on voltage plots represent an average of high voltages versus COI flow. For example the lowest point on each voltage graph is the average of 50 highest hourly Table Mountain 500 kV bus voltages when COI flow is at top 10%.
- Further analysis showed that low path 26 flows also increase the 500 kV bus voltages as well.

Local System Voltages (115 kV)



Cause of voltage Issues

- A major contributor to high voltage on 500 kV appears to be related to low COI flow
- There are several factors impacting voltage at local 115 kV and 60 kV networks:
  - Voltage at 230 kV system
  - 230/115 kV transformer taps
  - Scheduled voltage of generators
  - Status of shunts
  - Load power factor
- A combination of the above factors cause voltage issues at local network

Summary of Real Time Data Review

- High voltages are observed at all voltage levels in 2016
- High voltage on 500 kV appears to be related to COI flow
  - Also appears to be a potential link to Path 26 flows as well
  - Is more severe when one or both Diablo units are off-line
- High voltages on 115 kV buses are mostly caused by:
  - leading load power factor
    - outside of ISO Tariff requirements
  - high transformer tap settings; and
  - high 230 kV voltage

2017-18 TPP Study Plan Assumptions Regarding Voltage Assessment

Power Factor Assumptions in PG&E System

- Bus load power factor for the year 2019 were modeled based on the actual data recorded in the EMS system

- For the subsequent study years a power factor of 0.99 lagging for summer peak cases, and unity power factor for spring off-peak cases, were used.

Voltage Support Projects Model

- Voltage support projects were offline in the study cases:

Cayucos 70 kV Shunt Capacitor	CCLP
Diablo Canyon Voltage Support Project	CCLP
Bellota 230 kV Substation Shunt Reactor	CVLY
Rio Oso Area 230 kV Voltage Support	CVLY
Los Esteros 230 kV Substation Shunt Reactor	GBA
Borden 230 kV Voltage Support	GFA
Wilson Voltage Support	GFA
Maple Creek Reactive Support (Install 10 Mvar SVC at Maple Creek Sub)	Humboldt
Wheeler Ridge Voltage Support	Kern
Ignacio 230 kV Substation Shunt Reactor	NCNB
Cottonwood 115 kV Substation Shunt Reactor	NVLY
Delevan 230 kV Substation Shunt Reactor	NVLY

Voltage Study Results

Bulk System Voltage Issues

- Voltage at 500 kV system in North PG&E is high when COI flow is low. One potential mitigation measure is to install voltage support at Round Mountain.

- After Diablo Canyon plant retires dynamic voltage support will be required, with Gates being a potential location.

Voltage Issues in the Regional Studies

- High voltages are observed in 2019 Minimum Load and to some degree in 2019 Summer Peak load conditions.
  - One reason for higher voltage in 2019 is modelling load power factor in the base cases close to historical values obtained from EMS.

- Voltage issues in year 2022 is reduced if load power factor issues are fixed

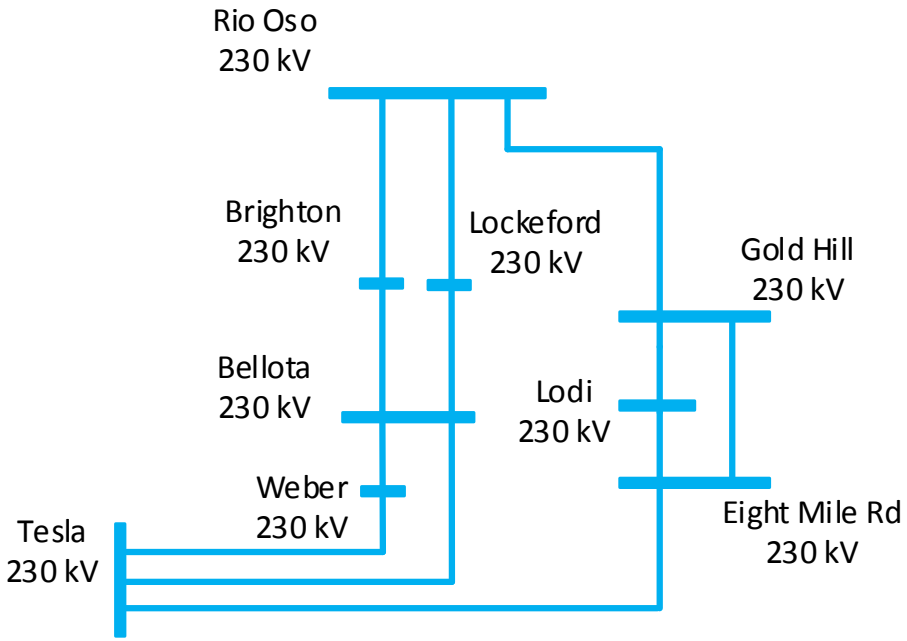
Reactive support projects approved in 2015-2016 Transmission Plan

Reactive projects approved in 2015-2016 Transmission Plan

Bellota 230 kV Substation Shunt Reactor	CVLY
Los Esteros 230 kV Substation Shunt Reactor	GBA
Wilson Voltage Support	GFA
Ignacio 230 kV Substation Shunt Reactor	NCNB
Cottonwood 115 kV Substation Shunt Reactor	NVLY
Delevan 230 kV Substation Shunt Reactor	NVLY

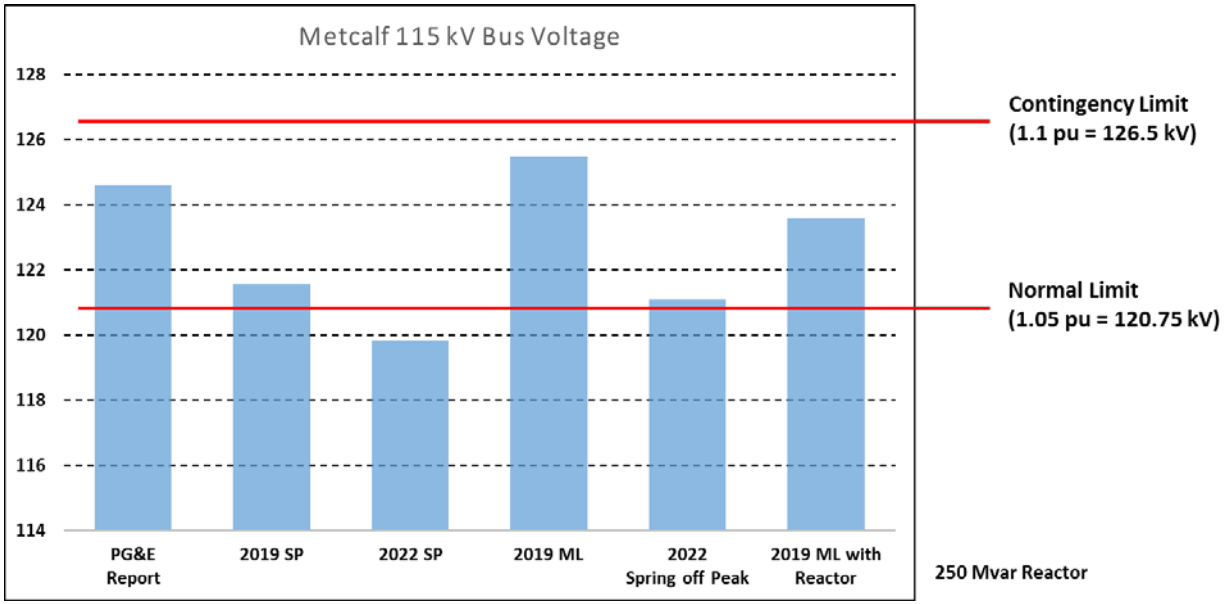
Bellota 230 kV Substation Shunt Reactor

- Original need
  - 2015-2016 TP: This project was approved to address high voltage issues observed in the area in real time.
- Reliability Assessment Need
  - NERC Categories P0.
- Mitigation still required
  - Needed to address voltage issues on 115 kV and 230 kV systems.
- Review of current project to meet need
  - Current scope of approved project mitigates identified criteria violation.
- Alternatives
  - N/A
- Preliminary conclusion
  - Proceed with the project



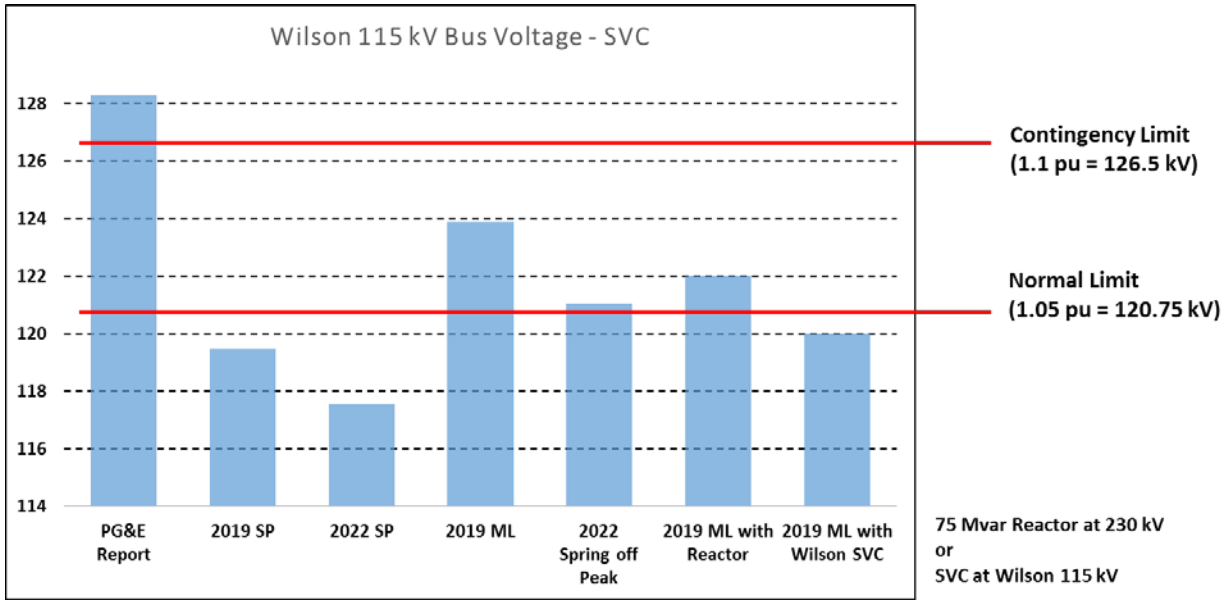
Los Esteros 230 kV Substation Shunt Reactor

- Original need
  - 2015-2016 TP: This project was approved to address high voltage issues in San Jose area under light load conditions.
- Reliability Assessment Need
  - NERC Categories P0.
- Mitigation still required
  - Needed to address voltage issues on 115 kV and 230 kV systems.
- Review of current project to meet need
  - Current scope of approved project mitigates identified criteria violation.
- Alternatives
  - N/A
- Preliminary conclusion
  - Proceed with the project



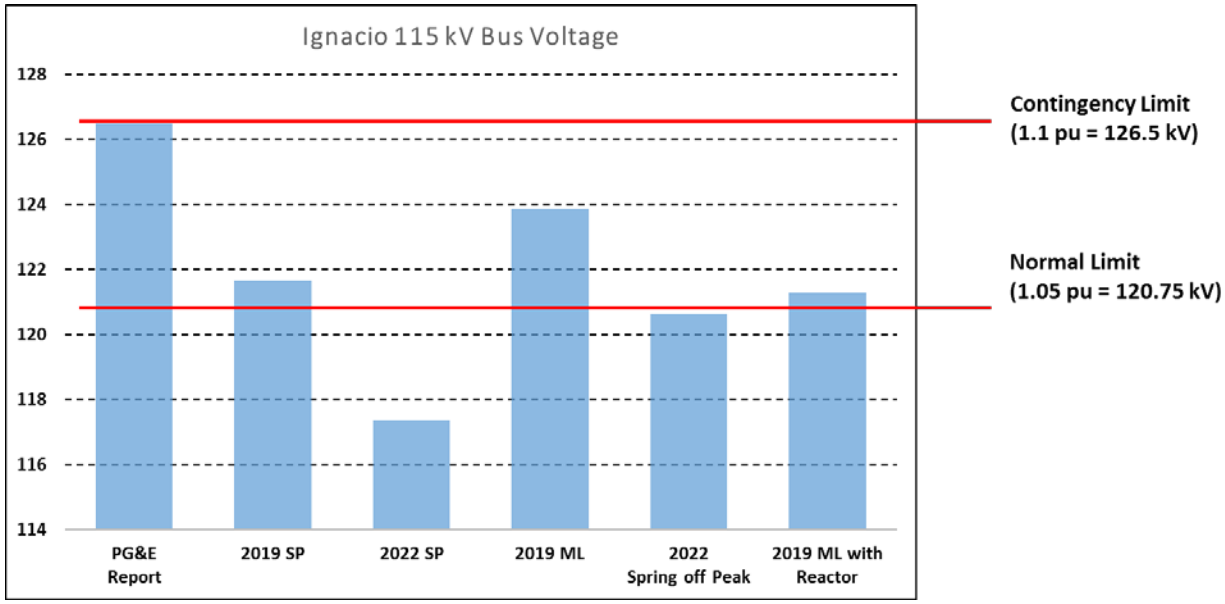
Wilson Voltage Support

- Original need
  - 2015-2016 TP: This project was approved to address high voltage issues in Northern Fresno Area.
- Reliability Assessment Need
  - NERC Categories P0.
- Mitigation still required
  - Needed to address voltage issues on 115 kV and 230 kV systems.
- Review of current project to meet need
  - Current scope of approved project mitigates identified criteria violation.
- Alternatives
  - N/A
- Preliminary conclusion
  - Proceed with the project



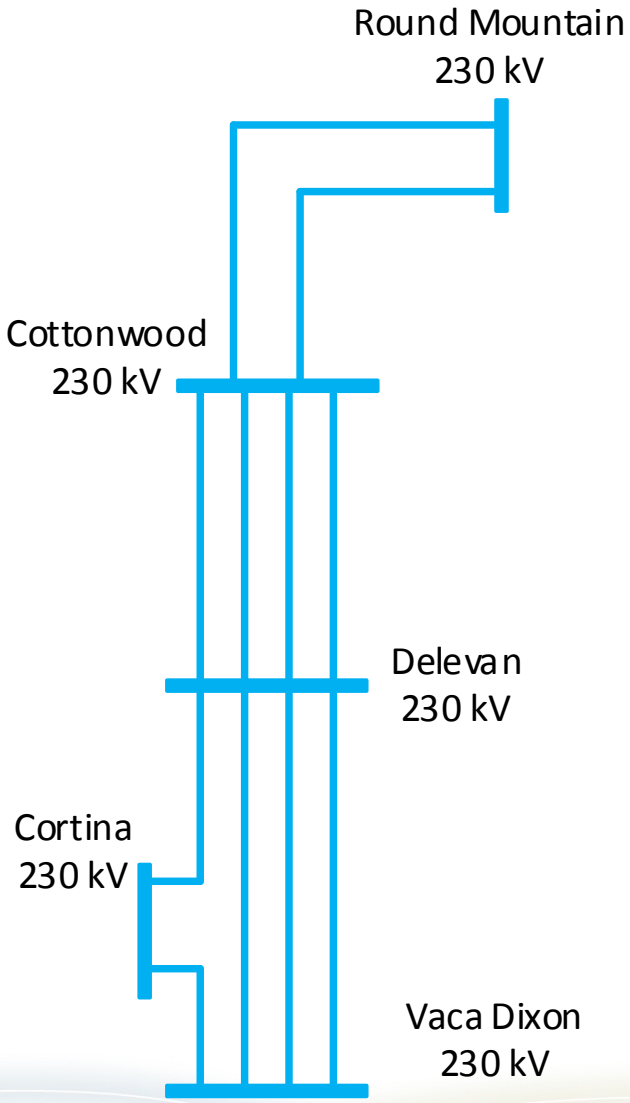
Ignacio 230 kV Substation Shunt Reactor

- Original need
  - 2015-2016 TP: This project was approved to address high voltage issues observed in the area in real time.
- Reliability Assessment Need
  - NERC Categories P0.
- Mitigation still required
  - Needed to address voltage issues on 115 kV and 230 kV systems.
- Review of current project to meet need
  - Current scope of approved project mitigates identified criteria violation.
- Alternatives
  - N/A
- Preliminary conclusion
  - Proceed with the project



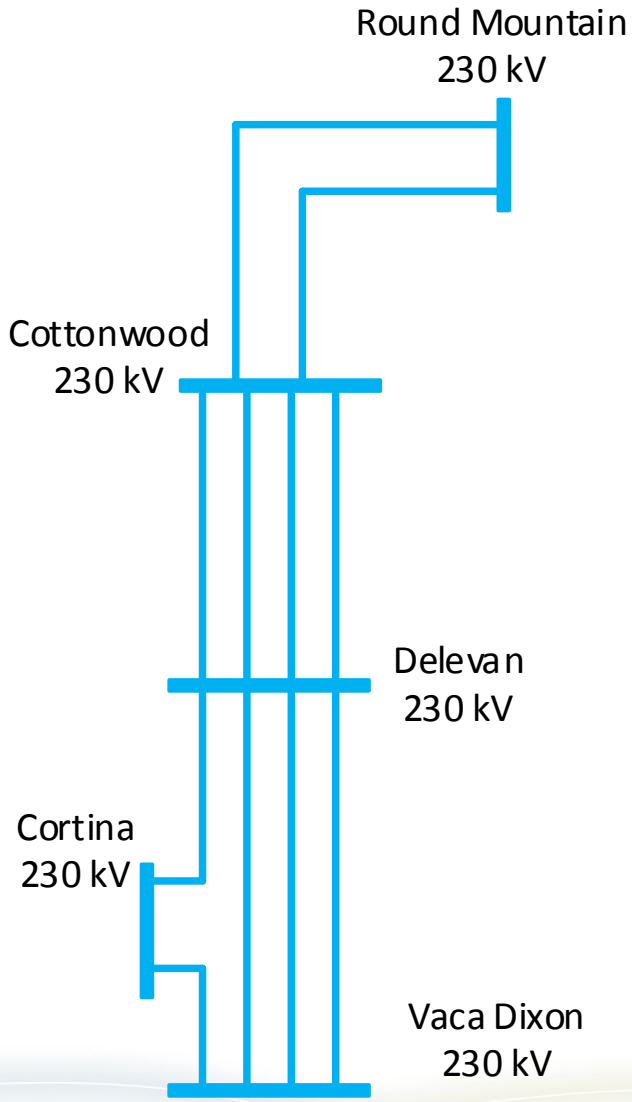
Cottonwood 115 kV Substation Shunt Reactor

- Original need
  - 2015-2016 TP: This project was approved to address high voltage issues observed in the area in real time.
- Reliability Assessment Need
  - NERC Categories P0.
- Mitigation still required
  - Needed to address voltage issues on 115 kV and 230 kV systems.
- Review of current project to meet need
  - Current scope of approved project mitigates identified criteria violation.
- Alternatives
  - N/A
- Preliminary conclusion
  - Proceed with the project



Delevan 230 kV Substation Shunt Reactor

- Original need
  - 2015-2016 TP: This project was approved to address high voltage issues observed in the area in real time.
- Reliability Assessment Need
  - NERC Categories P0.
- Mitigation still required
  - Needed to address voltage issues on 230 kV systems.
- Review of current project to meet need
  - Current scope of approved project mitigates identified criteria violation.
- Alternatives
  - N/A
- Preliminary conclusion
  - Proceed with the project



Voltage support projects approved in Transmission Plans prior to 2015

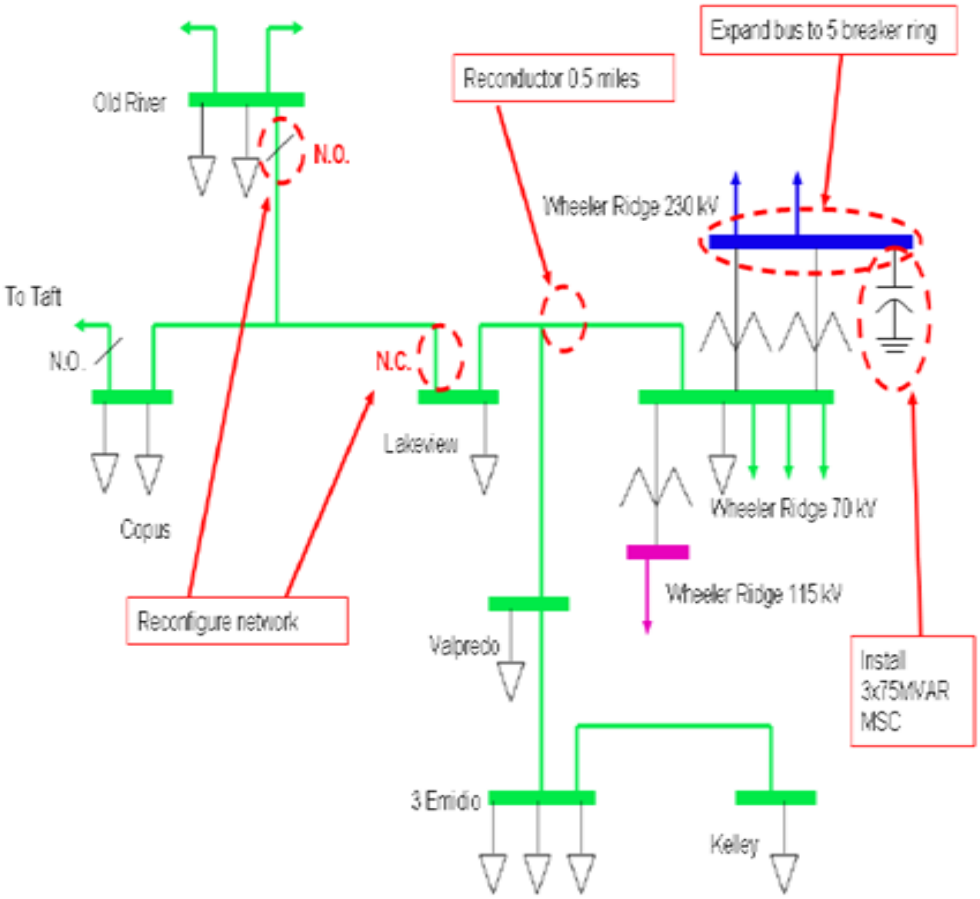
Voltage Support Projects Model

- Voltage support projects were offline in the study cases:

Wheeler Ridge Voltage Support	Kern
Cayucos 70 kV Shunt Capacitor	CCLP
Diablo Canyon Voltage Support Project	CCLP
Rio Oso Area 230 kV Voltage Support	CVLY
Borden 230 kV Voltage Support	GFA
Maple Creek Reactive Support (Install 10 Mvar SVC at Maple Creek Sub)	Humboldt

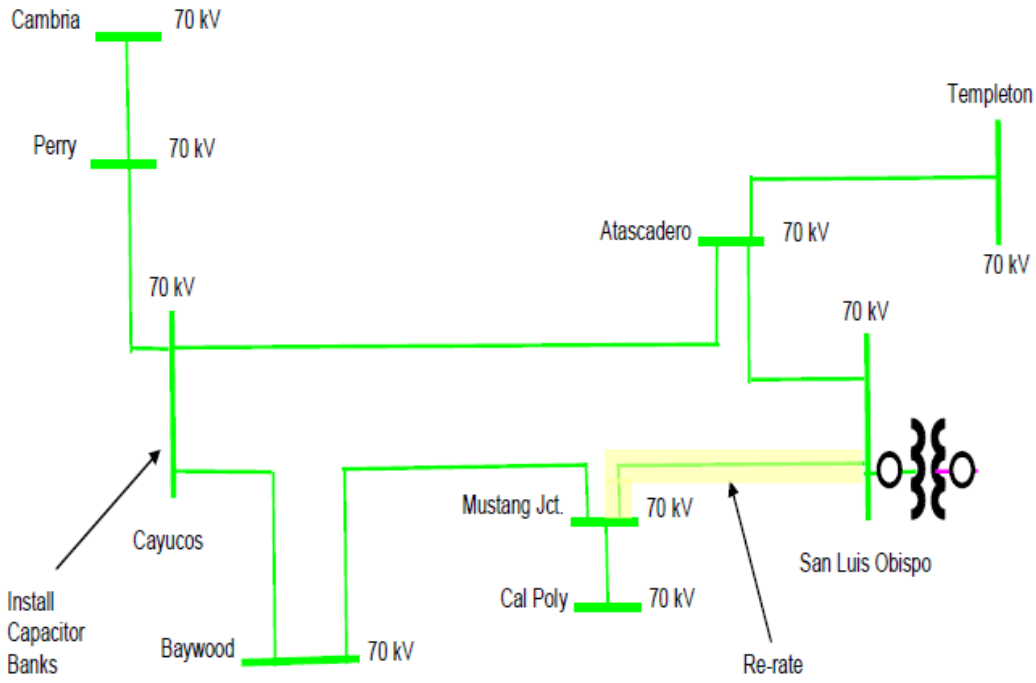
Wheeler Ridge Voltage Support

- Original need
  - 2011-2012 TPP: Category A, B & C low voltage in the Kern 70 kV & Wheeler Ridge 70 kV area.
- Reliability Assessment Need
  - Voltage issue are identified under P0, P1, P2.
- Mitigation still required
  - Mitigation is needed to address voltage issues
- Alternatives
  - N/A
- Preliminary conclusion
  - Proceed with the project



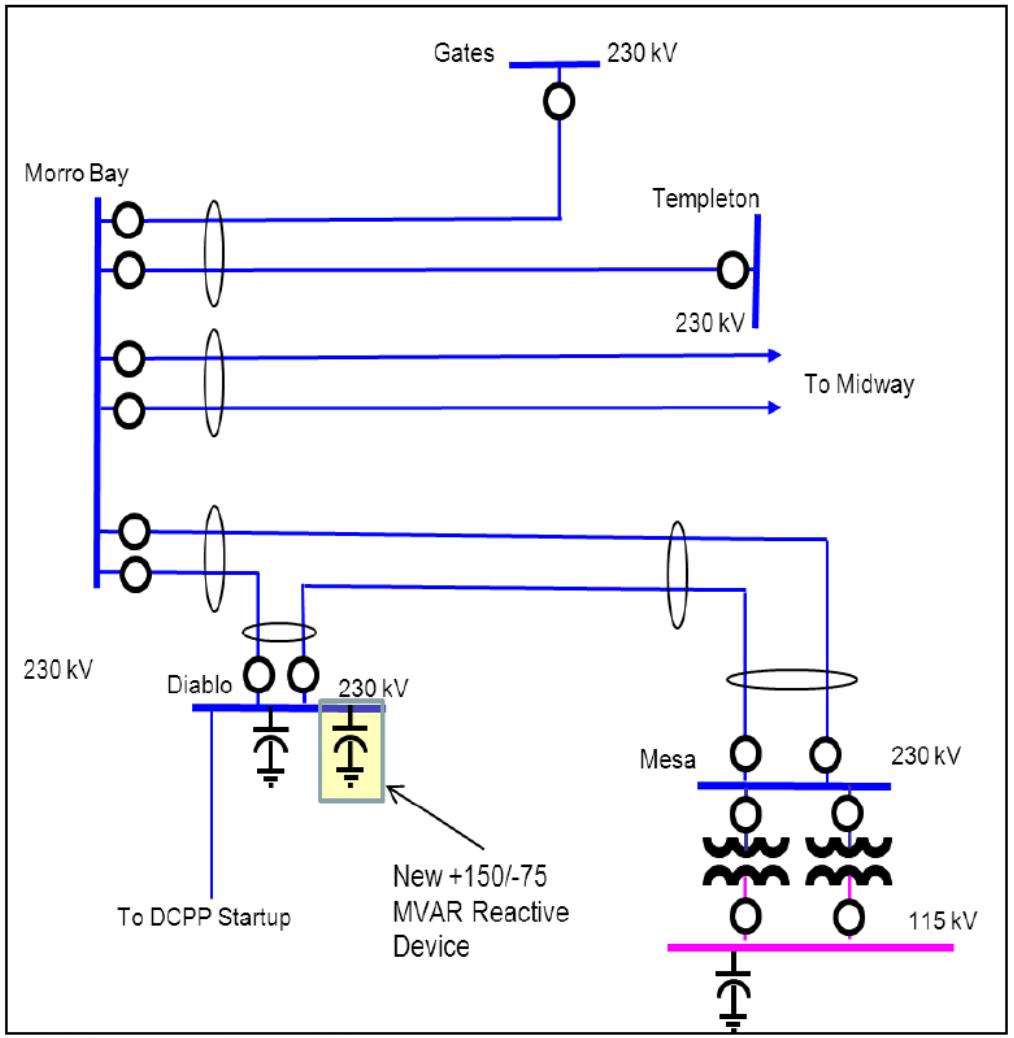
Cayucos 70 kV Shunt Capacitor Project

- Original need
  - 2010 TPP studies identified NERC Category B voltage deviation and Category C low voltage
- Reliability Assessment Need
  - No voltage issue was identified
- Mitigation still required
  - Further analysis is required
- Alternatives
  - Cancel the capacitor banks and keep the line Re-rate
  - Cancel both the capacitor bank and the line re-rate
- Preliminary conclusion
  - Further analysis required



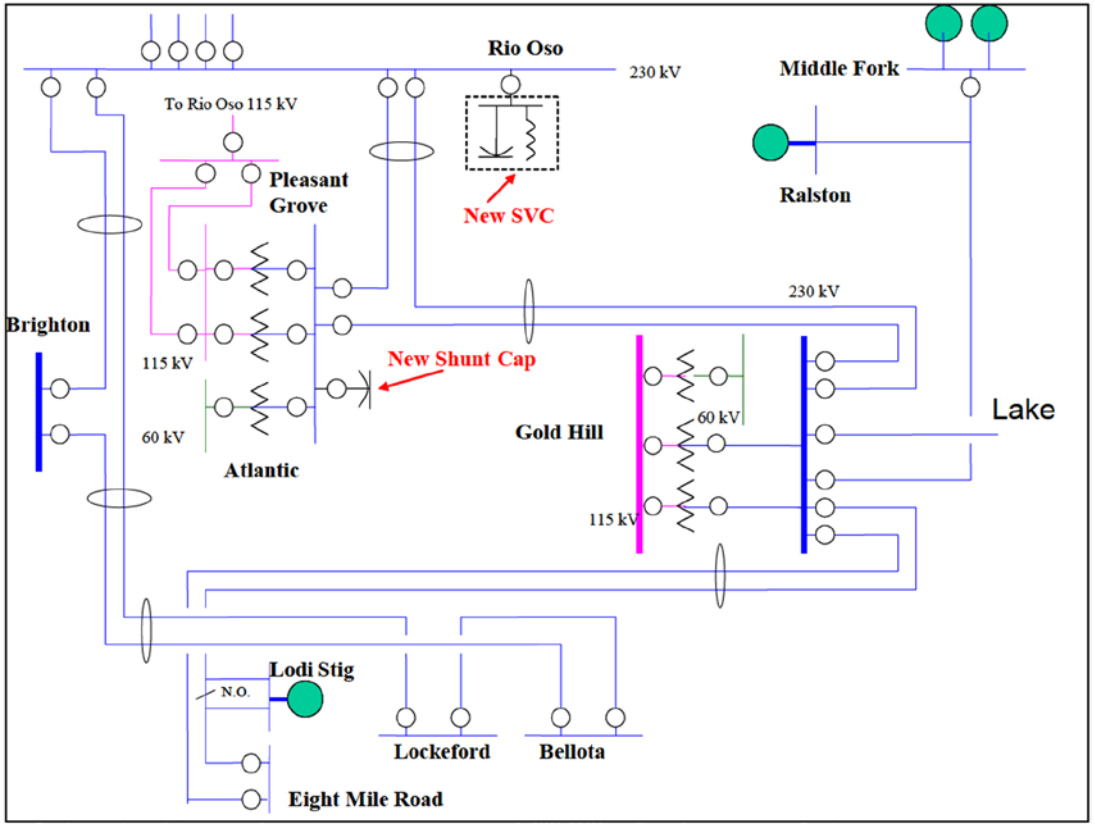
Diablo Canyon Voltage Support Project

- Original need
  - 2012-2013 TPP: NERC NUC-001-2, NERC TPL Standards and CAISO Category B (L-1/G-1) resulting in low voltages below 0.90pu.
- Reliability Assessment Need
  - Voltage issue are identified
- Mitigation still required
  - Further analysis is required
- Alternatives
  - Reactive support at Mesa
- Preliminary conclusion
  - Further analysis required



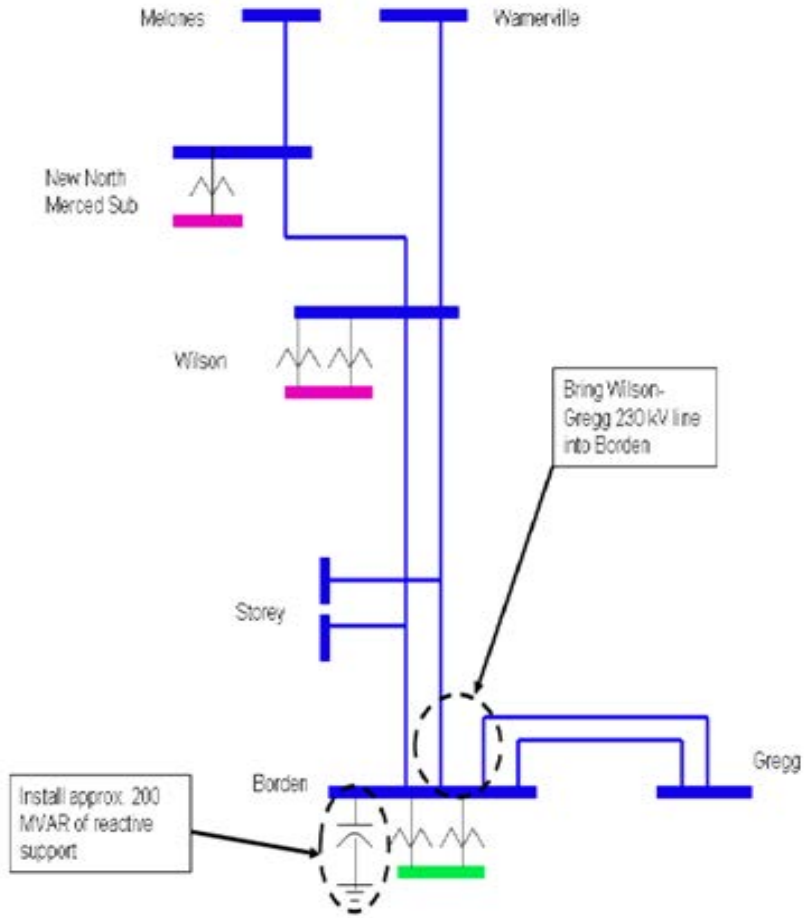
Rio Oso Area 230 kV Voltage Support

- Original need
  - 2011-2012 TPP: NERC Category P0 voltage issues.
- Reliability Assessment Need
  - NERC Categories P0, P2, and P7 voltage issues.
- Mitigation still required
  - Needed to address voltage issues.
- Review of current project to meet need
  - Under review for potential increase in the size of the SVC.
- Alternatives
  - Cancel Atlantic cap bank and proceed with SVC
  - Cancel SVC and proceed with Atlantic Cap bank
- Preliminary conclusion
  - Further analysis required



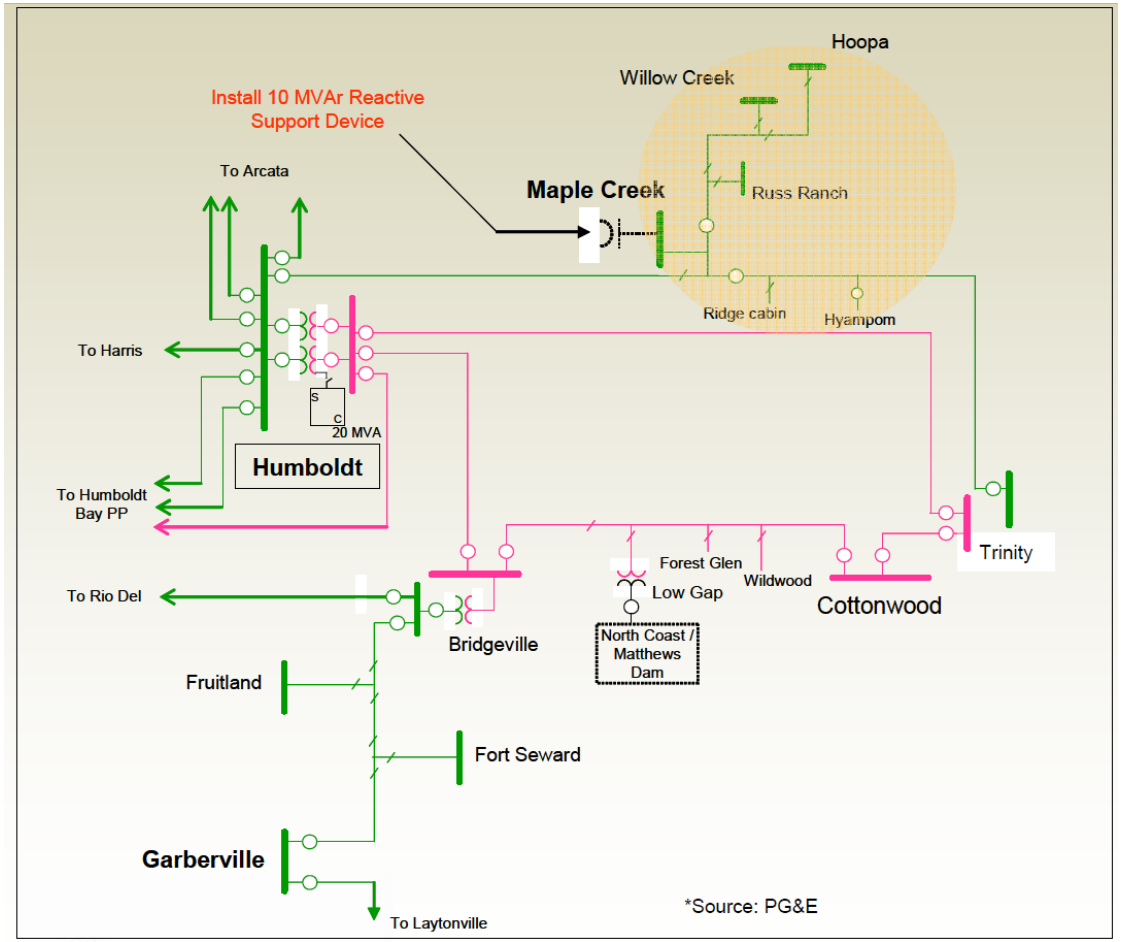
Borden 230 kV Voltage Support

- Original need
  - 2011-2012 TPP: P1 and P7 low voltage and voltage deviation.
- Reliability Assessment Need
  - Voltage issue are identified at Borden under P6
- Mitigation still required
  - Looping-in the Wilson-Gregg 230 kV line is needed for generation deliverability
- Alternatives
  - Proceed with looping-in and cancel the shunt capacitor
- Preliminary conclusion
  - Proceed with looping-in as it is needed for generation deliverability. The need for reactive support requires further analysis.



Maple Creek Reactive Support

- Original need
  - 2009 TPP: Category B/C low voltage.
- Reliability Assessment Need
  - Voltage issue are identified under P3, P6. P0 is marginal as well.
- Mitigation still required
  - Mitigation is needed to address voltage issues
- Alternatives
  - Mechanically or Thyristor switched shunts
- Preliminary conclusion
  - Further analysis required



Summary of Voltage Assessment Results (1/2)

- Planning studies as well as review of real time data indicate that there are voltage issues at all voltage levels across the PG&E system.

- Voltage at 500 kV system in North PG&E is high when COI flow is low. One potential mitigation measure is to install voltage support at Round Mountain.

- After Diablo Canyon plant retires dynamic voltage support will be required, with Gates being a potential location.

Summary of Voltage Assessment Results (2/2)

- The approved projects will not address all the issues if load power factor remains similar to historical values.
- PG&E has initiated review of potential mitigation to address load power factor issues.
  - Load power factors are being monitored to assess how effective the adjustments are in addressing the issue.
- A reassessment of the system with power factor corrections and voltage projects in service will determine the remaining voltage issues and potential mitigation measures.

PG&E Bulk System
Preliminary Reliability Assessment Results

Irina Green
Senior Advisor, Regional Transmission

2017-2018 Transmission Planning Process Stakeholder Meeting
September 21-22, 2017

SCE Bulk System
Preliminary Reliability Assessment Results

Nebiyu Yimer
Regional Transmission Engineer Lead

2017-2018 Transmission Planning Process Stakeholder Meeting
September 21-22, 2017

SCE Metro Area
Preliminary Reliability Assessment Results

Nebiyu Yimer
Regional Transmission Engineer Lead

2017-2018 Transmission Planning Process Stakeholder Meeting
September 21-22, 2017

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 16,185 MW in 2027
- Forecast 3,383 MW of BTM PV and 1,347 MW of AAEE by 2027
- 10,400 MW of existing generation of which 5,764 MW is scheduled to be retired.
- 2,150 MW of approved resources

SCE Metro Area Study Scenarios

- Base scenarios

No.	Case	Description
B1	2019 Summer Peak	Peak load time - hours between 16:00 and 18:00.
B2	2022 Summer Peak	
B3	2027 Summer Peak	
B4	2019 Spring Light Load	Spring light load time - hours between 02:00 and 6:00.
B5	2022 Spring Off-Peak	Spring Off-peak load time – weekend morning

- Sensitivity scenarios

No	Case	Description
S1	2019 Summer Peak	2019 SP with peak-shift adjustment
S2	2022 Summer Peak	2022 SP with peak-shift and high CEC load
S3	2022 Summer Peak	2022 SP with high renewable minimal gas generation output
S4	2027 Summer Peak	2027 SP with peak-shift adjustment
S5	2022 Spring Off-Peak	2022 spring off-peak with minimum net load

SCE Metro 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	2019 Summer Peak	17,961	371	1,414	531	17,059	231	352
B2	2022 Summer Peak	18,228	723	1,948	723	16,781	236	352
B3	2027 Summer Peak	18,784	1,347	3,383	1,252	16,185	236	352
B4	2019 Spring Light Load	5,051	107	1,414	0	4,944	231	352
B5	2022 Spring Off-Peak	10,911	425	1,948	608	9,877	236	352
S1	2019SP CEC Peak Shift	17,961	371	1,414	323	17,267	231	352
S2	2022SP High CEC Load & Peak Shift	18,775	723	1,948	292	17,760	236	352
S3	2022SP Heavy Renewables & Min Gas Gen	18,228	723	1,948	723	16,782	236	352
S4	2027SP CEC Peak Shift	18,784	1,347	3,383	423	17,014	236	352
S5	Spring Off-Peak with Maximum PV Output	7,119	693	2,824	2,349	4,077	236	352
Notes:	*DR and storage are modeled offline in starting base cases.*							

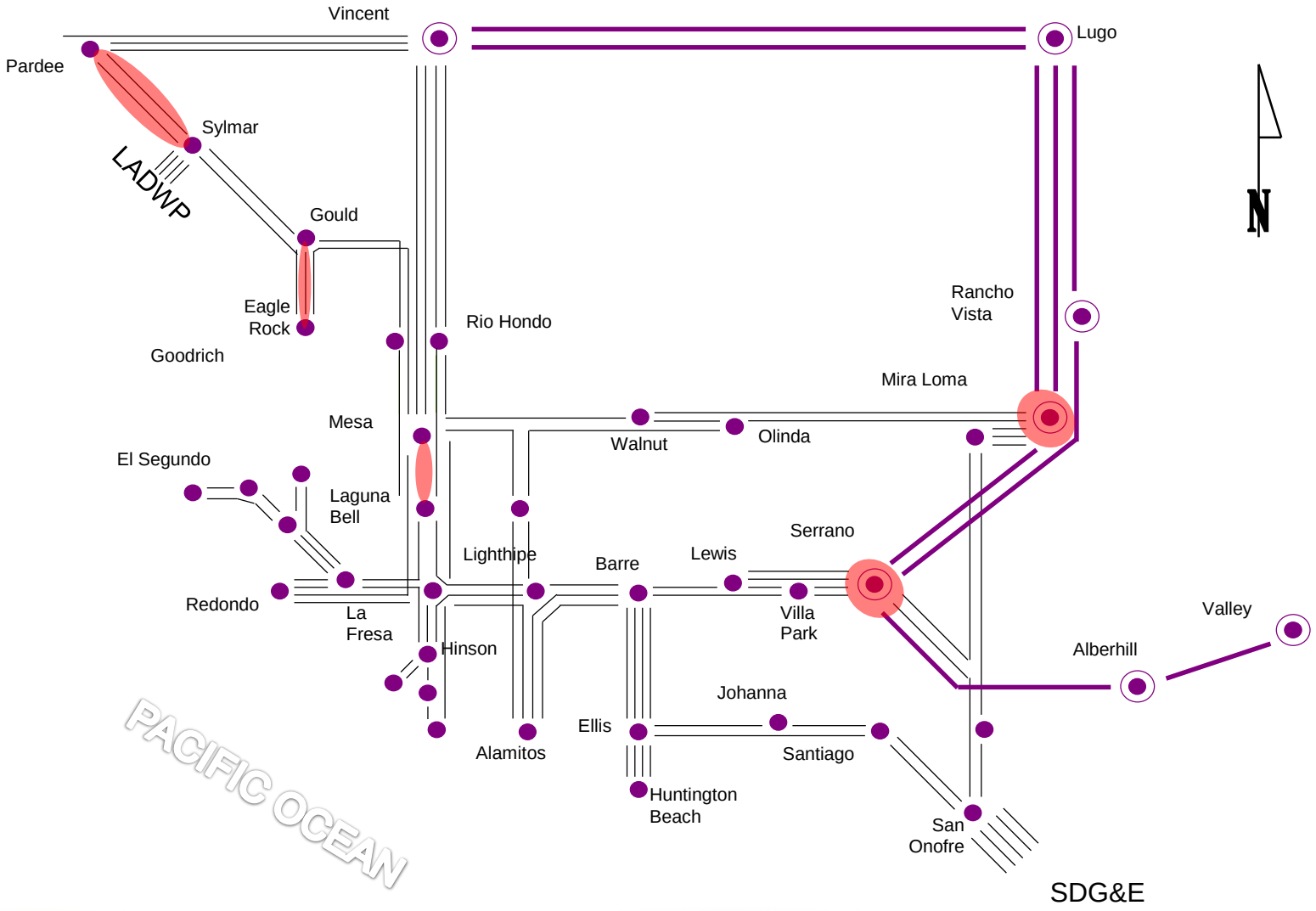
SCE Metro Supply Side Assumptions

No.	Base Case	Battery Storage (Installed)	Solar (Grid		Wind		Hydro		Thermal	
			Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)
B1	2019 Summer Peak	63	20	0	0	0	10	0	10,379	4,656
B2	2022 Summer Peak	327	383	122	0	0	10	0	6,569	4,009
B3	2027 Summer Peak	327	383	122	0	0	10	0	6,569	3,717
B4	2019 Spring Light Load	63	20	0	0	0	10	0	10,379	246
B5	2022 Spring Off-Peak	327	383	0	0	0	10	0	6,569	578
S1	2019SP CEC Peak Shift	63	20	0	0	0	10	0	10,379	4,656
S2	2022SP High CEC Load & Peak Shift	327	383	122	0	0	10	0	6,569	4,009
S3	2022SP Heavy Renewables & Min Gas Gen	327	383	316	0	0	10	0	6,569	3,460
S4	2027SP CEC Peak Shift	327	383	122	0	0	10	0	6,569	3,717
S5	Spring Off-Peak with Maximum PV Output	327	383	14	0	0	10	2	6,569	341

Metro Area Assessment Summary

Overloaded Facility	Worst Contingencies	Category	Category Description	Loading (%)				Potential Mitigation Solutions
				B1 2019 Summer Peak	B3 2027 Summer Peak	S1 2019 SP CEC Peak Shift	S2 2022SP High CEC Load & Peak Shift	
Pardee - Sylmar 230 kV	Other Pardee - Sylmar 230 kV & Victorville - Lugo 500 kV	P6	L-1/L-1	<100	**124**	**102**	<100	System adjustments after initial contingency
Eagle Rock - Gould 230 kV	Gould - Sylmar 230 kV & Victorville - Lugo 500 kV	P6	L-1/L-1	**105**	<100	**107**	<100	
Mesa - Laguna Bell 230 kV #1	Mesa - Redondo & Mesa - Lighthipe 230 kV lines	P6	L-1/L-1	<100	<100	<100	**102**	
Serrano 500/230 kV Transformer	Two Serrano 500/230 kV Transformers	P6	T-1/T-1	**122**	<100	**124**	**105**	System adjustments after initial or second contingency
Mira Loma 500/230 kV Transformer #4	Lugo - Rancho Vista & Mira Loma - Serrano 500 kV lines	P6	L-1/L-1	**117**	<100	**120**	<100	
Mira Loma 500/230 kV Transformer #1 or #2	Mira Loma - Serrano 500 kV & Mira Loma 500/230 kV Transformer #2 or #1	P6	L-1/T-1	**106**	<100	**108**	<100	

SCE Metro Area Thermal Overloads



Thank you

Tehachapi and Big Creek Corridor Preliminary Reliability Assessment Results

Mudita Suri
Regional Transmission Engineer

2017-2018 Transmission Planning Process Stakeholder Meeting
September 21-22, 2017

Agenda

- Area Introduction
- Study Scenarios
- Demand Side Assumptions
- Supply Side Assumptions
- TPP16-17 Approved Project
- Steady State Results
- Stability and Post-Transient Results

Tehachapi and Big Creek Corridor Area

- Comprises of 230 kV transmission facilities.
- Over 6,500 MW of existing generation.
- Existing pumping load of 720 MW.
- Existing Hydro installed capacity of 1170 MW

Study Scenarios

- Five Base scenarios

No	Case	Description	Renewables Dispatch
B1	2019 Summer Peak	1-in 10 summer peak - hours between 16:00 and 18:00.	Solar - 36% Wind - 0%
B2	2022 Summer Peak		
B3	2027 Summer Peak		
B4	2019 Spring Light Load	Spring light load time - hours between 02:00 and 6:00.	Solar - 0% Wind - 93%
B5	2022 Spring Off-Peak	Spring Off-peak load time – weekend morning	Solar - 93% Wind - 93%

Study Scenarios

- Six Sensitivity scenarios

No	Case	Description
S1	2019SP CEC Peak Shift	2019 SP with peak-shift adjustment
S2	2022SP High CEC Load & Peak Shift	2022 SP with peak-shift and high CEC load
S3	2022SP Heavy Renewables & Min Gas Gen	2022 SP with high renewable minimal gas generation output
S4	2022SP Low Big Creek Hydro	2022SP with extremely low Big Creek hydro
S5	2027SP CEC Peak Shift	2027 SP with peak-shift adjustment
S6	2022 Spring Off-Peak with Maximum BTM PV Output	2022 spring off-peak with increased BTM PV

SCE BC&TH Demand Side Assumptions

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	2019 Summer Peak	4142.3	78.7	423.0	227.0	3836.7	88.4	42.4
B2	2022 Summer Peak	4277.6	151.3	527.0	286.9	3839.4	97.3	43.4
B3	2027 Summer Peak	4579.4	268.0	841.0	443.7	3867.7	97.3	43.4
B4	2019 Spring Light Load	956.0	19.2	423.0	0.0	936.8	88.4	42.4
B5	2022 Spring Off-Peak	2673.2	92.2	527.0	241.0	2340.0	97.3	43.4
S1	2019SP CEC Peak Shift	4053.0	78.7	423.0	138.0	3836.3	88.4	42.4
S2	2022SP High CEC Load & Peak Shift	4248.3	151.3	527.0	115.6	3981.4	97.3	43.4
S3	2022SP Heavy Renewables & Min Gas Gen	4277.6	151.3	527.0	286.9	3839.4	97.3	43.4
S4	2022SP Low Big Creek Hydro	4277.6	151.3	527.0	286.9	3839.4	97.3	43.4
S5	2027SP CEC Peak Shift	4298.5	268.0	841.0	149.8	3880.7	97.3	43.4
S6	2022 Spring Off-Peak with Maximum BTM PV Output	2467.6	56.7	1241.0	972.0	1438.9	97.3	43.4

Note:

DR and storage are modeled offline in starting base cases.

Generation Assumption

- Summer Peak Base Cases:

  Minimum hydro generation required to mitigate N-1 overloads in Big Creek area (without any load arming)

- Low Hydro Sensitivity Case:

  Worst hydro generation periods (during peak load hours) were analyzed for 2015 Summer to evaluate lowest generation amount (330MW)

SCE BC&TH Supply Side Assumptions

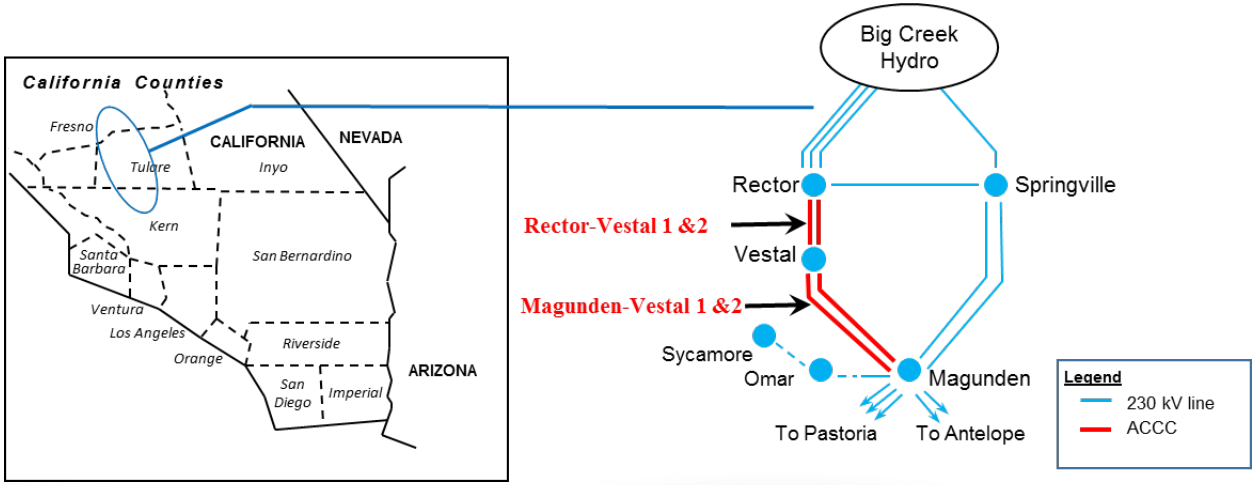
S. No.	Base Case	Battery Storage (MW)	Solar		Wind		Hydro		Thermal	
			Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)
B1	2019 Summer Peak	0.0	2894.0	945.0	3539.0	0.0	1169.9	604.0	4415.0	1510.0
B2	2022 Summer Peak	0.5	2905.0	945.0	3539.0	0.0	1169.9	604.0	4695.0	1759.0
B3	2027 Summer Peak	0.5	2905.0	956.0	3539.0	0.0	1169.9	652.0	4695.0	1685.5
B4	2019 Spring Light Load	0.0	2894.0	0.0	3539.0	3085.0	1169.9	396.0	4415.0	0.0
B5	2022 Spring Off-Peak	0.5	2905.0	2419.0	3539.0	3085.0	1169.9	562.0	4695.0	157.0
S1	2019SP CEC Peak Shift	0.0	2894.0	945.0	3539.0	0.0	1169.9	604.0	4415.0	1514.0
S2	2022SP High CEC Load & Peak Shift	0.5	2905.0	945.0	3539.0	0.0	1169.9	639.3	4695.0	1720.0
S3	2022SP Heavy Renewables & Min Gas Gen	0.5	2905.0	2624.0	3539.0	1415.6	1169.9	604.0	4695.0	795.0
S4	2022SP Low Big Creek Hydro	0.5	2905.0	945.0	3539.0	0.0	1169.9	345.0	4695.0	1726.0
S5	2027SP CEC Peak Shift	0.5	2905.0	956.0	3539.0	0.0	1169.9	652.0	4695.0	1685.5
S6	2022 Spring Off-Peak with Maximum BTM PV Output	0.5	2905.0	1470.0	3539.0	305.0	1169.9	203.7	4695.0	694.8

Note:

DR and storage are modeled offline in starting base cases.

Recap- TPP16-17 Approved project

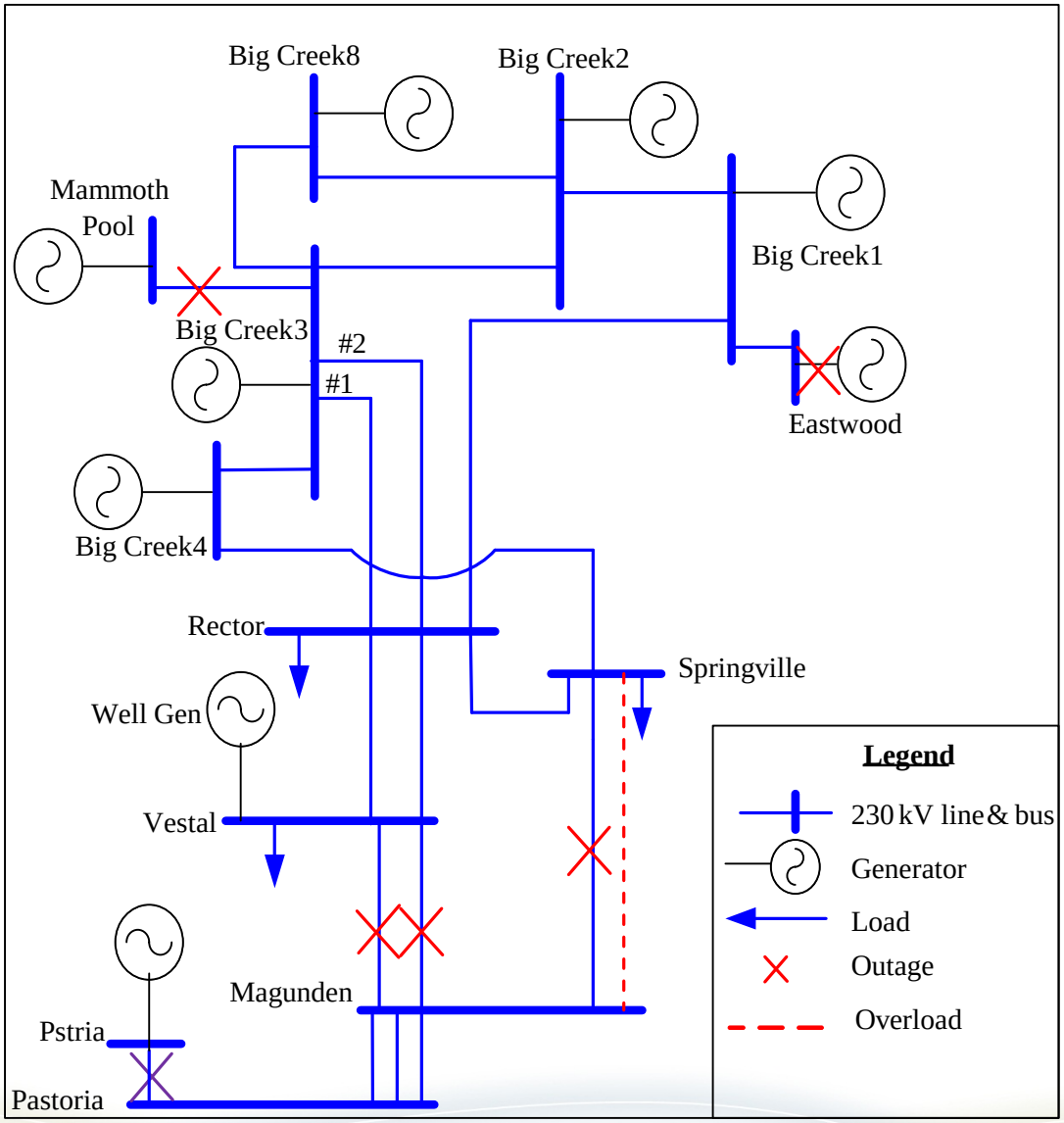
- **Project Name**: Big Creek Corridor Rating Increase
- **Project type**: Reliability
- **Expected In-Service**: 12/31/2018
- **Project Scope**: Upgrade four transmission structures and terminal equipment at Magunden and Vestal Substations and achieve a 4-hr emergency rating of 1520 Amps (currently 936 Amps) on the four 230 kV transmission lines.



Steady State Assessment Summary

Overloaded Facility	Worst Contingency	Category	Category Description	Loading (%) S4-2022SP Low Hydro	Potential Mitigation Solutions
MAGUNDEN-SPRINGVL 230 kV #2 line	MAGUNDEN-VESTAL 230kV 1 and 2 (with RAS)	P7	N-2	<100	Increase Big Creek Hydro output or arm load per Big Creek RAS
	MAGUNDEN-SPRINGVL 230 kV 1 and EASTWOOD 13.80 Unit ID 1	P3	N-1/G-1	104.27	System adjustments after initial contingency
	MAGUNDEN-SPRINGVL 230 kV 1 and BIG CRK1-EASTWOOD 230kV 1	P6	N-1-1	102.52	
	MAGUNDEN-SPRINGVL 230 kV 1 and MAMMOTH-BIG CRK3 230kV 1	P6	N-1-1	104.28	

SCE BC&TH Thermal Overloads



Post Transient & Stability Assessment Summary

Contingency	Category	Study	Mitigation
Pardee-Bailey 230kV and Bailey -Pastoria 230kV	P6	Low Voltage (Post-Transient analysis) at Bailey 230kV	Operating Procedure 46
Big Creek 1-Big Creek 2 230 kV	P5	Local area instability (Transient analysis)	Protection Project- OD of 12/31/2019
Big Creek 3-Rector No.2 & Big Creek 4-Springville	P6	Local area instability* (Transient analysis)	Big Creek generation runback. Modify Big Creek RAS

* This scenario was run on 2022 Spring Off peak base case with high (maximum) Big Creek Hydro output

Thank you

Questions?

North of Lugo Area
Preliminary Reliability Assessment Results

Meng Zhang
Senior Regional Transmission Engineer
2017-2018 Transmission Planning Process Stakeholder Meeting
September 21-22, 2017

North of Lugo (NOL) Area

- Comprised of 55, 115 and 230 kV transmission facilities
- Total installed generation capacity in the area is about 2100 MW.
- Summer peak loads of 964, 972 and 1000.8 MW in 2019, 2022 and 2027 respectively. These include AAEE as forecasted by CEC.
- 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

NOL Study Scenarios

- Base scenarios

No.	Case	Description
B1	2019 Summer Peak	1-in-10 summer peak – hours between 16:00 and 18:00
B2	2022 Summer Peak	
B3	2027 Summer Peak	
B4	2019 Spring Light Load	Minimum load condition – hours between 2:00-4:00
B5	2022 Spring Off-peak	50%~65% of peak loading condition – weekend morning

- Sensitivity scenario

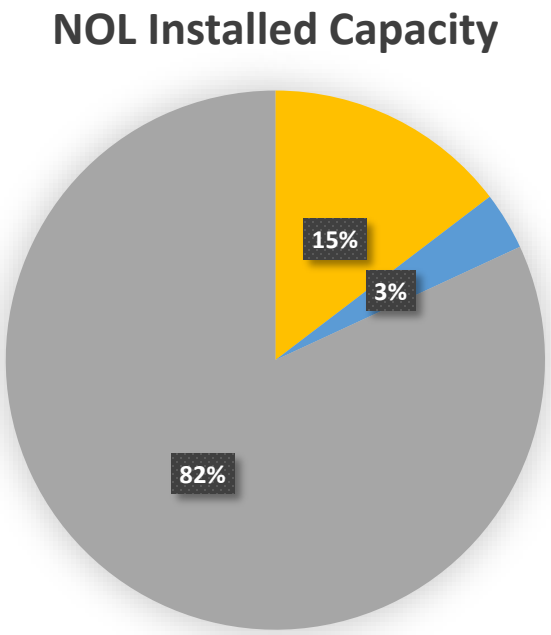
No.	Case	Description
S1	2022SP Heavy Renewables & Min Gas Gen	2022 summer peak with heavy renewable output and minimum gas generation commitment

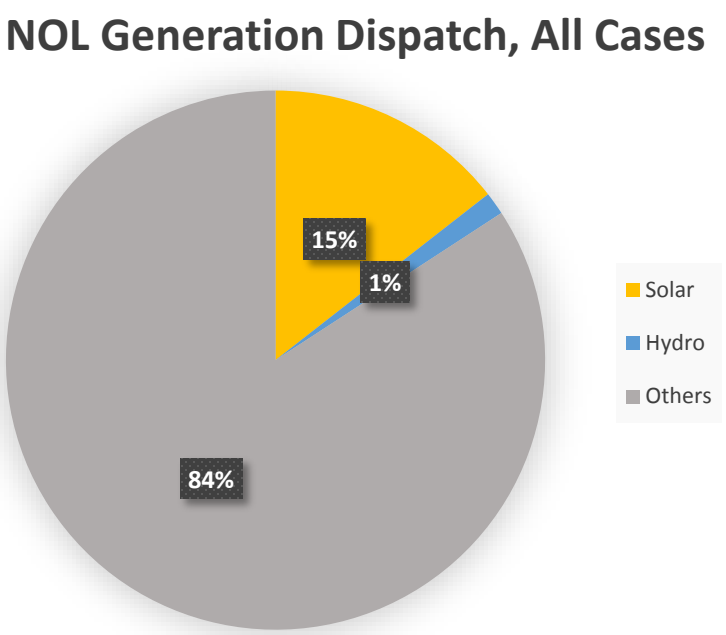
NOL Load and Load Modifier Assumptions

Case	Gross Load (MW)	AAEE (MW)	BTM-PV		Net Load (MW)	Demand Response	
			Installed	Output		Fast (MW)	Slow(MW)
2019 Summer Peak	978	14	156	64	900	82.44	0.77
2022 Summer Peak	1002	29	211	78	894	82.44	0.77
2027 Summer Peak	1056	55	316	117	884	82.44	0.77
2019 Spring Light Load	272	4	156	0	268	82.44	0.77
2022 Spring Off-peak	625	18	211	65	541	82.44	0.77
2022SP Heavy Renewable & Min Gas Gen	739	22	211	78	639	82.44	0.77

NOL Generation Assumptions

- Total Installed Capacity: 2132 MW
- Total Dispatch: 1543 MW





Previously Approved Transmission Projects

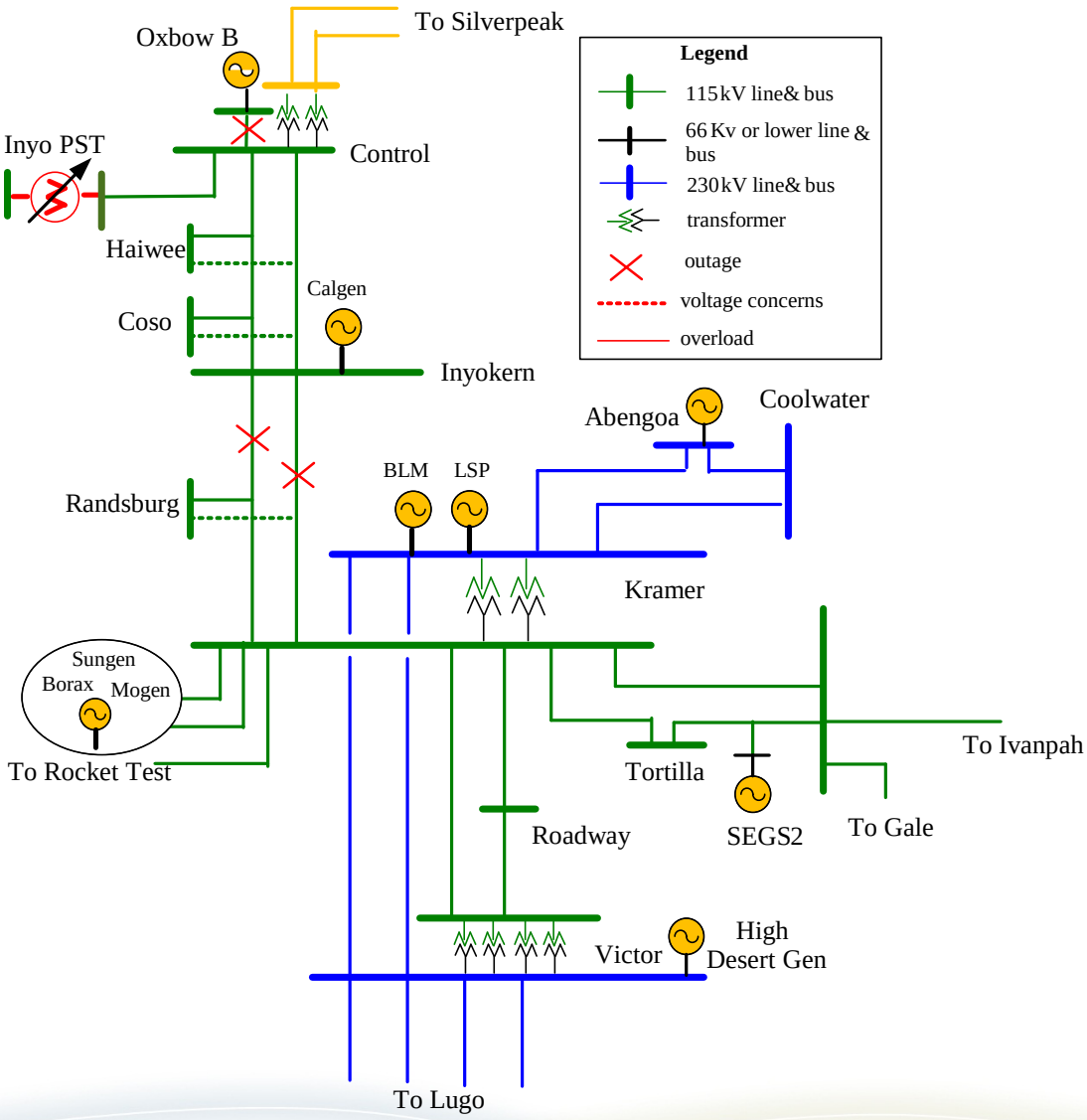
No.	Transmission Projects	First Year Modeled	Description
1	Victor Loop-in Project	2019	Loop-in the existing Kramer-Lugo Nos.1&2 230kV lines into Victor Substation
2	Kramer Reactor Project	2019	Install two 34 MVAR reactors to the 12kV tertiary winding of the existing 230/115kV Nos.1&2 transformers and one 45 MVAR shunt reactor at the Kramer 230kV bus

NOL Assessment Summary

- The assessment identified the following reliability concerns:
  - 1 facility overload for category P1 outage
  - 2 facilities overloads for category P7 outage
  - 5 facilities overloads for category P6 outages
  - 1 divergence issue for category P6 outage
  - 1 115kV bus low voltage issue for P2 outage
  - Voltage fails to recover following 1 category P4.2 outage
  - 2 voltage dip violations for P6 outages
  - No voltage deviation issues identified for all categories.
- Compared to last year's results:
  - Generation dispatch in NOL area is lower than previous planning cycle.
  - Most violations could be mitigated through existing RAS, SCE Operating Procedure and congestion management.

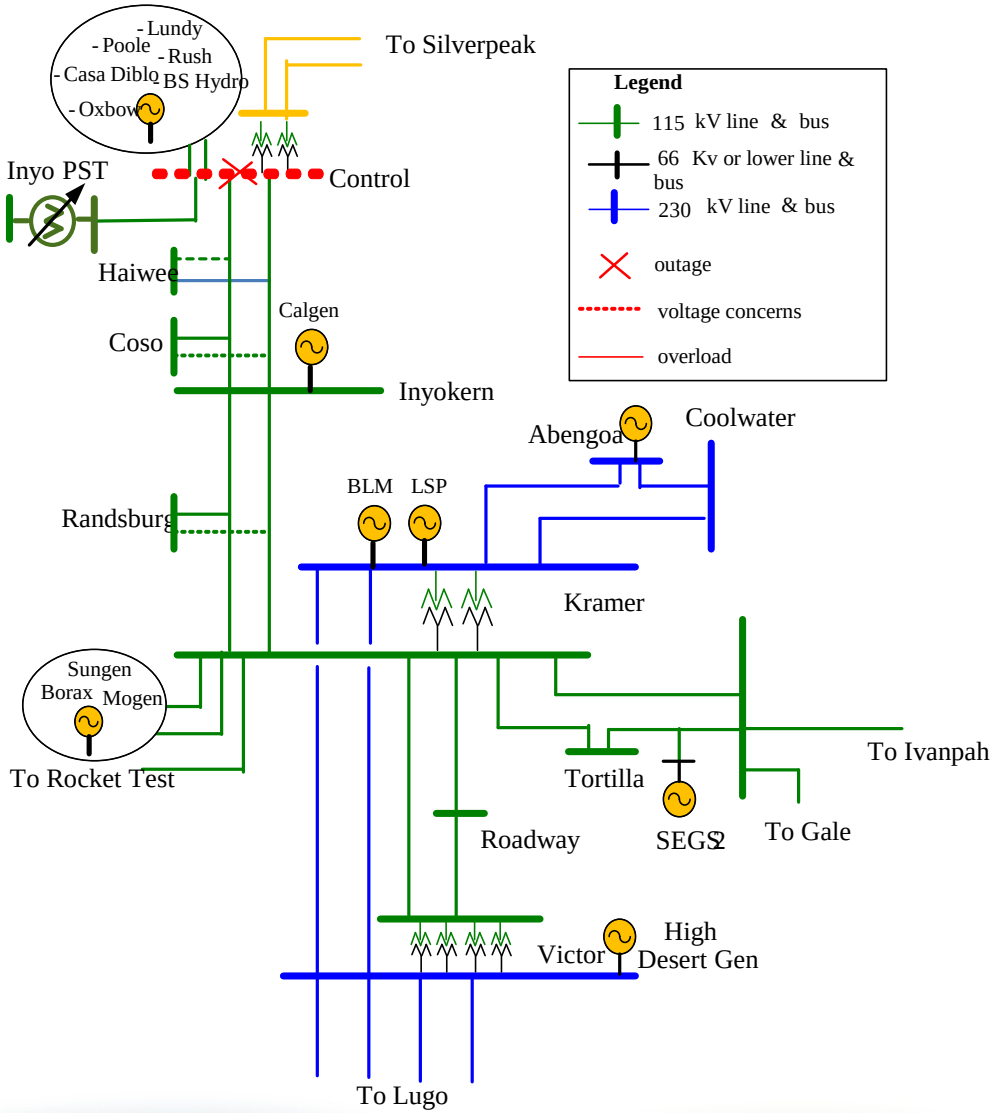
NOL P1 Steady-state Reliability Concern

- Thermal overload on Inyo 115kV phase shifter following P1 outage of Control-Oxbow B 115kV line in 2022 and 2027 summer case; following P6 outage of Inyokern-Kramer and Kramer-Randsburg-Inyokern 115kV lines in 2019 light load case.
- Potential mitigation: apply 2 hour emergency rating followed by congestion management.



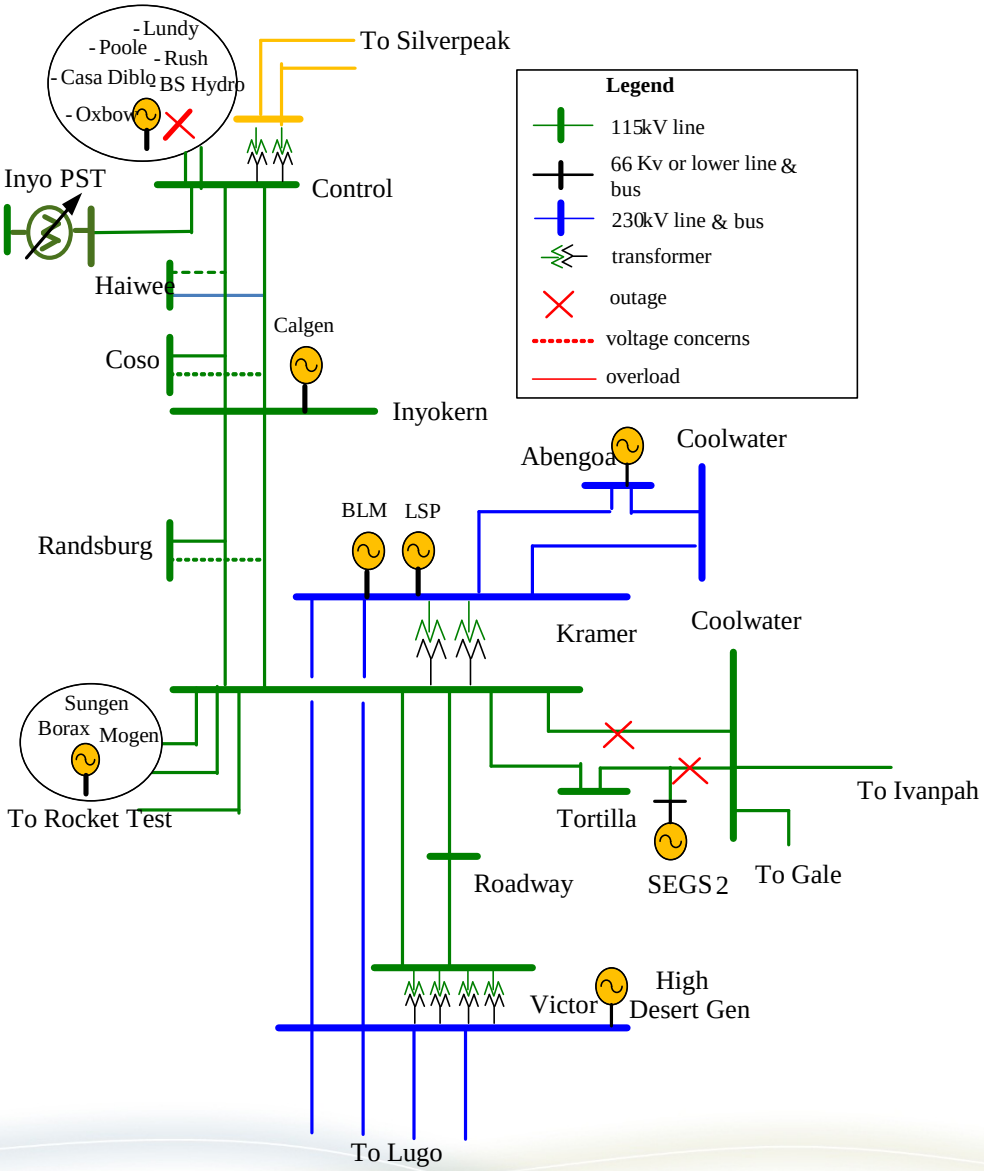
NOL Low Voltage Concern

- Control 115kV bus voltage below 0.9 p.u. following Control 115kV west bus fault in 2022 summer peak case.
- Potential mitigation: adjust voltage schedules and curtail distribution load at Control if necessary.



NOL Transient Stability Concern

- Voltage fails to recover to 80% of pre-contingency voltage for Control-Casa Diablo 115kV line outage with fault at 20% from Control and stuck breaker at Casa Diablo
- Voltages dip below 70% of pre-contingency voltage for more than 30 cycles for Coolwater-Kramer and Coolwater-Seg2-Tortilla 115kV lines fault at Coolwater.
- Potential mitigation:
  - consider local breaker failure backup (LBFB) scheme
  - Utilize existing Operating Procedure 127, open Ivanpah-Mountain Pass line



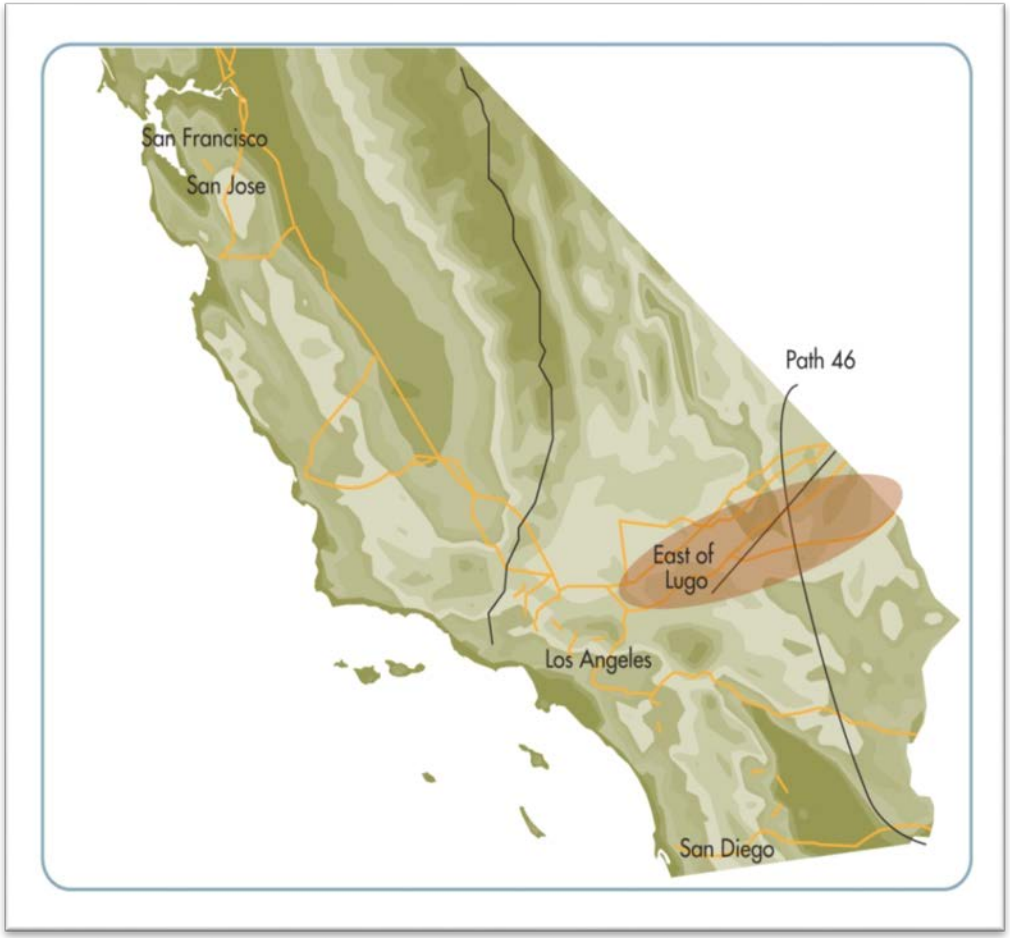
Thank you

East of Lugo Area
Preliminary Reliability Assessment Results

Meng Zhang
Senior Regional Transmission Engineer

2017-2018 Transmission Planning Process Stakeholder Meeting
September 21-22, 2017

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 2000 MW. And over 70% of the total capacity is solar generation.
- The load is mostly served from CIMA 66kV substation. 2027 load forecast is about 4.5 MW.

EOL Study Scenarios

- Base scenarios

No.	Case	Description
B1	2019 Summer Peak	1-in-10 summer peak – hours between 16:00 and 18:00
B2	2022 Summer Peak	
B3	2027 Summer Peak	
B4	2019 Spring Light Load	Minimum load condition – hours between 2:00-4:00
B5	2022 Spring Off-peak	50%~65% of peak loading condition – weekend morning

- Sensitivity scenario

No.	Case	Description
S1	2022SP Heavy Renewables & Min Gas Gen	2022 summer peak with heavy renewable output and minimum gas generation commitment

EOL Generation Assumption

Case	Solar		Others	
	Installed (MW)	Dispatch (MW)	Installed (MW)	Dispatch (MW)
2019 summer peak	1254	451	525	417
2022 summer peak	1514	545	525	417
2027 summer peak	1514	545	525	417
2019 light load	1254	0	525	417
2022 Off Peak	1514	1407	525	417
2022SP Heavy Renewable	1514	1407	525	417

Previously Approved Transmission Projects

No.	Transmission Projects	First Year Modeled	Description
1	Eldorado-Lugo Series Capacitor Upgrade	2022	Upgrade the existing 500KV line series capacitors at Eldorado and Lugo on the Eldorado-Lugo 500KV line
2	Lugo-Mohave Series Capacitor Upgrade	2022	Upgrade the existing 500kV lines series capacitors at Mohave on the Lugo-Mohave 500kV line
3	Calcite 230kV Substation	2022	Construct new Calcite 230kV substation and loop into Lugo-Pisgah #1 230kV line
4	Lugo-Victorville 500kV Line Upgrade	2022	Upgrade terminal equipment and remove ground clearance limitations to achieve higher ratings.

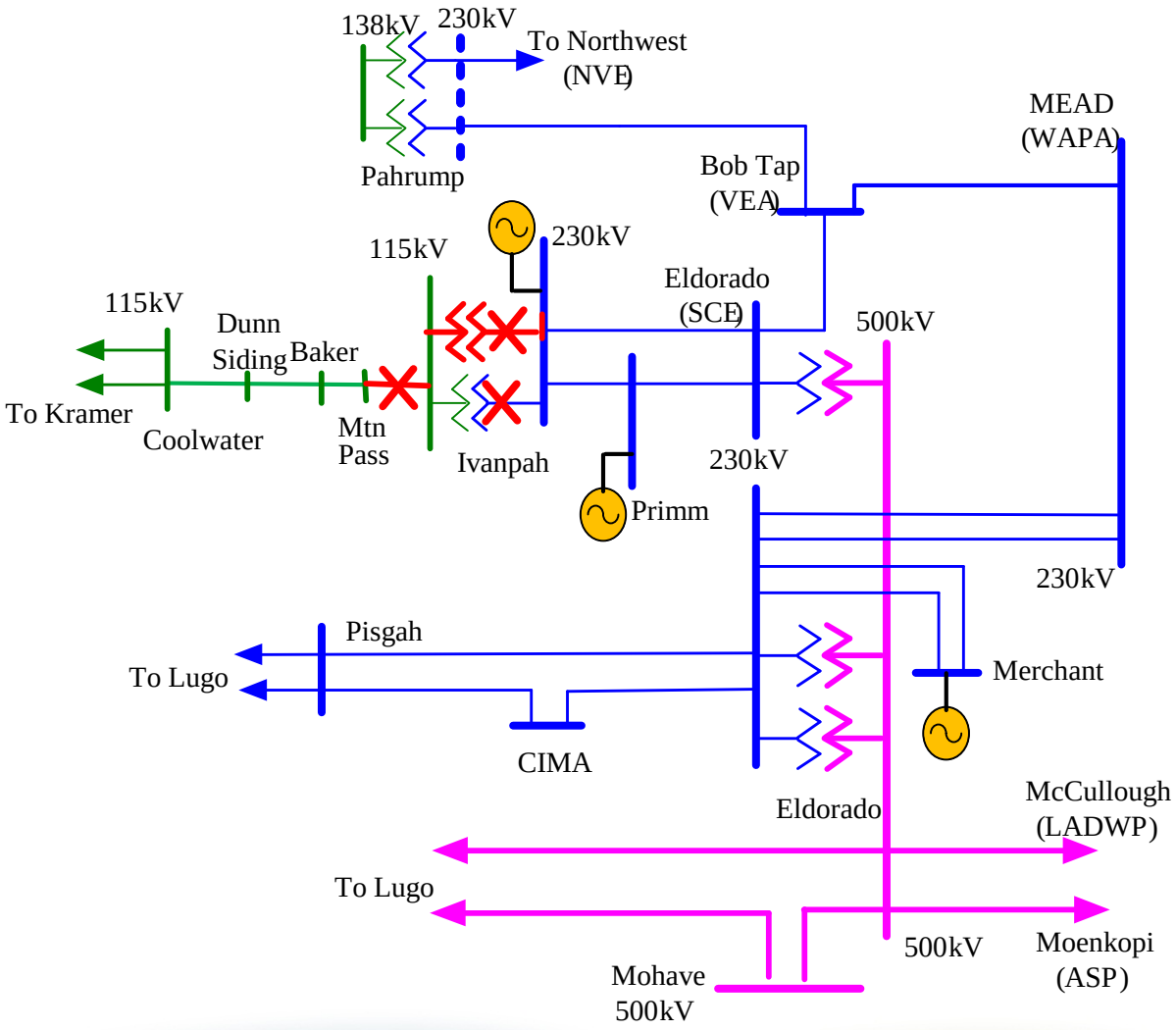
EOL Area Assessment Summary

- The assessment identified:
  - 3 facilities overloads for category P6 outages in off-peak and sensitivity cases
  - 2 potential system divergence for category P5 outages (fault plus relay failure to operate)

- Compared to last year's results:
  - Similar results due to similar load forecast and generation dispatch
  - Most steady-state violations can be mitigated by the existing RAS and CAISO approved transmission project in previous cycle
  - Potential mitigation solution for the new identified issue is to install redundant relay.

EOL Thermal Overload Concerns

- Ivanpah-Mountain Pass 115kV line is overserved to be overloaded in 2019, 2022 and 2027 summer peak cases following loss of both Ivanpah 230/115kV transformers.
- Ivanpah 230/115 kV transformers Nos.1&2 are observed to be overloaded in 2022 off-peak and 2022 high renewable sensitivity cases for loss of Ivanpah-Mountain Pass and the other Ivanpah 230/115kV transformer
- Potential Mitigation
  - Existing Ivanpah RAS
  - Congestion management



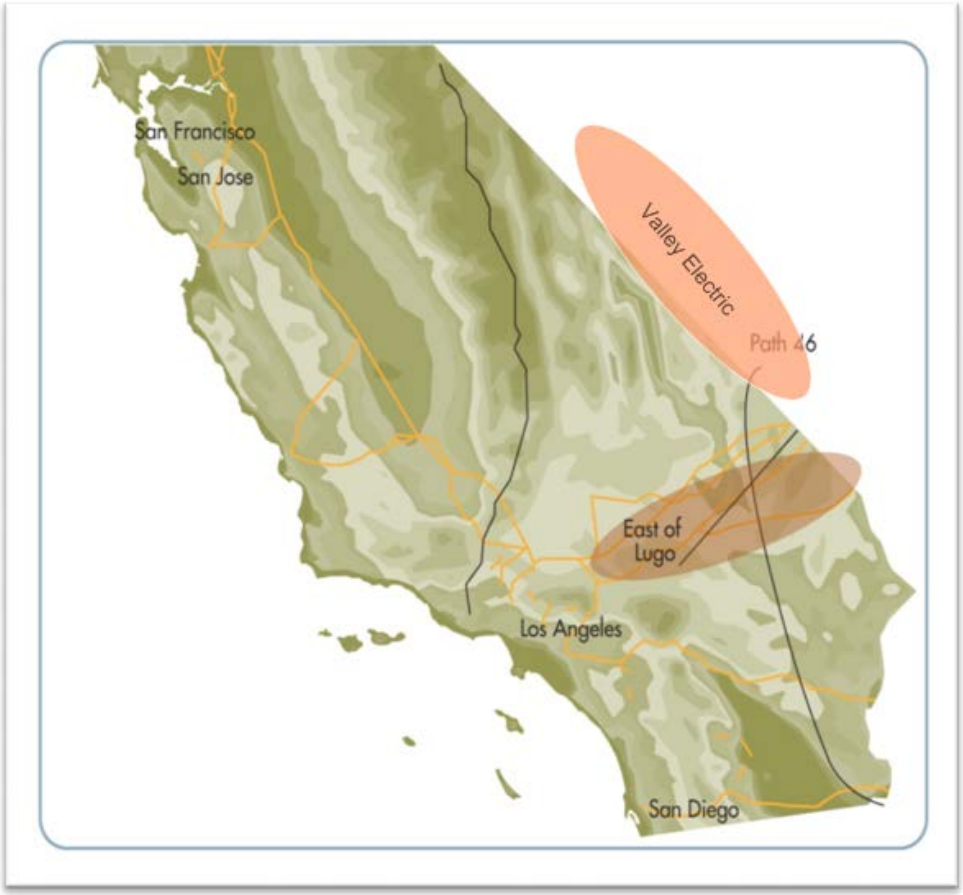
Thank you

Valley Electric Area
Preliminary Reliability Assessment Results

Meng Zhang
Senior Regional Transmission Engineer

2017-2018 Transmission Planning Process Stakeholder Meeting
September 21-22, 2017

Valley Electric Association (VEA) Area



- VEA system is comprised of 138 and 230 KV transmission facilities under ISO control
- Gridliance West Transco is now the Transmission Owner for the 230 kV facilities in the VEA area
- Connect to WAPA's Mead 230kV substation, WAPA's Amargosa 138kV substation, NV Energy's Northwest 230kV substation and share buses at Jackass 138kV and Mercury 138kV stations
- Approximately 15 MW of renewable generation is modeled.
- Forecasted 1-in-10 summer peak loads for 2018, 2022 and 2027 are 141, 144 and 153 MW respectively.

VEA Study Scenarios

- Base scenarios

No.	Case	Description
B1	2019 Summer Peak	1-in-10 summer peak – hours between 16:00 and 18:00
B2	2022 Summer Peak	
B3	2027 Summer Peak	
B4	2019 Spring Light Load	Minimum load condition – hours between 2:00-4:00
B5	2022 Spring Off-peak	50%~65% of peak loading condition – weekend morning

- Sensitivity scenario

No.	Case	Description
S1	2022OP Renewable Generation Addition	2022 summer off-peak with heavy renewable output and minimum gas generation commitment

Previously Approved Transmission Projects

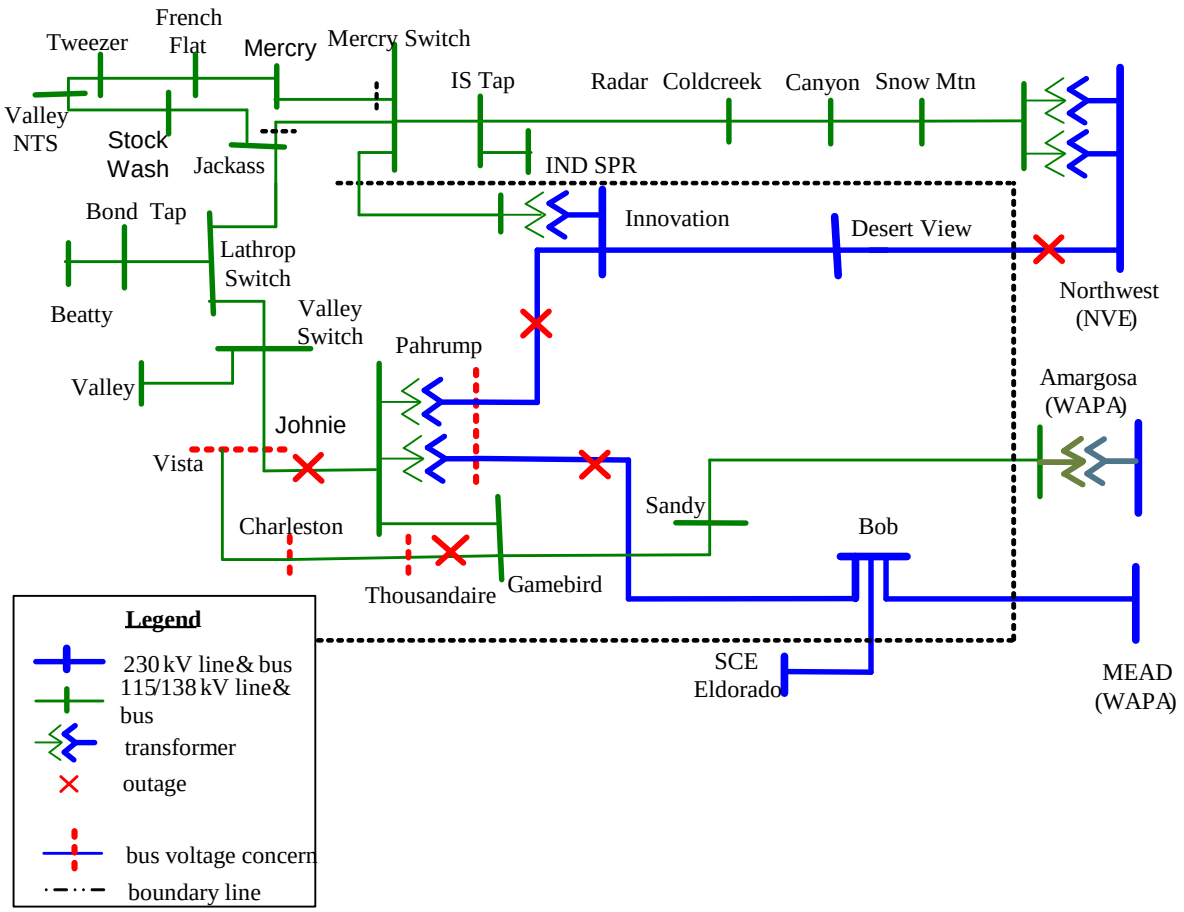
No.	Transmission Projects	First Year Modeled	Description
1	Bob 230kV Switching Station	2022	Build a new Bob 230kV Switching Station and loop into existing Pahrump-Mead 230kV Line
2	Eldorado-Bob 230kV Line	2022	New 230kV line between SCE's Eldorado 220kV substation and VEA's 230kV Bob switching station
3	Charleston-Vista 138kV Line	2022	New 138kV line between Charleston and Vista 138kV substations

VEA Assessment Summary

- The assessment identified:
  - Potential system divergence for category P6 outages
  - 1 230kV bus with low voltage concerns for category P6 outage.
  - Entire 138kV system experiencing high/low voltage concerns for category P6 outages.
  - Several 138kV lines overloaded for Category P1, P4, P6 and P7 outages in the sensitivity case
- Compared to last year results:
  - Very similar to last year's results since the planned upgrades modeled in this year's TPP base cases are the same as in last year's
  - All the identified issues could be mitigated through existing UVLS, RAS in the VEA area or system adjustment after the first outage.

VEA Thermal and Voltage Violations

- Low voltage at Pahrump 230kV bus following loss of Pahrump-Innovation and Pahrump-Mead 230kV lines in 2019 light load case
- Low voltages at Vista, Charleston and Thousandaire 138kV buses for loss of Gamebird-Thousandaire and Pahrump-Vista 138kV lines in 2019, 2022 and 2027 summer peak cases.
- Potential system diverge following loss of Pahrump-Bob SS and Pahrump-Innovation 230kV lines or loss of Pahrump-Bob SS and Desert View-Northwest 230kV lines in 2022 and 2027 summer peak cases
- Potential Mitigation
  - New Bob 230kV Switching Station
  - Exisiting UVLS and operation switching after first outage.



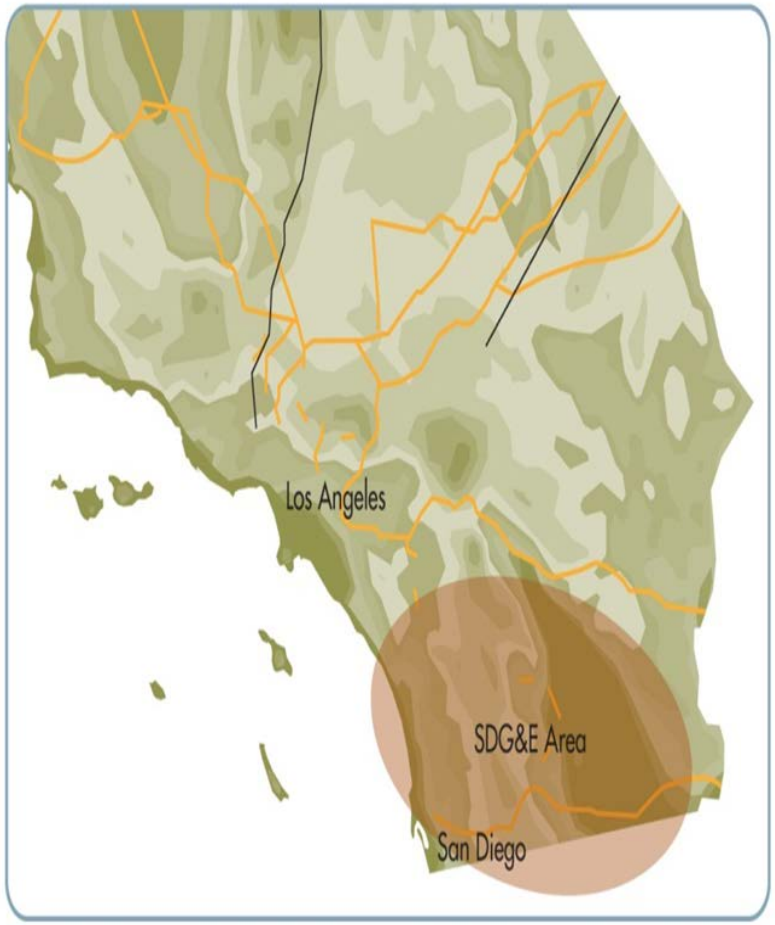
Thank you

SDG&E Main System
Preliminary Reliability Assessment Results

Frank Chen
Regional Transmission Engineer Lead

2017-2018 Transmission Planning Process Stakeholder Meeting
September 21-22, 2017

SDG&E Main Transmission System



- Covers San Diego, Imperial, and Southern Orange counties
- Comprised of 500 kV and 230 kV transmission facilities
- Net peak load of 4,555 MW with AAEE and BTM-PV load reduction in 2027
- Generation: 6000 MW of installed capacity by 2019, of which a total of 1970 MW renewable generation is expected to be operational
- A total of 1,563 MW BTM PV capacity and 401 MW of AAEE by 2027

Study Scenarios

- Five Baseline Study Cases
- Five Sensitivity Study Cases

Study Scenario	Baseline Cases (CEC 1-in-10 mid demand forecast with low AAEE)					Sensitivity Cases				
	B1-19SP	**B2-22SP**	**B3-27SP**	**B4-19LL**	**B5-22OP**	**S1-22SP HL-PS**	**S2-19SP PS**	**S3-27SP PS**	**S4-22SP HRPS**	**S5-22SP HNB**
Description	2019 Summer Peak Load	2022 Summer Peak Load	2027 Summer Peak Load	2019 Spring Light Load (35% of the peak load)	2022 Spring Off-Peak (65% of the peak load)	High CEC Load Forecast & Peak-Shift	CEC Peak-Shift		Heavy Renewable Output	Heavy NB Flow via the SONGS path

Load and Load Reduction Assumptions

Study Scenario	Baseline Cases					Sensitivity Cases				
	B1-19SP	B2-22SP	B3-27SP	B4-19LL	B5-22OP	S1-22SP HL-PS	S2-19SP PS	S3-27SP PS	S4-22SP HRPS	S5-22SP HNB
CEC Forecast Net Load (MW)	4753	4704	4555	1650	3031	5312	4960	5315	4704	
AAEE (MW)*	-151	-241	-401	-53	-158	-241	-151	-401	-241	
BTM-PV Load Reduction (MW)*	-327	-400	-574	0	-872	0	0	0	-400	
Demand Response (MW)**	-64	-64	-64	0	0	-64	-64	-64	-64	
LTPP Track-4 EE (MW)**	-22	-22	-22	-8	-15	-22	-22	-22	-22	
Gross Load (MW)*	5231	5345	5530	1703	4061	5553	5111	5716	5345	

Note: * Gross Load and load reduction of AAEE and DR were modeled in starting cases

** DR and LTPP Track-4 EE were modeled offline in starting cases

Generation Resources with 33% RPS

Study Scenario		Baseline Cases					Sensitivity Cases				
		B1-19SP	B2-22SP	B3-27SP	B4-19LL	B5-22OP	S1-22SP HL-PS	S2-19SP PS	S3-27SP PS	S4-22SP HRPS	S5-22SP HNB
Solar (MW)	Capacity	1373	1373	1373	1373	1373	1373	1373	1373	1373	1373
	Output	755	755	755	0	1112	0	0	0	1195	1195
Wind (MW)	Capacity	601	701	701	701	701	701	601	701	701	701
	Output	198	231	231	701	673	231	198	259	259	231
Storage (MW)	Capacity	98	124	124	124	124	124	98	124	124	124
	Dispatched	98	98	98	-98	0	98	98	98	98	98
Fuel-Fired (MW)	Capacity	3918	3918	3918	3918	3918	3918	3918	3918	3918	3918
	Dispatched	3113	2112	2753	676	3555	3541	3561	3359	1574	3745
Total in the SD-IV area (MW)	Capacity	5991	6117	6117	6117	6117	6117	5990	6117	6117	6117
	Output	4164	3196	3837	1279	5340	3870	3856	3716	3125	5268

Reliability Assessment Results Summary

- The assessment identified:
  - 5 branches 500/230 kV overloaded for P3/P6 outages
  - 9 branches 230 kV overloaded for P1/P2/P3/P4/P6/P7 outages
  - 2 SCE branches 220 kV overloaded for P6 outages
  - 2 tie branches 230 kV overloaded for P3/P6 outages, and
  - 1 potential high voltage at 500 kV substation for P1/P2/P4/P6
  - 0 transient instability

Reliability Assessment Results Summary - Cont'd

A list of reliability concerns identified in the baseline scenarios

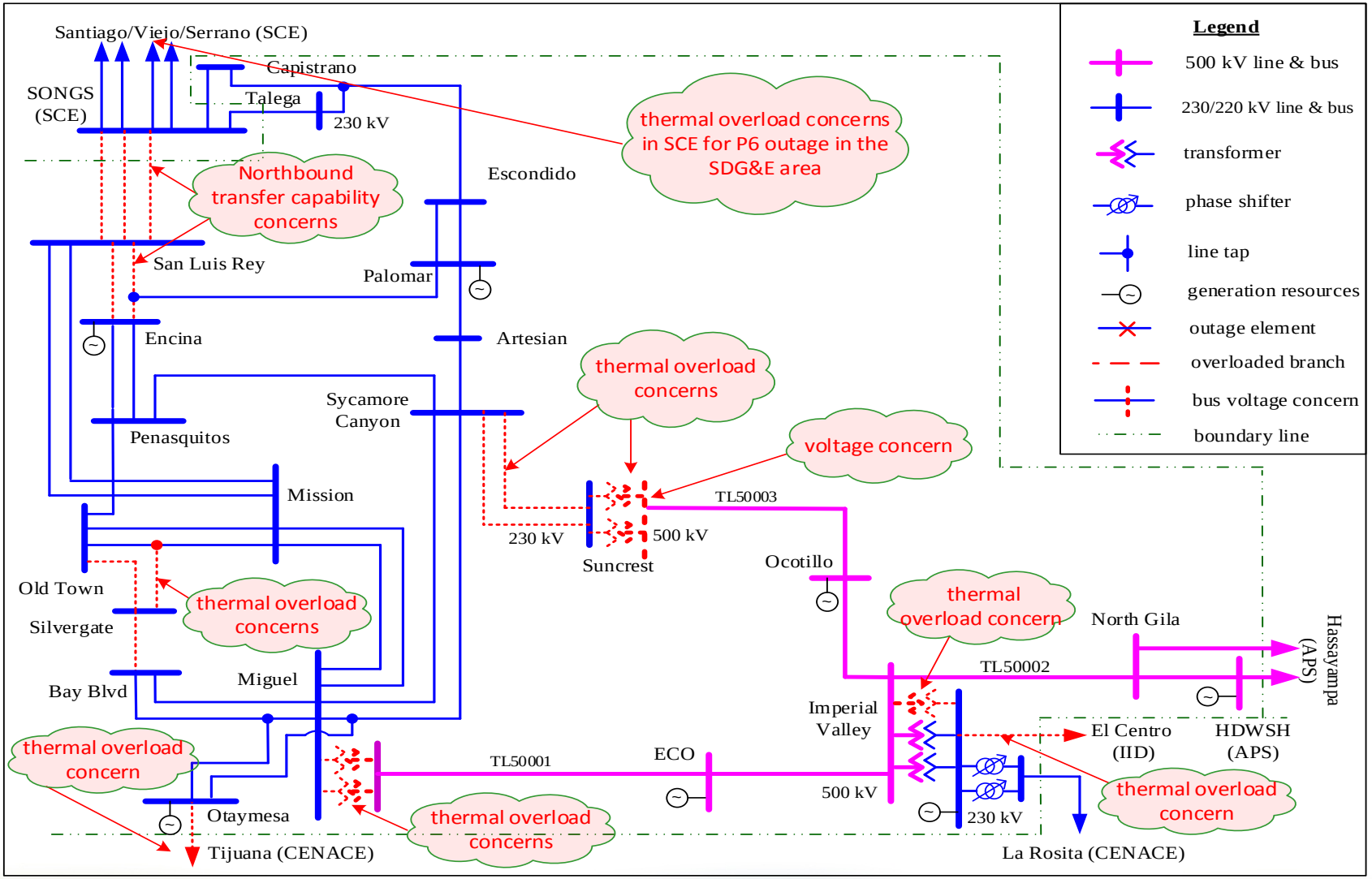
Reliability Concerns		Type of Concern	Baseline Cases				
			B1-19SP	B2-22SP	B3-27SP	B4-19LL	B5-22OP
No.01	San Luis Rey-SONGS 230 kV path	Overload					P2/P4/P6/P7
No.02	Encina-San Luis Rey 230 kV path	Overload					P1/P2/P4/P6/P7
No.03	Bay Blvd-Silvergate-OldTown 230 kV path	Overload	P6	P6			P4/P6
No.04	Miguel BK80 and BK81	Overload	P6	P6	P6		
No.05	Suncrest-Sycamore 230 kV path	Overload	P6	P6	P6		
No.06	Suncrest BK80 and BK81	Overload	P6	P6	P6		
No.07	Suncrest 500 kV bus	Voltage	P1/P2/P4/P6	P1/P2/P4/P6	P1/P2/P4/P6	P1/P2/P4/P6	P1/P2/P4/P6
No.08	Imperial Valley BK80	Overload	P6	P6	P6		P6
No.09	SCE's the Ellis south 220 kV corridor	Overload		P6			
No.10	Otay Mesa-Tijuana 230 kV tie	Overload	P6	P6			
No.11	Imperial Valley-El Centro 230 kV tie	Overload	P3/P6	P3/P6	P6		

Reliability Assessment Results Summary - Cont'd

A list of reliability concerns identified in the sensitivity scenarios, which will be reviewed case-by-case

Reliability Concerns		Type of Concern	Sensitivity Cases				
			S1-22SP HL-PS	S2-19SP PS	S3-27SP PS	S4-22SP HRPS	S5-22SP HNB
No.01	San Luis Rey-SONGS 230 kV path	Overload					
No.02	Encina-San Luis Rey 230 kV path	Overload					P1/P2/P4/P6
No.03	Bay Blvd-Silvergate-OldTown 230 kV path	Overload	P6	P6			P6
No.04	Miguel BK80 and BK81	Overload	P6	P6	P6	P6	P6
No.05	Suncrest-Sycamore 230 kV path	Overload	P6	P6	P6	P6	P6
No.06	Suncrest BK80 and BK81	Overload	P6	P6	P6	P6	P6
No.07	Suncrest 500 kV bus	Voltage	P1/P2/P4/P6	P1/P2/P4/P6	P1/P2/P4/P6	P1/P2/P4/P6	P1/P2/P4/P6
No.08	Imperial Valley BK80	Overload	P6	P6	P6	P6	P6
No.09	SCE's the Ellis south 220 kV corridor	Overload	P6		P6	P6	
No.10	Otay Mesa-Tijuana 230 kV tie	Overload				P6	P6
No.11	Imperial Valley-El Centro 230 kV tie	Overload	P3/P6	P3/P6	P3	P3/P6	

Reliability Assessment Results Summary - Cont'd



Reliability Assessment Results Summary - Cont'd

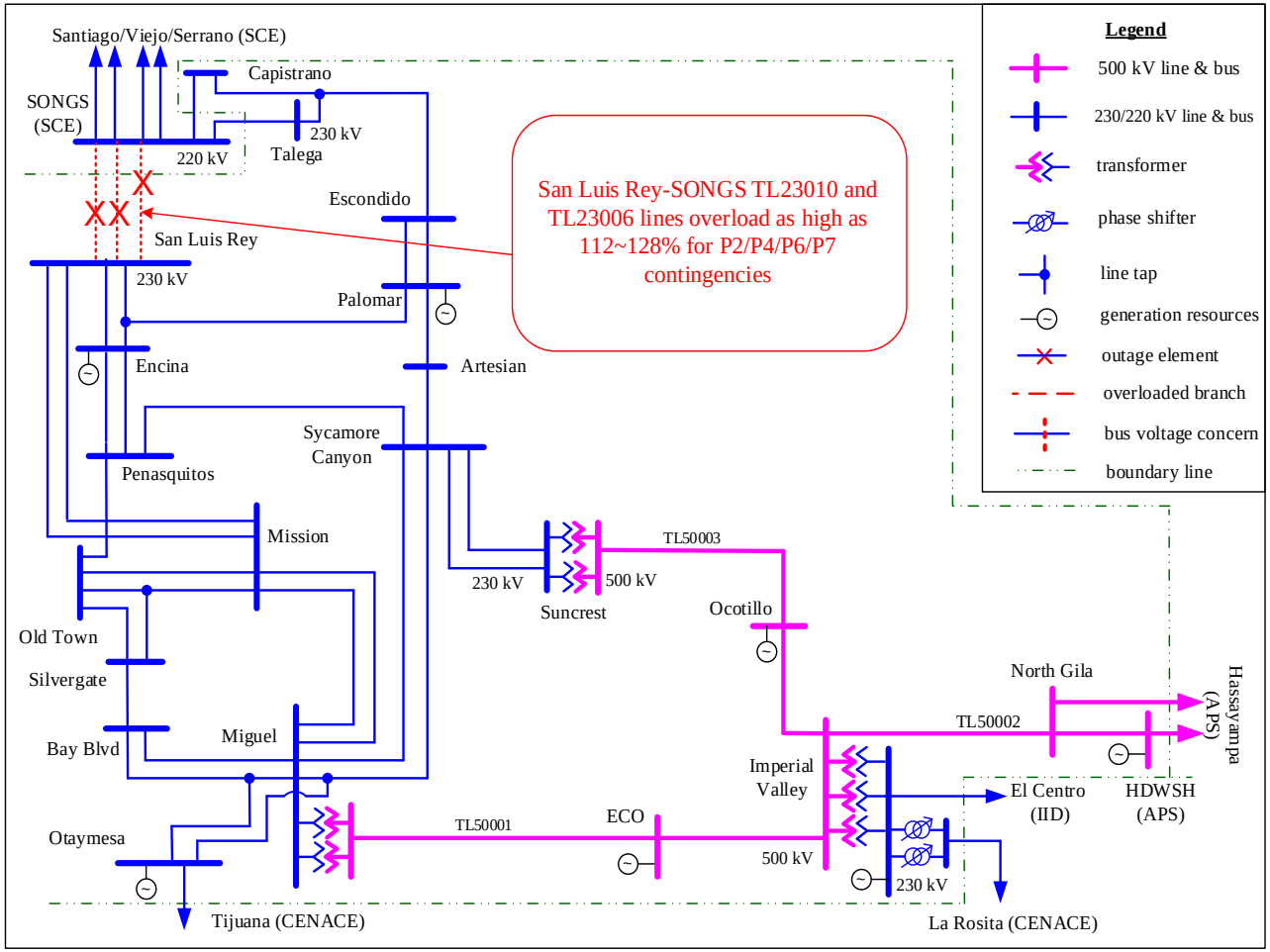
- Compared to last year results:
  - The Encina-San Luis Rey 230 kV overloads become more severe due to scope change of the SX-PQ project
  - The need for previously approved Mission-Penasquitos project was not identified due to scope change of the SX-PQ project
  - The CEC peak-shift load forecast was investigated as sensitivity scenario

Potential Mitigation Solutions Summary

- rely on operation procedure (OP)
- implement special protection system (SPS) as needed
- depend on short-time emergency rating if feasible
- suggest favored areas to procure preferred resources & energy storage
- develop cost-effective solutions as needed in the Encina-San Luis Rey 230/69 kV and the southern systems, such as system reconfiguration, reconductor, line compensation, and/or installation of flow controller
- develop 30-minute emergency rating for Suncrest 500/230 kV banks
- coordinate control schemes of the reactive power facilities at Suncrest

Detailed Discussions on the Identified Reliability Concerns and Potential Mitigation Solutions

Thermal Overload Concern – (No.1)



San Luis Rey-SONGS 230 kV Path

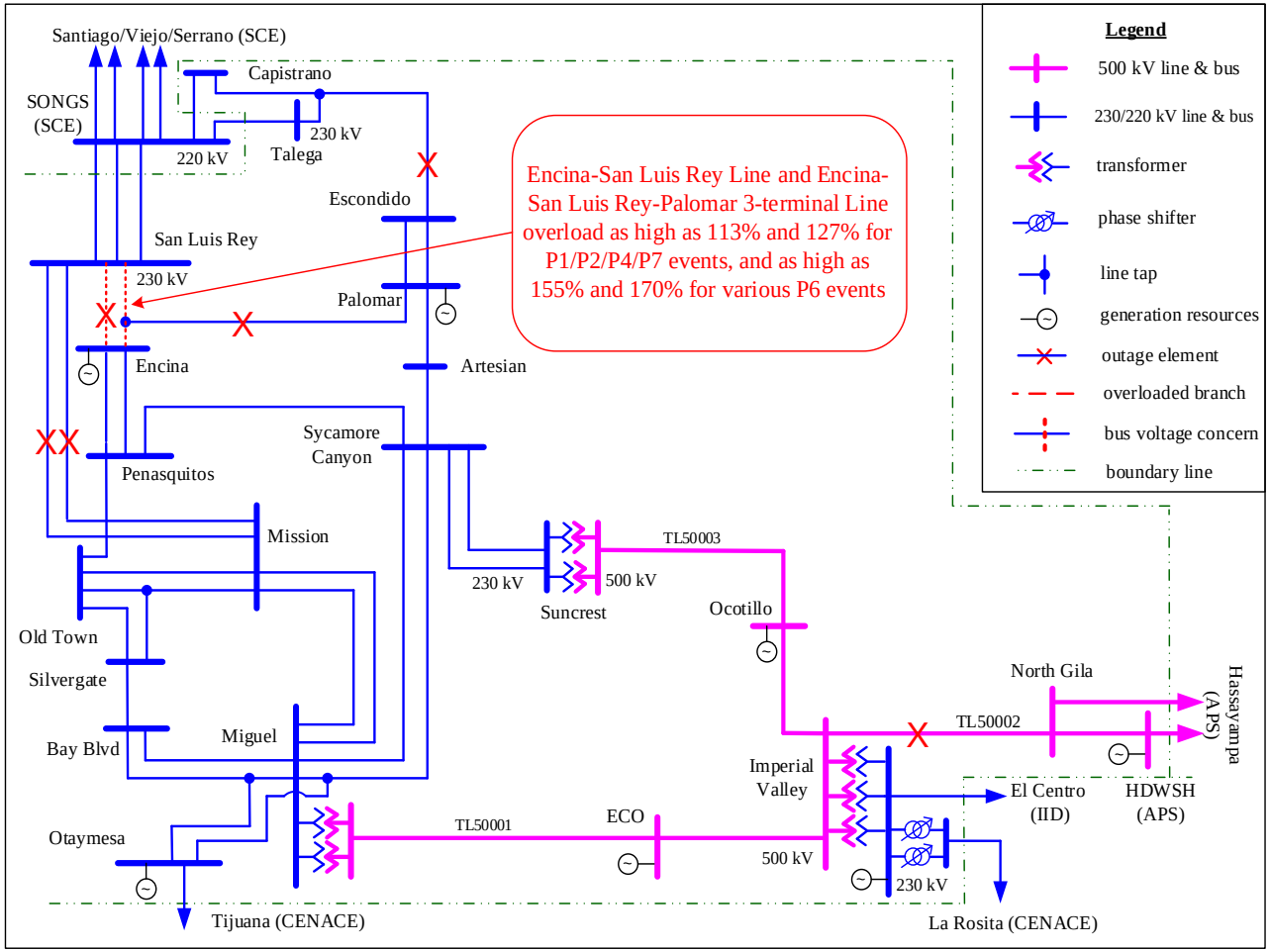
Thermal Overload

- for various P2/P4/P6/P7 contingencies in the off-peak case

Potential Mitigation

- OP to eliminate the P6 concerns
- SPS shedding Carlsbad units
- re-configuring system, compensating line, and/or reconductoring

Thermal Overload Concern – (No.2)



Encina-San Luis Rey 230 kV Path

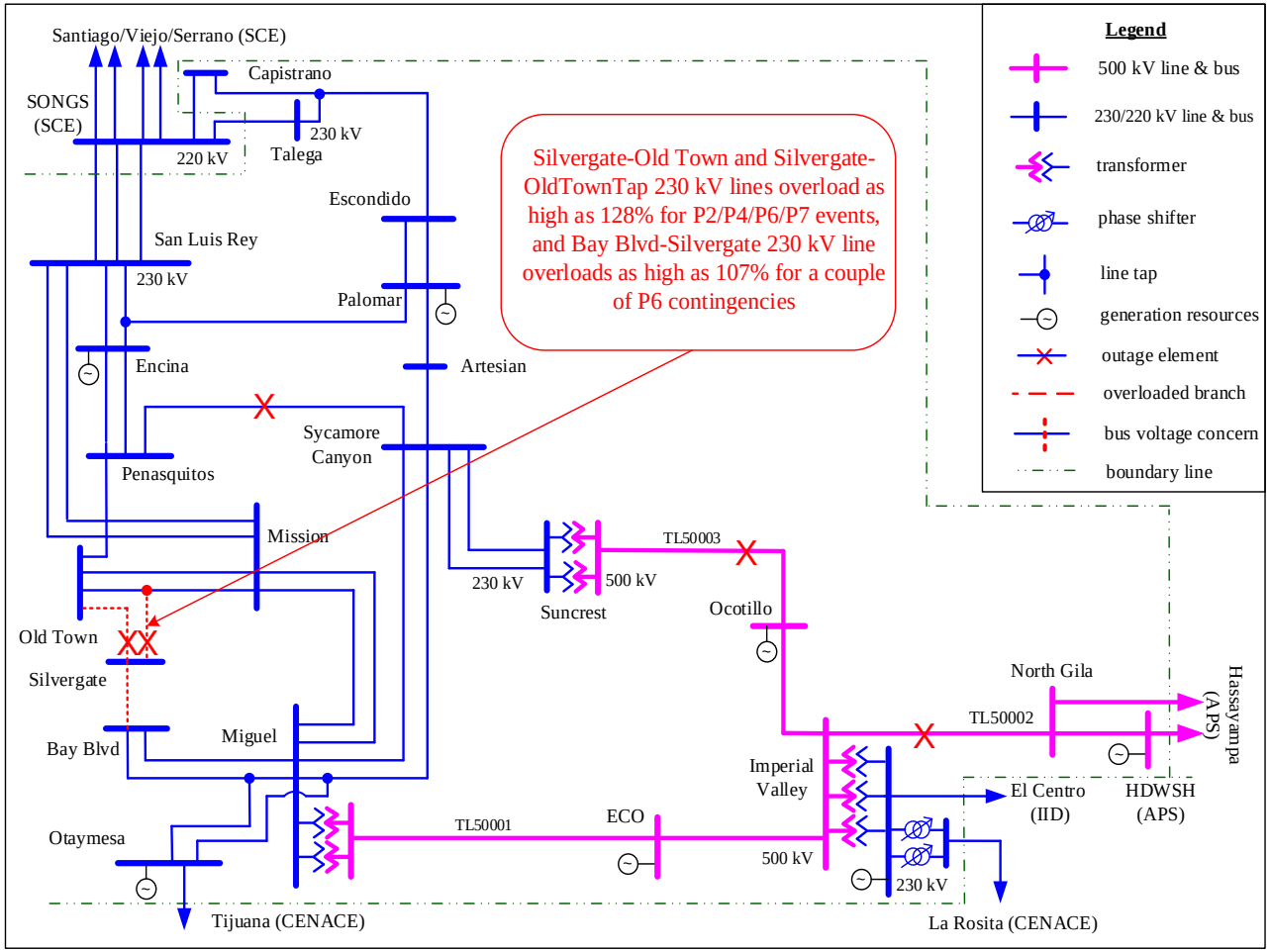
Thermal Overload

- for various P1/P2/P4/P6/P7 contingencies in the off-peak case

Potential Mitigation

- OP to eliminate the P6 concerns
- SPS shedding Carlsbad units
- reconfiguring system, compensating line, and/or reconductoring

Thermal Overload Concern – (No.3)



Old Town-Silvergate-Bay Blvd 230 kV path

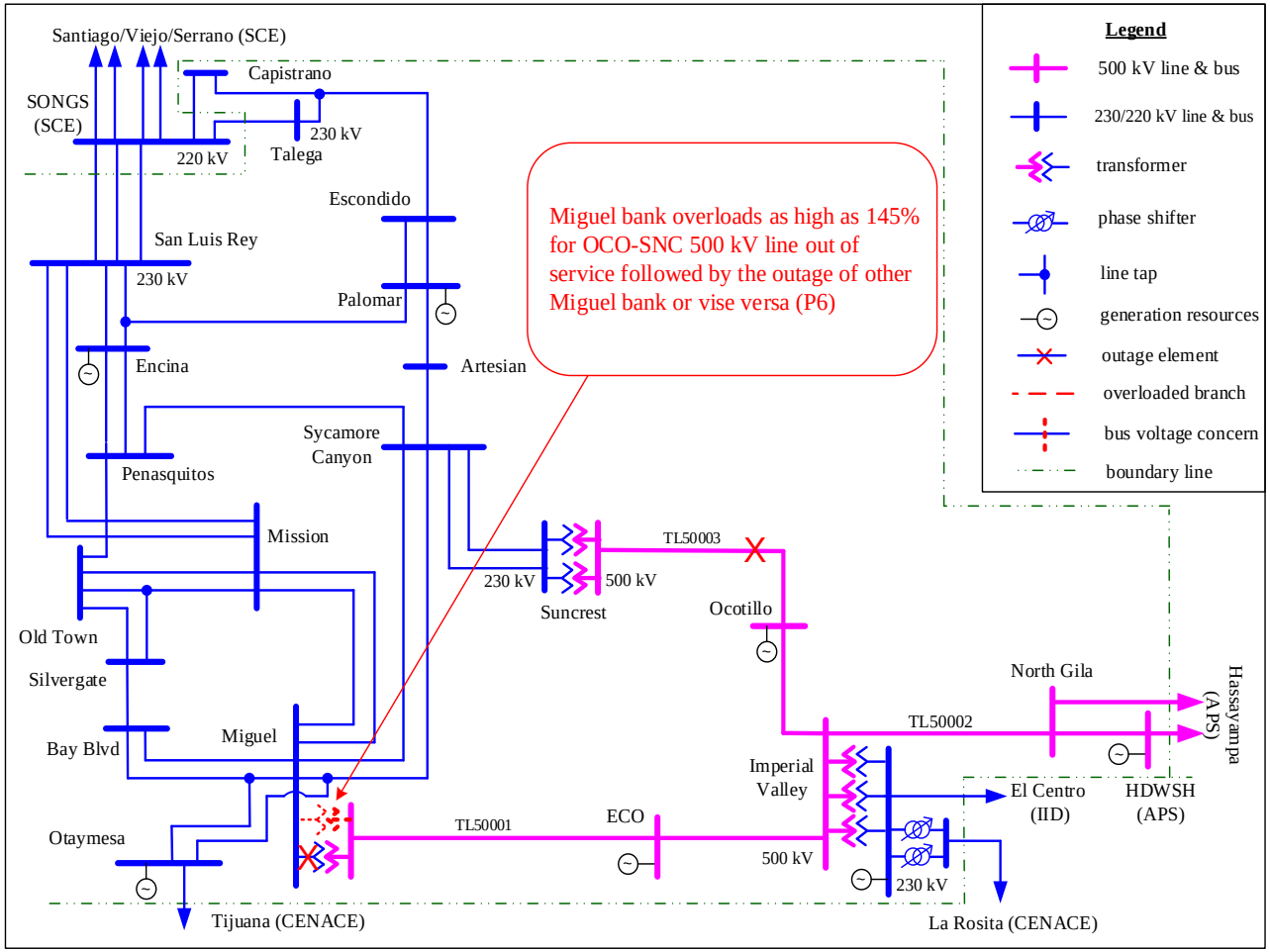
Thermal Overload

- for P2/P4/P6 contingencies (2019)

Potential Mitigation

- Procure PR and ES up to 160 MW in the north coast
- OP to eliminate the P6 concerns
- reconfiguring system, reconductoring, compensating line, and/or installing power flow controller

Thermal Overload Concern – (No.4)



Miguel BK80 and BK81

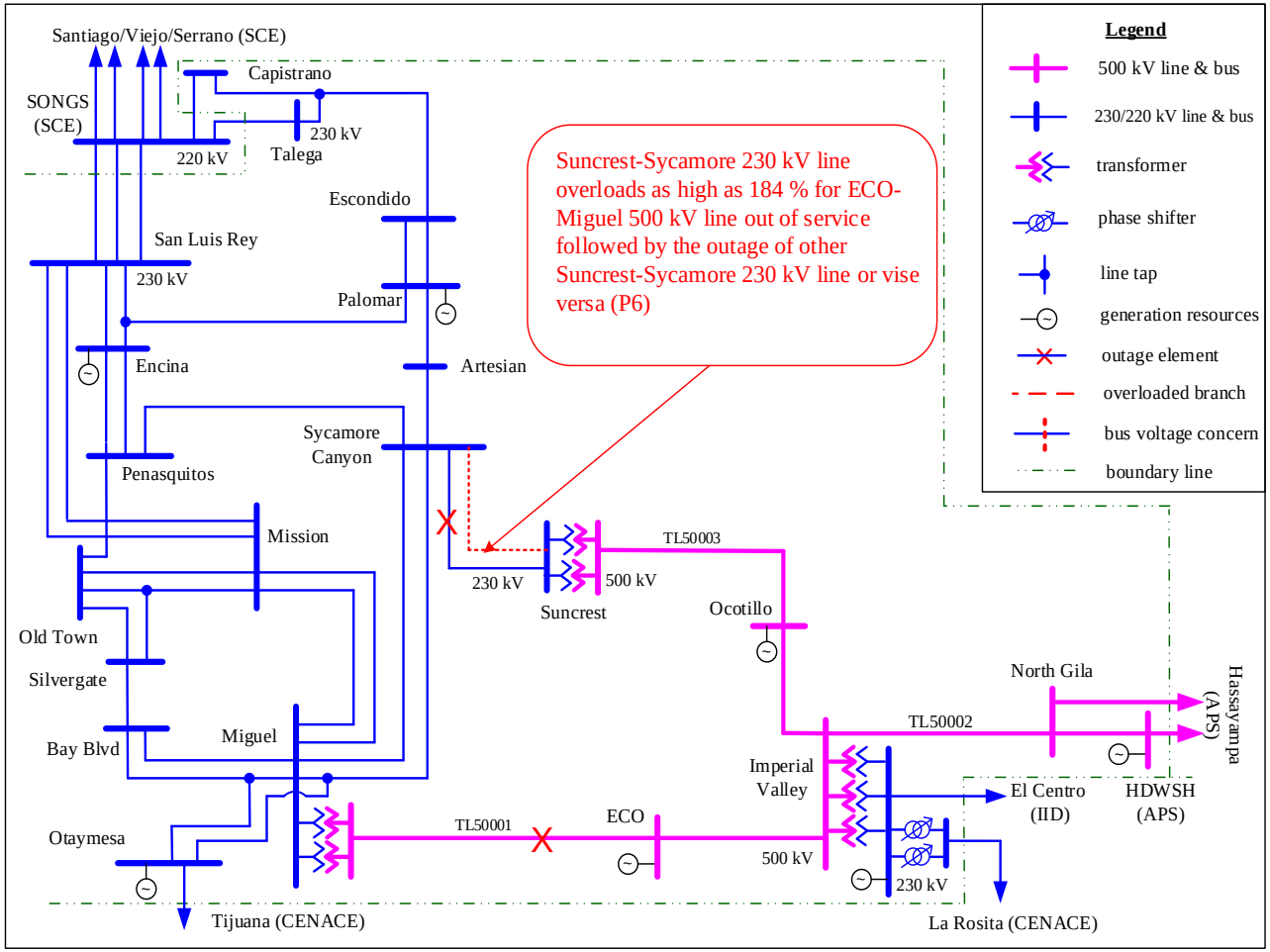
Thermal Overload

- For P6 contingencies (2019)

Potential Mitigations

- Modify existing Miguel bank SPS to open TL50001 as needed when TL50003 is out of service
- Implement OP to shed gen and to open TL50001 as needed when any of the banks is out of service
- Procure PR and ES up to 300 MW in the San Diego area

Thermal Overload Concern – (No.5)



Sycamore-Suncrest 230 kV lines

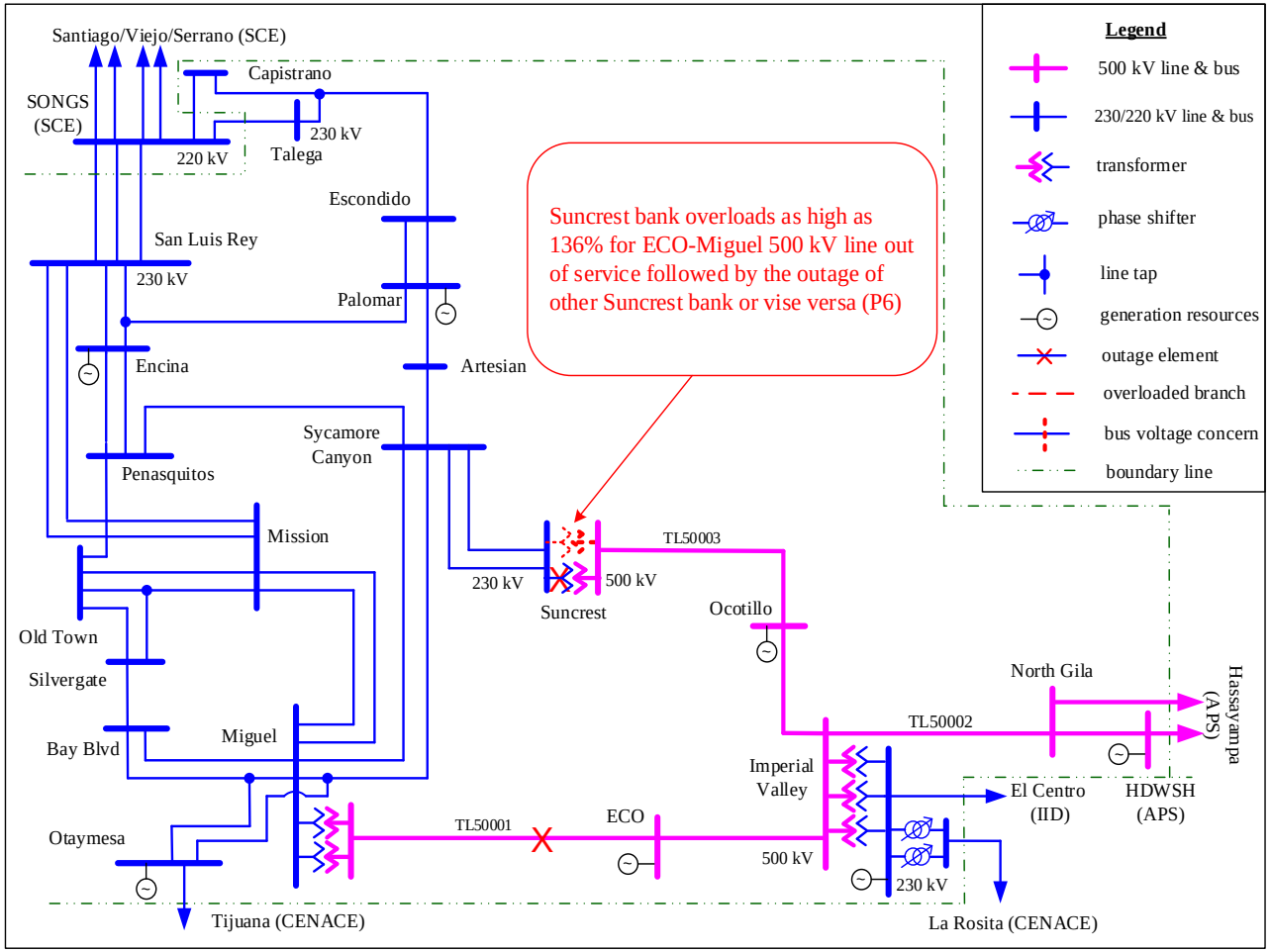
Thermal Overload

- for P6 contingencies (2019)

Potential Mitigation

- Add SPS to shed gen and to open TL50003 as needed when TL50001 is out of service first
- Implement OP to shed gen and to open TL50003 as needed when any of the 230 kV lines is out of service first
- Procure PR and ES up to 500 MW in San Diego
- Upgrade the 230 kV system

Thermal Overload Concern – (No.6)



Suncrest BK80 and BK81

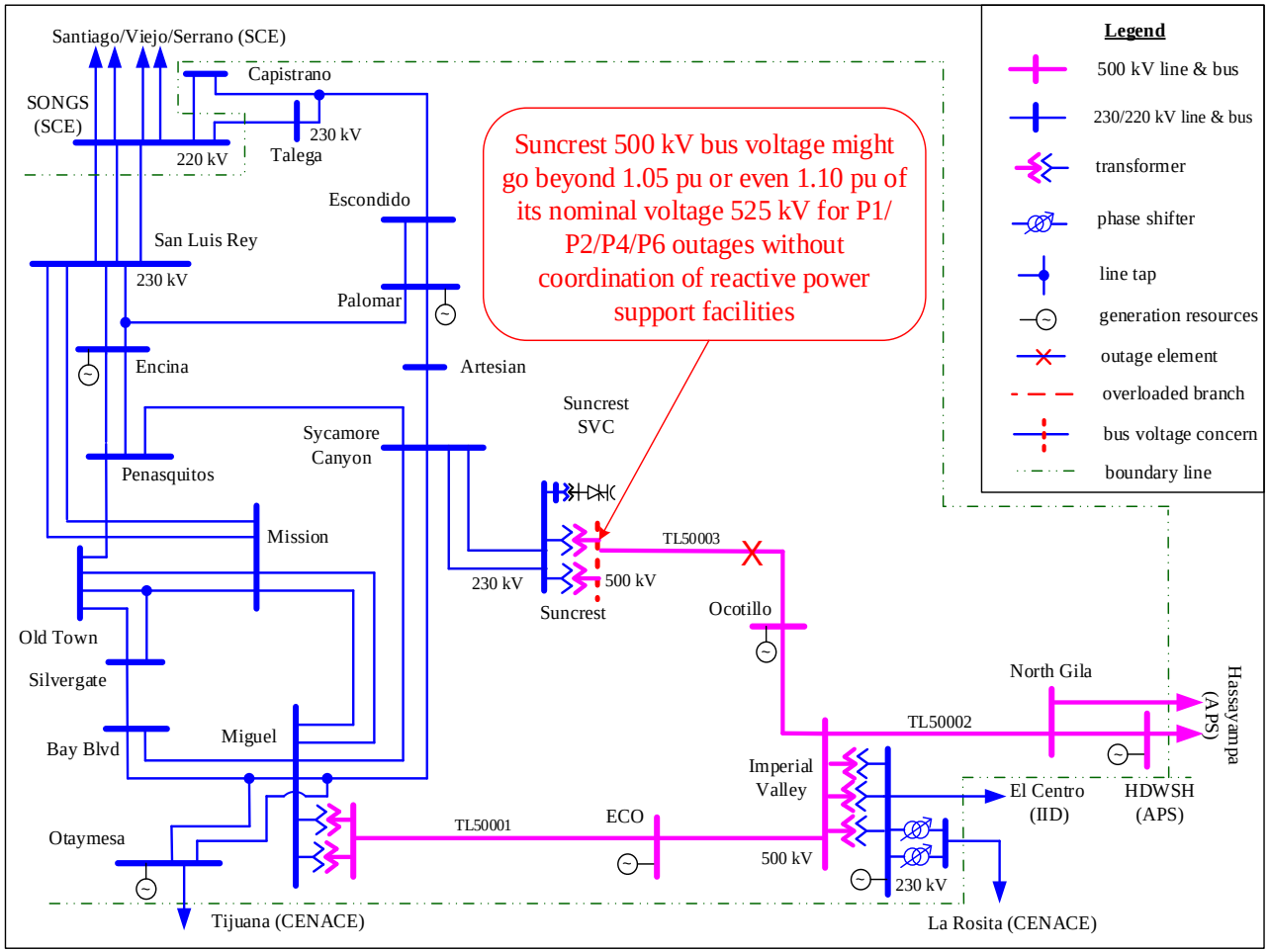
Thermal Overload

- For P6 contingencies (2019)

Potential Mitigations

- Develop 30-minute emergency ratings for the banks by upgrading their line drops

Voltage Concern – (No.7)



Suncrest 500 kV Bus

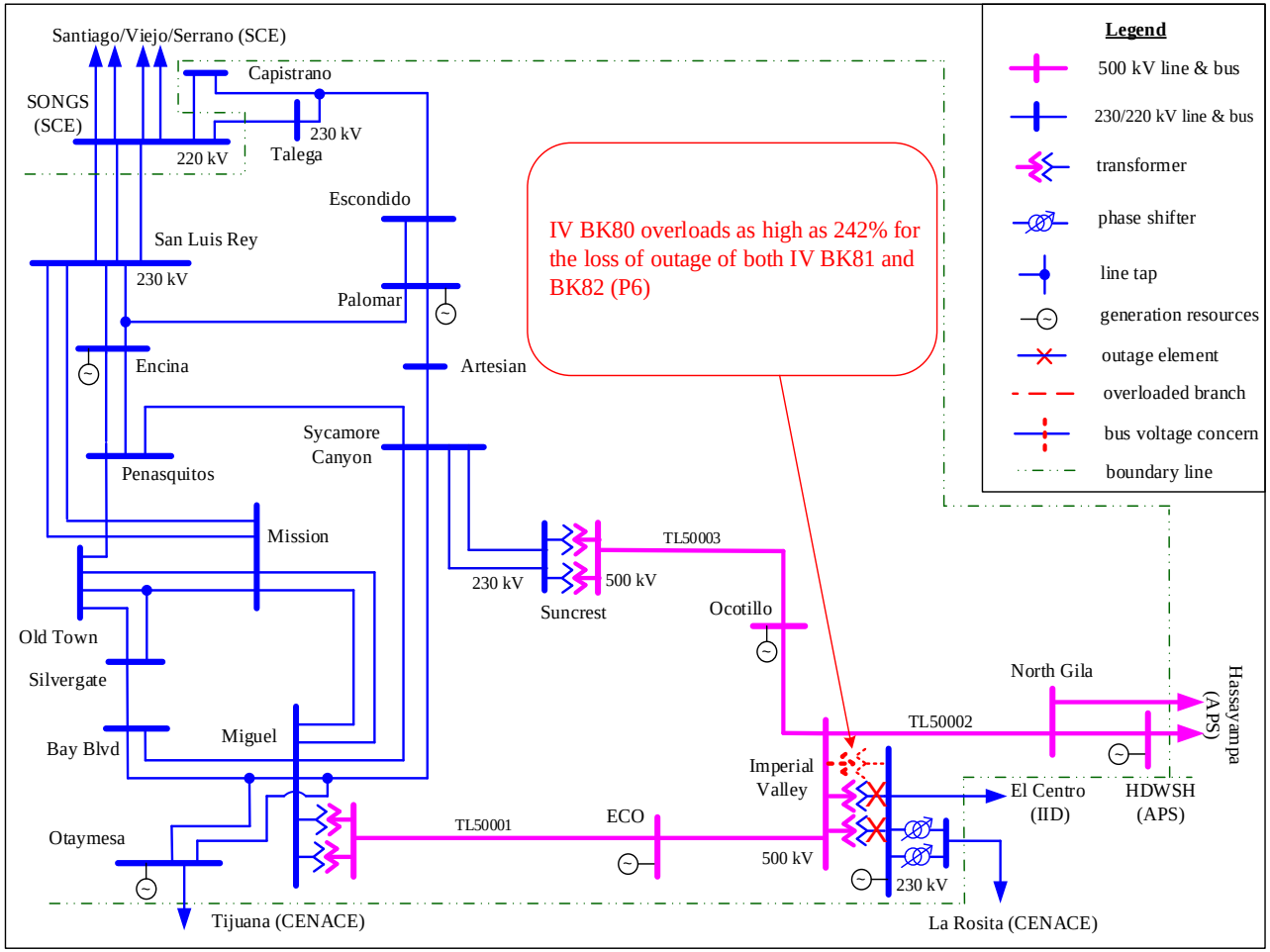
Potential High Voltage

- for P1/P2/P4/P6 contingencies if the reactive power facilities are not well coordinated

Potential Mitigation

- implement a coordinated control scheme of the reactive power facilities

Thermal Overload Concern – (No.8)



Imperial Valley BK80

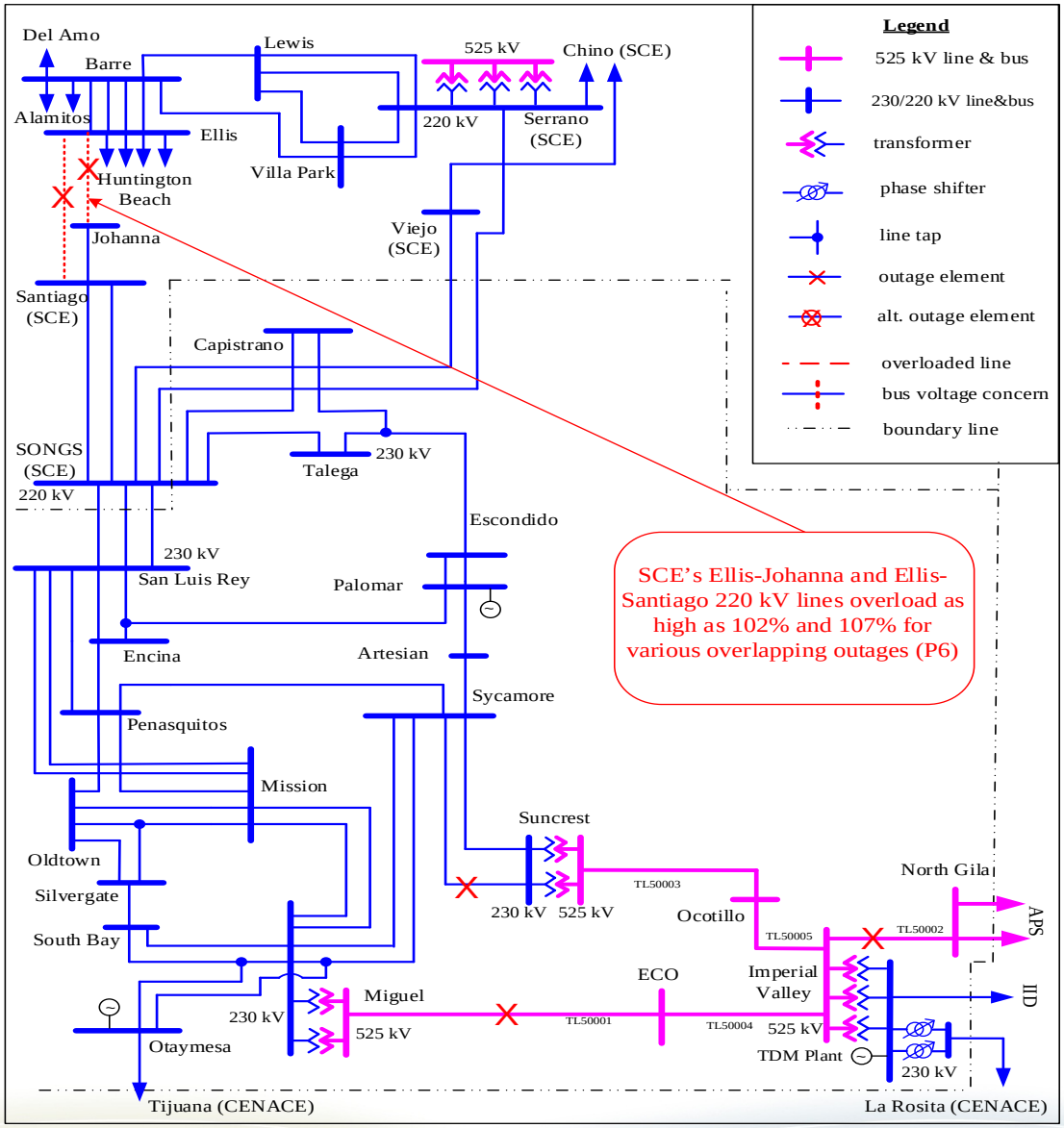
Thermal Overload

- For P6 contingency (T-1-1)

Potential Mitigation

- Maintenance program to upgrade added and non-standard IV BK80 and modify existing IV BK80 SPS accordingly

Thermal Overload - (No.9)



SCE's Ellis-Johanna and Ellis-Santiago 220 kV lines

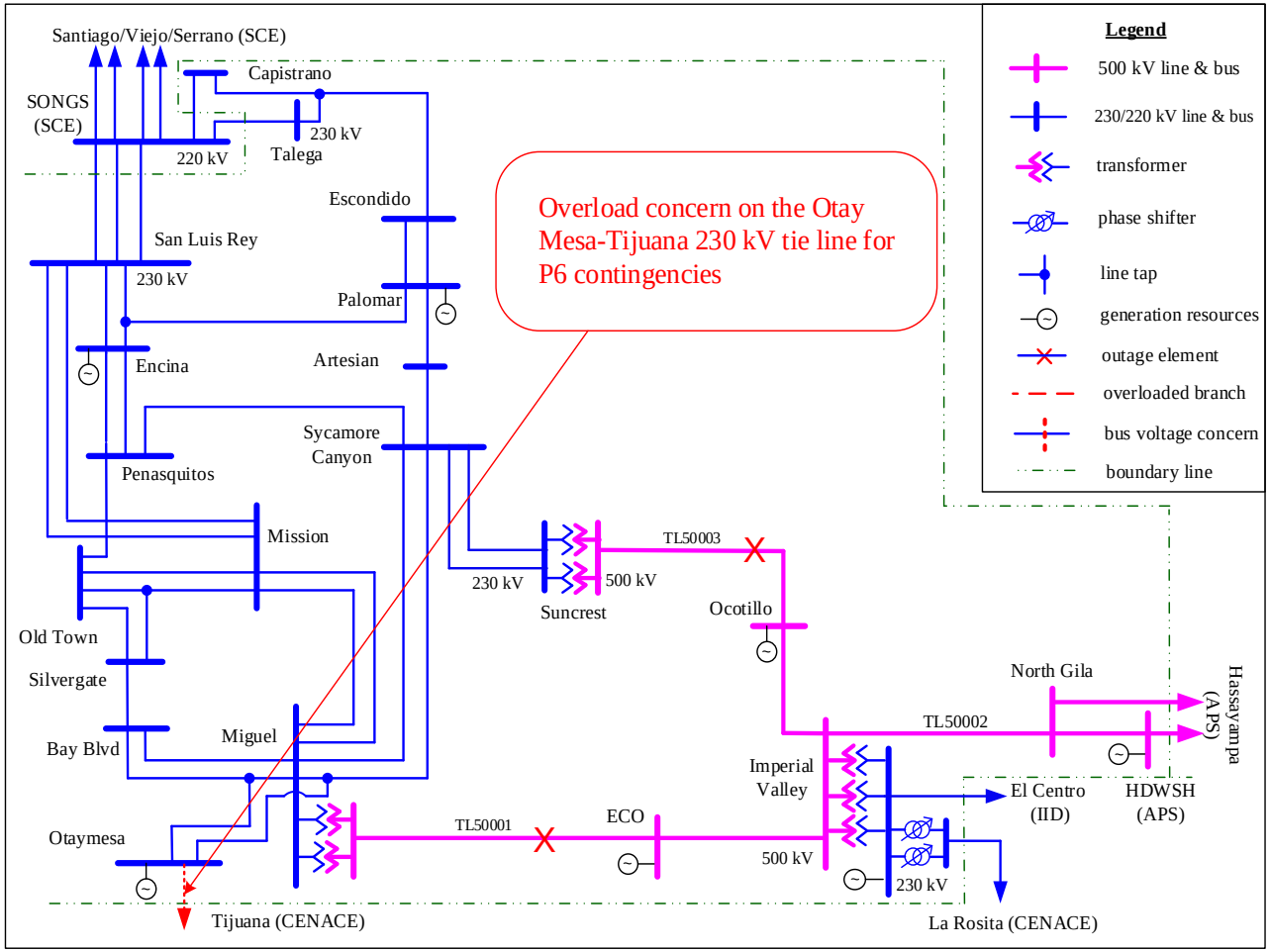
Thermal Overload

- for P3 contingencies

Potential Mitigation

- rely on the ISO market congestion management and operation procedure
- Procure PR and ES up to 250 MW in San Diego and Orange counties
- Upgrade the Ellis 220 kV south corridor

Thermal Overload Concern – (No.10)



Otay Mesa-Tijuana 230 kV tie line

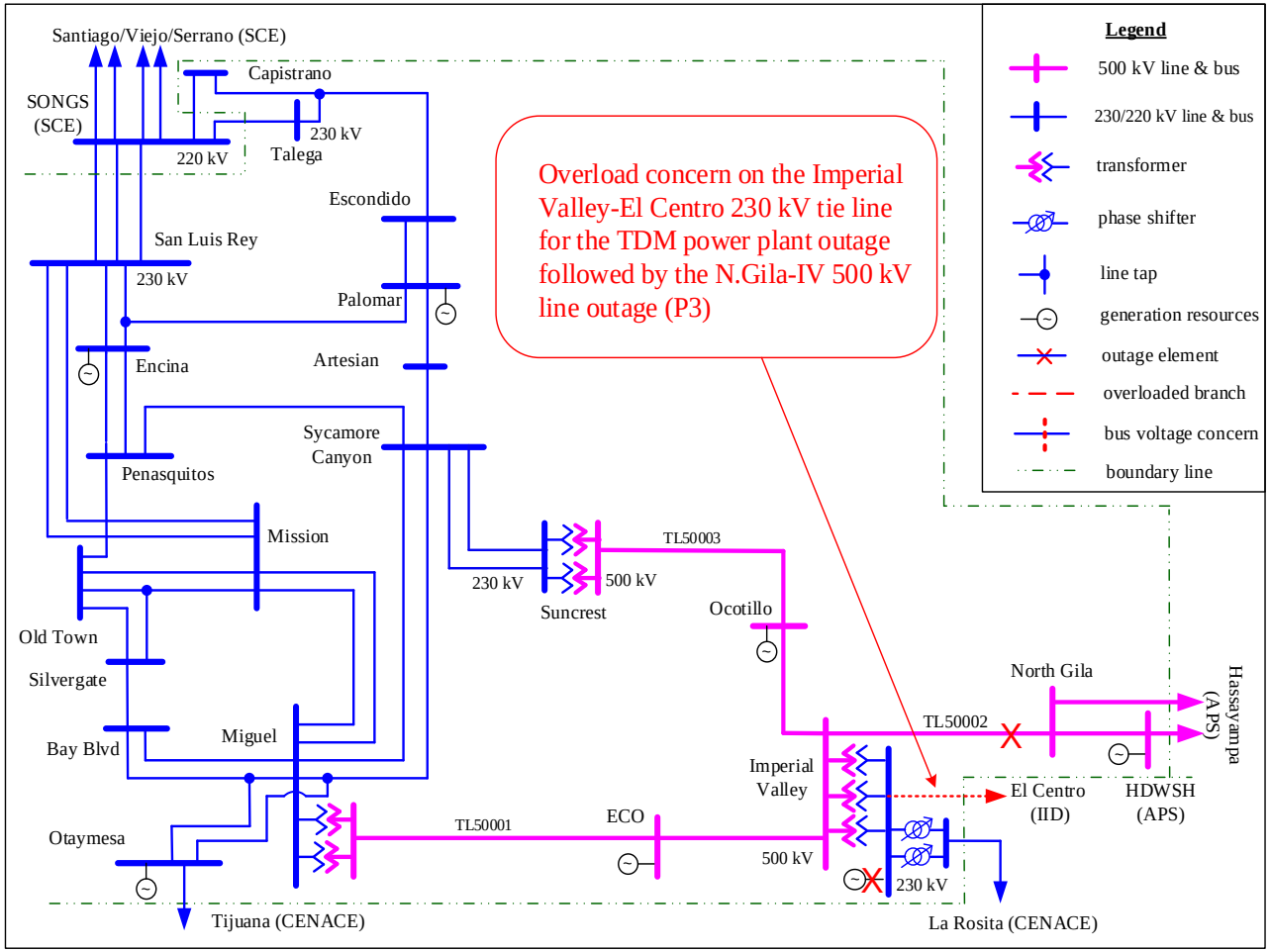
Thermal Overload

- for P6 contingencies

Potential Mitigation

- rely on the ISO market congestion management and operation procedure
- modify existing SPS adjusting phase angle of IV-PST after first level contingency

Thermal Overload Concern – (No.11)



Imperial Valley-El Centro 230 kV tie line

Thermal Overload

- for P3 contingencies

Potential Mitigation

- rely on the ISO market congestion management and operation procedure

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

Charles Cheung
Senior Regional Transmission Engineer

2017-2018 Transmission Planning Process Stakeholder Meeting
September 21-22, 2017

Study Scenarios

- 5 Baseline Scenarios:
  - 2019 Summer Peak
  - 2022 Summer Peak
  - 2027 Summer Peak
  - 2019 Spring Light Load
  - 2022 Spring Off-Peak

- 3 Sensitivity Scenarios:
  - 2019 Summer Peak with CEC peak-shift
  - 2022 Summer Peak with high CEC forecasted load and peak shift
  - 2027 Summer Peak with CEC peak-shift

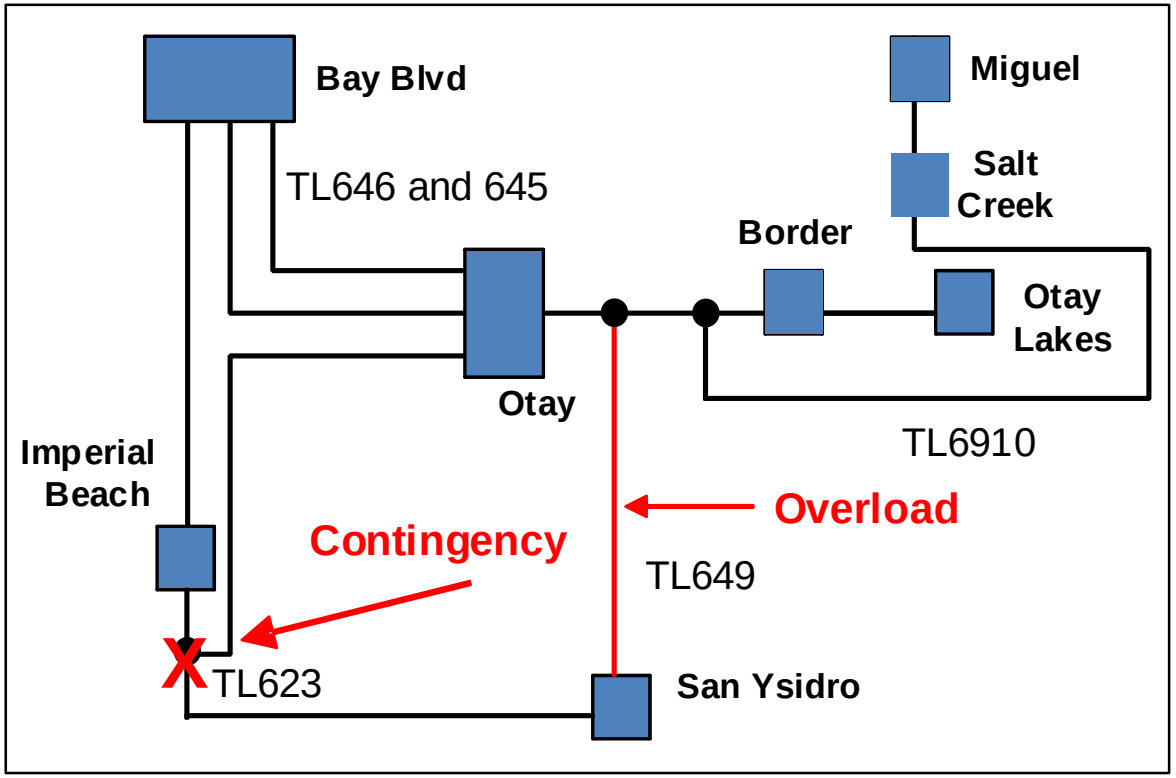
SDG&E Area Sub-Transmission Assessment Summary

- The assessment identified:
  - Thermal overloads due to Category P2.1 – 2, P3 – 4, P4 – 6, P6 – 43 and P7 – 9
- Compared to last year results:
  - More thermal violations in the Peak Shift scenarios

SDG&E Area Sub-Transmission Mitigation

- Potential Mitigation Solutions:
  - Network upgrades to address sub-transmission Category P1, P2.1, P6, and P7 issues
  - Operation Procedure, SPS

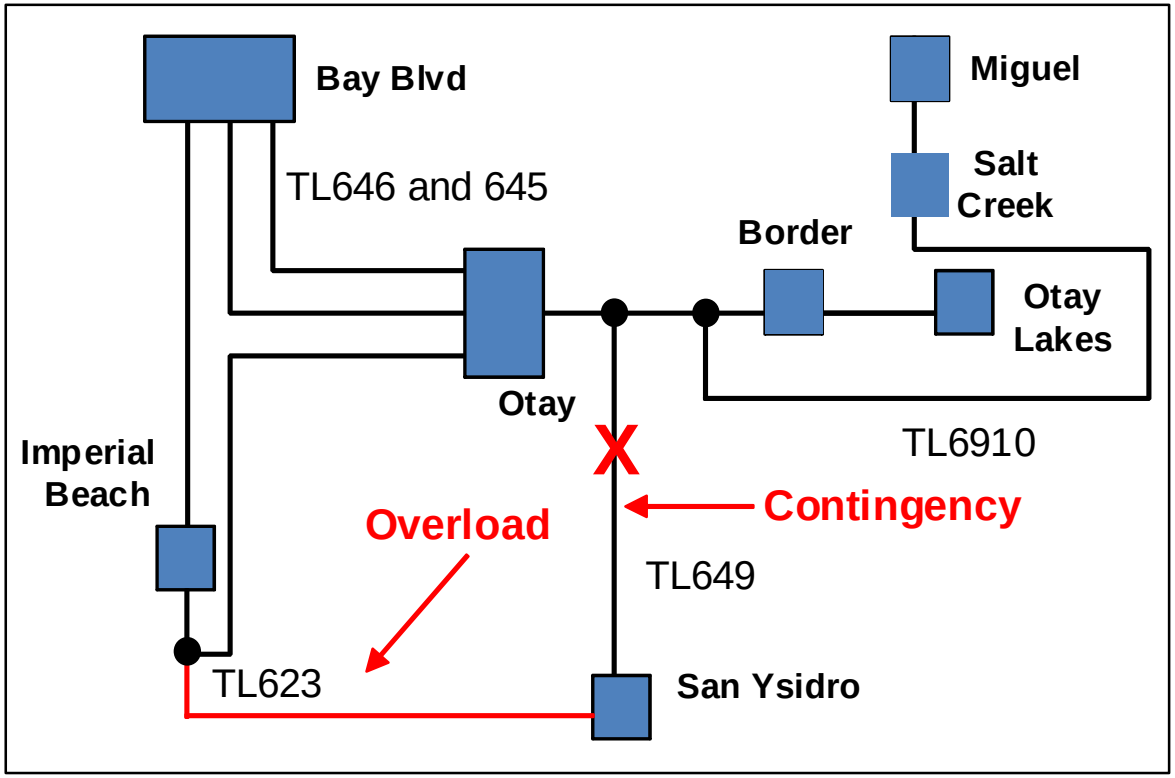
Category P1/P2.1 Thermal Violation (1)



Otay Lake Tap – San Ysidro 69 kV

- Thermal overload
  - TL649D overload at 100% for N-1 outage of TL623 with Peak Load at San Ysidro (All Peak cases)
- Potential Mitigation
  - Network Upgrade
  - 5-10 MW of 4-hour Preferred resources at San Ysidro

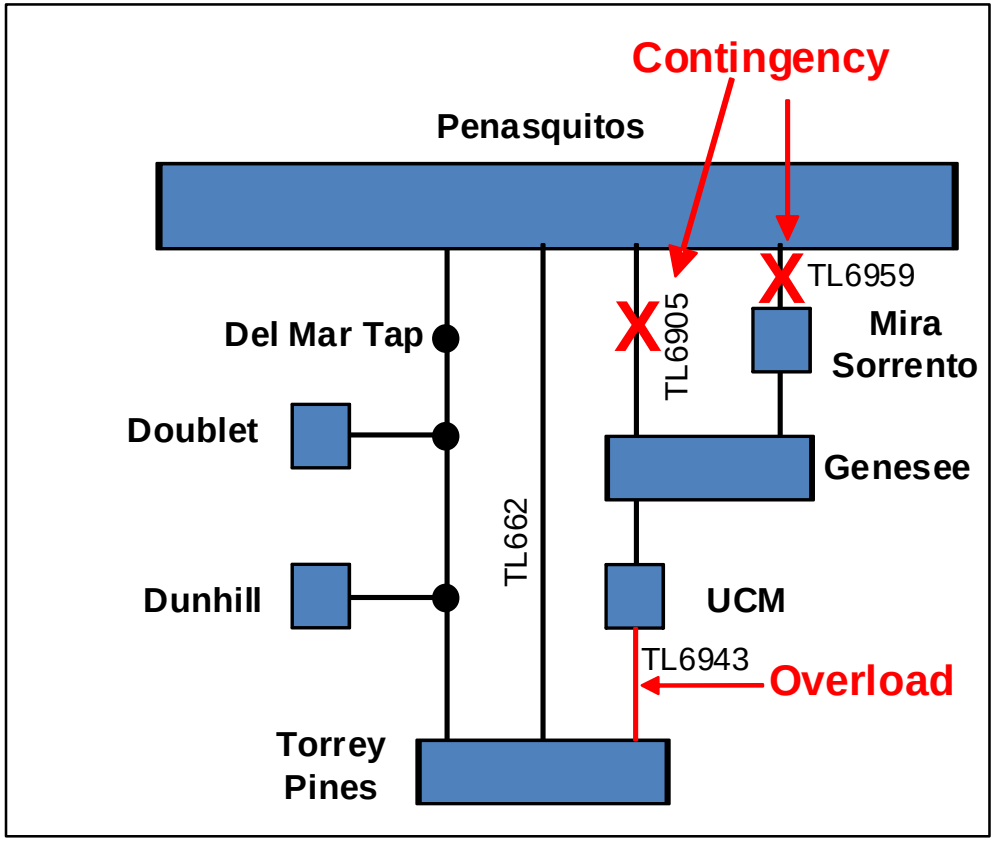
Category P1/P2.1 Thermal Violation (2)



Otay Tap – San Ysidro 69 kV

- Thermal overload
  - TL623C overload at 100% for N-1 outage of TL649 with Peak Load at San Ysidro (All Peak cases)
- Potential Mitigation
  - Network Upgrade
  - 5-10 MW of 4-hour Preferred resources at San Ysidro

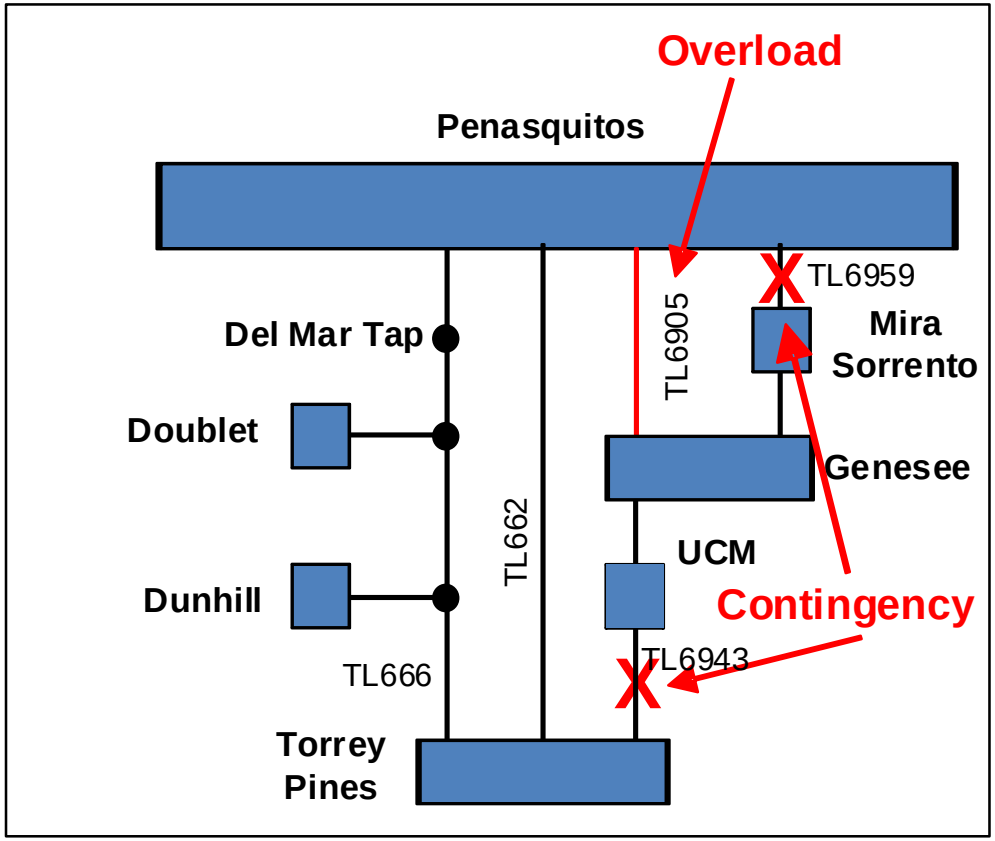
Category P6 Thermal Violation (1)



Penasquitos/Doublet/Dunhill/Torrey Pines/UCM/Genesee area 69 kV

- Thermal overload
  - TL6943 overload for N-1-1 outage of TL6959 and TL6905 in all Peak Base (122%) and Peak Shift (140%) cases
- Potential Mitigation
  - Network Upgrade (Add a new line PQ-UCM)
  - Loading shedding RAS

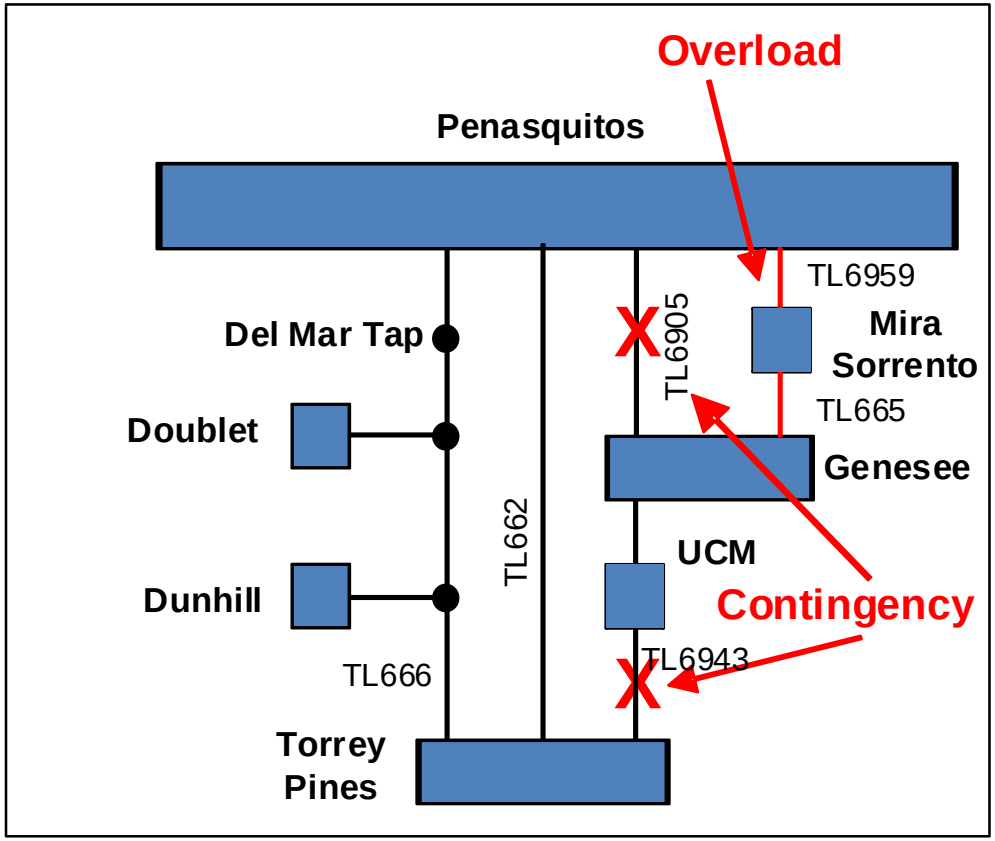
Category P6 Thermal Violation (2)



Penasquitos/Doublet/Dunhill/Torrey Pines/UCM/Genesee area 69 kV

- Thermal overload
  - TL6905 overload for N-1-1 outage of TL6959 and TL6943 in all Peak Base (117%) and Peak Shift (134%) cases
- Potential Mitigation
  - Network Upgrade (Add a new line PQ-UCM)
  - Loading shedding RAS

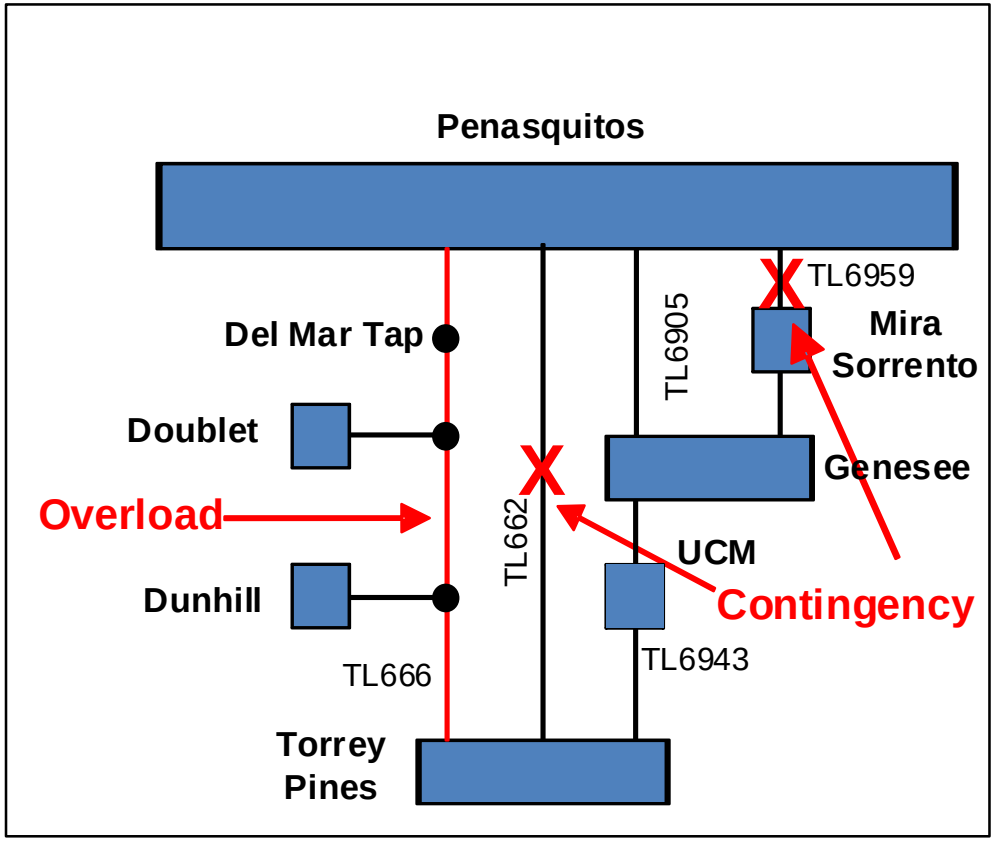
Category P6 Thermal Violation (3)



Penasquitos/Doublet/Dunhill/Torrey Pines/UCM/Genesee area 69 kV

- Thermal overload
  - TL6959 overload for N-1-1 outage of TL6905 and TL6943 in all Peak Base (116%) and Peak Shift (133%) cases, TL665 overload for 2022 (109%) and 2027 (110%) Peak Shift cases
- Potential Mitigation
  - Network Upgrade (Add a new line PQ-UCM)
  - Loading shedding RAS

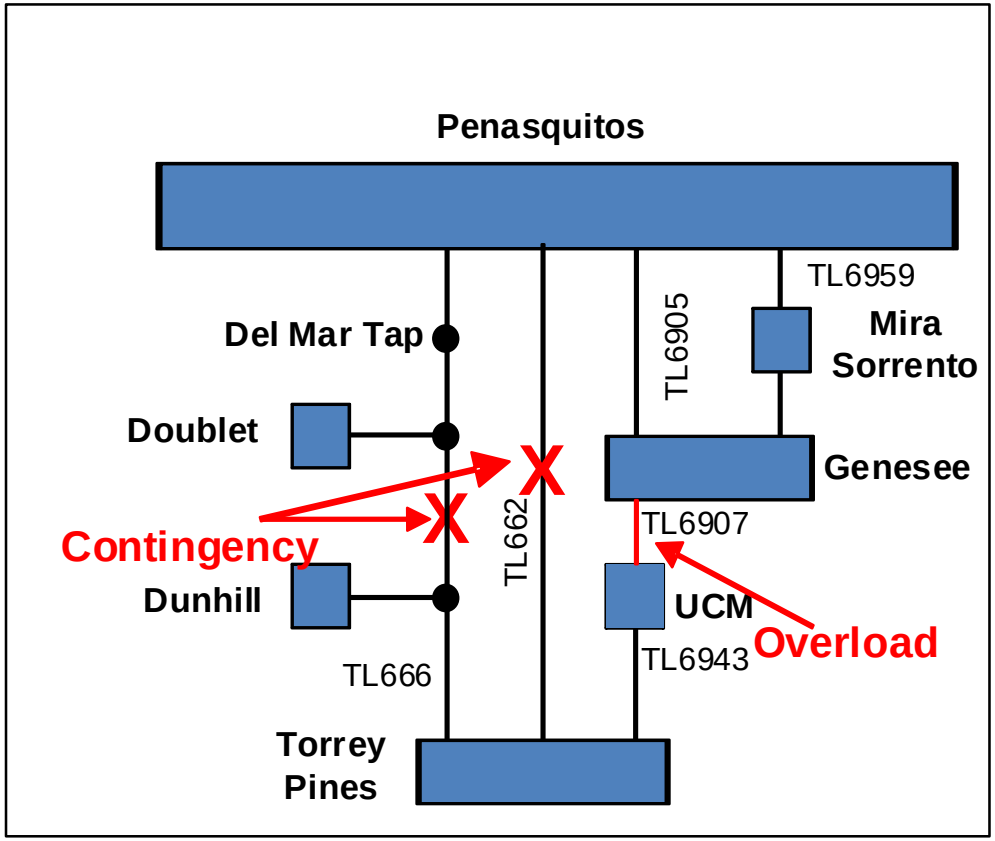
Category P6 Thermal Violation (4)



Penasquitos/Doublet/Dunhill/Torrey Pines/UCM/Genesee area 69 kV

- Thermal overload
  - TL666A, TL666B, TL666C, and TL666G overload for N-1-1 outage of TL6995 and TL662 in All Peak Shift cases (114%)
- Potential Mitigation
  - Network Upgrade (Add a new line PQ-UCM)
  - Loading shedding RAS

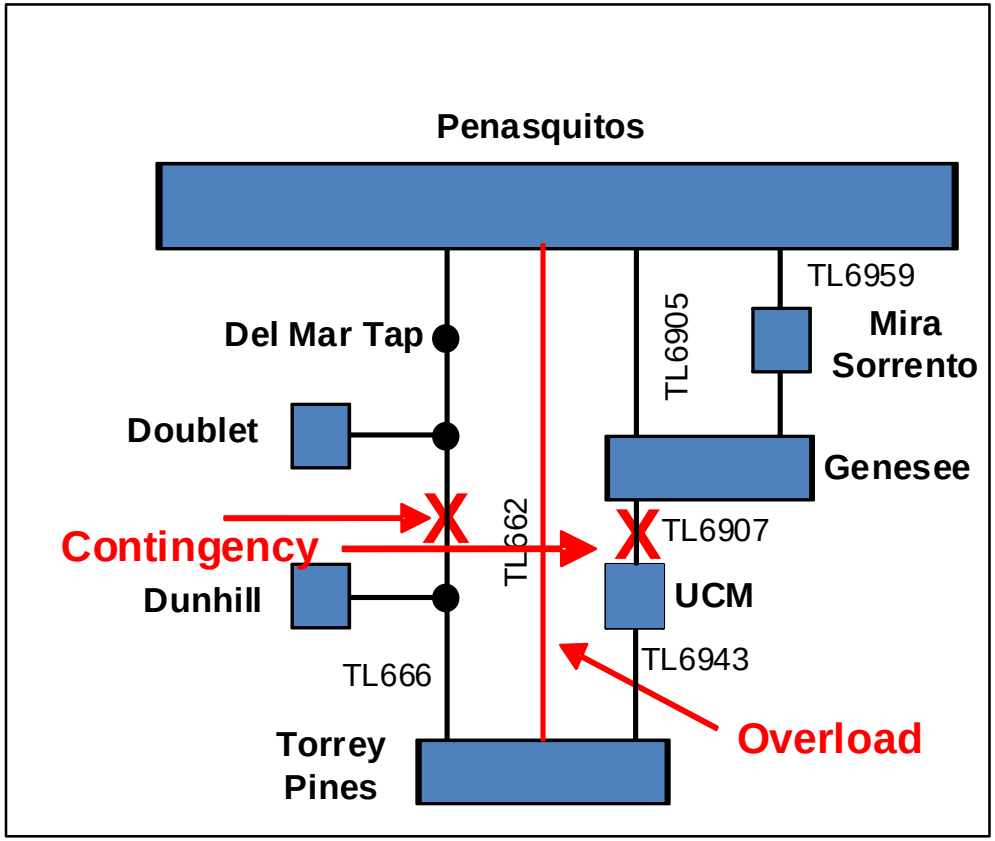
Category P6 Thermal Violation (5)



Penasquitos/Doublet/Dunhill/Torrey Pines/UCM/Genesee area 69 kV

- Thermal overload
  - TL6907 overload for N-1-1 outage of TL666 and TL662 in 2022 and 2027 Peak Shift cases (108%)
- Potential Mitigation
  - Network Upgrade (Add a new line PQ-UCM)
  - Loading shedding RAS

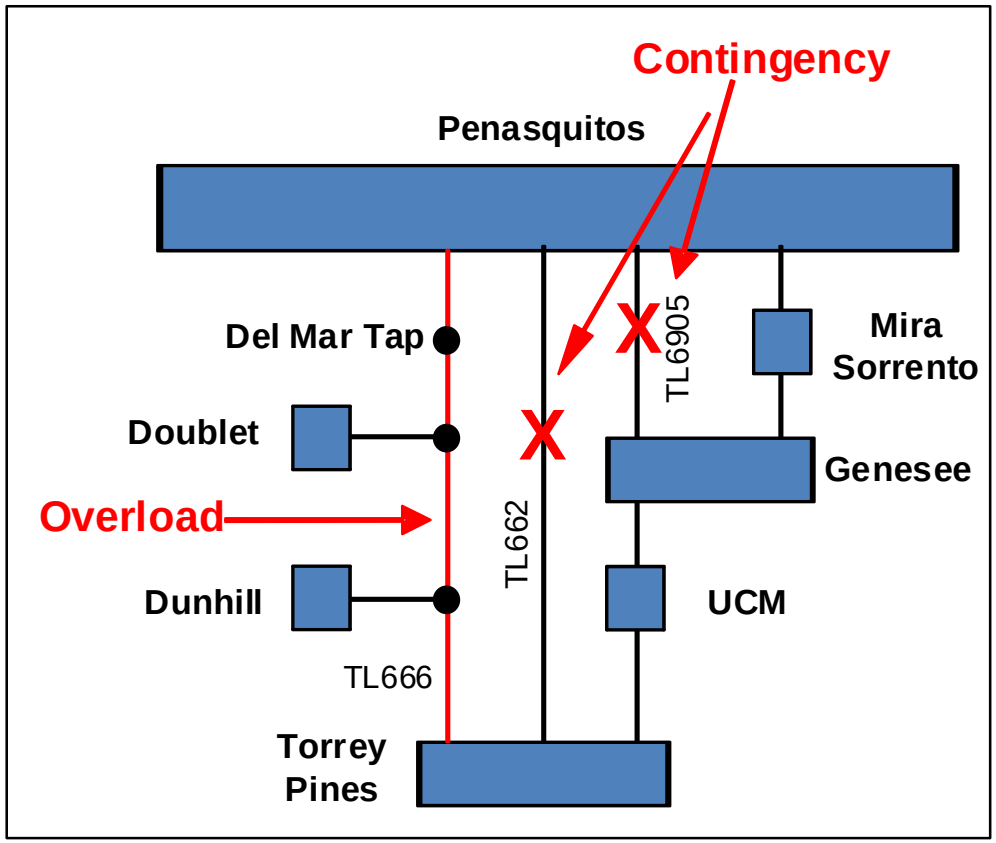
Category P6 Thermal Violation (6)



Penasquitos/Doublet/Dunhill/Torrey Pines/UCM/Genesee area 69 kV

- Thermal overload
  - TL662 overload for N-1-1 outage of TL666 and TL6907 in 2022 and 2027 Peak Shift cases (101%)
- Potential Mitigation
  - Network Upgrade (Add a new line PQ-UCM)
  - Loading shedding RAS

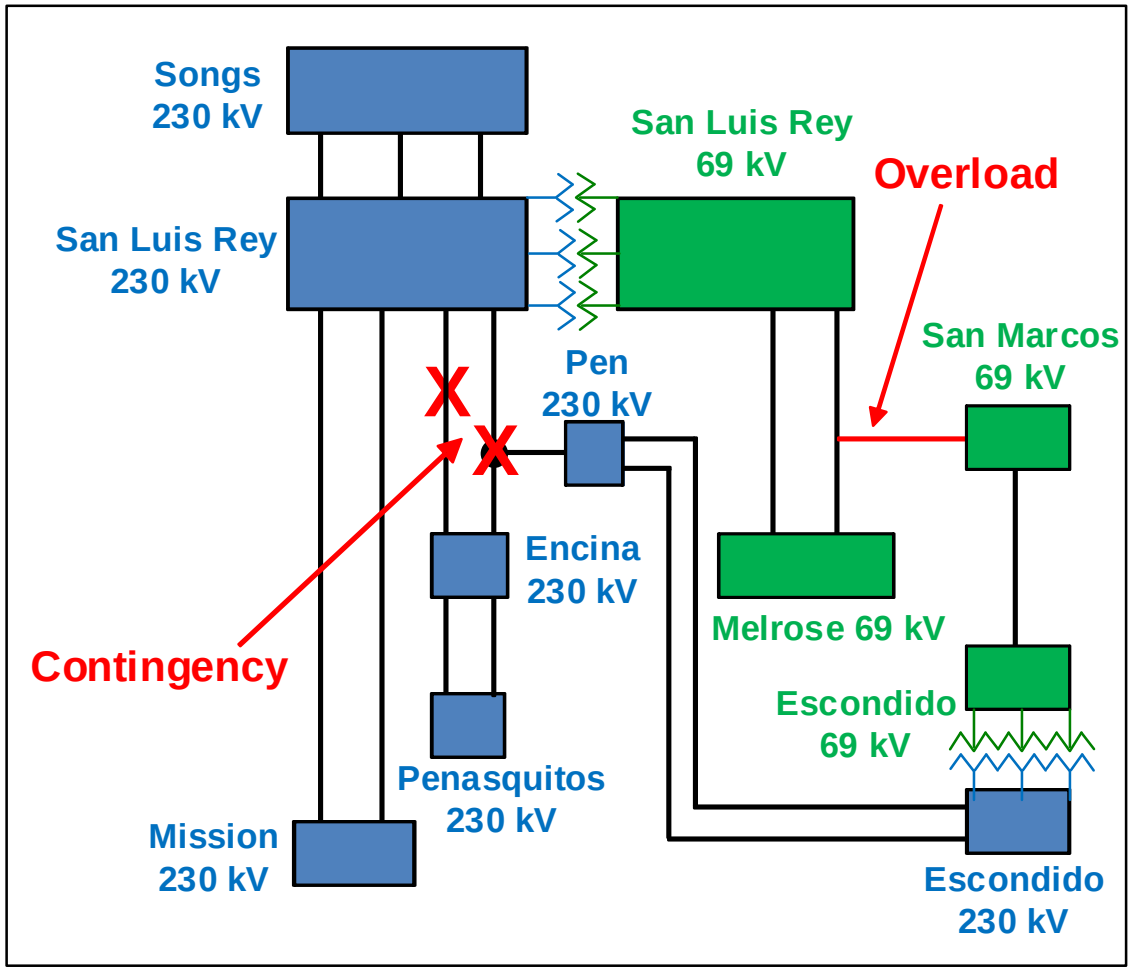
Category P7 Thermal Violation (1)



Penasquitos/Doublet/Dunhill/Torrey Pines/UCM/Genesee area 69 kV

- Thermal overload
  - TL666A, TL666B, TL666C, and TL666G overload for N-2 outage of TL662 and TL6905 in 2022 and 2027 Peak Shift cases (108%)
- Potential Mitigation
  - Network Upgrade (Add a new line PQ-UCM)
  - Loading shedding RAS

Category P7 Thermal Violation (2)



Melrose Tap – San Marcos 69 kV

- Thermal overload
  - TL680C overload (141%) for N-2 outage of TL23003 and TL23011 (2022 Off Peak)
  - Existing SPS trips the line and causes overload on Mission-San Luis Rey 230 kV
- Potential Mitigation
  - Open Encina 230 kV Tap and build a 230 kV extension from the Tap position to San Luis Rey
  - Generation Tripping RAS