Agenda – Day 1
Preliminary Reliability Assessment Results

Tom Cuccia
Lead Stakeholder Engagement and Policy Specialist

2015-2016 Transmission Planning Process Stakeholder Meeting
September 21-22, 2015

2015-2016 Transmission Planning Process Stakeholder Meeting - Today's Agenda

Topic	Presenter
Overview	Neil Millar - ISO
Transmission Reliability Studies – Study Plan & Criteria	Jeff Billinton
Preliminary Reliability Results	ISO Regional Transmission Engineers
Wrap-up & Next Steps	Tom Cuccia - ISO

Introduction and Overview
Preliminary Reliability Assessment Results

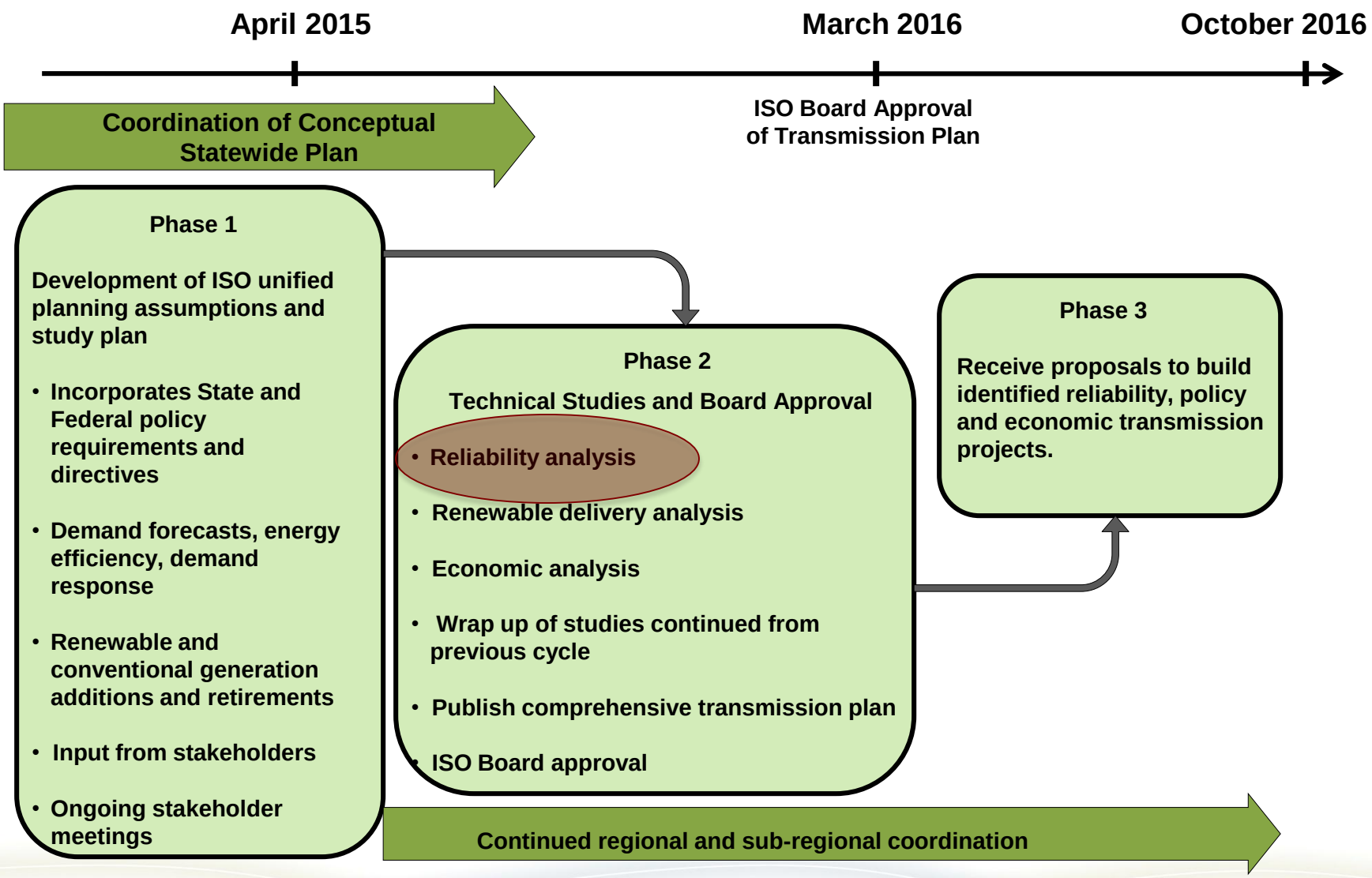
Neil Millar
Executive Director - Infrastructure Development

2015-2016 Transmission Planning Process Stakeholder Meeting
September 21-22, 2015

Overview

- Process
  - Implementing new standards
  - Non-conventional alternatives
  - Critical Energy Infrastructure Information
- Ongoing studies and related consultation
- Update on Interregional Transmission Planning Process
- Conceptual statewide plan
- Transmission Access Charge

2015-2016 Transmission Planning Cycle



2015-2016 Ten Year Reliability Assessment To Date

- Preliminary study results were posted on August 14, supplemental results were posted on August 31, 2015
  - Based on assumptions identified in Study Plan
  - Satisfy requirements of:
    - NERC Reliability Standards
    - WECC Regional Criteria
    - ISO Planning Standards
- Transmission request window opened August 15
  - Reliability driven projects
- PTO proposed mitigations
  - Submitted to ISO September 14

2015-2016 Ten Year Reliability Assessment going forward

- 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

Implementation of new standards:

- TPL-001-4 implementation having a significant effect on the presentation of results, as well as introducing new study requirements
- A separate presentation has been scheduled ahead of the presentation of the draft reliability results
- TPL-001-WECC-CRT-3 revises the transient voltage, transient frequency criteria, as well as providing a criterion for identifying risk of cascading outages. Draft criteria is out for comment and the Effective Date is January 1, 2016.

Alternatives to Transmission or Conventional Generation Methodology

- Planning efforts focus on:
  - Continuing to track forecast reliability in the LA Basin/San Diego area, with very high reliance on preferred resources developing
  - Continuing to explore other potential opportunities
- The issue of generic preferred resource characteristics versus characteristics tailored to local area needs continues to generate discussion
- The ISO is also participating in activities exploring related issues, including:
  - CPUC distributed energy resources proceeding
  - CEC and CPUC processes assessing load modifying resources
  - Resource procurement processes

Critical Energy Infrastructure Information

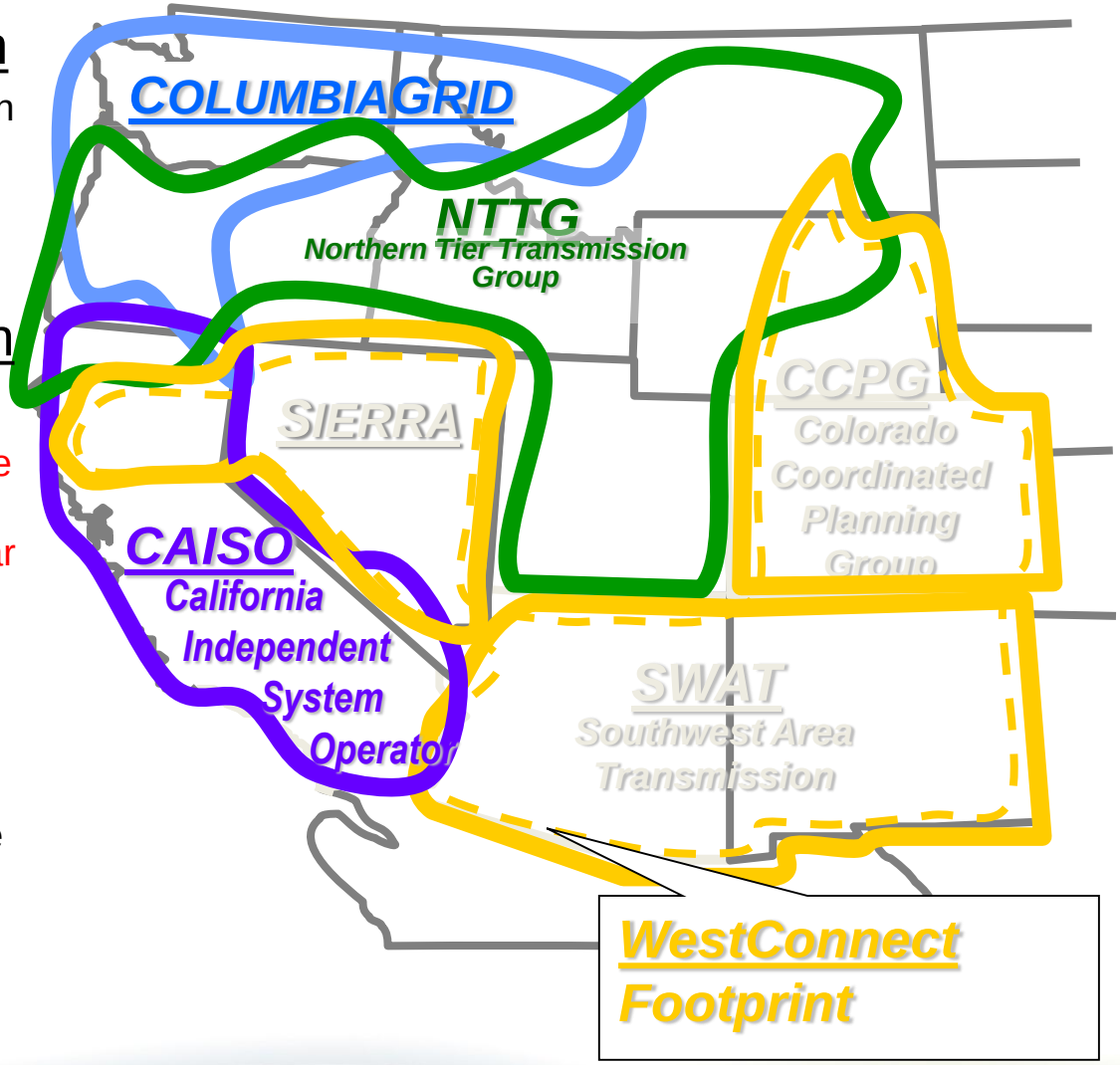
- The ISO is constantly re-evaluating its CEII practices to ensure they remain sufficient going forward.
- Continuing with steps established in previous years:
  - Continuing to not post category D contingency discussions in general - only shared on an exception basis where mitigations are being considered:
    - Details on secure web site
    - Summaries on public site
  - Continuing to migrating planning material over 1 year old to the secure website.
- One “bulk system” presentation has also been posted on the secure site.

Ongoing studies and related consultation

- ISO 50% special study
- Continuation of frequency response studies
- Gas/electric reliability in southern California
- Sensitivity studies in 2015-2016 Study Plan relating to Imperial Irrigation District
- Review of previously-approved projects in PG&E territory
- Large scale energy storage study
- Buck Blvd. Gen-Tie Loop-In Project – a continuation from the 2014-2015 planning cycle – will be presented separately after ISO 2015-2016 content

The ISO and our neighbors have an interregional coordination framework approved by FERC:

- Interregional coordination
  - Annual exchange of information
  - Annual public interregional coordination meeting
- Joint evaluation of interregional transmission projects
  - Biennial cycle; projects must be submitted no later than March 31st of any even-numbered year
- Interregional cost allocation
  - Each region determines (1) if project meets any regional needs and (2) if project is more cost effective or efficient than regional solution(s)
  - Costs shared in proportion to each region's share of total benefits

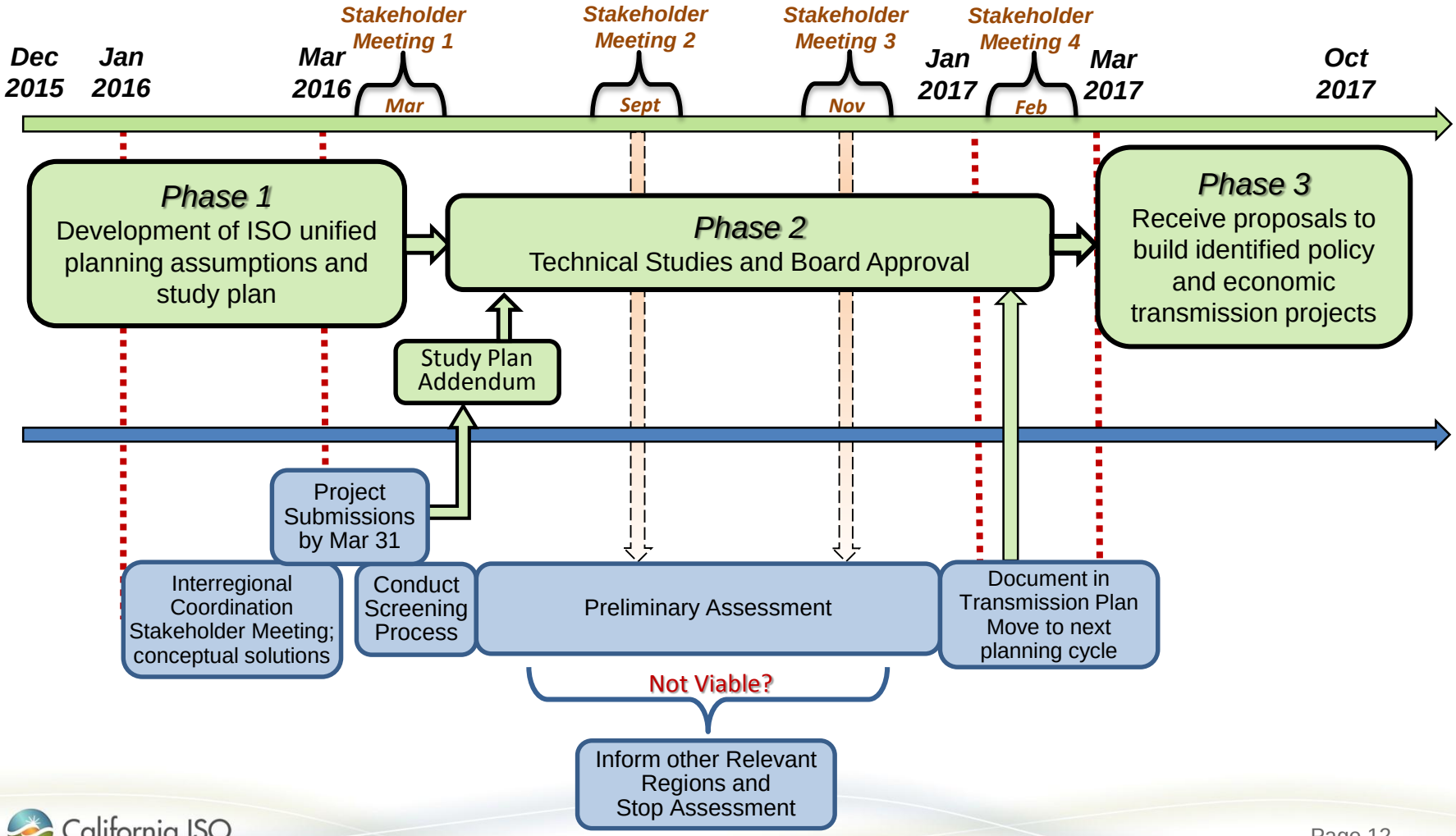


FERC Order 1000 Requirements

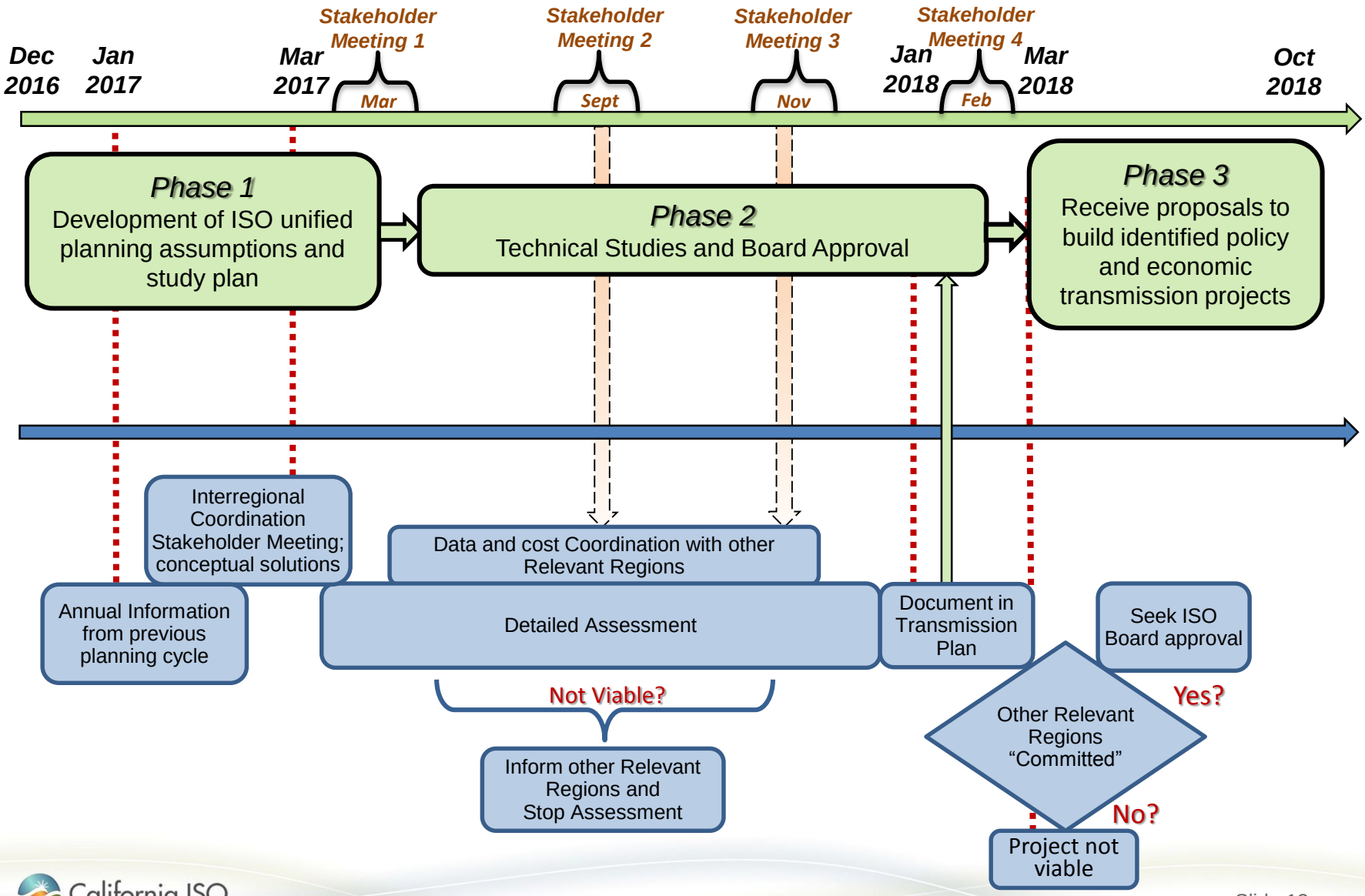
- **It Does Require**
  - Process to coordinate/share results/plans among planning regions
  - Procedure to identify & jointly evaluate interregional transmission projects
  - Annual exchange of planning data & related information
  - Mechanism for communicating information about planning processes

- **It Does not Require**
  - Formation of interregional transmission planning **entities**,
  - The creation of a distinct interregional transmission planning **process**, or
  - An interregional transmission **plan**

First cycle of CAISO's biennial FERC Order 1000 interregional planning project evaluation begins 2016



And continues into the 2016-2017 planning process



Draft Conceptual Statewide Plan has been posted for stakeholder review and comment

- Previous years have primarily relied upon CTPG annual report
  - CTPG activities currently on hold with FERC Order 1000

- This year's draft plan is based on previous CTPG report updated with publicly available information – as was done last year

- Comment period to October 20th

- We intend to review the value this provides, in light of the FERC Order 1000 regional and interregional planning requirements.

High Voltage Transmission Access Charge Estimating Model

- The 2014-2015 TPP model was posted and a stakeholder call held on May 18, 2015
- Following the call, the underlying estimated project data was posted
- Comments have been received for possible future refinements, and are being considered
- The model will be updated in late 2015 for January 2016 posting of draft transmission plan

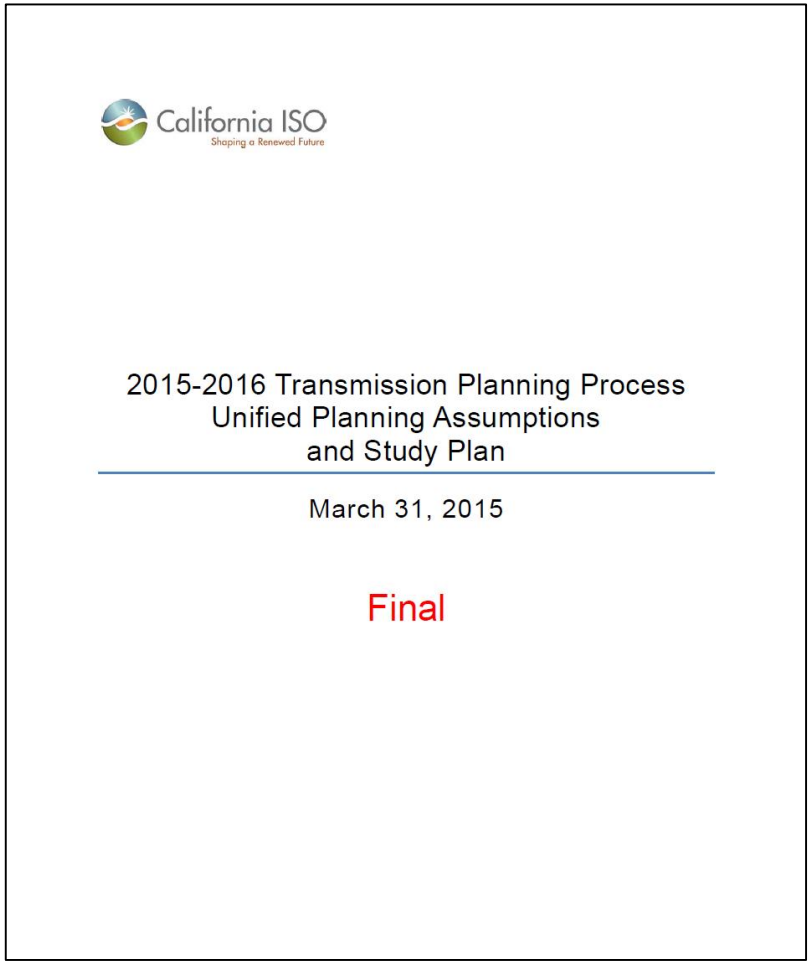
Transmission Reliability Studies Study Plan and Criteria

J.E.(Jeff) Billinton
Manager, Regional Transmission – North

2015-2016 Transmission Planning Process
September 21, 2015

2015-2016 Transmission Planning Process Reliability Studies

- Reliability Studies conducted per 2015-2016 TPP Assumptions and Study Plan



Application of ISO Planning Standards with TPL-001-4

- ISO Planning Standards applying TPL-001-4 have been approved by the ISO Board with an effective date of April 1, 2015

- http://www.caiso.com/Documents/FinalISOPlanningStandards-April12015_v2.pdf

Requirement R3
Contingency Category Comparison

- Contingencies
  - Naming convention has changed
  - Loss of a shunt device (capacitors, reactors, SVCs, etc.)
  - Loss of generator plus loss of another facility (G-1, N-1)
  - Separated and clarified stuck breaker versus relay failure contingencies

Requirement R3
Contingency Category Comparison

New Category	Old Category	Description
P0	Cat A	System intact
P1 P2.1 P3.2*	Cat B	Single contingency (Fault of a shunt device- fixed, switched or SVC/STATCOM is new)
P2	Cat C1, C2	Single event which may result in multiple element outage. Open line w/o fault, bus section fault, internal breaker fault
P3	Cat C3	Loss of generator unit followed by system adjustments + P1. No load shed is allowed
P4	Cat C	Fault + stuck breaker events
P5	n/a	Fault + non redundant relay failure to operate (new)
P6	Cat C3	Two overlapping singles (not generator)
P7	Cat C5, C4	Common tower outages; loss of bipolar DC

* ISO Planning Standard treated as Category B contingency

Contingency P2-1
Open-ended line analysis

- P2-1 – Opening of a line section without a fault
  - Opening of one end of a transmission line without a fault and serving load radially from a single point
    - Typically loads tapped off lines
  - Requires similar performance as P1
  - ISO is reviewing potential mitigation options

Sensitivity Studies
TPL-001-4 Requirement 2.1.4

- Sensitivity results considered on a case by case basis.
- Not mandatory to address a reliability issue of a single sensitivity case.
- Reliability issue identified in multiple sensitivity cases may warrant mitigation.
- Sensitivity results may also be used to favor a particular mitigation.

Sensitivity Study	Near-term Planning Horizon		Long-Term Planning Horizon
	2017	2020	2025
Summer Peak with high CEC forecasted load	-	-	PG&E Local Areas SCE Metro SCE Northern SDG&E Area
Summer Peak with heavy renewable output and minimum gas generation commitment	-	PG&E Bulk PG&E Local Areas SCE Bulk SCE Northern SCE North of Lugo SCE East of Lugo SCE Eastern SDG&E Area	-
Summer Off-peak with heavy renewable output and minimum gas generation commitment (renewable generation addition)	-	VEA Area	-
Summer Peak with OTC plants replaced	-	SCE Metro Area SDG&E Area	-
Summer Peak with low hydro output	-	SCE Northern Area	-
Retirement of QF Generations	-	-	PG&E Local Areas

Sparing Strategy
TPL-001-4 Requirement 2.1.5

- Assessment of sparing strategy for major Transmission Equipment that have a lead time of one year or more for P0, P1 and P2 contingencies
- ISO working with PTOs on sparing strategies of major Transmission Equipment that may have lead time of longer than one year
  - Such as SVC or reactive devices
- Results will be included in draft Transmission Plan

Short Circuit Assessment
TPL-004-1 Requirement 2.3

- Near-Term Transmission Planning Horizon
  - assess whether circuit breakers have interrupting capability for Faults they are expected to operate for.
- The ISO is coordinating with the PTOs on this this assessment who will conduct the studies.
- Circuit breakers that do not have interrupting capability are to be identified by PTOs
- Short circuit data will be provided to provided per the MOD-032 process documents posted on ISO website.
  - http://www.caiso.com/Pages/documentsbygroup.aspx?GroupID=F94E2438-69DA-4881-BCF7-3B937BE44593

PG&E Bulk Transmission System Preliminary Reliability Assessment Results

Available on Market Participant Portal

Confidential – Subject to Transmission Planning NDA

Abhishek Singh
Senior Regional Transmission Engineer
Irina Green
Senior Advisor Regional Transmission Engineer

2015-2016 Transmission Planning Process Stakeholder Meeting
September 21-22, 2015

California ISO
Shaping a Renewed Future

Humboldt, North Coast & North Bay Areas Preliminary Reliability Assessment Results

Rajeev Annaluru
Senior Regional Transmission Engineer

2015-2016 Transmission Planning Process Stakeholder Meeting
September 21-22, 2015

Humboldt Area

- 3000 sq. miles. NW corner of PG&E
- Cities: Eureka, Arcata, Garberville
- Generation - Humboldt Bay Power Plant , QFs, total 227 MW
- Voltage 115 kV – from Cottonwood, 60 kV – from Mendocino
- Winter peak 193 MW in 2025, summer peak 169 MW in 2025

Humboldt Area Assessment Summary

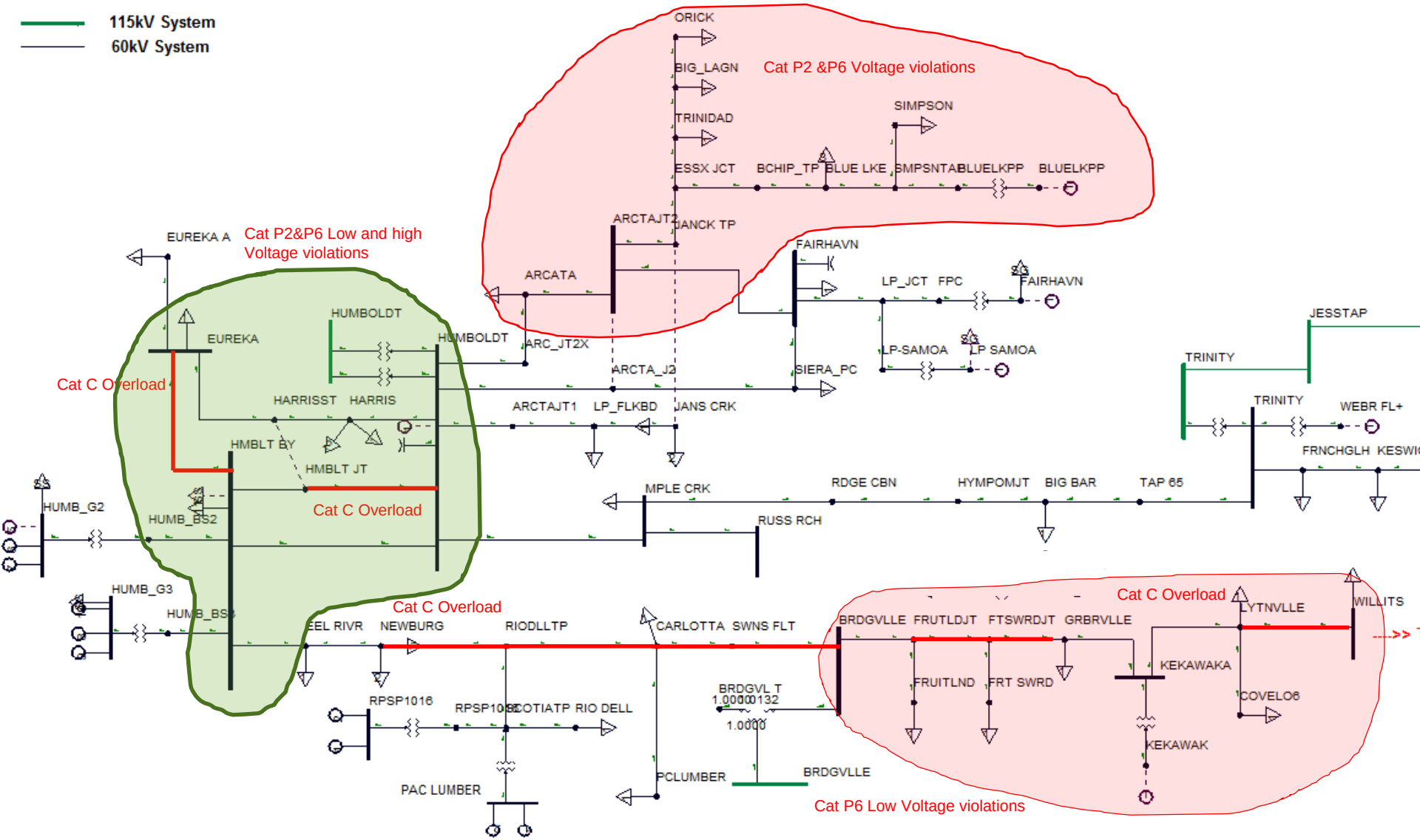
- The assessment identified:
  - Thermal overloads due to Category P2 - 8
  - Thermal overloads due to Category P6 - 13
  - Low voltage due to Category P1 – 2
  - Low voltage due to Category P2 – 2
  - Low voltage due to Category P6 – 1
- Compared to last year results:
  - New violations identified for new contingency categories
  - QF retirement sensitivity in Humboldt identified new violations

Humboldt Area – Results (Category P0 – P2)

- Thermal Overloads
  - Humboldt Bay - Rio Dell 60kV Line (Cat P2, 2017)
  - Rio Dell Jct - Bridgeville 60kV Line (Cat P2, 2017)
    - Mitigation Short term: Operating procedure to re-dispatch Humboldt generation.
    - Mitigation Long term: Potentially reconductor the line
- Low Voltage
  - Arcata area 60kV (Cat B, 2024)
    - Potential Mitigation: May need a new 60kV cap bank in the 7-10 year timeframe
  - Maple Creek 60kV (Cat B, 2016)
    - Mitigation: Maple creek reactive support project
- Voltage Deviation
  - Arcata area 60kV (Cat B, 2024)
    - Potential Mitigation: May need a new 60kV cap bank in the 7-10 year timeframe
  - Maple Creek 60kV (Cat B, 2016)
    - Mitigation: Maple creek reactive support project

Category C problems will be discussed in the area diagram in next slide

Humboldt Area – Results (cont'd)



Conclusion

- Retirement of Pacific Lumber (QF unit) has created new thermal constraints, which needs mitigation.
- Humboldt – Arcata pocket has both high and low voltage violations. Additional reactive support may be needed

North Coast and North Bay Areas

- North of the Bay Area and south of Humboldt
- Sonoma, Mendocino, Lake, Marin and part of Napa and Sonoma counties – 10,000 sq. miles
- Cities – Laytonville, Petaluma, San Rafael, Novato, Benicia, Vallejo
- Generation- Geysers Power Plants and QFs, total 1620 MW
- 60kV, 115kV and 230 kV facilities
- Summer peak 1538 MW in 2025

North Coast / North Bay Area Assessment Summary

- The assessment identified:
  - Thermal overloads due to Category P1 – 3, P2 - 31 and Category P6 & P7 - 64
  - Low voltages due to Category P1 & P2-1 – 3 and Category P2-P7 - 5
  - Voltage deviations due to Category P1 & P2 - 3

- Compared to last year results:
  - Most major issues identified in this years analysis are similar to the issues identified last year.
  - New issues identified due to new contingency categories

North Coast / North Bay Area – Results (Category P0-P2)

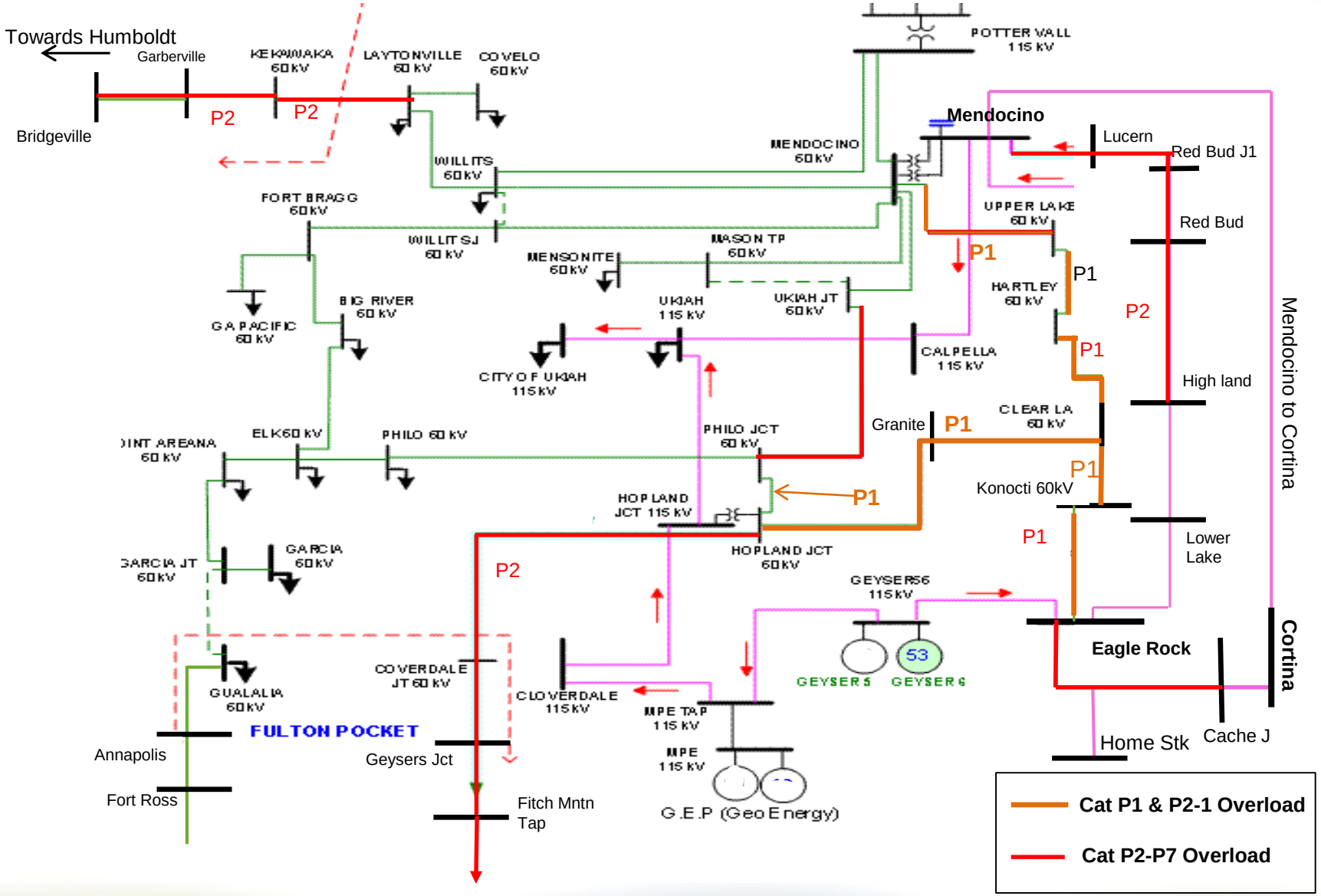
- Thermal Overloads
  - Highway Jct – Highway 115kV (Cat P0 for AAEE Sensitivity)
    - Potential mitigation: Reconductor the line
  - Ignacio – Bolinas #1 & #2 line (Cat P2-1)
    - Potential Mitigation – Reconductor the line between Olema & Bolinas
  - Mendocino – Hartley - Clear Lake 60 kV Line #1(Cat P2, P6, P7)
    - Mitigation – Clear Lake 60kV system reinforcement project
  - Clear Lake – Hopland 60kV line (Cat P1, P6, P7)
    - Mitigation – Clear Lake 60kV system reinforcement project
  - Clear Lake – Eagle Rock 60kV line (Cat P1, P2, P6, P7)
    - Mitigation – Clear Lake 60kV system reinforcement project
  - Bridgeville – Garberville 60kV line
    - Mitigation – Bridgeville – Garberville 115kV line project
  - Tulucay – Napa 60kV line #1 (Cat P2)
    - Mitigation – Reconductor the line
  - Fulton – Fitch Mountain 60kV line (Cat P2)
    - Mitigation – Reconductor the line

North Coast / North Bay Area – Results (Category P0-P2)

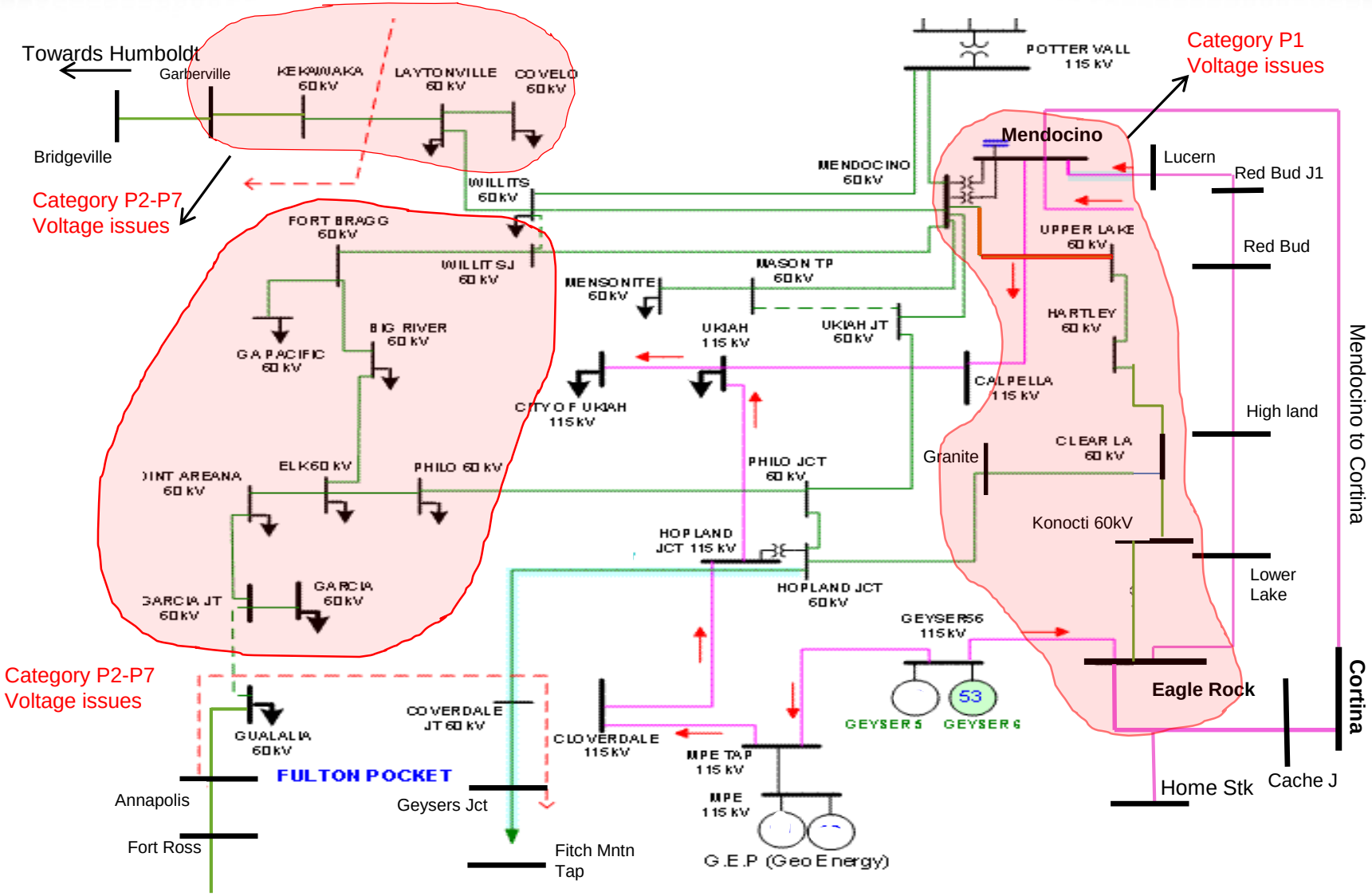
- Low Voltage
  - Clear Lake, Lower Lake, Konocti, Middle town (Cat P1, P2, P6)
    - Mitigation – Clear Lake 60kV system reinforcement project
  - Greenbrae, Sausalito 60kV (Cat P2)
    - Mitigation – Ignacio – Alto voltage conversion project
  - Bolinas, Stafford, Novato, Olema 60kV (Cat P2)
    - Potential Mitigation – Reconductor Olema – Bolinas 60kV line

- Voltage Deviation
  - Clear Lake, Lower Lake, Konocti, Middle town, Calistoga, Dunbar, St. Helna (Cat P1)
    - Mitigation – Clear Lake 60kV system reinforcement project
  - Greenbrae, Sausalito 60kV (Cat P2)
    - Mitigation – Ignacio – Alto voltage conversion project
  - Bolinas, Stafford, Novato, Olema 60kV (Cat P2)
    - Potential Mitigation – Reconductor Olema – Bolinas 60kV line

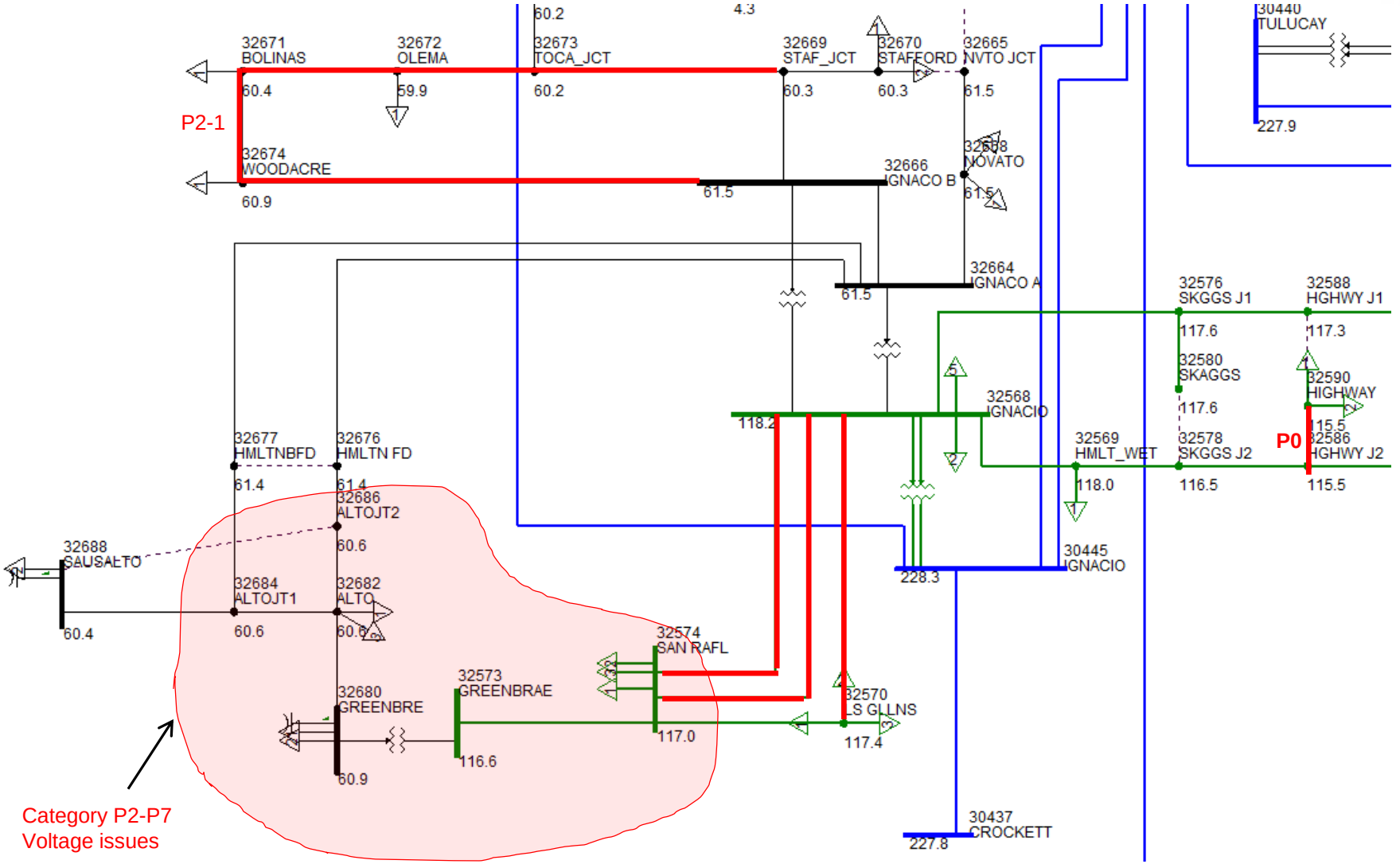
Mendocino - Eagle Rock Area Thermal Issues



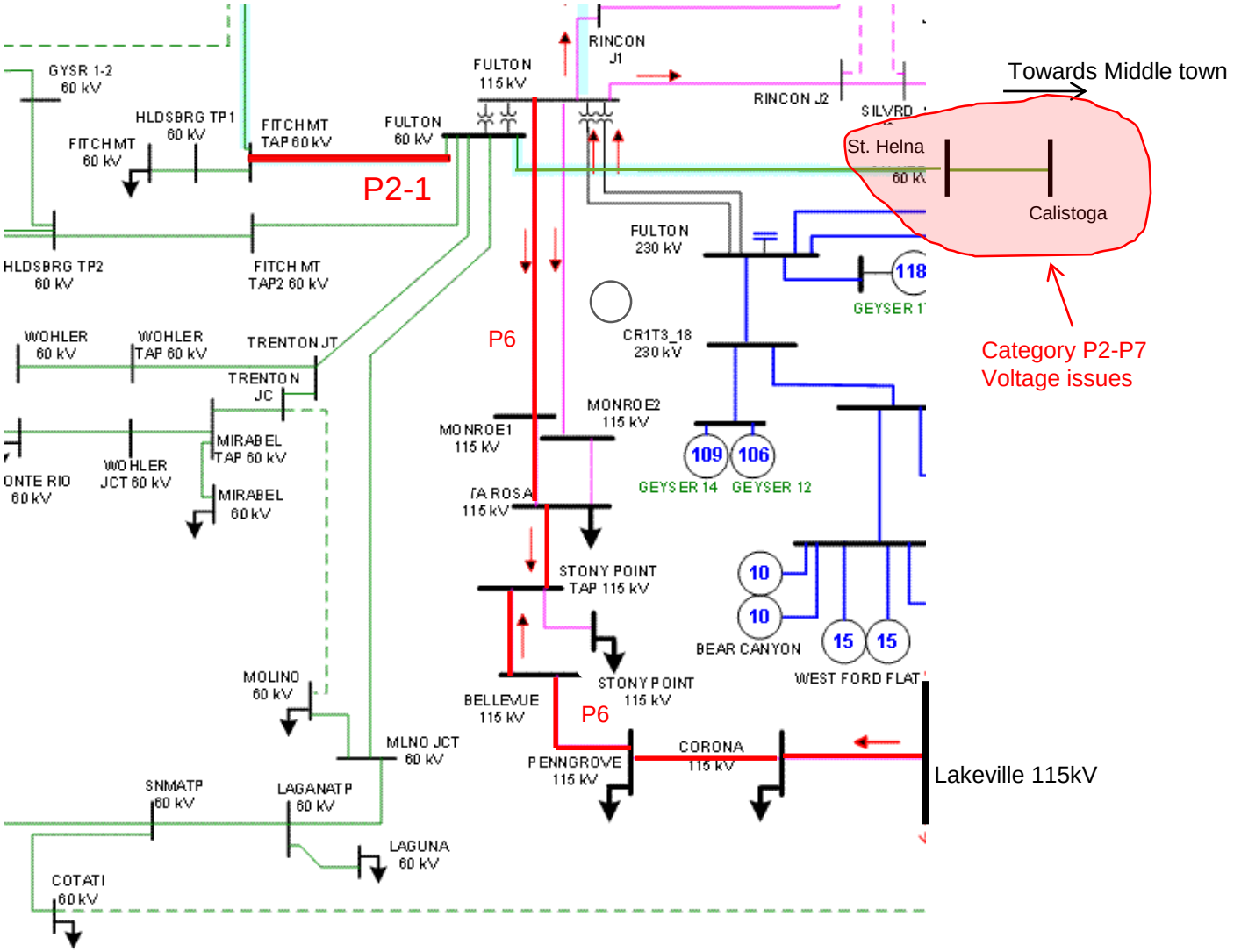
Mendocino - Eagle Rock Area Voltage Issues



Ignacio – Alto area issues



Fulton area issues



Conclusions

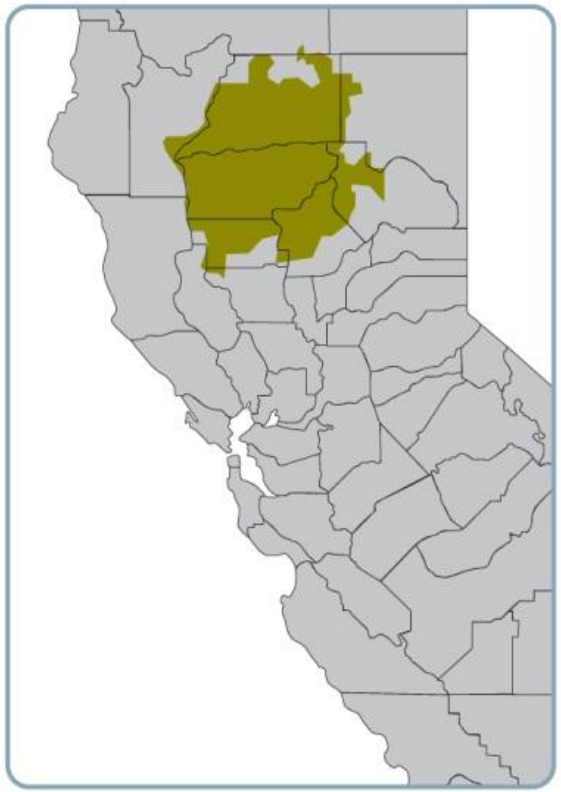
- Cat P0 overload identified (Highway Jct – Highway 115kV line) in no AAEE Sensitivity case.
- Ignacio – Bolinas #1&2 lines overloaded for P2-1 contingency.
- 115kV corridor between Fulton – Lakeville overloaded for P6 & P7 conditions. May need an SPS for load drop.

North Valley & Central Valley Areas Preliminary Reliability Assessment Results

Bryan Fong
Sr. Regional Transmission Engineer

2015-2016 Transmission Planning Process Stakeholder Meeting
September 21-22, 2015

North Valley Area



- 15,000 sq. miles NE corner of PG&E
- Cities: Chico, Redding, Red Bluff, Paradise
- Generation: Over 2,000 MW of hydro. Colusa is the largest generation facility (717 MW).
- Comprised of 60, 115, 230 & 500 kV transmission facilities.
- Summer Peak 1,037 MW in 2025 (49 MW of AAEE)

Study Scenarios

- 8 Baseline Scenarios
  - 2017 Summer Peak
  - 2020 Summer Peak
  - 2025 Summer Peak
  - 2017 Spring Off-peak
  - 2020 Light Load

- 3 Sensitivity Scenarios
  - 2025 Summer Peak No AAEE
  - 2025 Summer Peak No QF
  - 2020 Summer Peak High Renewable *(Existing & new renewables dispatched to Pmax)*

North Valley Area Assessment Summary

- The 2015-16 assessment identified:
  - Thermal overloads due to Category P0-3, P1 – 2, P2 – 8, P3 – 1, P6 - 18 and P7 – 3
  - Low voltages due to P1 – 4, P2 – 8 and P6 – 10
  - Voltage deviations due to P1 – 15 and P2 – 21
  - Low voltage at 60 and 115 kV buses only
  - One Category P-2 contingency - Table Mountain Stuck Bus-Tie Breaker resulted in divergence
- Compared to last year results:
  - 4 new Category P2-1 overload (new contingency category)

North Valley Area – Results (Category P0 & P1)

- Thermal Overloads
  1. Glenn #3 60 kV Line (Cat P0 – Summer 2020)
  2. Glenn #2 230/60kV Bank (Cat P1 – Summer 2025)
- Potential Mitigations
  - Interim action plans for overloads with long-term projects in place.

- Thermal Overloads (Sensitivity)
  1. Cottonwood-Anderson 60 kV line (Cat P1 – Summer 2025 No AAEE and 2025 High Renewable)
  2. Palermo-Big Bend 60 kV Line (Cat P1 – Summer 2025 No AAEE and 2025 QF Retirement and Summer 2020 High Renewable)
- Potential Mitigations
  - Interim action plans for overloads with long-term projects in place.
  - Load transfer

Thermal issues resulting from other contingency categories will be discussed in the area diagram

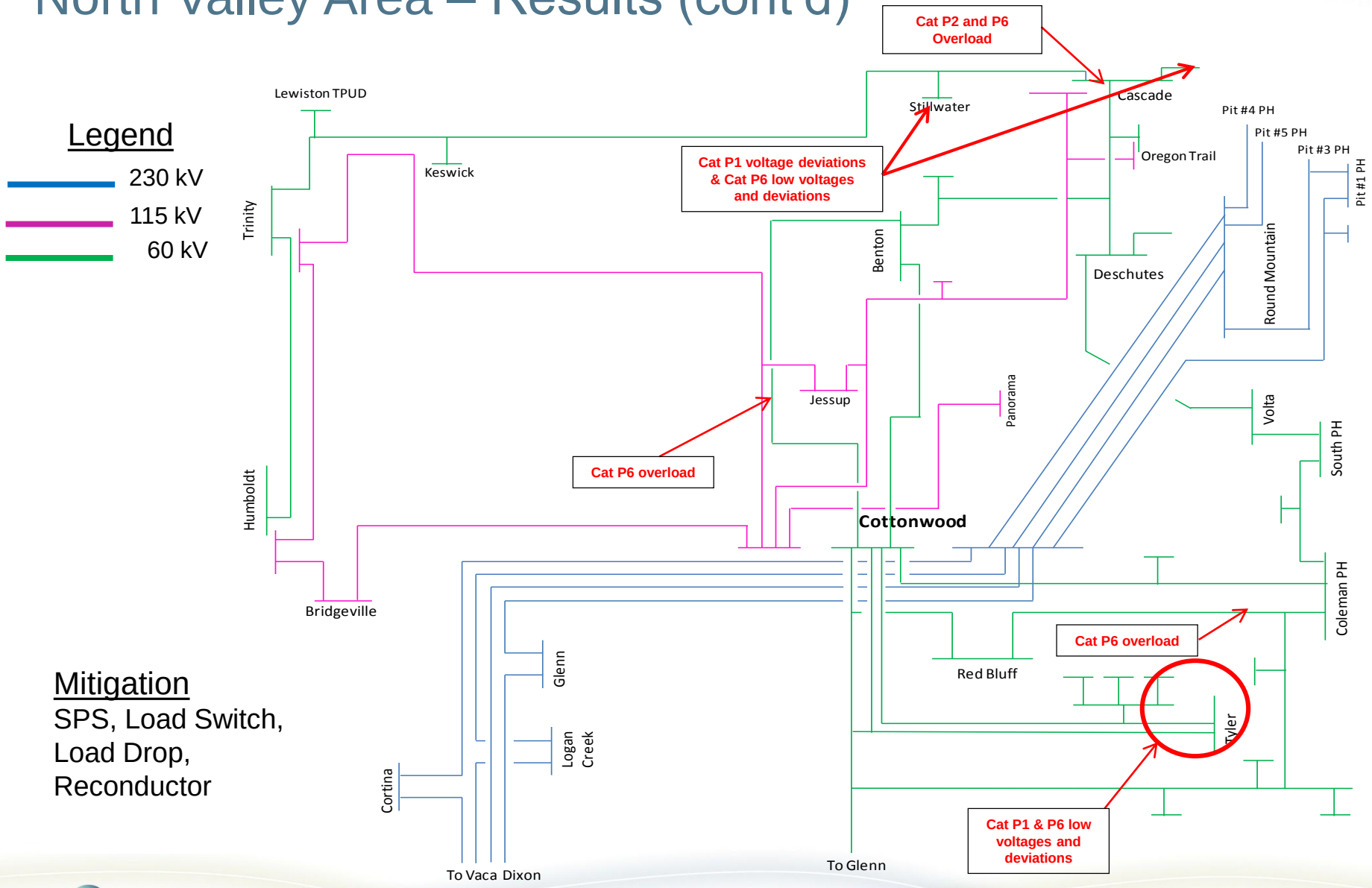
North Valley Area – Results (Category P0 & P1)

- Voltage Results
  - Cascade and Jessup Area 60 kV high voltage (Cat P1 – 2017 Spring Off Peak and 2020 Spring Light Load)
- Potential Mitigations
  - Interim action plans for overloads such as load transfer and may need additional reactive support
  - Mitigation under investigation for the high voltage issues

- Voltage Results (Sensitivity)
  - No Cat P0 nor Cat P1 voltage deviation issues
- Potential Mitigations
  - N/A

Voltage issues resulting from other contingency categories will be discussed in the area diagram

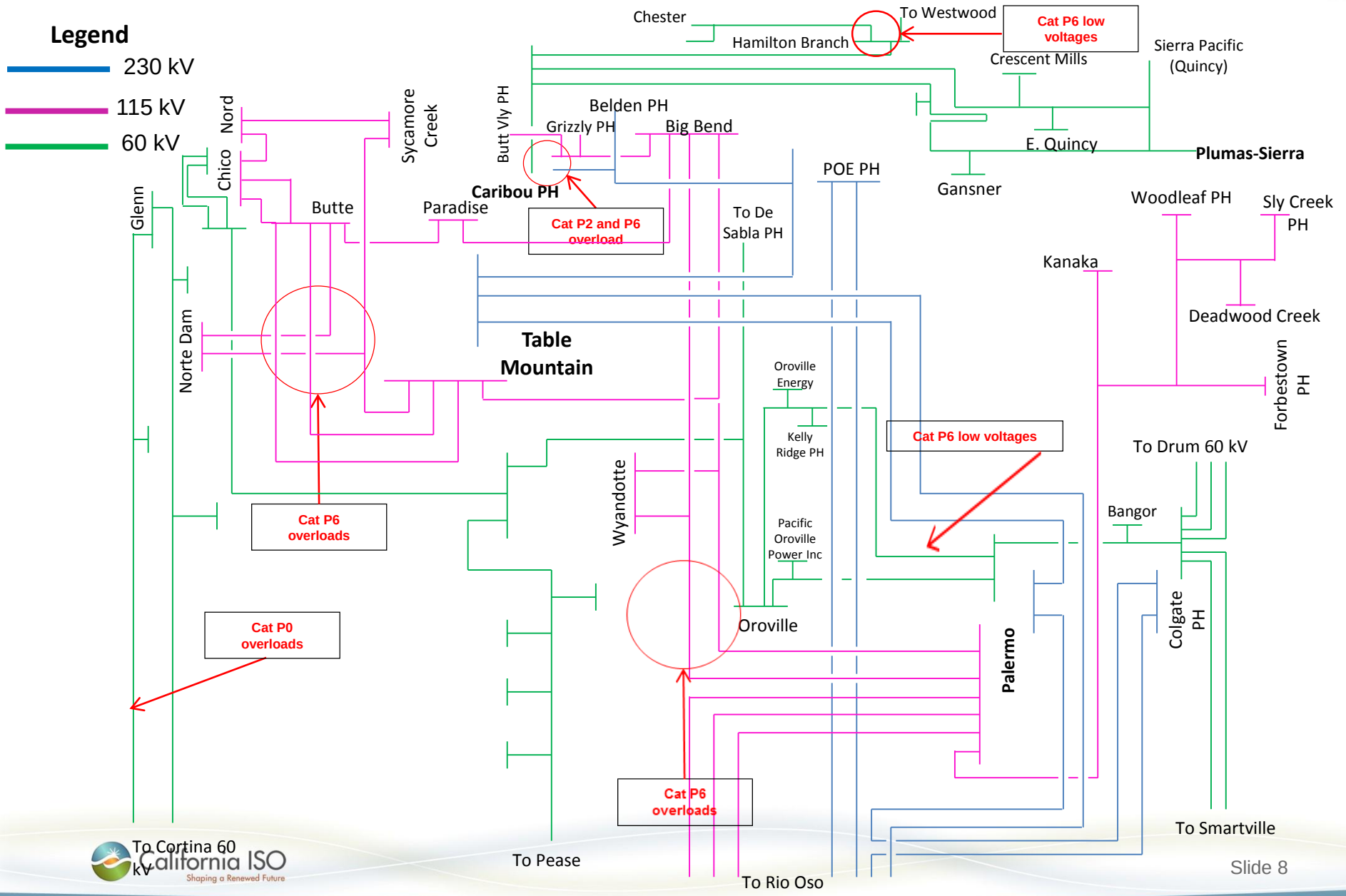
North Valley Area – Results (cont'd)



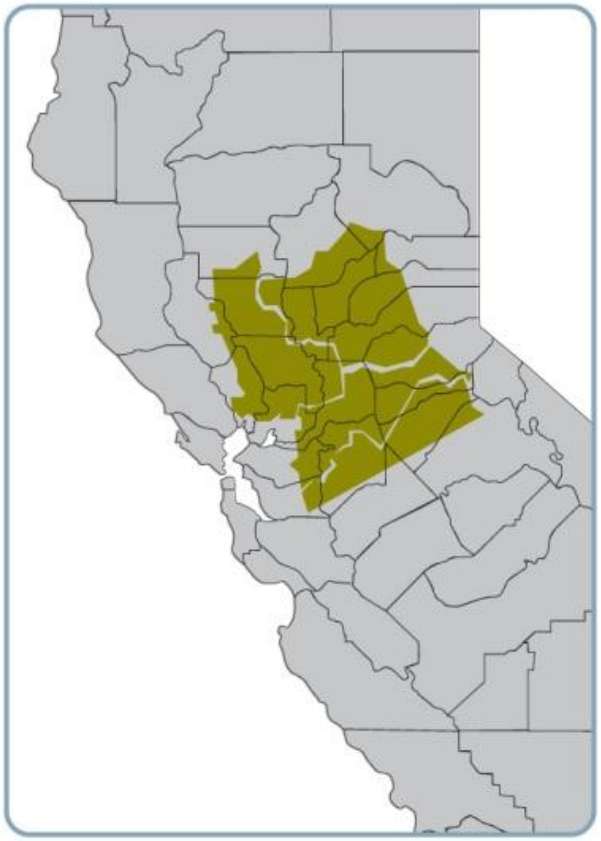
Mitigation

SPS, Load Switch, Load Drop, Reconductor

North Valley Area – Results (cont'd)



Central Valley Area



- Includes Sacramento, Sierra, Stockton & Stanislaus divisions
- Generation: Over 3,500 MW of generation
- Comprised of 60, 115, 230 & 500 kV transmission facilities.
- Summer Peak 4,631 MW in 2025 (262 MW of AAEE)

Central Valley Area Assessment Summary

- The assessment identified:
  - Thermal overloads due to Category P0 - 5 P1 – 10, P2 – 32, P3 – 17, P6 - 57 and P7 – 6
  - Low voltages due to P2 – 31 and P6 – 68
  - High voltages due to P1 – 28,
  - Voltage deviations due to P1 – 3 and P2 – 8
  - Area-wide high voltage under normal condition (light-load)
- Compared to last year results:
  - 3 new Category P1 thermal overload due to load increase
  - 5 new Category P2-1 overload (new contingency category)

Sacramento Area – Results (Category P0 & P1)

- Thermal Overloads
  1. Vaca Dixon –Winter 60kV Line(Cat P0 – Summer 2017)
  2. Vaca Dixon 115/60 kV Transformer Bank #5 (Cat P1 – Summer 2017)
- Potential Mitigations
  - Interim action plans transferring load to adjacent Distribution Planning Areas until Vaca-Davis Voltage Conversion

- Thermal Overloads (Sensitivity)
  1. Cortina 230/60 kV Bank (Cat P1 – Summer 2025 No AAEE, QF Retirement & 2020 Renewable)
- Potential Mitigations
  - Interim action plans for overloads with load transfer.

Thermal issues resulting from other contingency categories will be discussed in the area diagram

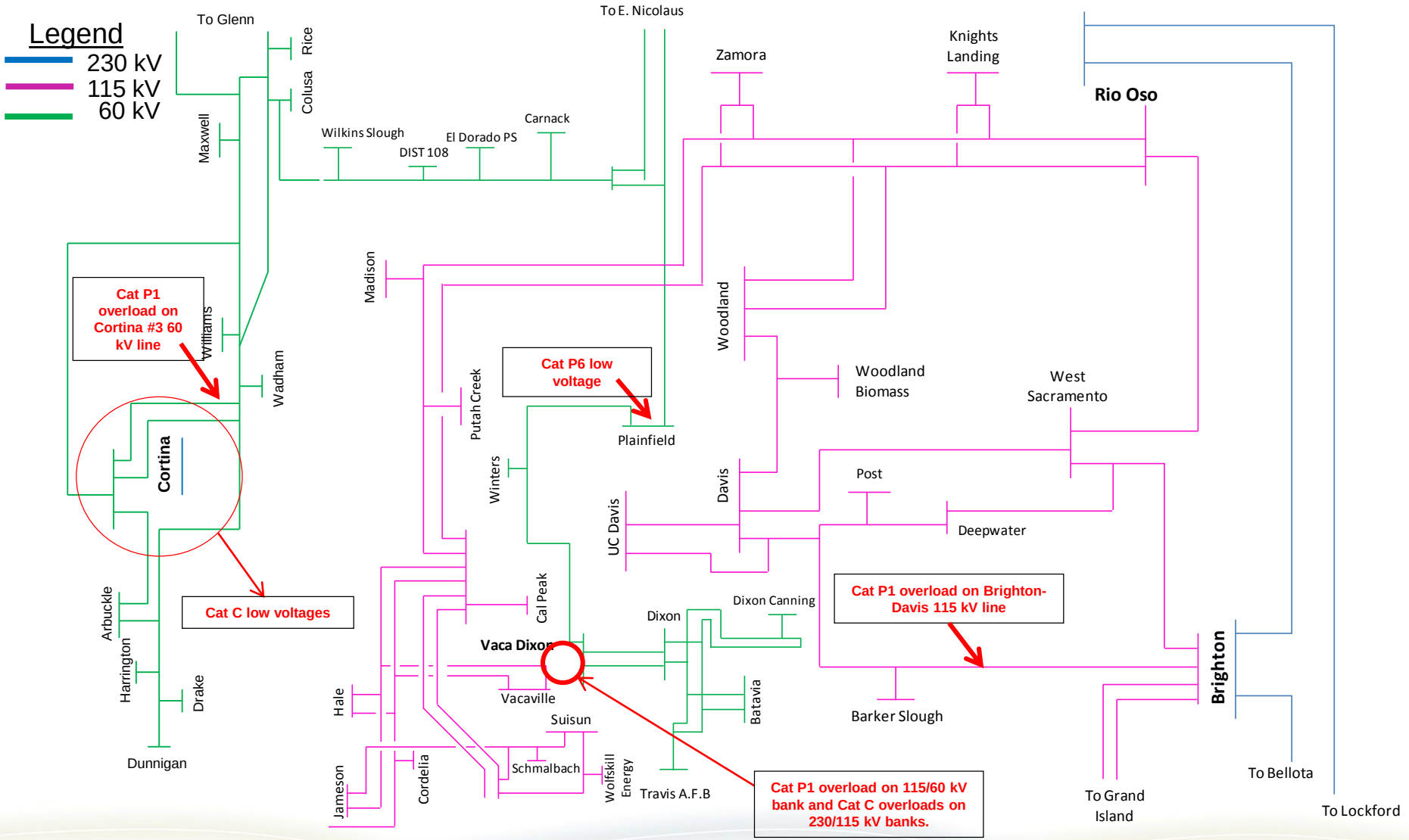
Sacramento Area – Results (Category P0 & P1)

- Voltage Results
  - Plainfield 60 kV (Cat P1 - 2017)
  - Colusa 60 kV (Cat P1 - 2025)
- Potential Mitigations
  - Interim action plans for overloads with long-term projects in place.
  - Mitigation may need additional reactive support

- Voltage Results (Sensitivity)
  - No Cat P0 nor Cat P1 voltage deviation issues
- Potential Mitigations
  - N/A

Voltage issues resulting from other contingency categories will be discussed in the area diagram

Sacramento Area – Results (cont'd)



Mitigation SPS, Load Switch, Load Drop, Reconductor

Sierra Area – Results (Category P0 & P1)

- Thermal Overloads
  1. Placer 115/60 kV Bank (Cat P1 – Summer 2025)
  2. East Nicolaus 115/60 kV Bank (Cat P1 – Summer 2017)
- Potential Mitigations
  - Interim action plans for overloads with long-term projects in place.

- Voltage Results (Sensitivity)
  - No Cat P0 nor Cat P1 issues
- Potential Mitigations
  - N/A

Thermal issues resulting from other contingency categories will be discussed in the area diagram

Sierra Area – Results (Category P0 & P1)

- Voltage Results
  - Atlantic Area 60 kV (Cat P1 - 2017)
  - Wheatland 60 kV (Cat P1 - 2017)
  - Higgins 115 kV (Cat P1 - 2017)
  - Grass Valley Area 60 kV (Cat P1 - 2025)
- Potential Mitigations
  - Interim action plans for overloads with long-term projects in place.
  - Potential Mitigation – Distribution load transfer / disable automatics and may add additional reactive support

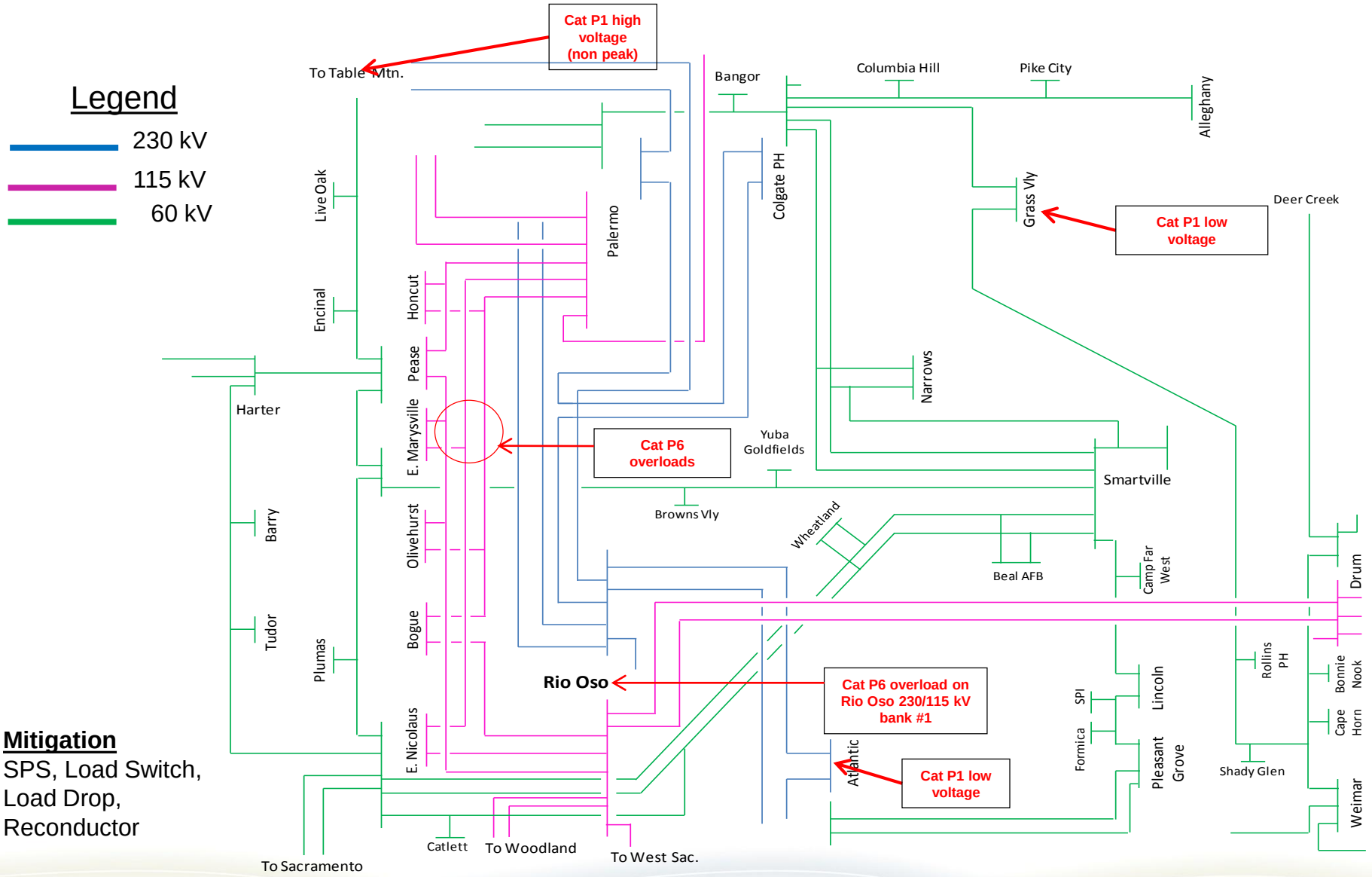
Voltage issues resulting from other contingency categories will be discussed in the area diagram

Sierra Area – Results (Category P0 & P1)

- Voltage Results (Sensitivity)
  - No Cat P0 nor Cat P1 voltage deviation issues
- Potential Mitigations
  - N/A

Voltage issues resulting from other contingency categories will be discussed in the area diagram

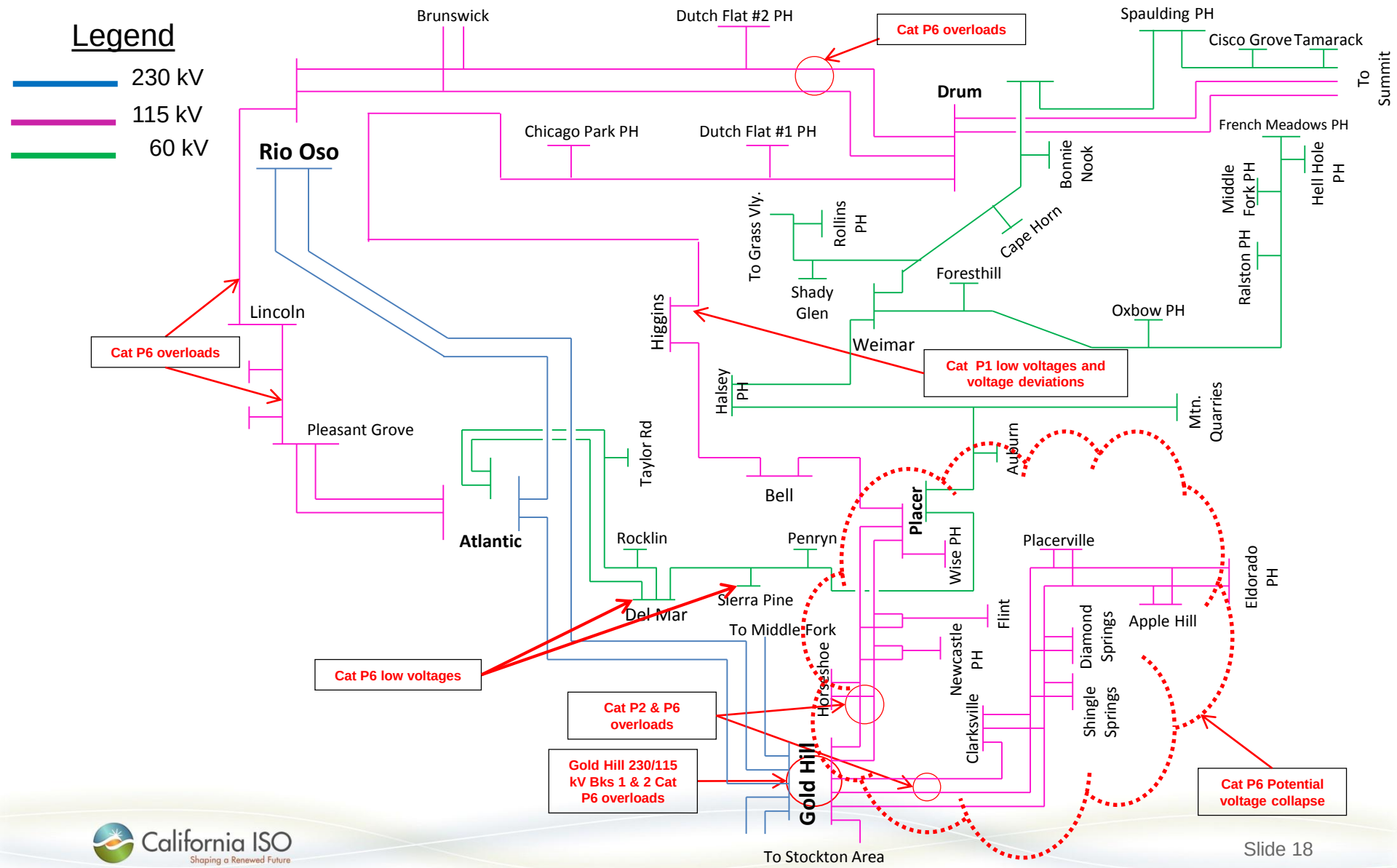
Sierra Area – Results (cont'd)



Mitigation

SPS, Load Switch, Load Drop, Reconductor

Sierra Area – Results (cont'd)



Stockton/Stanislaus Area – Results (Category P0 & P1)

- Thermal Overloads
  1. Valley Springs No. 1 60 kV Line (Cat P1 – Summer 2017)
- Potential Mitigations
  - Interim action plans for overloads with long-term projects in place.

- Thermal Overloads (Sensitivity)
  - No Cat P0 nor Cat P1 issues
- Potential Mitigations
  - N/A

Thermal issues resulting from other contingency categories will be discussed in the area diagram

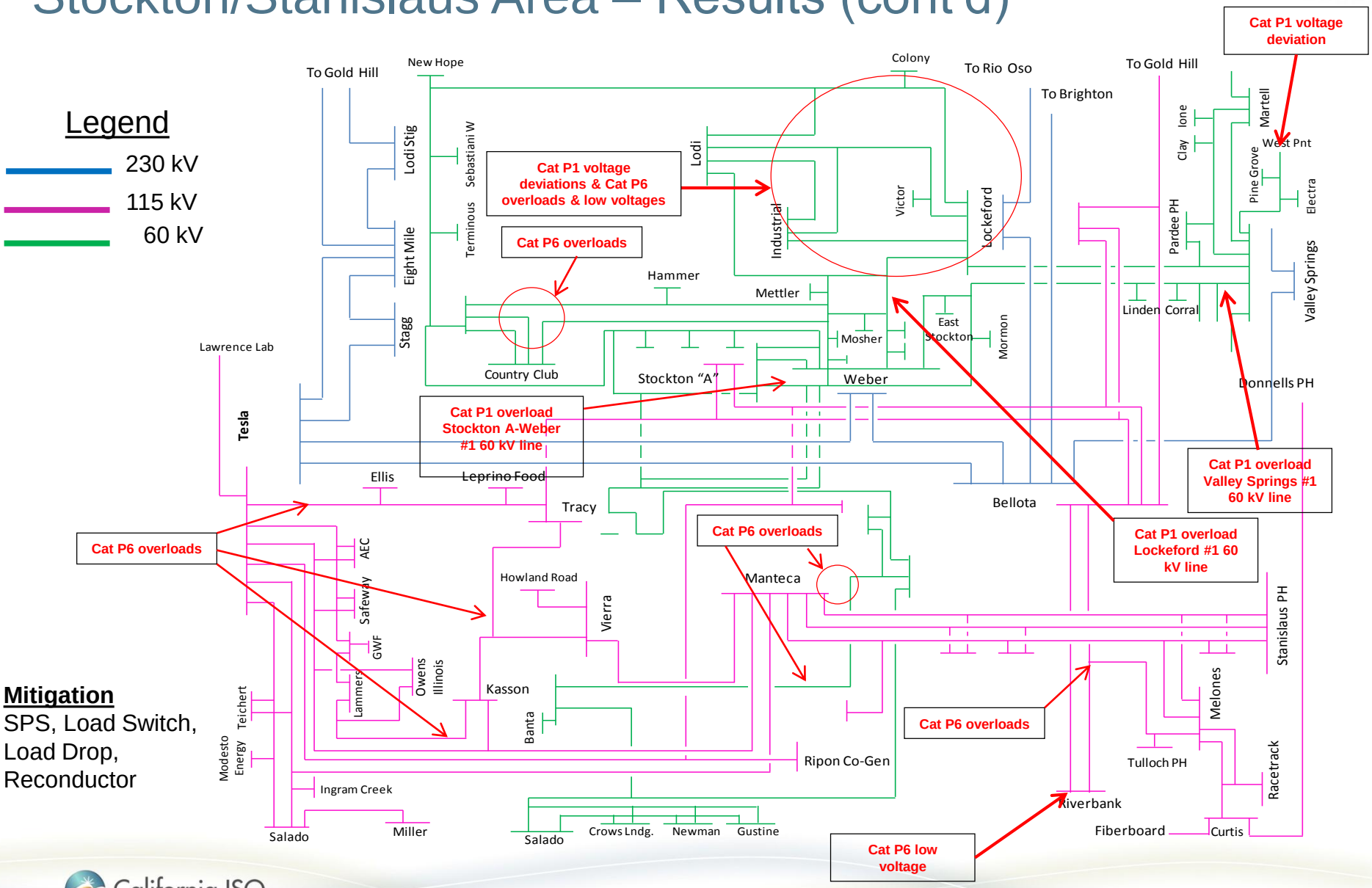
Stockton/Stanislaus Area – Results (Category P0 & P1)

- Voltage Results
  - Westley 60 kV (Cat P1 - 2017)
  - Lockford 230 kV (Cat P1 - 2017)
- Potential Mitigations
  - Interim action plans for overloads with long-term projects in place.
  - Potential Mitigation – Disable automatics during peak loading conditions and may need additional reactive support

- Voltage Results (Sensitivity)
  - No Cat P0 nor Cat P1 voltage deviation issues
- Potential Mitigations
  - N/A

Voltage issues resulting from other contingency categories will be discussed in the area diagram

Stockton/Stanislaus Area – Results (cont'd)



Mitigation
SPS, Load Switch, Load Drop, Reconductor

Conclusion

Reliability issues needing new mitigation

Area	Facility	Contingency Category	Potential Mitigation
North Valley 60 kV Area	Cottonwood-Benton 60kV Line	P2	System upgrade or preferred resource
	Cascade-Stillwater 60kV Line	P6	
Sierra 115 kV Area	East Nicolaus 115/60 kV Bank	P6	Approved project scope change if feasible
	Drum-Dutch Flat #1 115kV Line	P6	System upgrade or preferred resource
	Horseshoe-Newcastle #2 115kV Line	P6	
Sacramento 115 kV Area	Vica Dixon 230/115kV #3 Bank	P6	System upgrade or preferred resource
Stockton/ Stanislaus 115 kV Area	Stanislaus-Melone SW Station-Manteca #3 115 kV Line	P7	System upgrade or preferred resource
North & Central Valley Area	High voltage issues in light load and off-peak conditions	P1	Voltage support or storage

Greater Bay Area
Preliminary Reliability Assessment Results

Binaya Shrestha
Sr. Regional Transmission Engineer

2015-2016 Transmission Planning Process Stakeholder Meeting
September 21-22, 2015

Greater Bay Area

- Service areas cover Alameda, Contra Costa, Santa Clara, San Mateo and San Francisco counties
- 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

Greater Bay Area

- Major substations: Vaca Dixon, Tesla and Metcalf
- Supply sources: Vaca Dixon, Tesla and Metcalf
- Generation: Approximately 7,000 MW of generation capacity.
- Comprised of 60, 115 & 230 & 500 kV transmission facilities.
- Summer Peak 8,730 MW in 2025 (666 MW of AAEE) *(decrease of 112 MW from last year's forecast for 2024)*

Study Scenarios

- 8 Baseline Scenarios
  - 2017 Summer Peak
  - 2020 Summer Peak
  - 2025 Summer Peak
  - 2017 Spring Off-peak
  - 2020 Light Load
  - 2017 Winter Peak (SF & Peninsula)
  - 2020 Winter Peak (SF & Peninsula)
  - 2025 Winter Peak (SF & Peninsula)

- 3 Sensitivity Scenarios
  - 2025 Summer Peak No AAEE *(666 MW)*
  - 2025 Summer Peak No QF *(276 MW)*
  - 2020 Summer Peak High Renewable *(Existing & new renewables dispatched to Pmax)*

Greater Bay Area Assessment Summary

- The 2015-16 assessment identified:
  - Thermal overloads due to Category P1 – 3, P2 – 42, P3 – 1, P6 - 26 and P7 – 18
  - Low voltages due to P2 – 3, P6 – 9 and P7 – 9
  - Voltage deviations due to P1 – 3 and P2 – 8
  - Area-wide high voltage under normal condition (light-load)

- Compared to last year results:
  - 1 new Category P1 thermal overload due to load increase
  - 2 Category P1 overloads eliminated due to previously approved project.
  - 2 Category P1 overloads eliminated due to system reconfiguration.
  - 1 new Category P2-1 overload (new contingency category)
  - Last year there was 1 project approved in this area
    - TBC runback scheme modification & cable rerate.

Greater Bay Area – Results (Category P0 & P1)

- Thermal Overloads
  1. Potrero-Mission (AX) 115kV Cable (Cat P1 – Summer 2025 and Winter 2017, 2020 & 2025)
  2. Newark-Dixon Landing 115kV Line (Cat P1 – Summer 2017)
  3. Piercy-Metcalf 115kV Line (Cat P1 – Summer 2017)
- Potential Mitigations
  - Interim action plans for overloads with long-term projects in place.

- Thermal Overloads (Sensitivity)
  1. Jefferson-Stanford #1 60 kV line (Cat P1 – Summer 2025 No AAEE)
  2. Metcalf-Llagas 115 kV Line (Cat P1 – Summer 2025 High Renewable)
- Potential Mitigations
  - Interim action plans for overloads with long-term projects in place.
  - Generation redispatch

Thermal issues resulting from other contingency categories will be discussed in the area diagram

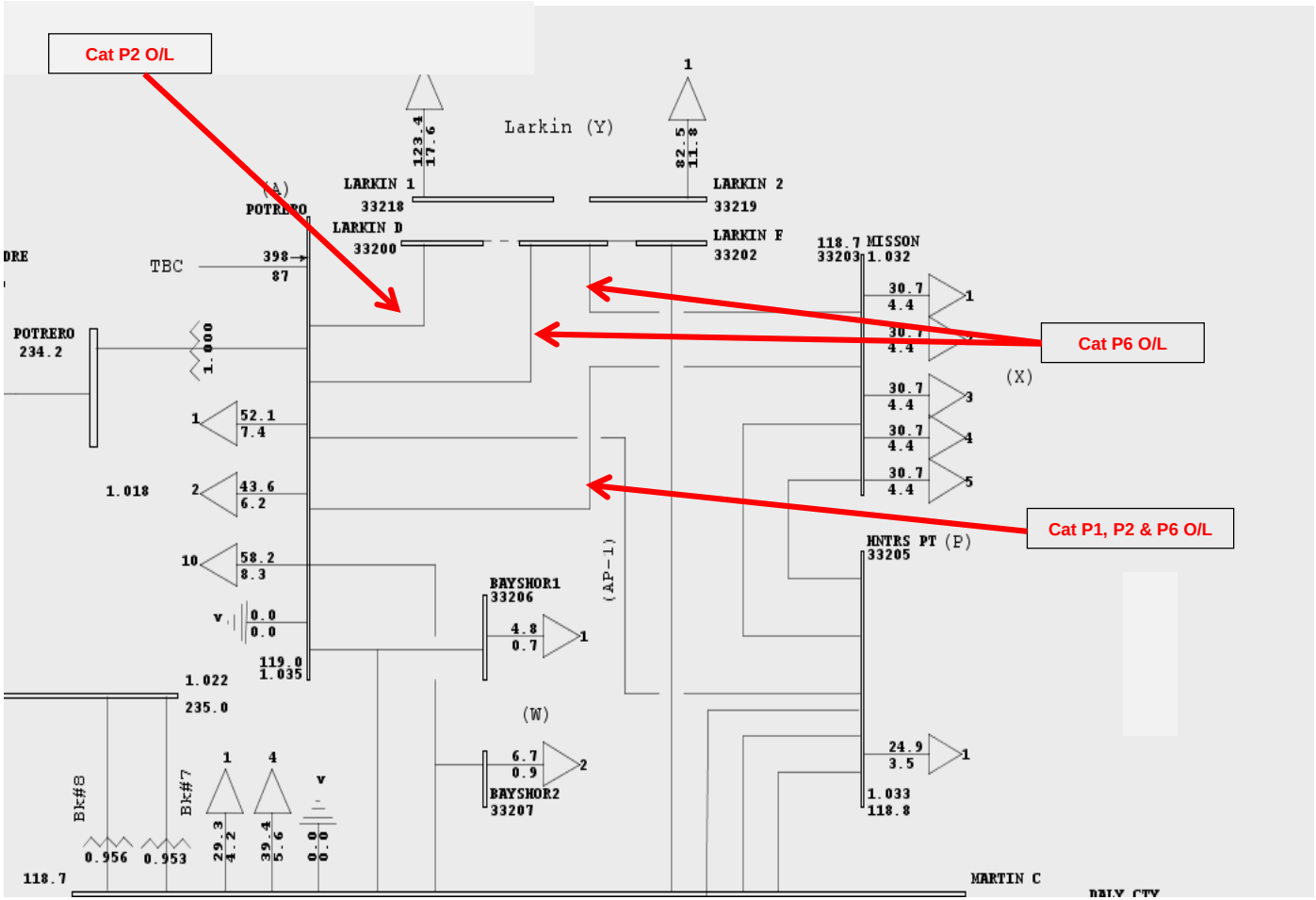
Greater Bay Area – Results (Category P0 & P1)

- Voltage Results
  - Dixon Landing 115 kV voltage deviation (Cat P1 - 2016)
  - Area-wide high voltage (Cat P0 – 2020 light-load)
- Potential Mitigations
  - Interim action plans for overloads with long-term projects in place.
  - Mitigation under investigation for the high voltage issues

- Voltage Results (Sensitivity)
  - Owens Brockway 115 kV voltage deviation (Cat P1 – Summer 2025 No AAEE)
  - Gilroy F & Llagas 115 kV voltage deviation (Cat P1 – Summer 2025 High Renewable)
- Potential Mitigations
  - Interim action plans for overloads with long-term projects in place.
  - Generation redispatch

Voltage issues resulting from other contingency categories will be discussed in the area diagram

San Francisco 115 kV system



Approved Projects

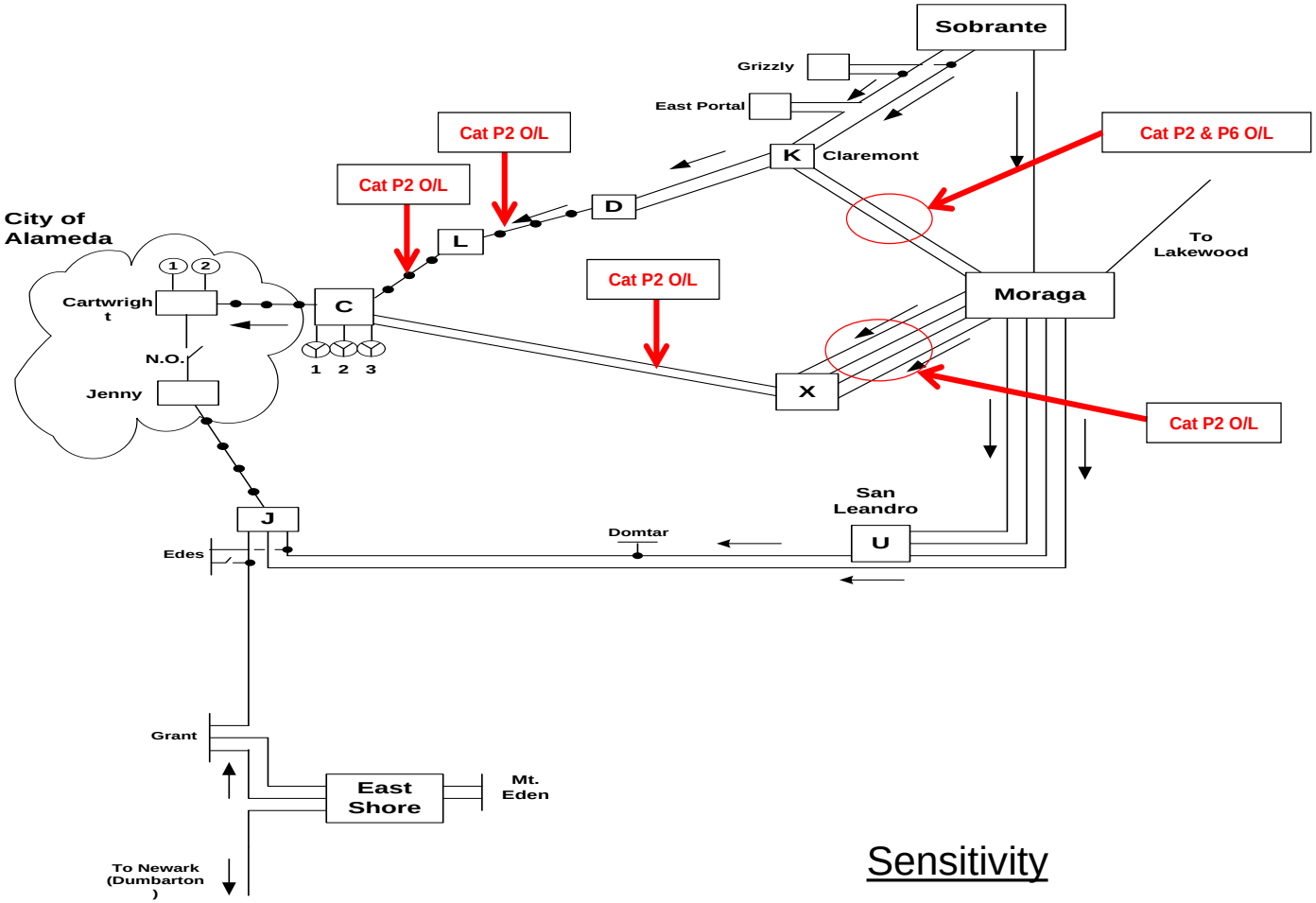
- TBC runback scheme modification & cable rerate

Sensitivity

- No significant impact

Oakland 115 kV system (Northern)

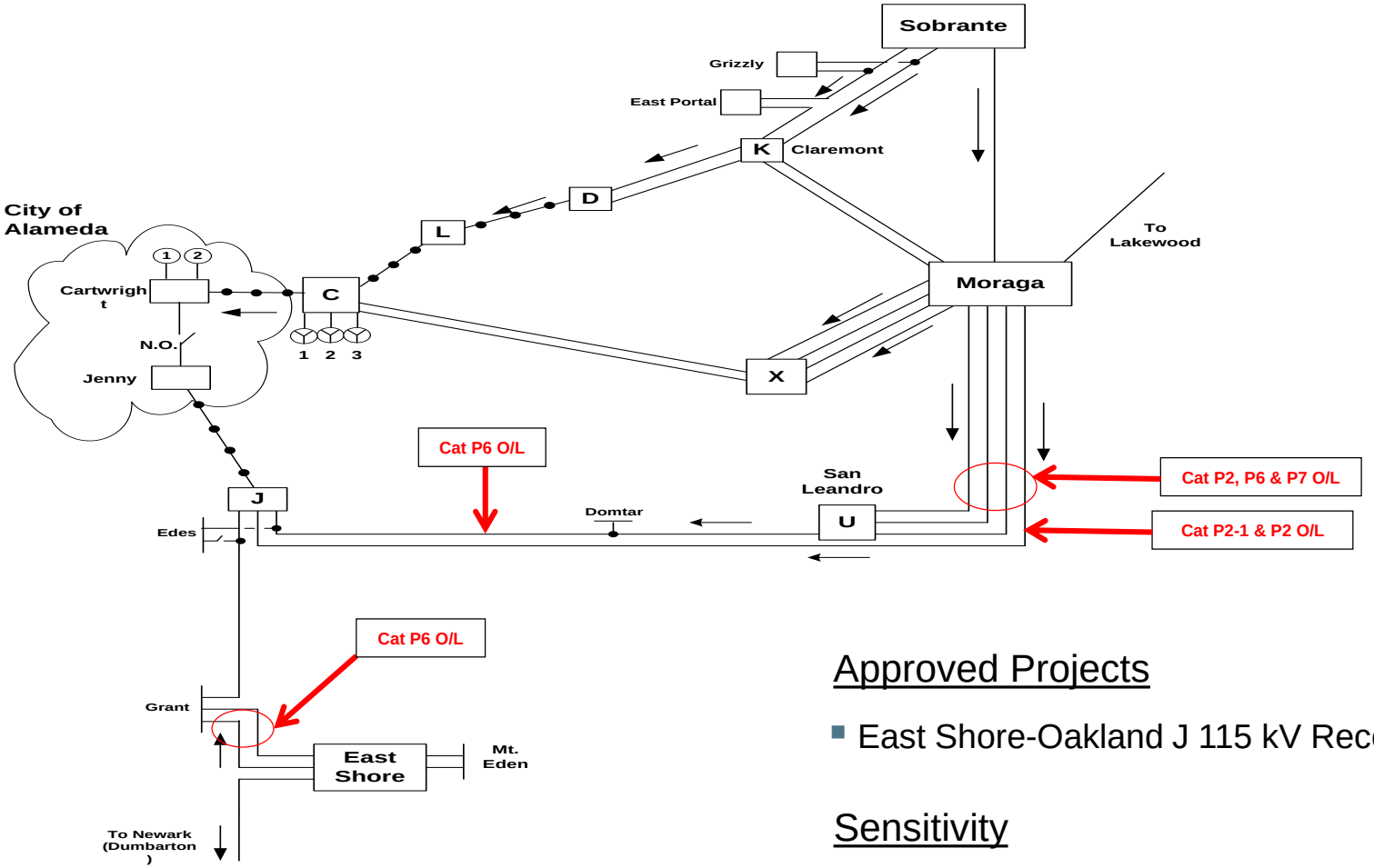
No local generation dispatched



Sensitivity

- Thermal loadings worsen in “No AAEE”

Oakland 115 kV system (Southern)



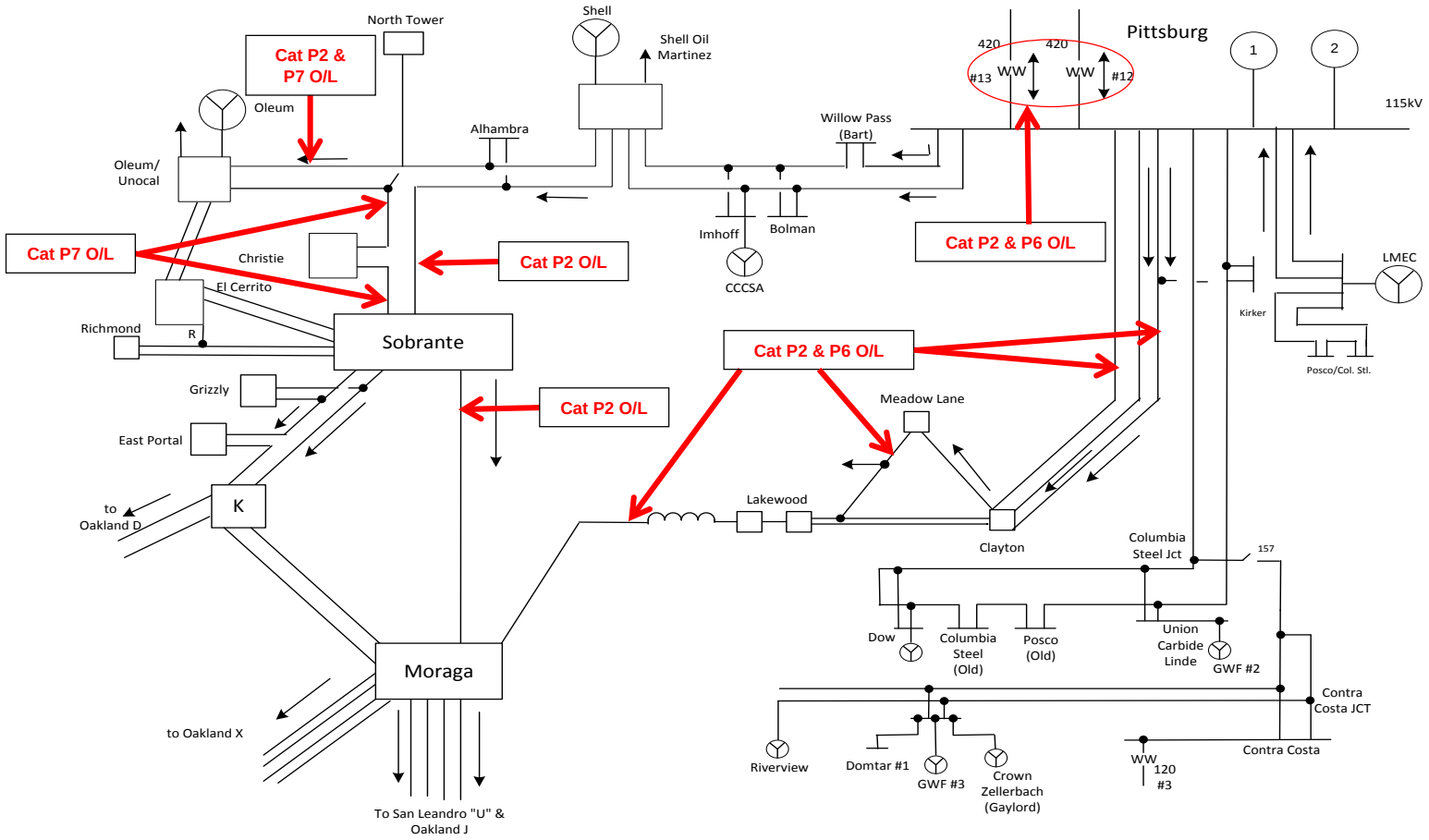
Approved Projects

- East Shore-Oakland J 115 kV Reconductoring

Sensitivity

- No significant impact
- One new voltage deviation in “No AAEE”

Pittsburg-Moraga 115 kV system



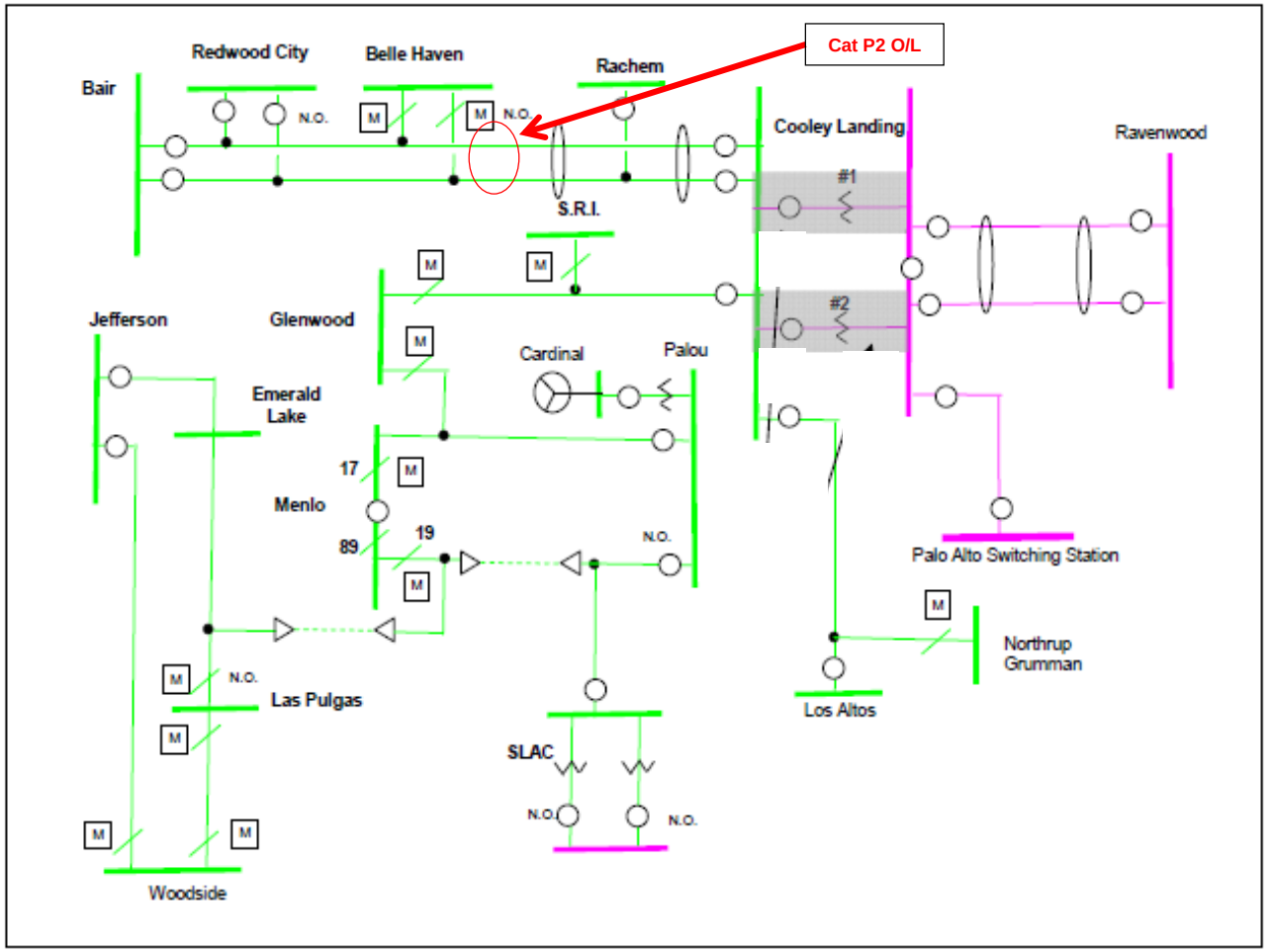
Approved Projects

- North Tower 115 kV Looping
- Pittsburg 230/115 kV Transformer Addition
- Pittsburg-Lakewood SPS

Sensitivity

- Thermal loadings worsen in “No AAEE”
- Couple of new contingency overloads in “No QF” & “High Renewable”

Peninsula 60 kV system



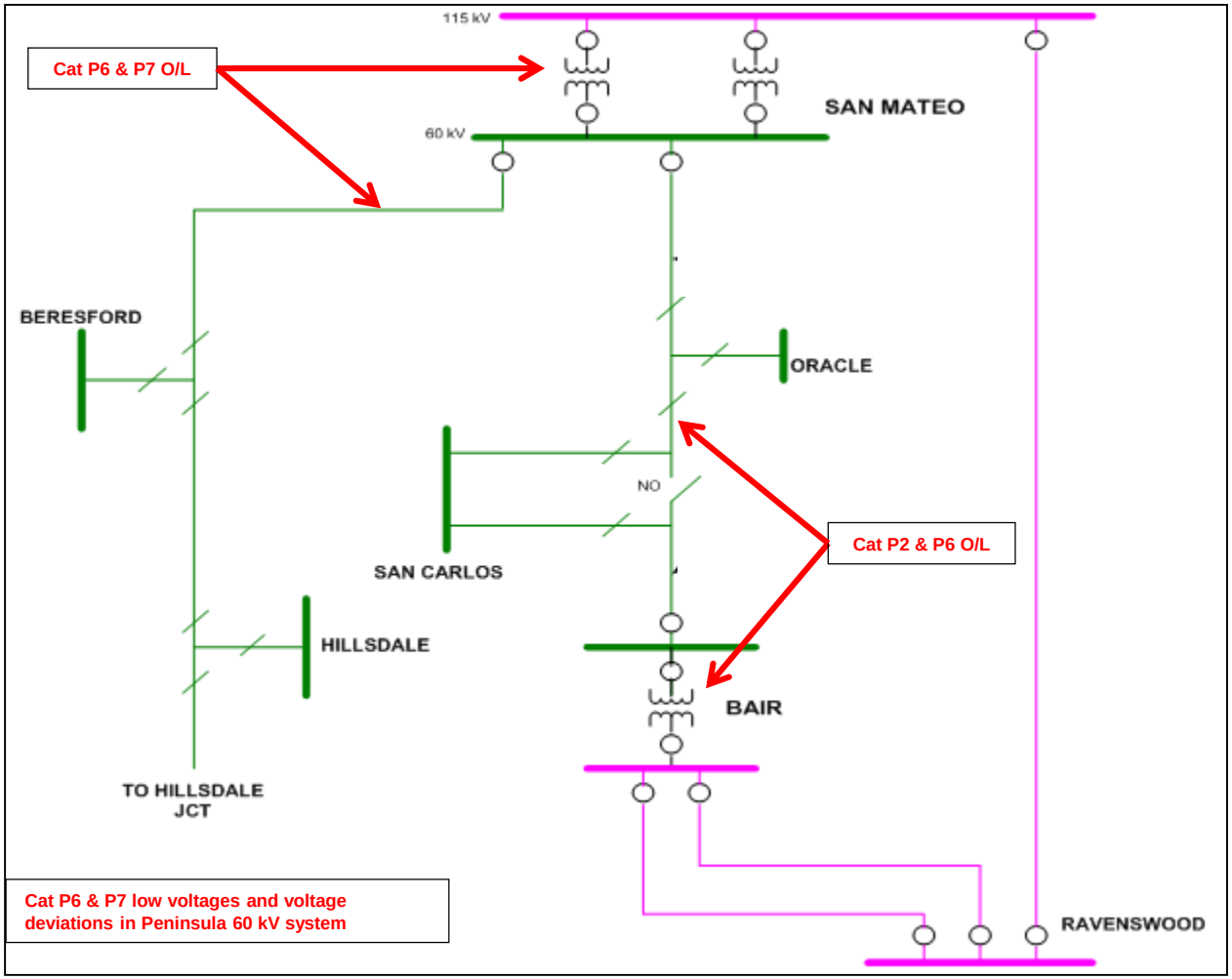
Approved Projects

- Jefferson-Stanford #2 60 kV line

Sensitivity

- Thermal loadings worsen in “No AAEE”
- One new overload in “No AAEE”

Peninsula 60 kV system



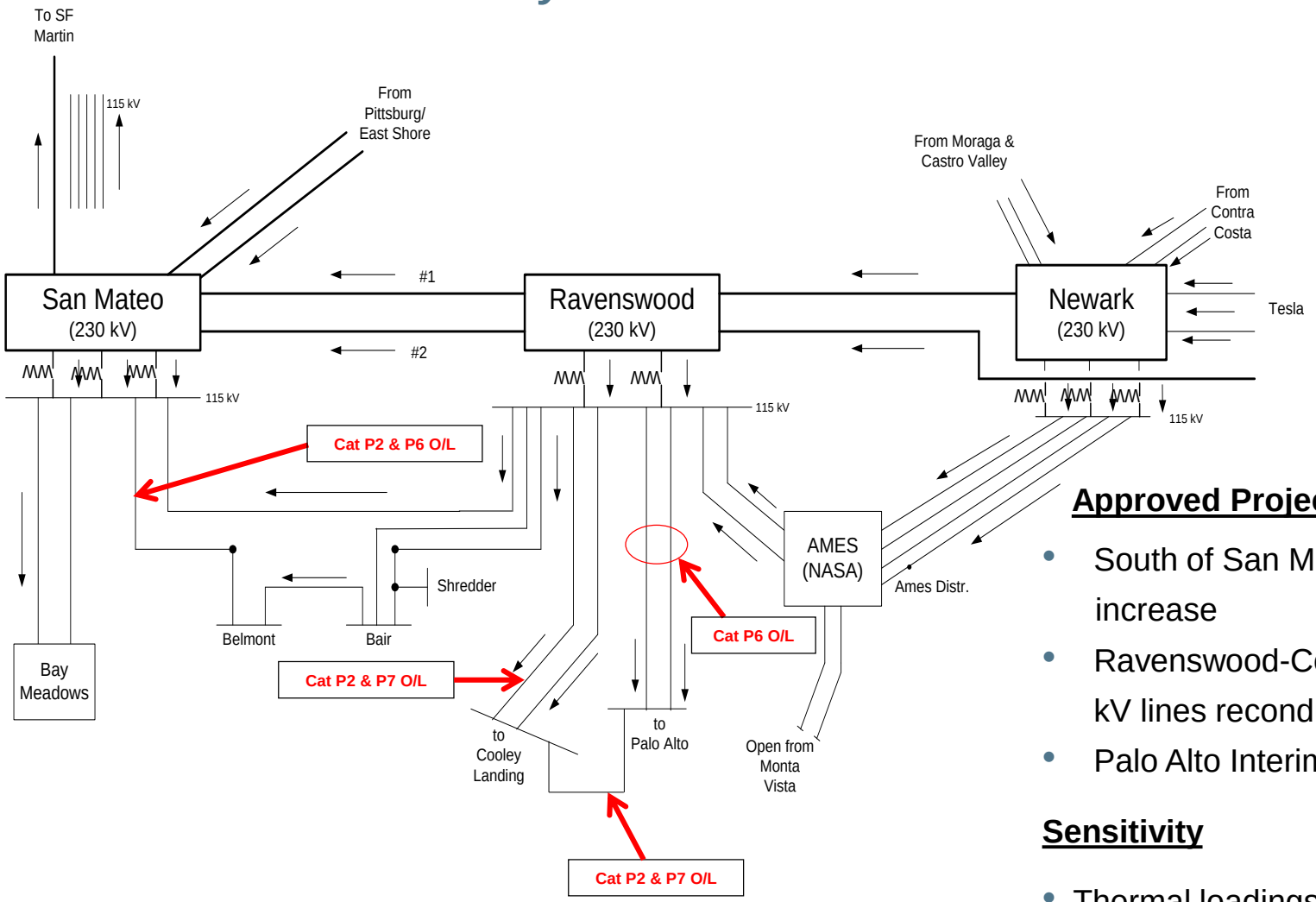
Approved Projects

- San Mateo-Bair 60 kV line reconductor project

Sensitivity

- Thermal loadings worsen in “No AAEE”

Peninsula 115 kV system



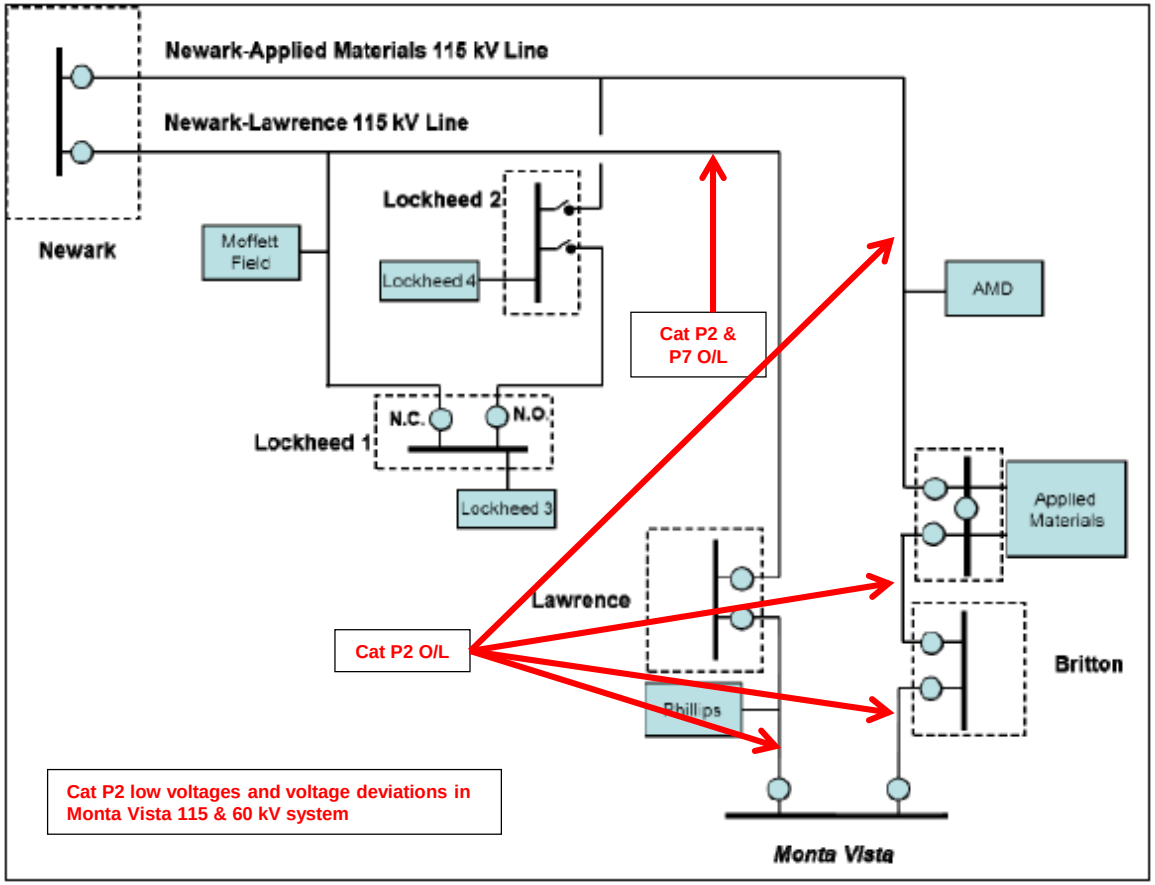
Approved Projects

- South of San Mateo capacity increase
- Ravenswood-Cooley Landing 115 kV lines reconductor
- Palo Alto Interim SPS

Sensitivity

- Thermal loadings slightly worsen in “No AAEE”

Newark-Monta Vista 115 kV system



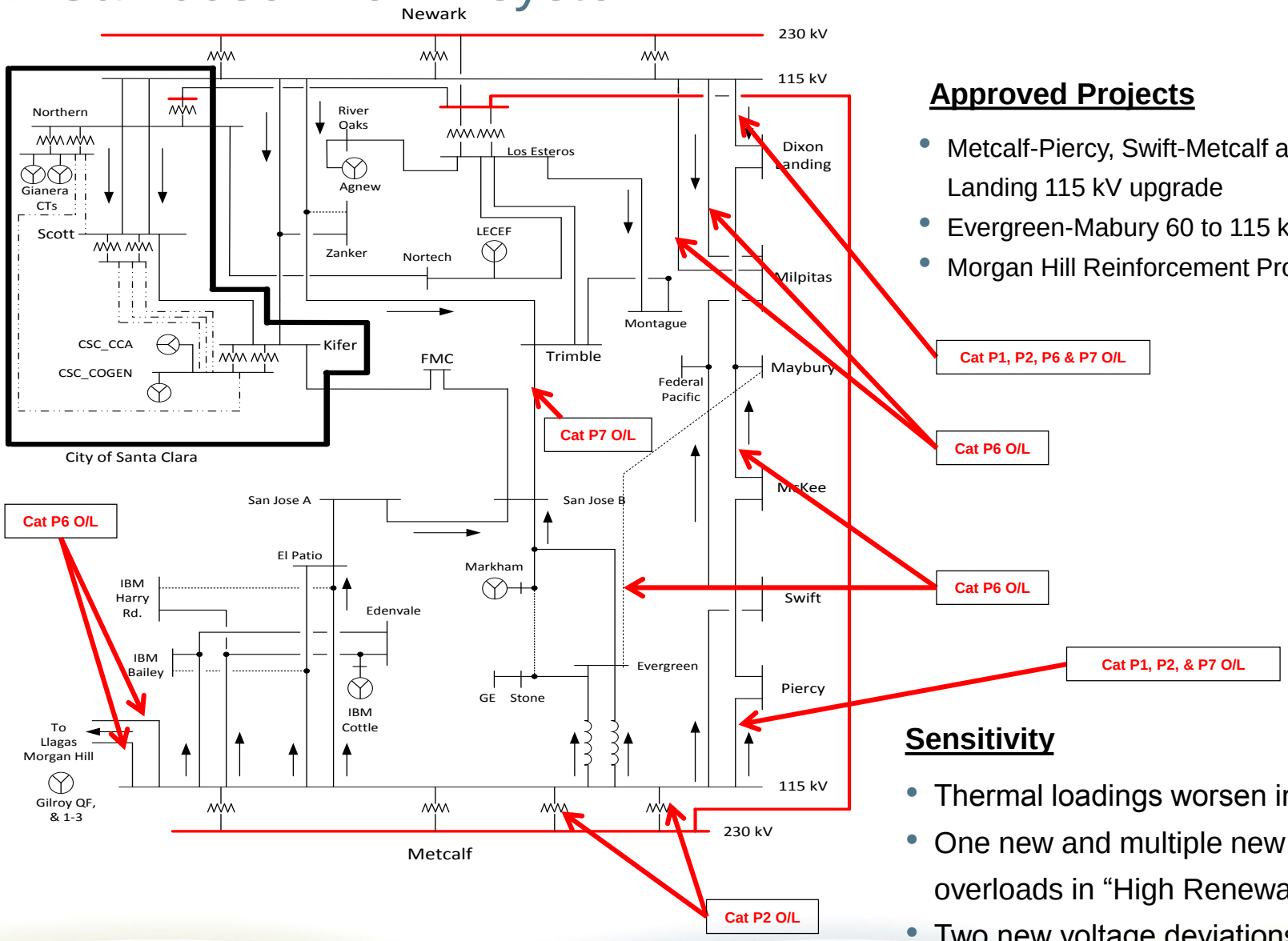
Approved Projects

- Newark-Applied Materials 115 kV substation equipment upgrade project
- Monta Vista 230 kV bus upgrade project

Sensitivity

- Thermal loadings worsen in “No AAEE”

San Jose 115 kV system



Approved Projects

- Metcalf-Piercy, Swift-Metcalf and Newark-Dixon Landing 115 kV upgrade
- Evergreen-Mabury 60 to 115 kV Conversion
- Morgan Hill Reinforcement Project

Sensitivity

- Thermal loadings worsen in “No AAEE”
- One new and multiple new contingency overloads in “High Renewable”
- Two new voltage deviations in “High Renewable”

Conclusion

Reliability issues needing new mitigation

Area	Facility	Contingency Category	Potential Mitigation
Oleum-Christie 115 kV Area	Oleum-Martinez 115kV Line	P2	System upgrade or preferred resource
	Christie-Sobrante (Oleum-Sobrante) 115kV Line	P6	
	Oleum-Christie 115kV Line	P7	
Metcalf 115 kV Area	Newark-Dixon Landing 115kV Line	P2 & P6	Approved project scope change if feasible
	Newark-Milpitas #1 115kV Line	P6	System upgrade or preferred resource
	Newark-Milpitas #2 115kV Line	P6	
	Dixon Landing-McKee 115 kV Line	P6	
	Mabury-Jennings J. 115 kV Line	P6	
Newark-Monta Vista 115 kV Area	Newark-Lawerence 115kV Line	P7	System upgrade or preferred resource
Peninsula 115 kV	San Mateo-Belmont 115kV Line	P6	Approved project scope change if feasible
Greater Bay Area	High voltage issues in light load conditions	P0	Voltage support or storage

East Bay Area Sensitivity Study
Preliminary Reliability Assessment Results

Binaya Shrestha
Sr. Regional Transmission Engineer

2015-2016 Transmission Planning Process Stakeholder Meeting
September 21-22, 2015

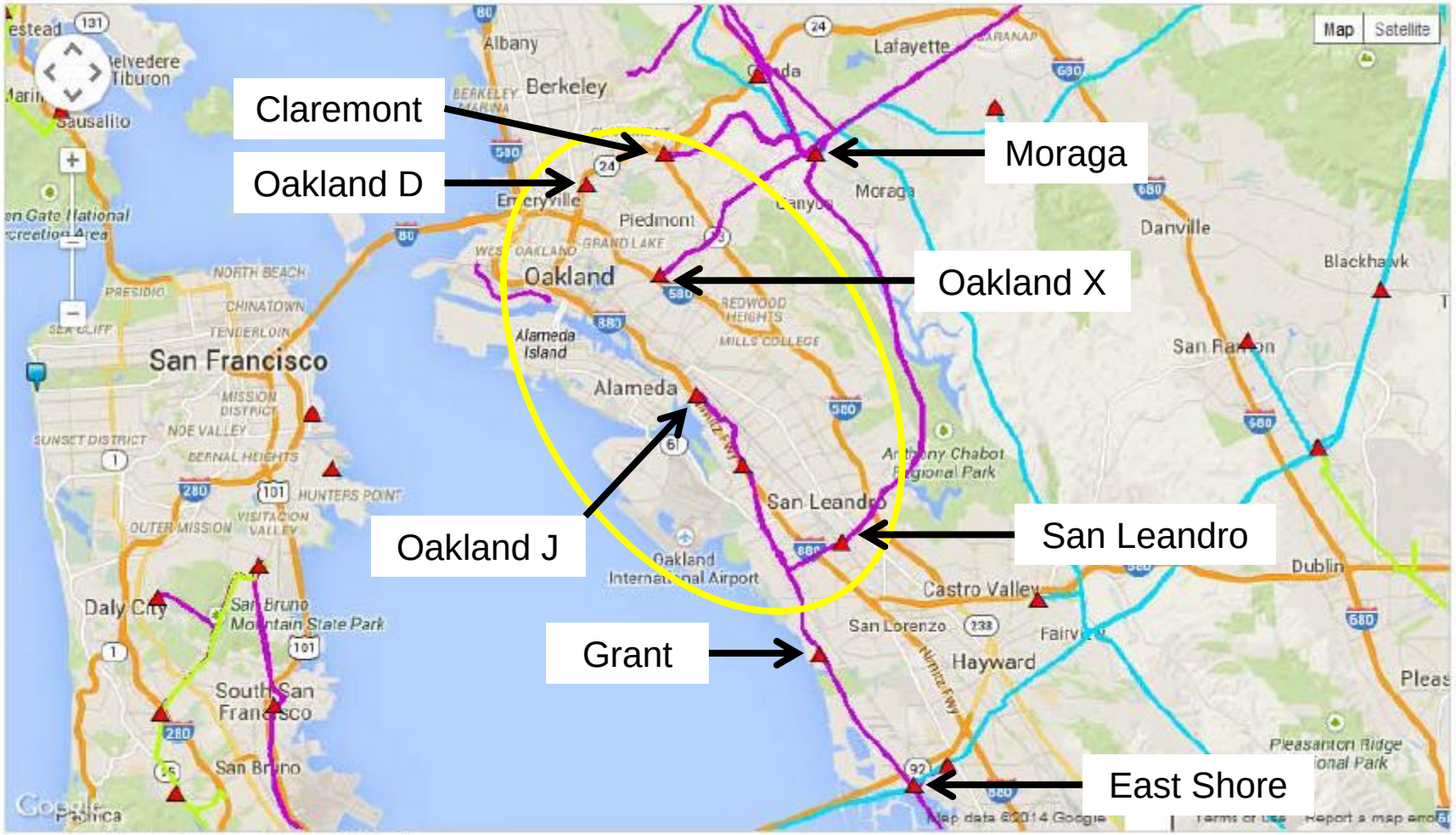
Objective

To identify the order of magnitude long-term reliability needs and assess reliance on existing SPS in East Bay area without the local generation being available.

Drivers for the long-term need

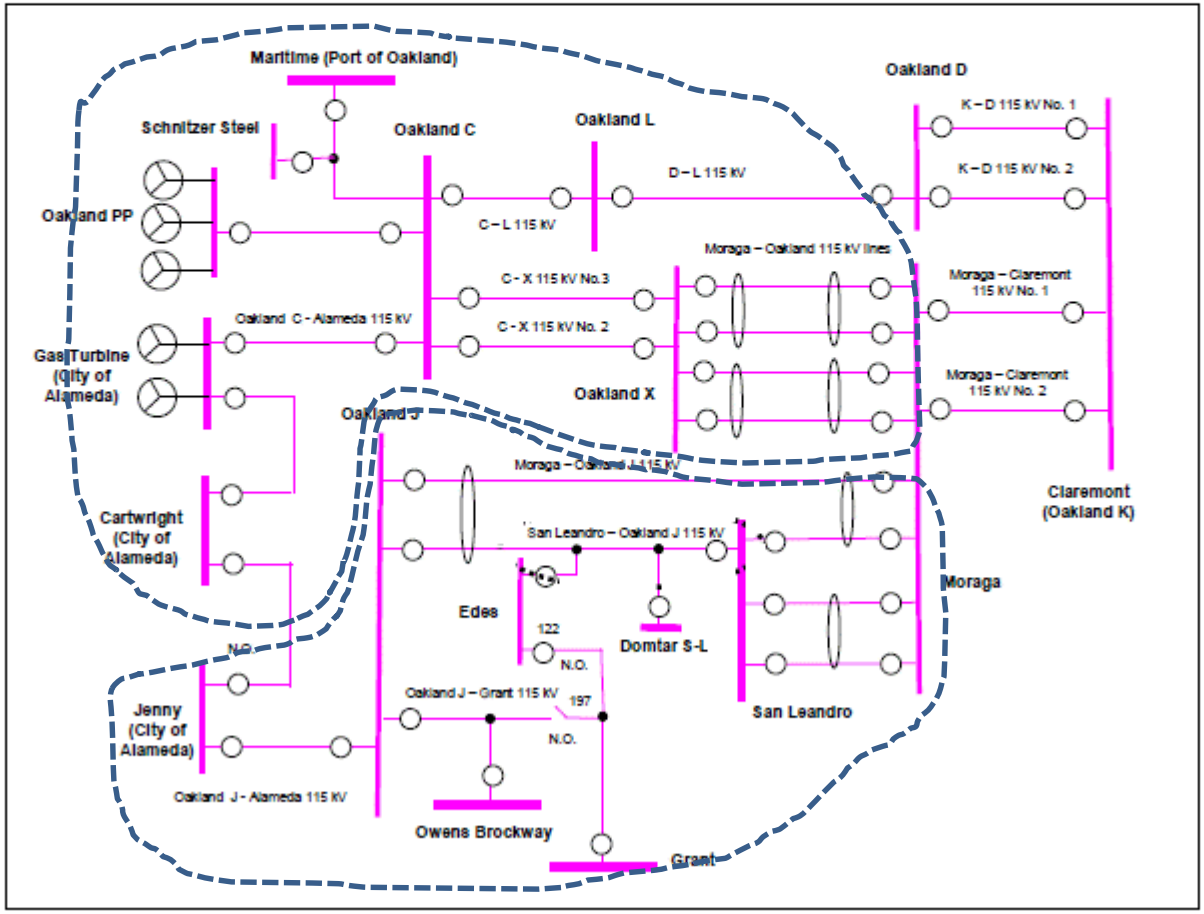
- Potential retirement of Oakland area generation due to age.
- Eliminate reliance on SPS per new ISO planning standard.

Geographic map – Oakland area transmission system



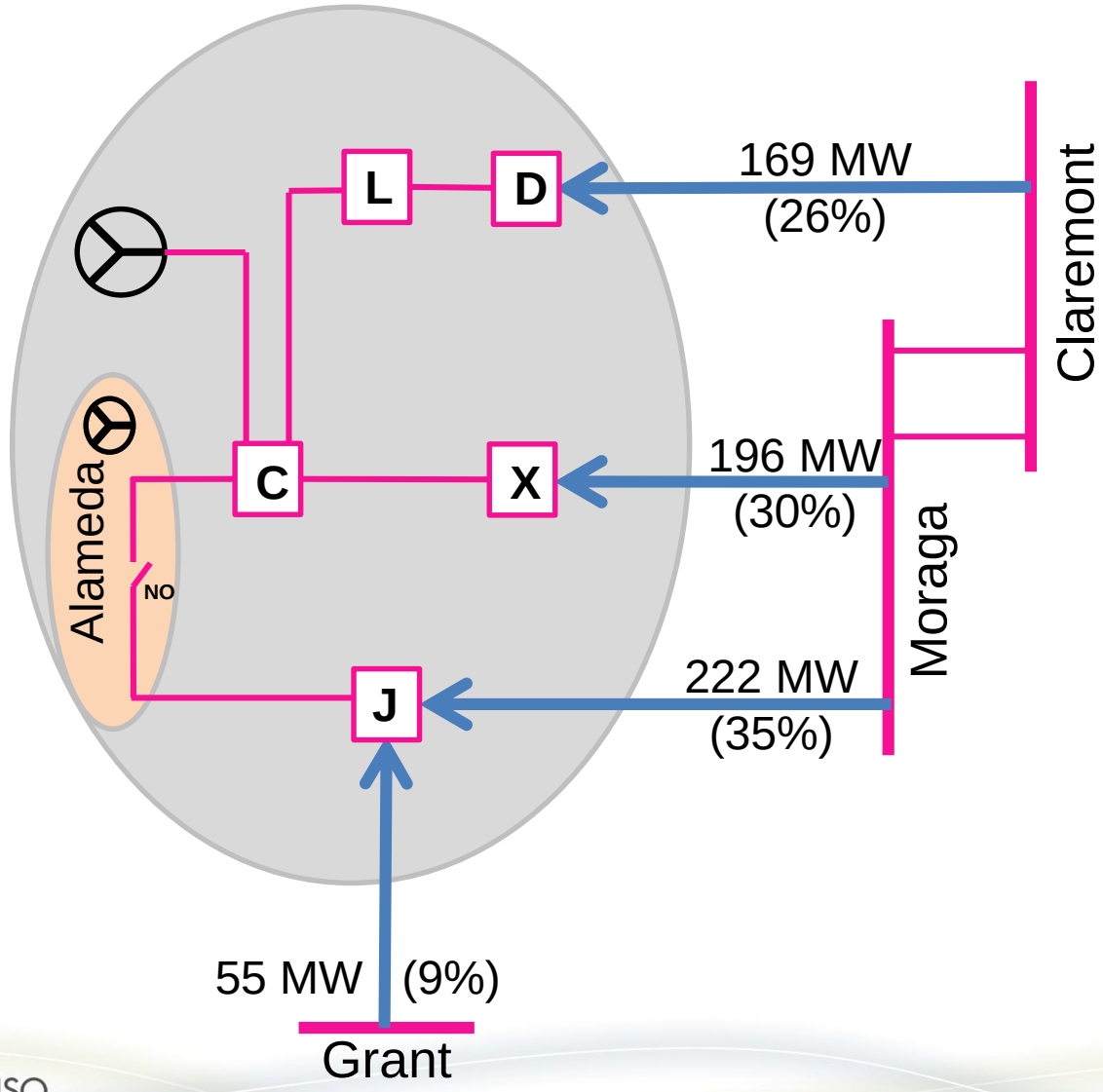
map width: 35.41 miles, map height: 20.20 miles

One-line Diagram – Oakland area transmission system



2025 Oakland Area Supply

(N-0, Zero local Generation)



Existing SPS in Oakland Area

SPS Name	Description
Moraga – Oakland J 115 kV Line Overload RAS	Prevents overloading of 115 kV lines from Moraga serving San Leandro and Oakland J. Opens circuit breakers at Oakland J to drop load.
Grant 115 kV Overload SPS	Prevents overloading of the Eastshore - Grant # 1 or # 2 115 kV lines. Trips distribution feeders at Grant.
Oakland 115 kV C-X cable Overload RAS	Prevents overloading of Oakland C – X #2 115 kV cable. Opens circuit breakers at Oakland C.
Oakland 115 kV D-L cable Overload RAS	Prevents overloading of Oakland D – L 115 kV cable. Opens circuit breakers at Oakland C.

Study Scenarios

- 3 Scenarios
  - 2025 Summer Peak all local generation ON
  - 2025 Summer Peak all local generation OFF
  - 2025 Summer Peak all local generation OFF and No AAEE

Overloads in northern part of Oakland 115 kV system

S. No.	Overloaded Facility	Worst Contingency	Category	2025 Summer Peak with max generation	2025 Summer Peak with zero generation	2025 Summer Peak with zero generation & no AAEE
1	Oakland D - Oakland L 115kV Cable	BUS-TIE BREAKER FAULT AT 32790 STATIN X 115.00	P2	62.48	132.39	137.36
2	Oakland C - Oakland L #1 115kV Cable	BUS-TIE BREAKER 162 FAULT AT 32780 CLARMNT 115.00	P2	97	99.64	105.71
3	Oakland C - Oakland X #2 115kV Cable	BUS-TIE BREAKER 162 FAULT AT 32780 CLARMNT 115.00	P2	31.66	113.86	120.26
4	Moraga-Claremont #1 115kV Line	BUS-TIE BREAKER FAULT AT 32790 STATIN X 115.00	P2	95.01	127.49	136.27
5	Moraga-Claremont #2 115kV Line	BUS-TIE BREAKER FAULT AT 32790 STATIN X 115.00	P2	95.15	127.67	136.47
6	Sobrante-Moraga 115kV Line	BUS-TIE BREAKER FAULT AT 30540 SOBRANTE 230.00	P2	91.01	96.47	106.11
7	Moraga-Station X 115 kV #1 Line	BUS-TIE BREAKER 162 FAULT AT 32780 CLARMNT 115.00	P2	46.23	111.91	119.31
8	Moraga-Oakland X #2 115kV Line	BUS-TIE BREAKER 162 FAULT AT 32780 CLARMNT 115.00	P2	41.91	111.91	119.31
9	Moraga-Station X 115 kV #3 Line	BUS-TIE BREAKER FAULT AT 33020 MORAGA 115.00	P2	86.8	154.22	165.91
10	Moraga-Station X 115 kV #4 Line	BUS-TIE BREAKER FAULT AT 33020 MORAGA 115.00	P2	86.8	154.22	165.91
11	Oakland D - Oakland L 115kV Cable	Oakland C - Oakland X #2 115kV Cable & Oakland C - Oakland X #3 115kV Cable	P6	<90	132.95	138.12
12	Oakland C - Oakland L #1 115kV Cable	Claremont K - Oakland D #1 115kV Cable & Claremont K - Oakland D #2 115kV Cable	P6	98.2	98.2	105.99
13	Oakland C - Oakland X #2 115kV Cable	Oakland C - Oakland X #3 115kV Cable & Oakland D - Oakland L 115kV Cable	P6	94.28	132.35	137.52
14	Moraga-Claremont #1 115kV Line	Oakland C - Oakland X #2 115kV Cable & Oakland C - Oakland X #3 115kV Cable	P6	<90	106.45	114.45
15	Moraga-Claremont #2 115kV Line	Oakland C - Oakland X #2 115kV Cable & Oakland C - Oakland X #3 115kV Cable	P6	<90	106.61	114.62
16	Moraga-Station X 115 kV #1 Line	Claremont K - Oakland D #2 115kV Cable & Claremont K - Oakland D #1 115kV Cable	P6	<90	112.21	119.63
17	Moraga-Oakland X #2 115kV Line	Claremont K - Oakland D #2 115kV Cable & Claremont K - Oakland D #1 115kV Cable	P6	<90	112.21	119.63
18	Moraga-Station X 115 kV #3 Line	Claremont K - Oakland D #2 115kV Cable & Claremont K - Oakland D #1 115kV Cable	P6	<90	112.21	119.63
19	Moraga-Station X 115 kV #4 Line	Claremont K - Oakland D #2 115kV Cable & Claremont K - Oakland D #1 115kV Cable	P6	<90	112.21	119.63
20	Moraga-Station X 115 kV #1 Line	Moraga-Oakland Nos. 3 & 4 115 kV lines	P7	42.26	99.07	106.26
21	Moraga-Oakland X #2 115kV Line	Moraga-Oakland Nos. 3 & 4 115 kV lines	P7	42.26	99.07	106.26
22	Moraga-Station X 115 kV #3 Line	Moraga-Oakland X Nos. 1 & 2 115 kV lines	P7	42.26	99.07	106.26
23	Moraga-Station X 115 kV #4 Line	Moraga-Oakland X Nos. 1 & 2 115 kV lines	P7	42.26	99.07	106.26

Overloads in southern part of Oakland 115 kV system

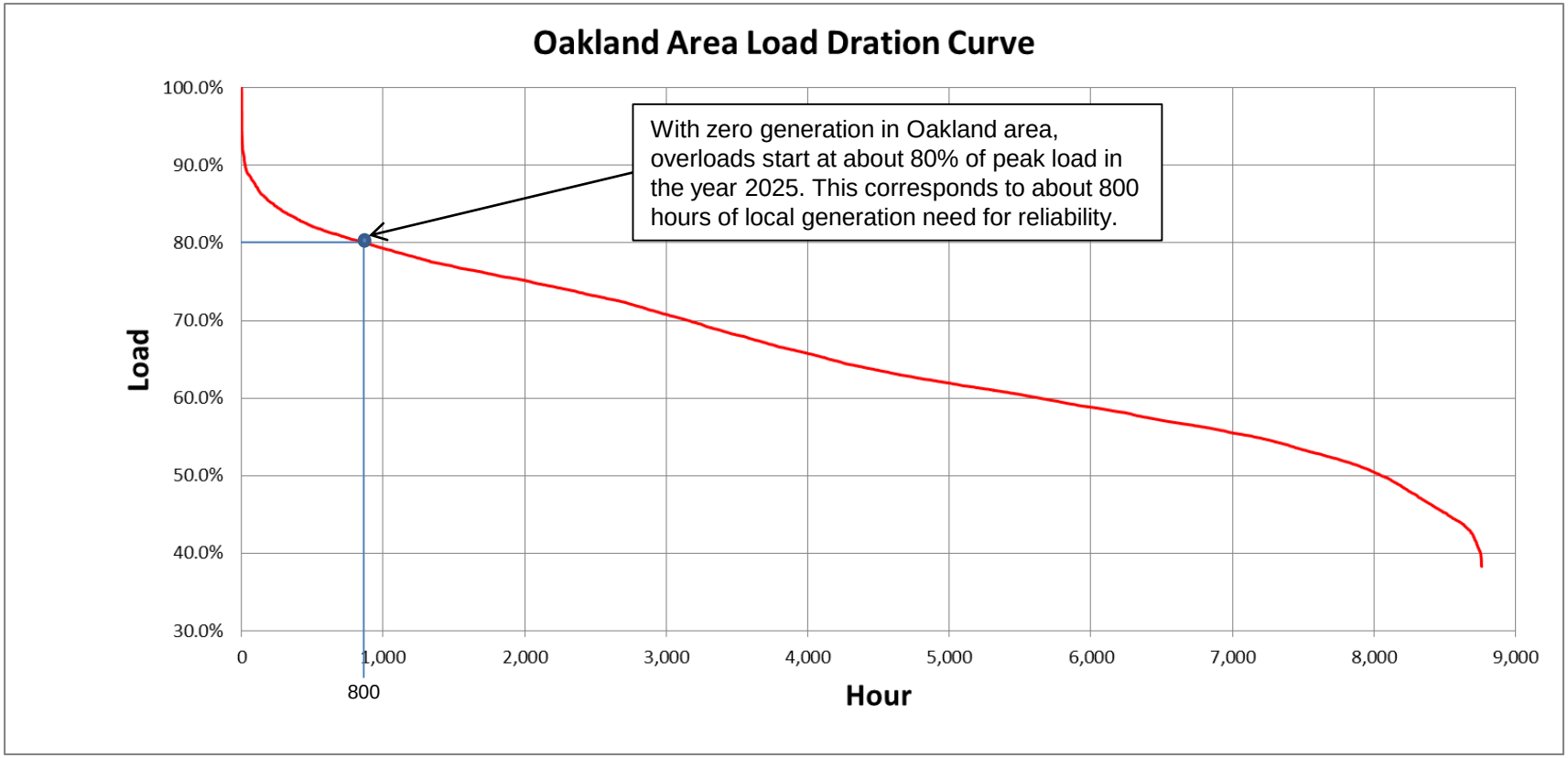
S. No.	Overloaded Facility	Worst Contingency	Category	2025 Summer Peak with max generation	2025 Summer Peak with zero generation	2025 Summer Peak with zero generation & no AAEE
1	Grant-Oakland J 115 kV Line	BUS-TIE BREAKER FAULT AT 30550 MORAGA 230.00	P2	77.85	100.48	109.43
2	San Leandro - Oakland J #1 115kV Line	Grant-Oakland J 115 kV Line & Moraga-Oakland J 115kV Line	P6	93.13	94.31	101.73
3	Moraga-San Leandro #1 115kV Line	Moraga-San Leandro #2 115kV Line & Moraga-San Leandro #3 115kV Line	P6	96.66	<90	100.48
4	Moraga-San Leandro #2 115kV Line	Moraga-San Leandro #1 115kV Line & Moraga-San Leandro #3 115kV Line	P6	97.12	<90	100.95

Load Drop Assessment

Existing SPS	Triggering Contingency Category	Load Drop Required		
		2025 Summer Peak with max generation	2025 Summer Peak with zero generation	2025 Summer Peak with zero generation & no AAEE
Oakland 115 kV C-X cable Overload RAS	P6	Not triggered	50 MW	58 MW
Oakland 115 kV D-L cable Overload RAS	P6	Not triggered	50 MW	58 MW
Moraga – Oakland J 115 kV Line Overload RAS	P6	Not triggered	Not triggered	4 MW
Grant 115 kV Overload SPS	Not triggered	Not triggered	Not triggered	Not triggered

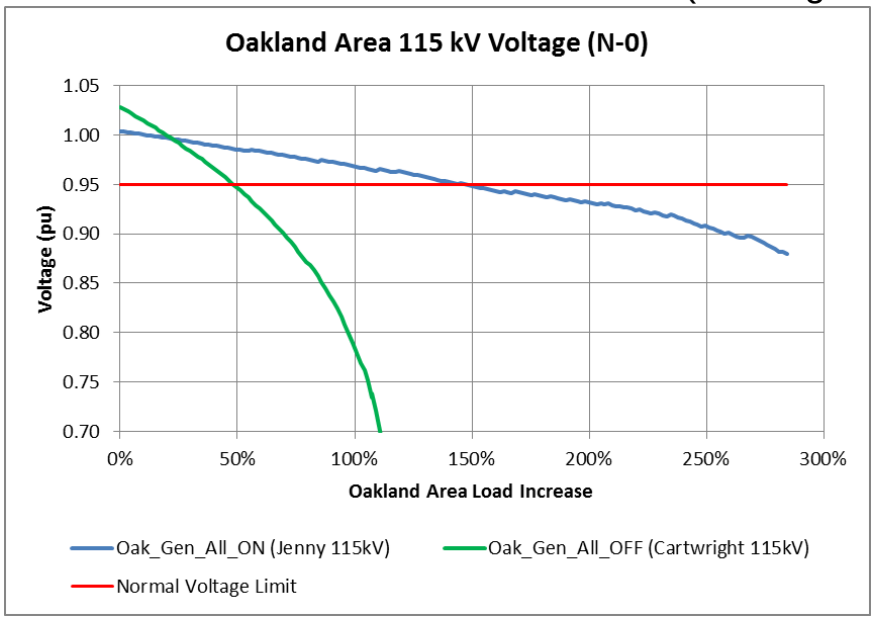
Worst contingency for remaining overloads	Contingency Category	Maximum load drop for overloads not mitigated by existing SPS		
		2025 Summer Peak with max generation	2025 Summer Peak with zero generation	2025 Summer Peak with zero generation & no AAEE
BUS-TIE BREAKER FAULT AT 33020 MORAGA 115.00	P2	Not triggered	165 MW	200 MW
Claremont K - Oakland D #2 115kV Cable & Claremont K - Oakland D #1 115kV Cable	P6	Not triggered	40 MW	60 MW
Moraga-Oakland X Nos. 1 & 2 115 kV lines	P7	Not triggered	Not triggered	18 MW

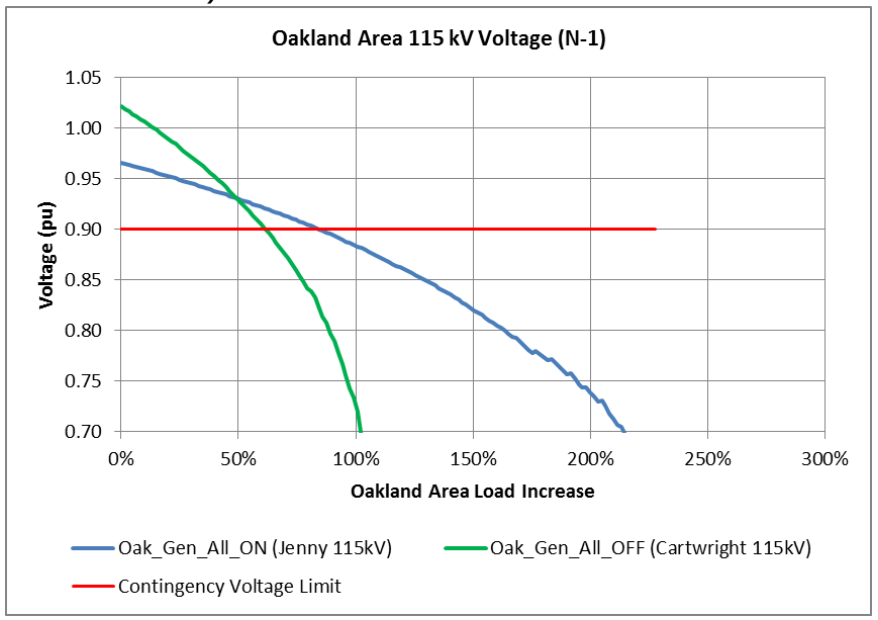
Estimate of generation run-time need for reliability in 2025

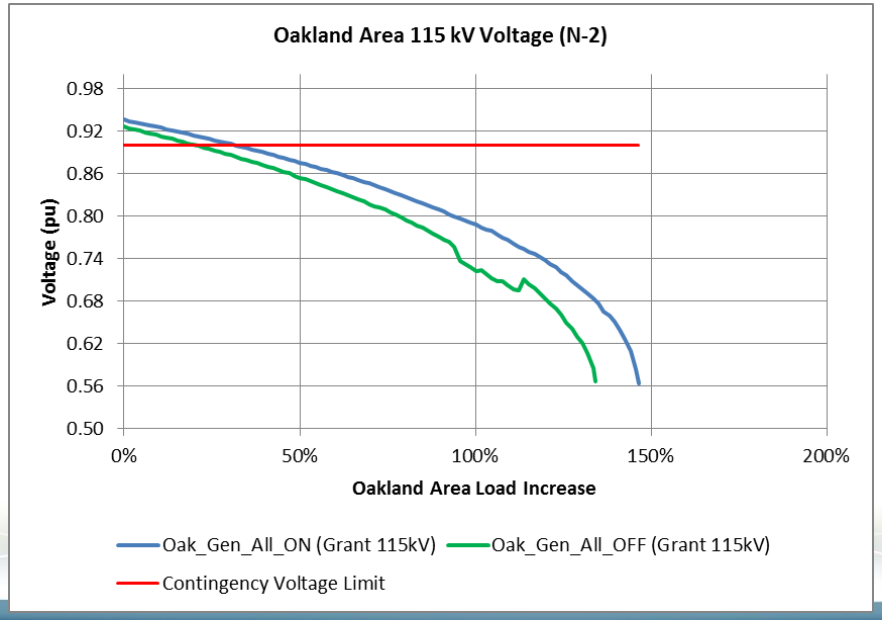


Oakland Area PV Plots

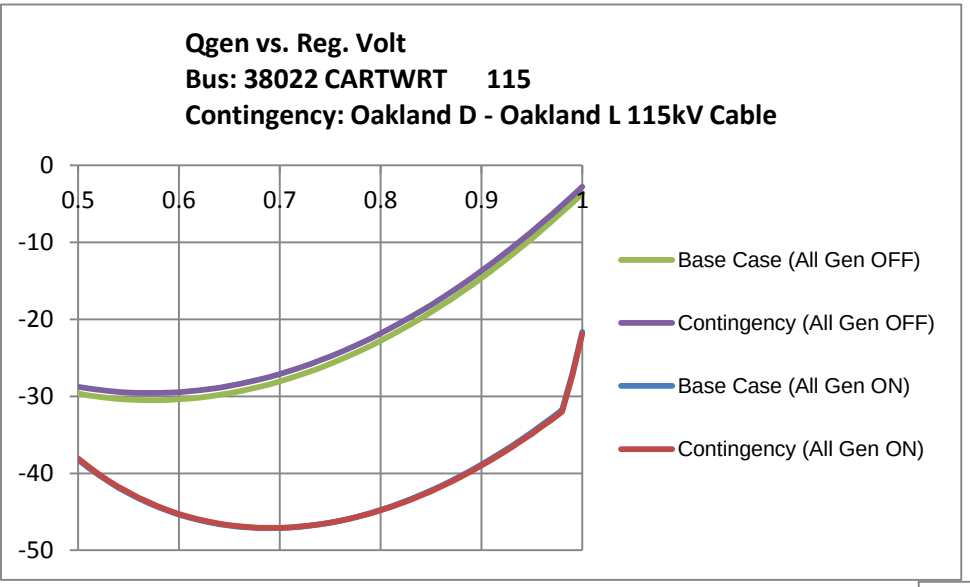
(Starting load level – 2025)

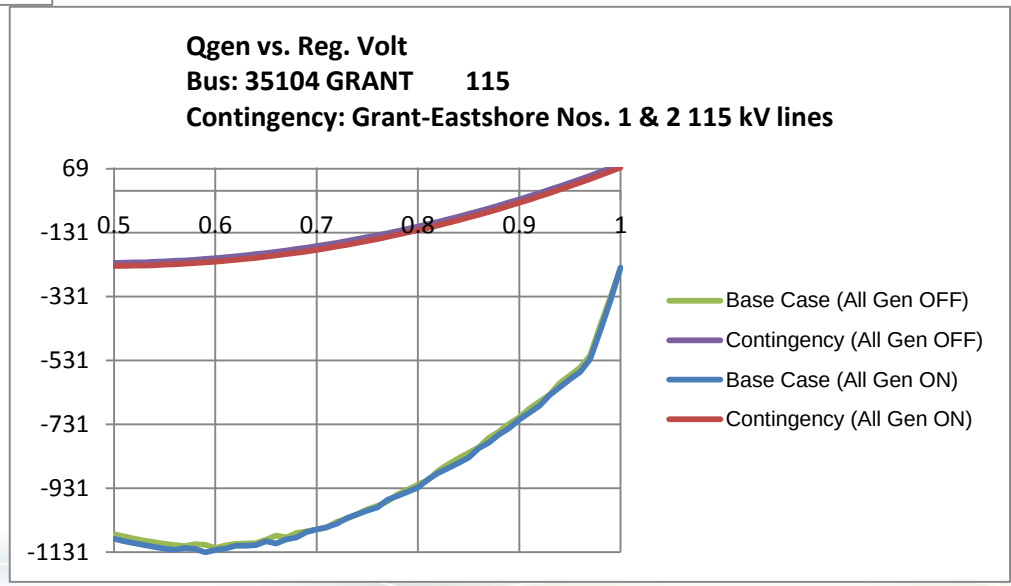






Oakland Area QV Plots





Potential Mitigations

- New transmission solution (~$200M)
  - Moraga – Oakland C 230 kV DCTL.
  - East Shore – Oakland C HVDC submarine cable.
  - Potrero – Oakland C HVDC submarine cable.

- Existing facility upgrade & preferred resources.
  - Preliminary assessment shows that adding at least one breaker at stations causing category P2 issue is feasible with an exception of Oakland C.
  - Demand response could mitigate issues resulting from category P6 contingencies.
  - Storage and possibly combination with small amount load dropping SPS could address issues resulting from category P7 contingencies.
  - Cables rerate, if feasible, could reduce the scope of required facility upgrade and preferred resource.

Summary

- No voltage issues even with no local generation being available.
- No thermal issues with all generation available.
- Existing SPS not triggered with all generation available.
- Ten 115 kV facilities overloads for various categories P2, P6 & P7 contingencies in northern part with no local generation available and no AAEE assumed. Worst overload being 165%.
- Four 115 kV facilities overloads for various categories P2 & P6 contingencies in southern part with no AAEE assumed. Worst overload being 109%.
- Existing SPS in northern part would require to drop ~58 MW load with no local generation available and no AAEE assumed. SPS in southern part would require to drop ~4 MW load.
- Overloads not addressed by existing SPS would require load reduction of ~200 MW with no local generation available and no AAEE assumed, if not addressed with system upgrade.

Conclusion

- With the reliance on aging generation in the area, the ISO is continuing to assess the transmission needs in the Oakland area without the generation being available.
- The ISO will be considering transmission, generation or non-transmission solutions as we assess the needs of the area.
- In the near-term the area relies on SPS with a relatively small amount of load shedding as per the ISO Planning Standards; however the ISO will consider alternatives for the long-term horizon.

Questions?

Reference Slides

All Contingency Report for mitigation development

S. No.	Overloaded Facility	All Contingency	Category	2025 Summer Peak with max generation	2025 Summer Peak with zero generation	2025 Summer Peak with zero generation & no AAEE
1	Grant-Oakland J 115 kV Line	BUS-TIE BREAKER FAULT AT 30550 MORAGA 230.00	P2	77.85	100.48	109.43
2	Moraga-Claremont #1 115kV Line	BUS 2D FAULT AT 33020 MORAGA 115.00	P2	85.86	112.35	120.69
		BUS E FAULT AT 32786 OAK C115 115.00	P2	95.01	111.09	119.34
		BUS-TIE BREAKER FAULT AT 30540 SOBRANTE 230.00	P2	75.33	105.06	114.29
		BUS-TIE BREAKER FAULT AT 32790 STATIN X 115.00	P2	64	127.49	136.27
3	Moraga-Claremont #2 115kV Line	BUS 1D FAULT AT 33020 MORAGA 115.00	P2	67.96	98.21	106.07
		BUS E FAULT AT 32786 OAK C115 115.00	P2	95.15	111.26	119.51
		BUS FAULT AT 32780 CLARMNT 115.00	P2	61.27	93.71	100.88
		BUS-TIE BREAKER FAULT AT 30540 SOBRANTE 230.00	P2	75.44	105.21	114.45
		BUS-TIE BREAKER FAULT AT 32790 STATIN X 115.00	P2	64.1	127.67	136.47
4	Moraga-Oakland X #2 115kV Line	BUS-TIE BREAKER 162 FAULT AT 32780 CLARMNT 115.00	P2	41.31	110.25	117.54
		BUS-TIE BREAKER 162 FAULT AT 32780 CLARMNT 115.00	P2	41.91	111.91	119.31
5	Moraga-Station X 115 kV #1 Line	BUS-TIE BREAKER 162 FAULT AT 32780 CLARMNT 115.00	P2	41.31	110.25	117.54
		BUS-TIE BREAKER 162 FAULT AT 32780 CLARMNT 115.00	P2	41.91	111.91	119.31
6	Moraga-Station X 115 kV #3 Line	BUS-TIE BREAKER 162 FAULT AT 32780 CLARMNT 115.00	P2	41.31	110.25	117.54
		BUS-TIE BREAKER FAULT AT 33020 MORAGA 115.00	P2	85.51	151.93	163.45
		BUS-TIE BREAKER 162 FAULT AT 32780 CLARMNT 115.00	P2	41.91	111.91	119.31
		BUS-TIE BREAKER FAULT AT 33020 MORAGA 115.00	P2	86.8	154.22	165.91
7	Moraga-Station X 115 kV #4 Line	BUS-TIE BREAKER 162 FAULT AT 32780 CLARMNT 115.00	P2	41.31	110.25	117.54
		BUS-TIE BREAKER FAULT AT 33020 MORAGA 115.00	P2	85.51	151.93	163.45
		BUS-TIE BREAKER 162 FAULT AT 32780 CLARMNT 115.00	P2	41.91	111.91	119.31
		BUS-TIE BREAKER FAULT AT 33020 MORAGA 115.00	P2	86.8	154.22	165.91
8	Oakland C - Oakland L #1 115kV Cable	BUS-TIE BREAKER 162 FAULT AT 32780 CLARMNT 115.00	P2	97.22	99.64	105.71
		BUS-TIE BREAKER FAULT AT 32790 STATIN X 115.00	P2	45.09	95.32	100.04
9	Oakland C - Oakland X #2 115kV Cable	BUS-TIE BREAKER 162 FAULT AT 32780 CLARMNT 115.00	P2	31.66	113.86	120.26
10	Oakland D - Oakland L 115kV Cable	BUS E FAULT AT 32786 OAK C115 115.00	P2	62.48	102.58	107.93
		BUS-TIE BREAKER FAULT AT 32790 STATIN X 115.00	P2	12.66	132.39	137.36
11	Sobrante-Moraga 115kV Line	BUS-TIE BREAKER FAULT AT 30540 SOBRANTE 230.00	P2	91.01	96.47	106.11

All Contingency Report for mitigation development “Cont.”

S. No.	Overloaded Facility	All Contingency	Category	2025 Summer Peak with max generation	2025 Summer Peak with zero generation	2025 Summer Peak with zero generation & no AAEE
1	Moraga-Claremont #1 115kV Line	ChevGen1 13.80 Generator ID 1 & Moraga-Claremont #2 115kV Line	P6	<90	97.6	100.14
		Claremont-East Portal 115kV section & Moraga-Claremont #2 115kV Line	P6	<90	97.27	100.06
		DEC STG1 24.00 Generator ID 1 & Moraga-Claremont #2 115kV Line	P6	<90	99.6	110.85
		DEC STG1 24.00 Generator ID 1 & Sobrante-Moraga 115kV Line	P6	<90	92.74	104.77
		LMECST1 18.00 Generator ID 1 & Moraga-Claremont #2 115kV Line	P6	<90	99.68	100.17
		Moraga-Claremont #2 115kV Line & Sobrante-Moraga 115kV Line	P6	<90	100.11	96.88
		Oakland C - Oakland X #2 115kV Cable & Oakland C - Oakland X #3 115kV Cable	P6	<90	106.45	114.45
		Sobrante 230/115kV Transformer #1 & Moraga-Claremont #2 115kV Line	P6	<90	98.32	100.39
		Sobrante 230/115kV Transformer #1 & Sobrante 230/115kV Transformer #2	P6	<90	101.87	108.46
		Sobrante 230/115kV Transformer #2 & Moraga-Claremont #2 115kV Line	P6	<90	97.49	100.3
		Sobrante-Grizzly-Claremont #1 115kV Line (Hillside-Grizzly JCT) & Moraga-Claremont #2 115kV Line	P6	<90	99.22	100.35
		Sobrante-Grizzly-Claremont #2 115kV Line (Hillside-Grizzly JCT) & Moraga-Claremont #2 115kV Line	P6	<90	99.46	100.18
2	Moraga-Claremont #2 115kV Line	ChevGen1 13.80 Generator ID 1 & Moraga-Claremont #1 115kV Line	P6	<90	97.69	100.24
		Claremont-East Portal 115kV section & Moraga-Claremont #1 115kV Line	P6	<90	97.36	100.15
		DEC STG1 24.00 Generator ID 1 & Moraga-Claremont #1 115kV Line	P6	<90	99.69	110.96
		LMECST1 18.00 Generator ID 1 & Moraga-Claremont #1 115kV Line	P6	<90	99.77	100.26
		Moraga-Claremont #1 115kV Line & Sobrante-Moraga 115kV Line	P6	<90	100.11	97.02
		Oakland C - Oakland X #2 115kV Cable & Oakland C - Oakland X #3 115kV Cable	P6	<90	106.61	114.62
		Sobrante 230/115kV Transformer #1 & Moraga-Claremont #1 115kV Line	P6	<90	98.41	100.48
		Sobrante 230/115kV Transformer #1 & Sobrante 230/115kV Transformer #2	P6	<90	102.02	108.62
		Sobrante 230/115kV Transformer #2 & Moraga-Claremont #1 115kV Line	P6	<90	97.58	100.39
		Sobrante-Grizzly-Claremont #1 115kV Line (Hillside-Grizzly JCT) & Moraga-Claremont #1 115kV Line	P6	<90	99.31	100.45
		Sobrante-Grizzly-Claremont #2 115kV Line (Hillside-Grizzly JCT) & Moraga-Claremont #1 115kV Line	P6	<90	99.55	100.27
3	Moraga-Oakland X #2 115kV Line	Claremont K - Oakland D #1 115kV Cable & Claremont K - Oakland D #2 115kV Cable	P6	<90	110.55	117.84
		Moraga-Oakland X #1 115kV Line & Moraga-Oakland X #3 115kV Line	P6	<90	98.52	100.04
		Moraga-Oakland X #1 115kV Line & Moraga-Oakland X #4 115kV Line	P6	<90	98.52	100.04
		Moraga-Oakland X #3 115kV Line & Moraga-Oakland X #4 115kV Line	P6	<90	98.52	100.04
		Oakland D - Oakland L 115kV Cable & Moraga-Oakland X #1 115kV Line	P6	<90	107.99	114.03
		Oakland D - Oakland L 115kV Cable & Moraga-Oakland X #3 115kV Line	P6	<90	107.99	114.03
		Oakland D - Oakland L 115kV Cable & Moraga-Oakland X #4 115kV Line	P6	<90	107.99	114.03

All Contingency Report for mitigation development “Cont.”

S. No.	Overloaded Facility	All Contingency	Category	2025 Summer Peak with max generation	2025 Summer Peak with zero generation	2025 Summer Peak with zero generation & no AAEE
4	Moraga-San Leandro #1 115kV Line	Moraga-San Leandro #2 115kV Line & Moraga-San Leandro #3 115kV Line	P6	96.66	<90	100.48
5	Moraga-San Leandro #2 115kV Line	Moraga-San Leandro #1 115kV Line & Moraga-San Leandro #3 115kV Line	P6	97.12	<90	100.95
6	Moraga-Station X 115 kV #1 Line	Claremont K - Oakland D #1 115kV Cable & Claremont K - Oakland D #2 115kV Cable	P6	<90	112.21	119.62
		Moraga-Oakland X #2 115kV Line & Moraga-Oakland X #3 115kV Line	P6	<90	98.52	100.04
		Moraga-Oakland X #2 115kV Line & Moraga-Oakland X #4 115kV Line	P6	<90	98.52	100.04
		Moraga-Oakland X #3 115kV Line & Moraga-Oakland X #4 115kV Line	P6	<90	98.52	100.04
		Oakland D - Oakland L 115kV Cable & Moraga-Oakland X #2 115kV Line	P6	<90	107.99	114.03
		Oakland D - Oakland L 115kV Cable & Moraga-Oakland X #3 115kV Line	P6	<90	107.99	114.03
		Oakland D - Oakland L 115kV Cable & Moraga-Oakland X #4 115kV Line	P6	<90	107.99	114.03
7	Moraga-Station X 115 kV #3 Line	Claremont K - Oakland D #1 115kV Cable & Claremont K - Oakland D #2 115kV Cable	P6	<90	112.21	119.62
		Moraga-Oakland X #1 115kV Line & Moraga-Oakland X #2 115kV Line	P6	<90	98.52	100.04
		Moraga-Oakland X #1 115kV Line & Moraga-Oakland X #4 115kV Line	P6	<90	98.52	100.04
		Moraga-Oakland X #2 115kV Line & Moraga-Oakland X #4 115kV Line	P6	<90	98.52	100.04
		Oakland D - Oakland L 115kV Cable & Moraga-Oakland X #1 115kV Line	P6	<90	107.99	114.03
		Oakland D - Oakland L 115kV Cable & Moraga-Oakland X #2 115kV Line	P6	<90	107.99	114.03
		Oakland D - Oakland L 115kV Cable & Moraga-Oakland X #4 115kV Line	P6	<90	107.99	114.03
8	Moraga-Station X 115 kV #4 Line	Claremont K - Oakland D #1 115kV Cable & Claremont K - Oakland D #2 115kV Cable	P6	<90	112.21	119.62
		Moraga-Oakland X #1 115kV Line & Moraga-Oakland X #2 115kV Line	P6	<90	98.52	100.04
		Moraga-Oakland X #1 115kV Line & Moraga-Oakland X #3 115kV Line	P6	<90	98.52	100.04
		Moraga-Oakland X #2 115kV Line & Moraga-Oakland X #3 115kV Line	P6	<90	98.52	100.04
		Oakland D - Oakland L 115kV Cable & Moraga-Oakland X #1 115kV Line	P6	<90	107.99	114.03
		Oakland D - Oakland L 115kV Cable & Moraga-Oakland X #2 115kV Line	P6	<90	107.99	114.03
		Oakland D - Oakland L 115kV Cable & Moraga-Oakland X #3 115kV Line	P6	<90	107.99	114.03
9	Oakland C - Oakland L #1 115kV Cable	Claremont K - Oakland D #1 115kV Cable & Claremont K - Oakland D #2 115kV Cable	P6	97.46	99.91	105.99
		Oakland C - Oakland X #2 115kV Cable & Oakland C - Oakland X #3 115kV Cable	P6	<90	95.72	100.59
10	Oakland C - Oakland X #2 115kV Cable	Claremont K - Oakland D #1 115kV Cable & Claremont K - Oakland D #2 115kV Cable	P6	<90	114.17	120.58
		Oakland C - Oakland X #3 115kV Cable & Oakland D - Oakland L 115kV Cable	P6	<90	132.35	137.52
		Oakland J - Alameda 115kV Cable & Oakland C - Oakland X #3 115kV Cable	P6	<90	99.89	100.93
11	Oakland D - Oakland L 115kV Cable	Oakland C - Oakland X #2 115kV Cable & Oakland C - Oakland X #3 115kV Cable	P6	<90	132.95	138.12
12	San Leandro - Oakland J #1 115kV Line	Moraga-Oakland J 115kV Line & Grant-Oakland J 115 kV Line	P6	93.13	94.31	101.71

All Contingency Report for mitigation development “Cont.”

S. No.	Overloaded Facility	All Contingency	Category	2025 Summer Peak with max generation	2025 Summer Peak with zero generation	2025 Summer Peak with zero generation & no AAEE
1	Moraga-Station X 115 kV #1 Line	Moraga-Oakland Nos. 3 & 4 115 kV lines	P7	40.62	97.61	104.69
		Moraga-Oakland Nos. 3 & 4 115 kV lines	P7	41.23	99.07	106.26
2	Moraga-Oakland X #2 115kV Line	Moraga-Oakland Nos. 3 & 4 115 kV lines	P7	40.62	97.61	104.69
		Moraga-Oakland Nos. 3 & 4 115 kV lines	P7	41.23	99.07	106.26
3	Moraga-Station X 115 kV #3 Line	Moraga-Oakland X Nos. 1 & 2 115 kV lines	P7	40.62	97.61	104.69
		Moraga-Oakland X Nos. 1 & 2 115 kV lines	P7	41.23	99.07	106.26
4	Moraga-Station X 115 kV #4 Line	Moraga-Oakland X Nos. 1 & 2 115 kV lines	P7	40.62	97.61	104.69
		Moraga-Oakland X Nos. 1 & 2 115 kV lines	P7	41.23	99.07	106.26

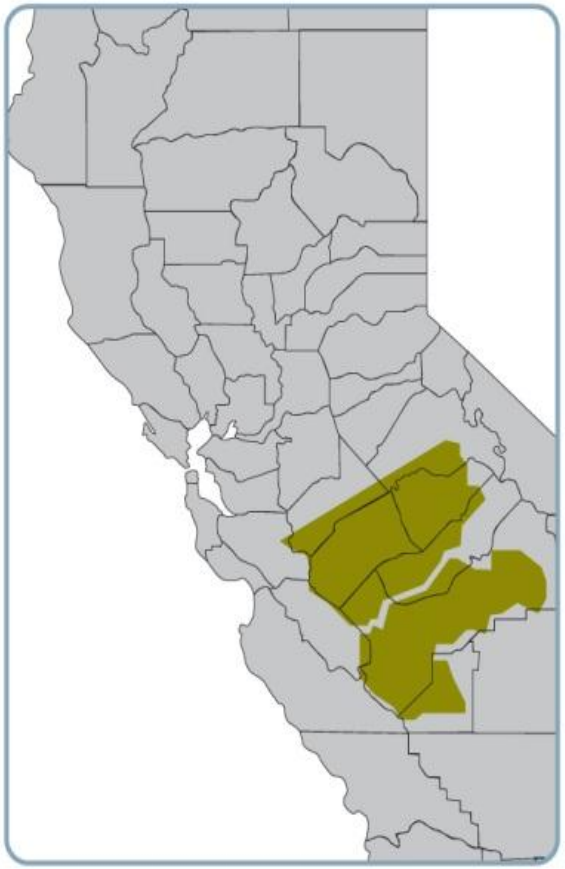
Fresno Area
Preliminary Reliability Assessment Results

Vera Hart
Regional Transmission Engineer

Abhishek Singh
Senior Regional Transmission Engineer

2015-2016 Transmission Planning Process Stakeholder Meeting
September 21-22, 2015

Greater Fresno Area



- Includes the San Joaquin Division
- Generation: Over 5,124 MW of generation in 2025 case
- Comprised of 60,115, 230 & 500 kV transmission facilities.
- Summer Peak 3,715 MW in 2025

Fresno Area Assessment Summary

- The assessment identified:
  - Thermal overloads due to Category P0 – 1, Category P1 - 5, Category P2-1 – 6, Category P2-2-P2-4- 56, Category P6- 73, Category P7- 16
  - Low voltages due to Category P1 - 8, Category P2-1 – 2 and Category P2-2-P2-4- 63, Category P3- 5, Category P6- 26
  - Voltage deviations due to Category P1- 8, Category P2-1 – 5 and Category P2-2-P2-4- 48
  - High Voltages due to P0 - 13, P1 - 5, P2-1 - 4 , P2-2-P2-4 - 14 , P7 – 4
  - For the loss of Gates-Gregg 230kV line, momentary drop of Henrietta 70kV due to SPS Action
- Compared to last year results:
  - One new Category P0 overload
  - One new High Voltage area for P0
  - No new P1 230kV line overloads and one new P1 115kV line overload
  - New Category P2-1 showing two new overloaded elements

Fresno Area – Thermal Results (P0, P1, and P2-1)

- Thermal Overloads (P0)
  - Chowchilla Cogen Jct-Chowchilla Cogen 115kV line (2020, 2025 Peak)
- Thermal Overloads (P1)
  - Panoche-Oro Loma 115kV (Panoche-Hammonds Section) (2017 & 2020 Peak)
  - Exchequer-Le Grand 115kV line(2020 & 2025 Peak)
  - San Miguel-Coalinga 70kV line (2017 Peak & Spring off Peak)
  - Coalinga 1-Coalinga 2 70kV (Coalinga 1-Tornado Tap Section) (2017Peak)
- Thermal Overloads (P2-1)
  - Panoche-Oro Loma 115kV (Panoche-Hammonds Section) (2020 & 2025 Peak)
  - Herndon-Bullard #2 (Prundale Jct-Bullard)115kV (2017, 2020, 2025 Peak)
  - Herndon-Bullard #1 (Prundale Jct-Bullard)115kV (2017, 2020, 2025 Peak)
  - Oro Loma #2 115/70kV (2017 Peak)
  - Mercy Springs-Canal-Oro Loma 70kV line(Ortiga-Mercy Springs section) (2017 Peak)
  - Coalinga1-Coalinga2 70kV line (Coalinga 1-Tornado Tap Section)(2017 Peak)

Fresno Area – Voltage Results (P0, P1, P2-1, P3)

- High Voltage (P0, P1, P2-1)
  - Exchequer 115kV and 70kV area (all years)
  - Kearney 70kV area (all years)
- Low Voltage (P1, P2-1, P3)
  - Chowchilla 115kV Area (2020, 2025 Peak)
  - Mendota 115kV Area (2017 Peak)
- Voltage Deviation (P1)
  - Chowchilla 115kV (Chowchilla 115kV Area) (2025 Peak)
  - Mendota 115kV (Mendota 115kV Area) (2017 Peak)

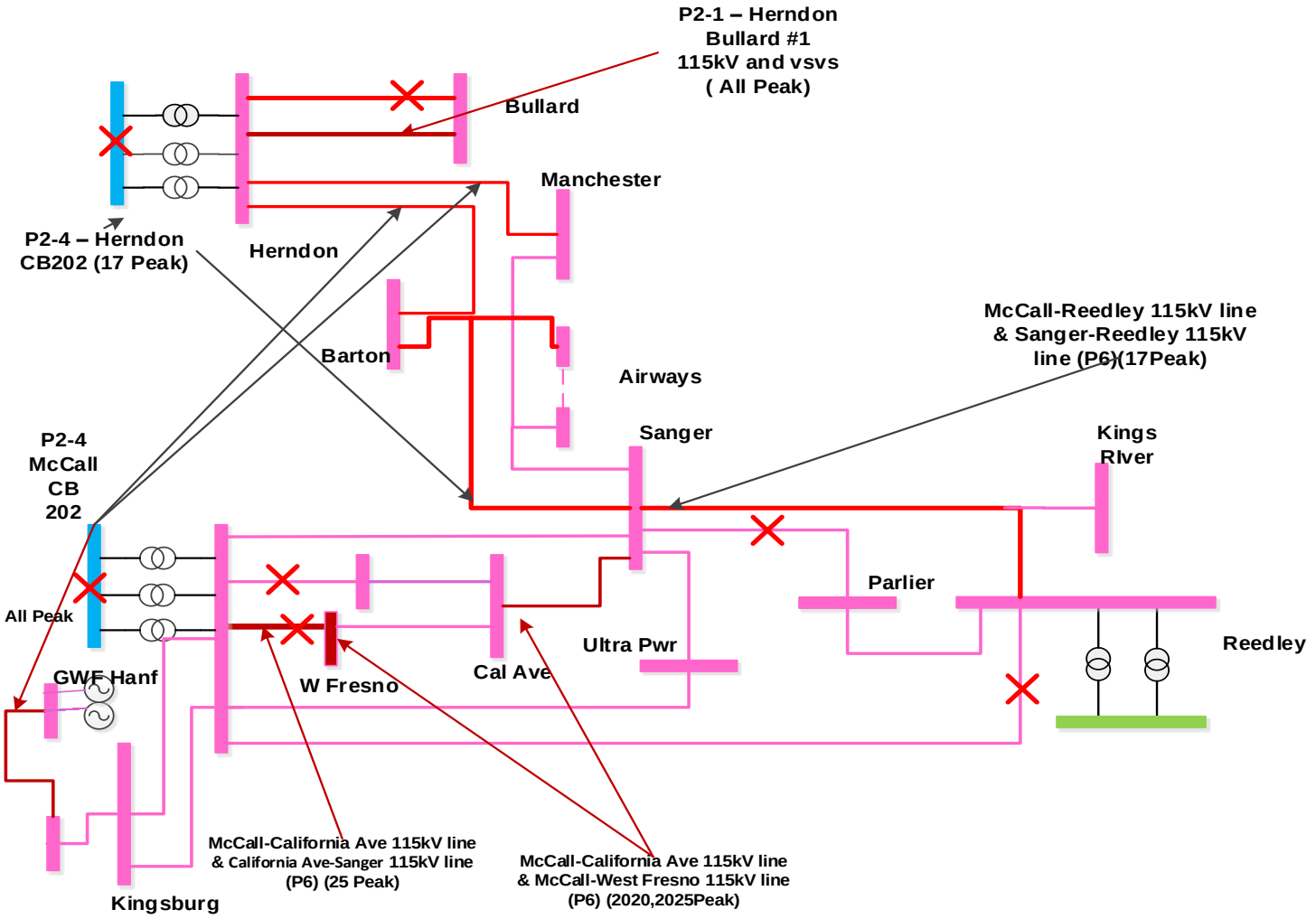
Fresno Area – Results- Herndon-McCall Area

Approved Projects

- Northern Fresno Reinforcement Project
- McCall-Reedley #2 line project

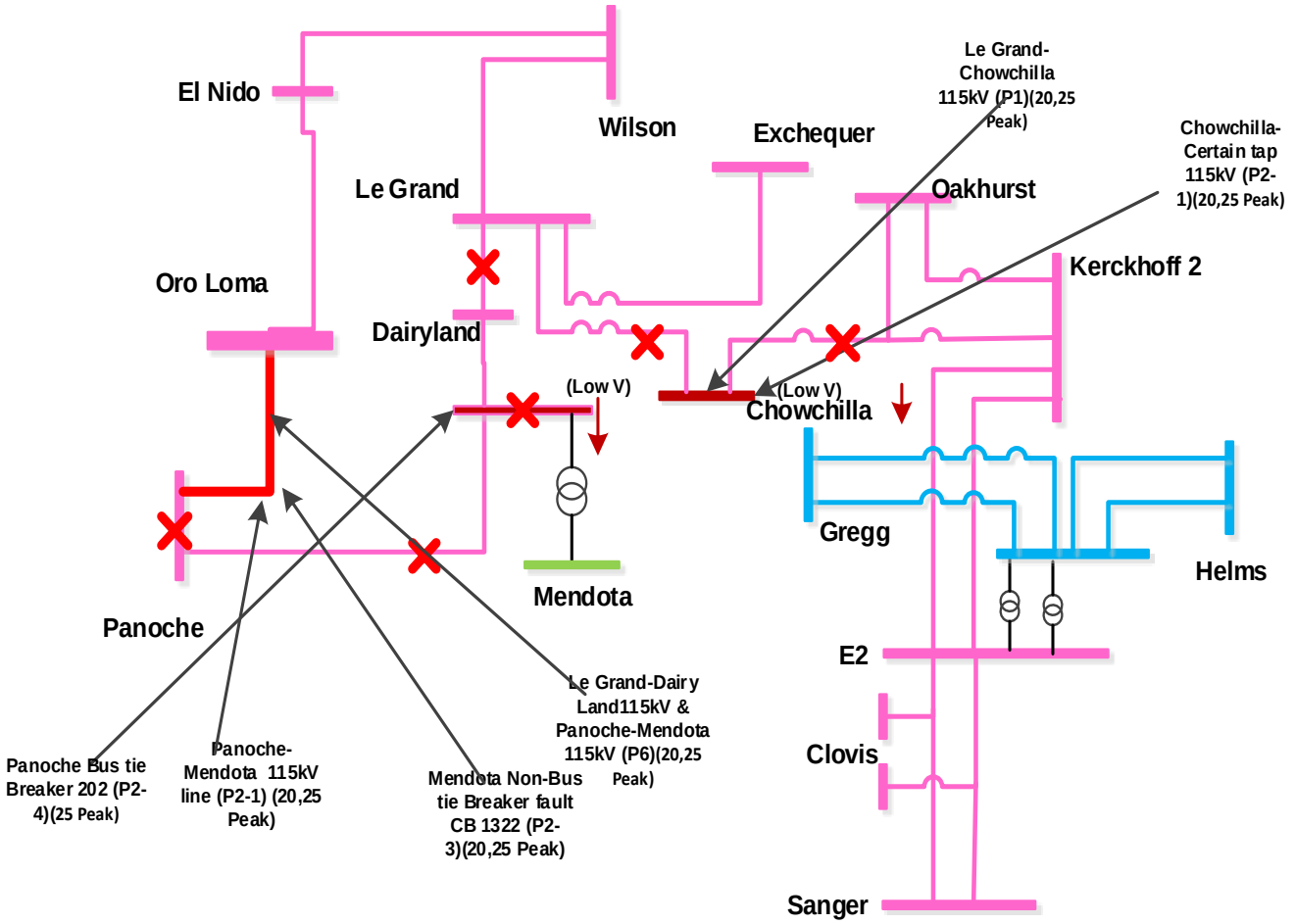
Sensitivities:

- Thermal loadings worsen in “No AAEE” and “No QF”
- Thermal loading lessens in High Renewables case



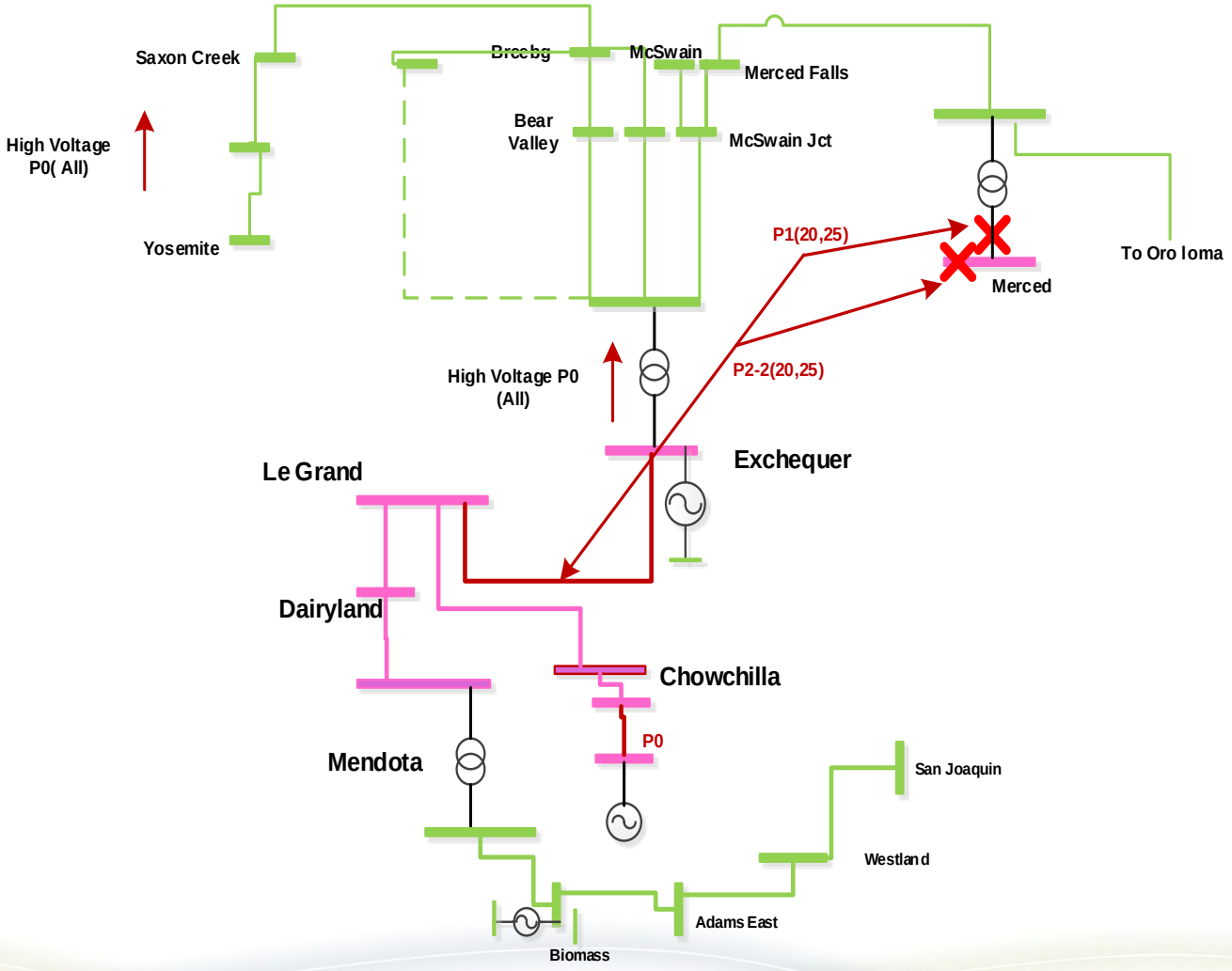
Fresno Area – Oro Loma-Chowchilla

- Approved Projects
  - Oro Loma 70kV reinforcement project (Mercy Springs 230/70kV bank)
  - Wilson 115 kV Area Reinforcement
- Sensitivities
  - Thermal loadings worsen in “No AAEE” and “No QF”
  - New overloads found



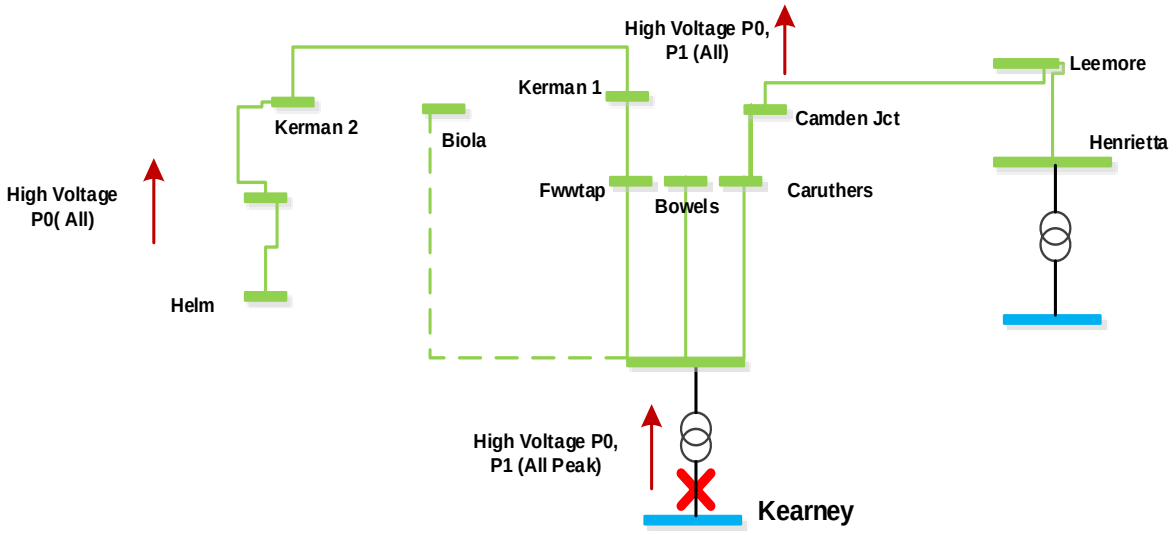
Fresno Area – Exchequer

- Approved Projects
  - None
- Sensitivities
  - Thermal loadings worsen in “No AAEE” and “No QF”
  - New Overload P0



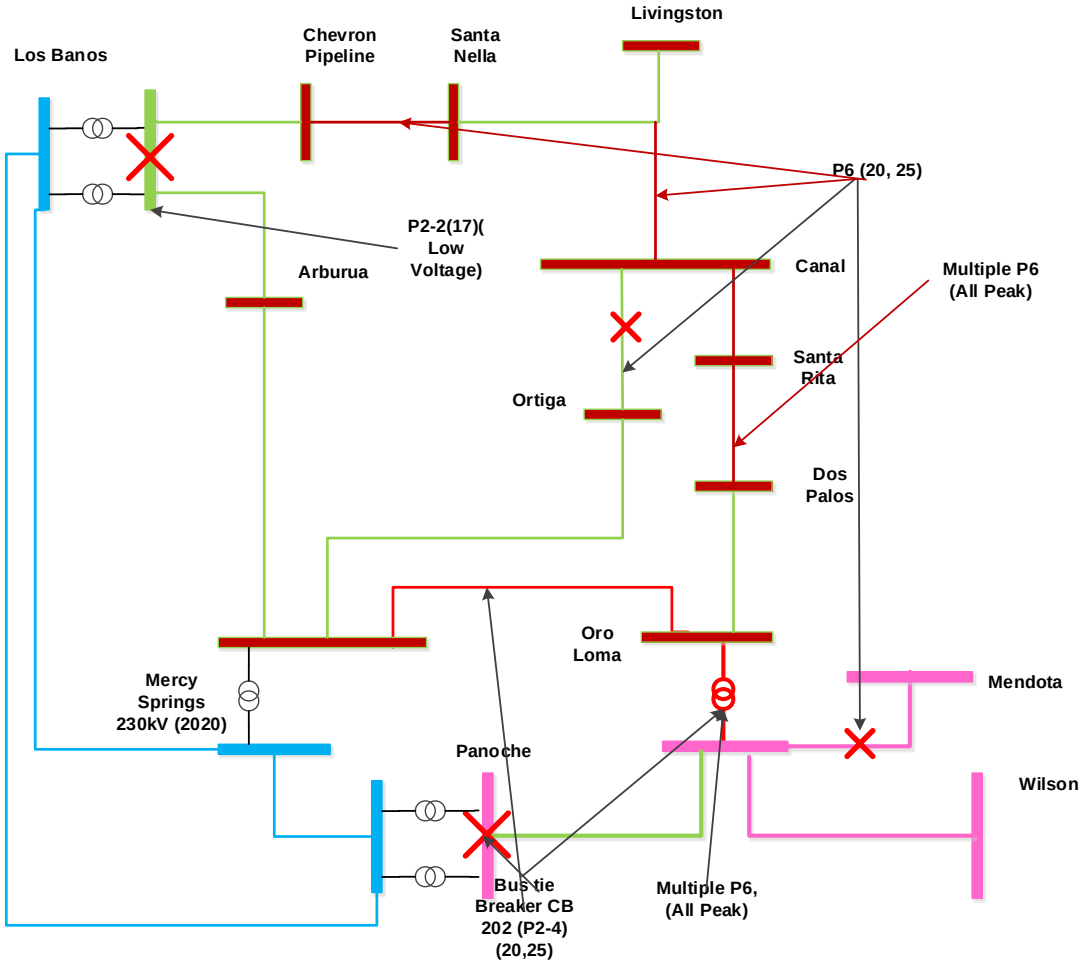
Fresno Area – Kearney 70kV

- Approved Projects
  - Kearney-Caruthers reconductoring
- Sensitivities
  - Voltages are better



Fresno Area – Oro Loma- Los Banos 70kV

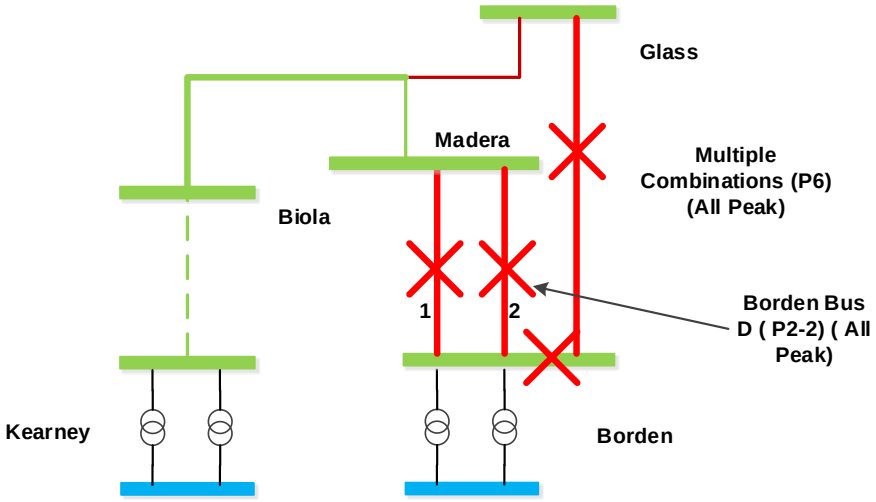
- Approved Projects
  - Oro Loma 70kV reinforcement project (Mercy Springs 230/70kV bank)
- Sensitivities
  - Thermal loadings worsen in “No AAEE” and “No QF”
  - One new Overload section in the High renewables case



Fresno Area -Borden-Madera 70kV-Results

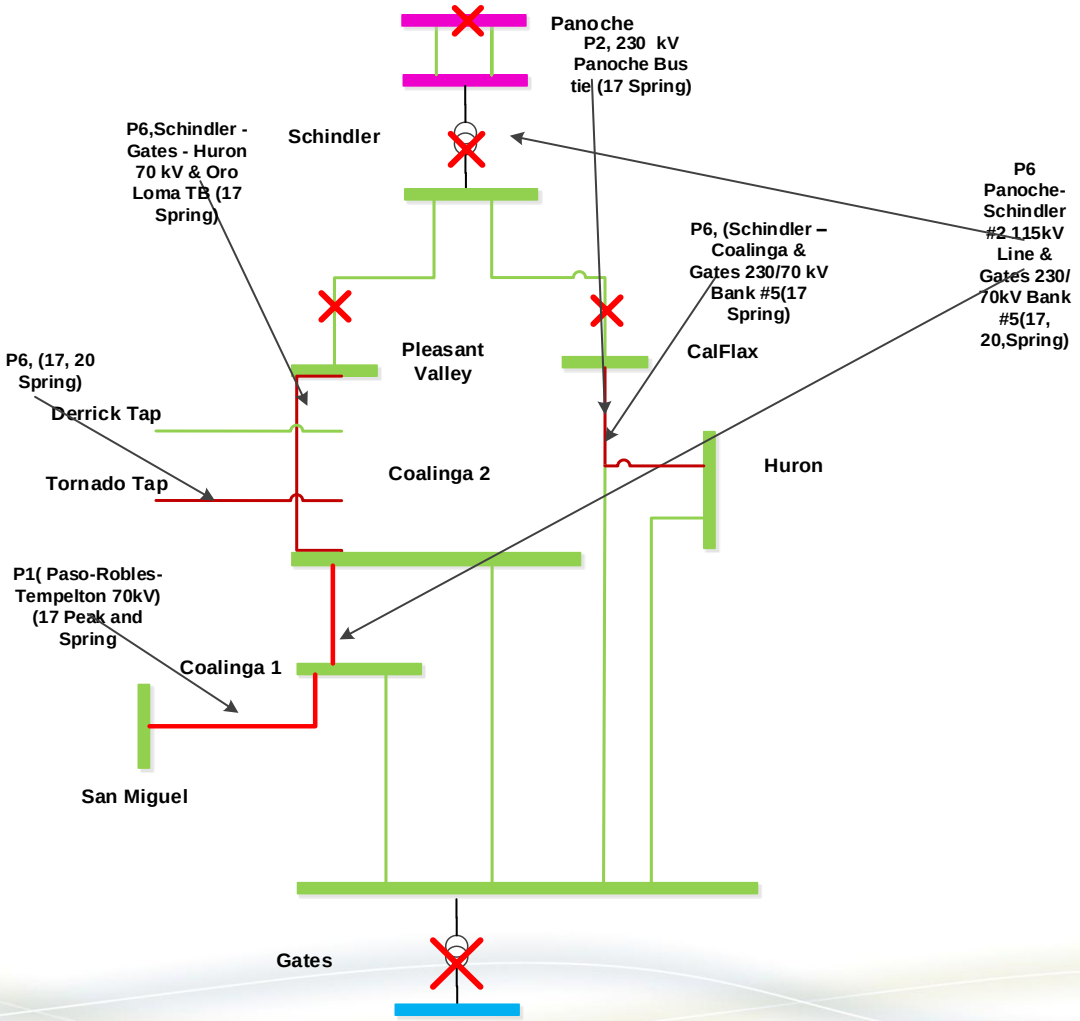
- Approved Projects
  - Borden 230 kV Voltage Support

- Sensitivities
  - Thermal loadings worsen in all cases



Fresno Area –Coalinga 70kV Results

- Approved Projects
  - Estrella Substation
- Sensitivities
  - Thermal loadings worsen in all cases
  - New P0 overload due to sensitivity



Conclusion

- Reliability Concerns in need of mitigation solution

Area	Facility	Contingency Category	Cases Overloaded	Potential Mitigation
Exchequer Area	Chowchilla Cogen Jct-Chowchilla Cogen 115kV line	P0	All Peak	Reconductor/Remove limiting elements if any
	Exchequer-Le Grand 115kV line	P1, P2-2	2020, 2025 Peak	Short Term rating/Upgrade/expand SPS
Oro Loma 115kV Area	Panoche Oro Loma 115kV Line (Panoche-Hammonds section)	P1, P2-1, P2-3, P6	2020, 2025 Peak	Reconductor/SPS/Operating Solution
	Panoche Oro Loma 115kV Line (Hammonds-Oro Loma sections)	P6	2020, 2025 Peak	Reconductor/SPS
Oro Loma 70kV Area	Oro Loma 115/70kV TB	P2-4, P6	All Peak	Upgrade the T/F/ Explore possible SPS Options.
	Mercy Springs-Oro Loma 70kV	P2-4	2020,2025 Peak	Reconductor/Remove limiting elements if any
	Oro Loma-Canal 70kV (Canal-Dos Palos section)	P6	All Peak	Explore Reactive support options
	Los Banos-Livingston Jct-Canal 70kV line (Chevpipe to Santa Nila section)	P6	2020,2025 Peak	SPS/Reconductor
	Los Banos-Livingston Jct-Canal 70kV line (Canal-Livingston section)	P6	2025 Peak	SPS/Reconductor
Borden 70kV	Borden-Madera-Glass 70kV lines	P6, P2-2	All Peak	Reconductor/SPS
McCall-Herndon 115kV Area	McCall-California Ave 115kV Line	P6	2020,2025 Peak	Reconductor/SPS/Operating Solution
	Sanger-California Ave 115kV line	P6, P7	2020,2025 Peak	Reconductor/SPS/Operating Solution
	McCall-West Fresno 115kV line	P6	2025	Reconductor/SPS/Operating Solution
	Herndon-Bullard #1 115kV line	P2-1	2020,2025 Peak	Reconductor/Remove limiting elemets, if any.
	Herndon-Bullard #2 115kV line	P2-1	2017,2020,2025 Peak	Reconductor/Remove limiting elemets, if any.
	GWF-Kingsburg 115kV line	P2-4	All Peak	Reduce GWF_HEP Generation
Coalinga 70kV Area	Shindler-Huron-Gates 70kV line (Huron-Calfax section)	P2-4, P6	2017 Spring, 2017, 2025 Peak	Reconductor/SPS/Operating Solution
	Coalinga 70kV area lines	P6	2017,2020 Spring	Explore Reactive support options

Conclusion- Continues

- Reliability Concerns in need of mitigation solution

Area	Voltage	Contingency Category	Cases Overloaded	Potential Mitigation
Exchequer 115kV and 70kV Area	>1.10	P0, P1	All Cases	Under Review with PTO/ Check T/F Taps
Kearney 70kV area	>1.10	P0, P1, P7	All Cases	Under Review with PTO/Check T/F Taps
Chowchilla 115kV	< 0.9	P1, P2-1	2020, 2025 Peak	Modify Exchequer SPS
DairyLand 115kV	< 0.9	P6	2025 Peak	Reconductor/SPS
Coalinga 70kV Area	< 0.9	P6	2020 Spring	Case Diverged/ Explore Reactive support options
Hernietta 230kV	< 0.9	P6	All Peak	Operating solution/ interim SPS
Cal Ave, West Fresno 115 kV pocket	< 0.9	P6	All Peak	Provide additional reactive support (Herndon/Mccall 115 kV pocket)

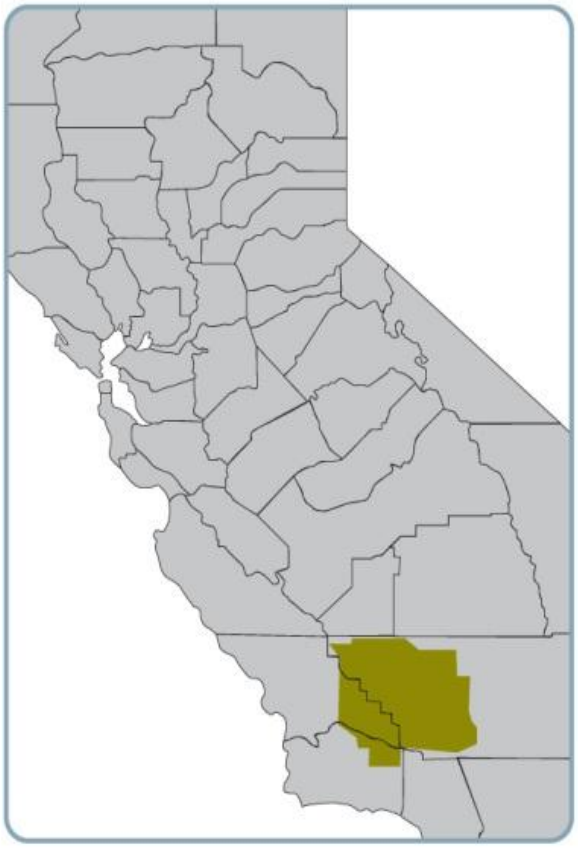
Questions?

Kern Area
Preliminary Reliability Assessment Results

Chris Mensah-Bonsu, Ph.D.
Lead Regional Transmission Engineer

2015-2016 Transmission Planning Process Stakeholder Meeting
September 21-22, 2015

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
- Generation: Approximately 3,500 MW of generation
- Transmission system includes 60, 115 and 230 kV facilities.
- 2025 Summer Peak: 2,367 MW

Study Scenarios

- 5 Baseline Scenarios
  - 2017 Summer Peak
  - 2020 Summer Peak
  - 2025 Summer Peak
  - 2017 Spring Off-peak
  - 2020 Light Load

- 3 Sensitivity Scenarios
  - 2025 Summer Peak No AAEE *(2,440 MW)*
  - 2025 Summer Peak No QF *(2,367 MW)*
  - 2020 Summer Peak High Renewable *(Existing & new renewables dispatched to Pmax)*

Kern Area Assessment Summary

- The 2015-2016 assessment identified:
  - Thermal overloads due to Category P1 – 0, P2 – 0, P3 – 0, P6 – 6 and P7 - 0
  - Low voltage concerns due to Category P1 – 0, P2 – 0, P3 – 2 and P6 – 13 (mostly in 2025)
  - Voltage deviations concerns due to Categories P3 – 4
- Compared to last year results:
  - 0 new Category P1 thermal overloads
  - 6 new Category P6 thermal overloads
  - Last year there was one project approved in this area
    - North East Kern Voltage Conversion Project

Kern Area – Results (Category P0 & P1)

- Thermal Overloads
  - No thermal overloads due to Categories P0 & P1
- Low Voltage – None
- Voltage Deviation – None

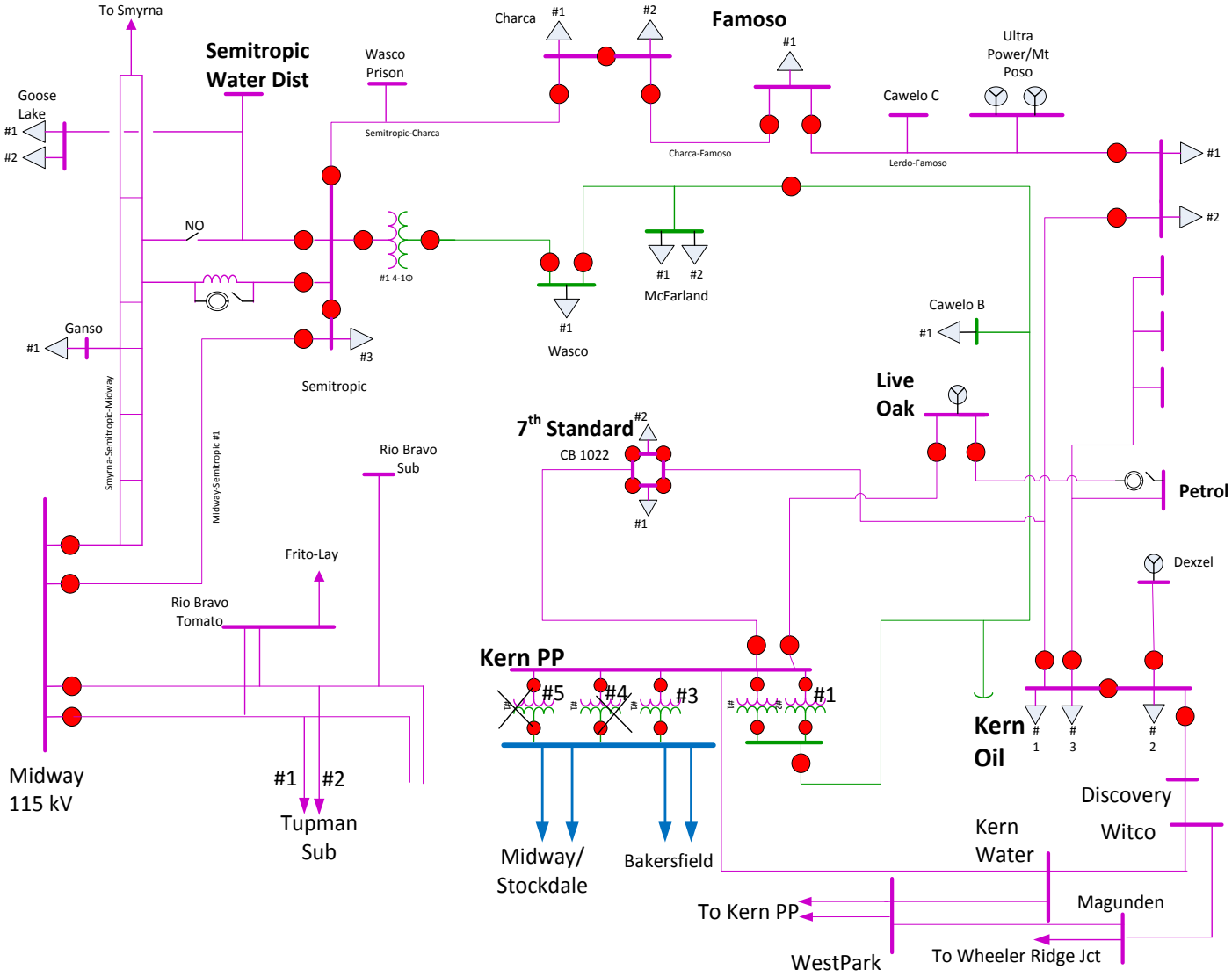
New thermal issues resulting from other contingency categories are discussed in the next slide

Kern Area – Results (Other Contingency Categories)

- Thermal Overloads
  1) Semitropic-Wasco Prison-Charka 115 kV #1 Line (Category P6 – Summer 2025)
  2) Semitropic D-Semitropic E 115 kV #1 Line (Category P6 – Summer 2025)
  3) Taft A-Texaco Buena Vista Hills 70 kV #1 Line (Category P6 – Summer 2025. 101% loading level)

- Potential Mitigations
  - Monitor facility loading levels due to long lead time

Kern Area – Results (Other Contingency Category)



Selected Approved Projects

- North East Kern 115 kV Voltage Conversion
- Wheeler Ridge Junction Station Project
- Kern PP 115 kV Area Reinforcement Project
- Midway-Kern PP #1, #3 & #4 230 kV Line Capacity Increase Project
- Midway-Temblor 115 kV Line Reconductor

Sensitivity

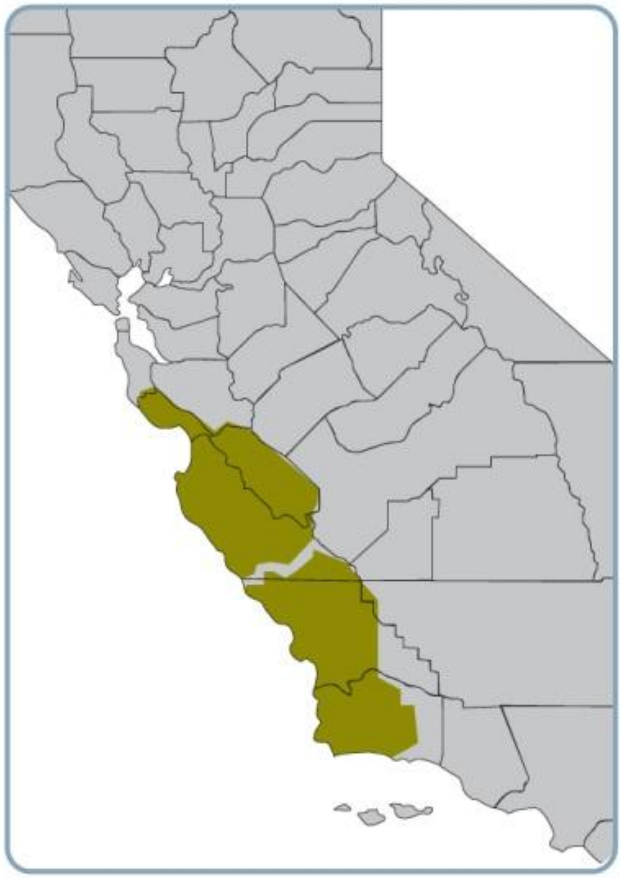
- Category P2-1 (new requirement) thermal overloads were identified with increased levels under No AAEE conditions
- Potential mitigation: Mitigation under review

Central Coast and Los Padres Areas Preliminary Reliability Assessment Results

Chris Mensah-Bonsu, Ph.D.
Lead Regional Transmission Engineer

2015-2016 Transmission Planning Process Stakeholder Meeting
September 21-22, 2015

Central Coast Area



- Located south of the Greater Bay Area, it extends along the central coast from Santa Cruz to King City
- Major substations: Moss Landing, Green Valley, Paul Sweet, Salinas, Watsonville, Monterey, Soledad and Hollister
- Supply sources: Moss Landing, Panoche, King City and Monta Vista
- Generation: Approximately 300 MW in 2017.
- Transmission system includes 60, 115, 230 and 500 kV facilities
- 2025 Winter Peak: 652 MW
- 2025 Summer Peak: 709 MW

Study Scenarios

- 8 Baseline Scenarios
  - 2017 Summer Peak
  - 2020 Summer Peak
  - 2025 Summer Peak
  - 2017 Spring Off-peak
  - 2020 Light Load
  - 2017 Winter Peak (Central Coast)
  - 2020 Winter Peak (Central Coast)
  - 2025 Winter Peak (Central Coast)

- 3 Sensitivity Scenarios
  - 2025 Summer Peak No AAEE *(798 MW)*
  - 2025 Summer Peak No QF *(739 MW)*
  - 2020 Summer Peak High Renewable *(Existing & new renewables dispatched to Pmax)*

Central Coast Area Assessment Summary

- The 2015-2016 assessment identified:
  - Newly identified thermal overloads due to Category P0 – 0, P1 – 0, P2 – 2, P(2-1) – 6, P3 – 0, P6 – 1 and P7 - 0
  - Thermal overloads (winter peak) due to Category P6 – 1 (Coburn 230/60 kV #2 Bank)
  - Low voltages due to P2 – 8, P3 – 1, P6 – 18 and P7 – 1 (mostly around 0.89 p.u.)
  - Voltage deviations due to P2 – 22, P7 - 6
  - Area-wide high voltages under normal (P0) conditions (light load)
- Compared to last year results:
  - 0 new Category P1 thermal overload concern identified
  - 2 Category P2
  - 6 Category P2-1

Central Coast Area – Results (Category P0 & P1)

- Thermal Overloads
  - No new thermal overloads due to Category P0 & P1
- Low Voltage - None
  - P2 – 5, P(2-1) – 4, P3 – 1, P6 – 19 and P7 - 1
  - Area-wide high voltages under Category P0 contingency conditions (mostly around 1.6 p.u.)
- Voltage Deviation – None

New issues resulting from other contingency categories are discussed in the next slide

Central Coast Area – Results

Selected Approved Projects

- Watsonville 115 kV Voltage Conversion Project
- Nativdad Substation Interconnection
- Crazy Horse Awitching Station
- Soledad 115/60 kV Tranformer Capacity Project
- Hollister 115 kV Reconductoring

Sensitivity

- Category P2-1 (new requirement) and P6 thermal overloads were observed with increased levels under No AAEE conditions
- Potential mitigation: Mitigated under review

Los Padres Area

- Located south of the Central Coast Division
- Major substations : Paso Robles, Atascadero, Morro Bay, San Luis Obispo, Mesa, Divide, Santa Maria and Sisquoc
- Key supply sources include Gates, Midway and Morro Bay
- Generation: Approximately 950 MW
- Diablo Canyon nuclear power plant (2400 MW) is located in Los Padres but does not serve the area
- Transmission system includes 70, 115, 230 and 500 kV facilities
- 2025 Summer Peak: 587 MW

Study Scenarios

- 5 Baseline Scenarios
  - 2017 Summer Peak
  - 2020 Summer Peak
  - 2025 Summer Peak
  - 2017 Spring Off-peak
  - 2020 Light Load

- 3 Sensitivity Scenarios
  - 2025 Summer Peak No AAEE *(622 MW)*
  - 2025 Summer Peak No QF *(587 MW)*
  - 2020 Summer Peak High Renewable *(Existing & new renewables dispatched to Pmax)*

Los Padres Area Assessment Summary

- The 2015-2016 assessment identified:
  - No new thermal overloads were identified
  - Low voltage due to Category P6 – 1 at 0.81p.u. in both 2020 & 2025)
  - There are no voltage deviation concerns
- Compared to last year results:
  - No new thermal overloads were identified
  - Last year, transmission projects were approved in this area
    - Estrella 230 kV Substation Project

Los Padres Area – Results (Category P0 & P1)

- Thermal Overloads
  - No new thermal overloads due to Category P0 or P1 contingency conditions

- Low Voltage due to Category P6 – 1
- Voltage Deviation – None

New issues resulting from other contingency categories are discussed in the next slide

Los Padres Area – Results

Selected Approved Projects

- Estrella Substation Project
- Midway-Andrew 230 kV Project
- Diablo Canyon Voltage Support Project
- Morro Bay 230/115 kV Transformer Addition Project
- Mesa-Sisquoc 115 kV Line Reconductoring Project

Sensitivity

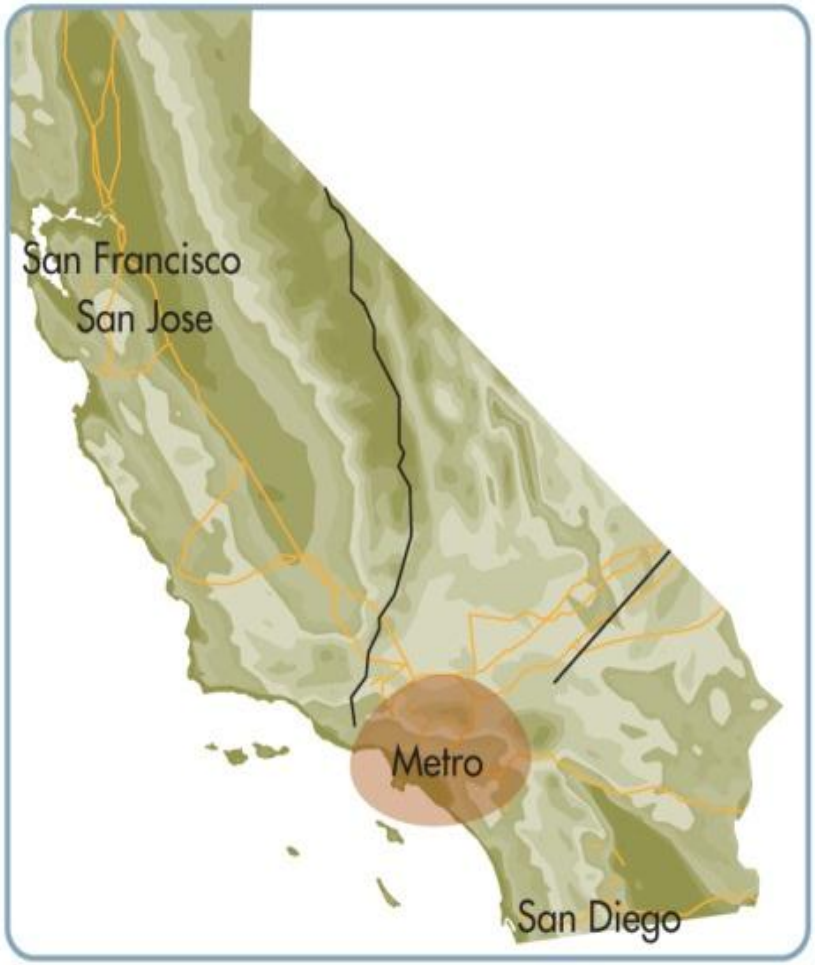
- Category P2-1 (new requirement) thermal overloads were observed with increased levels under No AAEE conditions
- Potential mitigation: Mitigated by already approved projects (Estrella 230 kV Substation, Midway-Andrew 230 kV Project, Morro Bay 230/115 kV Bank Addition Project, etc.)

SCE Metro Area
Preliminary Reliability Assessment Results

Nebiyu Yimer
Regional Transmission Engineer

2015-2016 Transmission Planning Process Stakeholder Meeting
September 21-22, 2015

SCE Metro Area



- Includes Los Angeles County, Orange County, and surrounding area and is bounded by Vincent, Lugo, Valley and San Onofre substations
- Comprised of 500 and 230 kV transmission facilities
- 1-in-10 Summer Peak load of 23,446 MW in 2025 (22,085 MW including AAEE)
- 12,150 MW of existing generation of which 6100 MW is scheduled for retirement.
- Procurement of about 2143 MW of conventional generation, preferred resources and energy storage underway (LA Basin & Moorpark)

Metro Area Study Scenarios

- 5 Baseline Scenarios

Scenario	Load	Dispatched Gen – Conv	Dispatched Gen. – Ren.	Preferred Res. & ES	Path 26, PDCI	Path 46 (MW)
2017 SP	1-in-10 mid with low-mid AAEE	< Max	Solar - 36% Wind - 0%	Not initially dispatched, used as mitigation	~ Max	7767
2020 SP						8122
2025 SP		~ Max				8800
2017 OP	65% of net 1-in-2	< Max	Solar - 93% Wind - 93%		< Max	6241
2020 LL	50% of net 1-in-2	~ 0	Solar - 0% Wind - 93%		< Max	6209

- 2 Sensitivity Scenarios

Scenario	Baseline	Change	Path 46
S1 - Early OTC Ret.	2020 SP	1350 MW reduction in available gen. in LA Basin	8134
S2 - High CEC Load	2025 SP	1557 MW increase in SoCal load	10468

Metro Area Assessment Summary

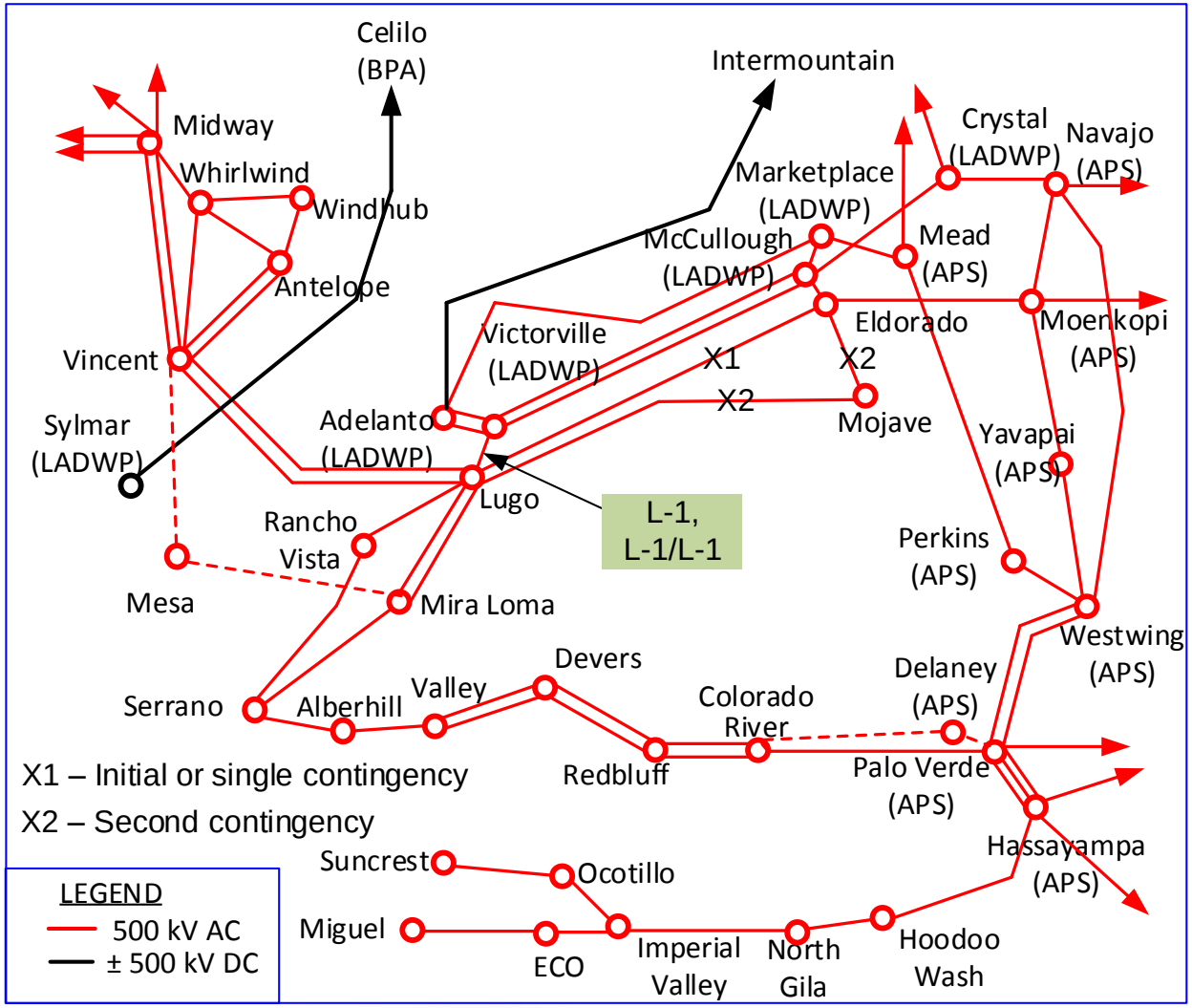
- The baseline assessment identified:
  - Thermal overload due to P1 single contingency – 1
  - Thermal overload due to P6/P7 multiple contingency – 5
- In addition, the sensitivity assessment identified:
  - Thermal overload due to P6 multiple contingency – 2
  - Stability-related issue due to P6 multiple contingency – 1
- Compared to last year results:
  - 2 new loading issues
  - Approved project helped in addressing 3 loading issues.
  - 1 new stability-related issue

Metro Area Potential Solutions

- Potential Mitigation Solutions
  - Increase line rating
  - Install hot spare transformer bank
  - Operating solutions including utilizing Preferred Resources & Storage

Lugo–Victorville 500 kV Thermal Overload

- Occurs under N-1/N-1 conditions in all summer peak cases
- Starts to occur under N-1 conditions in 2025 with all generation dispatched
- Higher load growth exacerbates the overload



Lugo–Victorville 500 kV Thermal Overload – Cont'd

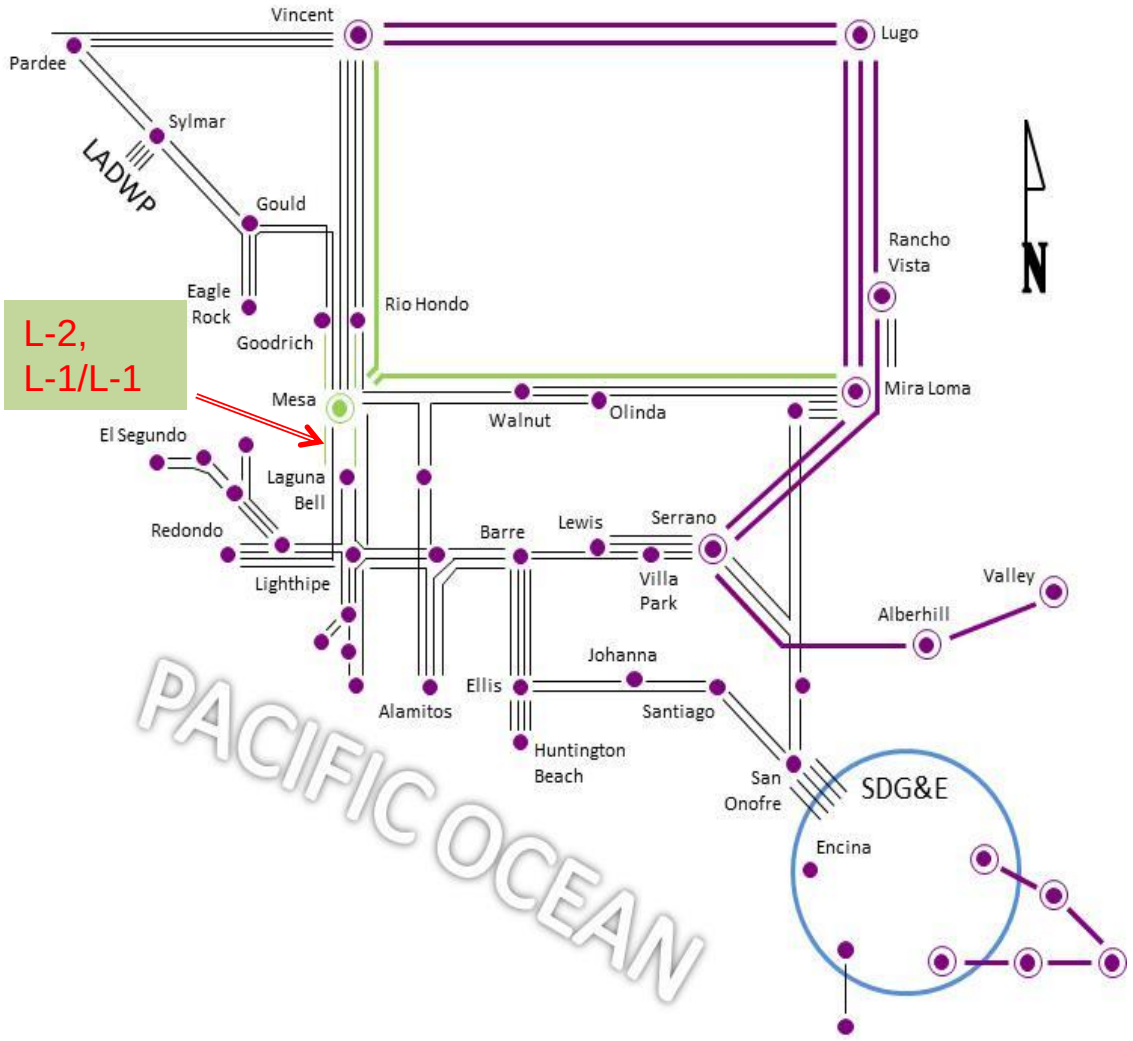
Worst Contingency	Category	Loading (%)						
		2017 SP	2020 SP	2025 SP	2017 OP	2020 LL	2020 SP S1	2025 SP S2
Eldorado–Lugo 500 kV	P1 (L-1)	*	*	100%	*	*	*	115%
Eldorado–Lugo 500 kV & Eldorado–Mohave or Mohave–Lugo 500 kV	P6 (L-1/L-1)	114%	112%	127%	*	*	116%	149%

* Loading <100%

- Potential Mitigation
  - Increase rating of the Lugo–Victorville 500 kV line

Mesa–Laguna Bell #1 230 kV Thermal Overload

- Occurs under N-2 and N-1/N-1 conditions in 2025 SP cases
- Loading in the 2025 SP baseline case < 100% when PR & ES are utilized.
- Additional mitigation may be needed if high load growth materializes



Mesa–Laguna Bell #1 230 kV Overload – Cont'd

Worst Contingency	Category	Loading (%)						
		2017 SP	2020 SP	2025 SP	2017 OP	2020 LL	2020 SP S1	2025 SP S2
Mesa–Lighthipe & Mesa–Laguna Bell #2	P7 (L-2)	*	*	102%	*	*	*	110%
Mesa–Lighthipe & Mesa–Redondo	P6 (L-1/L-1)	*	*	108%	*	*	*	116%
Mesa 500/230 KV #3 & #4 Banks	P6 (T-1/T-1)	*	*	105%	*	*	*	113%

* Loading <100%

- Potential Mitigation
  - System adjustment including utilizing Preferred Resources & Storage

Serrano 500/230 kV Banks Thermal Overload

Worst Contingency	Category	Loading (%)						
		2017 SP	2020 SP	2025 SP	2017 OP	2020 LL	2020 SP	2025 SP
Two Serrano 500/230 kV Banks	P6 (T-1/T-1)	101%	108%	117%	125%	*	123%	127%
One Serrano 500/230 kV Bank & Eco–Miguel 500 kV	P6 (T-1/L-1)	*	*	*	*	*	*	100%

* Loading <100%

- Potential Mitigation
  - Operating solution including utilizing Preferred Resources & Storage and post-contingency system reconfiguration
  - Install a hot spare

Mesa–Redondo 230 kV Thermal Overload

Worst Contingency	Category	Loading (%)						
		2017 SP	2020 SP	2025 SP	2017 OP	2020 LL	2020 SP S1	2025 SP S2
Mesa–Lighthipe & Mesa–Laguna Bell #2	P6 (L-1/L-1)	*	*	*	*	*	*	101%

Serrano–Villa Park #1 230 kV Thermal Overload

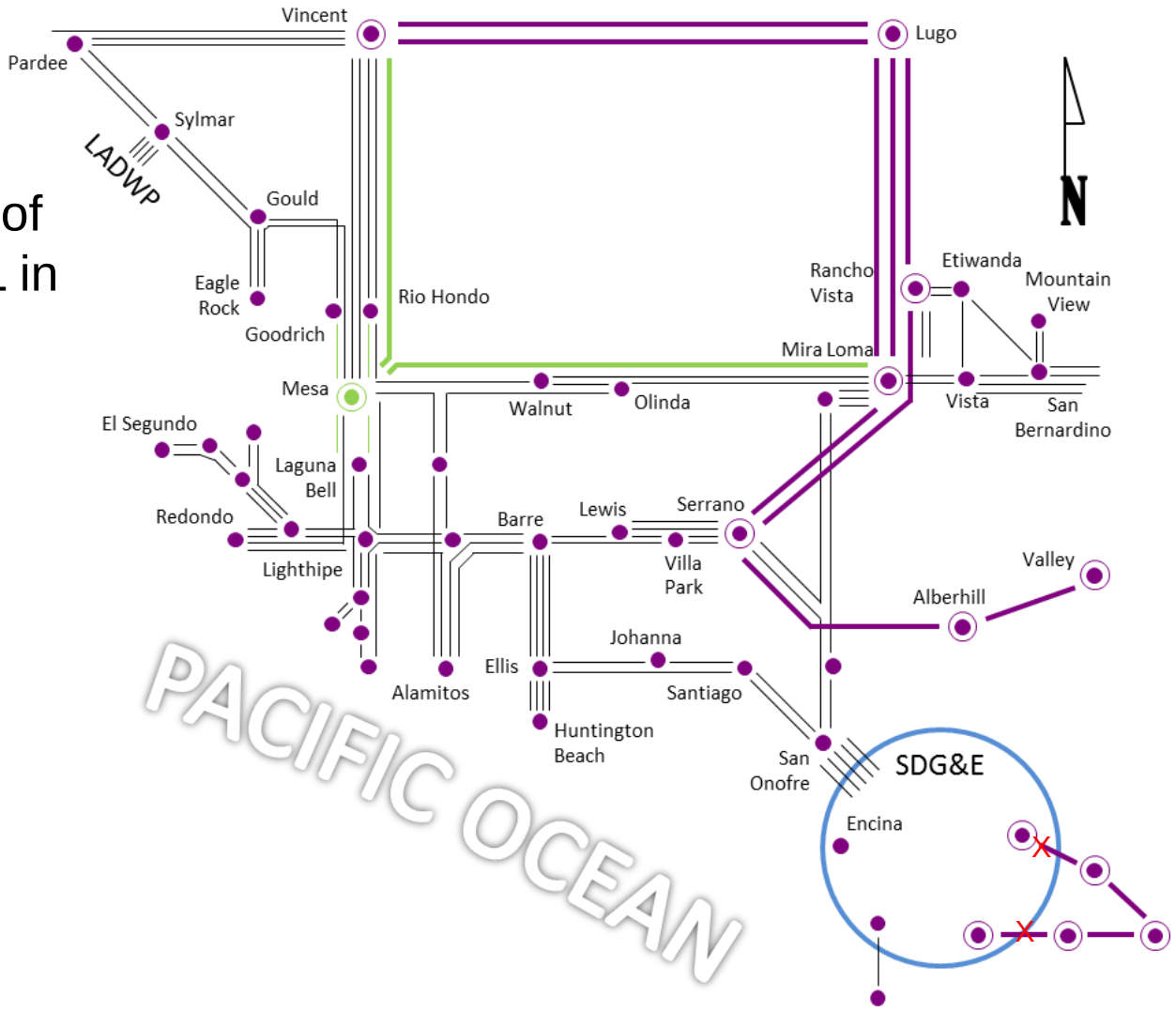
Worst Contingency	Category	Loading (%)						
Serrano–Lewis #1 or #2 & Serrano–Villa Park #2	P6 (L-1/L-1)	*	*	*	*	*	*	102%

* Loading <100%

- Potential Mitigation
  - Operating solution including utilizing Preferred Resources & Storage

Metro Area Transient Stability Results

- Voltage dip exceeding 30% following outage of SRPL and SWPL in sensitivity cases



Metro Area Transient Stability Results – Cont'd

Worst Contingency	Category	Transient Stability Performance						
		2017 SP	2020 SP	2025 SP	2017 OP	2020 LL	2020 SP S1	2025 SP S2
Eco–Miguel 500 kV & Ocotillo–Suncrest, 3-phase fault at Suncrest	P6 (L-1/L-1)	None	None	None	None	None	Up to 40.5% dip (V) at 9 buses	Up to 42.7% dip (V) at 26 buses

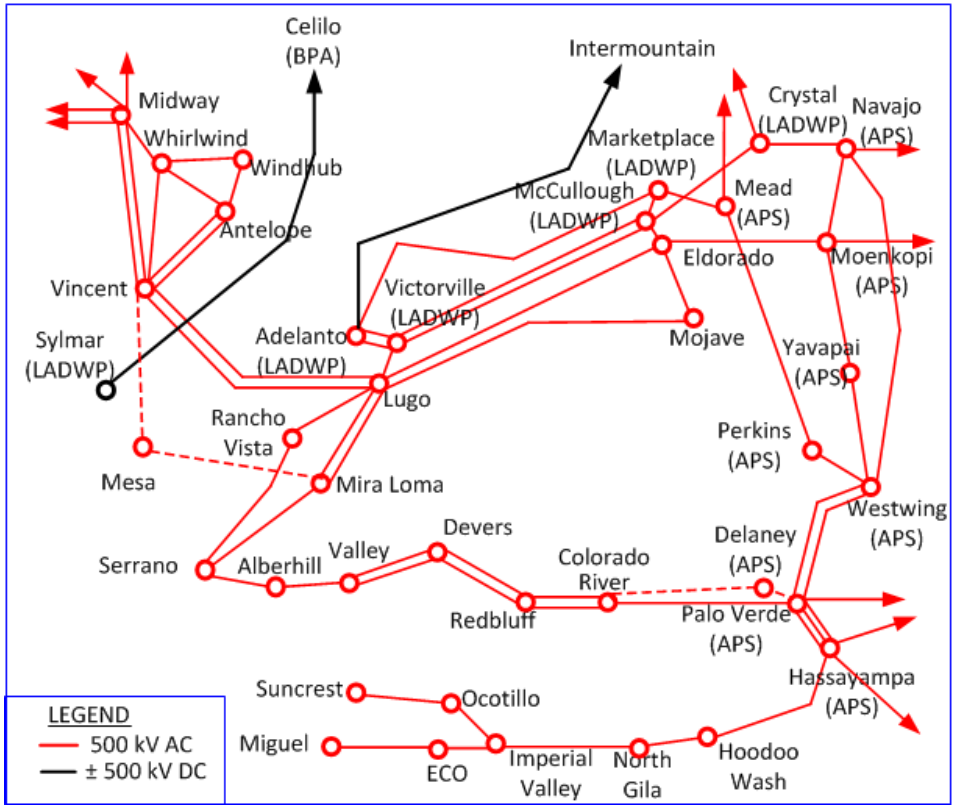
- Potential Mitigation
  - Issue only occurs in the sensitivity cases. Further evaluation needed.

SCE Bulk System
Preliminary Reliability Assessment Results

Charles Cheung
Senior Regional Transmission Engineer

2015-2016 Transmission Planning Process Stakeholder Meeting
September 21-22, 2015

SCE Bulk System



- Includes SCE's 500 kV system and interconnections with PG&E, SDG&E, LADWP, and APS
- About 25,000 MW of total existing generation
- Total 2025 SCE Area 1-in-5 Summer Peak net load – 25,720 MW
- Existing and authorized preferred resources were modeled per the study plan

SCE Bulk System Assessment Summary

- The assessment identified:

  Before utilizing DG, ES, DR and other system adjustments:

  - Thermal overload due to Category P1 and P6

  After utilizing DG, ES, DR and other system adjustments:

  - No issues identified

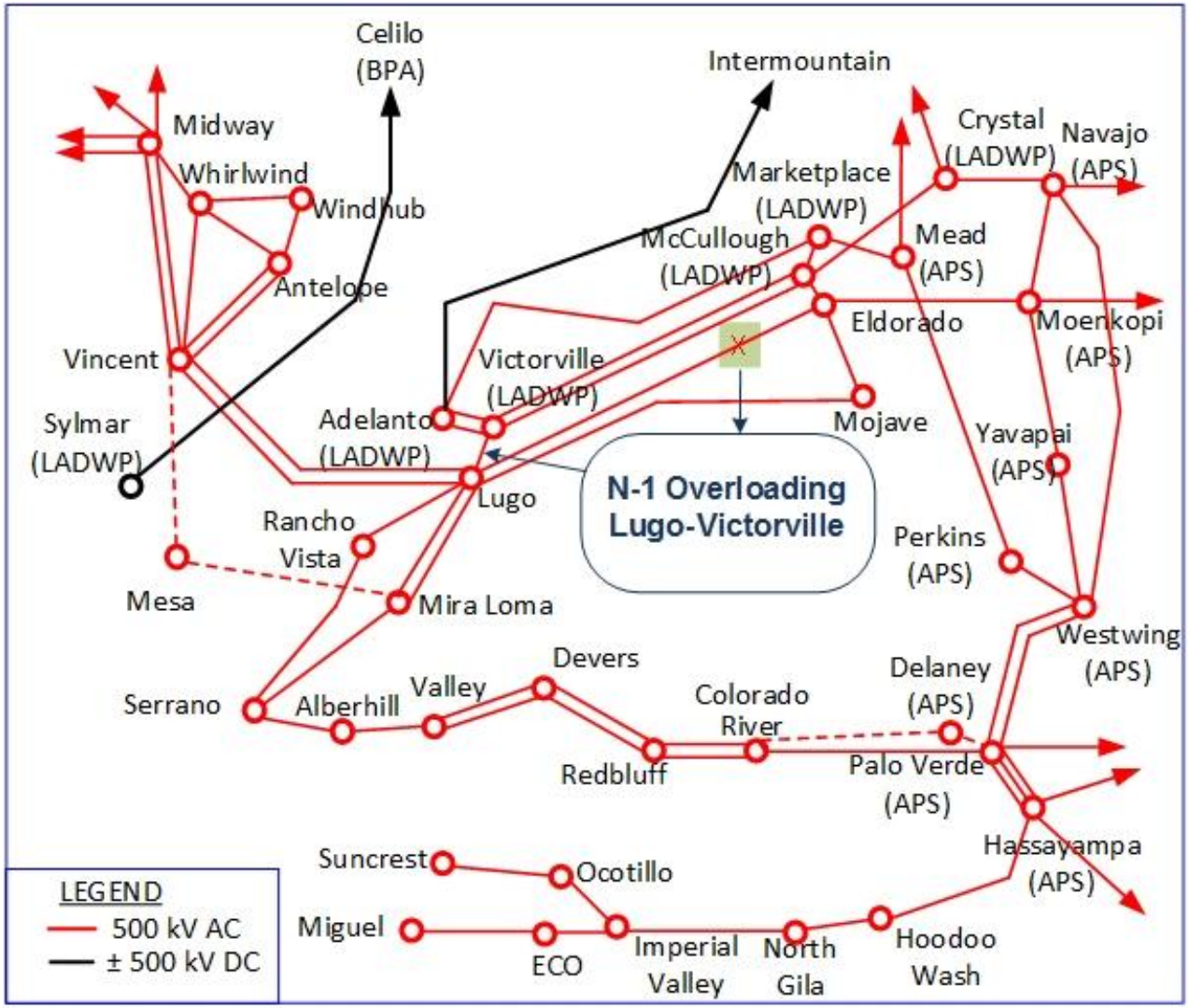
- Compared to last year results:
  - Same as last year

SCE Bulk System Potential Solutions

- Potential Mitigation Solutions
  - Utilize available DG, DR, ES and other system adjustments,
  - Increase emergency ratings of the line

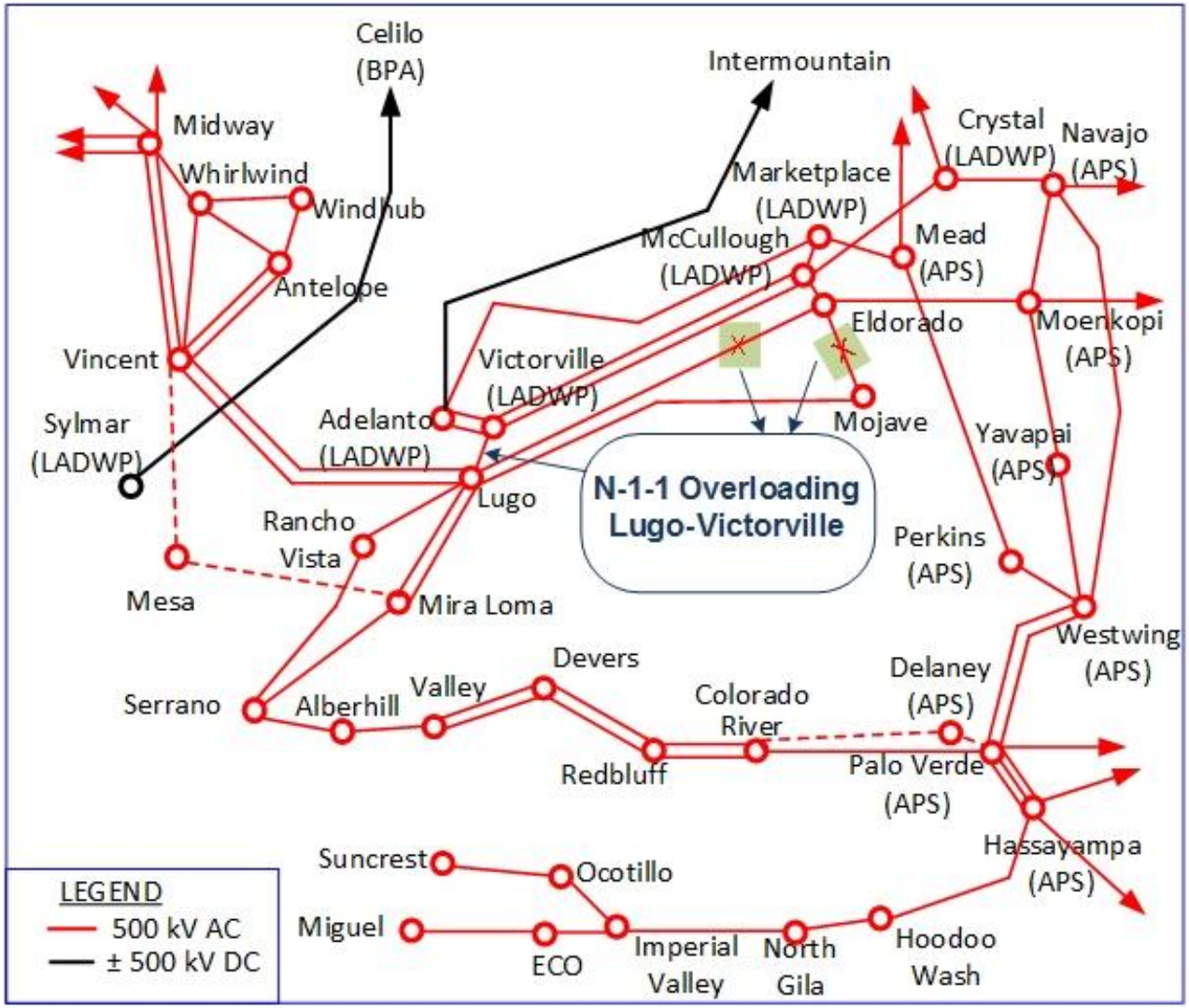
SCE Bulk System – P1 Results

- Thermal Overload
  - Lugo–Victorville 500 kV line (N-1, 2025 Partial Peak case)
- Potential Mitigation
  - Utilize available DG, ES, DR and other system adjustments
  - Increase emergency ratings of the line or
  - Add series reactors



SCE Bulk System – P6 Results

- Thermal Overload
  - Lugo–Victorville 500 kV line (N-1-1, All SP cases)
- Potential Mitigation
  - Utilize available DG, ES, DR and other system adjustments
  - Increase emergency ratings of the line or
  - Add series reactors



SCE Eastern Area
Preliminary Reliability Assessment Results

Charles Cheung
Senior Regional Transmission Engineer

2015-2016 Transmission Planning Process Stakeholder Meeting
September 21-22, 2015

SCE Eastern Area

- Includes the SCE owned transmission system in the Riverside County around and west of the Devers Substation
- Generation: over 3,100 MW of generation
- Comprised of 500, 230 and 161 kV transmission facilities.
- Summer Peak net load of 1,117 MW in 2025

SCE Eastern Area Assessment

- The assessment identified:

  Without allowable system adjustments:

  - Thermal overload due to Category P6
  - Voltage/transient instability due to Category P6
  - High voltage due to Category P1, P6

  With allowable system adjustments:

  - High voltage due to Category P1, P6

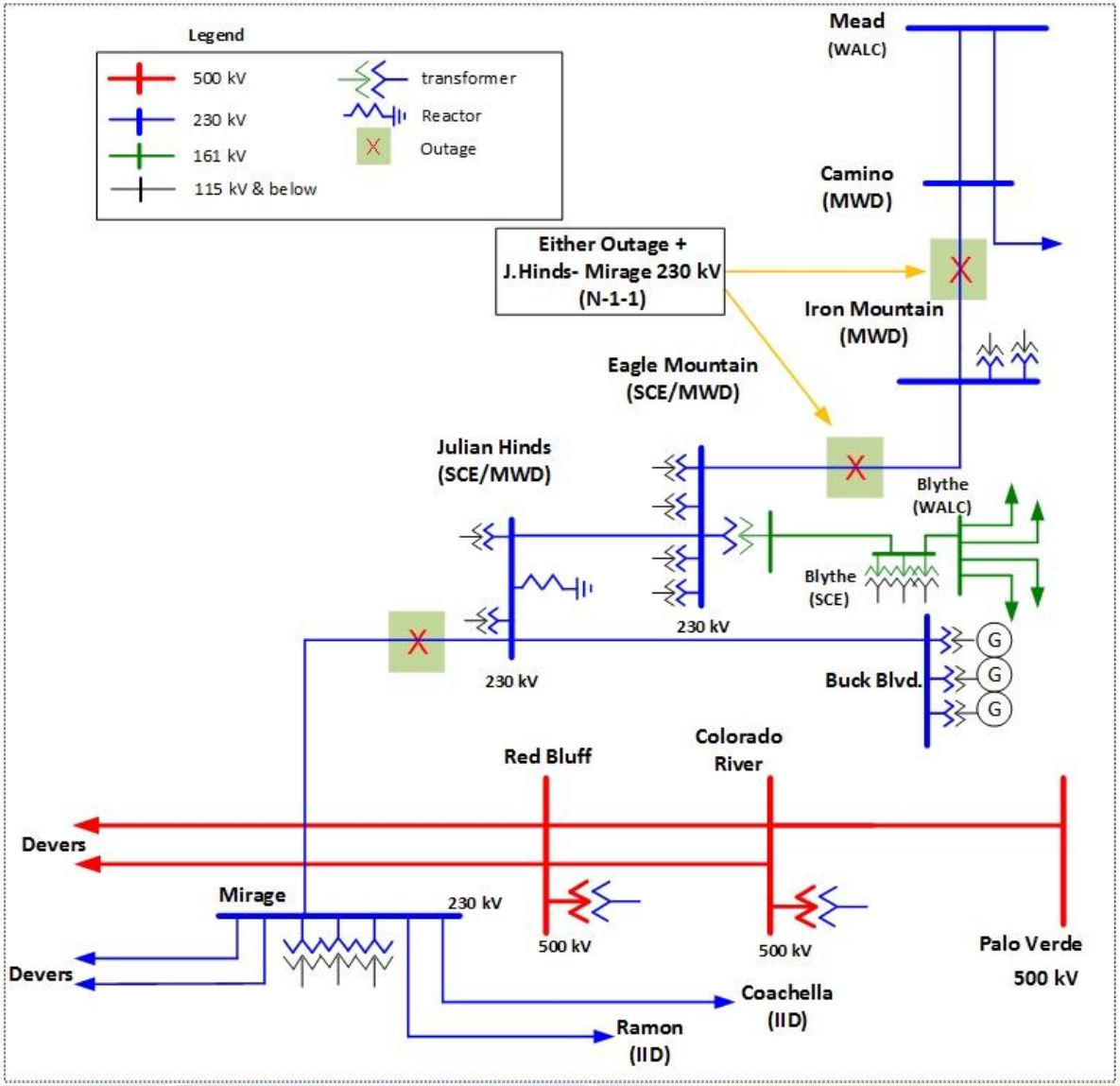
- Compared to last year results:
  - 1 new high voltage problem

SCE Eastern Area Proposed Solutions

- Potential Mitigation Solutions
  - System adjustment after contingency
  - Colorado River – Delaney 500 kV in service in 2020 to relieve Colorado River – Palo Verde 500 kV Outage

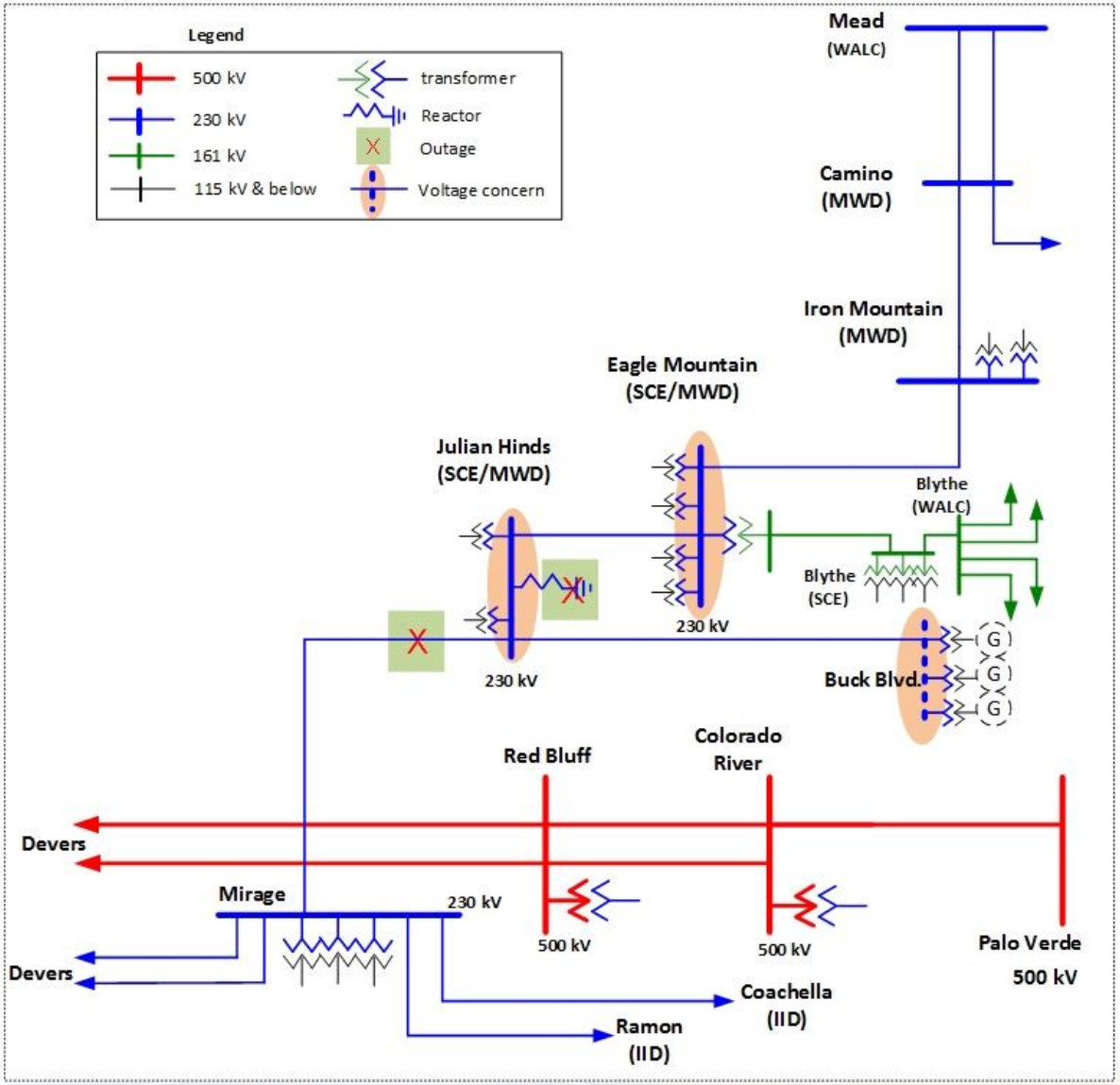
SCE Eastern Area – Results

- Voltage Instability
  - Julian Hinds-Mirage & Eagle Mtn-Iron Mtn (N-1-1)
  - Julian Hinds-Mirage & Iron Mtn-Camino-Mead-Gene (N-1-1)
- Potential Mitigation:
  - Operation Procedure 7720F



SCE Eastern Area – Results

- High Voltage
  - Buck Blvd., Eagle Mtn., Julian Hinds substation (N-1-1)
- Potential Mitigation:
  - Install shunt reactor in Eagle Mtn 230 kV



Tehachapi and Big Creek Corridor Preliminary Reliability Assessment Results

Piyasak Poonpun
Senior Operations Engineer

2015-2016 Transmission Planning Process Stakeholder Meeting
September 21-22, 2015

Tehachapi and Big Creek Corridor Area

- Comprised of 230 kV transmission facilities.
- Over 6,518 MW of existing generation.
- Existing pumping load of 720 MW.
- Summer Peak load of 2,083 MW in 2025.

Study Scenarios

- 5 Study Base Case Scenarios

Scenario	Load	Gen. Dispatch – Conv.	Gen. Dispatch – renewables	Preferred Res. & Storage
2017 Summer Peak	1-in-10 mid – Low-mid AAEE	< Max	Solar - 36% Wind - 0%	Not dispatched
2020 Summer Peak				
2025 Summer Peak				
2017 Spring Off-Peak	~ 65% 1-in-2	< Max	Solar - 93% Wind - 93%	
2020 Spring Light Load	~ 50% 1-in-2	~ 0	Solar - 0% Wind - 93%	

- 1 Sensitivity Scenario

Scenario	Baseline	Change
S1	2020 Summer Peak	Assumed 340 MW hydro generation based on last year average Big Creek hydro output during Summer peak hours.

Tehachapi and Big Creek Corridor Area Assessment Summary

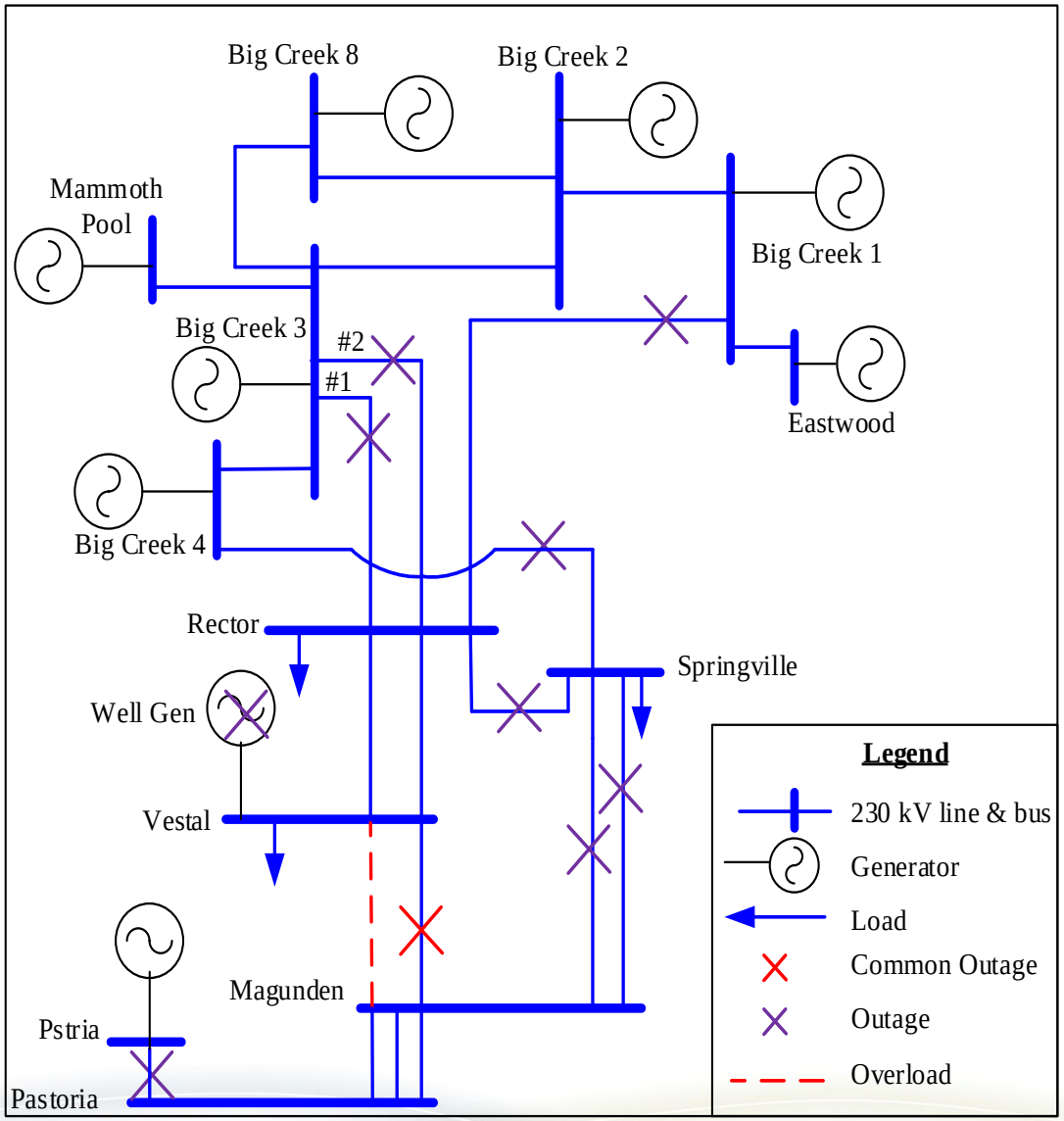
- The assessment identified:
  - No concerns were identified in Study Base Case Scenarios.
  - Thermal overload due to one Category P1, two Category P3, and twelve Category P6 contingencies were identified in Study Sensitivity Scenario.
- Compared to last year results:
  - P6 contingency identified last year was not observed due to lower load forecast.
  - Sensitivity study was not performed last year.

Tehachapi and Big Creek Corridor Area Potential Mitigation Solutions

- Potential Mitigation Solutions
  - Thyristor Controlled Series Capacitors (TCSC).
  - Manage hydro generation to utilize during peak hours.
  - Modify RAS arming for low hydro conditions.
  - Additional new Preferred Resources and Energy Storage.

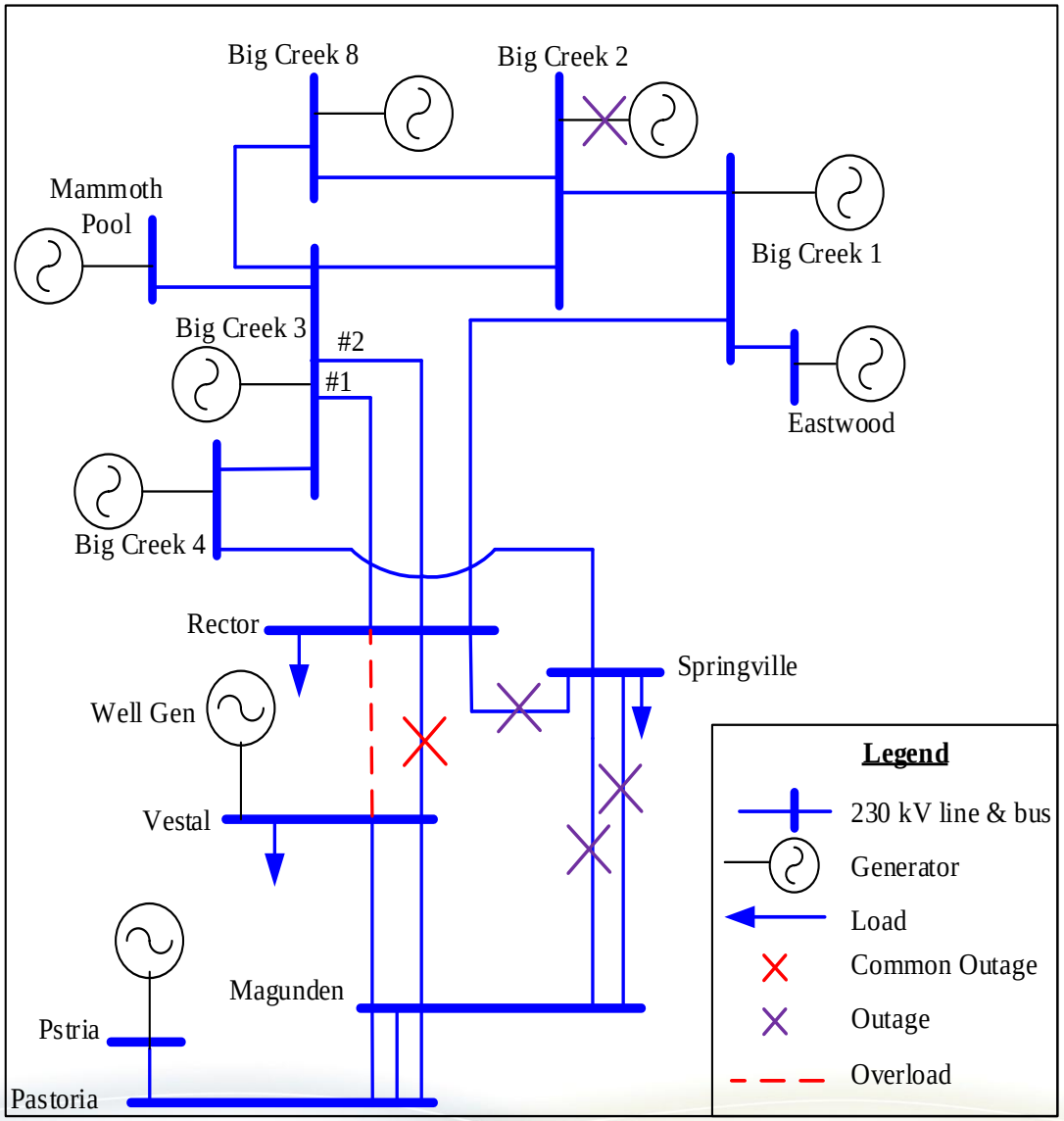
Tehachapi and Big Creek Corridor Area – Results

- Thermal overload
  - Magunden-Vestal 230 kV 1 or 2 overloaded for multiple contingencies.
- Potential Mitigation
  - Thyristor Controlled Series Capacitor (TCSC).
  - Manage hydro generation to utilize during peak hours.
  - Modify RAS arming for low hydro conditions.
  - Additional new Preferred Resources and Energy Storage.



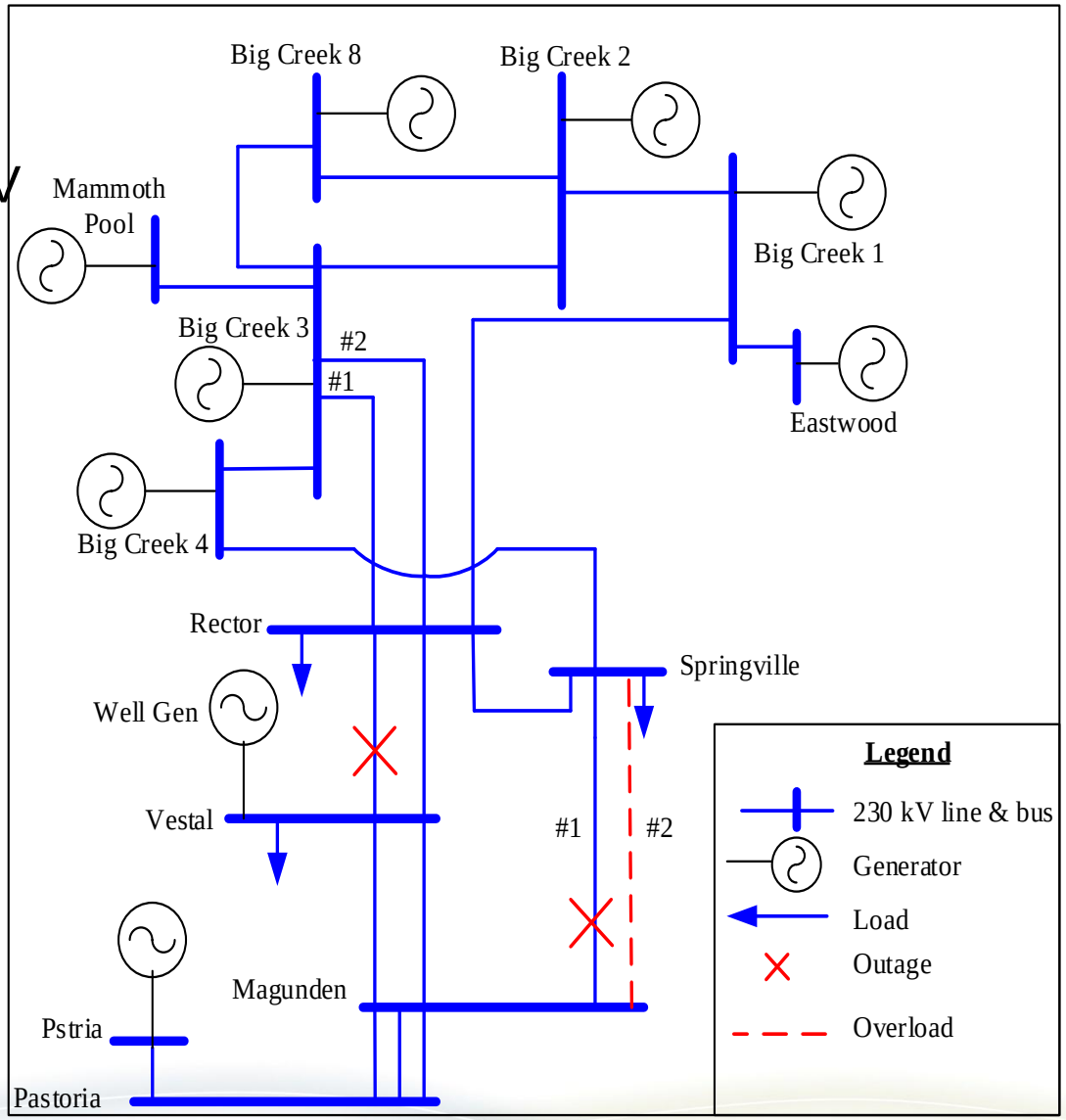
Tehachapi and Big Creek Corridor Area – Results

- Thermal overload
  - Rector-Vestal 230 kV 1 or 2 overloaded for multiple contingencies.
- Potential Mitigation
  - Thyristor Controlled Series Capacitor (TCSC).
  - Manage hydro generation to utilize during peak hours.
  - Modify RAS arming for low hydro conditions.
  - Additional new Preferred Resources and Energy Storage.



Tehachapi and Big Creek Corridor Area – Results

- Thermal overload
  - Magunden-Springville 230 kV 2 overloaded for Magunden-Springville 1 230kV and Rector-Vestal 230kV 1 or 2
- Potential Mitigation
  - Thyristor Controlled Series Capacitor (TCSC).
  - Manage hydro generation to utilize during peak hours.
  - Modify RAS arming for low hydro conditions.
  - Additional new Preferred Resources and Energy Storage.



North of Lugo Area
Preliminary Reliability Assessment Results

Sushant Barave
Sr. Regional Transmission Engineer

2015-2016 Transmission Planning Process Stakeholder Meeting
September 21-22, 2015

North of Lugo (NOL) Area

- Comprised of 55, 115, and 230 kV transmission facilities.
- More than 2,500 MW of existing generation.
- Summer Peak load of 1,132 MW in 2025.

NOL Area Assessment Summary

- The assessment identified:
  - 1 facility overload due to category P1 outage
  - 1 bus with high/low voltage concerns for category P0
  - 2 buses with high/low voltage concerns for category P1 outage
  - 3 facility overloads due to category P6 outages
  - 1 issue for further investigation due to category P6 outage
- Compared to last year results:
  - Load modeled in NOL area was lower
  - Generation retirements
  - Coolwater – Lugo 230 kV transmission project not modeled

NOL – P0 and P1 Issues

- P0 High voltage at Inyo PS 115 kV
- Potential Mitigation:

  Adjust generator voltage schedules, reactive devices and taps

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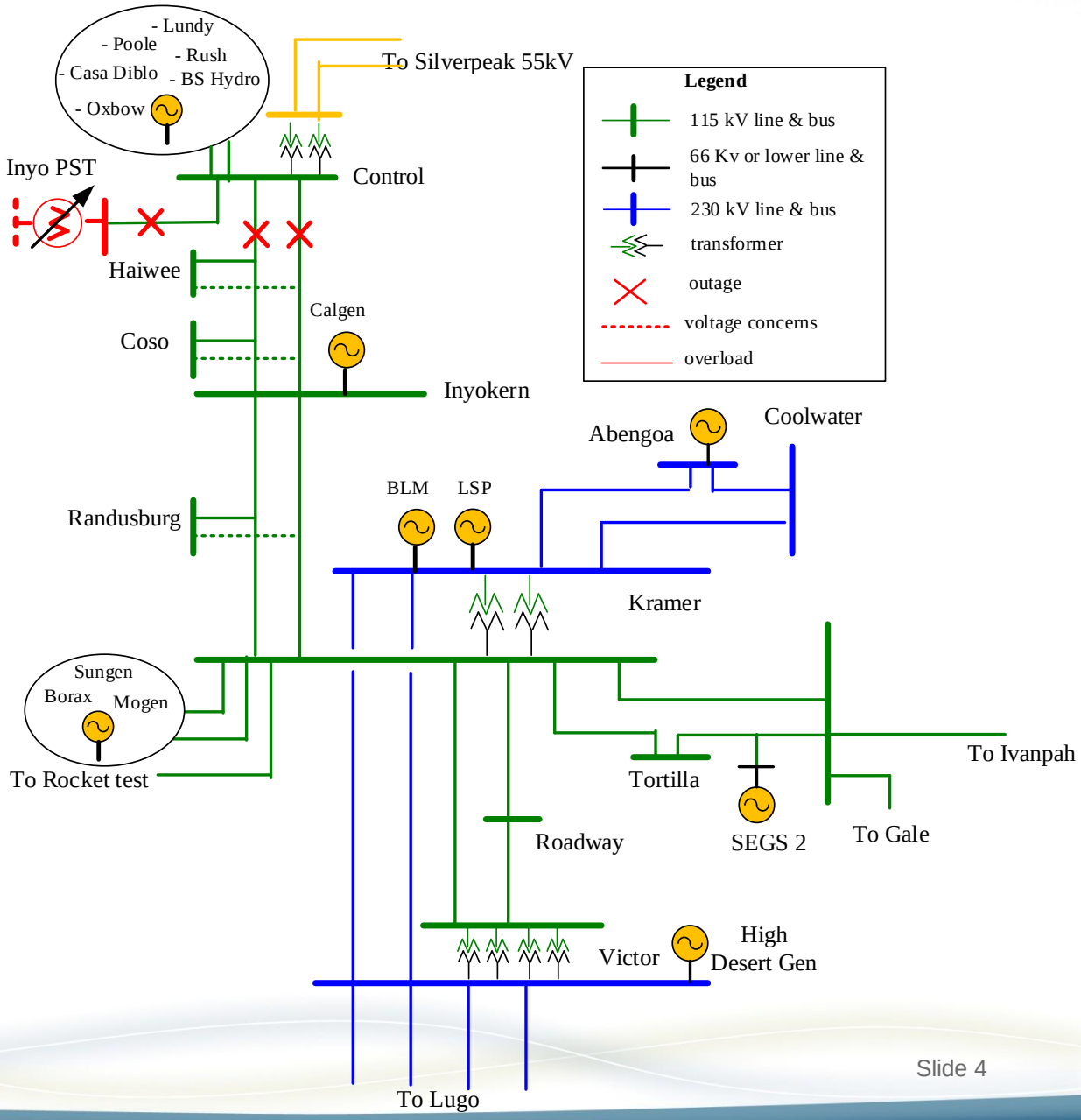
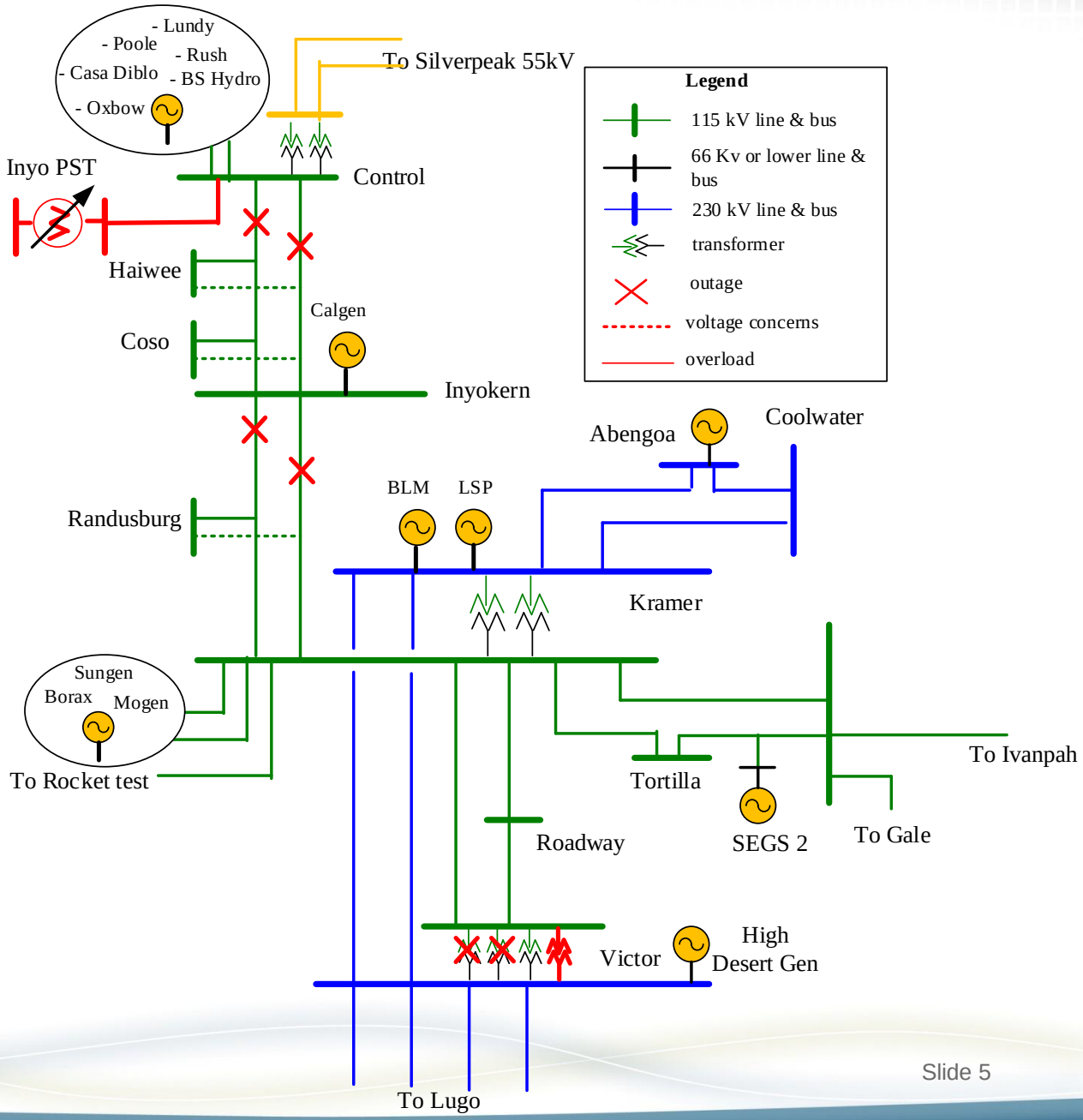
- P1 Thermal overload on Inyo phase shifter
- P1 High voltage at Inyo 115 kV

- Potential Mitigation:
  - Congestion management
  - Adjust generator voltage schedules, reactive devices and taps



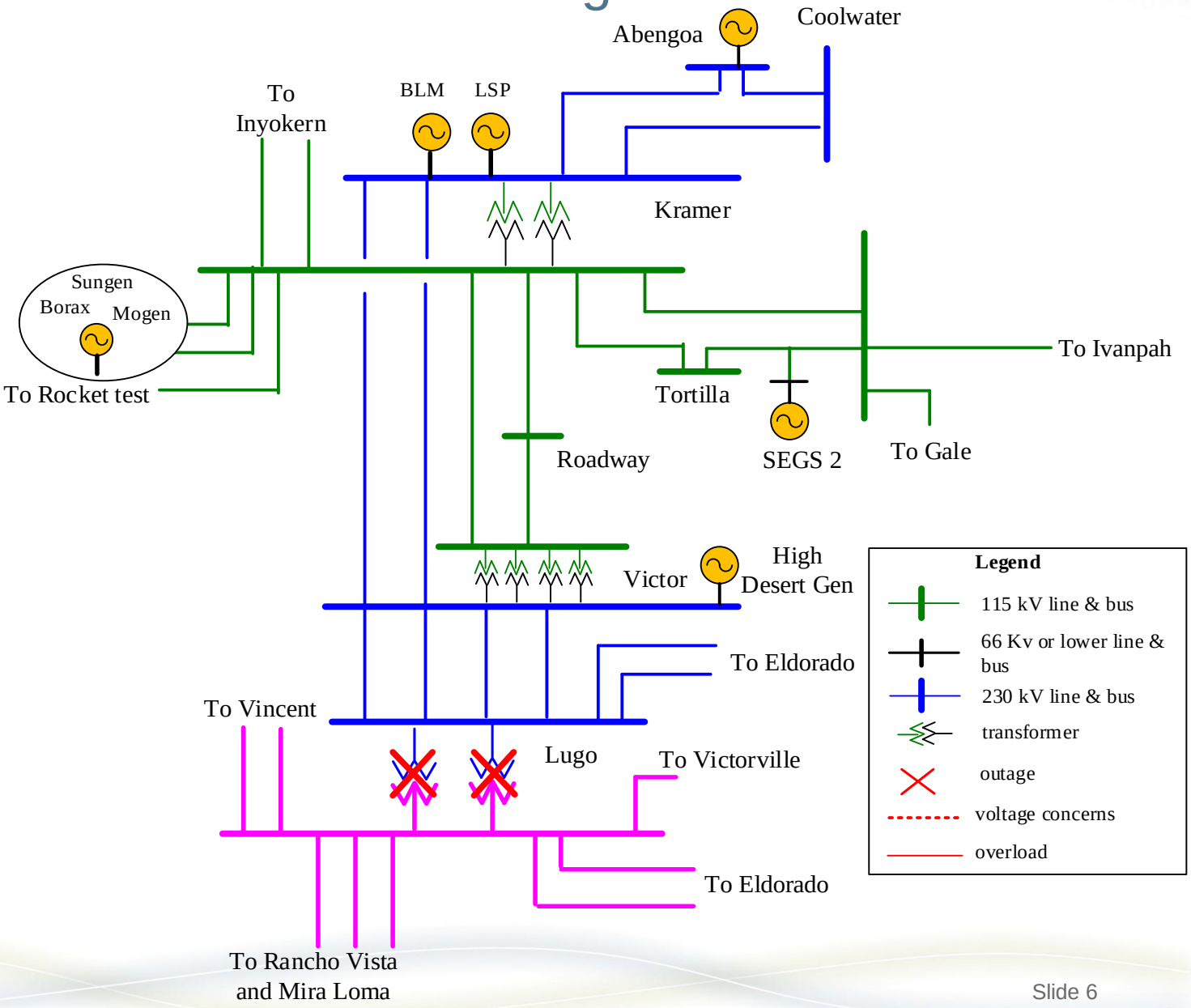
NOL – P6 Issues

- Thermal overloads
  - i. Victor 230/115 kV banks
  - ii. Control – Inyo 115 kV
  - iii. Inyo phase shifter
- Potential Mitigation:
  - i. Bring the hot spare bank in-service at Victor
  - ii. Maintain Inyokern area generation-load balance as described in SCE's SOB 209 (Kramer RAS)
  - iii. Redispatch generation North of Control after the first N-1



NOL – P6 Issue for Further Investigation

- Case divergence due to Lugo 500/230 kV banks (T-1-1)
- Potential Mitigation: Further investigation and operational evaluation of the existing RAS



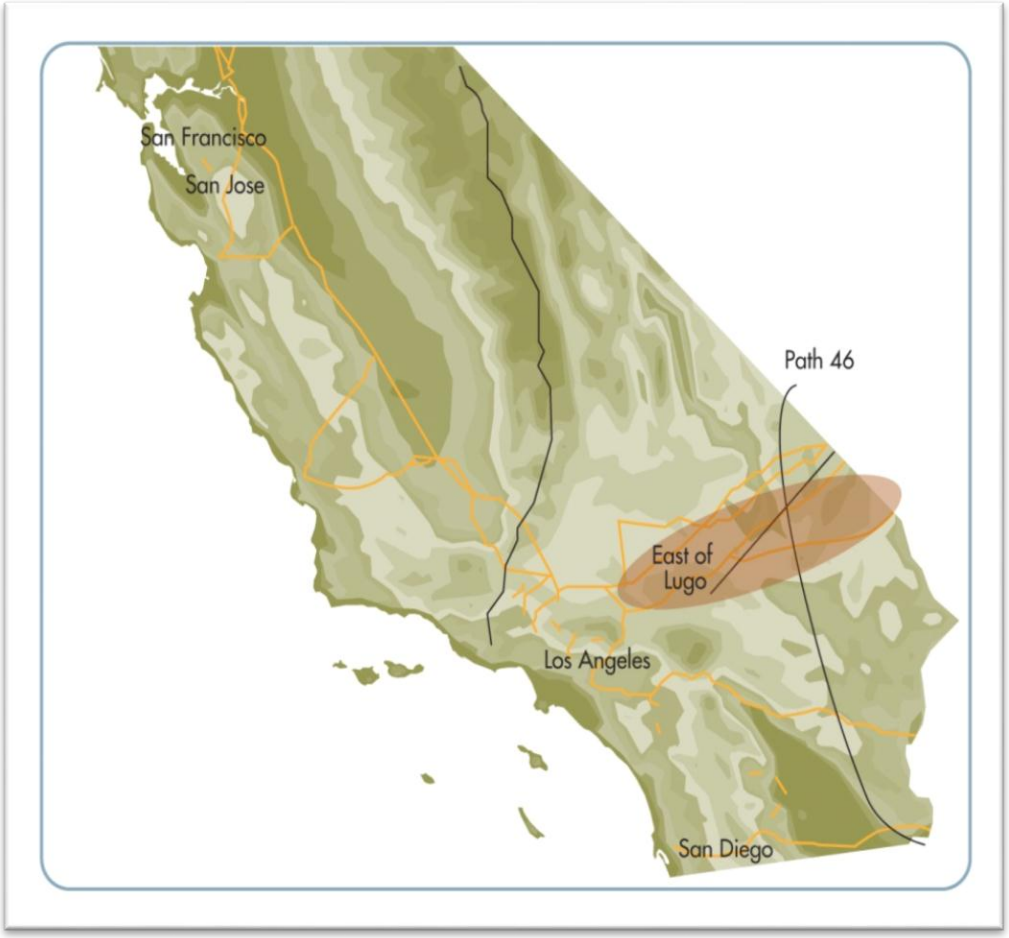
Thank you

East of Lugo Area
Preliminary Reliability Assessment Results

Sushant Barave
Sr. Regional Transmission Engineer

2015-2016 Transmission Planning Process Stakeholder Meeting
September 21-22, 2015

East of Lugo (EOL) Area



- Includes Eldorado, Mohave, Merchant, Ivanpah, CIMA, Pisgah Mountain Pass, Dunn Siding and Baker substations
- Generation:
  - 1111 MW
- Comprised of 115, 230 & 500 kV transmission facilities.
- Summer Peak load of 14 MW in 2025

EOL Area Assessment Summary

- The assessment identified:
  - 1 facility overload due to category P1 outage
  - 2 facility overloads due to category P6 outages
  - 1 facility overload due to category P1 outages (only in the sensitivity studies)

  - 1 voltage deviation issues due to category P1 outages
  - 1 voltage deviation issue due to category P6 outages

  - 5 high/low voltage issues due to category P0
  - 2 high/low voltage issues due to category P1 outages
  - 1 high/low voltage issues due to category P6 outage

- Compared to last year results:
  - Same Lugo – Victorville overload
  - Additional thermal issues observed at Ivanpah
  - Additional voltage issues observed

EOL Area Proposed Solutions

- Potential Mitigation Solutions
  - Congestion management
  - Future SPSs
  - Mitigation for Lugo-Victorville 500kV overload: Same as the mitigations discussed in SCE bulk system results
    - Congestion management
    - Increase the line rating

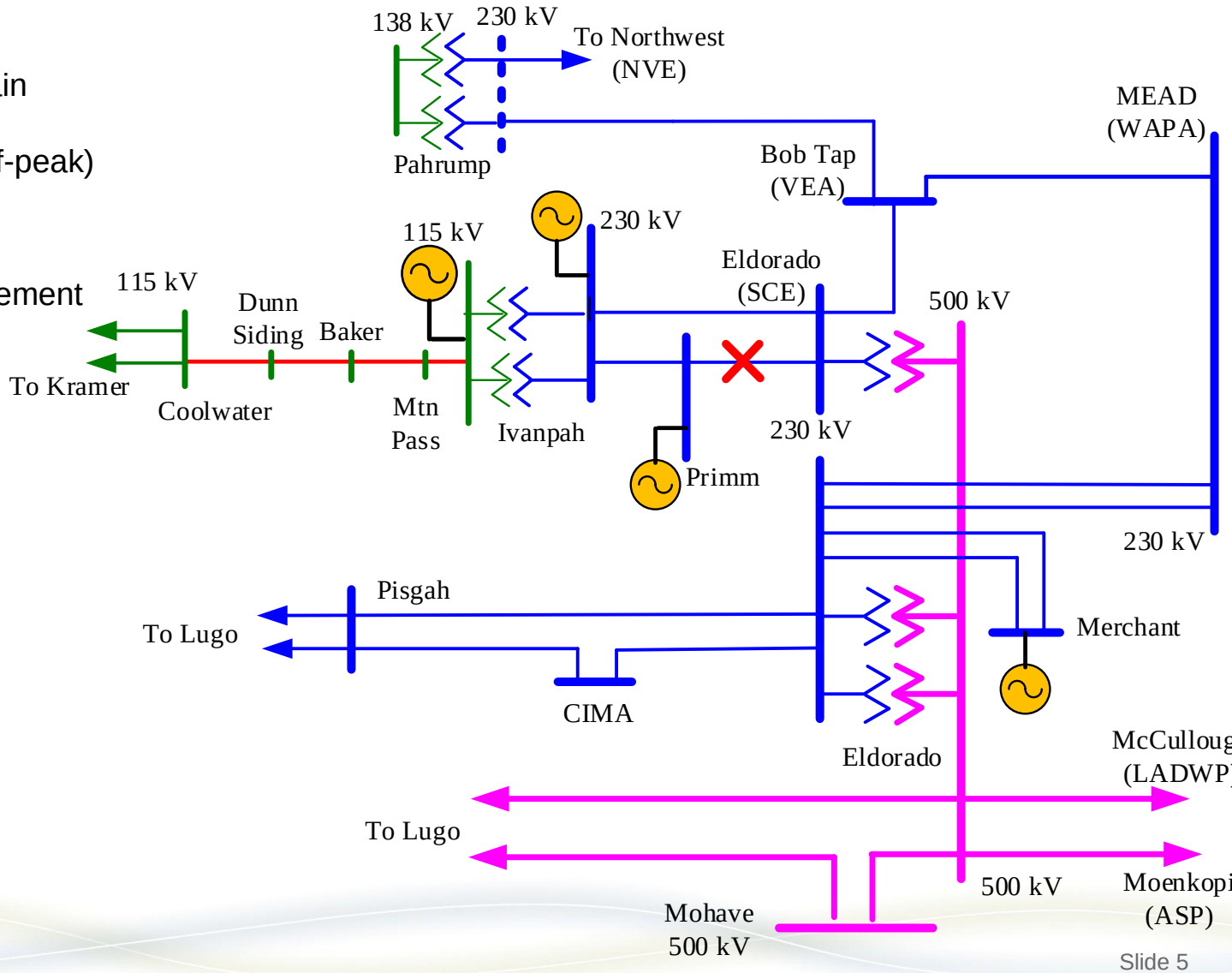
EOL Area – P1 (N-1) thermal issue

- Thermal Overload

  Ivanpah – Mountain Pass 115 kV line overload (2017 off-peak)

- Potential Mitigation

  - Congestion management
  - Upgrade
  - Series reactor



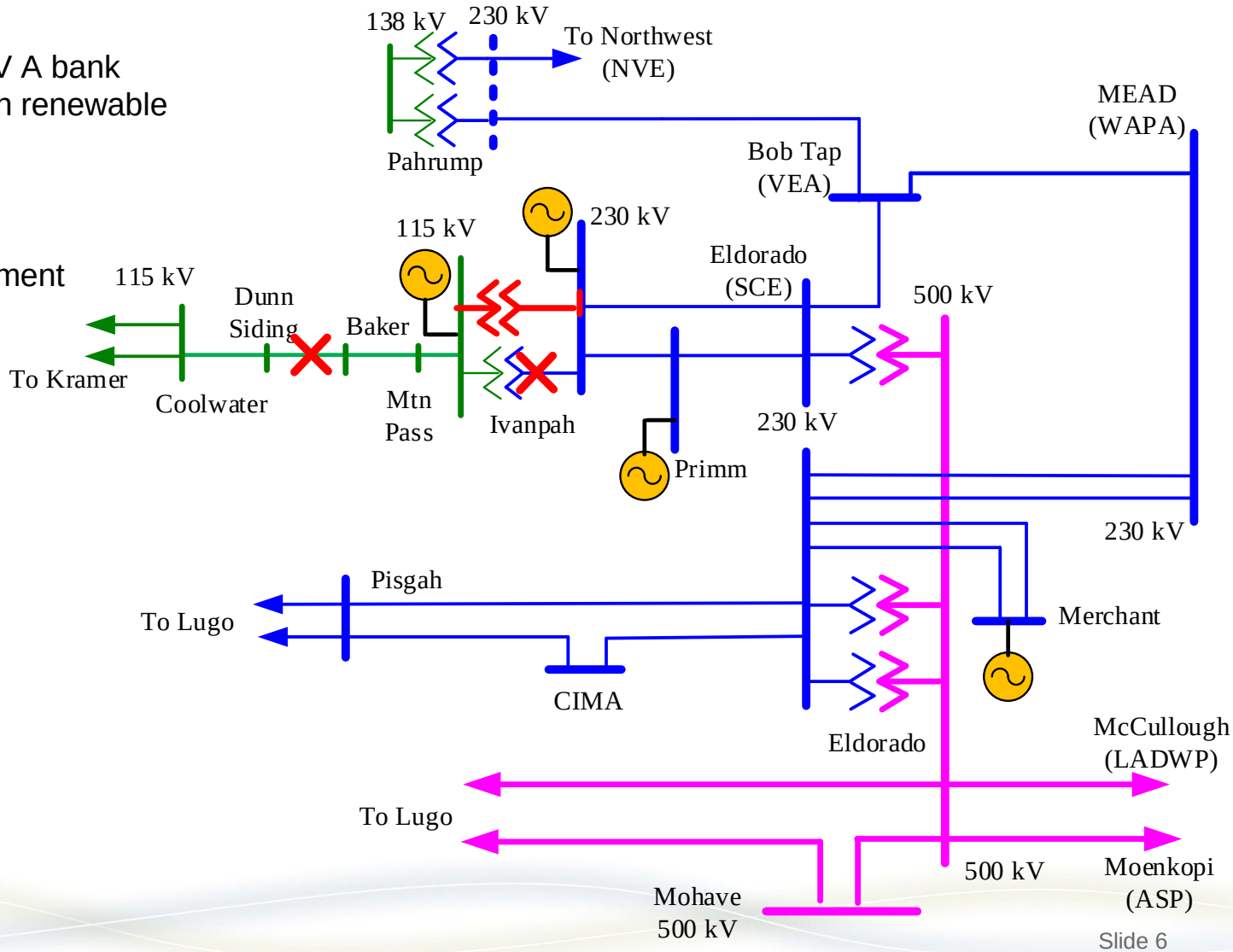
EOL Area – P6 (N-1-1) thermal issue 1

- Thermal Overload

  Ivanpah 230/115 kV A bank (2017 off-peak, high renewable sensitivities)

- Potential Mitigation

- Congestion management



EOL Area – P6 (N-1-1) thermal issue 2

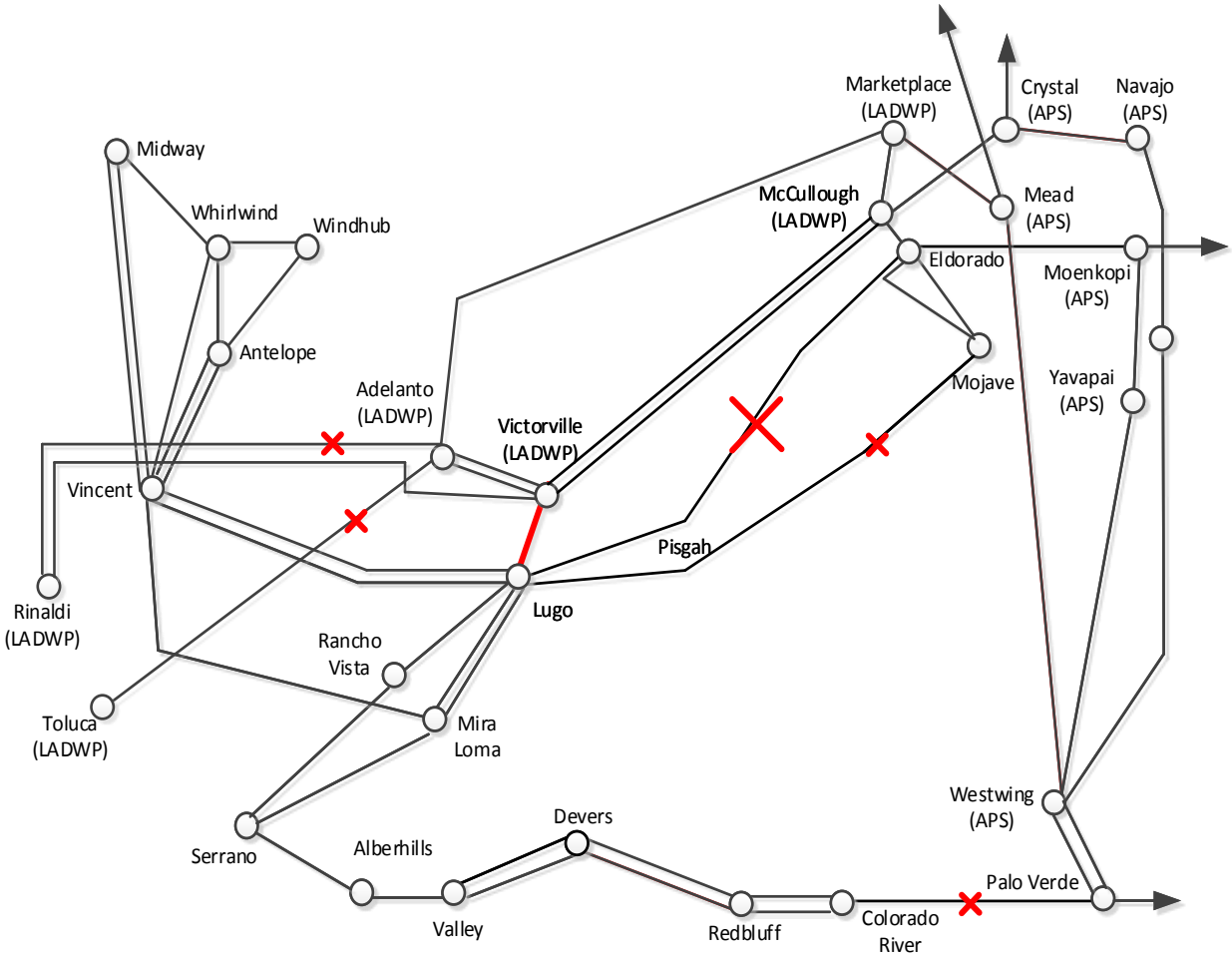
- Thermal Overload

  Lugo – Victorville 500kV (all scenarios except 2020 light load)

- Potential Mitigation

Same as the mitigations discussed in SCE bulk system results

- System adjustments after initial contingency including bypassing series caps per ISO OP 6610, dispatching Preferred Resources and Energy Storage (PR&ES) or
- Increase the emergency rating of the line (SCE and LADWP Portion)
- Install series reactors to limit flows on the line.



EOL Area – Voltage Deviation Issues

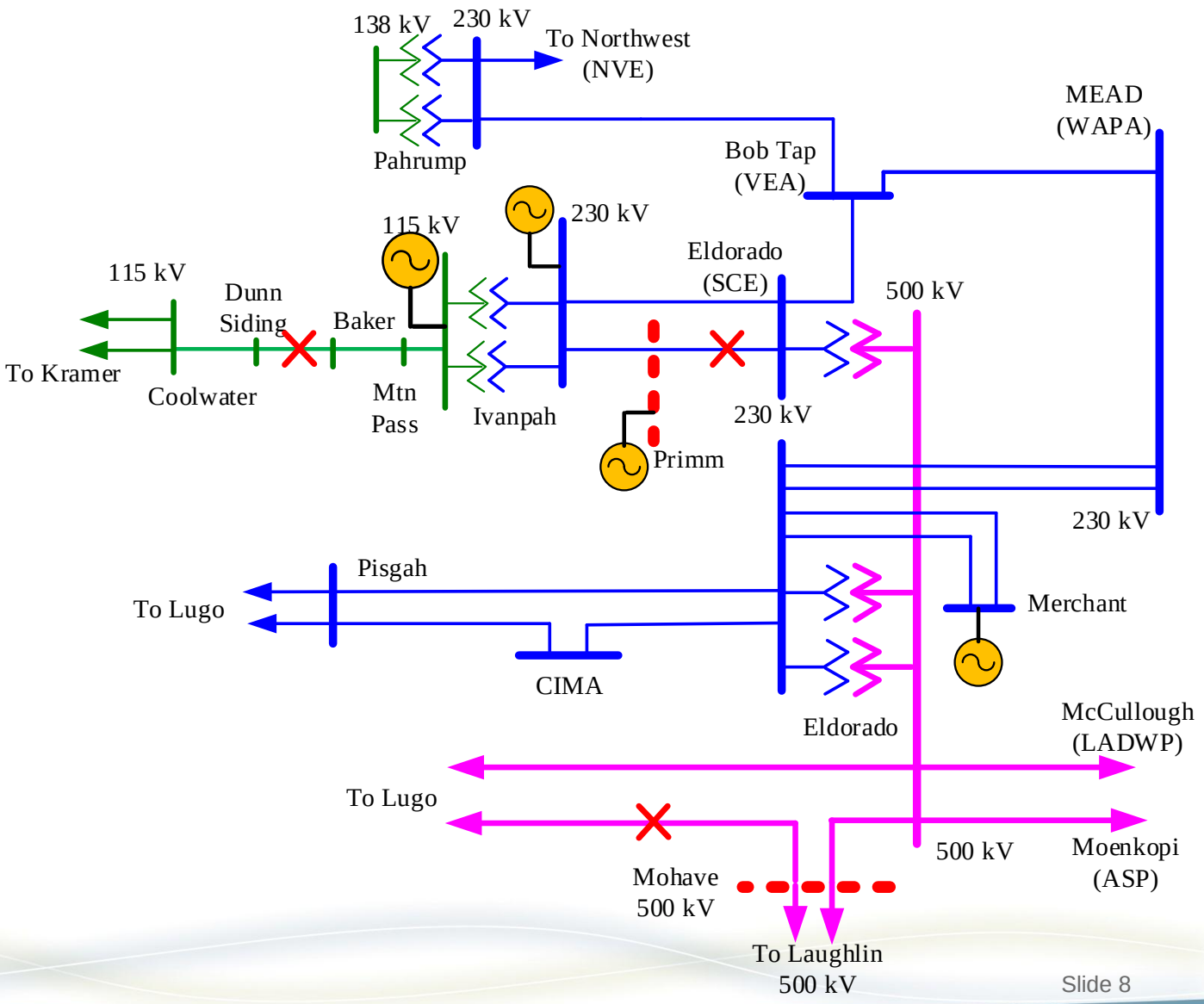
- Voltage deviation

  Laughlin 500 kV and Mohave 500 kV (P1: all years)

  Primm 230 kV (P6: 2017 off-peak)

- Potential Mitigation

- Exception or dynamic VAR support



EOL Area – High/Low Voltage Issues

- High/Low voltage issues

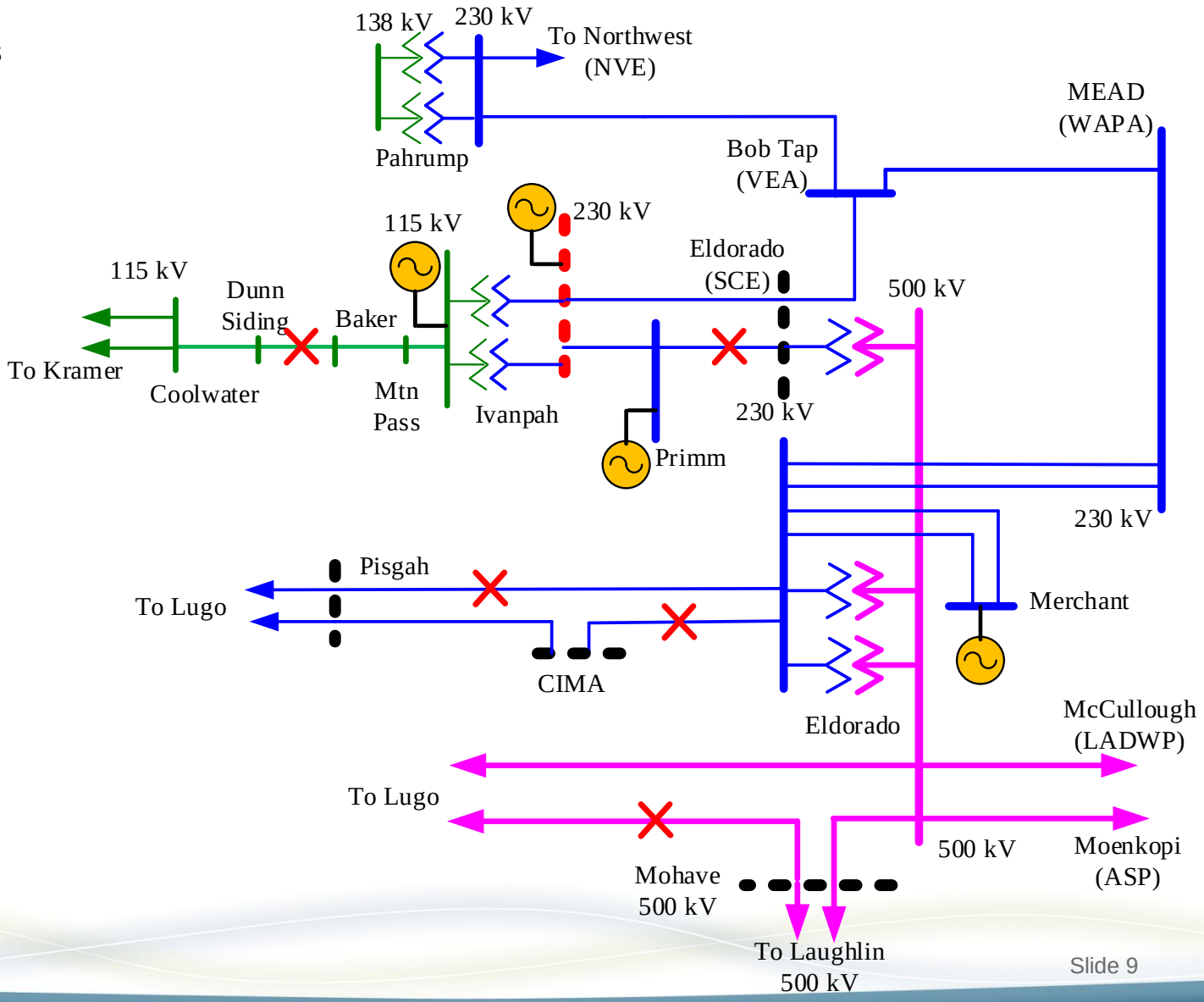
  Cima, Eldorado, Ivanpah, Pisgah and Primm 230 kV (P0: 2020 light-load)

  Laughlin and Mohave 500 kV (P1: all years)

  Ivanpah 230 kV (P6: 2017 off-peak)

- Potential Mitigation

- Adjust generator voltage schedules, taps and reactive devices.



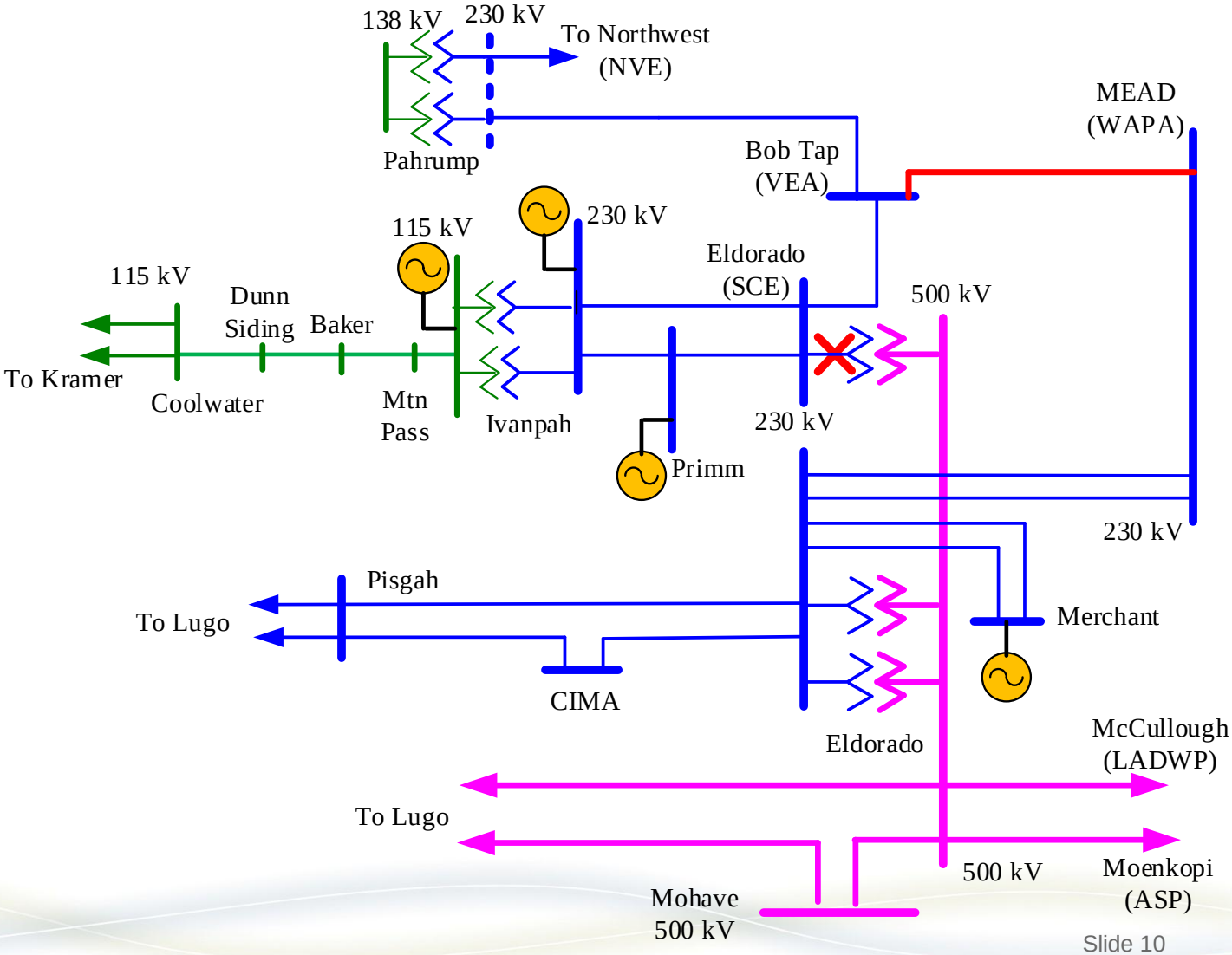
EOL Area – P1 (N-1) issue under sensitivity study

- Thermal Overload

  Mead – Bob 230 kV overload (only under high renewable sensitivities)

- Potential Mitigation

- Include Eldorado AA bank (T-1) outage in the Ivanpah RAS



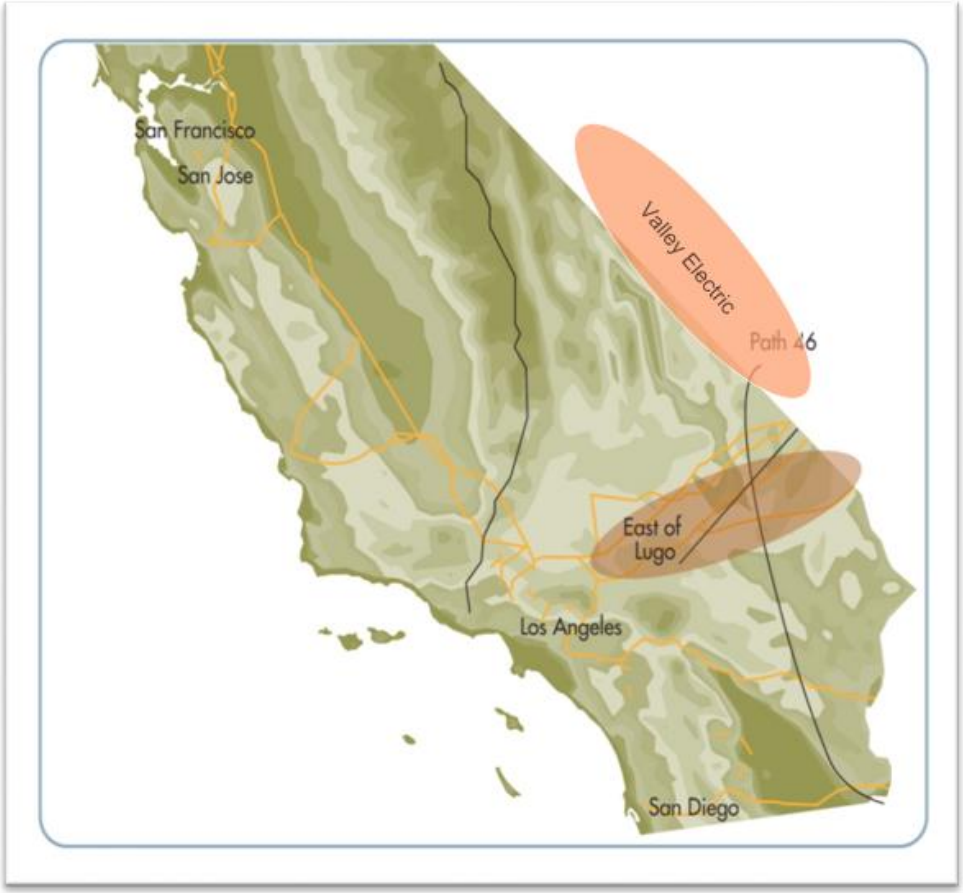
Thank you

Valley Electric Area
Preliminary Reliability Assessment Results

Sushant Barave
Sr. Regional Transmission Engineer

2015-2016 Transmission Planning Process Stakeholder Meeting
September 21-22, 2015

Valley Electric Association (VEA) Area



- VEA system is connected to WAPA's Mead 230kV substation, WAPA's Amargosa 138kV substation, NV Energy's Northwest 230kV substation and shared buses at Jackass 138kV and Mercury 138kV stations
- Generation Modeled:
  - 0 MW
- Comprised of 138 and 230 KV transmission facilities under ISO control
- Summer Peak load of 145 MW in 2025

VEA Assessment Summary

- The assessment identified:
  - 1 facility overload due to category P4 (breaker failure) outage
  - 4 facility overloads due to category P6 outages
  - 1 facility overload due to category P1 (only in the sensitivity study)

  - 2 buses with high/low voltage concerns for category P0
  - 20 buses with high/low voltage concerns for category P6 outages

  - 6 buses with voltage deviation concerns for category P1 outages
  - 19 buses with voltage deviation concerns for category P6 outages

- Compared to last year results:
  - Very similar to last year's results owing to the fact that planned upgrades modeled in this year's TPP are the same as last year's

VEA Potential Solutions

- Potential Mitigation Solutions
  - Existing UVLS in VEA area
  - Operational action plan for category P6 outages (switching after N-1 outage)
  - Planned future SPS for mitigating Bob-Mead 230 kV overload
  - Adjust voltage schedules, taps and reactive devices
  - Exception for certain buses

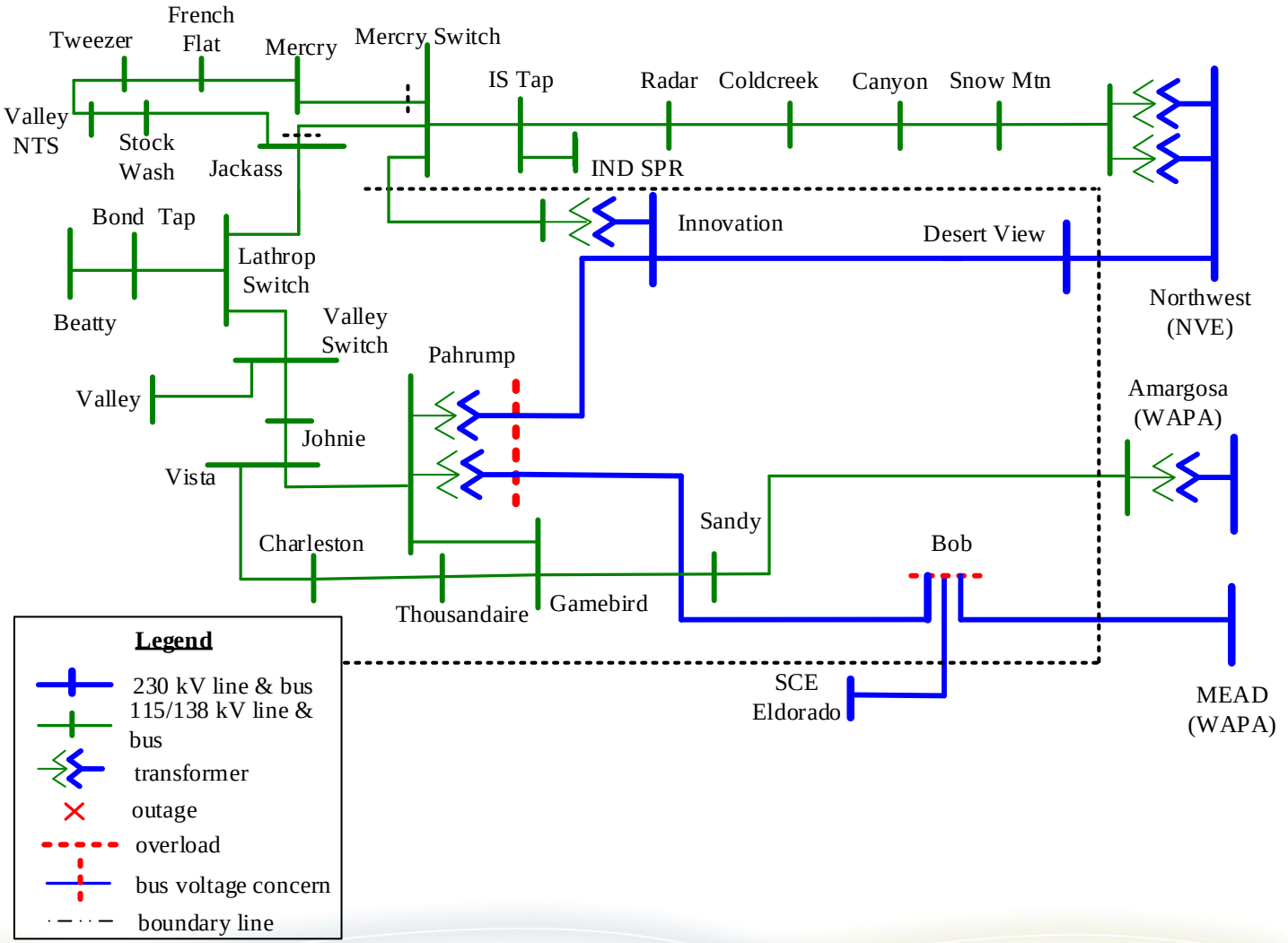
VEA – P0 (N-0) Issues

- High voltage

  Bob and Pahrump 230 kV (2020 light-load)

- Potential Mitigation

  Adjust generator voltage schedules, taps and reactive devices or seek for an exception

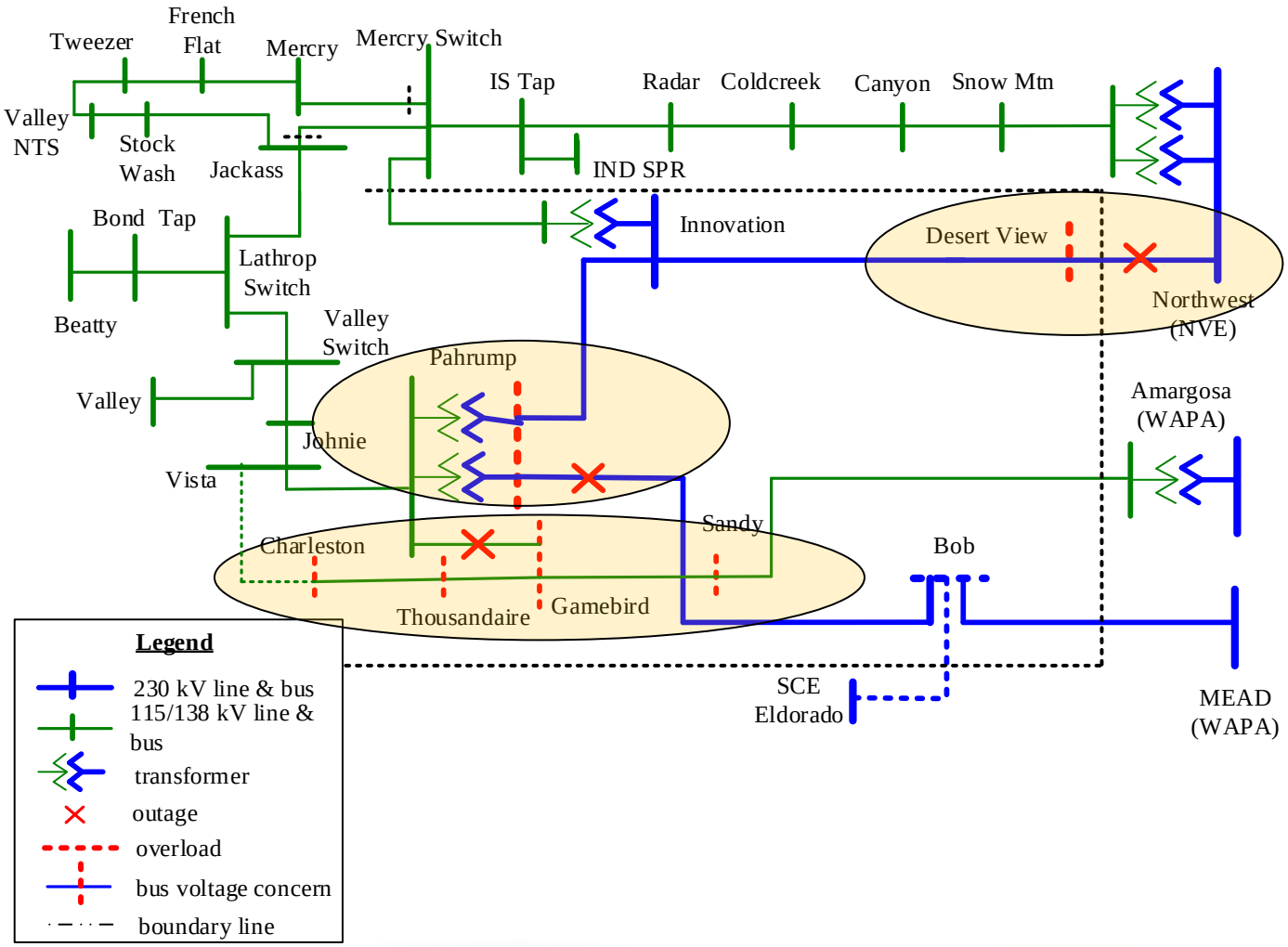


VEA – P1 (N-1) Issues

- Voltage deviation

  Charleston, Thousandaire, Gamebird and Sandy 138 kV (2017 peak)
  Pahrump 230 kV (2017 and 2025 peak)
  Desert View 230 kV (2020 light-load)

- Potential Mitigation
  - Planned Charleston – Vista 138 kV line will mitigate 138 kV issues.
  - An exception OR dynamic reactive support for other buses



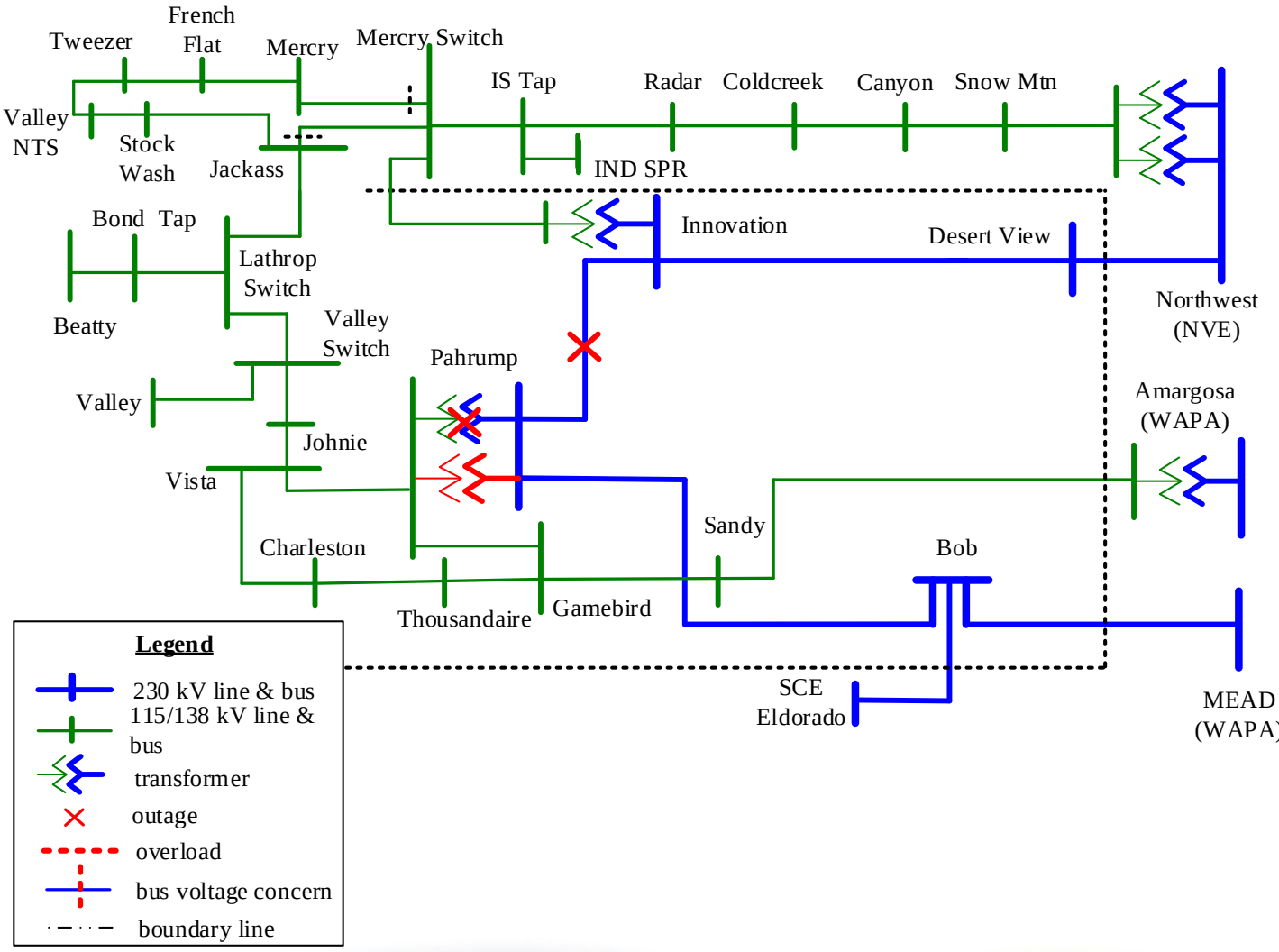
VEA – P4 (breaker failure) Issues

- Thermal overload

  Pahrump 230/115 kV transformer bank (2025 peak)

- Potential Mitigation

  Explore short-term emergency rating or rely on future generation in VEA or automatic load transfer SPS



VEA – Several P6 (N-1-1) Issues

- Overload

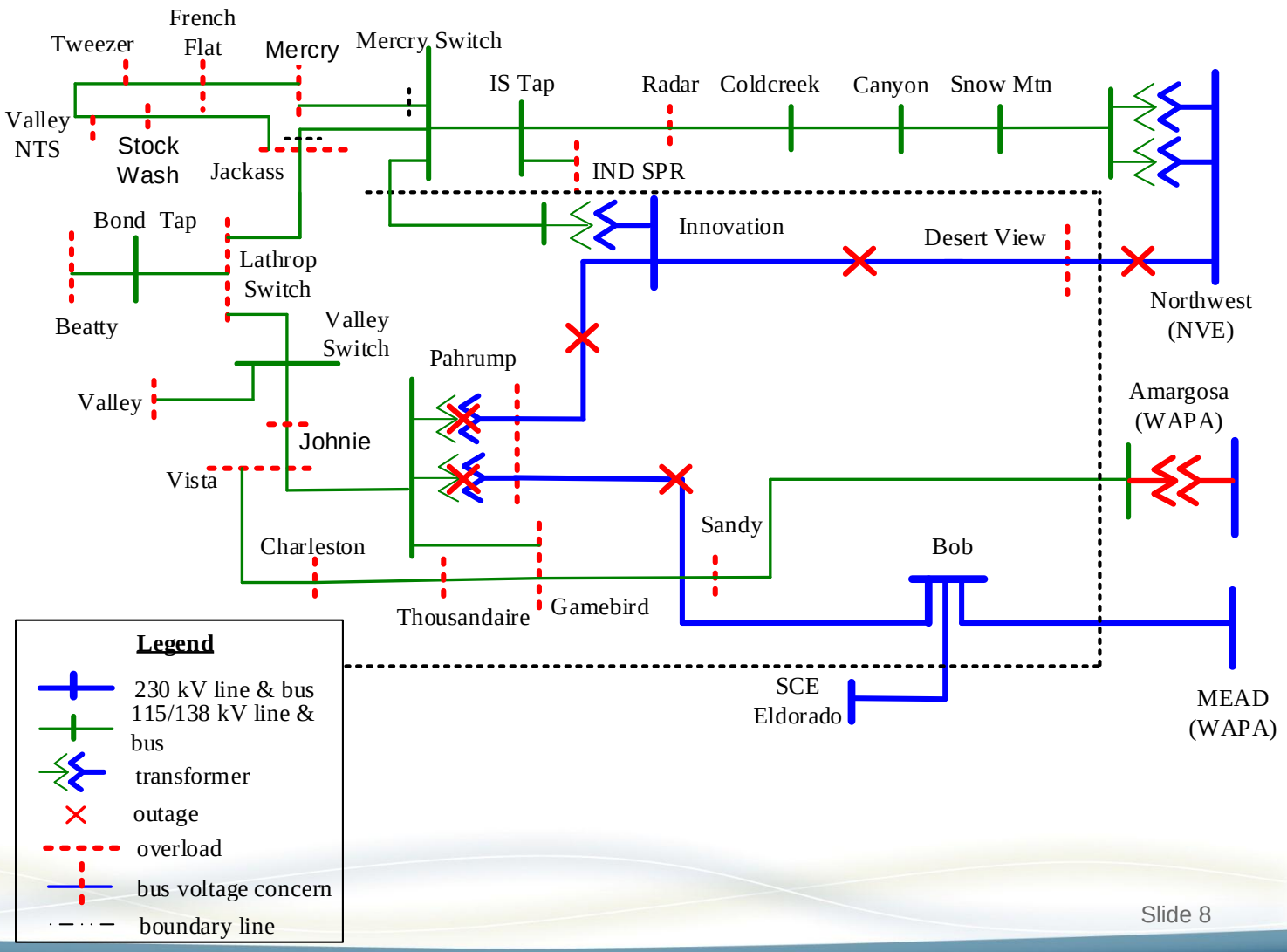
  Amargosa 230/138kV bank (2017, 2020 and 2025 peak)

- Voltage Concerns

  Deviations and low voltages across the 138kV system in VEA (all study years)

- Potential Mitigation

  Rely on UVLS or radially serve VEA 138 kV system after the 1st outage



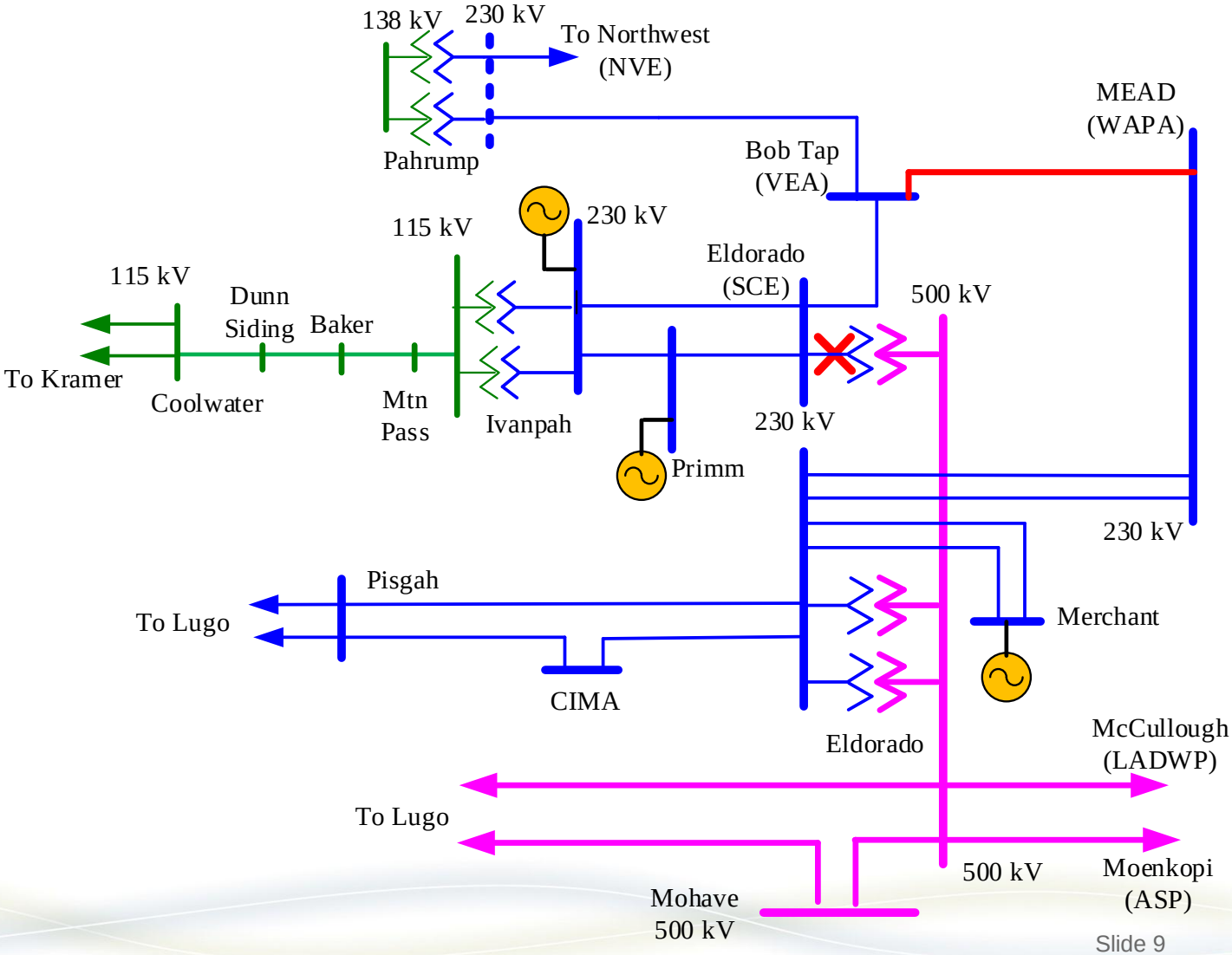
VEA – P1 (N-1) Issue – only under sensitivity scenario

- Thermal Overload

  Mead – Bob 230 kV overload (only under high renewable sensitivity)

- Potential Mitigation

- Include Eldorado AA bank (T-1) outage in the Ivanpah RAS



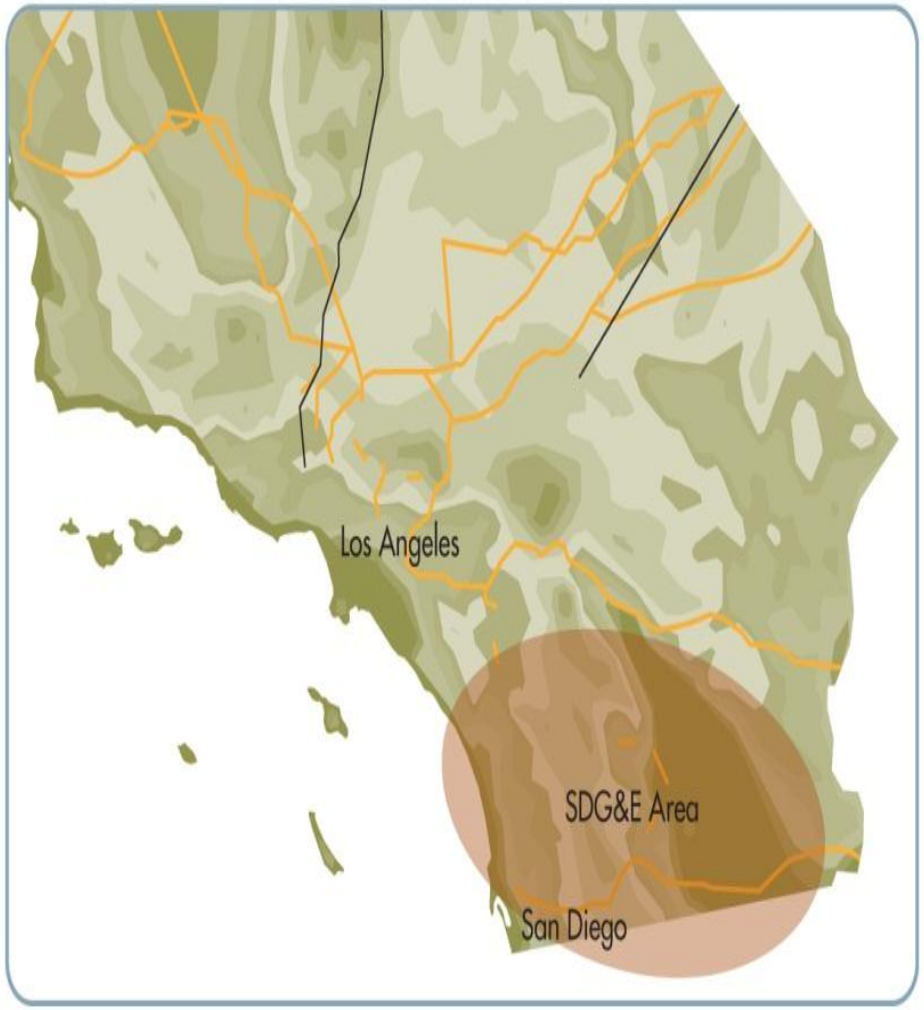
Thank you

San Diego Gas & Electric Main System Preliminary Reliability Assessment Results

Frank Chen
Sr. Regional Transmission Engineer

2015-2016 Transmission Planning Process Stakeholder Meeting
September 21-22, 2015

SDG&E System



- Peak Loads and AAEE in MW

1-in-10 Load (MW)	2017	2020	2025
Load Demand	5453	5654	5850
Energy Efficiency	-118	-213	-401
Net Peak Load	5335	5441	5449

- Area resources under CAISO control

Generation Resources (MW)		2017	2020	2025
by location	San Diego Metro	2382	2228	2189
	ECO	155	255	255
	OCO	265	265	265
	IV-SDGE	1915	1915	1915
	IV-IID	150	150	150
	HDWSH-APS	290	290	290
	Hassayampa-APS	292	292	292
by technology	Gas	3319	3165	3126
	PV	1593	1593	1593
	Wind	470	570	570
	Biomass	27	27	27
	Storage	40	40	40
Total in MW		5448	5394	5356

- Collaborated with IID and CENACE

Reliability Assessment Summary

- The assessment identified:
  - 9 branches in SWPL/SPL overloaded for P1/P2/P4/P6 outages
  - 4 branches 230 kV overloaded in SDGE for P2/P4/P6/P7 outages
  - 2 branches 220 kV overloaded in SCE for P6 outages
  - transient voltage dip concern in Southern California for P6 outages

Reliability Assessment Summary - Cont'd

- Compared to last year results:
  - SDG&E import capability increased with the IV PST in service
  - Higher thermal loadings in the SWPL/SPL system
  - Increased flow northbound via the SONGS transfer path under off-peak condition
  - thermal overloads on adjacent SCE system
  - transient instability concern observed for the first time

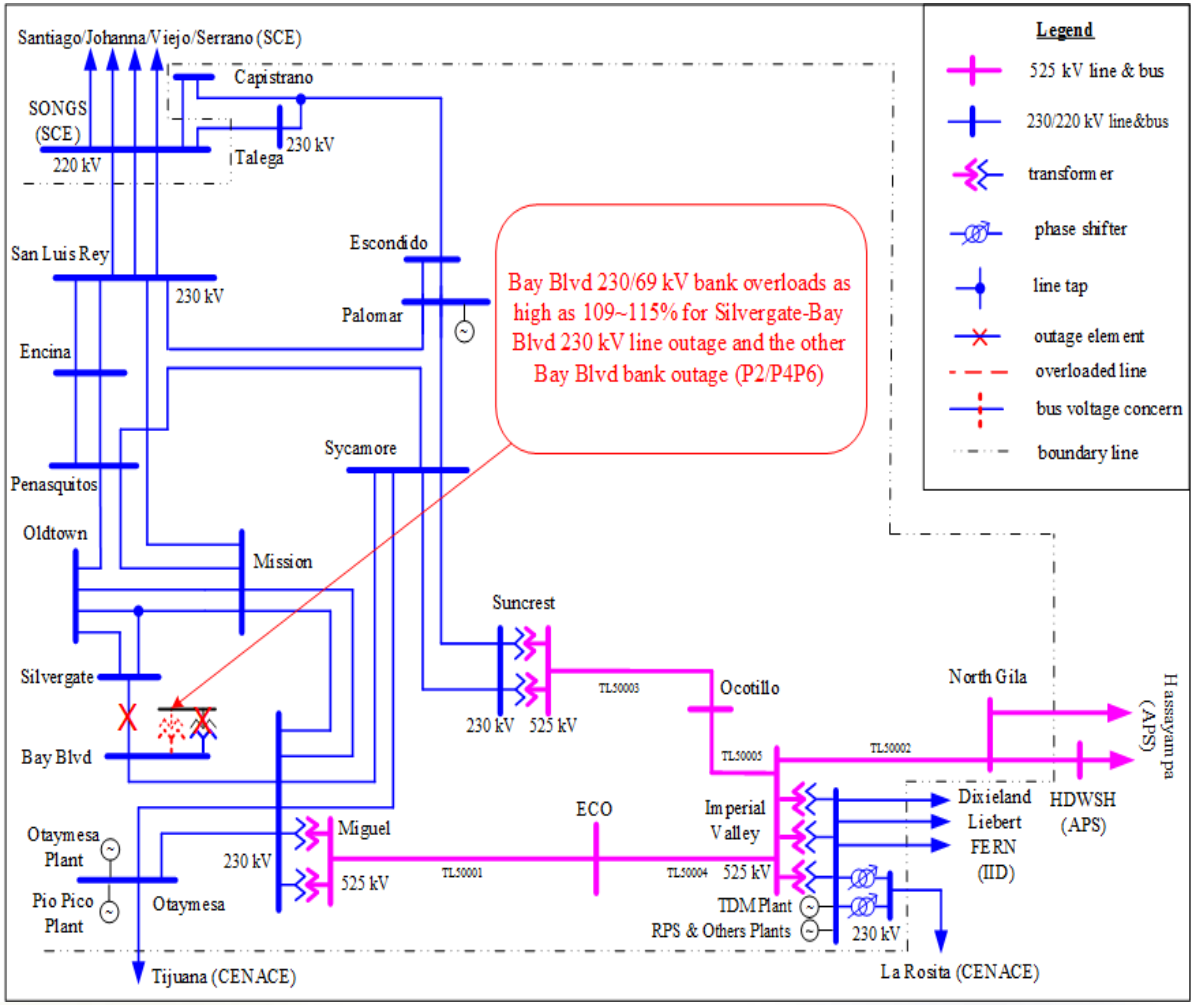
Potential Mitigation Solutions

- Distributed Generation(DG), Demand Response(DR), and Energy Storage (ES)
- Alternatives to address the P2/P4/P6/P7 branch thermal overloads in SDG&E and SCE include but are not limited to:
  - upgrade the Old Town-Mission 230 kV line
  - add 2nd circuit on double-circuit structure of Miguel-BayBlvd 230 kV line
  - upgrade the 230 kV system between Silvergate and Bay Blvd
  - add 3rd bank at Bay Blvd 230/69 kV substation
  - upgrade the Ellis 220 kV corridor by replacing terminal equipment & increasing line clearance
  - retain/repower resources that could potentially retire

Potential Mitigation Solutions – Cont'd

- Alternatives to address the P1/P2/P4/P6 thermal overloads in SWPL/SPL systems include but are not limited to:
  - add 3rd bank at Miguel
  - increase SWPL/SPL ratings by replacing 525 kV disconnect switches
  - add 3rd 230 kV line out of Suncrest
  - re-configure Banks #80/#81/#82 in IV 525/230 kV substation
  - Operation Procedure and SPS modifications prior to the IV PST in service
- Continuing to coordinate with CENACE on IV PST operation procedure along with elimination of CENACE's SPS cross tripping the SDGE-CENACE ties

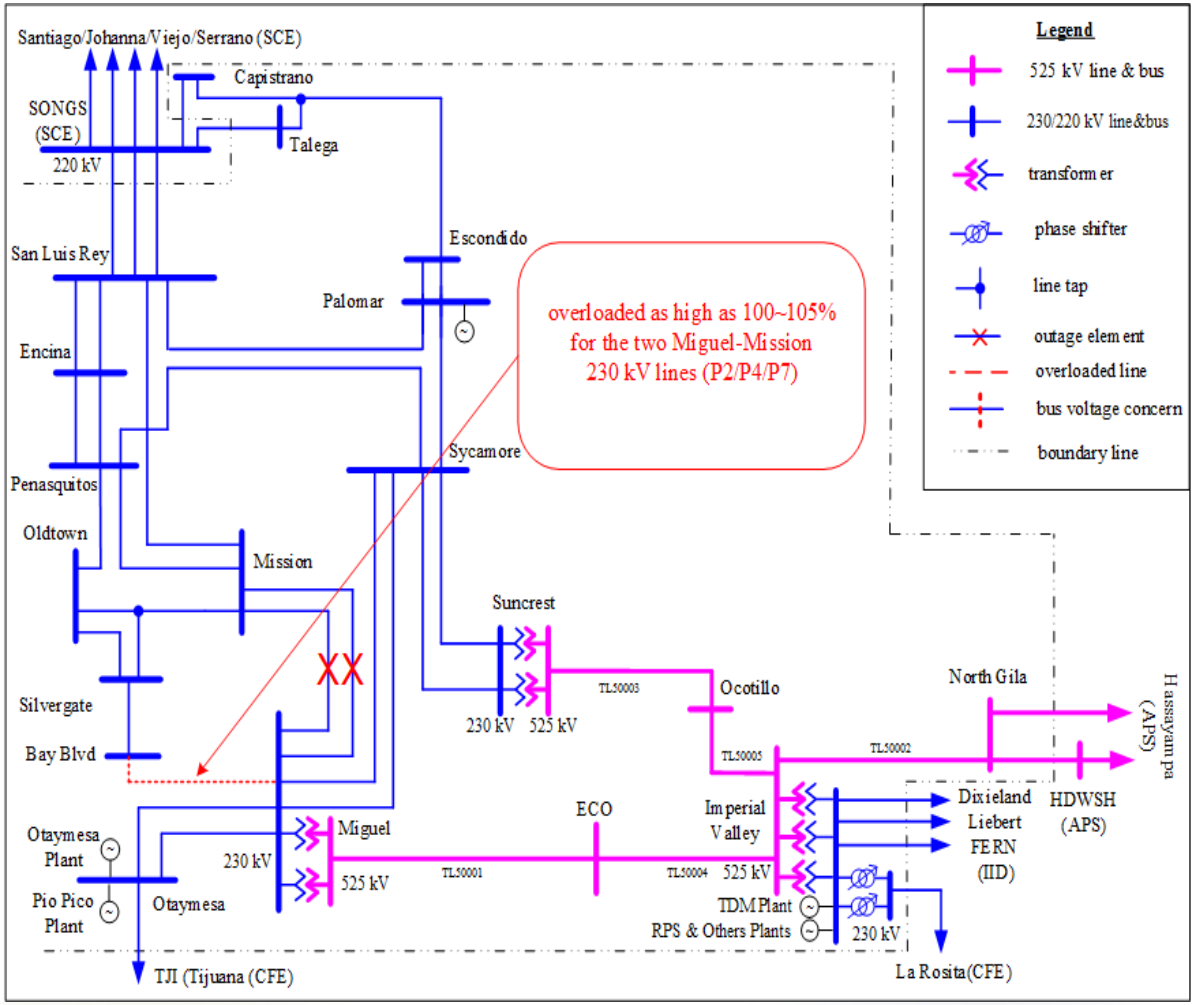
Category P2/P4/P6 Thermal Violation – (1)



Silvergate 230/69 kV Banks

- Thermal Overload
  - for outages of Silvergate-Bay Blvd 230 kV line and the other Bay Blvd 230/69 kV bank, starting from 2020
- Potential Mitigations
  - DG, DR, and ES
  - add 3rd bank at Bay Blvd
  - add 2nd Silvergate-South Bay Blvd 230 kV line
  - retain/repower retirement resources
  - Operation Procedure (OP)

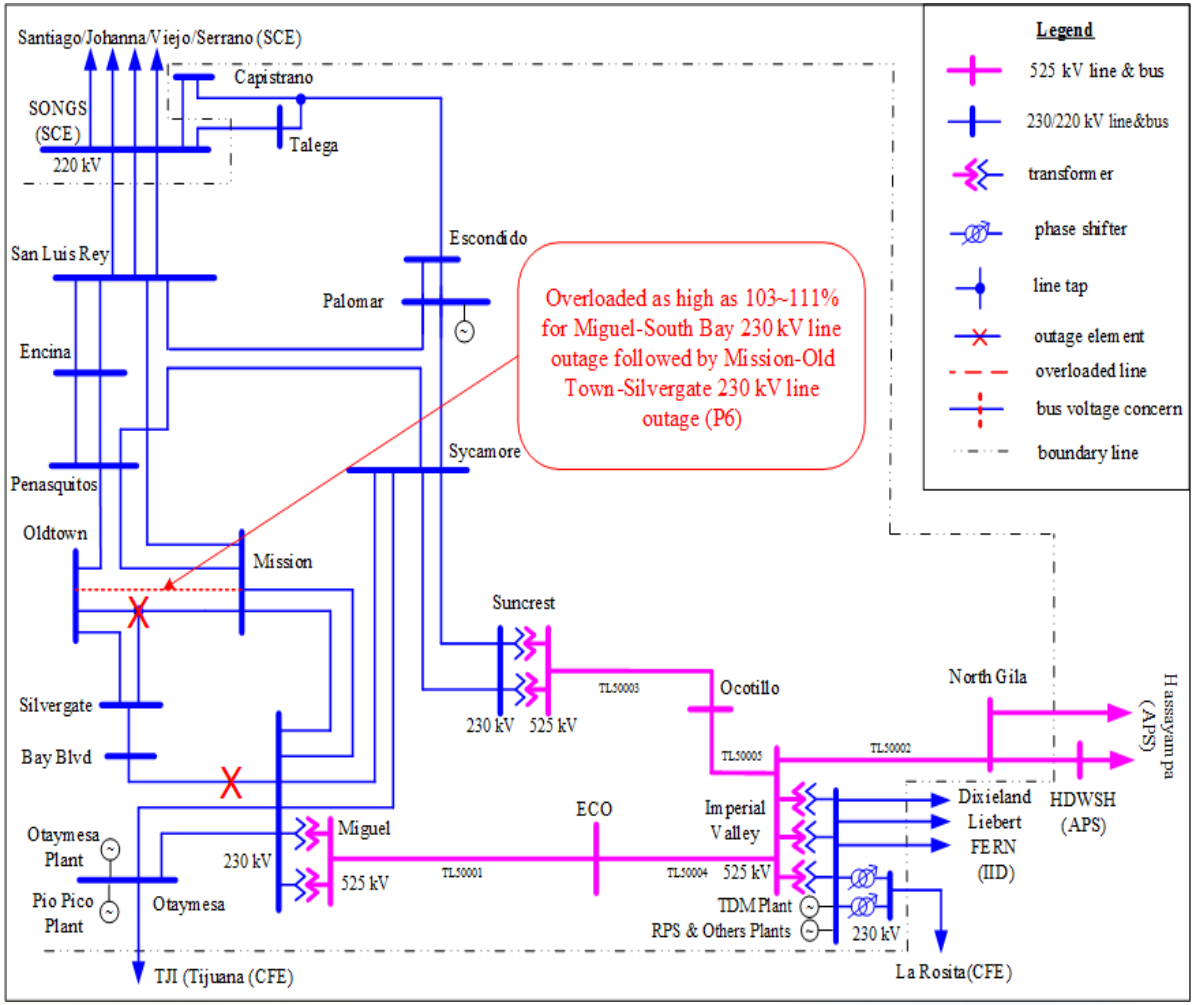
Category P2/P4/P7 Thermal Violation – (2)



Miguel-Bay Blvd 230 kV T/L

- Thermal Overload
  - for simultaneous outages of the two Miguel-Mission 230 kV lines (P2/P4/P7), starting from 2020
- Potential Mitigations
  - DG, DR, and Energy Storage
  - build 2nd 230 kV circuit between Miguel-Bay Blvd
  - retain/repower retirement resources
  - Operation Procedure

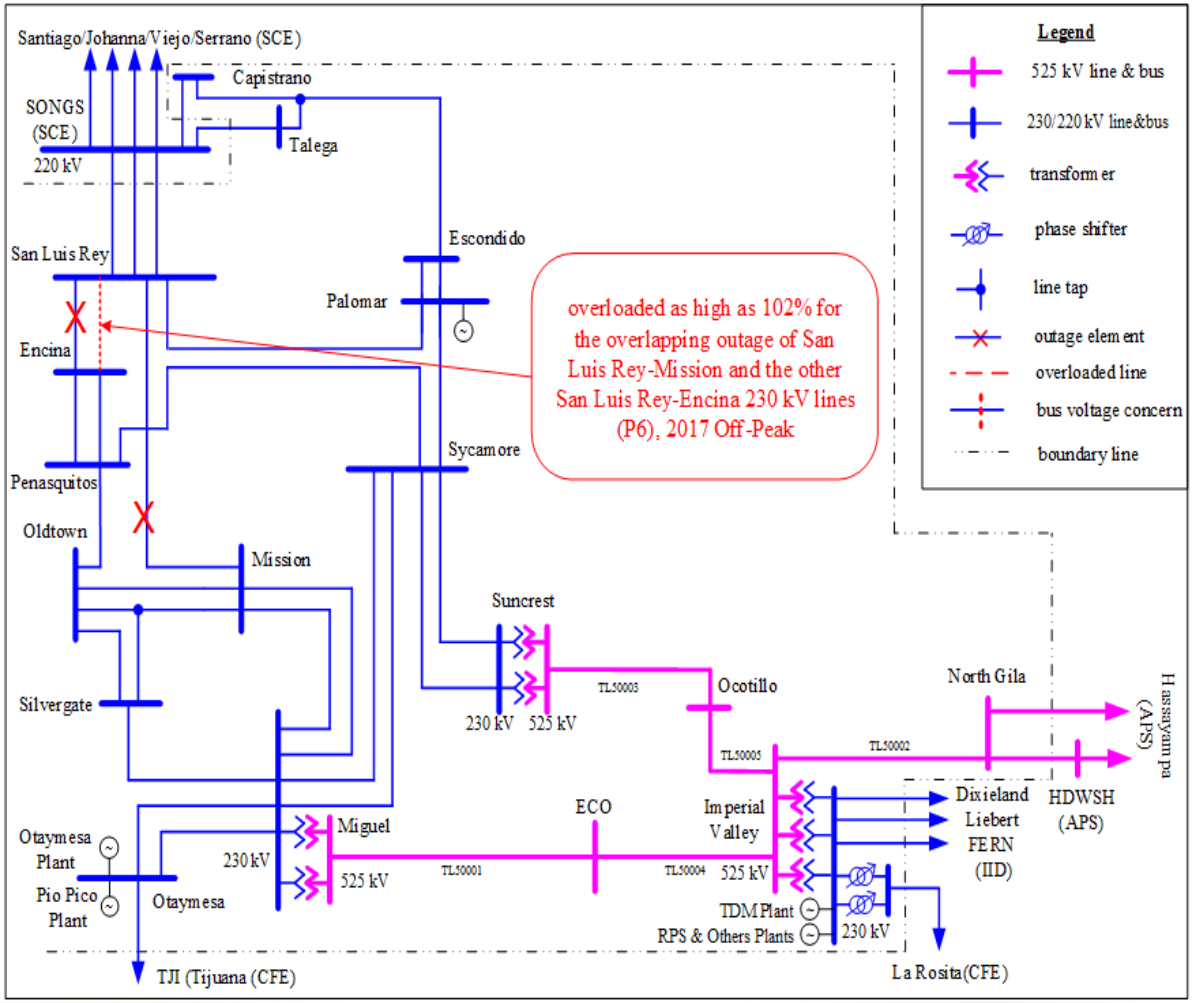
Category P6 Thermal Violation – (3)



Mission-OldTown 230KV T/L

- Thermal Overload
  - for overlapping outage of Miguel-Bay Blvd and Mission-OldTown-Silvergate 230 kV lines, starting from 2020
- Potential Mitigations
  - DG, DR, and ES
  - upgrade the Old Town-Mission 230 kV line,
  - add 2nd Miguel-Bay Blvd 230 kV line, and/or
  - retain/repower retirement resources
  - Operation Procedure

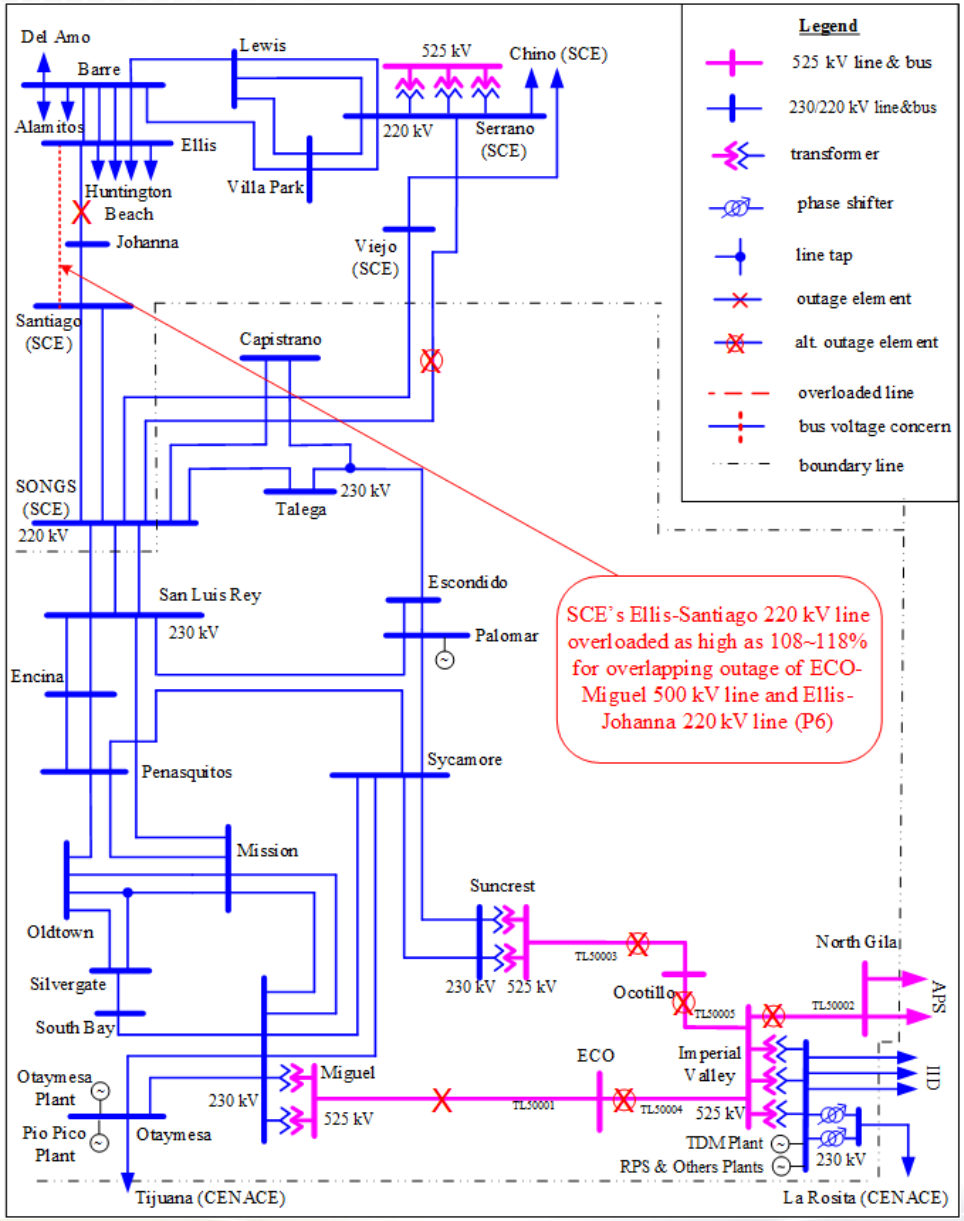
Category P6 Thermal Violation – (4)



San Luis Rey-Encina 230 kV T/Ls

- Thermal Overload
  - for overlapping outage of San Luis Rey-Mission and other San Luis Rey-Encina 230 kV lines (P6), 2017 off-peak
- Potential Mitigations
  - Operation Procedure to curtail northbound flow via the North of SONGS path until the Encina Power Plant retirement

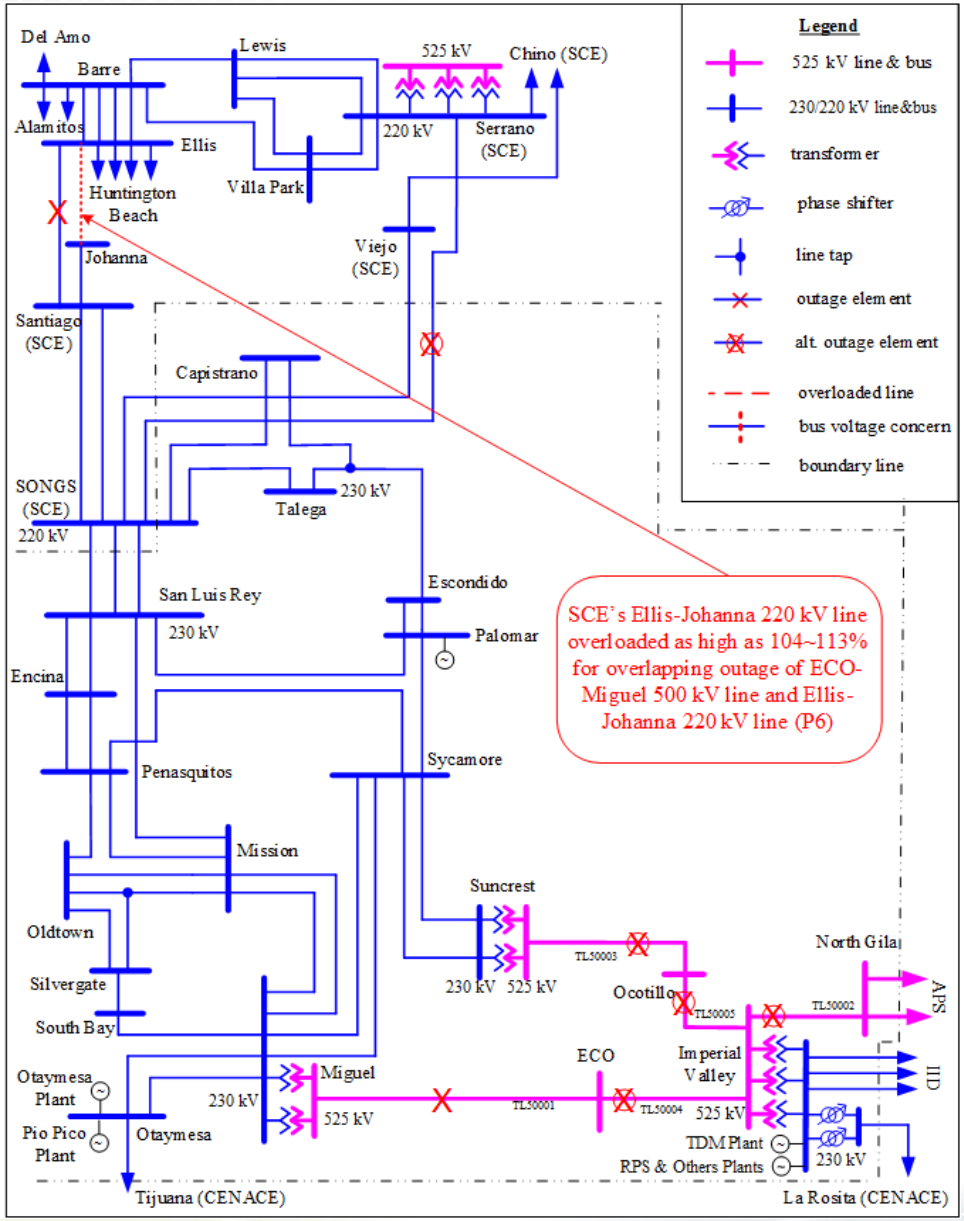
P6 Thermal Violation in SCE (5)



SCE's Ellis-Santiago 220 kV line

- Thermal Overload
  - for various P6 outages, the worst one is the overlapping outage of ECO-Miguel 525 kV line and Ellis-Johanna 230 kV line, starting from 2025
- Potential Mitigation
  - DG, DR, and ES
  - upgrade the Ellis 220 kV south corridor by replacing terminal equipment and increasing the line clearance
  - Operation Procedure adjusting system

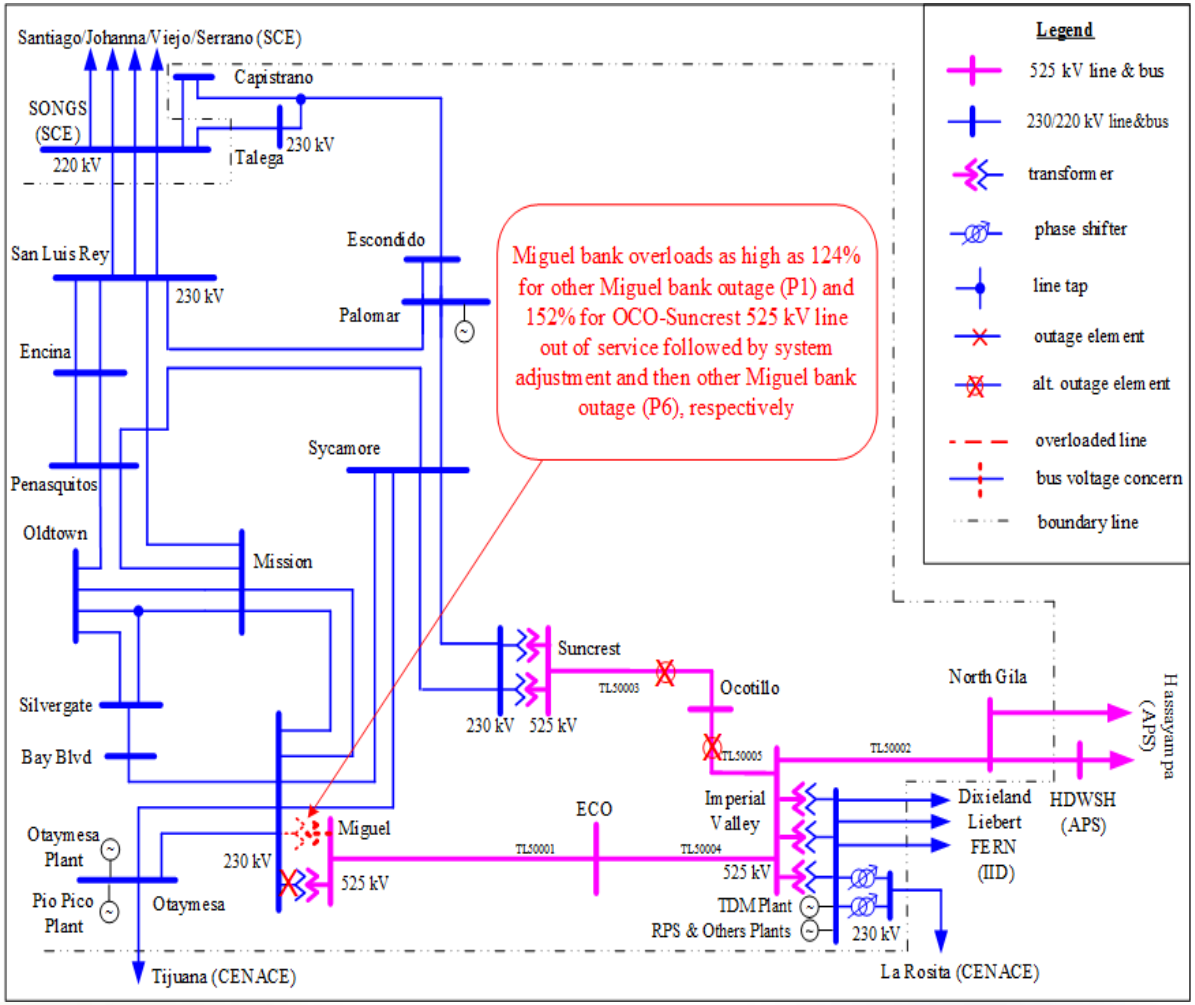
P6 Thermal Violation in SCE (6)



SCE's Ellis-Johanna 220 kV line

- Thermal Overload
  - for various P6 outages, the worst one is the overlapping outage of ECO-Miguel 525 kV line and Ellis-Santiago 220 kV line, starting from 2025
- Potential Mitigation
  - DG, DR, and Energy Storage
  - upgrade the Ellis south corridor by replacing terminal equipment and increasing the line clearance
  - Operation Procedure adjusting system

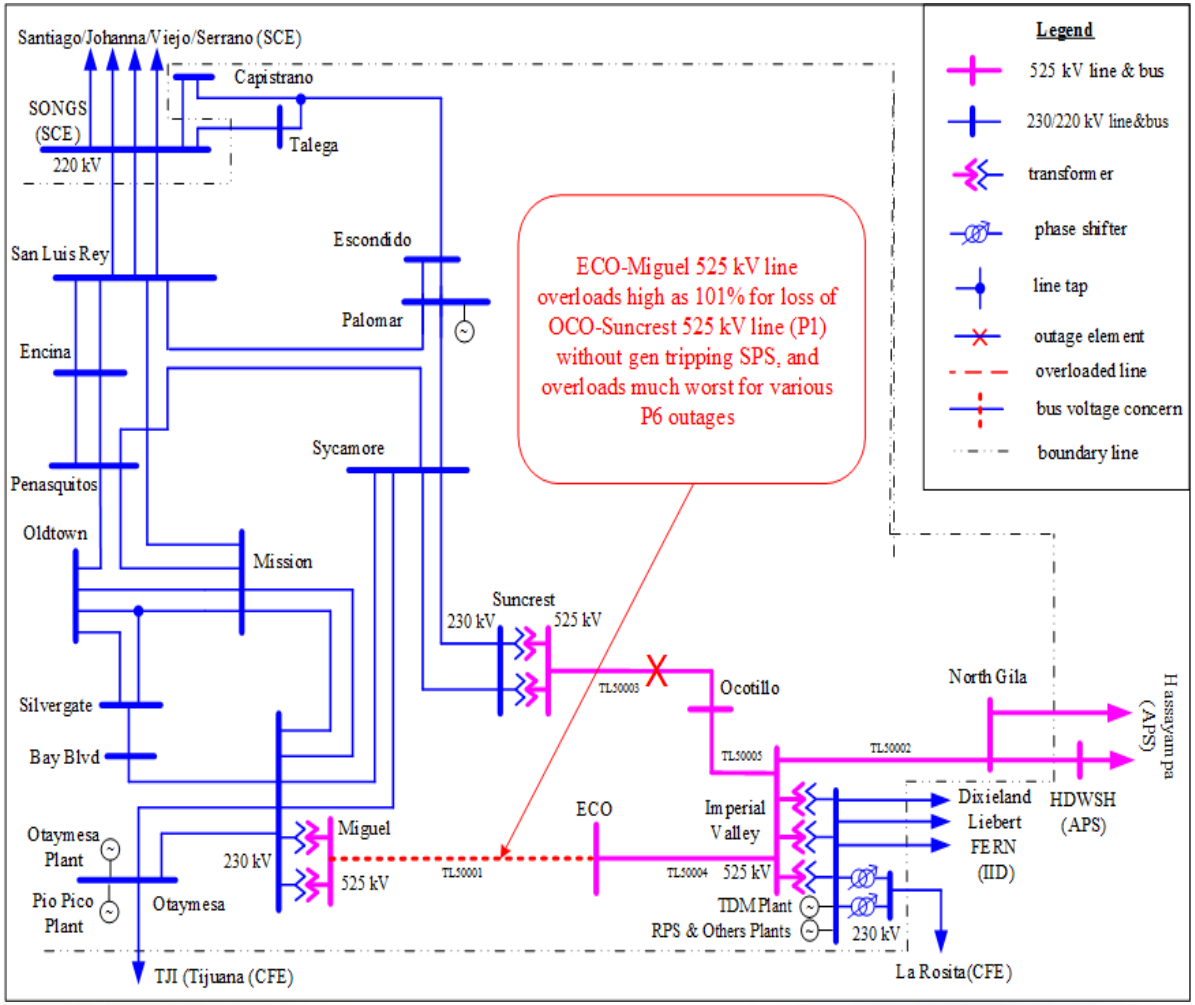
Category P1 Thermal Violation (7)



Miguel 525/230 kV Banks

- Thermal Overload
  - for loss of other Miguel 525/230 kV bank (P1) with gen tripping SPS
  - Heavily overloaded for various P3/P6 outages
- Potential Mitigation
  - DG, DR, and ES
  - modify Miguel Bank SPS
  - add SPS to open overloaded bank
  - add 3rd bank at Miguel
  - Operation Procedure adjusting system

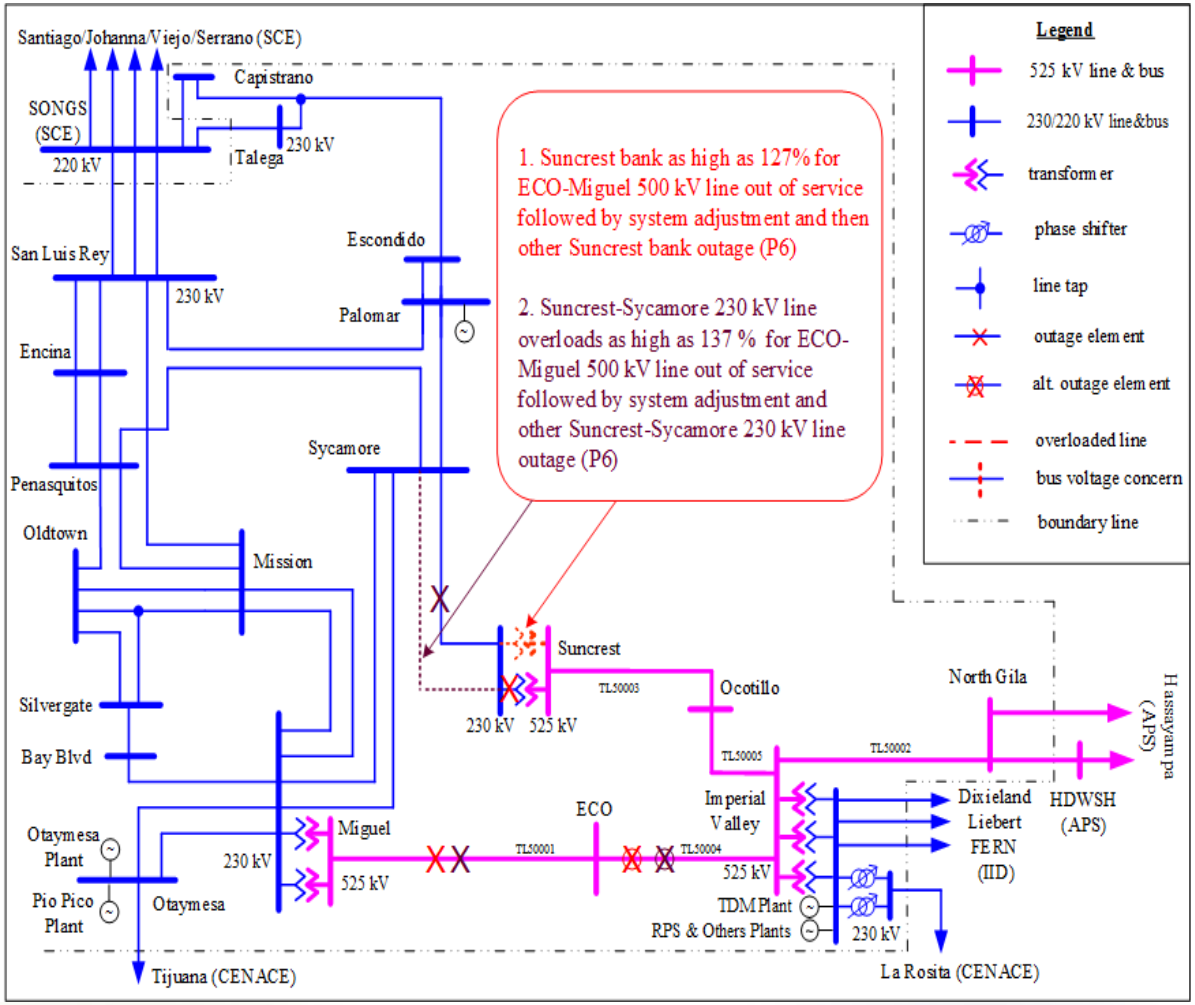
Category P1 Thermal Violation (8)



ECO-Miguel 525 kV T/L

- Thermal Overload
  - for loss of Ocotillo-Suncrest 525 kV Line (P1) without gen tripping SPS
- Potential Mitigation
  - DG, DR, and ES
  - *modify* SWPL SPS gen shedding
  - increase SWPL ratings by replacing disconnect switches
  - Operation Procedure adjusting system

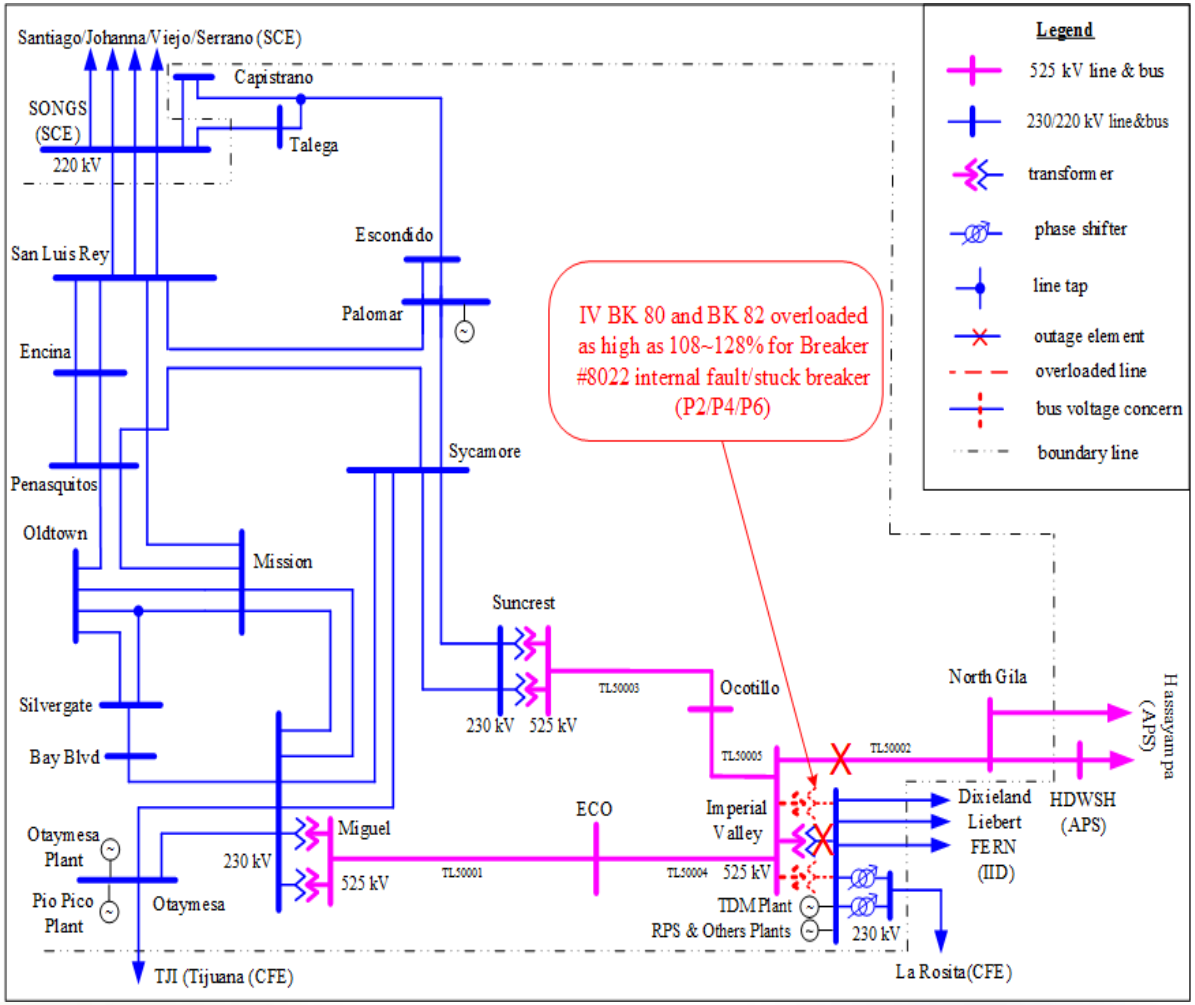
Category P1 Thermal Violation (9)



Suncrest 525/230 kV Banks and Suncrest-Sycamore 230 kV lines

- Thermal Overload
  - Heavily overloaded for various P6 outages respectively
- Potential Mitigation
  - DG, DR, and ES
  - modify SPL SPS and add SPS to open the overloaded bank or the line
  - add 3rd bank at Suncrest
  - increase SPL ratings by replacing switches
  - add 3rd 230 kV line out of Suncrest
  - Operation Procedure

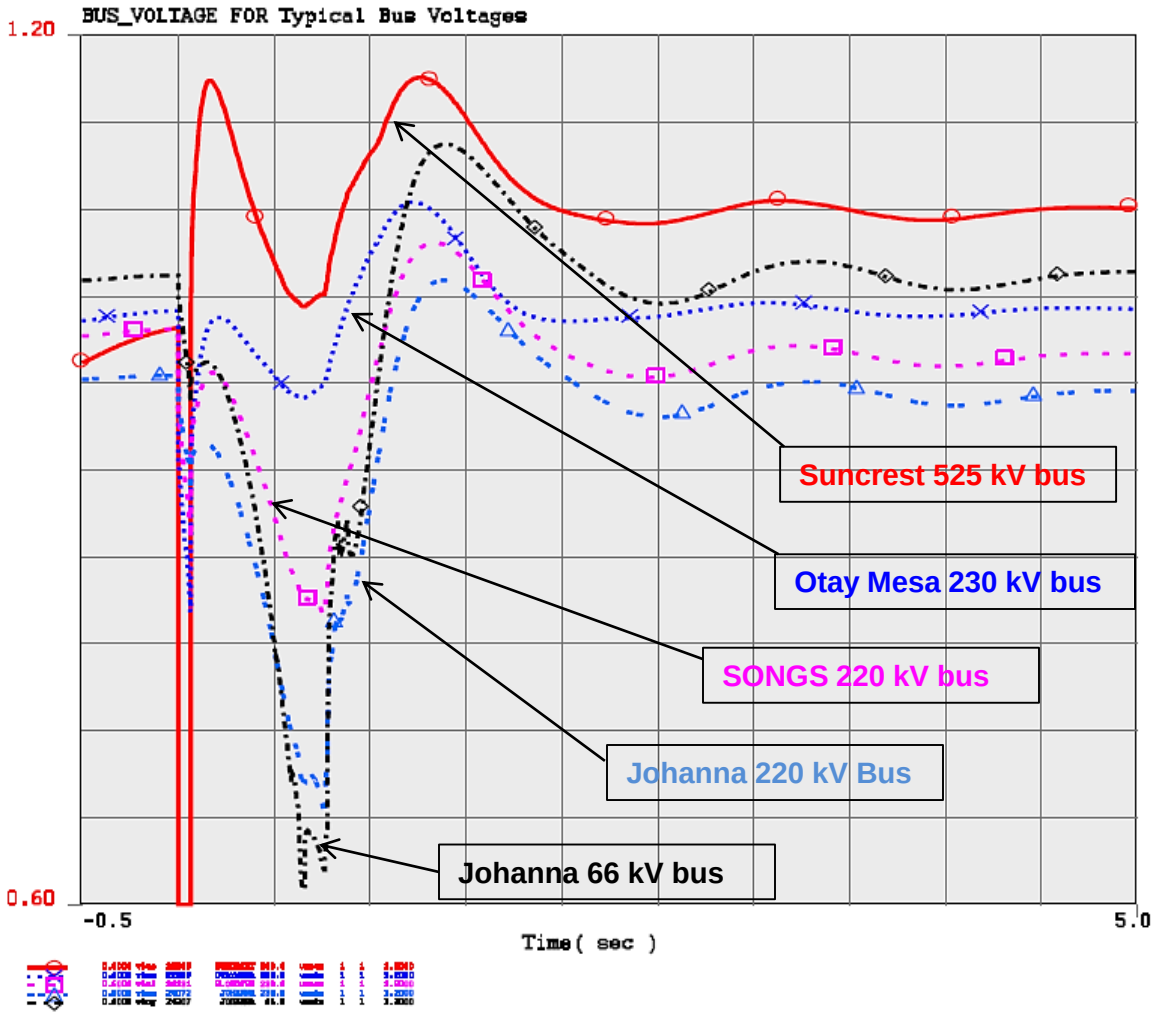
Category P2/P4 Thermal Violation (10)



IV 525/230 kV BK80 & BK82

- Thermal Overload
  - for CB #8022 internal fault/stuck breaker (P2/P4)
  - for various P6 outages
- Potential Mitigation
  - Operation Procedure
  - reconfigure BK81/80/82
  - develop higher ratings for the banks
  - modify SPS dropping generation in IV
  - upgrade aged BK80 in size of 600 MVA to 1120 MVA

Transient Instability Concern (11)



Transient Voltage Dip in SCE

- Transient Voltage Dip
  - Exceeds the 30% of WECC performance criterion at Johanna/Santiago/Ellis/ Viejo buses (as high as 39.8%) for ECO-Miguel 525kV line outage followed by system adjustments and a 3-phase fault at Suncrest 525 kV bus with normal clearing
- Potential Mitigation
  - Further Evaluation

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

Charles Cheung
Senior Regional Transmission Engineer

2015-2016 Transmission Planning Process Stakeholder Meeting
September 21-22, 2015

SDG&E Area Sub-Transmission Assessment Summary

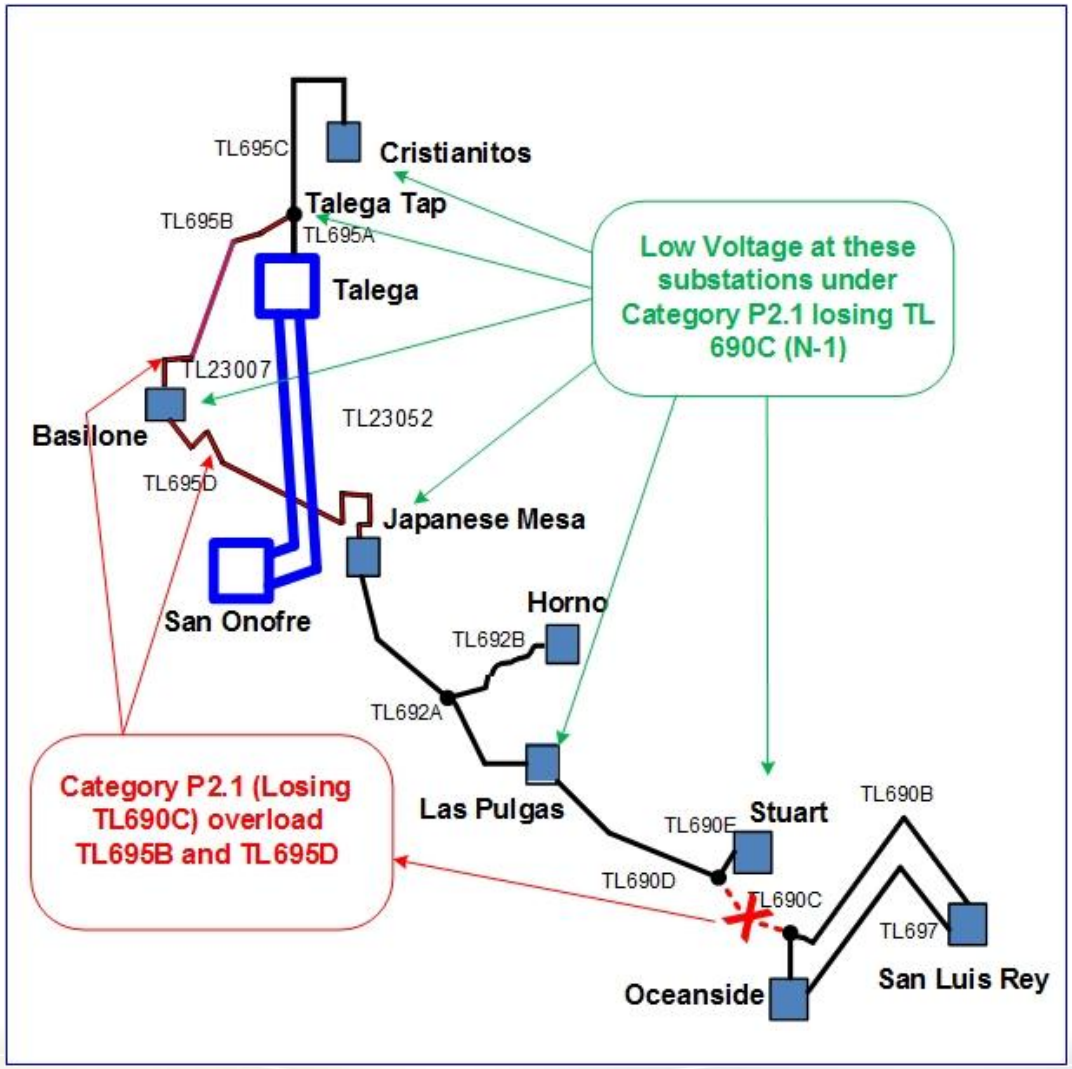
- The assessment identified:
  - Branches overloaded for Category P2, P6 and P7 outages
  - Low voltage for Category P2 outage
  - Voltage instability for contingencies in the Eastern area
- Compared to last year results:
  - A few thermal and voltage violations in the 69 kV sub-transmission system due to multi-terminal line contingencies (P2.1) and low power factor in 2017 SP case
  - Thermal violations and voltage instability in the sub-transmission system due to load growth

SDG&E Area Sub-Transmission Potential Mitigation Solutions

- Network upgrades to address sub-transmission Category P6 issues
- Increase power factor to improve high/low voltage
- Energy Efficiency, DG, Demand Response, and Energy Storage

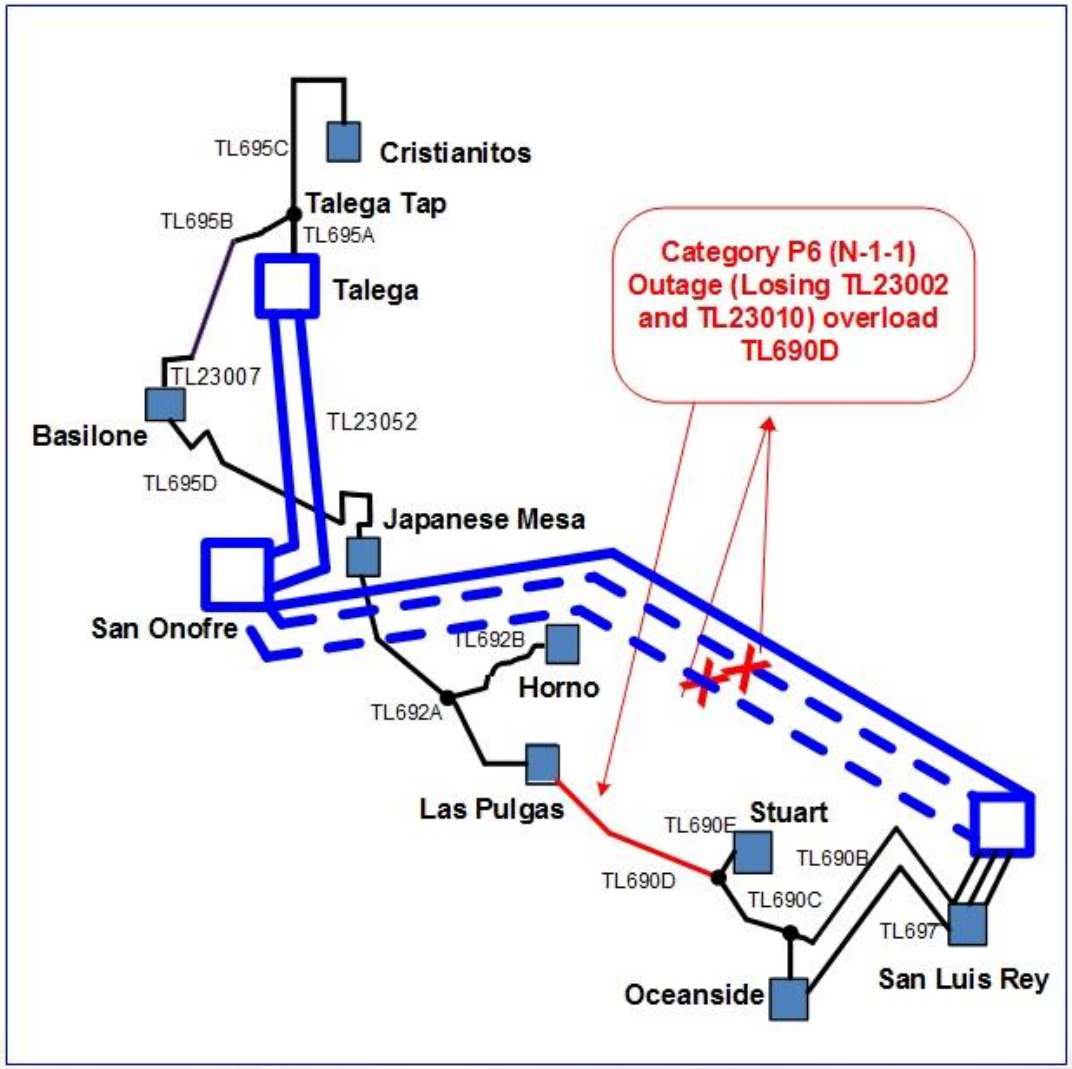
SDG&E Sub-Transmission 138/69 kV System

Category P2 Thermal and Voltage Violation (1)



- Thermal Overload
  - TL695 overload for losing one section of TL690 (2017SP)
- Low Voltage
  - Low power factor requiring reactive power import from Talega 69/138 kV Transformer
- Potential Mitigation
  - SPS to trip TL 695 for interim
  - Re-conduct Talega Tap-Stuart Tap 69 kV line in 2018
  - Increase power factor to increase voltage

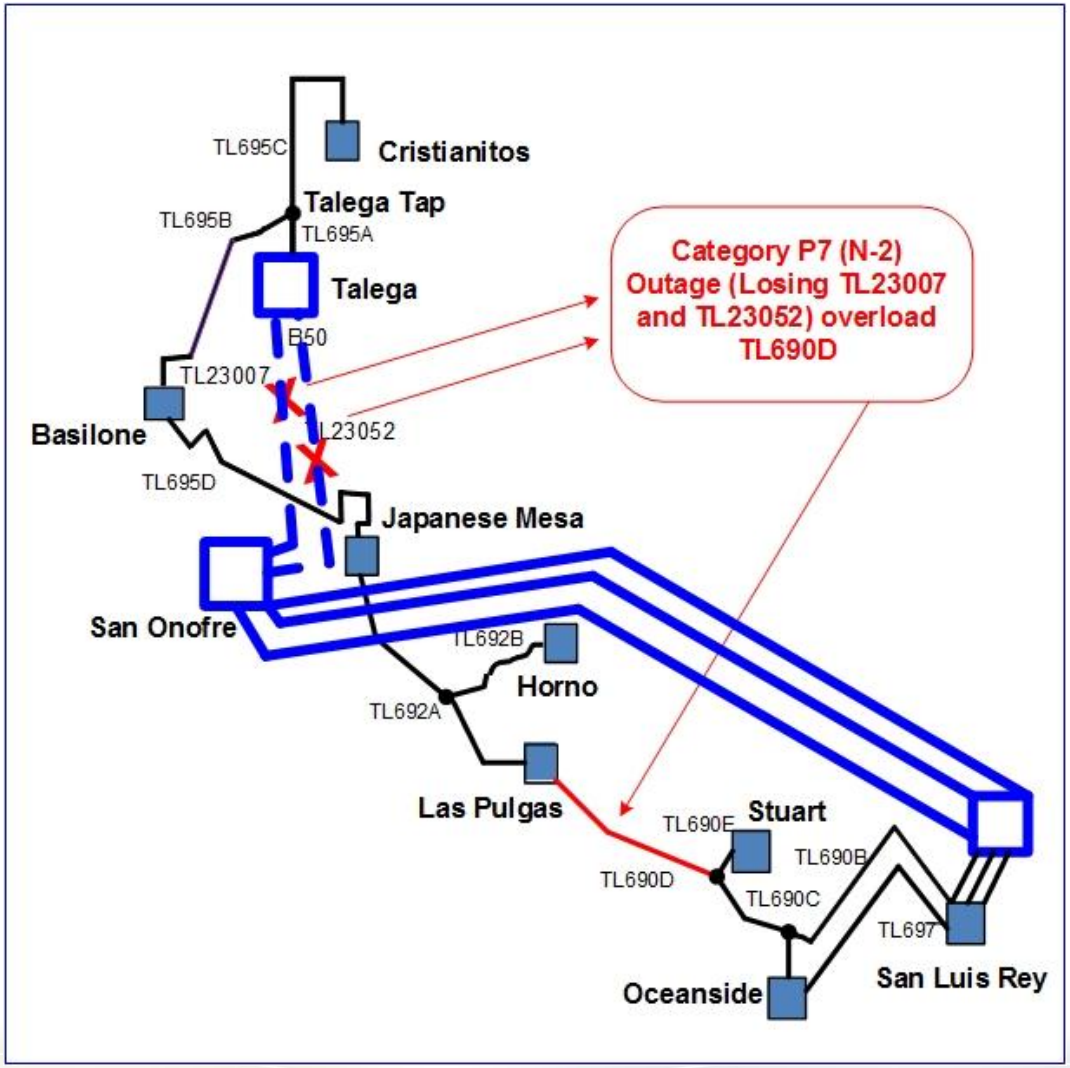
Category P6 Thermal Violation



Stuart Tap-Las Pulgas 69 kV

- Thermal Overload
  - TL690D overload for losing two San Luis Rey-S. Onofre lines (N-1-1) (2017OP)
- Potential Mitigation
  - Existing Talega SPS until the overloaded section is re-conducted

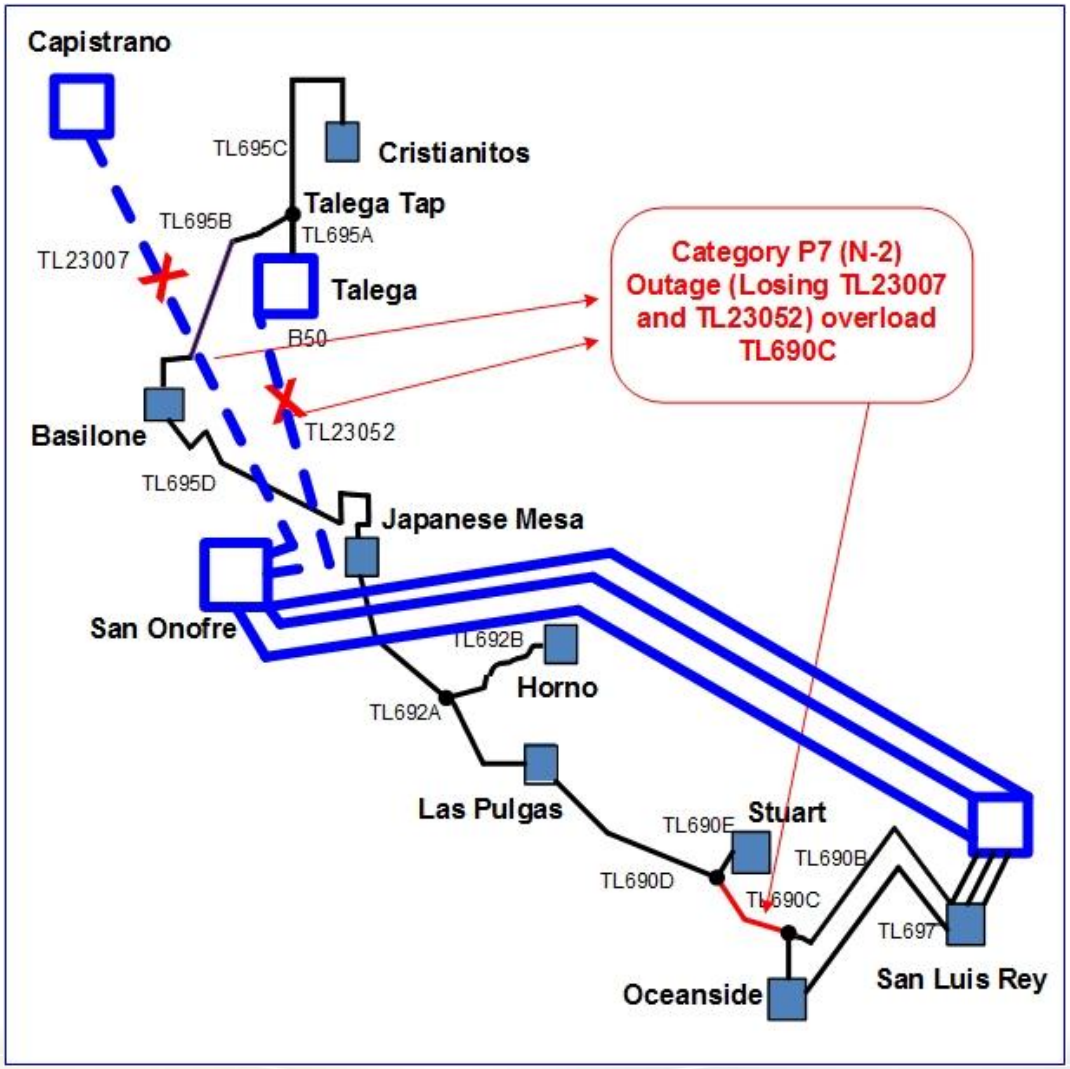
Category P7 Thermal Violation (1)



Stuart Tap-Las Pulgas 69 kV

- Thermal Overload
  - TL690D overload for losing two San Luis Rey-S. Onofre lines (N-1-1) (2017OP)
- Potential Mitigation
  - Existing Talega SPS until the overloaded section is re-conducted

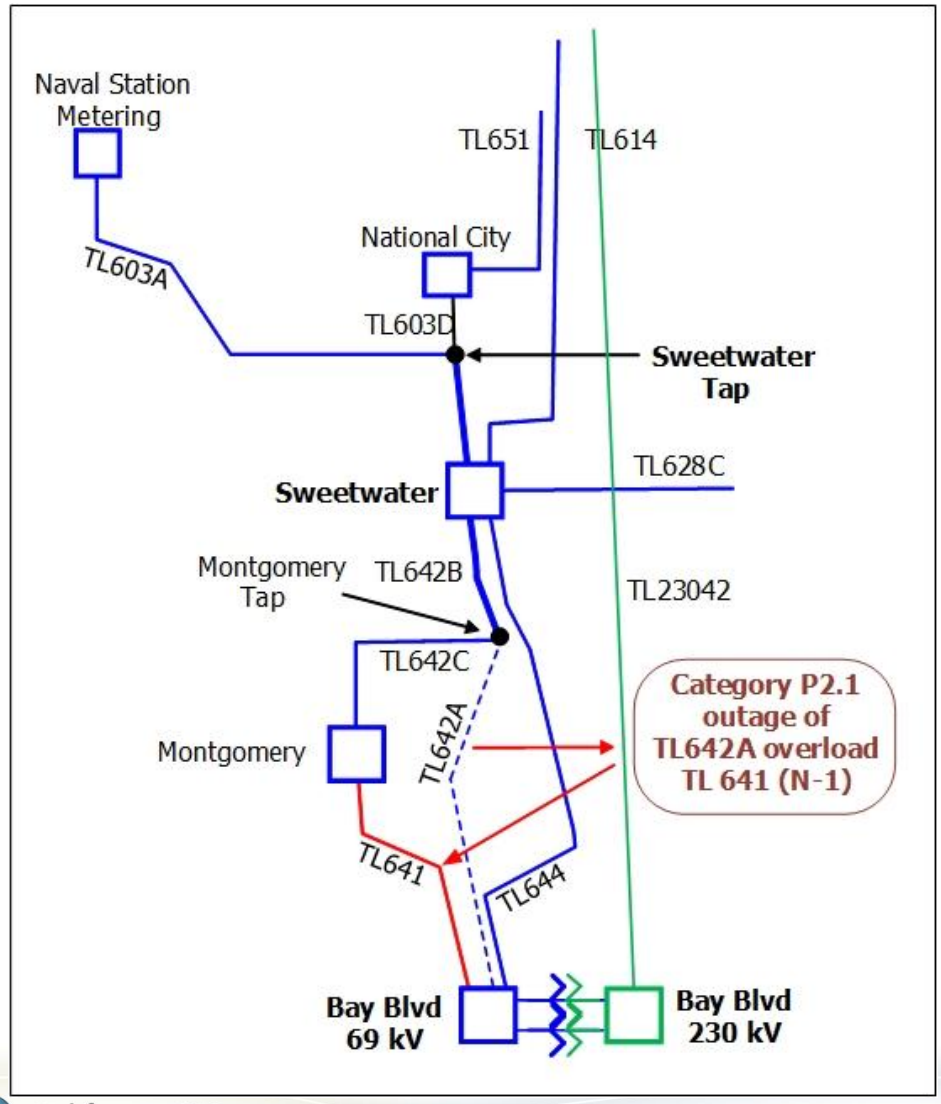
Category P7 Thermal Violation (2)



Oceanside Tap-Stuart Tap 69kV

- Thermal overload
  - TL690C section overload for N-2 outage of TL23052 and TL23007 (2020SP and 2025SP)
- Potential Mitigation
  - Modify the existing SPS
  - Re-conduct TL690C section as part of the wood-to-steel project

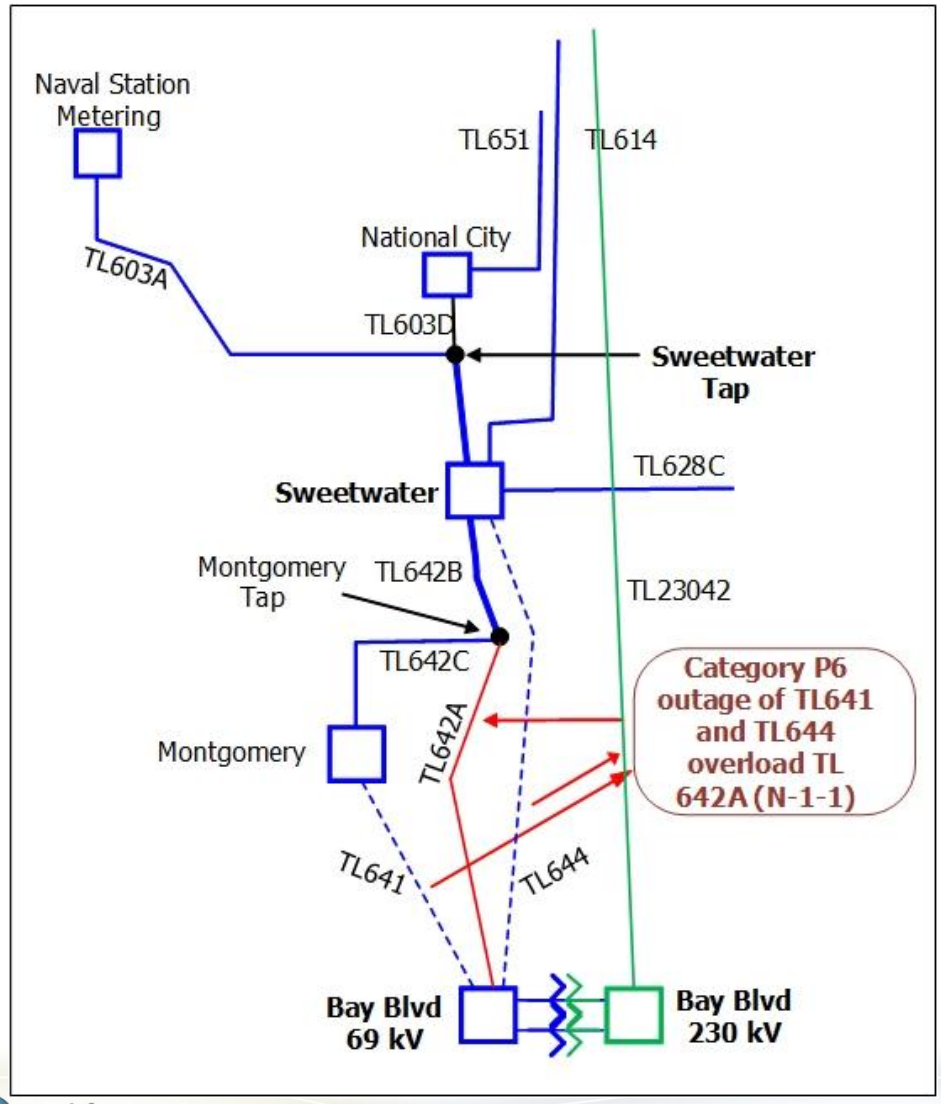
Category P2 Thermal Violation (2)



Bay Blvd-Montgomery 69kV

- Thermal overload
  - TL641 overload for N-1 outage of TL642A (2020SP and 2025SP) after Bay Blvd substation and transformers in service
- Potential Mitigation
  - Repower retired generation
  - SPS to trip Bay Blvd Transformer
  - Re-conduct Bay Blvd-Montgomery 69 kV

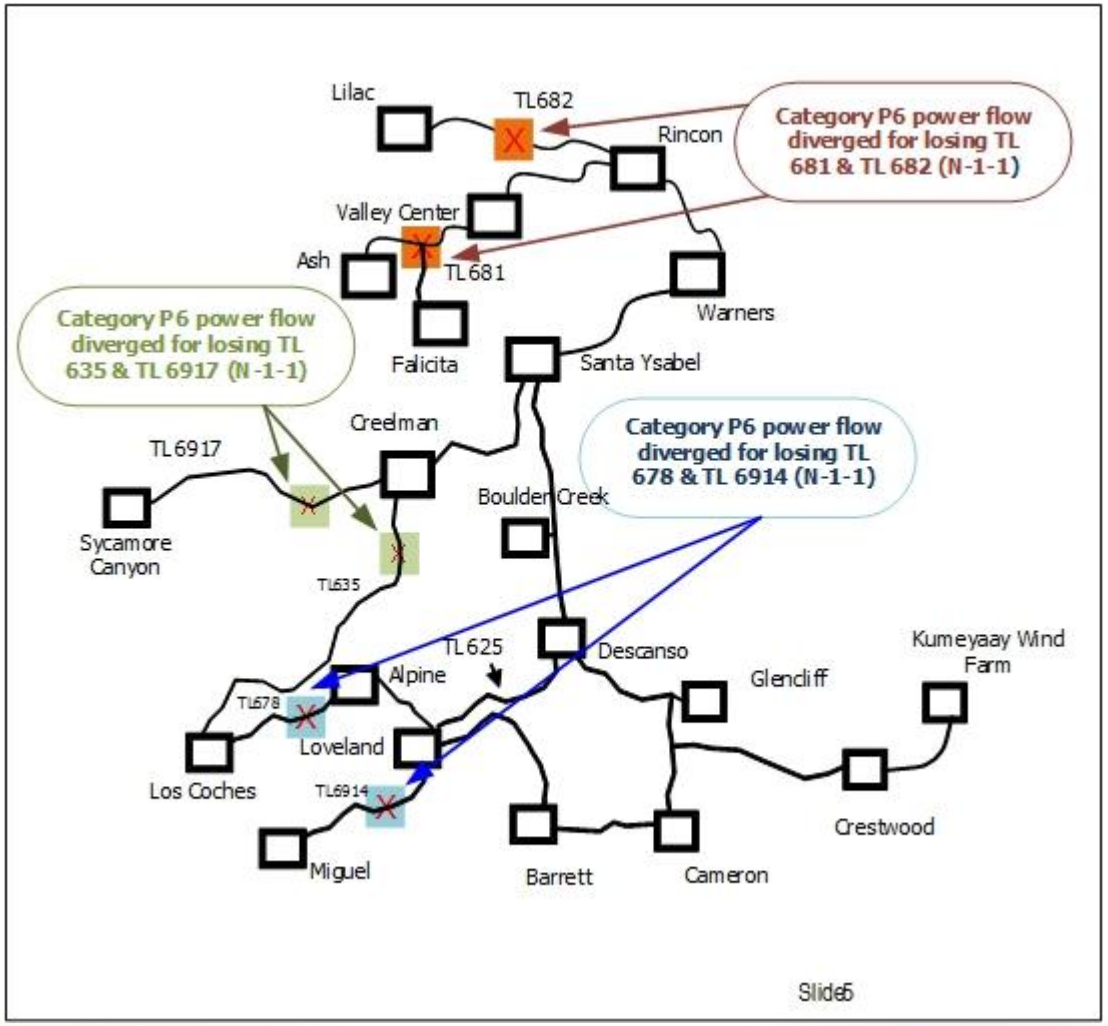
Category P6 Thermal Violation (2)



Bay Blvd-Montgomery Tap 69kV

- Thermal overload
  - TL642A overload for N-1-1 outage of TL641 and TL644 (2020SP and 2025SP) after Bay Blvd substation and transformers in service
- Potential Mitigation
  - Repower retired generation
  - SPS to trip Bay Blvd Transformer
  - Re-conduct Bay Blvd-Montgomery Tap 69 kV

Category P6 Voltage Instability



Eastern Back Country 69 kV Area

- Voltage instability in the Eastern back country 69 kV area for
  - Losing TL678 and TL6914 (All SP cases)
  - Losing TL635 and TL6917 (All SP cases)
  - Losing TL681 and TL682 (20SP and 25SP)
- Potential Mitigation
  - DG, DR, and Energy Storage
  - New 69 kV transmission source in the area
  - SPS to shed up to 70 MW loads for the 2nd contingency
  - Operation procedure to open TL626

Next Steps

Tom Cuccia
Lead Stakeholder Engagement and Policy Specialist

2015-2016 Transmission Planning Process Stakeholder Meeting
September 21-22, 2015

Next Steps

Date	Milestone
September 22	PTO presentations on mitigation solutions
September 22-October 6	Stakeholder comments to be submitted to regionaltransmission@caiso.com
October 15	Request window closes. Submissions to be submitted to requestwindow@caiso.com
October 30	Post final 2015-2016 reliability study results