

Proposed SCE Submittals into the 2022-2023 Transmission Planning Process

2022-2023 CAISO TPP
September 28, 2022

Summary of Proposed Projects

SCE conducts its Annual Transmission Reliability Assessment (ATRA) in coordination with the California ISO (CAISO). Based on the results, SCE is submitting the following reliability projects into the annual California ISO Transmission Planning Process (TPP) window closing September 15, 2022:

#	Project	Driver	Est. Cost	Need Date
1	Barre 230 kV Switchrack Conversion to Breaker-and-a-Half	SCD	\$45M	6/30/2026
2	Mira Loma 500 kV CB Upgrade	SCD	\$10M	12/31/2026
3	New Serrano 4AA 500/230 kV Bank and 230 kV GIS Rebuild	SCD & Capacity	\$120M	12/31/2027
4	New Colorado River 3AA 500/230 kV Bank	Capacity	\$75M	12/31/2027
5	New Lugo 3AA 500/230 kV Bank	Capacity	\$70M	12/31/2027
6	Lugo-Victor 230 kV Lines Reconductor	Capacity	\$112M	12/31/2027
7	New Coolwater A 115/230 kV Bank	Stability	\$47M	12/31/2026
8	New Control 115 kV Shunt Reactor	Voltage	\$4M	12/31/2026

All costs are in 2022 dollars and estimated according to the 2022 SCE Unit Cost Guide:
<http://www.caiso.com/Documents/SCE2022FinalPerUnitCostGuide.xlsx>

Proposed Reliability Projects

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Barre 230 kV Switchrack Conversion to BAAH Project

Area challenges

- Short circuit duty (SCD) exceeds existing 63 kA breaker rating today
- SCD exacerbated by the extension of once-through-cooling (OTC) units in the LA Basin, but >95% of capability without OTC units
- New generation in the area will be limited due to safety concerns
- Temporary complex operating procedure to manage circuit breaker overstress reduces reliability through curtailment of generation or other remedial operator interventions
- Supply chain delays and dependency on a planned MEER rebuild

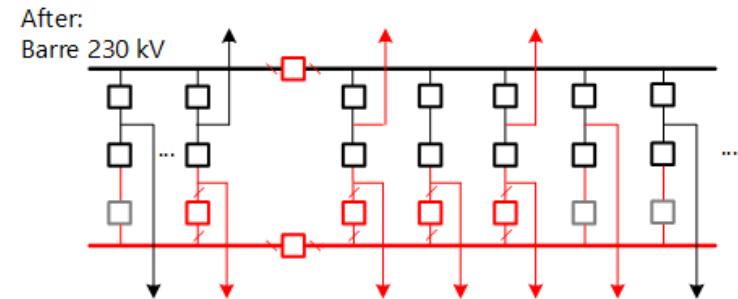
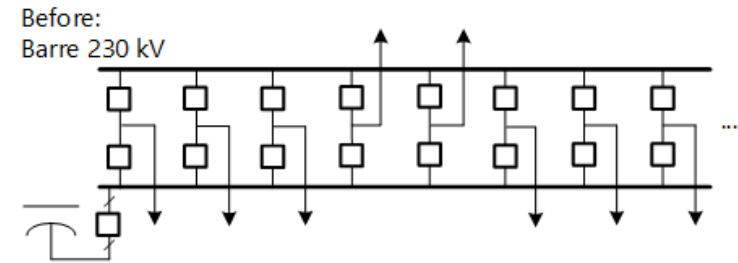
Proposed Scope

- Convert Barre 230 kV switchrack to breaker-and-a-half (BAAH) configuration by relocating the south bus and adding a third CB to four bay positions
- Add sectionalizing CBs and split Barre 230 kV to lower SCD
- Relocate 230 kV lines, towers, and other facilities within substation

Impact of Proposed Project

- Lowers SCD within allowable limits and increases margin significantly
- Enables new generation and transmission interconnections in the area
- Provides operational flexibility

Main System	Estimated Cost (\$M)	Proposed In-Service Date
Barre 230 kV Switchrack Conversion to BAAH	45	6/30/2026



Red – New Construction
or Line Relocation
Gray – Future

Barre 230 kV Switchrack Conversion to BAAH Project

SCD Calculation Results

Scenario	Pre Barre 230 kV Split			Post Barre 230 kV Split		
	Bus Name	Eff 3PH SCD	% Loaded	Bus Name	Eff 3PH SCD	% Loaded
2024	Barre 230 kV	66.0	104.8%	Barre A 230 kV	51.6	82.0%
				Barre B 230 kV	37.1	58.9%
2025	Barre 230 kV	68.3	108.4%	Barre A 230 kV	53.3	84.6%
				Barre B 230 kV	37.7	59.8%
Pre QC14P1	Barre 230 kV	65.3	103.6%	Barre A 230 kV	51.5	81.8%
				Barre B 230 kV	36.4	57.7%

Alternatives/Risks

Alternatives	Risks
<ul style="list-style-type: none"> Continue to use temporary operating procedure to curtail generation in real-time 	<ul style="list-style-type: none"> May not be able to bring required generation online during peak times
<ul style="list-style-type: none"> Limit new generation from coming online 	<ul style="list-style-type: none"> Consequential financial impacts as well as impediment of State's renewable goals
<ul style="list-style-type: none"> Build new 220/66 kV substation 	<ul style="list-style-type: none"> High costs (\$\$\$) and prolonged timeline (> 10 yrs)

Mira Loma 500 kV Circuit Breaker SCD Upgrade Project

Area challenges

- Four (4) 500 kV CBs at Mira Loma Substation exceed 95% of short circuit duty (SCD) capability in the 2024 case and the 2032 case
- Anticipated SCD exceeds 100% of the 50 kA capability in current cluster studies (QC13 & QC14)
- SCD could exceed 100% before the currently identified triggering cluster due to system changes and short circuit equivalent updates
- Supply chain challenges have increased the lead time for 500 kV circuit breakers, which limits SCE ability to quickly complete the required mitigation and the associated delay could become a barrier to new generation

Proposed Scope

- Replace four (4) 50 kA CBs at Mira Loma 500 kV with new 63 kA rated CBs

Impact of Proposed Project

- Lowers SCD within allowable limits and increases margin at Mira Loma 500 kV
- Enables new generation and transmission interconnections in the area

Main System	Estimated Cost (\$M)	Proposed In-Service Date
Upgrade Four 50 kA CBs at Mira Loma 500 kV to 63 kA	10	12/31/2026

Mira Loma 500 kV Circuit Breaker SCD Upgrade Project

SCD Calculation Results

Scenario	Pre Mira Loma 500 kV CB Upgrade			Post Mira Loma 500 kV CB Upgrade	
	Bus Name	Eff 3PH SCD	% Loaded	Eff 3PH SCD	% Loaded
2024	Mira Loma 500 kV	48.6	97.20%	46.2	73.30%
2032	Mira Loma 500 kV	49.25	98.49%	46.7	74.09%

Alternative/Risks

Alternatives	Risks
<ul style="list-style-type: none"> Do nothing until SCD exceeds 100% 	<ul style="list-style-type: none"> SCD rises faster than expected and creates an emergent overstress situation that delays new generation and decreases system reliability
<ul style="list-style-type: none"> Develop operating procedure to open 230 kV transmission lines in real time 	<ul style="list-style-type: none"> Opening 230 kV transmission lines during peak times could make matters worse

New Serrano 4AA 500/230 kV Transformer Bank and 230 kV GIS Rebuild Project

Area challenges

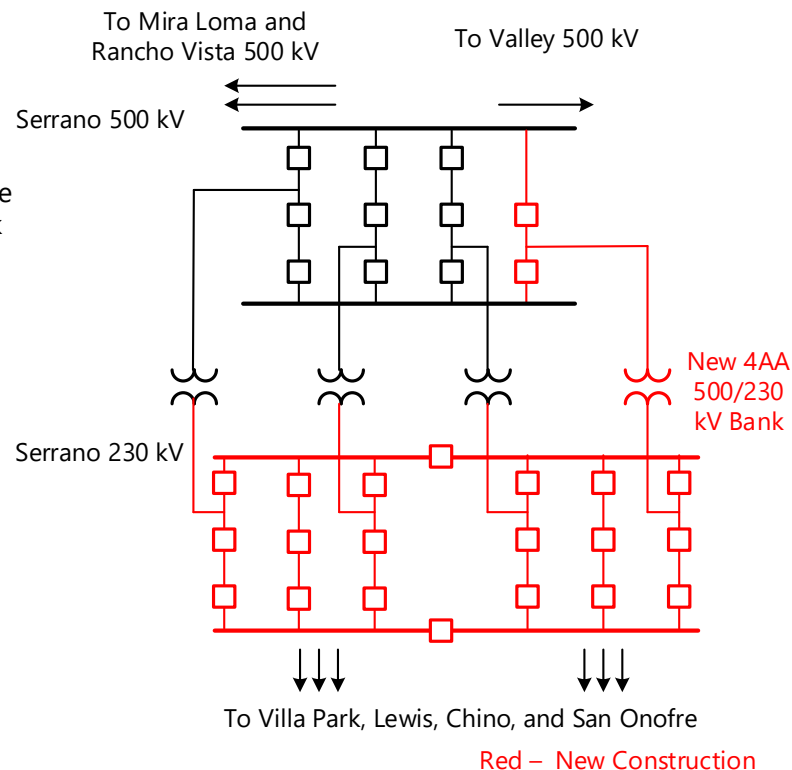
- Serrano 500/230 kV Substation is a main 500 kV hub for bringing renewable resources into LA Basin/ Orange County
- Remaining AA-bank at Serrano overloads for the loss of two AA-banks in 2032
- Adding capacity by installing a 4th AA-bank at Serrano will facilitate more flows into Orange County, but causes the existing 230 kV GIS switchrack to exceed its rated SCD limit
- All 14 - 230 kV CBs at Serrano Substation are at 95.2% SCD capability in the 2024 case and projected at 95.9% in the 2032 case without the 4AA bank
- Supply chain challenges have increased the lead time for transmission equipment, which limits SCE ability to quickly complete the required mitigation and the delay could become a barrier to new generation

Proposed Scope

- Add new 4th 500/230 kV AA transformer at Serrano
- Rebuild 230 kV GIS to 80 kA capability with option to sectionalize in the future and upgrade ground grid as-needed

Impact of Proposed Project

- Adds capacity to the Western LA Basin/Orange County
- Mitigates P6 contingencies (loss of two AA banks)
- Retire existing Operating Procedure that opens 2-230 kV lines and splits Orange County
- Prevents overstress on Serrano 230 kV circuit breakers currently >95% of interrupting rating
- New design for Serrano 230 kV provides environmental benefits through reduction of SF₆ usage by 10,000-20,000 lb



Main System	Estimated Cost (\$M)	Proposed In-Service Date
New Serrano 4AA 500/230 kV Transformer Bank and 230 kV GIS Rebuild	120	12/31/2027

New Serrano 4AA 500/230 kV Transformer Bank and 230 kV GIS Rebuild Project

Load Flow Results

Overloaded Facility	Contingency	Cat	Post Contingency Loading (%)		Proposed Corrective Action Plan	Post Upgrade Loading (%)	
			2027 Pk	2032 Pk		2027 Pk	2032 Pk
Serrano 1AA or 2AA or 3AA	Loss of two Serrano AA Banks	P6	99%	112%	4th Serrano AA-bank	<100	<100

SCD Calculation Results

Scenario	Existing System			With 4th AA Serrano 500/220 kV AA-Bank		With 4th AA Serrano 500/220 kV AA-Bank and Serrano 220 kV CBs upgraded to 80 kA	
	Bus Name	Eff SLG SCD	% Loaded	Eff SLG SCD	% Loaded	Eff SLG SCD	% Loaded
2024	Serrano 220 kV	60.0	95.2%	65.6	104.1%	65.6	82.0%
2024 w/OTC	Serrano 220 kV	61.1	97.0%	66.8	106.0%	66.8	83.5%
2032	Serrano 220 kV	60.4	95.9%	66.1	104.9%	66.1	82.6%
Pre QC14P1	Serrano 220 kV	62.8	99.7%	69.0	109.5%	69.0	86.3%

Alternative/Risks

Alternatives	Risks
<ul style="list-style-type: none"> Continue to use temporary operating procedure that opens two 230 kV transmission lines post contingency 	<ul style="list-style-type: none"> Opening 230 kV transmission lines during peak load will diminish system reliability and severely restrict operations
<ul style="list-style-type: none"> Build new 500 kV transmission line and 500/230 kV transformer bank into Orange County. 	<ul style="list-style-type: none"> High costs (\$\$\$) and prolonged timeline (> 10 yrs) Likely to cause >100% SCD overstress at Serrano 230 kV

New Colorado River 3AA 500/230 kV Bank Project

Area challenges

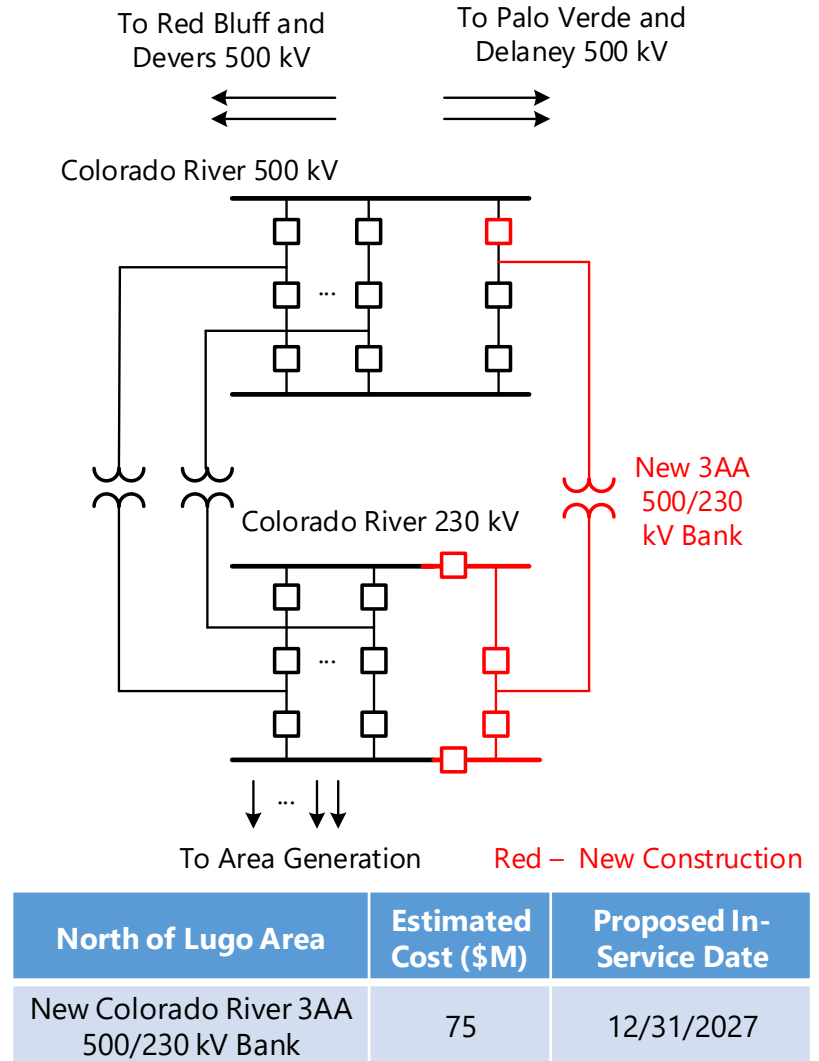
- Capability limit of 2,206 MVA (1AA+2AA) at Colorado River 230 kV and an overload on AA Banks under normal conditions (P0) in 2024
- Under an AA Bank N-1 (P1), the remaining AA Bank has a 1,344 MVA rating and CAISO limits RAS N-1 tripping to 1,150 MW
- Planned generation at the Colorado River 230 kV Bus:
 - 2,259 MW planned by August 2023
 - 3,939 MW (queued + existing)
- 3,939 MW – 1,344 MW (capacity) – 1,150 MW (RAS Tripping) = 1,445 MW of congestion management in advance of the N-1 after queued generation in-service

Proposed Scope

- Install four (4) single phase transformer units to create one (1) new No. 3AA 500/230 kV transformer bank at Colorado River Substation
- Extend the 230 kV Bus
- Equip one (1) 500 kV and one (1) 230 kV AA Bank Position, associated equip, & structures
- Add the 3rd AA Bank to existing West of Colorado River CRAS

Impact of Proposed Project

- Eliminate base case overload on AA Banks
- Increases deliverability at Colorado River Substation 230 kV by 1,000 MW



New Colorado River 3AA 500/230 kV Bank Project

Load Flow Results

Facility	Rating (MVA) 1120/1344/1792 (PLL/24H/1H)	Generation Capability (MW)	Category	Loading (%) (Power Factor =1)	
				Pre-Project	Post-Project
Colorado River 1AA or 2AA 500/230 kV Transformer Bank	2206 (1AA+2AA)	2259	P0	102	<100
	1344 (24H)	2259	P1	168	<100
	1120(>24H)	2259	P1	202	102

Colorado River 500/230 kV transformer banks are connected to 500 kV in radial system with renewable generation resources.

Alternative/Risks

Alternatives	Risks
<ul style="list-style-type: none"> • Curtail planned generation starting in August 2023 <ul style="list-style-type: none"> ○ Curtail more than 53 MW of generation in normal N-0 condition ○ Curtail more than 915 MW of generation during N-1 Colorado River 1AA or 2AA 500/230 kV Banks outage 	<ul style="list-style-type: none"> • Colorado River Substation is a generation collector substation with Solar and Battery Storage. These are important renewable generation resources, especially during heat waves. Curtailing generation may result in generation deficits that could affect system reliability. • After queued generation is in-service, more than 1,733 MW (3,939-2,206) generation would be curtailed in the P0 N-0 normal condition.

New Lugo 3AA 500/230 kV Bank Project

Area Challenges

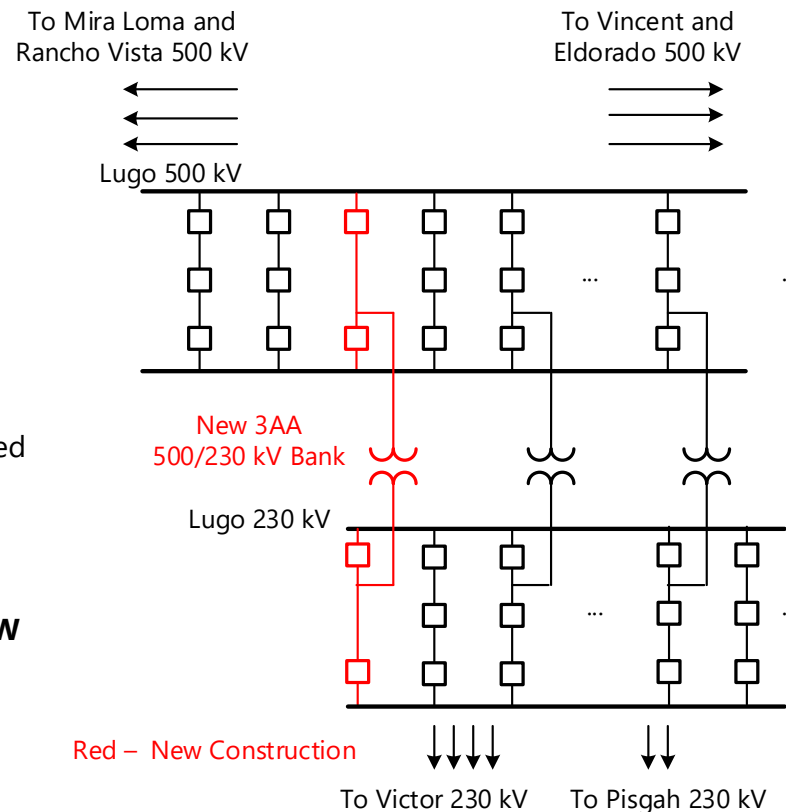
- Loss of both existing Lugo 500/230 kV 1AA and 2AA Banks (P6) causes divergence, which is currently mitigated by two RAS
- RAS solution limits available generation in SCE Northern Lugo Area to 1400 MW; 2,100+ MW expected by 2023
- Deliverability limitation at SCE Lugo AA 500/230 kV Banks
- Reliance of the North of Lugo area on the existing AA Banks causes extremely difficult maintenance & construction outages

Proposed Scope

- Install four (4) single phase transformer units to create one (1) new No. 3AA 500/230 kV Transformer Bank at Lugo Substation
- Extend 230 kV double operating bus
- Equip one (1) 500 kV and one (1) 230 kV bank position, associated equip, & structures

Impact of Proposed Project

- Mitigates Lugo AA bank constraints
- Increases deliverability in North of Lugo system area **by 980 MW**
- Enhances system reliability and aligns with the CAISO 20 Year Outlook
- Facilitates maintenance and construction outages



North of Lugo Area	Estimated Cost (\$M)	Proposed In-Service Date
New Lugo 3AA 500/230 kV Bank	70	12/31/2027

New Lugo 3AA 500/230 kV Bank Project

Load Flow Results

Overloaded Facility	Contingency	Cat	Post Contingency Loading (%)			Proposed Corrective Action Plan	Post Upgrade Loading (%)		
			2024 PK	2027 OP	2032 OP		2024	2027	2032
Remaining Lugo 500/230 kV No.2 or No.1 Transformer Bank	Lugo 500/230 kV No. 1 or No. 2 Transformer Bank	P1	116.1	108.6	139.3	New 500/230 kV Lugo 3AA-bank	<100	<100	<100
Voltage Collapse	Lugo 500/230 kV No. 1 and No. 2 Transformer Bank	P6	N/A	N/A	N/A	New 500/230 kV Lugo 3AA-bank	No Voltage Collapse		

Alternatives	Risks
<ul style="list-style-type: none"> Continue to trip all generation units participating in the Mojave Desert (MOD) RAS in addition to High Desert Power Project (HDPP) RAS 	<ul style="list-style-type: none"> Outages of a Lugo AA bank also requires dispatchers to manually arm the MOD/HDPP RAS to avoid over tripping gen in the NOL system for N-1 of the remaining AA bank During forced outages of a Lugo AA bank (i.e. a catastrophic failure of a bank), constraints will need to be imposed until the bank can be returned to service During planned outages (for maintenance or capital work) of either Lugo AA bank, post-contingency import/export limits are imposed on the NOL system to remain within the transmission capacity of the five (very limited) ties into the area

Lugo-Victor 230 kV Line Reconductor Project

Area challenges

- The north to south path from Victor Substation to Lugo Substation is a major corridor connecting the North of Lugo area to metropolitan Southern California
- Base case P0 and single contingency (P1) overload of the Lugo-Victor 230 kV lines
- South of Kramer – Victor to Lugo Area constraints
- Deliverability limitation

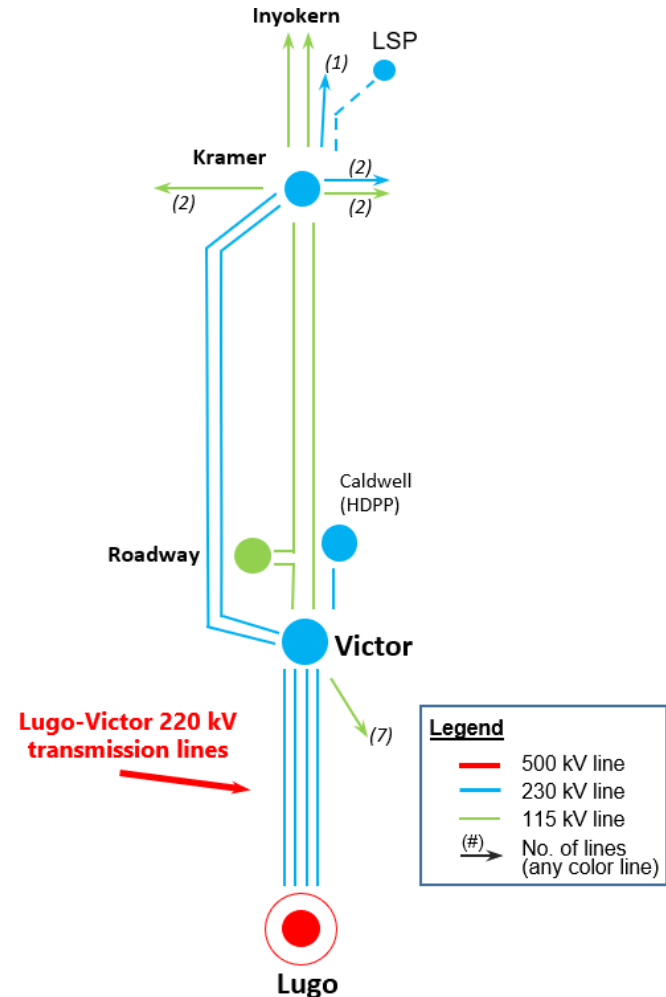
Proposed Scope

- Reconductor approx. 10.8 mi of existing Lugo-Victor No. 1, No. 2, No. 3, and No. 4 230 kV lines with a high temperature low sag (HTLS) conductor

Impact of Proposed Project

- Mitigates Lugo to Victor transmission line constraints for P0 (Base case) and P1 (loss of one circuit on a common tower) contingencies
- Increases rating of 230 kV lines to 1762/2392 Amps SN/SE
- Potential increase in deliverability in North of Lugo system area
- Enhances system reliability

North of Lugo Area	Estimated Cost (\$M)	Proposed In-Service Date
Lugo-Victor 230 kV Line Reconductor Project	112	12/31/2027



Lugo-Victor 230 kV Line Reconductor Project

Load Flow Results

Overloaded Facility	Contingency	Cat	Post Contingency Loading (%)	Proposed Corrective Action Plan	Post Upgrade Loading (%)
			2032 OP		2032 OP
Lugo - Victor No. 1, No. 2, No. 3 and No. 4 230 kV lines	Base Case	P0	101.8	Reconductor approx. 10.8 mi of existing Lugo-Victor No. 1, No. 2, No. 3, and No. 4 230 kV lines	<100
Lugo - Victor No. 1, No. 2, No. 3 and No. 4 230 kV lines	Any One of Lugo - Victor No. 1, No. 2, No. 3 or No. 4 230 kV lines	P1	102.7	Reconductor approx. 10.8 mi of existing Lugo-Victor No. 1, No. 2, No. 3, and No. 4 230 kV lines	<100

Alternatives	Risks
<ul style="list-style-type: none"> • Curtail approximately 75 MW of generation in Victor Area 	<ul style="list-style-type: none"> • Curtailing generation

New Coolwater 1A 230/115 kV Bank Project

Area challenges

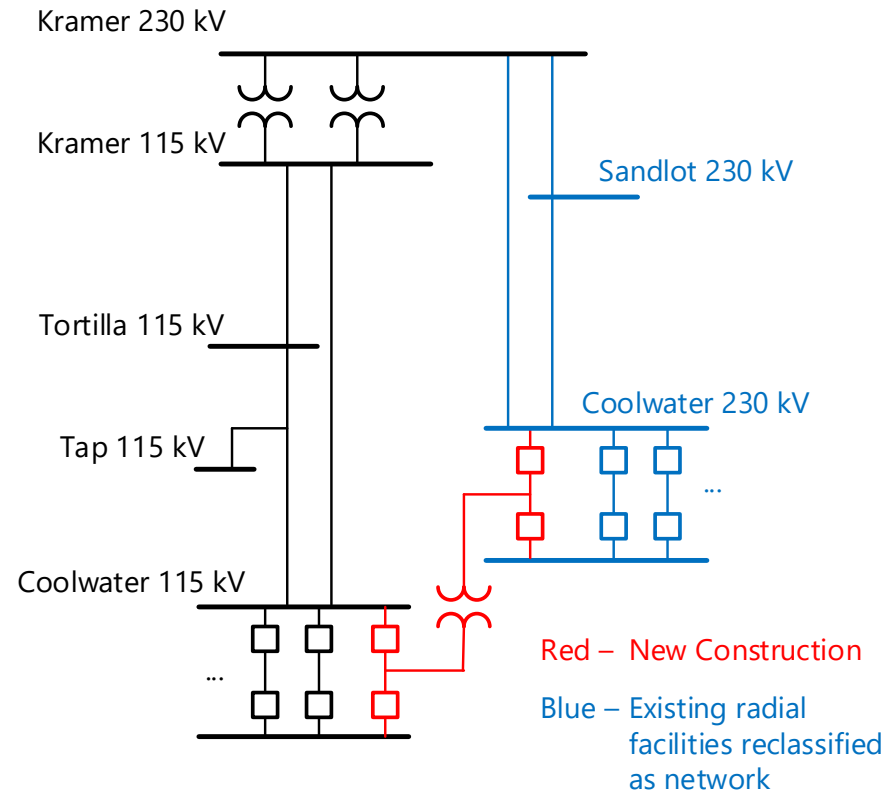
- Risk of potential post contingency voltage collapse in the North of Lugo area during P6 outages of the Kramer-Coolwater and Kramer - Tortilla 115 kV lines or Kramer - Coolwater and Coolwater - SEGS2 - Tortilla 115 kV lines
- Adding capacity by installing a new A-bank at Coolwater would facilitate more flows into North of Lugo area

Proposed Scope

- Add new 230/115 kV A transformer bank at Coolwater

Impact of Proposed Project

- Mitigates P6 contingencies of the Kramer-Coolwater and Kramer-Tortilla 115 kV lines or Kramer-Coolwater and Coolwater-SEGS2- Tortilla 115 kV lines
- Retire existing Operating Procedure that opens the Mountain Pass 115 kV circuit breakers at Ivanpah Substation for a forced or scheduled outage in advance of the P6 contingencies
- Electrically connects the existing Coolwater 230 kV and Coolwater 115 kV switchcracks and converts the Coolwater-Kramer, Kramer-Sandlot, and Coolwater-Sandlot 220 kV lines to CAISO network
- Allow the Brightline West High Speed Rail project to energize with minimal delays as this mitigation is needed for that retail load



North of Lugo Area	Estimated Cost (\$M)	Proposed In-Service Date
New Coolwater 1A 230/115 kV Transformer Bank Project	47	12/31/2026

Cost includes an estimated depreciated portion of the interconnection facilities at Sandlot 230 kV Substation and radial Kramer-Coolwater, Coolwater-Sandlot, and Sandlot-Kramer 230 kV lines

New Coolwater 1A 230/115 kV Bank Project

Load Flow Results

Overloaded Facility	Contingency	Cat	Post Contingency Voltage Values			Proposed Corrective Action Plan	Post Upgrade Loading (%)		
			2024	2027	2032		2024	2027	2032
Voltage Collapse	Kramer-Coolwater and Kramer - Tortilla 115 kV lines	P6	Does not solve			New 230/115 kV Coolwater A-bank	No Voltage Collapse		
Voltage Collapse	Kramer-Coolwater and Coolwater - SEGS2 - Tortilla 115 kV lines	P6	Does not solve			New 230/115 kV Coolwater A-bank	No Voltage Collapse		

Alternatives	Risks
<ul style="list-style-type: none"> Add new 115 kV line between Coolwater and Tortilla substations (11.26 miles) 	<ul style="list-style-type: none"> High costs (\$\$\$) and does not mitigate the impact of the future load interconnection

New Control 115 kV Shunt Reactor Project

Area challenges

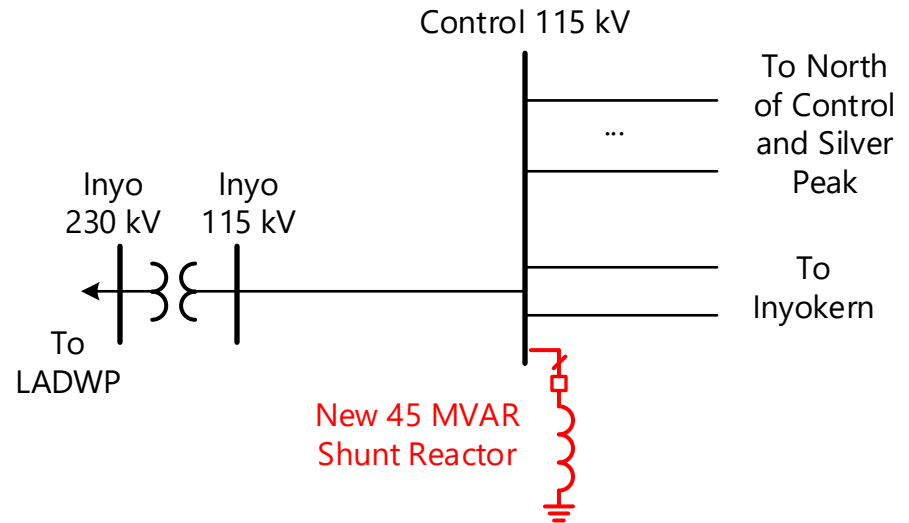
- High voltage issues identified at the Inyo 230 kV Bus
- SCE system operators can't manage the voltage issue without accepting about 10 MVARs from LADWP's system

Proposed Scope

- Add new 45 MVAR shunt reactor at Control 115 kV Substation

Impact of Proposed Project

- Mitigates high voltages at the Inyo 230 kV Bus
- Alleviates need to coordinate with CAISO on reducing area generation to maintain voltage



North of Lugo Area	Estimated Cost (\$M)	Proposed In-Service Date
New Control 115 kV Shunt Reactor Project	4	12/31/2026

New Control 115 kV Shunt Reactor Project

Load Flow Results

Facility	Contingency	Cat	Post Contingency kV/p.u.		Proposed Corrective Action Plan	Post Upgrade Loading kV/p.u.	
			2024 PK	2027 PK		2024 PK	2027 PK
Inyo 230 kV Bus	Base Case	P0	234.0/ 1.018	235.5/ 1.024	New 45 MVAR shunt reactor at Control 115 kV Substation	229.1/ 0.996	232.4/ 1.01
Control 115 kV Bus	Base Case	P0	115.4/ 1.003	115.5/ 1.004	New 45 MVAR shunt reactor at Control 115 kV Substation	109.9/ 0.955	110.2/ 0.958

Alternatives	Risks
<ul style="list-style-type: none"> Continue to utilize the existing system operating bulletins (SOB 80 and SOB 17) 	<ul style="list-style-type: none"> Coordinate with CAISO on reducing area generation to maintain voltage SCE system operators can't manage the voltage issue without accepting about 10 MVARs from LADWP's system, although the Inyo intertie contracted capacity is 0 MW when the phase shifter is in-service

Eldorado Short Circuit Duty

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Eldorado System Short Circuit Duty (SCD)

- Over the last few years, there has been a large influx of generation interconnections in the LADWP, NV Energy, and SCE areas impacting the Eldorado system.
- Based on the latest SCE's queued generation studies conducted in coordination with LADWP and NV Energy, the SCD at the Eldorado 230 kV Joint-Owned Bus could exceed the existing breaker duty rating (63 kA) as soon as 2024.
- Potential SCD mitigations are being analyzed through power flow, transient, and post-transient stability studies to determine the most effective mitigation option.
- Final mitigation option will be presented at the CAISO Stakeholder meeting in February 2023.
- SCE is also working with LADWP and NV Energy to develop an interim SCD solution with a target completion date of Q1 2023.

Example of SCD Mitigation Option

