San Jose Area Transmission Plan

Engineering Study Report

Draft Report

Revision: R0

November 5, 2024

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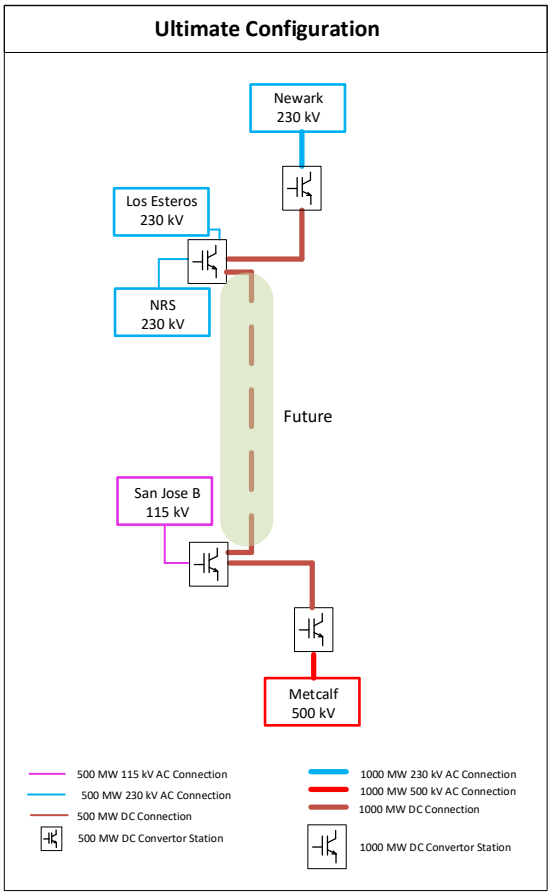
Appendices

Executive Summary

In the 2021-2022 Transmission Plan, the ISO approved the Newark – NRS High Voltage Direct Current (HVDC) project and the Metcalf – San Jose B HVDC project to enhance the transmission system in the area to reliably serve the forecast load in the long term. The ISO's competitive solicitation process that followed the board approval of the 2021-2022 Transmission Plan, selected LS Power Grid California LLC (LSPGC) as the project sponsor for both above HVDC projects. While the approval was just for the two point-to-point HVDC projects, the longer term vision was to connect the two HVDC projects through an HVDC cable and form a multi-terminal HVDC scheme to provide sufficient capacity in the long term. Figure ES-1 provides a schematic diagram of the ultimate multi-terminal HVDC scheme envisioned for the area in the long term. The requested ratings and other parameters of the HVDC projects and their ultimate multi-terminal configuration are detailed in the Functional Specification.[1]

Figure ES-1: Ultimate Multi-terminal HVDC Configuration in San Jose Area in 2021-2022 TPP



As part of the 2024-2025 Transmission Planning Process (TPP), the ISO modeled all the previously-approved projects in our study cases across the system but identified many performance issues in the San Jose area transmission system under normal as well as contingency conditions. The main reason behind the performance issues in this particular area

[1] https://stakeholdercenter.caiso.com/InitiativeDocuments/AppendixG-BoardApproved-2021-2022TransmissionPlan.pdf

was the increased load forecast in the area. Mostly driven by the datacenter load, the long term load forecast in the San Jose area has increased from around 2,100 MW in the 2021-2022 transmission plan studies to around 3,400 MW in the base scenario and around 4,200 MW in the sensitivity scenario in the current 2024-2025 transmission planning studies.

In addition, LS Power informed ISO of the increased cost estimate for the HVDC projects.

The ISO considered number of modifications to mitigate the identified overloads and whether an Alternating Current (AC) solution would be sufficient to provide the required capacity in the area to reduce the overall cost. The following alternatives were studied in detail. Other concepts were also considered but not pursued further due to performance issues identified in the preliminary results.

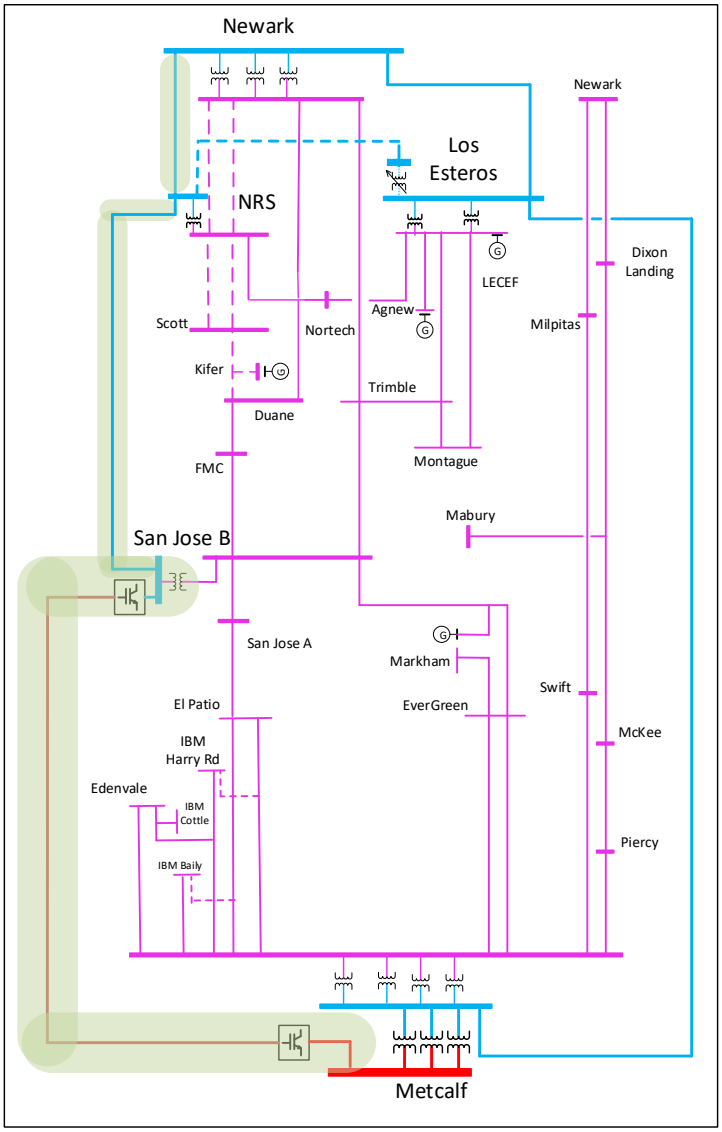
- Multi-terminal HVDC configuration as envisioned in the 2021-2022 Transmission Plan
- Three, high capacity 230 kV AC lines: Newark – NRS, NRS – San Jose B, San Jose B – Metcalf
- Bipole multi-terminal HVDC
- Hybrid HVDC and high capacity 230 kV AC lines

Based on the results of the contingency analysis on all alternatives, a hybrid solution that includes a 1,000 MW HVDC link between Metcalf 500 kV and San Jose B 230 kV substation, a 1,000 MVA 230 kV AC circuit between Newark and NRS 230 kV substations with a 230/115 kV transformer connecting to PG&E's 115 kV substation, and a 1,000 MVA 230 kV AC circuit between NRS and San Jose B 230 kV substation will provide the required capacity for the forecast load and have the flexibility for future expansion should the load forecast further increases. Figure ES-2 provides the schematic diagram of the transmission system in the San Jose study area with recommended transmission plan highlighted in the diagram.

Considering the in service date requirements, cost effectiveness, and the flexibility for long term expansion, the hybrid HVDC and high capacity 230 kV AC line has the optimum performance.

- Modifications:
    - A 1000 MW HVDC link between Metcalf and San Jose B 230 kV switchyard
    - Instead of HVDC, a high capacity 230 kV AC circuit between Newark and NRS
- A new project being considered in the 2024-2025 planning cycle:
    - A high capacity 230 kV circuit between San Jose B and NRS

Figure ES-2: Recommended Transmission Plan for the San Jose Area



1 Background and Objective

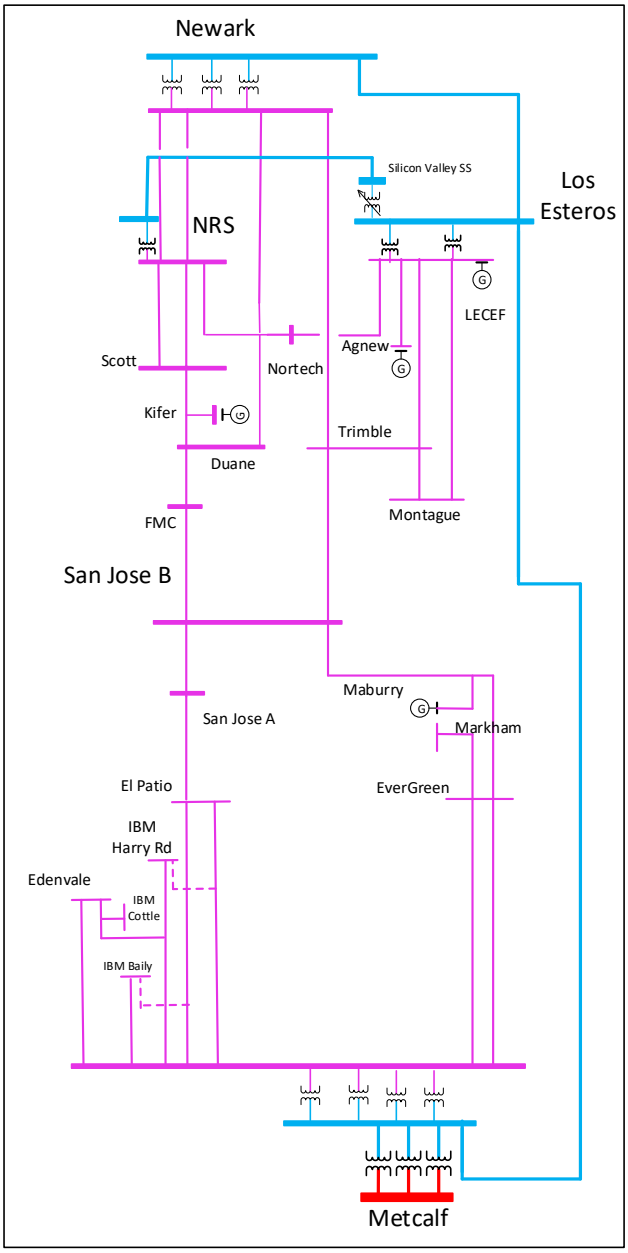
The ISO Board of Governors at its March 17, 2022 meeting approved the 2021-2022 Transmission Plan that included, among other projects, the following reliability driven projects that were eligible for the competitive solicitation process:

- San Jose Area HVDC Line (Newark – NRS)
- San Jose Area HVDC Line (Metcalf – San Jose)

Following the approval of the 2021-2022 Transmission Plan by the ISO Board of Governors, the ISO initiated a competitive solicitation process and on 3/21/2023 selected LS Power Grid California LLC (LSPGC) as the project sponsor for both the Newark – NRS HVDC project and the Metcalf – San Jose B HVDC project. The expected in-service-dates for both projects are June, 2028.

The above projects were approved to serve the forecast load in the San Jose area which for the purpose of this analysis is the area shown in Figure 1-1. Mostly driven by the datacenter load, the long term load forecast in the San Jose area has increased from 2,100 MW in the 2021-2022 Transmission Plan to around 3,400 MW in the base scenario and around 4,200 MW in the sensitivity scenario in the current 2024-2025 transmission planning studies. Given the significant increase in the long term load forecast in the area, the ISO's studies identified that the above projects no longer provide the required capacity to reliably serve the load in the area. In addition, LSPGC has indicated potential cost increases related to the HVDC equipment. Considering the increased load forecast and potential cost increase of HVDC projects, CAISO performed a planning assessment for the San Jose area to identify the optimum modified transmission solution to serve the forecast load and have the flexibility for expansion to serve additional load in the longer term. This report provides the details of the assessment.

Figure 1-1: San Jose Study Area in this Analysis



2 Study Methodology and Criteria

The Greater Bay Area (GBA) 2039 summer peak base case was considered for this assessment to identify the required transmission capacity in the longer term and to develop a transmission plan for the area that provides such long term capacity. However only components of the plan will be recommended for approval that are required to address a need identified in the 10-year planning horizon.

The assessment was conducted to ensure the CAISO-controlled grid is in compliance with the NERC TPL-001-5 standards, WECC TPL-001-WECC-CRT-4.0 regional criteria, and CAISO planning standards.

2.1 System Data and Study Assumptions

2.1.1 Load and Generation Assumptions

Figure 2-1 provides a summary of load and generation in different pockets within the San Jose study area. The total load in the study area in the base scenario is 3,335 MW and the total generation is 1,259 MW in the 2039 summer peak condition.

In this year's TPP analysis in GBA, a South Bay high load sensitivity case was studied for the year 2034 which has more than 800 MW additional load in the study area compared to the base 2034 summer peak case. Although a 2039 South Bay high load sensitivity case was not part of the base cases in this year's TPP analysis in GBA, a conservative assumption is that such sensitivity case would have more than 4,200 MW load in the study area in summer peak of 2039.

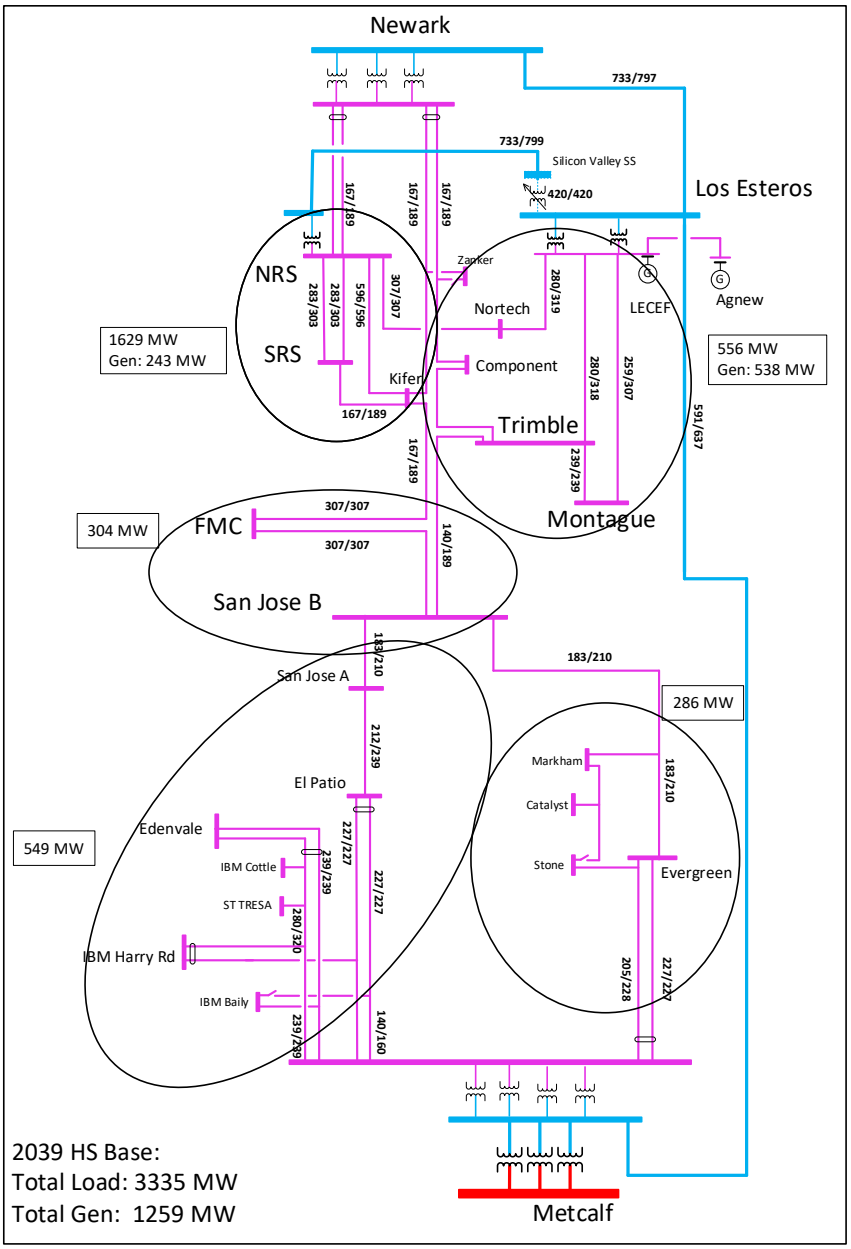
2.1.2 Transmission Projects

All the following transmission projects in the study area that have been approved in previous TPP cycles were modeled in the starting base case.

- Series Compensation on Los Esteros-Nortech 115 kV Line, Dec – 2025
- South Bay Area Limiting Elements Upgrade, Mar – 2026
- Metcalf-Piercy & Swift and Newark-Dixon Landing 115 kV Upgrade, Mar – 2027
- Metcalf 230/115 kV Transformers Circuit Breaker Addition, Jun – 2027
- San Jose Area HVDC Line (Newark - NRS), Apr – 2028
- San Jose Area HVDC Line (Metcalf – San Jose) May – 2028

In the initial base cases, the Newark – NRS HVDC and Metcalf – San Jose B HVDC projects were dispatched to deliver 400 MW to NRS and San Jose B respectively.

Figure 2-1: Load and Generation in San Jose Area in 2039 Summer Peak Case

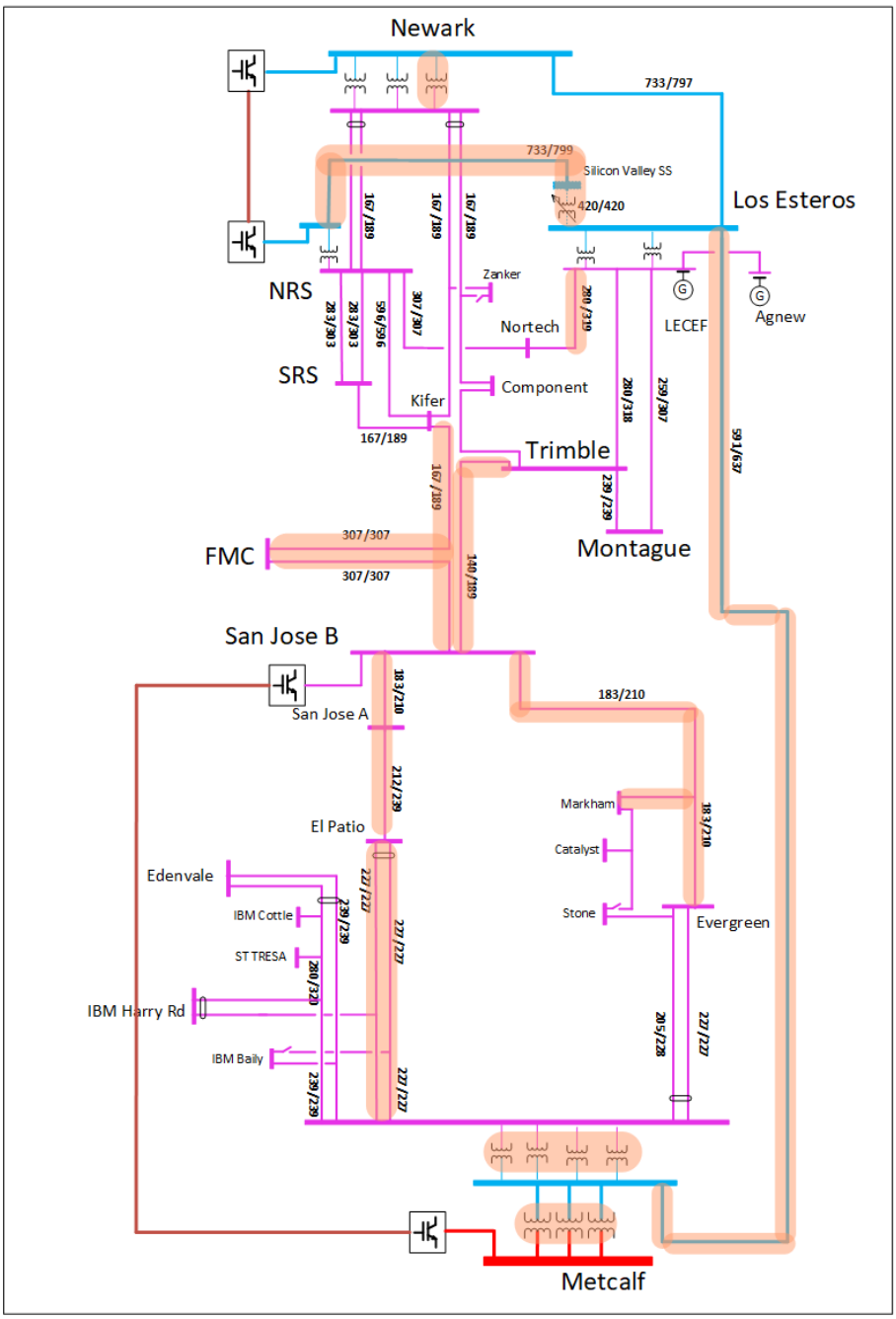


3 Need Assessment and Alternative Study Results

3.1 Need Assessment Study Results

With all the approved transmission projects modeled in the 2039 summer peak case, a number of overloads were identified in the area under normal and P1-P7 contingency conditions. The overloaded elements are shown in Figure 3-1.

Figure 3-1: Overload Results in 2039 Summer Peak Case



3.2 Transmission Development Modifications

A number of transmission modification alternatives were considered to address the overloads identified in the need assessment analysis.

- Multi-terminal HVDC: In this alternative, the original long term vision for the area was studied in which a multi-terminal HVDC scheme was formed by connecting the Newark – NRS HVDC and Metcalf – San Jose B HVDC on the DC side.
- High capacity AC lines: In this alternative, a high capacity 230 kV path with three lines were studied: Newark – NRS 230 kV AC line, Metcalf – San Jose B 230 kV AC line, and NRS – San Jose B 230 kV AC line. No HVDC converter or line was considered in this alternative
- Bipole multi-terminal HVDC: In this alternative, the original long term vision of multi-terminal HVDC that was based on symmetrical monopole HVDC was enhanced to bipole multi-terminal HVDC.
- Hybrid HVDC and high capacity 230 kV AC: This alternative shown in Figure 3-2, includes a high capacity 230 kV AC line from Newark to NRS (instead of HVDC link), a 1,000 MW HVDC link from Metcalf to a San Jose B 230 kV substation with a 230/115 kV transformer to San Jose B 115 kV substation, and a high capacity 230 kV AC line from NRS to San Jose B 230 kV substation.

3.2.1 Comparative Analysis of Alternatives

Contingency analysis was performed on all alternatives and the study results indicated that hybrid HVDC and high capacity 230 kV AC lines and the bipole multi-terminal HVDC options would both address most of the overloads identified in the need assessment study. However considering other factors such as cost, feasibility, required in-service-date, and the technology risk, the hybrid solution based on a combination of HVDC and high capacity 230 kV AC lines alternative shown in Figure 3-2 is recommended as the long term solution for the San Jose Area.

3.2.2 Cost Estimate

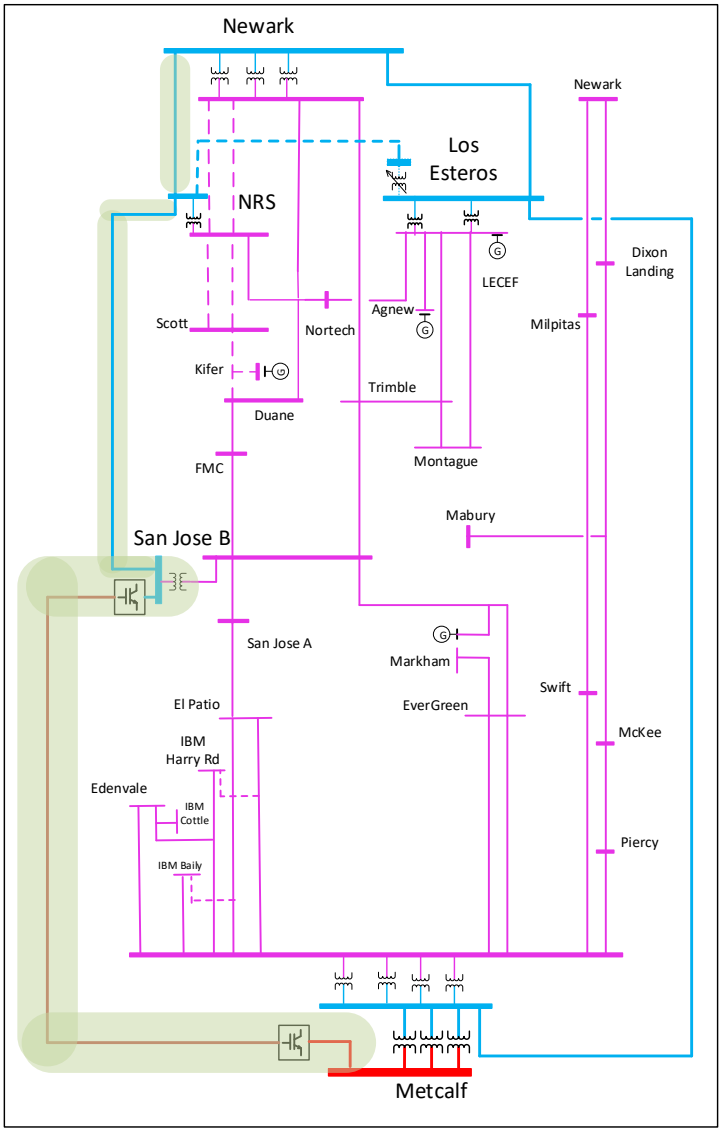
LS Power Grid California has provided revised cost estimate for the projects as follows:

- Metcalf – San Jose B Project
    - Budgetary Incremental Cost Estimate: $100 – $150 million incremental cost to CPCN estimate of $1.221 billion. Based on CAISO's calculations, the revised cost estimate for the project is $1.321 B – $1.371 B
- Newark – NRS Project
    - Budgetary Incremental Cost Estimate: $265 – $530 million net savings to CPCN estimate of $1.123 billion. Based on CAISO's calculations, the revised cost estimate for the project is $593 M – $858 M

3.2.3 Local 115 kV Overloads in the Study Area

Number of local overloads were identified in the need assessment study results that will not be resolved by any of the alternatives considered in this study. Independent of the alternative selected to address the overload on the major transmission lines in the study area, further enhancements to the local 115 kV system will be required to address the identified overloads.

Figure 3-2: Recommended Transmission Plan for the San Jose Area



4 Summary and Conclusions

The ISO Board of Governors at its March 17, 2022 meeting approved the 2021-2022 Transmission Plan that included, among other projects, the following reliability driven projects that were eligible for the competitive solicitation process:

- San Jose Area HVDC Line (Newark – NRS)
- San Jose Area HVDC Line (Metcalf – San Jose)

Following the approval of the 2021-2022 Transmission Plan by the ISO Board of Governors, the ISO initiated a competitive solicitation process and on March 21, 2023 selected LS Power Grid California LLC (LSPGC) as the project sponsor for both the Newark – NRS HVDC project and the Metcalf – San Jose B HVDC project. The expected in-service-dates for both projects are June, 2028.

The above projects were approved to serve the forecast load in the San Jose area. Mostly driven by the datacenter load, the long term load forecast in the San Jose area has increased from 2,100 MW in the 2021-2022 transmission plan to around 3,400 MW in the base scenario and around 4,200 MW in the sensitivity scenario in the current 2024-2025 transmission planning studies. Given the significant increase in the long term load forecast in the area, the ISO's studies identified that the above projects no longer provide the required capacity to reliably serve the load in the area and therefore has modified the transmission plan in the San Jose area as detail in this report. Specifically, the scope of the above two HVDC projects have been modified as follows:

1- The Newark – NRS HVDC project is modified to Newark – NRS 230 kV project. No HVDC converters or lines are required in the modified scope and the modified scope includes only a high capacity 230 kV AC line (1,000 MVA) from PG&E's Newark substation to Silicon Valley Power's (SVP's) NRS substation.

2- The scope of the Metcalf – San Jose B HVDC project is modified as follows:

   a. The power injection at San Jose B is increased to 1,000 MW from 500 MW.

   b. The voltage at the AC side of the San Jose B converter station is changed from 115 kV to 230 kV.

   c. A 230 kV switchyard and a 230/115 kV transformer will be required at San Jose B.

APPENDIX A: Functional Specification for the Newark – NRS 230 kV Line Project

230 kV Transmission Line Functional Specifications - Newark – NRS 230 kV Line

Line Terminus 1: Newark 230 kV Bus

Line Terminus 2: Northern Receiving Station (NRS) 230 kV Bus

Nominal Phase to Phase Voltage: 230 kV

Minimum Line Continuous Ampacity - Summer: 2500 Amps per circuit

Minimum Line Continuous Ampacity – Winter: 2500 Amps per circuit

Minimum Line 4 Hour Emergency Ampacity – Summer: 2500 Amps per circuit

Minimum Line 4 Hour Emergency Ampacity – Winter: 2500 Amps per circuit

Approximate Line Impedance: 0.000018 + j0.00029 pu/mile (100 MVA base) ±20% for the cable sections and 0.00012 + j0.0011 pu/mile (100 MVA base) ±20% for the overhead sections of the line.

Approximate Line Length: 12 miles depending on the routing of the line

Latest In Service Date: June 1, 2028

APPENDIX B: Functional Specification for the Metcalf – San Jose B HVDC Project

Functional Specifications for Metcalf – San Jose B HVDC Project

Rated Real Power: ±1000 MW measured at San Jose B 230 kV substation.

Rated Reactive Power: ±300 MVAR measured at Metcalf 500 kV and San Jose B 230 kV substations.

At Metcalf 500 kV end, the entire inductive (absorption) range should be continuously available when the AC voltage is in the 500 kV – 550 kV range and the entire capacitive (injection) range should be available when the voltage is in the 473 kV – 540 kV range.

At San Jose B 230 kV end, the entire inductive (absorption) range should be continuously available when the AC voltage is in the 230 kV – 242 kV range and the entire capacitive (injection) range should be available when the voltage is in the 207 kV – 238 kV range.

To support voltage in the area, the reactive output range should be available independent of the real power flow on the HVDC. If the DC cable is out of service, the converters should be able to operate to support the voltage.

Response time: The time required for the output to go from 10% of the final value to 90% of the final value should be less than 150 ms.

Nominal Terminal AC Voltage: 500 kV at Metcalf and 230 kV at San Jose B. Typically the bus voltage at Metcalf 500 kV bus is at 525 kV.

Latest in Service Date: June 1, 2028

Inverter Ride Through Capability: NERC PRC-024 requirements and NERC industry recommendation on momentary cessation [2]

Availability and Reliability requirements: The project shall be designed for high availability of at least 97%. All proposals shall provide a calculation identifying the designed annual availability of the system proposed.

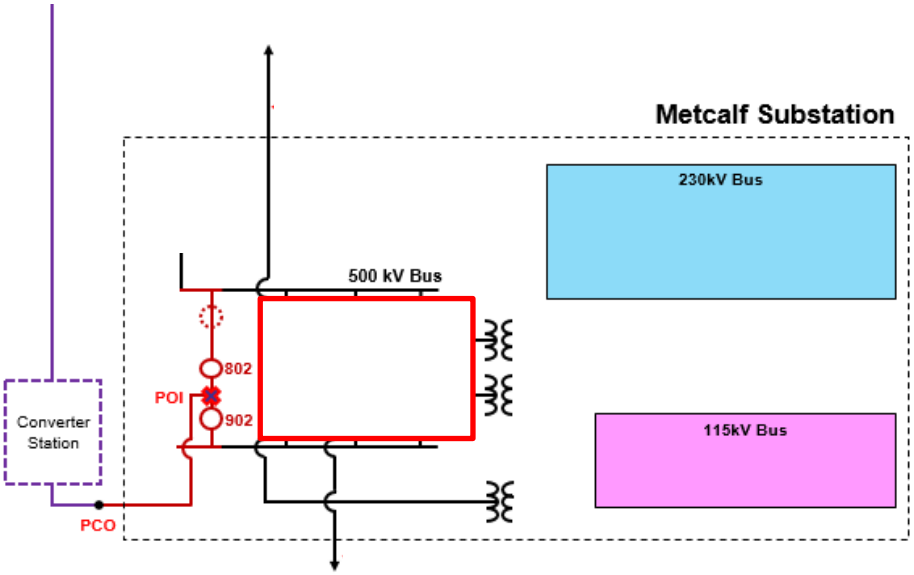
Gas Insulation Required: No, but if proposed shall be enclosed

CIP 14 requirement: The substation perimeter should be fenced by a wall

Run back capability: The HVDC controls should be able to receive signals for line statuses, and line loadings and implement a logic that will run HVDC back to preset power levels to address overloads.

[2] https://www.nerc.com/pa/rrm/bpsa/Alerts%20DL/NERC_Alert_Loss_of_Solar_Resources_during_Transmission_Disturbance-II_2018.pdf

Figure B-1: Interconnection to Metcalf 500 kV and San Jose B 230 kV Substations



Conceptual and Preliminary Layout and Interconnection to PG&E San Jose B 230/115 kV Substation