Reliability Assessment for the Transmission System in the Big Creek Corridor / San Joaquin Valley

Central California Clean Energy Transmission Project (C3ETP)

Study Results

Amos Ang, SCE Transmission Planning
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Presentation Outline

- Study Objectives
- Study Base Cases
- Study Alternatives
  - Transient Voltage Stability Results
  - Thermal Loading Results
- Conclusions
STUDY OBJECTIVES

- The objective of this study is to perform a reliability assessment of the SCE transmission system, considering and comparing the various proposed Central California Clean Energy Transmission Project (C3ETP) alternatives.
STUDY BASE CASES

- **2033 Summer Peak Base Case**
  - Uses PG&E 2014 C3ETP Summer Peak Base Case with Fresno load scaled up to 2033 levels
  - SCE SJV area 2033 heavy summer load levels (1-in-10 heat storm) ~ 2024 MW
  - Summer on-peak Big Creek Hydro generation pattern

- **2033 Off-Peak Base Case for Thermal Loading Analysis**
  - 66% of summer peak load levels
  - Hydro generation – not generating
Service Territory Map

(Source: California Energy Commission website)
TRANSMISSION & INTERCONNECTION PLANNING
T&D BUSINESS UNIT

STUDY ALTERNATIVE – SCE 1

SCE-1:
“MAGUNDEN-RECTOR 230-kV PROJECT”
(non-approved)
(PG&E ALT-1, ALT-2, ALT-2D,
ALT-5, ALT-7, ALT-8, ALT-9
AND ALT-10)
STUDY RESULTS – SCE 1

- **Stability Results**
  - 19 voltage drop violations (Level B / N-1 outages)
  - 14 out of 19 resulted in system voltage collapse
  - Worst Voltage Drop is 37.9% below pre fault voltage

- **Thermal Loading Results**
  - Magunden-Vestal 230 kV # 1 or #2 overloads to 104% of emergency due to loss of the adjacent line.
  - Antelope-Magunden 230 kV # 1 overloads to 109% of emergency due to loss of the adjacent line.
  - These overloads can be relieved by operating procedures
STUDY ALTERNATIVE – SCE 1b (SENSITIVITY)

SCE-1A: “MAGUNDEN-RECTOR 230-kV PROJECT WITH SIX 50 MW OF PEAKERS” (NON-APPROVED)
STUDY RESULTS – SCE 1b

This is a sensitivity study of adding six 50 MW peakers: two at Rector, two at S1, two at Springville

- **Stability Results**
  - 8 voltage drop violations (Level B / N-1 outages)
  - Worst Voltage Drop is 28.7% below pre fault voltage
  - It would require an estimated 200 MVAR SVC at Rector to meet minimum system reliability on top of the existing Rector SVC

- **Thermal Loading Results**
  - No identified power flow overloads
STUDY ALTERNATIVE – SCE 1c (SENSITIVITY)

SCE-1b: “Magunden-Rector 230-kV Project with three 200 MVAR of SVCs” (NON-APPROVED)
STUDY RESULTS – SCE 1c

This is a sensitivity study that adds 3 SVCs each one located at S1, Springville, and Vestal

- **Stability Results**
  - 11 voltage drop violations (Level B / N-1 outages)
  - Worst Voltage Drop is 35.2% below pre fault voltage
  - It would require an estimated 800 MVAR SVC: 200 MVAR each at S1, Springville, Vestal, and Magunden to meet the minimum system reliability on top of the existing Rector SVC

- **Thermal Loading Results**
  - Magunden-Vestal 230 kV # 1 or #2 overloads to 104% of emergency due to loss of the adjacent line.
  - Antelope-Magunden 230 kV # 1 overloads to 109% of emergency due to loss of the adjacent line.
  - These overloads can be relieved by operating procedures
STUDY ALTERNATIVE – SCE 2A

SCE-2A:
“S2 Substation”
& Midway-E2
500-kV DCTL

(PG&E ALT-2A)
STUDY RESULTS – SCE 2A

- **Stability Results**
  - 11 voltage drop violations (Level B / N-1 outages)
  - 2 voltage drop duration violations
  - Worst Voltage Drop is 36.3% below pre fault voltage
  - It would require an estimated 350 MVAR SVC at S1 to meet minimum system reliability

- **Thermal Loading Results**
  - Magunden-Vestal 230 kV #1 or #2 overloads to 126% of emergency due to loss of the adjacent line.
  - These overloads cannot be relieved by operating procedures, upgrades need to be employed
STUDY ALTERNATIVE – SCE 2B

SCE-2B: “S2 and S3 Substations” & S3-Whirlwind

(PG&E Alt-2B)
STUDY RESULTS – SCE 2B

- **Stability Results**
  - 7 voltage drop violations (Level B / N-1 outages)
  - 2 voltage drop violations due to loss of a 500/230 kV transformer
  - Worst Voltage Drop is 32.1% below pre fault voltage
  - It would require an estimated 230 MVAR SVC at S1 to meet minimum system reliability

- **Thermal Loading Results**
  - Magunden-Vestal 230 kV # 1 or #2 overloads to 128% of emergency due to loss of the adjacent line.
  - These overloads cannot be relieved by operating procedures, upgrades need to be employed
STUDY ALTERNATIVE – SCE 2E

SCE-2E: “S1 Substation” & Midway-Gregg 500 kV (PG&E Alt-2d Modified)
STUDY RESULTS – SCE 2E

- **Stability Results**
  - No voltage drop violation
  - No voltage drop duration violation

- **Thermal Loading Results**
  - Magunden-Vestal 230 kV # 1 or #2 overloads to 102% of emergency due to loss of the adjacent line.
  - These overloads can be relieved by operating procedures
STUDY ALTERNATIVE – SCE 3

SCE-3: “S2 Substation” & Midway-E2 500-kV SCTL

(PG&E Alt-3)
STUDY RESULTS – SCE 3

- **Stability Results**
  - 12 voltage drop violations (Level B / N-1 outages)
  - 2 voltage drop duration violations
  - 2 voltage drop violations due to loss of a 500/230 kV transformer
  - Worst Voltage Drop is 38.6% below pre fault voltage
  - It would require an estimated 390 MVAR SVC at S1 to meet minimum system reliability

- **Thermal Loading Results**
  - Magunden-Vestal 230 kV # 1 or #2 overloads to 122% of emergency due to loss of the adjacent line.
  - These overloads cannot be relieved by operating procedures, upgrades need to be employed
STUDY ALTERNATIVE – SCE 4

SCE-4: “S2 Substation” & Midway-Whirlwind 500-kV DCTL

(PG&E Alt-4)
STUDY RESULTS – SCE 4

- **Stability Results**
  - 10 voltage drop violations (Level B / N-1 outages)
  - 2 voltage drop duration violations
  - 2 voltage drop violations due to loss of a 500/230 kV transformer
  - Worst Voltage Drop is 37.2% below pre fault voltage
  - It would require an estimated 370 MVAR SVC at S1 to meet minimum system reliability

- **Thermal Loading Results**
  - Magunden-Vestal 230 kV # 1 or #2 overloads to 117% of emergency due to loss of the adjacent line.
  - These overloads can be relieved by operating procedures
STUDY ALTERNATIVE – SCE 6

SCE-6:
SCE-PG&E
BIG CREEK
CORRIDOR
230-kV
SYSTEM TIE

(PG&E Alt-6)
STUDY RESULTS – SCE 6

- **Stability Results**
  - 12 voltage drop violations (Level B / N-1 outages)
  - 4 out of the 12 voltage drop violations resulted in voltage collapse
  - 6 voltage drop duration violations
  - Worst Voltage Drop is 35.6% below pre fault voltage
  - Two faults on the PG&E 230 kV system have an adverse effect on the SCE 230 kV system that could not be mitigated with the Big Creek RAS.
  - It would require an estimated 400 MVAR SVC at S1 to meet minimum system reliability

- **Thermal Loading Results**
  - Antelope-Magunden 230 kV #1 is overloaded to 108% under base case conditions
  - Magunden-Vestal 230 kV #1 or #2 overloads to 138% of emergency due to loss of the adjacent line.
  - These overloads cannot be relieved by operating procedures so these lines have to upgraded due the base case and N-1 overloads stated above
STUDY ALTERNATIVE – SCE ONLY

SCE-only:
WHIRLWIND-S1
500 kV
STUDY RESULTS – SCE ONLY

- **Stability Results**
  - No voltage drop violation
  - No voltage drop duration violation

- **Thermal Loading Results**
  - No identified power flow overloads
Conclusion

- In this assessment, SCE has validated the capabilities of the alternatives which are then divided in three categories.
- The first category results in systems that would not meet NERC/WECC/CAISO criteria and/or it is limited in its performance or feasibility even with additional system upgrades.
- The second category results in systems that do not meet NERC/WECC/CAISO criteria as is but may be able to meet the stated criteria with additional feasible system upgrades.
- The third category results in systems that meet the NERC/WECC/CAISO criteria without additional system upgrades.
Conclusion

230 kV options

- The following alternatives do not meet the NERC/WECC/CAISO Reliability Standards and are limited in their performance even with the additional transmission upgrades.
  - SCE-1, SCE-1b, SCE-1c
  - SCE-6
- This alternatives are only a 230 kV option which is not robust enough to support an increase in load
Conclusion (cont.)

500 kV options

- The following alternatives do not meet the NERC/WECC/CAISO Reliability Standards without additional transmission upgrades. But these alternatives perform better compared to the alternatives stated above and with the included transmission upgrades as part of the sensitivity; it would meet the NERC/WECC/CAISO Reliability Standards.
  - SCE-2a
  - SCE-2b
  - SCE-3
  - SCE-4

- These alternatives are a set of alternatives that provide a 500 kV source that is located at load center which provided the necessary voltage support to meet the reliability standards and future load support.
Conclusion (cont.)

500 kV options

- The following alternatives meet the NERC/WECC/CAISO Reliability Standards without additional transmission reinforcement.
  - SCE-2e
  - SCE only

- These alternatives are a set of alternatives that provide a 500 kV source that is located at load center which provided the necessary voltage support to meet the reliability standards and future load support.