Central California Clean Energy Transmission Project

Preliminary Draft Report
Section 3.1.1
PG&E Greater Fresno Area Load Serving Capability Study

Attachment 4
Transient Stability Analysis
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Summary of Dynamic Analysis Results

Table 1 summarizes the dynamic analysis results for Alternative 1 under the 2014 summer peak conditions studied. Table 2 summarizes the dynamic analysis results for the 14 alternatives under the 2033 summer peak conditions studied.

Table 1
Summary of Dynamic Analysis Results
(2014 Summer Peak Conditions)

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Contingency</th>
<th>Dynamic Analysis Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 1: Upgrade existing</td>
<td>3ph fault at Gregg followed by the loss of Helms-Gregg #1 230kV line and</td>
<td>Stable and damped</td>
</tr>
<tr>
<td>system without building new lines</td>
<td>one Helms generation unit</td>
<td></td>
</tr>
<tr>
<td>(2014 summer peak base case)</td>
<td>3ph fault at Gregg followed by the loss of Gates-Gregg 230kV line</td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>SLG fault at Gregg followed by the loss of Helms-Gregg 230kV DCTL and three</td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>Helms generation units</td>
<td></td>
</tr>
</tbody>
</table>

Table 2
Summary of Dynamic Analysis Results
(2033 Summer Peak Conditions)

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Contingency</th>
<th>Dynamic Analysis Results</th>
</tr>
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<tbody>
<tr>
<td>Alternative 1: Upgrade existing</td>
<td>3ph fault at Gregg followed by the loss of Helms-Gregg #1 230kV line and</td>
<td>First swing instability at Helms PSP and voltage instability at many load buses in Fresno</td>
</tr>
<tr>
<td>system without building new lines</td>
<td>one Helms generation unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3ph fault at Gregg followed by the loss of Helms-Gregg #1 230kV line and</td>
<td>First swing instability at Helms PSP and voltage instability at many load buses in Fresno</td>
</tr>
<tr>
<td></td>
<td>one Helms generation unit</td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>(Install 400MVAR SVC at Gregg 230kV bus.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3ph fault at E2 followed by the loss of E2-Gregg 230kV line</td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>SLG fault at E2 followed by the loss of Midway-E2 500kV DCTL</td>
<td>Stable and damped</td>
</tr>
<tr>
<td>Alternative 2: Build Midway-E2</td>
<td>SLG fault at E2 followed by the loss of E2-Gregg 230kV DCTL</td>
<td>Stable and damped</td>
</tr>
<tr>
<td>500kV DCTL</td>
<td>SLG fault at E2 followed by the loss of Helms-E2 230kV DCTL and three Helms generation units</td>
<td>Stable and damped</td>
</tr>
</tbody>
</table>
Table 2 (continue)
Summary of Dynamic Analysis Results
(2033 Summer Peak Conditions)

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Contingency</th>
<th>Dynamic Analysis Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 2a: Build Midway-E2 500kV DCTL with S2 loop-in</td>
<td>3ph fault at E2 followed by the loss of E2-Gregg #1 230kV line</td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>SLG fault at E2 followed by the loss of Midway-E2 and E2-S2 500kV DCTL</td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>SLG fault at Gregg followed by the loss of E2-Gregg 230kV DCTL</td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>SLG fault at E2 followed by the loss of Helms-E2 230kV DCTL and three Helms generation units</td>
<td>Stable and damped</td>
</tr>
<tr>
<td>Alternative 2b: Build Midway – E2 500kV DCTL, S2 and S3 Loop-in, and Whirlwind – S3 500 kV SCTL</td>
<td>3ph fault at E2 followed by the loss of E2-Gregg #1 230kV line</td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>SLG fault at E2 followed by the loss of Midway-E2 500kV DCTL</td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>SLG fault at Gregg followed by the loss of E2-Gregg 230kV DCTL</td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>SLG fault at E2 followed by the loss of Helms-E2 230kV DCTL and three Helms generation units</td>
<td>Stable and damped</td>
</tr>
<tr>
<td>Alternative 2d: Build Midway – Gregg 500kV DCTL</td>
<td>3ph fault at E2 followed by the loss of Helms-Gregg #1 230kV line and one Helms generation unit</td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>SLG fault at Gregg followed by the loss of Midway-Gregg 500kV DCTL</td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>SLG fault at Gregg followed by the loss of Helms-Gregg 230kV DCTL and three Helms generation units</td>
<td>Stable and damped</td>
</tr>
<tr>
<td>Alternative 3: Build Midway – E2 500kV SCTL with S2 Loop-in</td>
<td>3ph fault at E2 followed by the loss of Helms-E2 #1 230kV line and one Helms generation unit</td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>3ph fault at E2 followed by the loss of E2-S2 500kV SCTL</td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>SLG fault at Gregg followed by the loss of E2-Gregg 230kV DCTL</td>
<td>Stable and damped</td>
</tr>
<tr>
<td>Alternative 4: Build Whirlwind – E2 500kV DCTL with S2 Loop-in</td>
<td>3ph fault at E2 followed by the loss of Helms-E2 #1 230kV line and one Helms generation unit</td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>SLG fault at Gregg followed by the loss of E2-Gregg 230kV DCTL</td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>SLG fault at E2 followed by the loss of S2-E2 and Whirlwind-E2 500kV DCTL</td>
<td>Stable and damped</td>
</tr>
</tbody>
</table>
Table 2 (continue)
Summary of Dynamic Analysis Results
(2033 Summer Peak Conditions)

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Contingency</th>
<th>Dynamic Analysis Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternatives 5: Build Midway – E2 230kV DCTL</td>
<td>3ph fault at E2 followed by the loss of Helms-E2 #1 230kV line and one Helms generation unit.</td>
<td>Transient VD &gt; 20% at load bus for more than 20 cycles</td>
</tr>
<tr>
<td></td>
<td>3ph fault at E2 followed by the loss of Helms-E2 #1 230kV line and one Helms generation unit. <strong>(Install 400 MVAR SVC at Gregg 230kV bus.)</strong></td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>3ph fault at Gregg followed by the loss of Gates-Gregg 230kV line</td>
<td>First swing instability at Helms PSP and voltage instability at many load buses in Fresno</td>
</tr>
<tr>
<td></td>
<td>3ph fault at Gregg followed by the loss of Gates-Gregg 230kV line. <strong>(Install 400 MVAR SVC at Gregg 230kV bus.)</strong></td>
<td>Stable and damped</td>
</tr>
<tr>
<td>Alternatives 6: Build Fresno – Big Creek 230kV Tie</td>
<td>3ph fault at E2 followed by the loss of Helms-E2 #1 230kV line and one Helms generation unit</td>
<td>Not meet WECC Transient Voltage Dip Standard</td>
</tr>
<tr>
<td></td>
<td>3ph fault at E2 followed by the loss of Helms-E2 #1 230kV line and one Helms generation unit. <strong>(Install 400 MVAR SVC at Gregg 230kV bus.)</strong></td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>3ph fault at Gregg followed by the loss of Gates-Gregg 230kV DCTL</td>
<td>First swing instability at Helms PSP and Big Cr hydro plants. Voltage instability at many load buses in Fresno and Big Cr area</td>
</tr>
<tr>
<td></td>
<td>3ph fault at E2 followed by the loss of E2-Gregg #1 230kV line. <strong>(Install 400 MVAR SVC at Gregg 230kV bus.)</strong></td>
<td>Stable and damped</td>
</tr>
<tr>
<td>Alternatives 7: Build Midway – McCall – E2 230 kV DCTL</td>
<td>3ph fault at Gregg followed by the loss of Gates-Gregg 230kV line</td>
<td>First swing instability at Helms PSP and voltage instability at many load buses in Fresno</td>
</tr>
<tr>
<td></td>
<td>3ph fault at Gregg followed by the loss of Gates-Gregg 230kV line. <strong>(Install 400 MVAR SVC at Gregg 230kV bus)</strong></td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>3ph fault at E2 followed by the loss of Helms-E2 #1 230kV line and one Helms generation unit</td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>SLG fault at E2 followed by the loss of Helms-E2 230kV DCTL and three Helms generation units</td>
<td>Stable and damped</td>
</tr>
</tbody>
</table>
Table 2 (continue)
Summary of Dynamic Analysis Results
(2033 Summer Peak Conditions)

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<th>Alternative</th>
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</thead>
<tbody>
<tr>
<td>Alternative 8: Build Gates - Gregg – E2 230kV DCTL</td>
<td>3ph fault at Gregg followed by the loss of Gates-Gregg 230kV line</td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>3ph fault at Gregg followed by the loss of Helms-Gregg #1 230kV line and one Helms generation unit</td>
<td>Not meet WECC Transient Voltage Dip Standard</td>
</tr>
<tr>
<td></td>
<td>3ph fault at Gregg followed by the loss of Helms-Gregg #1 230kV line and one Helms generation unit. (<em>Install 400 MVAR SVC at Gregg 230kV bus</em>)</td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>SLG fault at Gregg followed by the loss of Helms-Gregg 230kV DCTL and three Helms generation units</td>
<td>Stable and damped</td>
</tr>
<tr>
<td>Alternative 9: Build Raisin City Switching Station</td>
<td>3ph fault at Gregg followed by the loss of Raisin City-Gregg 230kV line</td>
<td>First swing instability at Helms PSP and voltage instability at many load buses in Fresno</td>
</tr>
<tr>
<td></td>
<td>3ph fault at Gregg followed by the loss of Raisin City-Gregg 230kV line. (<em>Install 400 MVAR SVC at Gregg 230kV bus</em>)</td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>3ph fault at Gregg followed by the loss of Helms-Gregg #1 230kV line and one Helms generation unit. (<em>Install 400 MVAR SVC at Gregg 230kV bus</em>)</td>
<td>Transient VD &gt; 20% at load bus for more than 20 cycles. Not meet WECC Transient Voltage Dip standards</td>
</tr>
<tr>
<td>Alternative 10: New Generation (400MW at Borden + 600MW at McCall)</td>
<td>3ph fault at Gregg followed by the loss of Helms-Gregg #1 230kV line and one Helms generation unit</td>
<td>Stable and damped</td>
</tr>
<tr>
<td></td>
<td>SLG fault at Gregg followed by the loss of Helms-Gregg 230kV DCTL and three Helms generation units</td>
<td>Stable and damped</td>
</tr>
</tbody>
</table>
2014 Summer Peak Base Case

Alt-1: Upgrade the existing system without building new lines (2014 summer peak base case)

Case 1: 3ph fault at Gregg followed by the loss of Helms – Gregg 1 230 kV line and the trip of one Helms generator under 2014 summer peak (Category “B”)

Results: Stable and damped
Figure A4-Alt1-2
Loss of Helms – Gregg #1 230 kV Line and one Helms generator (Category “B”)
Alt-1: Upgrade the existing system without building new lines
(2014 Summer Peak Base Case)
Case 2: 3ph fault at Gregg followed by the loss of Gates – Gregg 230 kV line under 2014 summer peak (Category “B”)

Results: Stable and damped

Figure A4-Alt1-3
Loss of Gates – Gregg 230 kV Line (Category “B”)
Alt-1: Upgrade the existing system without building new lines
(2014 Summer Peak Base Case)
Figure A4-Alt1-4
Loss of Gates – Gregg 230 kV Line (Category “B”)
Alt-1: Upgrade the existing system without building new lines
(2014 Summer Peak Base Case)
Case 3: SLG fault at Gregg followed by the loss of Helms – Gregg 230 kV DCTL and the loss of three Helms generation units under 2014 summer peak (Category “P7”)

Results: Stable and damped

Figure A4-Alt1-5
Loss of Helms – Gregg 230 kV DCTL and three Helms generation units (Category “P7”)
Alt-1: Upgrade the existing system without building new lines
(2014 Summer Peak Base Case)
Figure A4-Alt1-6
Loss of Helms – Gregg 230 kV DCTL and three Helms generation units (Category “P7”)
Alt-1: Upgrade the existing system without building new lines
(2014 Summer Peak Base Case)
2033 summer Peak Base Case:

**Alt-1:** Upgrade the existing system without building new lines (2033 summer peak base case)

Case 1: 3ph fault at Gregg followed by the loss of Helms – Gregg 1 230 kV line and one Helms generation unit under 2033 summer peak (Category “B”)

Results: First swing instability at Helms generators and many other local generators. Voltage instability triggers UVLS to drop non-consequential loads in the Greater Fresno area.

Figure A4-Alt1A-1

Loss of Helms – Gregg #1 230 kV Line and one Helms generator (Category “B”)

Alt-1A: Upgrade the existing system without building new lines (2033 Summer Peak Base Case)
Figure A4-Alt1A-2
Loss of Helms – Gregg #1 230 kV Line and one Helms generator (Category “B”)
Alt-1A: Upgrade the existing system without building new lines
(2033 Summer Peak Base Case)
Case 1A: 3ph fault at Gregg followed by the loss of Helms – Gregg 1 230 kV line and one Helms generation unit under 2033 summer peak (Category “B”). Install 400MVAR SVC at Gregg 230kV bus

Results: Stable and damped

Figure A4-Alt1A-3
Loss of Helms – Gregg #1 230 kV Line and one Helms generator (Category “B”)
Alt-1A: Upgrade the existing system without building new lines; Install 400mvar SVC (2033 Summer Peak Base Case)
Figure A4-Alt1A-4
Loss of Helms – Gregg #1 230 kV Line and one Helms generator (Category “B”)
Alt-1A: Upgrade the existing system without building new lines; Install 400mvar SVC
(2033 Summer Peak Base Case)
Case 2: 3ph fault at Gregg followed by the loss of Gates – Gregg 230 kV line under 2033 summer peak (Category “B”)

Results: First swing instability at Helms generators and many other local generators. Voltage instability triggers UVLS to drop non-consequential loads in the Greater Fresno area.

Figure A4-Alt1A-5
Loss of Gates – Gregg 230 kV Line (Category “B”)
Alt-1A: Upgrade the existing system without building new lines
(2033 Summer Peak Base Case)
Figure A4-Alt1A-6
Loss of Gates – Gregg 230 kV Line (Category “B”)
Alt-1A: Upgrade the existing system without building new lines
(2033 Summer Peak Base Case)
Case 2A: 3ph fault at Gregg followed by the loss of Gates – Gregg 230 kV line under 2033 summer peak (Category “B”). Install 400MVAR SVC at Gregg 230kV bus

Results: Stable and damped.

Figure A4-Alt1A-7
Loss of Gates – Gregg 230 kV Line (Category “B”)
Alt-1A: Upgrade the existing system without building new lines
(2033 Summer Peak Base Case)
Figure A4-Alt1A-8
Loss of Gates – Gregg 230 kV Line (Category “B”)
Alt-1A: Upgrade the existing system without building new lines
(2033 Summer Peak Base Case)
Case 3: SLG fault at Gregg followed by the loss of Helms – Gregg 230 kV DCTL and the loss of three Helms generation units under 2033 summer peak (Category “P7”)

Results: Stable and damped

Figure A4-Alt1A-9
Loss of Helms – Gregg 230 kV DCTL and three Helms generation units (Category “P7”)  
Alt-1: Upgrade the existing system without building new lines  
(2033 Summer Peak Base Case)
Figure A4-Alt1A-10
Loss of Helms – Gregg 230 kV DCTL and three Helms generation units (Category “P7”)
Alt-1: Upgrade the existing system without building new lines
(2033 Summer Peak Base Case)
Alt-2: Build Midway – E2 500 kV DCTL

Case 1: 3ph fault at E2 230kV followed by the loss of E2 - Gregg #1 230 kV Line (Category “B”)

Results: Stable and damped

Figure A4-Alt2-1
Loss of E2 - Gregg #1 230 kV Line (Category “B”)
Alt-2: Build Midway – E2 500 kV DCTL
(2033 Summer Peak Base Case)
Figure A4-Alt2-2
Loss of E2 - Gregg #1 230 kV Line (Category “B”)
Alt-2: Build Midway – E2 500 kV DCTL
(2033 Summer Peak Base Case)
Case 2: SLG fault at E2 500kV followed by the loss of Midway – E2 500 kV DCTL (Category “P7”)

Results: Stable and damped

Figure A4-Alt2-3
Loss of Midway – E2 500 kV DCTL (Category “P7”)
Alt-2: Build Midway – E2 500 kV DCTL
(2033 Summer Peak Base Case)
Figure A4-Alt2-4
Loss of Midway – E2 500 kV DCTL (Category “P7”)  
Alt-2: Build Midway – E2 500 kV DCTL  
(2033 Summer Peak Base Case)
Case 3: SLG fault at Gregg 230kV followed by the loss of E2-Gregg 230 kV DCTL (Category “P7”)

Results: Stable and damped

Figure A4-Alt2-5
Loss of E2 - Gregg 230 kV DCTL (Category “P7”)
Alt-2: Build Midway – E2 500 kV DCTL
(2033 Summer Peak Base Case)
Figure A4-Alt2-6
Loss of E2 - Gregg 230 kV DCTL (Category “P7”)
Alt-2: Build Midway – E2 500 kV DCTL
(2033 Summer Peak Base Case)
Case 4: SLG fault at E2 230kV followed by the loss of Helms-E2 230 kV DCTL and three Helms generation units (Category “P7”)

Results: Stable and damped

Figure A4-Alt2-7
Loss of E2 - Helms 230 kV DCTL and three Helms generation units (Category “P7”)
Alt-2: Build Midway – E2 500 kV DCTL
(2033 Summer Peak Base Case)
Figure A4-Alt2-8
Loss of E2 - Helms 230 kV DCTL and three Helms generation units (Category “P7”)
Alt-2: Build Midway – E2 500 kV DCTL
(2033 Summer Peak Base Case)
Alt-2a: Build Midway – E2 500 kV DCTL with S2 Loop-in

Case 1: 3ph fault at E2 230kV followed by the loss of E2 - Gregg #1 230 kV Line (Category “B”)

Results: Stable and damped

Figure A4-Alt2a-1
Loss of E2 - Gregg #1 230 kV Line (Category “B”)
Alt-2a: Build Midway – E2 500 kV DCTL with S2 Loop-in
(2033 Summer Peak Base Case)
Figure A4-Alt2a-2
Loss of E2 - Gregg #1 230 kV Line (Category “B”)
Alt-2a: Build Midway – E2 500 kV DCTL with S2 Loop-in
(2033 Summer Peak Base Case)
Case 2: SLG fault at E2 500kV followed by the loss of Midway – E2 and E2-S2 500 kV DCTL (Category “P7”)

Results: Stable and damped

Figure A4-Alt2a-3
Loss of Midway – E2 and E2-S2 500 kV DCTL (Category “P7”)
Alt-2a: Build Midway – E2 500 kV DCTL with S2 Loop-in
(2033 Summer Peak Base Case)
Figure A4-Alt2a-4
Loss of Midway – E2 and E2 - S2 500 kV DCTL (Category “P7”)
Alt-2a: Build Midway – E2 500 kV DCTL with S2 Loop-in
(2033 Summer Peak Base Case)
Case 3: SLG fault at Gregg 230kV followed by the loss of E2-Gregg 230 kV DCTL (Category “P7”)

Results: Stable and damped

Figure A4-Alt2-5
Loss of E2 - Gregg 230 kV DCTL (Category “P7”)
Alt-2a: Build Midway – E2 500 kV DCTL with S2 Loop-in
(2033 Summer Peak Base Case)
Figure A4-Alt2-6
Loss of E2 - Gregg 230 kV DCTL (Category “P7”)
Alt-2a: Build Midway – E2 500 kV DCTL with S2 Loop-in
(2033 Summer Peak Base Case)
Case 4: SLG fault at E2 230kV followed by the loss of Helms-E2 230 kV DCTL and three Helms generation units (Category “P7”)

Results: Stable and damped

Figure A4-Alt2-7
Loss of E2 - Helms 230 kV DCTL and three Helms generation units (Category “P7”)
Alt-2a: Build Midway – E2 500 kV DCTL with S2 Loop-in (2033 Summer Peak Base Case)
Figure A4-Alt2-8
Loss of E2 - Helms 230 kV DCTL and three Helms generation units (Category “P7”)
Alt-2a: Build Midway – E2 500 kV DCTL with S2 Loop-in
(2033 Summer Peak Base Case)
Alt-2b: Build Midway – E2 500kV DCTL, S2 and S3 Loop-in, and Whirlwind – S3 500 kV SCTL

Case 1: 3ph fault at E2 230kV followed by the loss of E2 - Gregg #1 230 kV Line (Category “B”)

Results: Stable and damped
Figure A4-Alt2b-2
Loss of E2 - Gregg #1 230 kV Line (Category “B”)
Alt-2b: Build Midway–E2 500 kV DCTL, S2&S3 Loop-in, Whirlwind-S3 500kV SCTL
(2033 Summer Peak Base Case)

C3ETP TRANSMISSION ASSESSMENT BASE CASE
2033SUMPK: COI=4800MW (n2s), P26=4000MW (n2s), SCCI=3100MW (n2s)
ALT-2B: MIDWAY-S3-S2-E2 500KV DCTL + S3-WHIRLWIND 500KV SCTL  TGRA ON
P1: LOSE GREGG - E2 230KV LINE; 3PH FAULT AT E2
FAULT ON E2 230 KV BUS

0.2 vt 30805 BORDEN 230.0 2 1 1.2
0.2 vt 30841 FIGRDN 1 230.0 1 1 1.2
0.2 vt 30850 ASHLAN 230.0 2 1 1.2
0.2 vt 34240 GLASS 70.0 1 1 1.2
0.2 vt 34252 MADERA 70.0 2 1 1.2
0.2 vt 34482 OLDKERN 70.0 1 1 1.2
Case 2: SLG fault at E2 500kV followed by the loss of E2-S2 and E2-S3 500 kV DCTL (Category “P7”)

Results: Stable and damped

Figure A4-Alt2b-3
Loss of E2-S2 and E2-S3 500 kV DCTL (Category “P7”)
Alt-2b: Build Midway–E2 500 kV DCTL, S2&S3 Loop-in, Whirlwind-S3 500kV SCTL (2033 Summer Peak Base Case)
Figure A4-Alt2b-4
Loss of E2-S2 and E2-S3 500 kV DCTL (Category “P7”)
Alt-2b: Build Midway–E2 500 kV DCTL, S2&S3 Loop-in, Whirlwind-S3 500kV SCTL
(2033 Summer Peak Base Case)
Case 3: SLG fault at Gregg 230kV followed by the loss of E2-Gregg 230 kV DCTL (Category “P7”)

Results: Stable and damped

Figure A4-Alt2b-5
Loss of E2 - Gregg 230 kV DCTL (Category “P7”)
Alt-2b: Build Midway–E2 500 kV DCTL, S2&S3 Loop-in, Whirlwind-S3 500kV SCTL (2033 Summer Peak Base Case)
Figure A4-Alt2b-6
Loss of E2 - Gregg 230 kV DCTL (Category “P7”)
Alt-2b: Build Midway–E2 500 kV DCTL, S2&S3 Loop-in, Whirlwind-S3 500kV SCTL
(2033 Summer Peak Base Case)
Case 4: SLG fault at E2 230kV followed by the loss of Helms-E2 230 kV DCTL and three Helms generation units (Category “P7”)

Results: Stable and damped

Figure A4-Alt2b-7
Loss of E2 - Helms 230 kV DCTL and three Helms generation units (Category “P7”)
Alt-2b: Build Midway–E2 500 kV DCTL, S2&S3 Loop-in, Whirlwind-S3 500kV SCTL (2033 Summer Peak Base Case)
Loss of E2 - Helms 230 kV DCTL and three Helms generation units (Category “P7”)

Alt-2b: Build Midway–E2 500 kV DCTL, S2&S3 Loop-in, Whirlwind-S3 500kV SCTL
(2033 Summer Peak Base Case)
Alt2d: Build Midway – Gregg 500 kV DCTL

Case 1: 3ph fault at Gregg 230kV followed by the loss of Helms - Gregg #1 230 kV Line and one Helms generation unit (Category “B”)

Results: Stable and damped
Figure A4-Alt2d-2
Loss of Gregg – Helms #1 230 kV Line and one Helms unit (Category “B”)
Alt-2: Build Midway – E2 500 kV DCTL
(2033 Summer Peak Base Case)
Case 2: SLG fault at Gregg followed by the loss of Midway – Gregg 500 kV DCTL (Category “P7”)

Results: Stable and damped

Figure A4-Alt2d-3
Loss of Midway – Gregg 500 kV DCTL (Category “P7”)
Alt2d: Build Midway – Gregg 500 kV DCTL
(2033 Summer Peak Base Case)
Figure A4-Alt2d-4
Loss of Midway – Gregg 500 kV DCTL
Alt2d: Build Midway – Gregg 500 kV DCTL
(2033 Summer Peak Base Case)
Case 3: SLG fault at Gregg 230kV followed by the loss of Helms - Gregg 230 kV DCTL and three Helms generation units (Category “P7”)

Results: Stable and damped

Figure A4-Alt2d-5
Loss of Helms-Gregg 230 kV DCTL and three Helms units (Category “P7”)
Alt2d: Build Midway – Gregg 500 kV DCTL
(2033 Summer Peak Base Case)
Figure A4-Alt2d-6
Loss of Helms-Gregg 230 kV DCTL and three Helms units (Category “P7”)
Alt2d: Build Midway – Gregg 500 kV DCTL
(2033 Summer Peak Base Case)
Alt3: Build Midway – E2 500 kV SCTL with S2 Loop-in

Case 1: 3ph fault at E2 230kV followed by the loss of Helms-E2 #1 230 kV Line and one Helms generation unit (Category “B”)

Results: Stable and damped

Figure A4-Alt3-1
Loss of Helms-E2 #1 230 kV Line and one Helms unit (Category “B”)

Alt-2: Build Midway – E2 500 kV SCTL with S2 Loop-in
(2033 Summer Peak Base Case)
Figure A4-Alt3-2
Loss of Helms-E2 #1 230 kV Line and one Helms unit (Category “B”)
Alt-3: Build Midway – E2 500 kV SCTL with S2 Loop-in
(2033 Summer Peak Base Case)
Case 2: 3ph fault at E2 500kV followed by the loss of E2 – S2 500 kV Line (Category “B”)

Results: Stable and damped

Figure A4-Alt3-3
Loss of E2 – S2 500 kV Line (Category “B”)
Alt-3: Build Midway – E2 500 kV SCTL with S2 Loop-in
(2033 Summer Peak Base Case)
Loss of E2 – S2 500 kV Line (Category “B”)
Alt-3: Build Midway – E2 500 kV SCTL with S2 Loop-in
(2033 Summer Peak Base Case)

Figure A4-Alt3-4

C3ETP TRANSMISSION ASSESSMENT BASE CASE
2033SUMPPK: COI=4800MW, P26=4000MW; PDCI=3000MW; HELMS=1200
ALT-3: MIDWAY-S2-E2 500KV SCTL TWRD ON
F1: LOSE E2 - S2 500KV LINE, 3PH FAULT AT E2;
FAULT ON E2 500 KV BUS
Case 3: SLG fault at Gregg 230kV followed by the loss of E2 - Gregg 230 kV DCTL (Category “P7”)  

Results: Stable and damped  

Figure A4-Alt3-5  
Loss of E2 - Gregg 230 kV DCTL (Category “P7”)  
Alt-3: Build Midway – E2 500 kV SCTL with S2 Loop-in  
(2033 Summer Peak Base Case)
Figure A4-Alt3-6
Loss of E2 - Gregg 230 kV DCTL (Category “P7”)
Alt-3: Build Midway – E2 500 kV SCTL with S2 Loop-in
(2033 Summer Peak Base Case)
Alt-4: Build E2 - Whirlwind 500 kV DCTL with S2 Loop-in

Case 1: 3ph fault at E2 230kV followed by the loss of Helms – E2 #1 230 kV Line and one Helms generation unit (Category “B”)

Results: Stable and damped.

Figure A4-Alt4-1
Loss of Helms – E2 #1 230kV line and one Helms generation unit (Category “B”)
Alt-4: Build E2-Whirlwind 500 kV DCTL with S2 Loop-in
(2033 Summer Peak Base Case)
Figure A4-Alt4-2
Loss of Helms – E2 #1 230kV line and one Helms generation unit (Category “B”)
Alt-4: Build E2-Whirlwind 500 kV DCTL with S2 Loop-in
(2033 Summer Peak Base Case)
Case 2: SLG fault at Gregg 230kV followed by the loss of E2 - Gregg 230 kV DCTL (Category “P7”)

Results: Stable and damped.

Figure A4-Alt4-3
Loss of E2 - Gregg 230kV DCTL (Category “P7”)
Alt-4: Build E2-Whirlwind 500 kV DCTL with S2 Loop-in
(2033 Summer Peak Base Case)
Figure A4-Alt4-4
Loss of E2 - Gregg 230kV DCTL (Category “P7”)
Alt-4: Build E2-Whirlwind 500 kV DCTL with S2 Loop-in
(2033 Summer Peak Base Case)
Case 3: SLG fault at E2 500kV followed by the loss of E2 - Whirlwind and E2-S2 500 kV DCTL (Category “P7”)

Results: Stable and damped.
Figure A4-Alt4-6
Loss of E2 - Whirlwind and E2-S2 500kV DCTL (Category “P7”)
Alt-4: Build E2-Whirlwind 500 kV DCTL with S2 Loop-in
(2033 Summer Peak Base Case)
Alt-5: Build Midway – E2 230 kV DCTL

Case 1: 3ph fault at E2 230kV followed by the loss of Helms – E2 #1 230 kV Line and one Helms generation unit (Category “B”)

Results: Transient voltage drop greater than 20% at many Fresno area load buses for more than 20 cycles that violate WECC transient voltage dip standard.

Figure A4-Alt5-1
Loss of Helms-E2 #1 230kV line and one Helms unit (Category “B”)
Alt-5: Build Midway – E2 230 kV DCTL
(2033 Summer Peak Base Case)
Figure A4-Alt5-2
Loss of Helms-E2 #1 230kV line and one Helms unit (Category “B”)
Alt-5: Build Midway – E2 230 kV DCTL
(2033 Summer Peak Base Case)

VD > 20% for more than 20 cycles
Case 1A: 3ph fault at E2 230kV followed by the loss of Helms – E2 #1 230 kV Line and one Helms generation unit (Category “B”). Install 400MVAR SVC at Gregg 230kV bus

Results: Stable and damped.

Figure A4-Alt5-3
Loss of Helms-E2 #1 230kV line and one Helms unit (Category “B”)
Alt-5: Build Midway – E2 230 kV DCTL; Install 400MVAR SVC at Gregg
(2033 Summer Peak Base Case)
Figure A4-Alt5-4
Loss of Helms-E2 #1 230kV line and one Helms unit (Category “B”)
Alt-5: Build Midway – E2 230 kV DCTL; Install 400MVAR SVC at Gregg
(2033 Summer Peak Base Case)
Case 2: 3ph fault at Gregg followed by the loss of Gates - Gregg 230 kV Line (Category “B”)

Results: First swing instability at Helms generators and many other local generators. Voltage instability triggers UVLS to drop non-consequential loads in the Greater Fresno area.

Figure A4-Alt5-5
Loss of Gates - Gregg 230kV line (Category “B”)
Alt-5: Build Midway – E2 230 kV DCTL
(2033 Summer Peak Base Case)
Figure A4-Alt5-6
Loss of Gates - Gregg 230kV line (Category “B”)
Alt-5: Build Midway – E2 230 kV DCTL
(2033 Summer Peak Base Case)
Case 2A: 3ph fault at Gregg followed by the loss of Gates - Gregg 230 kV Line (Category “B”), Install 400MVAR SVC at Gregg 230kV bus

Results: Stable and damped.

Figure A4-Alt5-7
Loss of Gates - Gregg 230kV line (Category “B”)
Alt-5: Build Midway – E2 230 kV DCTL; Install 400MVAR SVC at Gregg
(2033 Summer Peak Base Case)
Loss of Gates - Gregg 230kV line (Category “B”)

Alt-5: Build Midway – E2 230 kV DCTL; Install 400MVAR SVC at Gregg
(2033 Summer Peak Base Case)

0.2 vt 30805 BORDEN 230.0 2 1 1.2
0.2 vt 30841 FIGRDN 1 230.0 1 1 1.2
0.2 vt 30850 ASHLAN 230.0 1 1 1.2
0.2 vt 34237 CANANDGA 70.0 1 1 1.2
0.2 vt 34240 GLASS 70.0 1 1 1.2
0.2 vt 34252 MADERA 70.0 2 1 1.2
Alt-6: Build Fresno – Big Creek 230 kV Tie

Case 1: 3ph fault at E2 230kV followed by the loss of Helms – E2 #1 230 kV Line and one Helms generation unit (Category “B”)

Results: Not meet WECC Transient Voltage Dip Standards

Figure A4-Alt6-1
Loss of Helms-E2 #1 230kV line and one Helms generation unit (Category “B”)
Alt-6: Build Fresno – Big Creek 230 kV Tie
(2033 Summer Peak Base Case)
Figure A4-Alt6-2
Loss of Helms-E2 #1 230kV line and one Helms generation unit (Category “B”)
Alt-6: Build Fresno – Big Creek 230 kV Tie
(2033 Summer Peak Base Case)

VD > 20% at load bus for more than 20 cycles
Case 1A: 3ph fault at E2 230kV followed by the loss of Helms – E2 #1 230 kV Line and one Helms generation unit (Category “B”), Install 400MVAR SVC at Gregg 230kv bus.

Results: Stable and damped

Figure A4-Alt6-3
Loss of Helms-E2 #1 230kV line and one Helms generation unit (Category “B”)
Alt-6: Build Fresno – Big Creek 230 kV Tie; Install 400MVAR SVC at Gregg (2033 Summer Peak Base Case)
Figure A4-Alt6-4
Loss of Helms-E2 #1 230kV line and one Helms generation unit (Category “B”)
Alt-6: Build Fresno – Big Creek 230 kV Tie; Install 400MVAR SVC at Gregg
(2033 Summer Peak Base Case)
Case 2: 3ph fault at Gregg 230kV followed by the loss of Gates-Gregg 230 kV Line (Category “B”)

Results: Stable and damped.

Figure A4-Alt6-5
Loss of Gates - Gregg 230kV line (Category “B”)
Alt-6: Build Fresno – Big Creek 230 kV Tie
(2033 Summer Peak Base Case)
Figure A4-Alt6-6
Loss of Gates - Gregg 230kV line (Category “B”)
Alt-6: Build Fresno – Big Creek 230 kV Tie
(2033 Summer Peak Base Case)

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CSTP TRANSMISSION ASSESSMENT BASE CASE
2033SUMPK: COI=4800MW (n2s), P26=4000MW (n2s), SEC1=3100MW (n2s)
ALT-6: BIG CREEK 230KV TIE
FAULT ON GREGG 230KV BUS
Fault on GREGG 230 kV Bus
Case 3: 3ph fault at E2 230kV followed by the loss of E2 - Gregg 230 kV Line (Category “B”)

Results: First swing instability at Helms generators and SCE’s Big Creek area generators. Voltage instability triggers UVLS to drop non-consequential loads in the Greater Fresno area and SCE’s Big Creek area.

Figure A4-Alt6-7
Loss of E2 - Gregg 230kV #1 230 kV line (Category “B”)
Alt-6: Build Fresno – Big Creek 230 kV Tie
(2033 Summer Peak Base Case)
Figure A4-Alt6-8
Loss of E2 - Gregg 230kV #1 230 kV line (Category “B”)
Alt-6: Build Fresno – Big Creek 230 kV Tie
(2033 Summer Peak Base Case)
Case 3A: 3ph fault at E2 230kV followed by the loss of E2 - Gregg 230 kV Line (Category “B”); Install 400 MVAR SVC at Gregg 230kV bus

Results: Stable and damped.

Figure A4-Alt6-9
Loss of E2 - Gregg 230kV #1 230 kV line (Category “B”)
Alt-6: Build Fresno – Big Creek 230 kV Tie; Install 400MVAR SVC at Gregg (2033 Summer Peak Base Case)
Figure A4-Alt6-10
Loss of E2 - Gregg 230kV #1 230 kV line (Category “B”)
Alt-6: Build Fresno – Big Creek 230 kV Tie; Install 400MVAR SVC at Gregg
(2033 Summer Peak Base Case)

C3ETP TRANSMISSION ASSESSMENT BASE CASE
2033SUMPK: CO1=4800MW (n2a), P26=4000MW (n2a), PDC1=3100MW (n2a)
P1: LOSE GREGG - E2 230KV LINE; 3PH FAULT AT E2
FAULT ON E2 230 KV BUS

0.2 vt 24212 RCTOR 66.0 1 1 1.2
0.2 vt 24215 SPRINKVL 66.0 1 1 1.2
0.2 vt 30805 BORDEN 230.0 2 1 1.2
0.2 vt 30841 PYSHDN 1 230.0 1 1 1.2
0.2 vt 30850 ASHLAN 230.0 1 1 1.2
Alt-7: Build Midway – McCall 230 kV DCTL

Case 1: 3ph fault at Gregg followed by the loss of Gates - Gregg 230 kV Line (Category “B”)

Results: First swing instability at Helms generators and many other local generators. Voltage instability triggers UVLS to drop non-consequential loads in the Greater Fresno area.

Figure A4-Alt7-1
Loss of Gates - Gregg 230kV line (Category “B”)
Alt-7: Build Midway – McCall 230 kV DCTL
(2033 Summer Peak Base Case)
Figure A4-Alt7-2
Loss of Gates - Gregg 230kV line (Category “B”)
Alt-7: Build Midway – McCall 230 kV DCTL
(2033 Summer Peak Base Case)
Case 1A: 3ph fault at Gregg followed by the loss of Gates - Gregg 230 kV Line (Category “B”); Install 400 MVAR SVC at Gregg 230kV bus

Results: Stable and damped.

Figure A4-Alt7-3
Loss of Gates - Gregg 230kV line (Category “B”)
Alt-7: Build Midway – McCall 230 kV DCTL; 400MVAR SVC at Gregg
(2033 Summer Peak Base Case)
Figure A4-Alt7-4
Loss of Gates - Gregg 230kV line (Category “B”)
Alt-7: Build Midway – McCall 230 kV DCTL; 400MVAR SVC at Gregg
(2033 Summer Peak Base Case)
Figure A4-Alt7-5
Loss of Gates - Gregg 230kV line (Category “B”)
Alt-7: Build Midway – McCall 230 kV DCTL; 400MVAR SVC at Gregg
(2033 Summer Peak Base Case)
Case 2: 3ph fault at E2 followed by the loss of Helms – E2 #1 230 kV Line and one Helms generation unit (Category “B”)

Results: Stable and damped.

Figure A4-Alt7-6
Loss of Helms-E2 #1 230kV line and one Helms unit (Category “B”)
Alt-7: Build Midway – McCall 230 kV DCTL
(2033 Summer Peak Base Case)
Loss of Helms – E2 #1 230kV line and one Helms unit (Category “B”)
Alt-7: Build Midway – McCall 230 kV DCTL
(2033 Summer Peak Base Case)
Case 3: SLG fault at E2 followed by the loss of Helms – E2 1&2 230 kV DCTL and three Helms generation units (Category “P7”)

Results: Stable and damped.

Figure A4-Alt7-8
Loss of Helms-E2 1&2 230kV DCTL and three Helms unit (Category “P7”)
Alt-7: Build Midway – McCall 230 kV DCTL
(2033 Summer Peak Base Case)
Figure A4-Alt7-9
Loss of Helms-E2 1&2 230kV DCTL and three Helms unit (Category “P7”)
Alt-7: Build Midway – McCall 230 kV DCTL
(2033 Summer Peak Base Case)

0.2 vt 34610 HAAS 13.8 2 1 1.2
0.2 vt 34612 BLCH 2-2 13.8 1 1 1.2
0.2 vt 30805 BORDEN 230.0 2 1 1.2
0.2 vt 30841 PYSHDN 1 230.0 1 1 1.2
0.2 vt 30850 ASHLAN 230.0 1 1 1.2
0.2 vt 34252 MADERA 70.0 1 1 1.2
Alt-8: Build Gates – Gregg 230 kV DCTL

Case 1: 3ph fault at Gregg followed by the loss of Gates-Gregg 230 kV Line (Category “B”)

Results: Stable and damped.

Figure A4-Alt8-1
Loss of Gates - Gregg 230kV line (Category “B”)
Alt-8: Build Gates - Gregg 230 kV DCTL
(2033 Summer Peak Base Case)
Figure A4-Alt8-2
Loss of Gates - Gregg 230kV line (Category “B”)
Alt-8: Build Gates - Gregg 230 kV DCTL
(2033 Summer Peak Base Case)
Case 2: 3ph fault at Gregg followed by the loss of Helms - Gregg #1 230 kV Line and one Helms generation unit (Category “B”)

Results: Not meet WECC Transient Voltage Dip Standard.

Figure A4-Alt8-3
Loss of Helms-Gregg #1 230kV line and one Helms generation unit (Category “B”)
Alt-8: Build Gates - Gregg 230 kV DCTL
(2033 Summer Peak Base Case)
Figure A4-Alt8-4
Loss of Helms-Gregg #1 230kV line and one Helms generation unit (Category “B”)
Alt-8: Build Gates - Gregg 230 kV DCTL
(2033 Summer Peak Base Case)

VD > 20% at load bus for more than 20 cycles
Case 2A: 3ph fault at Gregg followed by the loss of Helms - Gregg #1 230 kV Line and one Helms generation unit (Category “B”); Install 400MVAR SVC at Gregg 230kV bus

Results: Stable and Damped.

Figure A4-Alt8-5
Loss of Helms-Gregg #1 230kV line and one Helms generation unit (Category “B”)
Alt-8: Build Gates - Gregg 230 kV DCTL; 400MVAR SVC at Gregg (2033 Summer Peak Base Case)
Figure A4-Alt8-6
Loss of Helms-Gregg #1 230kV line and one Helms generation unit (Category “B”)
Alt-8: Build Gates - Gregg 230 kV DCTL; 400MVAR SVC at Gregg
(2033 Summer Peak Base Case)
Case 3: SLG fault at Gregg followed by the loss of Helms - Gregg 1&2 230 kV DCTL and three Helms generation units (Category “P7”)

Results: Stable and damped.

Figure A4-Alt8-7
Loss of Helms-Gregg 1&2 230kV DCTL and three Helms units (Category “P7”)
Alt-8: Build Gates - Gregg 230 kV DCTL
(2033 Summer Peak Base Case)
Figure A4-Alt8-8
Loss of Helms-Gregg 1&2 230kV DCTL and three Helms units (Category “P7”)
Alt-8: Build Gates - Gregg 230 kV DCTL
(2033 Summer Peak Base Case)
**Alt-9: Build Raisin City Switching Station**

Case 1: 3ph fault at Gregg followed by the loss of Raisin City - Gregg 230 kV Line (Category “B”)

Results: First swing instability at Helms generators and many other local generators. Voltage instability triggers UVLS to drop non-consequential loads in the Greater Fresno area.

Figure A4-Alt9-1

Loss of Raisin City - Gregg 230kV DCTL (Category “B”)
Alt-9: Build Raisin City Switching Station
(2033 Summer Peak Base Case)
Figure A4-Alt9-2
Loss of Raisin City - Gregg 230kV DCTL (Category “B”)
Alt-9: Build Raisin City Switching Station
(2033 Summer Peak Base Case)
Case 1A: 3ph fault at Gregg followed by the loss of Raisin City - Gregg 230 kV Line (Category “B”); Install 400MVAR SVC at Gregg

Results: Stable and damped.

Figure A4-Alt9-3
Loss of Raisin City - Gregg 230kV DCTL (Category “B”)
Alt-9: Build Raisin City Switching Station; 400MVAR SVC at Gregg
(2033 Summer Peak Base Case)
Figure A4-Alt9-4
Loss of Raisin City - Gregg 230kV DCTL (Category “B”)
Alt-9: Build Raisin City Switching Station; 400MVAR SVC at Gregg
(2033 Summer Peak Base Case)
Figure A4-Alt9-5
Loss of Raisin City - Gregg 230kV DCTL (Category “B”)
Alt-9: Build Raisin City Switching Station; 400MVAR SVC at Gregg
(2033 Summer Peak Base Case)
Case 2: 3ph fault at Gregg 230kV bus followed by the loss of Helms – Gregg #1 230 kV line; Trip one Helms generation unit (Category “B”); Install 400 MVAR SVC at Gregg 230kV bus

Results: Transient voltage dip > 20% for more than 20 cycles at load bus which does not meet WECC transient voltage dip standards

Figure A4-Alt9-6
Loss of Helms – Gregg #1 230 kV line; Trip one Helms generator (Category “B”)
Alt-9: Build Raisin City Switching Station; 400MVAR SVC at Gregg
(2033 Summer Peak Base Case)
Figure A4-Alt9-7
Loss of Helms – Gregg #1 230 kV line; Trip one Helms generator (Category “B”)
Alt-9: Build Raisin City Switching Station; 400MVAR SVC at Gregg
(2033 Summer Peak Base Case)
Alt-10: Install 1,000 MW New Generation (3x200MW at McCall, 2x200MW at Borden)

Case 1: 3-ph fault at Gregg followed by the loss of Helms - Gregg #1 230 kV Line and one Helms generation unit (Category “B”)

Results: Stable and damped.

Figure A4-Alt10-1
Loss of Helms-Gregg #1 230kV line and one Helms generation unit (Category “B”)
Alt-10: Install 1,000 MW New Generation
(2033 Summer Peak Base Case)
Figure A4-Alt10-2
Loss of Helms - Gregg #1 230kV line and one Helms generation unit (Category “B”)  
Alt-10: Install 1,000 MW New Generation  
(2033 Summer Peak Base Case)
Case 2: SLG fault at Gregg followed by the loss of Helms - Gregg 1&2 230 kV DCTL and three Helms generation units (Category “P7”)

Results: Stable and damped.

Figure A4-Alt10-3
Loss of Helms - Gregg 1&2 230kV DCTL and three Helms units (Category “P7”)
Alt-10: Install 1,000 MW New Generation
(2033 Summer Peak Base Case)
Figure A4-Alt10-4
Loss of Helms - Gregg 1&2 230kV DCTL and three Helms units (Category “P7”)
Alt-10: Install 1,000 MW New Generation
(2033 Summer Peak Base Case)