Appendix A – WDT431

[redacted]

Final Report

November 12, 2010

This study has been completed in accordance with Southern California Edison Cluster Large Generator Interconnection Procedures (CLGIP) for Interconnection Requests in a Queue Cluster Window

Table of Contents

Attachments:

1. **Generator Machine Dynamic Data**
2. **Dynamic Stability Plots (see Appendix F of the Group Report)**
3. **SCE Interconnection Handbook**
4. **Short Circuit Calculation Study Results (see Appendix H of the Group Report)**
5. **Deliverability Assessment Results (see Appendix I of the Group Report)**
6. **Allocation of Network Upgrades for Cost Estimates**

1. Executive Summary

The Southern California Edison Company (SCE) received an interconnection request fro[redacted] for the interconnection of its [redacted] (Project), pursuant to the Cluster Large Generator Interconnection Procedures (CLGIP) under the SCE Wholesale Distribution Access Tariff (WDAT). The Project is a photovoltaic PV solar plant with an output of 100 MW to the Point of Interconnection (POI) which is at Southern California Edison Company's (SCE) Pearblossom – Vincent 220 kV T/L. The Interconnection Customer has requested Full Capacity deliverability status and Commercial Operation Date of [redacted] for the Project.

In accordance with Federal Energy Regulatory Commission (FERC) approved Cluster Large Generator Interconnection Procedures (CLGIP), SCE Transmission and Interconnection Planning has performed a Phase I Interconnection Study to determine the impacts of the group as well as impacts of the Project on the ISO controlled grid and SCE Distribution System.

The group report has been prepared separately identifying the combined impacts of all projects in the CAISO Generation Interconnection Queue Cluster 2 Phase I Study (QC2) group on the CAISO Controlled Grid. This report focuses only on the impacts of the Project.

The report provides the following:

1. Transmission and Distribution system impacts caused by the Project,

2. System reinforcements necessary to mitigate the adverse impacts caused by the Project under various system conditions,

3. A list of required facilities and a non-binding, good faith estimate of the Project's cost responsibility and time to construct these facilities.

The QC2 study has determined that the Project contributes to various reliability and/or deliverability problems for which mitigation plans have been proposed. These mitigation plans are detailed in Section 10 of this report.

The non-binding cost estimate of Interconnection Facilities[1] to interconnect the Project is approximately **$13,006,000** including ITCC[2]. The maximum cost responsibility for the SCE Network Upgrades[3] to interconnect the Project is **$3,697,000,** the cost of the SCE Non-Network Non-CAISO Transmission Upgrades[4] is **$76,492,000**, and the cost of the Distribution Upgrades[5] is **$0**. The maximum cost

[1] The transmission facilities necessary to physically and electrically interconnect the Project to the CAISO Controlled Grid at the point of interconnection.

[2] Income Tax Component of Contribution

[3] The SCE transmission facilities, other than Interconnection Facilities, beyond the point of interconnection necessary to physically and electrically interconnect the Project safely and reliably to the CAISO Controlled Grid

[4] Radial connected transmission facilities, other than Interconnection Facilities, beyond the point of interconnection necessary to physically and electrically interconnect the Project safely and reliably to the SCE Controlled Grid

[5] These upgrades are not identified in the ISO tariff, and are not reimbursable.

responsibility for the PG&E Network Upgrades[6] to interconnect the Project is **$2,304,000.**

The non-binding construction schedule to engineer and construct the facilities is approximately 84 months from the signing of the Large Generator Interconnection Agreement (LGIA).

2. Project and Interconnection Information

Table 2-1 provides general information about the Project.

Table 2-1: [redacted]

Project Location
SCE Planning Area
Number and Type of Generators
Interconnection Voltage
Maximum Generator Ou
Generator Auxiliary Loa
Maximum Net Output to
Power Factor Range
Step-up Transformer
Point of Interconnection
Commercial Operation D

Figure 2-1 provides the map for the Project and the transmission facilities in the vicinity. Figure 2-2 shows the conceptual single line diagram of the Project.

[6] The PG&E transmission facilities, other than Interconnection Facilities, beyond the point of interconnection necessary to physically and electrically interconnect the Project safely and reliably to the CAISO Controlled Grid

PAGES OMITTED FOR CEII REGULATIONS

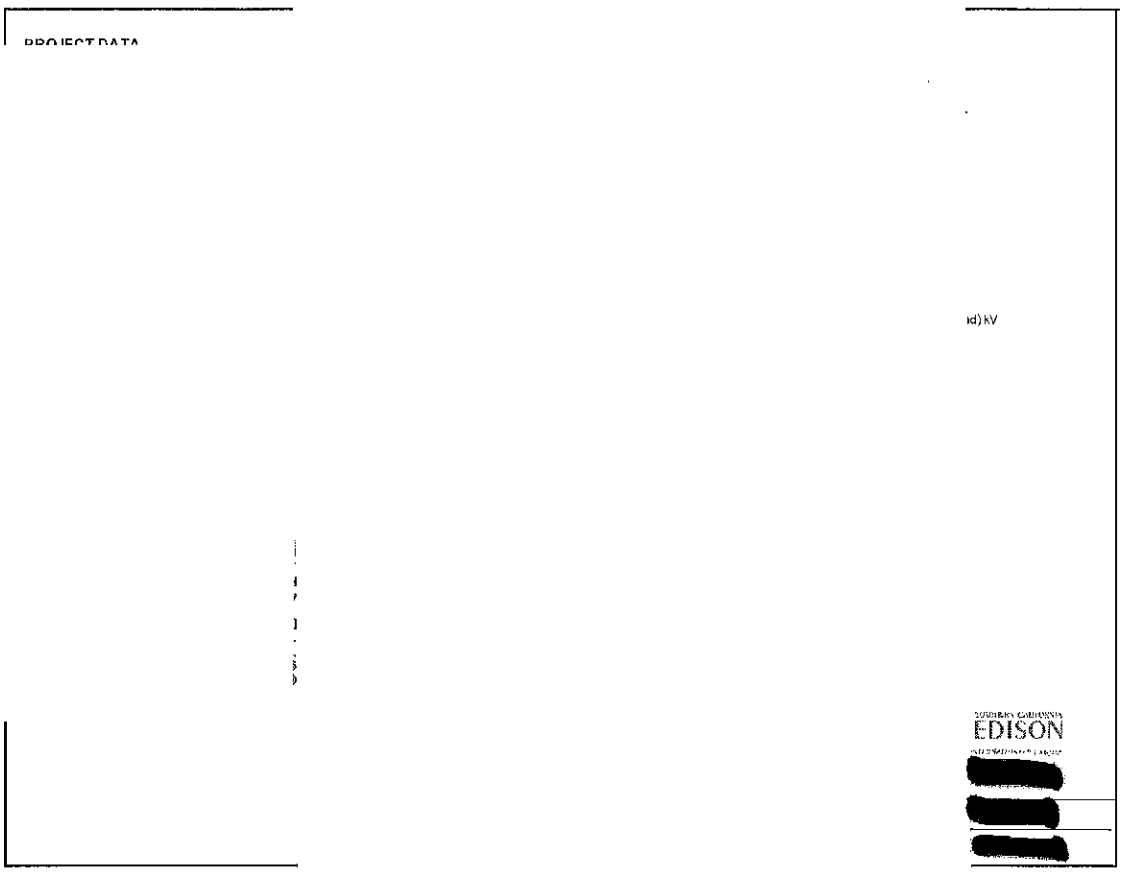

Figure 2-2: Proposed Single Line Diagram

3. Study Assumptions

For detailed assumptions, please refer to the main report. The following assumptions are only specific to the Project:

A. The following Facilities were estimated and are included in the Phase I Study:
   - The second telecommunications path from the generating facility to the SCE looped substation.
   - Loop in of the Pearblossom – Vincent 220 kV line.
   - SCE gen-tie line which will be one additional structure and a total of two spans (approximately 1000') of line to from the SCE interconnection facility (looped substation) to the project's last structure of their gen-tie line.
   - The required revenue metering cabinet and retail load meters to be installed at the generating facility.
   - The required remote terminal unit (RTU) to be installed at the generating facility.

B. The following facilities needed to support the 220 kV Gen Tie are to be installed by the Interconnection Customer and are not estimated or included in this Phase I Study:

- The project's gen tie line from the generating facility to the last structure outside the SCE looped substation property line. The 220 kV Gen Tie Line Right of Way should extend up to the edge of the SCE Substation Property Line.
- The project's gen tie line must be equipped with fiber optic cable to provide [redacted] telecommunication paths required for the line protection scheme.
- All required CAISO metering equipment at the generating facility.
- All required revenue metering equipment to meter the generating facility retail load will be specified by SCE and will be installed by the project on the project side of the gen-tie.
- The 220 kV gen tie line protection and SPS relays specified by SCE and installed at the generating facility.

4. Power Flow Analysis

The group study indicated that the Project contributes to the following transmission facility overloads or non-convergence problems. The details of the analysis and overload levels are provided in the group study.

Overloaded Transmission Facilities

Recommended Mitigations

- Midway-Whirlwind 500 kV T/L Loop in
- Kramer-Windhub 500 kV T/L
- Short-Circuit Duty Mitigations

See the Group report for additional details.

5. Short Circuit Analysis

Short circuit studies were performed to determine the fault duty impact of adding the QC1 projects to the transmission system and to ensure system coordination. The fault duties were calculated with and without the projects to identify any equipment overstress conditions. Once overstressed circuit breakers are identified, the fault current contribution from each individual project in QC2 is determined. Each project in QC2 will be responsible for its share of the upgrade cost based on the rules set forth in CAISO Tariff Appendix Y.

5.1 Short Circuit Study Input Data

The following input data provided by the Applicant of the Project was used in this study:

Satcon PowerGate Plus Inverter Short Circuit Data :

- Nominal output current: 2178 A (per phase)
- Maximum output fault current: 2614 A (per phase

Station Step-up Transformers (total of one)

This transformer is a three-phase 220/ 34.5/13.8 (assumed) kV (YG-D-YG) rated for 66/88/110 MVA OA/FA/FA @ 65 C temperature rise with the following impedance information:

- H-X Impedance Value: 8.0% @ 66 MVA
- H-Y Impedance Value: 12.4% @ 66 MVA
- X-Y Impedance Value: 2.8% @ 66 MVA

NOTE: The tertiary winding voltage value for the Main transformer was not provided by the IC.

Generation Tie Line

The generation tie line was assumed to be 0.3 miles of 556 ACSR Dove conductor.

5.2 Results

All bus locations where the QC2 Projects increase the short-circuit duty by 0.1 kA or more and where duty is in excess of 60% of the minimum breaker nameplate rating are listed in the Group Report Appendix H. These values have been used to determine if any equipment is overstressed as a result of the QC2 interconnections and corresponding network upgrades, if any.

The responsibility to finance short circuit related Reliability Network Upgrades identified through a Group Study shall be assigned to all Interconnection Requests in that Group Study pro rata on the basis of short circuit duty contribution of each Large Generating Facility.

As discussed in the Group Report, the QC2 breaker evaluation identified overstressed circuit breakers at the following buses. The pro-rata cost allocation for this project, based on SCD contribution at each location, is also provided:

- [redacted] 220 kV CBs at Serrano Substation (1.15%)

5.3 Preliminary Protection Requirements

Protection requirements are designed and intended to protect SCE's system only. The preliminary protection requirements were based upon the interconnection plan as shown in Figure 2-2.

The applicant is responsible for the protection of its own system and equipment and must meet the requirements in the SCE Interconnection Handbook provided in Attachment 3.

6. Reactive Power Deficiency Analysis

Reactive power deficiency analysis was performed in the group study. The reactive power deficiency analysis included power flow sensitivity analysis in the Northern Bulk System as well as reactive margin (QV) analysis on selected non-convergent cases from the power flow study. The analysis found that the QC2 Projects, including this Project, collectively contribute to severe reactive power deficiencies in the transmission system under base case and contingency conditions, and voltage criteria violations under contingency conditions.

In particular, the reactive power deficiency analysis confirmed that the non-convergence cases in the power flow analysis were real transmission system deficiencies due to the addition of QC2 projects – such as insufficient reactive margin – and not numerical solution problems. The study concluded that construction of

additional area export transmission facilities will be required. For additional details, see the group report. More detailed reactive power deficiency analysis will be performed as part of the Phase II study.

The Project will be required to operate in accordance with the requirements in SCE's Interconnection Handbook (see Attachment 3) to maintain voltage and power factor requirements. Also, the Project will be subjected to all other applicable SCE rules, and Federal Energy Regulatory Commission (FERC) approved rules, tariffs, and regulations.

7. Transient Stability Evaluation

Limited transient stability studies were conducted using full loop base cases to ensure that the transmission system remains in operating equilibrium, as well as operating in a coordinated fashion, through abnormal operating conditions after the QC2 projects begin operation. The generator dynamic data used in the study for the Project is shown in Attachment 1.

7.1 Transient Stability Study Scenarios

Disturbance simulations were performed for a study period of 10 seconds to determine whether the QC2 projects will create any system instability during a variety of line and generator outages. The most critical single contingency and double contingency outage conditions in the [redacted] were evaluated. For the list of specific line and generator outages evaluated, see the group report.

7.2 Results

In the stability analysis performed in the [redacted] with the addition of QC2 projects, transmission system stability problems under various N-1 and N-2 outage conditions were identified. The study concluded that additional area export transmission facilities would have a significant positive impact on system stability margins with the addition of QC2 projects. More detailed stability analysis will be performed as part of the Phase II study. Stability plots are shown in Appendix F of the group report.

8. Deliverability Assessment

8.1 On Peak Deliverability Assessment

CAISO performed an On-Peak Deliverability Assessment. No delivery upgrade is identified under the peak condition.

8.2 Off- Peak Deliverability Assessment

A modified version of the power flow 2014 Spring Off-Peak base case was created to perform the off-peak deliverability assessment of the QC2

projects. The assumptions to create this case are listed in the group study report. The following Delivery Upgrades are required for the Project:

- Windhub – Kramer 500kV line

For details of the off-peak deliverability assessment, please see Section 6 of the Group Report.

9. Environmental Evaluation/Permitting

Please see Section 12 of group report.

10. Upgrades, Cost Estimates and Construction schedule estimates

To determine the cost responsibility of each generation project in QC2, the CAISO developed cost allocation factors based on the individual contribution of each project (Attachment 6). The cost allocation for the Interconnection Facilities and Network Upgrades for which the Project is solely responsible is as follows:

PTO's INTERCONNECTION FACILITIES

1. **Transmission:**
   220 kV Generation Tie Line
   Insta[redacted] dead end structure and 1500' circuit feet of 2B-1590.

2. **Substation:**
   The Interconnection Facilities will be installed as follows:
   - [redacted] dead end structure
   - [redacted] 220 kV CCVTs
   - [redacted] Line Tie-Downs with 2-1590 kcmil ACSR conductors
   - Protection Relays

3. **Power System Controls**
   Install[redacted] at the generating facility substation to monitor typical generation elements such as MW, MVAR, terminal voltage and circuit breaker status at each generating unit and the plant auxiliary load and transmit this information to the SCE regional grid control center.

4. **Telecomm**
   Install approximately 10 miles of telecom between WDT431 and Palmdale Substation, and communication channels required for the customer interconnection.

5. **Corporate Environmental Health and Safety, Transmission Project & Licensing, and Real Properties**

Perform all required activities related to the interconnection facilities for the project.

6. **Metering Services Organization**
   Install a revenue metering cabinet and revenue meters required to meter the retail load at the generating facility.

PLAN OF SERVICE RELIABILITY NETWORK UPGRADES

No Plan of Service Reliability Network Upgrades were identified for this Project.

RELIABILITY NETWORK UPGRADES

Midway-Whirlwind 500 kV T/L Loop in (SCEand PG&E)
Loop the Midway-Whirlwind 500 kV T/L into the new Q582 Substation

Transmission Network Circuit Breaker Upgrades (SCD)
Upgrade transmission network circuit breakers (pro-rata share of upgrade based on project contribution to SCD at each location)

DELIVERY NETWORK UPGRADES

Kramer-Windhub 500 kV T/L
Install a new 45-mile 500 kV T/L between Kramer and Windhub Substations.

See the Group Report for additional details

DISTRIBUTION UPGRADES

No Distribution Upgrades were indentified for this Project.

NON-NETWORK, NON-CAISO UPGRADES

Transmission
220 kV Loop in (Non-Network, Non-CAISO Transmission Upgrade)
Install [redacted] single circuit dead end structures, [redacted] double circuit dead end structures, and 2500' circuit feet of 605 ACSR. Remove [redacted] existing structure.

Substation
Construct a 220 kV facility to loop the existing Pearblossom-Vincent 220 kV line and provide [redacted] line position to terminate the project gen-tie line.

Power Systems Control
Install [redacted] at the new tapped substation to monitor typical generation elements such as MW, MVAR, terminal voltage and circuit breaker status at each generating unit and the plant auxiliary load and transmit this information to

the SCE regional grid control center. (Non-Network, Non-CAISO Transmission Upgrade).

Telecomm
Install approximately 13.5 miles of fiber optic cable and communication channels between Pearblossom, Little Rock, and WDT 431 Substations for line protection and SCADA. (Non-Network, Non-CAISO Transmission Upgrade).

Corporate Environmental Health and Safety, Transmission Project & Licensing, and Real Properties
Perform all required activities related to the Non-Network, Non-CAISO Transmission Upgrade for the project.

Table 10.1: Upgrades, Estimated Costs, and Estimated Time to Construct Summary

Type of Upgrade	Upgrade (May include the following)	Description	Estimated Cost x 1000	Estimated Time to Construct *(Note 3)*
PTO's Interconnection Facilities *(Note 1)*	Subtransmission, Substations, Metering Services Organization, Power System Control	Non-network facilities needed to enable interconnection	$ 13,006	60 Months
Plan of Service Reliability Network Upgrades	N/A	Direct Assigned Network Upgrades needed to enable interconnection.	N/A	N/A
Reliability Network Upgrades	SPS, Substation, Telecommunications, Power System Control, Real Properties, Transmission Projects Licensing, and Environmental Health and Safety	Allocated Network Upgrades needed to maintain system Reliability	$ 2,466	48 Months
Delivery Network Upgrades	Transmission, Substations, Telecommunications, Real Properties, Transmission Projects Licensing, and Environmental Health and Safety	Network Upgrades needed to support Full Capacity interconnection status (Full Deliverability)	$1,230	84 Months
Distribution Upgrades *(Note 2)*	None	Non-CAISO SCE Distribution Facilities	N/A	N/A
Non-Network Non-CAISO Upgrades *(Note 2)*	Transmission, Substations, Power System Control, Telecommunications, Real Properties, Transmission Projects Licensing, and Environmental Health and Safety	Non-CAISO SCE Radial Connected Transmission Facilities	$76,492	60 Months
Total SCE Allocated Cost			**$ 93,195**	**84 Months**
PG&E Reliability Network Upgrades	Transmission, Substation	Allocated PG&E Network upgrades needed to maintain system Reliability	$2,304	36 Months
Total PG&E Allocated Cost			**$2,304**	**36 Months**

Note 1: The Interconnection Customer is obligated to fund these upgrades and will not be reimbursed.

Note 2: These upgrades are not identified in the ISO tariff, and are not reimbursable. Allocated costs may change if all projects responsible for these upgrades do not execute LGIAs.

Note 3: The estimated time to construct (ETC) is for a typical project; schedules duration may change due to number of projects approved and release dates. Stacked projects impact resources, system outage availability, and environmental windows of construction. Assumption is SCE will need to obtain CPUC licensing and regulatory approvals prior to design, procurement and construction of the proposed facilities required to serve the interconnection customer and prerequisite facilities are in service.

11. Items not covered in this study

11.1 Conceptual Plan of Service
The results provided in this study are based on conceptual engineering and a preliminary plan of service and are not sufficient for permitting of facilities. The Plan of Service is subject to change as part of the Phase II Interconnection Study.

11.2 Customer's Technical Data
Additional technical data related to the Interconnection Customer's project may be required as part of the Phase II Study. The study accuracy and results for the Phase I Study are contingent upon the accuracy of the technical data provided by the Interconnection Customer. Any changes from the data provided could void the Study results.

11.3 Study Impacts on Neighboring Utilities
Results or consequences of this Phase I Study and/or to-be-performed Phase II Interconnection Study may require additional studies, facility additions, and/or operating procedures to address impacts to neighboring utilities and/or regional forums. For example, impacts may include but are not limited to WECC Path Ratings, short circuit duties outside of the CAISO Controlled Grid, and sub-synchronous resonance (SSR).

11.4 Use of SCE Facilities
The Interconnection Customer is responsible for acquiring all property rights necessary for the Interconnection Customer's Interconnection Facilities, including those required to cross SCE facilities and property. This Interconnection Study does not include the method or estimated cost to the Interconnection Customer of SCE mitigation measures that may be required to accommodate any proposed crossing of SCE facilities with Interconnection Customer's Interconnection Facilities. The use of SCE property rights shall only be permitted upon written agreement between SCE and the Interconnection Customer at SCE's sole determination. Any proposed use of SCE property rights may require a separate study and/or evaluation, at the Interconnection Customer's expense, to determine whether such use may be accommodated.

11.5 SCE Interconnection Handbook
The Interconnection Customer shall be required to adhere to all applicable requirements in the SCE Interconnection Handbook. These include, but are not limited to, all applicable protection, voltage regulation, VAR correction, harmonics, switching and tagging, and metering requirements.

11.6 Western Electricity Coordinating Council (WECC) Policies
The Interconnection Customer shall be required to adhere to all applicable WECC policies including, but not limited to, the WECC Generating Unit Model Validation Policy.

11.7 System Protection Coordination
Adequate Protection coordination will be required between SCE-owned protection and Interconnection Customer-owned protection. If adequate protection coordination cannot be achieved, then modifications to the Interconnection Customer-owned facilities (i.e.,

Generation-tie or Substation modifications) may be required to allow for ample protection coordination

11.8 Standby Power and Temporary Construction Power

The QC2 Study does not address any requirements for standby power or temporary construction power that the Project may require prior to the in-service date of the Interconnection Facilities. Should the Project require standby power or temporary construction power from SCE prior to the in-service date of the Interconnection Facilities, the IC is responsible to make appropriate arrangements with SCE to receive and pay for such retail.

11.9 Construction Schedule

The estimated time to construct (ETC) is for a typical project; schedules and duration may change due to number of projects approved and release dates. Stacked projects impact resources, system outage availability, and environmental windows of construction. The assumption is that SCE will need to obtain CPUC licensing and regulatory approvals prior to design, procurement and construction of the proposed facilities required to serve the interconnection customer and prerequisite facilities are in service.

11.10 Network/Non-Network Classification of Telecommunication Facilities

The cost for telecommunication facilities that were identified as part of the IC's Interconnection Facilities was based on an assumption that these facilities would be sited, licensed, and constructed by SCE as opposed to the IC doing this work (IC may own, operate, maintain, and construct diverse telecommunication paths associated with the IC's gen tie, excluding terminal equipment at both ends). In addition, the telecommunication requirements for SPS were assumed based on tripping of the generator breaker as opposed to tripping the circuit breakers at the SCE substation. Due to uncertainties related to telecommunication upgrades for the numerous projects in queue ahead of QC2, telecommunication upgrades for higher queued projects were not considered in this study. Depending on the outcome of interconnection studies for higher queued projects, the telecommunication upgrades identified for QC2 may be reduced. Any changes in these assumptions may affect the cost and schedule for the identified telecommunication facilities.

Attachment 1

Attachment 2

Dynamic Stability Plots

Please refer to Appendix F of the Group Report.

Attachment 3

SCE Interconnection Handbook

Preliminary Protection Requirements for Interconnection Facilities are outlined in the SCE Interconnection Handbook.

Attachment 4

Short Circuit Calculation Study Results

Please refer to Appendix H of the Group Report.

Attachment 5

Deliverability Assessment Results

Please refer to the Appendix I of the group report.

Attachment 6

Allocation of Network Upgrades for Cost Estimates

Upgrades	Type	Needed For	Total Cost ($1000)	Cost Share	Allocated Cost ($1000)
ıop C582 into Midway - Whirlwind No. (SCE Portion)	Reliability	Balancing Path 26 line flows and mitigate Antelope - Vincent N-2 voltage collapse	$24,770	3.7%	$917
indhub - Kramer 500kV line	Delivery	Increasing area export capability limited by voltage collapse under Vincent - Lugo N-2 outage condition	$472,799	0.26%	$1,230
ıop C582 into Midway - Whirlwind No. (PG&E Portion)	Reliability	Balancing Path 26 line flows and mitigate Antelope - Vincent N-2 voltage collapse	$62,200	3.7%	$2,304
ɛrrano 220kV bus split	Reliability	Short Circuit Duty mitigation	$134,670	1.15%	$1,549
ɔtal					$6,000