Appendix A – WDT425

[redacted]

Final Report

November 12, 2010

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

Table of Contents

1. Executive Summary 1
2. Project and Interconnection Information 2
3. Study Assumptions 4
4. Power Flow Analysis 5
   - 4.1 Distribution Analysis 5
   - 4.2 Transmission System Analysis 5
5. Voltage Control 6

   Distribution 6
6. Short Circuit Analysis 6
   - 6.1 Short Circuit Study Input Data 6
   - 6.2 Results 7
   - 6.3 Preliminary Protection Requirements 7
7. Reactive Power Deficiency Analysis 7
8. Transient Stability Evaluation 8
   - 8.1 Transient Stability Study Scenarios 8
   - 8.2 Results 8
9. Deliverability Assessment 9
   - 9.1 On Peak Deliverability Assessment 9
   - 9.2 Off- Peak Deliverability Assessment 9
10. Environmental Evaluation/Permitting 9
11. Upgrades, Cost Estimates and Construction schedule estimates 9
12. Study Caveats 14

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

On January 29, 2010, the Southern California Edison Company ("SCE") received an interconnection request from [redacted] Systems 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 plant with an output of 60 MW to the requested Point of Interconnection (POI) on Southern California Edison Company's (SCE) Borel – Isabella – KR 3 – Lakegen – Weldon 66 kV line. The Interconnection Customer's requested Full Capacity deliverability status and Commercial Operation Date of December 31, 2012.

In accordance with Federal Energy Regulatory Commission (FERC) approved Cluster Large Generator Interconnection Procedures (CLGIP, the Project was grouped with CAISO Generation Interconnection Queue Cluster 2 projects in a Phase I Interconnection Study (QC2) to determine the impacts of the group as well as impacts of the Project on the CAISO Controlled Grid and SCE's Distribution System.

The group report has been prepared separately identifying the combined impacts of all projects in the group on the CAISO Controlled Grid. This individual report focuses only on the impacts associated with 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 (a) the Project's cost responsibility, and (b) the time required to permit, engineer, design, procure and construct these facilities.

The [redacted] 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 11 of this report.

The non-binding cost estimate of Interconnection Facilities[1] to interconnect the Project is approximately **$1,822,000** including ITCC[2]. The maximum cost responsibility for the SCE Network Upgrades[3] to interconnect the Project is **$563,000** and the cost of the SCE Distribution Upgrades[4] is **$527,148,000**. 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] These upgrades are not part of the ISO Controlled Grid, and are not reimbursable.

responsibility for the PG&E Network Upgrades[5] to interconnect the Project is **$1,382,000.**

The non-binding construction schedule to engineer and construct the facilities is approximately 48 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 as modeled in the [redacted] Study.

Table 2-1: [redacted]

Project Location	[redacted]
SCE Planning Area	[redacted]
Number and Type of Generators	[redacted]
Interconnection Voltage	[redacted]
Maximum Generator Output	[redacted]
Generator Auxiliary Load	[redacted]
Maximum Net Output to Grid	[redacted]
Power Factor Range	[redacted]
Step-up Transformer	[redacted]
Point of Interconnection	[redacted]
Commercial Operation Date	[redacted]

Figure 2-1 provides the map for the Project and the distribution facilities in the vicinity.

Figure 2-1 : Map of the Project

[5] 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

3. Study Assumptions

For detailed assumptions, please refer to the main report. The following assumptions are only specific to the [redacted]

A. The following Facilities were estimated and included in th[redacted]

- Tap line to connect the new tapped substation to the new Isabella – Weldon 66 kV 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.
- Isabella Substation upgrade requirements.

B. The following facilities are to be installed by the Interconnection Customer and <u>are not</u> included in this [redacted] Study:

- Conduit for control wiring between the IC's substation and the SCE substation.
- 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 line protection relays, to be installed at the generating facility, will be specified by SCE and provided by the generator.

4. Power Flow Analysis

The group study indicated that the Project is contributing to overloading of the transmission facilities. The details of the analysis and overload levels are provided in the group study.

4.1 Distribution Analysis

4.2 Transmission System 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. The Project was allocated cost for the following mitigations.

4.2.1 Recommended Mitigations

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

See the Group report for additional details.

5. Voltage Control

Distribution

The total generation ([redacted]) output and total VAR production of generation facility [redacted] will not affect local subtransmission and distribution voltages. 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.

6. Short Circuit Analysis

Short circuit studies were performed to determine the fault duty impact of adding the [redacted] 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 [redacted] 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.

6.1 Short Circuit Study Input Data

The following input data provided by the IC was used in this study:

Inverter Generator Short Circuit Data @ 100 MVA Base:

Positive Sequence subtransient reactance (X"1)	= 0.8328 p.u.
Negative Sequence subtransient reactance (X"2)	= 0.8328 p.u.
Zero Sequence subtransient reactance (X"0)	= 0.8328 p.u.

Station Step-up Transformers

1. [redacted]-phase 0.265/34.5 kV rated for 1.0 MVA OA @ 65 degree C temperature rise with an H-X impedance of 5.75% at 1.0 MVA base.

2. [redacted]-phase 34.5/66 kV rated for 36.0/48.0/60.0 MVA OA @ 65 degree C temperature rise with an H-X impedance of 9.0% at 32.4 MVA base, H-Y impedance of 15.0% at 32.4 MVA base, X-Y impedance of 18.0% at 32.4 MVA base.

6.2 Results

All bus locations where the [redacted] 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 [redacted] 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 [redacted] 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]

6.3 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.

7. 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 [redacted] as well as reactive margin (QV) analysis on selected non-convergent cases from the power flow study. The analysis found that the [redacted] 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 o[redacted]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.

8. 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[redacted]projects begin operation. The generator dynamic data used in the study for the Project is shown in Attachment 1.

8.1 Transient Stability Study Scenarios

Disturbance simulations were performed for a study period of 10 seconds to determine whether the[redacted]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.

8.2 Results

In the stability analysis performed in the [redacted]with the addition of [redacted]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[redacted]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.

9. Deliverability Assessment

9.1 On Peak Deliverability Assessment

CAISO performed an On-Peak Deliverability Assessment. The Project does not contribute to any of the delivery problems identified.

9.2 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 [redacted] projects. The Project does not contribute to any of the delivery problems identified.

10. Environmental Evaluation/Permitting

See Section 12 of the Group Report.

11. Upgrades, Cost Estimates and Construction schedule estimates

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

INTERCONNECTION FACILITIES

A. Sub - Transmission:
WDT425 66 kV Generation Tie Line
Install approximately 250 circuit feet of 954 SAC conductor and one engineered, bolted footing steel pole.

B. Substation:
Tapped Substation
Construct a single circuit breaker 66 kV tapped substation to terminate the new WDT425 66 kV gen tie line.

The Interconnection Facilities will be installed as follows:

- [redacted]dead-end structure
- [redacted]of 1200A disconnect switches
- [redacted]kV surge arrestors
- [redacted]Relay
- [redacted]Relay
- [redacted]Relays
- [redacted]voltage transformers

- [redacted] 9" Racks
- [redacted] of control cable

C. Power System Controls
Install one RTU 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.

D. Telecommunications

E. Corporate Environmental Health and Safety, Transmission Project & Licensing, and Real Properties
Perform all required activities related to the interconnection facilities for the project.

F. 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 have been allocated to the Project.

20

DISTRIBUTION UPGRADES

The addition of the Project triggers a violation of a subtransmission criteria, which limits the number of terminal points on a subtransmission line. In order to interconnect the Project, the violation must be mitigated. The proposed mitigation requires

reconfiguring the Borel-Isabella-Kern River #3-Lakegen-Weldon 66kV subtransmission line into three separate lines that loop into Isabella Substation. To accommodate this reconfiguration and meet the current standards, the 66kV rack at Isabella Substation must also be rebuilt.

A. Sub - Transmission:

WDT425 Tap Line

Install approximately 800 circuit feet of SAC conductor, two engineered, bolted footing steel poles, three light weight steel poles, three center break switches, and 5000' of fault return conductor. Remove three wood poles and re-arrange conductor to accommodate the installation of the new substation.

Isabella Substation Loop ins

The following scope of work is specified for looping the Borel-Isabella-Kern River #3-Lakegen-Weldon 66kV subtransmission line into Isabella Substation as three lines:

- Borel-Isabella 66kV Line
- Isabella-Kern River #3-Lakegen 66kV Line
- Isabella-Weldon 66kV Line

Install approximately 2500 circuit feet of 954 SAC conductor, five engineered, bolted footing steel poles, four light weight steel poles, and 3000' of fault return conductor. Remove four pole switches and seven wood poles. Re-arrange conductor to accommodate the new configuration.

Line Reconductoring

Reconductor 1.2 miles of the Vestal – Kern River No. 3 66 kV line
Reconductor 12.5 miles of Kern River No. 3 – Lakegen leg of Borel – Isabella – Weldon 66 kV line.
Reconductor 43.9 miles of the Vestal – Kern River No. 3 66 kV line
Reconductor 44.7 miles of the Vestal – Glenville – Greenhorn – Kern River No. 3 66 kV line.

B. Substation:

Tapped Substation

- [redacted]dead-end structures
- [redacted]CB rated
- [redacted]sets disconnect switches
- MEER

Isabella Substation

- Construct an Operating/Transfer bus
- Equ[redacted]positions

Borel Powerhouse

Install the following relays:

- [redacted]
- [redacted]

Kern River 3 Powerhouse

Install the following relays:

- [redacted]
- [redacted]

C. Power System Controls

Install one RTU 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.

Install one RTU at Isabella 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.

D. Telecomm

Install approximately 36 miles of fiber and communication channels between Kern River #3, Borel, Isabella, and WDT 425 Substations for line protection and SCADA.

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

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

Table 11.1: 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)*	Transmission, Substations, Metering Services Organization, Power System Control, Telecommunications, Real Properties, Transmission Projects Licensing, and Environmental Health and Safety	Non-network facilities needed to enable interconnection	$1,822	48 Months
Plan of Service Reliability Network Upgrades	None	Direct Assigned Network Upgrades needed to enable interconnection.	N/A	N/A
Reliability Network Upgrades	Transmission, Substations	Allocated Network Upgrades needed to maintain system Reliability	$563	48 Months
Delivery Network Upgrades	None	Network Upgrades needed to support Full Capacity interconnection status (Full Deliverability)	N/A	N/A
Distribution Upgrades *(Note 2)*	Transmission, Substations, Power System Control, Telecommunications, Real Properties, Transmission Projects Licensing, and Environmental Health and Safety	Non-CAISO SCE Distribution Facilities	$527,148	48 Months
Total SCE Allocated Cost			**$529,533**	**48 Months**
PG&E Reliability Network Upgrades	Transmission, Substations	Allocated PG&E Network upgrades needed to maintain system Reliability	$1,382	36 Months
Total PG&E Allocated Cost			**$1,382**	**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.

12. Study Caveats

12.1 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.

12.2 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 [redacted] 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.

12.3 Study Impacts on Neighboring Utilities
Results or consequences of this [redacted] 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).

12.4 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.

12.5 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.

12.6 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.

12.7 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

12.8 Standby Power and Temporary Construction Power

The [redacted] 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.

12.9 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 [redacted] 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 [redacted] may be reduced. Any changes in these assumptions may affect the cost and schedule for the identified telecommunication facilities.

Attachment 1

Generator Machine Dynamic Data

Attachment 2

Dynamic Stability Plots

Attachment 3

SCE Interconnection Handbook

Attachment 4

Short Circuit Calculation Study Results

Attachment 5

Deliverability Assessment Results

Please refer to 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)
Loop C582 into Midway - Whirlwind No. 3 (SCE Portion)	Reliability	[redacted]	$24,770	2.22%	$550
Loop C582 into Midway - Whirlwind No. 3 (PG&E Portion)	Reliability	[redacted]	$62,200	2.22%	$1,382
Serrano 220kV bus split	Reliability	[redacted]	$134,670	0.01%	$13
Total					$1,946