Appendix A – WDT343

[redacted]

Final Report

May 14, 2010

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

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1. Executive Summary

On July 31, 2009, the Southern California Edison Company (SCE) received an interconnection request from [redacted] for the interconnection of its [redacted] pursuant to the Cluster Large Generator Interconnection Procedures (CLGIP) under the SCE Wholesale Distribution Access Tariff (WDAT). The [redacted] is a photovoltaic PV solar plant with an output of 100 MW to the primary Point of Interconnection (POI) which is at Southern California Edison Company's (SCE) [redacted]. As discussed in the scoping meeting, SCE, and [redacted] decided that the [redacted] would be evaluated interconnecting at the proposed new SCE [redacted] since the [redacted] cannot be directly tapped to the 115 kV T/L. To provide this interconnection, the In-Service date of SCE's planned distribution substation [redacted] will need to be advanced. The method of service for serving this new substation consists of looping the [redacted]. This new 115 kV substation will become the physical interconnection point for the [redacted]. The customer requested Commercial Operation Date of the [redacted] is June 15, 2012.

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 [redacted] 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 Queue Cluster 1 Phase I Study (QC1) group on the CAISO Controlled Grid. This report focuses only on the impacts of the [redacted]

The report provides the following:

1. Transmission and Distribution system impacts caused by the [redacted]
2. System reinforcements necessary to mitigate the adverse impacts caused by the [redacted] under various system conditions,
3. A list of required facilities and a non-binding, good faith estimate of the [redacted] cost responsibility and time to construct these facilities.

The Phase I Study has determined that the [redacted] contributes to the overloading of transmission facilities for which mitigation plans have been proposed. These mitigation plans include the use of congestion management for base case overloads and Special Protection System (SPS) to trip the [redacted] under identified contingency outage conditions.

In addition, the [redacted] may also be partly responsible for overstressing circuit breakers at the Pisgah 220 kV[1], Whirlwind 220 kV, Vista 115 kV, and Highgrove 115 kV buses.

The [redacted] did not violate any parts of voltage criteria and hence caused no adverse voltage impacts on the grid. Also, the [redacted] did not significantly impact the transmission system's transient stability performance following selected contingencies. However, more detailed voltage impact and transient stability performance analysis will be performed as part of the Phase II study.

The non-binding cost estimate of Interconnection Facilities[2] to interconnect the [redacted] is **$ 39,736,000** including ITCC[3]. The maximum cost responsibility for the Network Upgrades[4] to interconnect the [redacted] is **$ 852,000**, and the cost of the Distribution Upgrades[5] is **$ 7,000**.

The non-binding construction schedule to engineer and construct the facilities is approximately 36 months from the signing of the Cluster Large Generator Interconnection Agreement (CLGIA).

2. Project and Interconnection Information

Table 2-1 provides general information about the [redacted]

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]

[1] Identification of facility voltages (220 kV) in this Phase I Study are shown consistent with SCE System Operating Bulletin 123. However, all studies were predicated on the base voltages reflected in the Western Electricity Coordinating Council (WECC) base cases. For the SCE bulk power system, the WECC base cases reflect 230 kV and 500 kV base voltages; consequently, all per-unit calculations presented were based on 230 kV and 500 kV voltages.

[2] The transmission facilities necessary to physically and electrically interconnect the Project to SCE's Distribution System.

[3] Income Tax Component of Contribution

[4] The additions, modifications, and upgrades to the CAISO Controlled Grid required at or beyond the Point of Interconnection to accommodate the interconnection of the Generating Facility to the CAISO Controlled Grid. Network Upgrades shall consist of Delivery Network Upgrades and Reliability Network Upgrades. Network Upgrades do not include Distribution Upgrades.

[5] These upgrades are not identified in ISO tariff, and need to be negotiated between the IC and the PTO

Step-up Transformer	[redacted]
Point of Interconnection	[redacted]
Commercial Operation Date	[redacted]

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

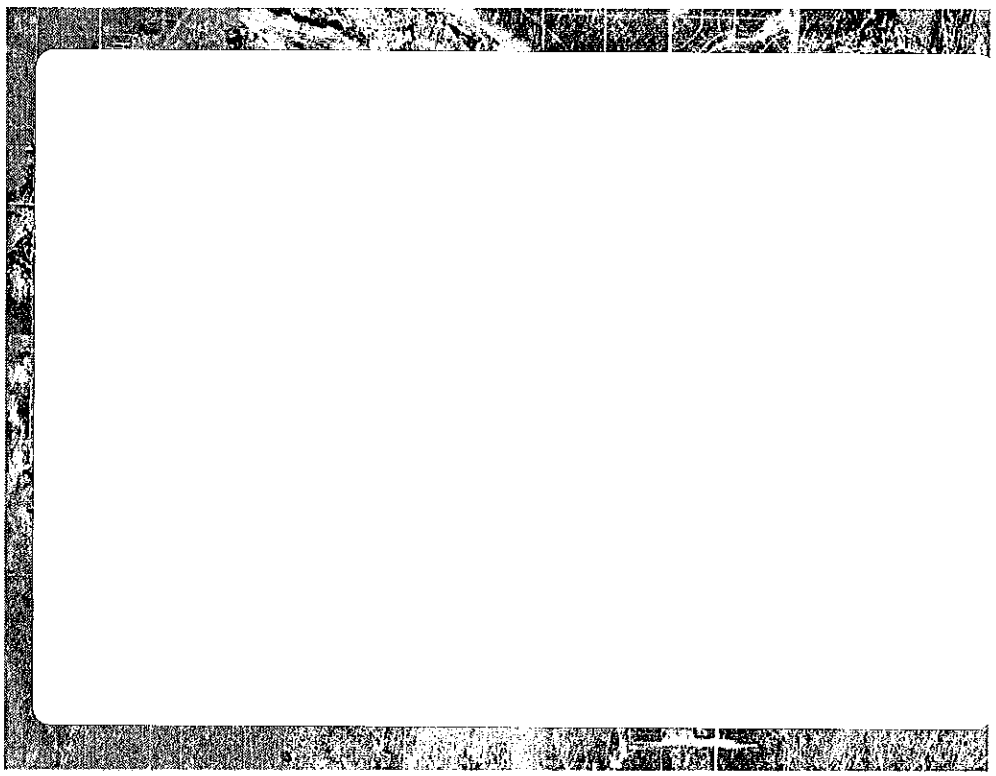

Figure 2-1 : Map of the [redacted]

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 [redacted]

A. The following Facilities were estimated and are included in the Phase I Study:
   - A portion of the existing Victor-Phelan 115 kV T/L between Victor Substation and proposed Winton Substation must be re-built to a double-circuit structure with both sides strung with 954 SAC conductor to mitigate line overloads.
   - One of two telecommunication paths from the generating facility to the proposed Winton Substation will be installed by SCE.
   - It is assumed SCE would be required to install one additional Dead-End Structure and a total of two spans of line to reach the proposed 115 kV line position at Winton Substation.
   - The required revenue metering cabinet and retail load meters to be installed at the generating facility will be installed by SCE.
   - The required remote terminal unit (RTU) to be installed at the generating facility will be installed by SCE.

B. The following facilities needed to support the 115 kV Gen Tie are to be installed by the Interconnection Customer and <u>are not</u> estimated or included in this Phase I Study:

- Winton Substation is currently planned with an operating date of 2017. However, this date is subject to change as load demands change. The cost of Winton Substation is estimated to be $25,000,000. The cost to the [redacted] to accelerate the construction of Winton is not included in this study. A Phase II study will further evaluate the feasibility and cost implications of advancing Winton Substation.
- The [redacted] tie line from the generating facility to the last structure outside the proposed SCE Winton Substation property line will be installed by [redacted] gen tie line right of way should extend up to the edge of the SCE Winton Substation property line.
- The [redacted] gen tie line must be equipped with optical ground wire (OPGW) to provide [redacted] telecommunication paths required for the line protection scheme and the Special Protection System (SPS).
- All required revenue metering equipment to meter the generating facility retail load will be specified by SCE and installed by the customer at their end of the VSO 115 kV gen tie line.
- The following 115 kV gen tie line protection to be installed at the generating facility will be specified by SCE and provided by the customer and [redacted] included in the Phase I Study. The interconnection customer and SCE will coordinate protection facilities after the completion of the Phase II Interconnection Study.
  - [redacted] current differential relay with dual dedicated digital communication channels to Winton Substation.
  - [redacted] current differential relay with dual dedicated digital communication channels to Winton Substation.
  - [redacted] relays (one each for SPS A and B) to trip the main generator breaker

4. Power Flow Analysis

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

4.1 Overloaded Transmission Facilities

Category "A"

[redacted]

Category "B"

[redacted]

Category "C"

[redacted]

4.2 Power Flow Non-Convergence

There were no non-convergence issues identified with this project.

4.3 Recommended Mitigations

A combination of congestion management for base case overloads and SPS to trip the [redacted] under identified contingency outage conditions is required to mitigate the power flow impacts of the [redacted] described above. See the group report for additional details.

The scope and pro rata share of the cost for this mitigation assigned to the [redacted] is as follows:

Install SPS to trip [redacted] under the 1) [redacted]

Cost allocation is 100%.

5. Short Circuit Analysis

Short circuit studies were performed to determine the fault duty impact of adding the QC 1 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 QC 1 is determined. Each project in QC1 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 [redacted] was used in this study:

Satcon Inverter Short Circuit Data @ 1 MVA Base:

- Positive Sequence subtransient reactance (X"1) = ∞ p.u.
- Negative Sequence subtransient reactance (X"2) = ∞ p.u.

- Zero Sequence subtransient reactance (X"0) = ∞ p.u.

Station Step-up Transformers (total of two)

- This transformer is a three-phase 115/34.5/Buried kV rated for 110 MVA OA/FA/FA @ 65 degree C temperature rise with 8/12.4/2.8% impedance on a 66 MVA base

Generation Tie Line

The generation tie line was assumed to be 8.5 miles of 556 ACSR Dove conductor.

5.2 Results

All bus locations where the QC1 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 QC1 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 QC1 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:

- Pisgah 220 kV – 2.19%
- Whirlwind 220 kV – 0.02%
- Vista 115 kV – 0.12%
- Highgrove 115 kV – 0.05%

In order to mitigate single line to ground (SLG) short circuit duty (SCD) issues, QC 1 generation projects may be required to install transformers that limit each project's contribution to SLG SCD on the SCE system. This may be accomplished by installing transformers with delta-connected high side windings or with "impedance-grounded" wye-connected high side windings. These requirements will be further evaluated as part of the Phase II Study.

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

Limited reactive power deficiency analysis was performed. The power flow studies for Category "B" and Category "C" contingencies indicated that the [redacted] did not cause voltage drops of 5% or more from the pre-project levels, or cause the SCE system to fail to meet applicable voltage criteria. The [redacted] therefore, did not cause any adverse voltage impacts on the CAISO Controlled Grid. More detailed reactive power deficiency analysis will need to be performed as part of the Phase II Study.

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 QC 1 projects begin operation. The generator dynamic data used in the study for the [redacted] 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 QC 1 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 Lugo Hub area within the overall greate[redacted] were evaluated. For the list of specific line and generator outages evaluated, see the group report.

7.2 Results

Limited stability analysis was performed for the [redacted] to identify "relative" as opposed to "absolute" conclusions regarding the stability impacts of this QC 1 Phase 1 queued generation project.

In the limited stability analysis performed in the 500 kV, 220 kV and 115 kV systems with the upgrades in place to mitigate base case and outage related overload problems, no significant transmission system stability problems relative to existing stability criteria were identified. The study concluded that the [redacted] would not cause the transmission system to go unstable under Category "B" and Category "C" outages. More

detailed stability analysis will need to 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. The power flow study results for Category "A", "B", and "C" are detailed in Attachment 5.

9. Environmental Evaluation/Permitting

The Licensing, Permitting, and Environmental activities associated with the siting and construction of electric facilities 50kV and greater are discussed in Section 12 of the Group Report.

10. Upgrades, Cost Estimates and Construction schedule estimates

To determine the cost responsibility of each generation project in QC 1, 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 [redacted] is solely responsible is as follows:

PTO's INTERCONNECTION FACILITIES

1. **Sub - Transmission:**
   [redacted] **Tie Line**
   Install [redacted] 54 SAC conductor, insulators, line hardware and shield wire to make the connection between the new substation rack and the generator's last transmission structure.

2. **Substation:**
   Winton Substation
   Install a dedicated single circuit breaker 115 kV line position to terminate the new [redacted] gen tie line.

   The interconnection facilities will be installed as follows:
   - [redacted] dead-end structure
   - [redacted] 115 kV circuit breaker
   - [redacted] A disconnects
   - [redacted] CCVTs
   - [redacted] ine current differential
   - [redacted] line current differential relay
   - Appropriate SPS Relays

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

The customer will provide the required metering equipment (voltage and current transformers).

4. **Power System Control**
Install one RTU at the generating facility 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.

5. **Real Properties, Transmission Project Licensing, and Environmental Health and Safety**
Obtain easements and/or acquire land, obtain licensing and permits, and perform all required environmental activities for the installation of the SCE portion of the [redacted] gen tie line.

PLAN OF SERVICE RELIABILITY NETWORK UPGRADES

No Plan of Service Reliability Network upgrades identified.

RELIABILITY NETWORK UPGRADES

1. **SPS**

Trip the [redacted] to eliminate overloading the Lugo – [redacted] 220 kV T/Ls under one of the following contingencies:

- N – [redacted]
- N [redacted]
- N - [redacted]

2. **Transmission Network Circuit Breaker Upgrades**

Upgrade the following transmission network circuit breakers (pro-rata share of upgrade based on project contribution to SCD at each location)

- Pisg[redacted]
- Whirlwind [redacted]

DELIVERY NETWORK UPGRADES

No Delivery Network upgrades identified.

DISTRIBUTION UPGRADES

1. **Victor-Winton No.1 and No.2 115 kV T/L (approximately 5 miles)**
Re-build portion of the existing [redacted]15 kV T/L to double circuit structures with 954 SAC between the [redacted] and proposed Winton Substation.

2. **SPS**
Trip the [redacted] to eliminate overloading the [redacted] 15 [redacted] th [redacted] 15 [redacted]

3. **Distribution Circuit Breaker Upgrades**
Upgrade the following distribution circuit breakers (pro-rata share of upgrade based on project contribution to SCD at each location)
   - Highgrove [redacted]
   - [redacted]

4. **Real Properties, Transmission Project Licensing, and Environmental Health and Safety**
Obtain easements and/or acquire land, obtain licensing and permits and perform all required environmental activities for the installation of new double-circuit 115 kV T/L, advancement of the proposed Winton Substation, and new telecommunication facilities to support the SPS.

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

Type of Upgrade	Upgrade (May include the following)	Description	Cost Allocation Factor	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	100%	$ 39,736	24 Months
Plan of Service Reliability Network Upgrades	N/A	Direct Assigned Network upgrades needed to enable interconnection.	100%	$ 0	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	Multiple (See Sections 4 and 5)	$ 852	24 Months
Delivery Network Upgrades	N/A	Network upgrades needed to support Full Delivery, if requested	Multiple(See Section 8)	$ 0	N/A
Distribution Upgrades *(Note 2)*	Dsitribution Circuit Breakers, Subtransmission Line, Substation, Telecommunications, Power System Control, Real Properties, Transmission Projects Licensing, and Environmental Health and Safety	Non-CAISO SCE Distribution Facilities	Multiple (See Section 5)	$ 7	36 Months
Total				**$ 40,595**	**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 ISO tariff, and need to be negotiated between the IC and the PTO

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. 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 Phase 1 Study does not address any requirements for standby power or temporary construction power that the [redacted] may require.

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 Phase I Study assumes that all telecommunication facilities required to implement an SPS for generators interconnecting to the CAISO controlled system will be classified as Reliability Network Upgrades. Actual classification of each telecommunication component may change depending on final SPS design, consistent with FERC definitions of network facilities and non-network facilities. This will be further evaluated as part of the Phase II Study.

PAGES OMITTED FOR CEII REGULATIONS

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)
SPS tripping WDAT 343	Reliability	[redacted]	$776	100.0%	$776
Whirlwind [redacted]	Reliability	[redacted]	$2,471	0.02%	$0.49
Pisgah [redacted]	Reliability	[redacted]	$3,424	2.2%	$75