# Appendix A – WDT400

[redacted]

[redacted] Phase II Final Report

August 25, 2011

This study has been completed in coordination with Southern California Edison Generator Interconnection Procedures 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 (CAISO)
6. Allocation of Network Upgrades for Cost Estimates

## 1. Executive Summary

[redacted] has submitted a completed Interconnection Request (IR) to the Southern California Edison Company (SCE) for their proposed [redacted] (Project) under SCE's Wholesale Distribution Access Tariff (WDAT). The Project is an existing Energy Only wind generation power plant with an output of 30 MW with a Point of Interconnection (POI) on Southern California Edison Company's existing [redacted] 115 kV Substation. The Interconnection Customer's requested Commercial Operation Date of the Project is April 1, 2012.

Pursuant to the Generator Interconnection Procedures (GIP) Cluster Study process under the SCE WDAT, the Project was grouped with the [redacted] and Queue [redacted] Phase II Study (Phase II) projects to determine the impacts of the group as well as impacts of the Project on SCE's distribution system and the CAISO Controlled Grid.

The group report has been prepared separately identifying the combined impacts of all projects in the group on the CAISO Controlled Grid. This report focuses on the impacts of this Project.

The report provides the following:

1. Transmission 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 Phase II 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 **$0** including ITCC[2]. The maximum cost responsibility for the SCE Network Upgrades[3] to interconnect the Project is **$15,000** and the cost of the SCE Distribution Upgrades[4] is **$0.**

The estimated costs above have been provided in 2011 constant dollars. Table 11.1 provides the estimated costs escalated to the estimated Operating Date year of the upgrade, which would be the basis for the ICs financial responsibilities.

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[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. The ITCC included in this cost estimate was computed using a 35% rate. Due to the enactment of H.R. 4853, the Tax Relief, Unemployment Insurance Reauthorization and Job Creation Act of 2010, and upon formal acceptance by the CPUC of SCE's advice letter (filed on December 27, 2010), this rate may change for electric CIAC recorded or received after September 8, 2010 through December 31, 2011.

[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 reimbursable.

The non-binding schedule to license, engineer, and construct the facilities is approximately 24 months from the signing of the Generator Interconnection Agreement (GIA).

## 2. Project and Interconnection Information

Table 2-1 provides general information about the Project as shown in the customer's IR.

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 Regulation Range | [redacted] |
| Step-up Transformer(s) | [redacted] **Individual Padmount Transformer(s) Data (x15):** [redacted] |
| Point of Interconnection | [redacted] |
| Commercial Operation Date | [redacted] |

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 as modeled in the study.

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## 3. Study Assumptions

For detailed assumptions, please refer to the Group Report. [redacted] is a turbine replacement project of an existing generation unit at SCE's Pan Aero Substation.

## 4. Power Flow Analysis

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

### 4.1 Overloaded Transmission Facilities

**Category "A"**

[redacted]

**Category "B"**

- None

**Category "C"**

- None

### 4.2 Power Flow Non-Convergence

There were no non-convergence issues identified by the addition of this project with all proposed system upgrades.

### 4.3 Recommended Mitigations

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

The scope of the mitigations assigned to the Project are as follows:
(Refer to Section 11 for a brief description of the upgrades)

**Reliability Network Upgrades**

- Short Circuit Duty (SCD) Mitigation

**Delivery Network Upgrades**

- None

**Distribution Upgrades**

- None

## 5. Short Circuit Analysis

Short circuit studies were performed to determine the fault duty impact of adding the Phase II 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 Phase II is determined. Each project in Phase II 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:

Short Circuit Data @ 35.25 MVA Base:

- Positive Sequence subtransient reactance (X"1) = 0.131 p.u.
- Negative Sequence subtransient reactance (X"2) = 0.131p.u.
- Zero Sequence subtransient reactance (X"0) Infinity

Generation Step-up Transformer(s)

**Main Transformer Data (total of one):**

One transformer, three-phase 115/34.5 kV (D-YG) rated for 20/26.7/33.3 MVA with the following impedance information:

- H-X Impedance Value: 8 % @ 30 MVA

**Individual Padmount Transformer Data (total of 15):**

Each transformer is three-phase 34.5/0.69 kV (D-Y) rated for 2.35 MVA with the following impedance information:

- H-X Impedance Value: 11.6 % @ 2.35 MVA

## 5.2 Results

All bus locations where the Phase II 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 Phase II 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 Generating Facility. In addition, the SCD impact of the associated proposed Network Upgrades was allocated to each Generating Facility using the same percentage assigned for the triggered Network Upgrade.

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

- Upgrade [redacted] circuit breakers at Vincent Substation
- Upgrade [redacted] circuit breakers at Lugo Substation
- Split the 66 kV bus at Windhub Substation

**Table 5.1 SCD Allocation**

| Project Name | Vincent | | Lugo | | Windhub (Reliability) | | Total |
|---|---|---|---|---|---|---|---|
| | % Allocated | Cost (x1,000) | % Allocated | Cost (x1,000) | % Allocated | Cost (x1,000) | (x1,000) |
| WDT400 | 0.1 | $ 11 | 0.1 | $ 4 | 0 | $ - | $ 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

Limited reactive power deficiency analysis was performed. In the base case study, serious voltage and VAR issues were identified based on system VAR requirements for power flow convergence. Specifically, with addition o[redacted] projects, the following VAR support is proposed:

- One [redacted] shunt Capacitor is needed at [redacted] kV bus to maintain minimum base case voltage a[redacted]
- One [redacted] shunt Capacitor is needed at [redacted] 500 kV bus to compensate for the VAR losses on the AA - Banks
- [redacted] shunt Capacitors are needed at [redacted] 220 kV bus to maintain operating voltages.

With all proposed system upgrades listed above and in Section 4.3, the power flow studies for Category "B" and Category "C" contingencies indicated that this Phase II project 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. This project, therefore, did not cause any adverse voltage impacts on the CAISO Controlled Grid with the proposed upgrades in place.

This Project did not cause any post-transient violations with all proposed system upgrades.

## 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 Phase II Cluster 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 Phase II Cluster 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 Phase II Cluster projects and 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 Project would not cause the transmission system to go unstable under Category "B" and Category "C" outages. For a more detailed discussion on the stability analysis see the group report. Stability plots are shown in Appendix F of the group report.

# 8. Deliverability Assessment

There is no deliverability assessment required for the Energy Only project.

# 9. Operational Studies

## 9.1 IC Proposed Project Timelines

The latest information provided by the IC has indicated that the proposed Commercial Operation Date is April 1, 2012.

## 9.2 System Upgrade Timelines

The Operational Studies identified that the following facilities are required in order to provide for Energy Only interconnection:

### 9.2.1 PTO's Interconnection Facilities

See Section 11

### 9.2.2 Plan of Service Reliability Network Upgrades

See Section 11

### 9.2.3 Reliability Network Upgrades

#### 9.2.3.1 Special Protection System (SPS)

None

#### 9.2.3.2 Short-Circuit Duty (SCD) Mitigation

The circuit breaker upgrades that were triggered by queued-ahead projects are identified in Section 4.6 of the group report. The Operational Study undertaken as part of this Phase II Study identified the required timing for circuit breaker upgrades triggered by queued-ahead generation projects. Timing for breaker upgrades at each of the substations identified as queued ahead is shown below in Table 9.2.1:

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#### 9.2.3.3 Reactive Support Upgrades

None

#### 9.2.3.4 Subtransmission Upgrades

None

### 9.2.4 Distribution Upgrades

None

### 9.2.5 Other Energy Only Operational Issues

None

## 9.3 System Upgrades Required for Full Capacity Service

Not Applicable – This project requested Energy Only service.

## 9.4 Conclusion

The requested generator In-Service date of August 1, 2012 can be met since the timing of need for the allocated Reliability Network Upgrades is beyond the requested in-service date.

# 10. Environmental Evaluation/Permitting

Please see Section 12 of group report.

# 11. Upgrades, Cost Estimates and Construction schedule estimates

To determine the cost responsibility of each generation project in Phase II, 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**

There were no Interconnection Facilities costs allocated to the Project.

**PLAN OF SERVICE RELIABILITY NETWORK UPGRADES**

There were no Plan of Service Reliability Network Upgrade costs allocated to the Project.

## RELIABILITY NETWORK UPGRADES

**Short Circuit Duty (SCD) Mitigation:**
Upgrade transmission network circuit breakers (pro-rata share of upgrade based on project contribution to SCD at each location).

Vincent Substation
Upgrade [redacted] circuit breakers.

Lugo Substation
Upgrade [redacted] circuit breakers.

See the Group Report for additional details.

## DELIVERY NETWORK UPGRADES

There were no Delivery Network Upgrade costs allocated to the Project.

## DISTRIBUTION UPGRADES

There were no Distribution Upgrade costs allocated to the Project.

## Table 11.1: Upgrades, Estimated Costs, and Estimated Time to Construct Summary

Each Upgrade category may contain multiple scope durations. The longest duration is shown under the Estimated Time to Construct.

| Type of Upgrade | Upgrade (May include the following) | Description | Estimated Cost x 1,000 Constant Dollar (2011) *(Note 4)* | Estimated Cost x 1,000 Constant Dollar (OD Year) *(Note 4)* | | Estimated Time to Construct *(Note 3)* |
|---|---|---|---|---|---|---|
| **PTO's Interconnection Facilities** *(Note 1)* | See Section 11 - PTO'S Interconnection Facilities | Non-network facilities needed to enable interconnection | $0 | $0 | - | 0 Months |
| **Plan of Service Reliability Network Upgrades** | See Section 11 – Plan of Service Reliability Network Upgrades | Direct Assigned Network Upgrades needed to enable interconnection. | $0 | $0 | - | 0 Months |
| **Reliability Network Upgrades** | See Section 11 - Reliability Network Upgrades in the Eastern Group Report | Allocated Network Upgrades needed to maintain system Reliability | $0 | $0 | - | 0 Months |
| **Reliability Network Upgrades** | See Section 11 - Reliability Network Upgrades (SCD) in the Eastern Group Report | SCD Mitigation Allocated to maintain system Reliability | $15 | $17 | 2014 | 24 Months |
| **Delivery Network Upgrades** | See Section 11 - Delivery Network Upgrades in the Eastern Group Report | Network Upgrades needed to support Full Delivery, if requested | $0 | $0 | - | 0 Months |
| **Distribution Upgrades** *(Note 2)* | See Section 11 – Appendix A | Non-CAISO SCE Distribution Facilities | $0 | $0 | - | 0 Months |
| **Total Cost** | | | **$15** | | | **24 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.*

*Note 4: SCE's Phase II cost estimating is done in 'constant' dollars 2011 and then escalated to the estimated O.D.year. For the Phase II study, the estimated O.D. is derived by assuming the duration of the work element will begin approximately in January 2012, which is roughly the CAISO tariff scheduled completion date of the Phase II study plus 90 days for the LGIA signing period. For instance, if a work element is estimated to take a total of 24 months (permitting, design, procurement, and construction), then the estimated O.D. would be January 2014. If an IC's requested O.D.(in- service) is beyond the estimated O.D. of a work element, the IC's requested O.D. is used.*

## 12. Items Not Covered In This Study

### 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

The study accuracy and results for the Phase II 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 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 Relocations and Other Use of SCE Facilities

The Interconnection Customer is responsible for all costs associated with necessary relocation of any SCE facilities as a result of this project and acquiring all property rights necessary for the Interconnection Customer's Interconnection Facilities, including those required to cross SCE facilities and property. The relocation of SCE facilities or use of SCE property rights shall only be permitted upon written agreement between SCE and the Interconnection Customer. Any proposed relocation of SCE facilities or use of SCE property rights may require a separate study and/or evaluation to determine whether such use may be accommodated, and any associated cost would be non-refundable.

### 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 18.

### 12.8 Standby Power and Temporary Construction Power

The Phase II 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 service.

### 12.9 Construction Schedule

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.

### 9.1 Telecommunication Assumptions

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 Phase II, 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 Phase II may be reduced. Any changes in these assumptions may affect the cost and schedule for the identified telecommunication facilities.

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## 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.

## (This will be included in the final report)

## Attachment 4

## Short Circuit Calculation Study Results

Please refer to the Appendix H of the Group report.