

[REDACTED]

*WDAT 884 ISP*

*WDAT  
INDEPENDENT SYSTEM IMPACT STUDY*

*June 15, 2012*



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## EXECUTIVE SUMMARY

[REDACTED] applied to Southern California Edison ("SCE") for interconnection and wholesale distribution service for its proposed Solar Project pursuant to SCE's Wholesale Distribution Access Tariff ("WDAT") Generation Interconnection Procedures. SCE performed an Independent System Impact Study as requested by [REDACTED] for a 12 kV interconnection and distribution service from an existing 12 kV distribution line ("Minotaur 12 kV"). The interconnection is an applicant owned 12 kV switchgear which will be located approximately 0.65 miles from San Bernardino Substation, connected to a 12 kV circuit out of SCE's San Bernardino 66/12 kV Substation. The request is for a WDAT photovoltaic ("PV") generation facility with a total capacity of 5.0 MW. The initial request is for service to commence by March 1, 2013<sup>1</sup>.

The new generation, consisting of photovoltaic panels [REDACTED] 500 kW Satcon inverters, and [REDACTED] 500 kVA 0.208/12 kV transformers would receive interconnection service from SCE's existing Minotaur 12 kV out of San Bernardino Substation via an underground line extension to the applicant owned 12 kV switchgear. The generated power would be delivered to the California Independent System Operator ("CAISO") grid at the 220 kV bus of SCE's San Bernardino Substation.

The purpose of this Independent System Impact Study is to determine the effect of the proposed generation addition on the SCE distribution system and the portion of SCE's electrical system that is part of the CAISO controlled grid, and to identify in general additional Interconnection Facilities, Distribution Upgrades, additions or modifications, or other facilities required to provide the requested service. The study was performed in two parts: Part A (performed by SCE's Distribution Field Engineering department) examines impacts related to that part of the SCE distribution system energized at less than 66 kV and also briefly summarizes the results of Part B, while Part B (performed by SCE's Generation Interconnection Planning department) examines impacts and facilities related to the portion of the SCE electrical system energized at 220 kV and above (the bulk power system), and impacts and facilities associated with the CAISO controlled portion of the SCE grid. This is the Part A study report; a detailed report of the Part B study results is included as Attachment B.

The Part A study was performed for expected year 2012 through 2021 projected peak load conditions as well as 2012 through 2021 minimum load conditions.

The Part A Independent System Impact Study consisted of a power flow analysis, three-phase short circuit duty analysis based on most current thevenin equivalents and circuit voltage profile analysis. The analyses were performed to determine whether the energy associated with the [REDACTED] Project can be transmitted through SCE's distribution system to the ISO grid at the 220 kV bus of San Bernardino Substation, without creating the need for modifications to SCE's distribution system and/or to the ISO grid. The study showed that, with the [REDACTED] Project on-line:

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<sup>1</sup> Date as requested in the application. Actual operating date depends on design, procurement, and construction requirements. Interconnection Studies will ultimately determine in-service date.

- For both peak load and light load conditions, the addition of the 5.0 MW [REDACTED] Project resulted in no violations of SCE's thermal loading criteria under base case and N-1 conditions for the SCE distribution System.
- The addition of the 5.0 MW [REDACTED] Project resulted in minimal voltage rise not exceeding allowable Rule 2 limits.
- The addition of the 5.0 MW [REDACTED] Project resulted in the increase of three-phase short-circuit duties at [REDACTED] distribution substation. The circuit breaker interrupting capabilities were reviewed at these substation and it was determined that [REDACTED] circuit breakers will be required to be upgraded based on most current thevenin equivalents. The final results and financial responsibilities will be determined on the Cluster study process in accordance to the WDAT ISP study procedures.
- Since the project is connecting on the SCE distribution system and the project consist of inverter facilities which have limited short-circuit duty contribution, the SCD analysis determined no impact on SCE's high-voltage bulk power system after inclusion of the project.
- This project individually will not contribute to any power flow issues in the Metro Area bulk system. The existing system has sufficient transmission capability to accommodate the project without any significant upgrades or modification to existing Special Protection System (SPS).

- Non-binding order of magnitude cost estimates for the required interconnection facilities and system upgrades are as follows:

<b><u>Interconnection Facilities/Automation</u></b>	\$72.0 K
○ Approximately 250 feet of primary cable (350 JCN)	
○ Remote Control Switch	
○ 12 kV Metering, CTs, PTs, and associated wiring	
<b><u>Telemetry Requirements</u></b>	\$5.0 K
○ Power system controls (PSC)	
○ Telecom facilities	
<b><u>Distribution Upgrades Subject – New Installation</u></b>	\$219.0 K
○ Approximately 1300 feet of new primary underground cable (350 JCN)	
○ 4-Way Padmounted Gas Switch	
○ Automatic Recloser	
○ Addition of Watt and VAR data points to RTU	
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ITCC (35%)	\$0.0K
Total non-binding order of magnitude cost estimate	<b><u>\$296 K<sup>2</sup></u></b>

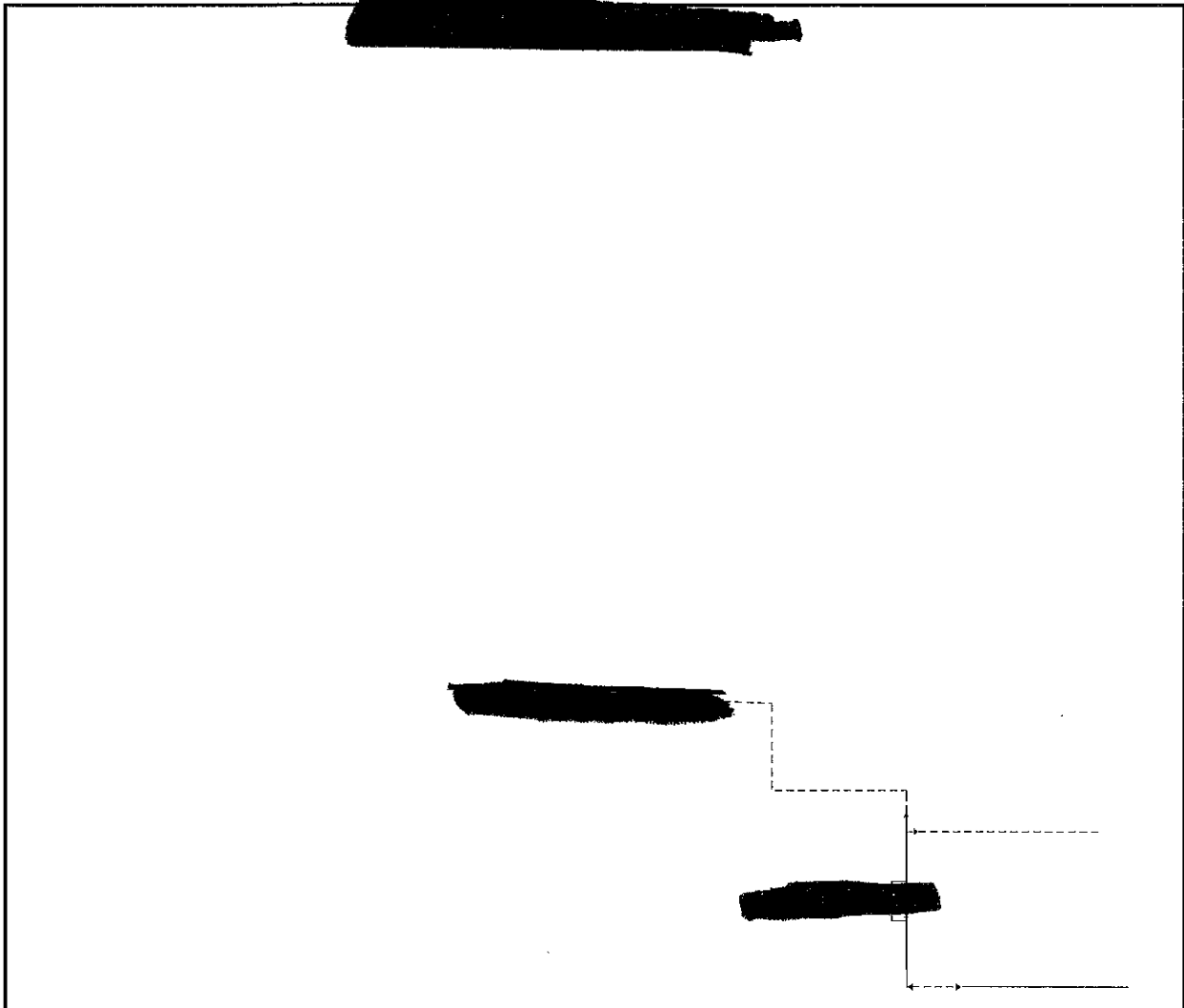
<sup>2</sup> Cost Estimate includes 35% ITCC. Cost estimate are in 2012 Dollars.

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## I. INTRODUCTION TO PART A

[REDACTED] applied to Southern California Edison ("SCE") for interconnection and wholesale distribution service for its proposed Solar Project pursuant to SCE's Wholesale Distribution Access Tariff ("WDAT") Generation Interconnection Procedures. SCE performed an Independent System Impact Study as requested by [REDACTED] for a 12 kV interconnection and distribution service from an existing 12 kV distribution line ("Minotaur 12 kV"). The interconnection is an applicant owned 12 kV switchgear which will be located approximately 0.65 miles from San Bernardino Substation, connected to a 12 kV circuit out of SCE's San Bernardino 66/12 kV Substation. The request is for a WDAT photovoltaic ("PV") generation facility with a total capacity of 5.0 MW. The initial request is for service to commence by March 1, 2013<sup>3</sup>.



<sup>3</sup> Date as requested in the application. Actual operating date depends on design, procurement, and construction requirements. Interconnection Studies will ultimately determine in-service date

The new generation, consisting of photovoltaic panels, [REDACTED] 500 kW Satcon inverters, and [REDACTED] 500 kVA 0.208/12 kV transformers would receive interconnection service from SCE's existing Minotaur 12 kV out of San Bernardino Substation via an underground line extension to the applicant owned 12 kV switchgear. The generated power would be delivered to the California Independent System Operator ("CAISO") grid at the 220 kV bus of SCE's San Bernardino Substation.

The purpose of this Independent System Impact Study is to determine the impact of the proposed generation addition on the SCE distribution system and to identify in general additional Interconnection Facilities, Distribution Upgrades, additions or modifications, or other facilities required to provide the requested service. This study was performed for expected year 2012 through 2021 peak load conditions as well as low demand conditions.

## **II. PART A: SYSTEM IMPACT STUDY CONDITIONS & METHODOLOGY**

### **Planning Criteria**

The thermal rating of any conductor, connector, or apparatus should not exceed 100% of its normal rated capacity with all facilities in service (base case).

The thermal rating of any conductor, connector, or apparatus should not exceed 100% of its emergency rating under N-1 conditions.

Operational flexibility and reliability of the distribution system shall be maintained at all times.

Circuit voltage profiles should be maintained to comply within CPUC's Rule 2 requirements.

### **System Conditions**

The power factor for the new generation facility was assumed to be within WDAT requirements of 0.95 lagging or leading.

Expected loading on the distribution system as projected by the SCE 2012 - 2021 plan was used.

Distributed Generation resources connected to the distribution system are analyzed offline and online during peak load conditions as well as during minimum daytime load conditions as to determine worst case scenario.

The Short circuit contribution from the inverter systems was determined using inverter manufacturer datasheets.

Thevenin equivalents for this study are based on most current thevenin equivalents. Final Short circuit study and cost responsibilities for breaker upgrades will be conducted in the cluster process in accordance with WDAT ISP.

### **III. PART A: SYSTEM IMPACT STUDY RESULTS**

#### **Short Circuit Analysis**

Using the short circuit models from the inverter systems being utilized in this solar generation project, it was calculated that the short circuit contribution at [REDACTED] 12 kV substation bus was more than 0.1 kA and concluded that [REDACTED] 12 kV circuit breakers required replacement as a result of this project.

#### **System Protection Considerations**

Considering the findings and the proposed method of service stated below, some changes to the protection system of the SCE electrical system are required due to the additional generation. The study identified that the addition of the 5.0 MW [REDACTED] Project triggered a problem, not allowing the proper relay coordination between the customer's high side circuit breaker and the 12 kV line and the relay at San Bernardino Substation. Therefore the changes to the SCE protection system include the installation of a new Remote Automated Re-closer along with some modifications in relay settings.

#### **Thermal Loading**

The line section between the customer's facility and the 12 kV Point of Interconnection is expected to experience a reverse power flow of approximately 5.0 MW during minimum loading. Of that 5.0 MW, [REDACTED] will flow back into the 12 kV bus at San Bernardino 66/12 kV Substation during minimum loading. As a result of the reverse power flow back to the 12 kV bus at San Bernardino Substation, revision to the programming of an existing RTU will be required for monitoring purposes<sup>4</sup>.

#### **Distribution Voltage Control**

The Minotaur 12 kV circuit is not expected to experience a voltage rise that would exceed the allowable Rule 2 requirements, from the controlled voltage at San Bernardino 12 kV bus.

<sup>4</sup> This requirement will not prevent the project for being interconnected to the distribution system if adequate arrangements are made in the interconnection agreement to fund this scope of work



### **Harmonic impact**

The harmonic impact of the subject inverter based generation was not part of this System Impact Study. Despite the relatively low THD (<3%) of the equipment, impacts on voltage distortion levels may be significant due to the high penetration level of the generation facility with respect to the local distribution grid strength. As with all equipment connected to the SCE distribution system, the generation project will be subject to the provisions of Rule 2.E, allowing SCE to require customer mitigation of interference with SCE service, including harmonic impacts, if harmonic interference is caused by the customer. Since the THD values which were provided are for individual inverters and not for the total generation requested, it will be required to determine the total harmonic contribution for the entire generation facility prior to approving the generation to interconnect to the SCE distribution system. Given the amount of generation and the strength of the distribution system, SCE will not require a harmonic study but strongly encourages that the applicant completes a harmonic study during the Facility Study Phase. During the commissioning test of the generation system, SCE will be part of the commissioning test, install power quality equipment to verify that the total harmonic contribution from the generation system to the SCE meets the required standards. If during the commissioning test, it is found that the projects do not meet the harmonic standards, the project will not be allowed to interconnect to the SCE system until the harmonic deviations are rectified. Therefore, it is encouraged that the applicant completes a harmonic study during the Facility Study to insure that the harmonic requirements are met. If the applicant chooses to complete a harmonic study, SCE will then provide the required SCE distribution system data that are to be used as part of the harmonic study

## **IV. PART A: GENERAL DESCRIPTION OF IDENTIFIED UPGRADES**

### **Distribution Upgrades**

Distribution Upgrades will include the installation of approximately 1300 feet of primary 350 JCN cable, a 4-way Automated Pad Mounted Gas Switch, and Automatic Recloser and the addition of Watt and VAR data points to an existing RTU at San Bernardino Substation. The total cost estimate for the distribution upgrades is \$219.0K.

### **Interconnection Facilities**

#### **Electrical Systems**

Interconnection Facilities will be required to interconnect this generation project. These facilities include approximately 250 feet of underground primary 350 JCN cable, a RCS controller, 12 kV metering CTs and VTs, metering, and associated wiring. The total cost estimate for the distribution interconnection facilities is \$72.0K.

#### **Telemetry requirements**

Real-time telemetry will be required. In order to provide the adequate telemetry requirements, the existing Data Processing Gateway (DPG), RTU and telecomm installed under WDAT 347 will be utilized. SCE Power System Control (PSC) will be required to program the additional data points in SCE's RTView servers. The total cost for telemetry requirements is 5.0K.

### **Customer Equipment**

The interface protection will be provided by the applicant. It will include a 12 kV circuit breaker which is to be installed on the applicant owned 12 kV switchgear. The applicant's protection must be coordinated with SCE's San Bernardino substation circuit breaker controls to provide adequate protection for the distribution system. The relay settings are subject to SCE approval prior to setting and certified timed trip testing report results using primary injection will need to be provided to SCE to verify relay and circuit breaker performance prior to energizing.

The switchgear must meet SCE's published Electrical Service Requirements ("ESR") to the extent applicable. Drawings required by the ESR shall be submitted, reviewed, modified, and approved by SCE prior to release for fabrication/purchase of the equipment. Each medium voltage service is an individually engineered application at SCE.

Applicant generation interconnection equipment must comply with SCE's Interconnection Handbook in regards to generation protection and lockable-visible disconnecting means at the point of interconnection.

Additionally, the applicant will be responsible for the installation and costs of certain underground facilities (i.e., ducts, structures, etc.) to the extent required by the final design. The construction of the underground facilities will be as per SCE's project drawings.

**Interconnection Facilities Study**

An Independent Facilities Study will be required to determine and redefine the cost and time to complete the required interconnection facilities for the [REDACTED]

**V. NON-BINDING ORDER OF MAGNITUDE COST ESTIMATE**

- Non-binding order of magnitude cost estimates for the required interconnection facilities and system upgrades are as follows:

**Interconnection Facilities/Automation** \$72.0 K

- Approximately 250 feet of primary cable (350 JCN)
- Remote Control Switch
- 12 kV Metering, CTs, PTs, and associated wiring

**Telemetry Requirements** \$5.0 K

- Power system controls (PSC)
- Telecom facilities

**Distribution Upgrades – New Installation** \$219.0 K

- Approximately 1300 feet of new primary underground cable (1000 JCN)
- 4-Way Padmounted Gas Switch
- Automatic Recloser
- Addition of Watt and VAR data points to RTU

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ITCC (35%) \$0.0 K

Total non-binding order of magnitude cost estimate **\$296.0 K**<sup>5</sup>

<sup>5</sup> Cost Estimate includes 35% ITCC. Cost estimate are in 2012 Dollars

## VI. PART A: SUMMARY

The Part A System Impact Study showed:

1. Distribution upgrades will be required for this project. Distribution upgrades include approximately 1300 feet of new primary underground 350 JCN cable a 4-Way Automated Padmounted Gas Switch, an Automatic Recloser and the addition of Watt and Var data points to an existing RTU.
2. Interconnection facilities include the installation approximately 250 feet of primary underground cable, a Remote Control Switch, 12 kV CTs, meters, and associated wiring.
3. Real-time telemetry will be required. In order to provide the adequate telemetry requirements, the existing Data Processing Gateway (DPG), RTU and telecomm installed under WDAT 347 will be utilized. SCE Power System Control (PSC) will be required to program the additional data points in SCE's RTView servers.
4. Non-binding order of magnitude cost estimates for the required interconnection facilities and system upgrades are as follows:

Interconnection Facilities/Automation	\$72.0 K
Telemetry Requirements	\$5.0 K
Distribution Upgrades Subject – New Installation	\$219.0 K
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ITCC (35%)	\$0.0 K
Total non-binding order of magnitude cost estimate	<b><u>\$296.0 K<sup>6</sup></u></b>

<sup>6</sup>Cost Estimate includes 35% ITCC. Cost estimate are in 2012 Dollars

5. This Independent System Impact Study is based on various technical data previously provided by the applicant. If any of that information changes significantly, as determined by SCE, the results of this study may no longer be appropriate and may necessitate a new study.
6. The Independent System Impact Study is based on applicant's queue position. Additional studies may be needed if any changes occur in the projects ahead in the queue.
7. Applicant is responsible for the cost of civil work which is required for the distribution and interconnection electrical facilities.
8. Current distribution standards are being updated to address generation interconnection systems. The proposed method of service in this report may change according on final design to comply with the updated distribution design standards.
9. An Independent Facilities Study detailing required scope and cost of the identified upgrades is required to proceed with the project.
10. Upgrades identified are general and preliminary descriptions only. The costs indicated are non-binding order of magnitude only. The schedule is projected and preliminary.
11. Cost does not include any associated with environmental surveys or reviews needed for the licensing or permitting of the proposed generation project.
12. Applicant is required to complete the coordination study prior to the completion of the execution or in conjunction with Facility Study to determine the exact location of the Automatic Recloser.

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CEII REGULATIONS**

**ATTACHMENT B – BULK POWER SYSTEM IMPACT STUDY REPORT**

**ATTACHMENT B – BULK POWER SYSTEM IMPACT STUDY REPORT**

CAISO Controlled Bulk System

Short Circuit Duty

Since the project is connecting on the SCE distribution system and the project consist of inverter facilities which have limited short-circuit duty contribution, the SCD analysis determined no impact on SCE's high-voltage bulk power system after inclusion of the project.

Power Flow Study

This project individually will not contribute to any power flow issues in the Metro Area bulk system. The existing system has sufficient transmission capability to accommodate the project without any significant upgrades or modification to existing Special Protection System (SPS).