[redacted]

WDT1362ISP

Energy Storage and Generation

[redacted] Subtransmission System Assessment

SOUTHERN CALIFORNIA
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Southern California Edison Company

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Attachments:

1. Facility Scope and Cost Estimate

1. Purpose

The [redacted] Project submitted an interconnection request for a [redacted] utilizing [redacted] connecting to the [redacted] The point of interconnection for the [redacted] is the [redacted]

The purpose of this study is to determine the adequacy of SCE's electrical subtransmission system to accommodate the [redacted] and to identify system limitations that would require Distribution Upgrades on the subtransmission system to mitigate any identified impacts. The study included all existing and queued ahead generation projects in the [redacted] Subtransmission System, regardless of the in-service dates of such prior queued generation projects. The study considered minimum daytime levels of load demand with maximum generation dispatch as well as maximum levels of load demand couple with maximum charging of energy storage facilities and minimal generation within the local subtransmission system. In addition the short circuit duty contribution of the project was also analyzed to assess the system's protection capability.

2. Villa Park BESS Project Interconnection Information

The essential data obtained from the interconnection request for the [redacted] is listed below in Table A.1. The Project shall consist of the Project Generating Facility in Figure 2.1 and the Project Interconnection Facility as illustrated in Figure 2.2. In addition, Figure 2.3 provides a map that illustrates the geographic location of the Project.

Table A.1: Project General Information

Project Location	[redacted]
Participating TO's Planning Area	SCE Metro Area
Number and Types of Generators	[redacted]
Interconnection Voltage	[redacted]
Maximum Generator Output	[redacted]
Generator Auxiliary Load	[redacted]
Maximum Net Output at Generation Facility	[redacted]
Estimated Generation Tie-Line Losses	Not Applicable
Estimated Maximum Net Output at POI	[redacted]
Power Factor Range	Lead 0.95 / Lag 0.95 at POI per interconnection application
Step-up Transformer(s)	Main Transformer: [redacted] Pad-Mount Transformers: [redacted]

	H-X Impedance Value:[redacted]
Point of Interconnection	[redacted]
IC Requested COD	December 31, 2019

Figure 2.1: Project Generating Facilities One-Line Diagram

[redacted]

Figure 2.2: Project Interconnection Facilities One-Line Diagram

[redacted]

Figure 2.3: Project Location Map

[redacted]

3. System Assumptions

3.1 Planning Criteria

The generator interconnection studies were conducted utilizing SCE's Reliability Planning Criteria. More specifically, the main criteria applicable are as follows:

Power Flow Analysis

The following contingencies are considered for subtransmission lines and 220/66 kV transformer banks ("A-banks"):

- Single Contingencies (N-1) – Loss of one line or one A-bank
- Double Contingencies (N-2) – Loss of two lines

The following reliability criteria are used:

Subtransmission Lines	Base-Case	Limiting Component Normal Rating
	N-1 and N-2	Limiting Component Emergency Rating
220/66 kV Transformer Banks (A-banks)	Base-Case	Normal Loading Rating *
	N-1 and N-2	As defined by SCE Operating Bulletin

* Please note that Normal Rating has been reduced to reflect 95% of name-plate rating for charging cases.

3.1.1 Normal Overloads

Normal overloads are those that exceed 100 percent of normal facility rating with all facilities in-service (base case). Mitigation will be required to address any identified normal overload triggered by the inclusion of QC8 Phase I projects.

3.1.2 Contingency Overloads

Contingency overloads are those that exceed 100 percent of emergency ratings under outage conditions. Mitigation will be required to address any identified contingency overload triggered by the inclusion of QC8Phase I projects.

3.1.3 Voltage Criteria

Voltage performance under single and double outage conditions will be limited to 5 percent and 10 percent deviation respectively.

3.1.4 Power Factor Criteria

All projects will need to comply with SCE's Interconnection Handbook requirements.

3.2 Load Assumptions

The load assumptions used for local subtransmission system initially considered a 2020 load forecast. The 2020 load forecast was derived using SCE's Distribution Engineering A-bank Planning load forecast as well as the individual load serving substation (B-bank) load forecast for 2014-2023.

This System Impact Study (SIS) used the SCE's Distribution Engineering's 2014-2023 Subtransmission System Planning A-bank Planning load forecast, individual load serving substation (B Bank) load forecast for 2014-2023, and a normalized historical A-bank hourly load performance (maximum historical load = 1.0) shown in Figure 3.1. This was done in order to provide a means for scaling to reflect comparable hourly performance with a year 2020 load forecast. The A-Bank Normal load forecast was distributed to each individual B-Bank substation (substations used to connect low voltage distribution to 66 kV system) on a pro-rata basis. The resulting individual B-Bank substation values are shown below in Table 3.1 and were used as the basis for evaluating subtransmission system performance. It is important to note that the actual distribution at the B-Bank level may be different than actual performance. Also note that charging load from queued ahead battery storage projects are included in Table 3.1.

Figure 3.1
Normalized Local Subtransmission System
A-bank Hourly Load Performance

[redacted]

The assessment evaluating maximum generation output considered the minimum load for the study. Utilizing the normalized hourly load performance shown above in Figure 3.1, the lowest per-unit load was applied to define two maximum generation output scenarios. The first scenario would use the minimum per-unit load during the daytime (shown as L1) while the second scenario would use the minimum value identified at any time of the day (shown as L2). For energy storage, the assessment evaluating maximum charging considered four scenarios with the maximum load. The first charging scenario would use the maximum per-unit load during the 2:00 AM – 6:00 AM time period (shown as L3). The second charging scenario would use the maximum per-unit load during the 8:00 AM – 12:00 PM time period (shown as L4). The third charging scenario would use the maximum per-unit load during the 2:00 PM – 6:00 PM time period (shown as L5). Lastly, the fourth charging scenario would use the maximum per-unit load during the 8:00 PM – 12:00 AM time period (shown as L6).

Table 3.1: Local Subtransmission System Load Assumptions

[redacted]

*Note: Charging load is represented by the maximum amount of queued ahead [redacted] operating in charge mode which are seeking interconnection within the [redacted] Subtransmission System. Studies will evaluate the compounding impact of additional charging corresponding to this project.

3.3 Generation Assumptions

The [redacted] includes a [redacted] of existing generation. In addition to the existing generation, a total of [redacted] of new generation as summarized below in Table 3.2 are seeking interconnection in the [redacted] Subtransmission System.

Table 3.2: [redacted] Generation Interconnection Queue

[redacted]

3.4 Subtransmission System Assumptions

The [redacted] Independent Study modeled the existing [redacted] without any additional upgrades. The study considered existing system operating bulletins/procedures that transfer system load from [redacted] to adjacent systems under certain outage conditions.

3.5 Study Methodology

3.5.1 Power Flow Study

The base cases were developed to represent stressed scenarios of loading and generation conditions for the study group area. This assessment is comprised of power flow study scenarios that represent load conditions reflected in Table 3.1.

The critical outage conditions evaluated are provided below in Table 3.3.

Table 3.3
List of Contingencies Evaluated

[redacted]

Note: Though other relevant contingencies were also evaluated, only those listed above were the most critical and seen to create overloads that could be attributed to the addition of the [redacted]

3.5.2 Post Transient Voltage Study

The power flow study voltage results were used as a screen to identify those contingencies that may require additional post-transient voltage studies. Contingencies identified in the power flow to have a voltage drop in excess of 5% were selected for post-transient voltage analysis. The Post-transient voltage studies compare voltage deviations to the reliability requirements for contingency outages on the subtransmission system. Mitigation measures will be recommended for any criteria violation identified to be triggered with the inclusion of the [redacted]

4 Power Flow Results

A base case overload was identified under minimum generation coupled with maximum load during the peak hours of load demand for all three [redacted] as well as contingency overloads identified between the hours of 8AM-12AM requiring the need for the Project to install a storage control system to monitor and restrict charging of [redacted] during the aforementioned hours of the day.

4.1 Maximum Generation Coupled with Minimum Load Conditions

Based on the assumptions listed above, the addition of the Project did not trigger any base case or single contingency subtransmission overloads under maximum generation with minimum load study conditions.

4.2 Maximum Generation Coupled with Maximum Load Conditions

Based on the assumptions listed above, the addition of the Project did not trigger any base case or single contingency subtransmission overloads under maximum generation with maximum load study conditions.

4.3 Maximum Energy Storage Coupled with Minimum Local Subtransmission Generation Conditions

The storage facility charging study was performed using the load assumptions discussed above in Table 3.1. Study results for each applicable time-block are provided below.

4.3.1 Base Case Conditions

A base case overload was identified during the L5 Maximum Load assumption for the [redacted] Implementation of a [redacted] will be required under loading conditions L5 to restrict charging of all [redacted] Figure 4.1 provides a visual representation of the base case overload condition.

Figure 4.1
Villa Park A-Bank Loading Results

[redacted]

Note: The impact of the Project for this time block was analyzed with the base case assumption of the [redacted] loading regulated to 100% simulating the [redacted] of the queued ahead [redacted]

4.3.2 Contingency: Time Block L3 (2 AM – 6 AM)

The study identified loading on the [redacted] following the loss of either of the [redacted] to be well within the long-term emergency rating (1A, 3A = 311.2 MVA; 2A = 332.0 MVA) as well as the short-term emergency rating (1A, 3A = 393.3 MVA; 2A = 438.9 MVA) as shown below in Figure 4.2. Since loading is within the long-term and short-term emergency rating, no mitigation is required for this time period.

Figure 4.2
[redacted] Loading Results

[redacted]

4.3.3 Contingency: Time Block L4 (8 AM – 12 PM)

Loading on the A-Bank was identified to increase from 731.3 MW to 751.3 MW during this time block; therefore loss of either of the A-Banks results in loadings that are in excess of the long-term emergency ratings combined (622 MVA) and the short-term emergency rating (786.6 MVA) as shown below in Figure 4.3. A [redacted] is required to address this identified contingency overload problem.

Figure 4.3
[redacted] Loading Results

[redacted]

Note: A procedure is in place that consists of a load rolling scheme to mitigate the Pre-Project overload under loss of either A-bank. The [redacted] is required to address the incremental loading on the banks identified with the addition of the Project.

4.3.4 Contingency: Time Block L5 (2 PM – 6 PM)

A sensitivity analysis was performed which reduced system load to a point where the base case overload was eliminated. This was done to evaluate results for loss of A-Bank under high load that is less than peak. The sensitivity study identified that the full charging capability can only be accommodated if the system load is less than 775 MW. Under this condition, the same [redacted] required to address base case overload issues will be used to turn off charging should loss of an A-Bank occur. Figure 4.4, illustrates the resulting overloads for this sensitivity under loss of A-Bank.

Figure 4.4
Villa Park A-Bank Loading Results

[redacted]

Note: A procedure is in place that consists of a load rolling scheme to mitigate the Pre-Project overload under loss of either A-bank. The [redacted] is required to address the incremental loading on the banks identified with the addition of the Project.

4.3.5 Contingency: Time Block L5 (8 PM – 12 AM)

With the existing A-Banks, no base case overloads were identified during this time-block as the increase from 684.6 MW to 704.6 MW is within the normal limits of both A-Banks. However, the study identified loading on the [redacted] following the loss of either of the A-Banks to be in excess of both the long-term emergency rating (622 MVA) and the short-term emergency rating (786.6 MVA) as shown below in Figure 4.5. A [redacted] will be required to address this identified contingency overload problem.

Figure 4.5
Villa Park A-Bank Loading Results

[redacted]

Note: A procedure is in place that consists of a load rolling scheme to mitigate the Pre-Project overload under loss of either A-bank. The [redacted] is required to address the incremental loading on the banks identified with the addition of the Project.

4.4 Power Flow Study Observations, Notes, and Restriction to[redacted]

(a) N-1-1 Outages

There is an operational risk associated with non-common corridor N-2 outages. Loss of two lines under a non-common mode failure is considered an N-1-1 contingency event which allows for manual system adjustments between contingencies if an overload is anticipated for the next contingency that follows the first contingency. It is important to note that under such potential conditions, curtailment of generation output will be implemented under real-time operation of the system, if required, in advance of the second outage to ensure potential overload is properly mitigated. Because all interconnection agreements contain provision to enable such generation curtailment, no additional physical upgrades were identified to be required under any such N-1-1 outage conditions.

(b) Energy Storage Restrictions

The study determined that insufficient capacity exists in the existing 66 kV subtransmission system for the Project requesting interconnection to the [redacted] Subtransmission area under normal conditions. Restrictions to charging under normal conditions were identified during the 2-6 pm time period which will require the implementation of a storage control system. In addition, further restrictions will exist under loss of an A-Bank during the hours of 8am-12pm, 2-6pm, and 8pm-12am to prevent overloading the remaining A-Banks under loss of bank condition.

Additional charging restrictions not defined in this study may occur in the future under the following conditions, but not limited to:

- Incremental load growth beyond forecasts
- Decrease in amount of internal generation in the area assumed to be available
- Additional future [redacted] interconnection requests
- Limitations on CAISO network corresponding to operating conditions that involve loss of multiple elements
- Maintenance and/or unplanned outage conditions

4.5 Subtransmission Assessment Mitigations

The study determined that provided the implementation of a [redacted] there is sufficient capacity in the existing 66 kV subtransmission system for the Project requesting interconnection to the [redacted] Subtransmission area under normal conditions. The Project will need to install a [redacted] in order to interconnect to the [redacted] An order of magnitude cost for such system is $550k but will be further reviewed as part of the Facilities Study.

5 Post Transient Voltage Stability Assessment Results

Review of the power flow study results identified that no voltage deviations exceeded the criteria discussed above. As a result, no further post-transient analysis on the subtransmission system was performed.

6 Short Circuit Duty Assessment Results

The study identified short-circuit duty overstressed breakers for the three-phase-to-ground fault currents for the [redacted] 66kV Subtransmission System. Project contributions to fault duty at locations with overstressed circuit breakers are provided below in Table 6.1. While the project does not trigger the overstressed conditions at the [redacted] the project contributes to the issue and may later become the triggering project if queued ahead projects ultimately withdraw.

Table 6.1
Application Queue Three-Phase-To-Ground Short-Circuit Duty Results
[redacted] Subtransmission System

[redacted]

6.1 Short Circuit Duty Mitigations

Projects in this area will need to wait for mitigation to be put in place prior to allowing for interconnection. SCE is currently developing a circuit breaker replacement project that will address the overstressed circuit breakers. This excludes one circuit breaker which is assigned to a queued ahead project. As part of this study, no mitigation is assigned to this Project at this time but may later be assigned if project withdrawals occur.

7 Conclusion

The study found the existing [redacted] 66 kV sub-transmission system to have thermal issues under certain scenarios and conditions, mainly between the hours of 8am – 12pm. A [redacted] will need to be implemented to monitor and in the event of thermal overloads, regulate the amount of charging allowable to the BESS. The cost for design, construction and implementation of the Interconnection and Distribution facilities, including [redacted] needed to connect [redacted] are discussed in Attachment 1. In addition, the existing [redacted] 66kV sub-transmission facilities are not able to accommodate the generation interconnection queue without upgrades to previously identified overstressed 66kV circuit breakers at [redacted] 66kV Substation.

A Facilities Study will be required to properly define the Interconnection Facilities and [redacted] and provide proper cost estimates and durations required to enable the project to interconnect. As noted above, circuit breaker mitigation will not be allocated to this project at this time but the project may need to wait for upgrades to be implemented.

Attachment 1
Facilities Scope and Cost Estimate

A. Facilities Scope

For WDT1362 [redacted] SCE will design, install, own, operate and maintain a new [redacted] at [redacted] and [redacted] at the SCE Substation to the first transmission structure outside of the SCE substation property line.

The customer will design, install, own, operate, and maintain the [redacted] between the 1st structure outside SCE's Substation property line and the customer owned facility.

[redacted]

INTERCONNECTION FACILITIES:

Switchrack
- [redacted]

Subtransmission
- [redacted]

  Note: For this study purpose, the assumption is the generation tie will be [redacted]

Telecomm
- [redacted]

  Note: Telecommunication paths will be provided by the customer via fiber optics on the generation tie line.

Corporate Environmental Health and Safety Licensing Real Properties
- Perform all required activities related to the SCE scope of work for the WDT1362 [redacted] including substation, transmission and telecom elements.

Power Systems Control
- Install a [redacted] at the generating facility location to monitor 66 kV lines MW, MVAR, phase amps, 66 kV CB status/control and generation data such as 66 kV generation-tie line net MW, net MVAR, kV, CB status, units MW, MVAR, terminal voltage, auxiliary load MW, MVAR and relay protection status alarm.

Metering Services Organization
- Install revenue and wholesale meters required to meter the retail load and the wholesale load at the generating facility.

DISTRIBUTION FACILITIES:

Switchrack
- [redacted]

[redacted]

- Install and provide in service testing for the [redacted] to monitor the A-banks overload (for the N-1 condition).

B. Facilities Cost Estimate

The total estimated cost of all elements associated with interconnection of the WDT1362 [redacted] as identified above in this Facilities Scope is $4.8 million and the Distribution Facilities is $2.2 million.

Facilities Scope and Cost Estimate Conclusions

- The total estimated order of magnitude cost to interconnect the WDT1362 [redacted] is approximately $7 million.
- The time required to complete the proposed project will be approximately 27 months after receiving project authorization and funding. This time includes engineering, material procurement and construction. This timeframe is subject to final verification by SCE of available resources at the time the Project proceeds.
- The costs indicated above are shown 2016 dollars and are not firm. These are only preliminary estimates based on conceptual engineering and system unit costs, and are subject to change based on the final design and actual material costs.