GENERATOR INTERCONNECTION

SYSTEM IMPACT STUDY REPORT

for integration of the proposed

[redacted] **PROJECT**

(IDAHO POWER QUEUE #549)

to the

IDAHO POWER COMPANY ELECTRICAL SYSTEM

in

TWIN FALLS COUNTY, IDAHO

for

[redacted]

REPORT v.0

August 19, 2019

Revision History

Date	Revision	Initials	Summary of Changes
8/19/2019	0	[redacted]	Initial version

Table of Contents

List of Tables

1.0 INTRODUCTION

[redacted] has contracted with Idaho Power Company ("Transmission Provider") to perform a Generator Interconnection System Impact Study (SIS) for the integration of the proposed [redacted] project (the Project). The Project location (~ coordinates [redacted] is in Idaho Power Company's (IPC's) Southern Region in Twin Falls County, Idaho. The Project is Generation Interconnect (GI) queue number 549 (GI #549). The specific point of interconnection (POI) studied is the 345 kV [redacted]

The Project has chosen to be studied for Network Resource (NR) Interconnection Service in the SIS. The Project has an associated Transmission Service Request (TSR), OASIS #88754196, thus an assessment of existing Transmission Provider transmission capacity was also performed in this SIS to determine if adequate transmission capacity is available to provide Network Transmission Service from the Project POI to Idaho Power load.

IPC GI queue #502, #503, #513, #514, #517, and #523 are senior queued projects, also with an associated TSR (OASIS #88754178), and the facilities and subsequent cost to integrate the [redacted] Project #549 is contingent on facilities required to integrate these senior projects as identified in TSR OASIS #88754178.

This report documents the basis for and the results of this SIS for the GI #549 Generation Interconnection Customer. The report describes the proposed project, the determination of project interconnection system impact and estimated costs for integration of the Project to the Transmission Provider's transmission system. This report satisfies the SIS requirements of the Idaho Power Tariff.

2.0 SUMMARY

The **total preliminary cost estimate** to interconnect the Project to the Transmission Provider's system is [redacted] This cost estimate assumes that the necessary facilities were installed to integrate senior projects GI #502, #503, #513, #514, #517, and #523 as identified in TSR OASIS #88754178.

Integrating GI #549 to the Transmission Provider's transmission system will require relay and control wiring and metering equipment to connect GI #549 to the 345kV ring bus substation required for GI #502, #503, #513, #514, #517, and #523, as identified in TSR OASIS #88754178, without additional upgrades.

The Project will not meet the reactive power requirements required by the Transmission Provider based on the data provided by the customer. Meeting this requirement is the responsibility of the Interconnection Customer. This is discussed further in Section 8.2.

GI #549 will be required to control voltage in accordance with a voltage schedule as provided by Idaho Power Grid Operations and will be required to manage the real power at the POI. Also, it may be beneficial for the Interconnection Customer, for their own NERC Reliability Standard modeling compliance requirements, to install additional PMU devices at their facilities to monitor the generation source(s).

Under stressed transmission flow conditions, when the shunt capacitor at [redacted] substation is energized, the Project may be subject to tripping (by its own protection) due to overvoltage conditions based on the Low/High Voltage Ride Through generator protection (lhvrt) model parameters provided by the customer. The lhvrt parameters are compliant with the PRC-024-2 standard, but tripping can be avoided by coordinating the lhvrt settings with nearby switched shunt reactive devices. The Project is encouraged to work with the Transmission Provider to adjust their protection settings to avoid tripping under high stressed conditions.

3.0 SCOPE OF INTERCONNECTION SIS

The Interconnection SIS was conducted and prepared in accordance with the Transmission Provider's Standard Generator Interconnection Procedures to provide an evaluation of the system impact of the interconnection of the proposed generating project to the Transmission Provider's system. The scope of the Interconnection System Impact Study is detailed in the System Impact Study Agreement.

All other proposed Generation projects prior to this project in the Generator Interconnect queue were considered in this study. A current list of these projects can be found in the Generation Interconnection folder located on the Idaho Power web site at the link shown below:

http://www.oatioasis.com/ipco/index.html

4.0 CONTINGENT FACILITIES

The 345kV ring bus substation facilities required for GI #502, #503, #513, #514, #517, and #523, as identified in TSR OASIS #88754178, are modeled as in service in this study. These facilities are necessary to integrate GI #549 to the Transmission Provider's system. Changes to GI #502, #503, #513, #514, #517, and #523, including in-service date or withdrawal from the queue, may trigger a restudy associated with GI #549 to determine the extent of the upgrades required.

5.0 DESCRIPTION OF PROPOSED GENERATING PROJECT

[redacted] GI #549, proposes to interconnect to the 345 kV Idaho Power transmission system with a total injection of 100 MW (maximum project output) using [redacted] inverters. The interconnection point is IPC's 345 kV [redacted] Transmission line. This project's projected in-service date is December 1, 2023.

Table 1: Project Specifications

Project Location	[redacted]
Number and Type of Generators	[redacted] Quantity = 60
Individual Generator Nameplate Rating	1,666 kW
Total Output Power Rating	99,960kW (Summer) / 99,960kW (Winter) 111,000kVA (Summer) / 111,000kVA (Winter)
Rated Power Factor	0.9 Leading / 0.9 Lagging
New Step-Up Transformer	(60) 1,850 kVA, 3-phase, 0.385kV(Wye-Gnd)/ 34.5kV(Delta), Z = 5.75% on 1,850 kVA base
New Step-Up Transformer	(1) 110 MVA, 3-phase, 34.5kV(Wye-Gnd)/345kV(Wye-Gnd)/13.8kV(Delta), Z = 9% on 65 MVA base
Interconnection Voltage	345 kV

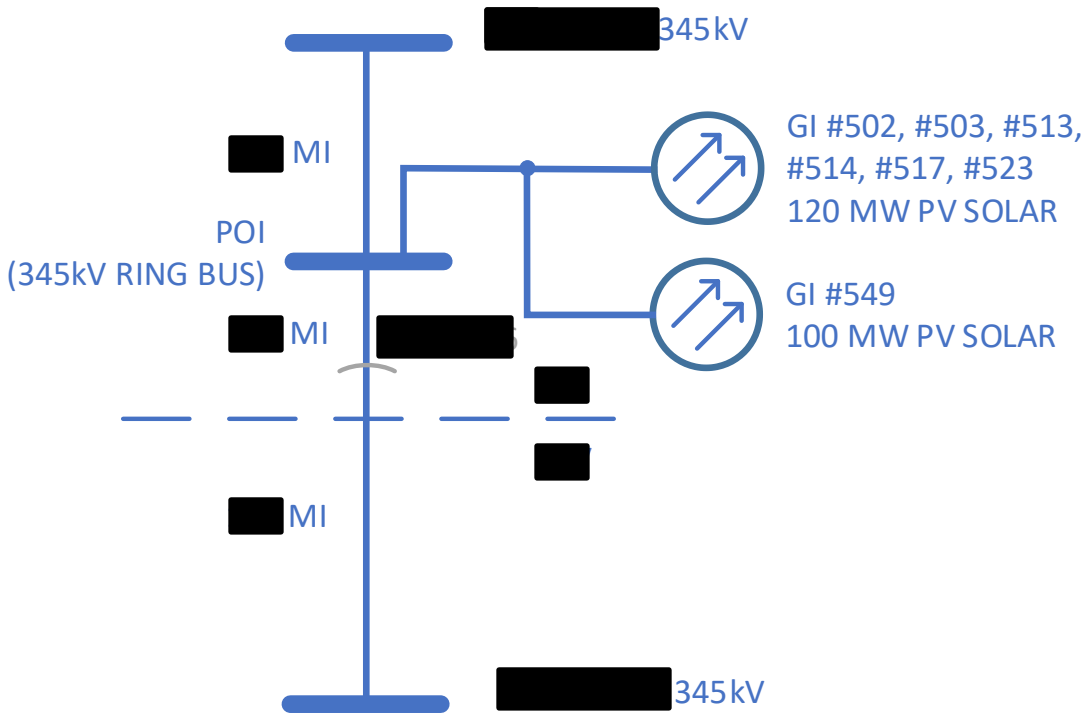

Figure 1 GI#549 Connection to [redacted] 345kV Line

6.0 EXISTING TRANSMISSION COMMITMENTS

The Project POI is on the 345 kV [redacted] transmission line. This line is also known as [redacted] The [redacted] cut plane is defined at the [redacted] state border. Since the Project POI is located north of the [redacted] state border, the flow of power from the Project POI northward to local IPC area load will not cross [redacted]. It will originate just to the north of [redacted] and cross two internal Idaho Power transmission paths – Midpoint West and Boise East. An assessment was performed to determine if there is sufficient capacity across these paths to deliver energy from the Project to IPC load. The assessment found that there is sufficient capacity and no additional transmission upgrades are necessary to deliver power from the Project to IPC load.

7.0 DESCRIPTION OF POWER FLOW CASES

The Western Electricity Coordination Council (WECC) 2019 Heavy Summer 3 Operating Base Case was chosen as the initial power flow case for this System Impact Study. This initial power flow case was modified to include the proposed GI #502, #503, #513, #514, #517, and #523 PV generation projects (120 MW total) as well as the proposed GI # 549 PV generation project.

The customer-provided power flow data was used to model GI #549. The parameter for shunt susceptance (B per unit) for the equivalent collector system was adjusted from 0.000831 (provided by the customer in .epc format) to 0.013251 to appropriately reflect the collector data separately provided by the customer in spreadsheet format.

The case was modified to develop scenarios with flows on [redacted] stressed to the path rating (as defined in the 2019 WECC Path Catalog) in both directions: [redacted]. Additionally, cases were developed with and without [redacted] generation in-service in northern [redacted].

Each scenario case was benchmarked using a pre-Project case (Project offline) and compared to a post-Project case (Project online at full output) to determine the system impact of the proposed GI #549 Project on the surrounding transmission system.

8.0 STUDY RESULTS

8.1 Power Flow Results (Thermal and Voltage Analysis)

Power flow analysis was performed on both the pre- and post-Project cases described above to simulate the impact of the proposed GI #549 Project.

The contingencies simulated included several N-1 and N-2 outages in the Idaho Power system and several N-1 outages in the [redacted] transmission system. Remedial action schemes (RAS) in [redacted] were also simulated.

The study area included WECC base case areas IDAHO and [redacted]. The study area was monitored for thermal and voltage violations pre- and post- contingency by evaluating the following limits:

- Pre-contingency flows within continuous MVA ratings
- Post-contingency flows within summer emergency MVA ratings
- Pre-contingency bus voltages between 0.95 per unit and 1.05 per unit.
- Post-contingency voltages between 0.90 per unit and 1.10 per unit.
- Post-contingency voltage deviation at load buses must be less than 8%.

Power flow solution was achieved for all the contingencies simulated. Key findings from the power flow analysis are as follows:

- Overloading. There were no significant overloads that resulted from adding the Project to the system.
- Voltage Deviation. There were no significant voltage deviations in the power flow analysis at load buses that resulted from adding the Project to the system.
- Voltage Violations. There were no significant voltage violations in the power flow analysis that resulted from adding the Project to the system.
- [redacted] Ratings. It is expected that the Project can be interconnected without adversely impacting the [redacted] ratings as documented in the 2019 WECC Path Rating Catalog

8.2 Reactive Power Requirements

The installed reactive power capability of the project must have a power factor operating range of 0.95 leading to 0.95 lagging at the POI over the range of real power output (up to maximum output of 100 MW).

From the application provided by the developer the inverter reactive capability at rated power is ≥ 0.9 PF. At maximum rated real power output of 1666 MW, this equates to ± 804 kVAr per inverter. It is assumed there is one inverter per inverter step-up transformer for a total of 60 inverters. Hence, at rated power the Project should be able to provide ± 48.25 MVAr.

Power flow analysis indicates that the reactive compensation range of the proposed GI #549 does **not** have sufficient capacity to provide a 0.95 leading power factor at the POI at full output of 100 MW based on the data provided by the customer. Given a maximum output of 100 MW at the POI, 32.9 MVAr is required at the POI to achieve a power factor of 0.95. A simulation of the inverters supplying a maximum output of 100 MW of real power and a maximum output of 48.25 MVAr of reactive power, results in 28.4 MVAr being supplied at the POI with a POI voltage of 1.0 per unit. This is lower than the required 32.9 MVAr to achieve 0.95 power factor. The difference between the amount of reactive power supplied by the inverters and the reactive power measured at the POI is due to reactive losses in the GSU transformer, collector system, and inverter

step-up transformers. These reactive losses are based on the power flow data provided by the customer to represent these facilities. Meeting this requirement is the responsibility of the Interconnection Customer.

The Project does have sufficient capacity to provide a 0.95 lagging power factor at the POI at minimum output of 0 MW based on the data provided by the customer.

8.3 Transient Stability Results

Transient stability runs were simulated for 10 seconds to ensure the system is stable and positively damped. All faults were simulated as three-phase faults with zero fault impedance.

The following buses were monitored and plotted during the Transient Stability simulation runs:

The following transient stability simulations were performed:

- 3PH fault on [redacted] 345kV line, 90% from [redacted] 4 cycle clearing time
- 3PH fault on [redacted] 345kV line, 90% from [redacted] 4 cycle clearing time
- 3PH fault at the POI 345kV bus with 4 cycle clearing time

These simulations were performed on cases with [redacted] at [redacted] with and without [redacted] generation in service, and on cases with [redacted] at [redacted] with and without [redacted] generation in service.

Transient stability simulations were monitored for violations of the transient stability performance criteria listed in WECC regional criteria TPL-001-WECC-CRT-3.2. The results showed no transient stability violations.

Under stressed transmission flow conditions, when the shunt capacitor at [redacted] substation is energized, the Project may be subject to tripping (by its own protection) due to overvoltage conditions based on the Low/High Voltage Ride Through generator protection (lhvrt) model parameters provided by the customer. The lhvrt parameters are compliant with the PRC-024-2 standard, but tripping can be avoided by coordinating the lhvrt settings with nearby switched shunt reactive devices. The Project is encouraged to

work with the Transmission Provider to adjust their protection settings to avoid tripping under high stressed conditions.

8.4 Post-Transient Voltage Stability (Reactive Margin) Results

Post-transient voltage stability analyses were performed for the scenario cases with the Project modeled with and without [redacted] generation in service. Post-transient voltage stability was demonstrated due to all simulated contingencies reaching a valid power flow solution with 105% of rated [redacted] flow in the north-to-south and south-to-north directions.

8.5 Short Circuit Results

Studies indicate that there is adequate short circuit interrupting capability on breakers in the area for the addition of this generation project.

8.6 Other Operating Requirements

GI #549 will be required to control voltage in accordance with a voltage schedule as provided by Idaho Power Grid Operations. And GI #549 will be required to install a plant controller for managing the real power output at the project POI.

The project is required to comply with the applicable Voltage and Current Distortion Limits found in IEEE Standard 519-1992 *IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems*.

The Project will be required to reduce output to levels directed by IPC Grid Operations during transmission system contingencies and other reliability events. This will be accomplished with a Generator Output Limit Control (GOLC) setpoint sent from IPC to the Project.

9.0 COST ESTIMATE OF REQUIRED FACILITIES

In Table 2 below is a conceptual-level cost estimate to interconnect the GI #549 [redacted] project to Idaho Power's system. This cost estimate assumes that the necessary facilities were installed to integrate senior projects GI #502, #503, #513, #514, #517, and #523 as identified in TSR OASIS #88754178. Should these projects drop out of the queue then this project will be responsible for the facilities.

GI #549 [redacted] Project **POI – 345kV Ring Bus Station on [redacted] 345kV Line**	
Direct Assigned and Network Resource Transmission Upgrades[1]	**Cost**
Integrate GI#549 to POI 345kV Station[1] Relay and control wiring and metering equipment	[redacted]
Subtotal	[redacted]
Contingencies (~20%)	[redacted]
Subtotal	[redacted]
Overheads (~10.0%)	[redacted]
Total Estimated Cost	[redacted]

Table 2. Estimated GI #549 Project's Interconnection Costs

(1) Project GI#549 will use the facilities constructed for GI #502, #503, #513, #514, #517, and #523

- Note that these estimates do not include the cost of the customer's equipment/facilities
- These are estimated costs only and final charges to the customer will be based on the actual construction costs incurred.
- These are non-binding conceptual level cost estimates that will be further refined in the Facilities Study phase of the interconnection process.

The cost estimate includes direct equipment and installation labor costs, indirect labor costs, general overheads, and a contingency allowance. These are only cost estimates and final charges to the customer will be based on the actual construction costs incurred. It should be noted that the preliminary cost estimate of [redacted] does not include the cost of the customer's owned equipment to construct the solar generation site.

10.0 CONCLUSIONS

GI #549 can be interconnected to the Idaho Power 345kV transmission system.

Interconnection requirements, detailed in Section 9.0 totaling [redacted] are required to interconnect the Project. This cost estimate assumes that the necessary facilities were installed to integrate senior projects GI #502, #503, #513, #514, #517, and #523 as identified in TSR OASIS #88754178.

APPENDIX A

A-1.0 Method of Study

The SIS plan inserts the Project up to the maximum requested injection into the selected Western Electric Coordinating Council (WECC) power flow case and then, using Power World Simulator or GE's Positive Sequence Load Flow (PSLF) analysis tool, the impacts of the new resource on Idaho Power's transmission system (lines, transformers, etc.) within the study area are analyzed. The WECC and Idaho Power reliability criteria and Idaho Power operating procedures were used to determine the acceptability of the configurations considered. For distribution feeder analysis, Idaho Power utilizes Advantica's SynerGEE Software.

A-2.0 Acceptability Criteria

The following acceptability criteria were used in the power flow analysis to determine under which system configuration modifications may be required:

The continuous rating of equipment is assumed to be the normal thermal rating of the equipment. This rating will be as determined by the manufacturer of the equipment or as determined by Idaho Power. Less than or equal to 100% of continuous rating is acceptable.

Idaho Power's Voltage Operating Guidelines were used to determine voltage requirements on the system. This states, in part, that distribution voltages, under normal operating conditions, are to be maintained within plus or minus 5% (0.05 per unit) of nominal everywhere on the feeder. Therefore, voltages greater than or equal to 0.95 pu voltage and less than or equal to 1.05 pu voltage are acceptable.

Voltage flicker during starting or stopping the generator is limited to 5% as measured at the point of interconnection, per Idaho Power's T&D Advisory Information Manual.

Idaho Power's Reliability Criteria for System Planning was used to determine proper transmission system operation.

All customer generation must meet IEEE 519 and ANSI C84.1 Standards.

All other applicable national and Idaho Power standards and prudent utility practices were used to determine the acceptability of the configurations considered.

The stable operation of the system requires an adequate supply of volt-amperes reactive (VAr) to maintain a stable voltage profile under both steady-state and dynamic system conditions. An inadequate supply of VArs will result in voltage decay or even collapse under the worst conditions.

Equipment/line/path ratings used will be those that are in use at the time of the study or that are represented by IPC upgrade projects that are either currently under construction or whose budgets have been approved for construction in the near future. All other potential future ratings are outside the scope of this study. Future transmission changes may, however, affect current facility ratings used in the study.

A-3.0 Electrical System Protection Guidance

IPCo requires electrical system protection per the Facility Connection Requirements document found on the Idaho Power Web site,

https://docs.idahopower.com/pdfs/BusinessToBusiness/FacConnReq.pdf