**GENERATOR INTERCONNECTION**

**FEASIBILITY STUDY REPORT**

for integration of the proposed

**2 MW [redacted] PROJECT**

**IPC PROJECT QUEUE #664**

to the

**IDAHO POWER COMPANY ELECTRICAL SYSTEM**

for

[redacted] Solar LLC

**REPORT v.0**

**September, 2022**

# Revision History

| Date | Revision | Initials | Summary of Changes |
|---|---|---|---|
| Sept 2022 | 0 | dlj | FeSR GI #664 – Original issue. |

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## 1.0 Introduction

[redacted] Solar LLC Energy has contracted with Idaho Power Company (IPC) to perform a Generator Interconnection Feasibility Study for the integration of the proposed 2 MW [redacted] Project (the Project). The Project is proposed to be located in IPC's Western Region near [redacted] in [redacted] County (See Figure 2: Location of [redacted] Project – GI # 664 in Appendix B). The project latitude and longitude are approximately [redacted]. The Project is Generation Interconnect queue number 664 (GI #664).

The Project has applied to connect to the Idaho Power distribution system for an injection of 2 MW at a single Point of Interconnection (POI) at [redacted] kilovolts (kV). The POI evaluated is located in the Cairo (CARO) 011 distribution circuit boundary.

This report documents the basis for and the results of this feasibility study for the GI #664 Generation Interconnection Customer. The report describes the proposed project, the determination of project interconnection feasibility and estimated costs for integration of the Project to the Idaho Power System. This report satisfies the feasibility study requirements of the Idaho Power Tariff.

## 2.0 Summary

The feasibility of interconnecting the 2 MW [redacted] Project to IPC's [redacted] kV [redacted] distribution circuit was evaluated. The POI evaluated is approximately located at [redacted].

The power flow analysis indicated that interconnecting the [redacted] Project to [redacted] is feasible with modifications discussed in this report.

The Project will be required to control voltage in accordance with a voltage schedule as provided by Idaho Power Grid Operations. Therefore, GI #664 will be required to install a plant controller for managing the real and reactive power output of the 2 MW project at the project POI. The project will need to meet the reactive power requirements for the interconnection. This is often accomplished by increasing the inverter count or increasing the inverter size.

Generator interconnection service, either as an Energy Resource or a Network Resource, does not in any way convey any right to deliver electricity to any specific customer or point of delivery.

The total preliminary cost estimate to interconnect the [redacted] Solar Project to the [redacted] distribution circuit is $723,608, and includes the following tasks:

- Install a four-pole [redacted] kV generation interconnection package at the POI. This includes an SEL-421 protective relay, a 3-phase potential transformer (PT) and a 3-phase current transformer (CT) on the IPC side of the recloser, and a single-phase PT on the customer side of the recloser for dead-line checking prior to recloser closing
- Distribution express circuit rebuild of approximately [redacted] miles of 2/0 ASCR conductor to 795 ASCR conductor double circuited with 2/0 ASCR
- Distribution express circuit rebuild of approximately [redacted] miles of #4 ASCR conductor to 795 ASCR conductor double circuited with #4 ASCR

- Distribution circuit rebuild of approximately [redacted] miles of 2/0 ASCR to 336 ASCR conductor
- Distribution express circuit new build of approximately [redacted] miles of 795 ASCR conductor

The cost estimate includes direct equipment and installation labor costs, indirect labor costs and general overheads. The estimate includes a 30% contingency allowance. These are cost estimates only 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 $723,608 does not include the cost of the customer's owned equipment to construct the solar generation.

In the scenario that a project(s) in the queue prior to this project withdraws or falls out of the queue, system impact studies for this project will need to be reevaluated and potentially re-studied. This may result in required system upgrades for GI #664.

## 3.0 Scope of Interconnection Feasibility Study

The Interconnection Feasibility Study was done and prepared in accordance with Idaho Power Company Standard Generator Interconnection Procedures to provide a preliminary evaluation of the feasibility of the interconnection of the proposed generating project to the Idaho Power system. As listed in the Interconnection Feasibility Study agreement, the Interconnection Feasibility Study report provides the following information:

- preliminary identification of any circuit breaker short circuit capability limits exceeded as a result of the interconnection
- preliminary identification of any thermal overload or voltage limit violations resulting from the interconnection
- preliminary description and non-binding estimated cost of facilities required to interconnect the Small Generating Facility to the IPC system and to address the identified short circuit and power flow issues

All other proposed generation projects prior to the 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 Description of Proposed Generating Project

The proposed [redacted] Project, GI #664, consists of a single 2 MW tracking photovoltaic solar plant and 1.2875 MW of battery storage which requested to be connected to Idaho Power's [redacted] kV [redacted] distribution circuit. The project will need to install a plant controller for managing the real and reactive power output. The supplied single line drawing shows the project using 16 SMA Peak 125kW (SG125HV) inverters AC coupled with two 643.75 kW/3080.4 kWh Tesla Megapacks. [redacted] identified the 32-relay functionality to limit the AC coupled output of the project to 2 MW.

## 5.0 Description of Transmission Facilities

The Project, GI #664, is in IPCO's Western load serving area and does not directly impact any monitored transmission path. However due to its proximity to the Idaho-Northwest path this Transmission System Impact Study was studied with high flows on the path and studied under heavy and light load conditions.

## 6.0 Description of Substation Facilities

Idaho Power's [redacted] substation is located in [redacted] County, Oregon. The existing substation transformer, [redacted], is a three-phase [redacted] kV, [redacted] MVA transformer.

## 7.0 Description of Distribution Facilities

The requested POI for the Project is on the CARO-011 distribution circuit. This is a grounded-wye circuit operating at [redacted] kV at the POI. The Project must have a grounded-wye transformer connection on the IPC side, as well as a wye or grounded wye connection on the Project side of the transformer.

Refer to Appendix A, Section 3, for additional grounding requirements.

## 8.0 Description of Power Flow Case

The Project was studied using DNV-GL Synergi load flow analysis software to analyze the impact to the [redacted] distribution circuit. The Project was studied at peak load, minimum load, and minimum daytime load conditions with all generators on the distribution circuit generating at 100% and weather-based output.

The Project was also studied using Power World version 22 load flow analysis software to analyze the impact to the transmission system. The Project was studied at peak load and minimum load conditions with all senior queued generation interconnections generating at 100% output. The Project was modeled on the Cairo [redacted] kV bus with the Ontario to Cairo Substation 138 kV Idaho Power project in service.

This study utilized the WECC approved 21LW1 case as the starting point for the high path flow case, the 22HS2 case for the heavy load conditions, and the 20LSP1 case for the light load conditions of the studies.

The pre-contingency flows across the Idaho-Northwest cut-plane was modeled near its rating in order to capture the potential impact of the Project on the existing capabilities of the surrounding paths and the interconnected transmission systems. Performing the studies at these levels ensure that the Total Transfer Capability of the adjacent paths are not impacted by the Project.
The heavy and light load cases were used to study the impact to the local transmission system. The limits used for this analysis are as follows:

1. Voltage magnitude during normal operating steady-state must remain between 0.95 per unit and 1.05 per unit.

2. Line loading must be less than 100% of line rating during normal steady-state operation. Steady-state line loading above 100% requires network upgrades.

3. Post-transient line overloading must not exceed 100% of the emergency line rating resulting from an N-1 contingency. Post-transient line loading above the emergency line rating resulting from an N-1 contingency requires network upgrades.

## 9.0 Power Flow Analysis Study Results

The Project will be required to provide a plant controller that will operate the inverter system in Volt/VAR control mode in order to regulate voltage according to a voltage schedule that will be provided by Idaho Power and limit the coupled AC output from the solar plant and the battery system to 2 MW.

In addition, the following power flow analysis upgrades will be required to IPC-owned facilities to facilitate the interconnection of GI #664:

- Distribution express circuit rebuild of approximately [redacted] miles of 2/0 ASCR conductor to 795 ASCR conductor double circuited with 2/0 ASCR
- Distribution express circuit rebuild of approximately [redacted] miles of #4 ASCR conductor to 795 ASCR conductor double circuited with #4 ASCR
- Distribution circuit rebuild of approximately [redacted] miles of 2/0 ASCR to 336 ASCR conductor
- Distribution express circuit new build of approximately [redacted] miles of 795 ASCR conductor

The impact of the proposed Project on the IPC transmission system was analyzed. Results from the studies performed indicate the addition of the Project, GI #664, will not result in N-1 contingency violations impacting either transmission path or any local transmission system elements.

## 10.0 Short Circuit Study Results

The fault current contribution from the solar generator and battery unit shown in Table 1 does not exceed any circuit breaker rating.

Table 1: GI #664 Short Circuit Currents, POI

| Fault Study (w/ GINT#664) | | | |
|---|---|---|---|
| **Location** | **SLG (A)** | **LTL (A)** | **3PH (A)** |
| **@011A FEEDER BREAKER** | 6015.4 | 4542 | 5125.6 |
| **@12.5kV POI** | 2666 | 2646 | 3026 |

The protection package would be a standard SEL-421 interconnection relay setup with a standard 4-pole installation. The 4-pole setup includes a 3-phase PT and a 3-phase CT on the IPC side of the recloser and a single-phase PT on the customer side of the recloser for dead-line checking prior to recloser closing.

## 11.0 Description of Required Facility Upgrades

The Project will be required to provide a plant controller that will operate the inverter system in Volt/VAR control mode. This is to regulate voltage according to a voltage schedule that will be provided by Idaho Power and limit the coupled AC output from the solar plant and the battery system to a total of 2 MW.

The following upgrades will also be required to IPC-owned facilities to facilitate the interconnection of GI #664:

- Install a four-pole [redacted] kV generation interconnection package at the POI. This includes a SEL-421 protective relay, a 3-phase PT and a 3-phase CT on the IPC side of the recloser, and a single-phase PT on the customer side of the recloser for dead-line checking prior to recloser closing
- Distribution express circuit rebuild of approximately [redacted] miles of 2/0 ASCR conductor to 795 ASCR conductor double circuited with 2/0 ASCR
- Distribution express circuit rebuild of approximately [redacted] miles of #4 ASCR conductor to 795 ASCR conductor double circuited with #4 ASCR
- Distribution circuit rebuild of approximately [redacted] miles of 2/0 ASCR to 336 ASCR conductor
- Distribution express circuit new build of approximately [redacted] miles of 795 ASCR conductor

The upgrades are shown in Figure **3**: Generation Integration Distribution Upgrades which can be found in Appendix B.

See the conceptual-level cost estimate in Table **2Error! Reference source not found.**.

Table 2: Conceptual-level Cost Estimate for GI #664

| Item of Work | Estimate |
|---|---|
| Generation interconnection and protection package | $230,000 |
| Substation upgrades | $0 |
| Distribution upgrades | $284,200 |
| Transmission upgrades | $0 |
| Unloaded costs | $514,200 |
| Contingency 30% (1) | $154,260 |
| Total unloaded costs | $668,460 |
| Overheads (2) | $55,148 |
| Total loaded costs | $723,608 |
| **Total Conceptual-level Cost Estimate in 2022 dollars (3)** | **$723,608** |

(1) Contingency is added to cover the unforeseen costs in the estimate. These costs can include unidentified design components, material cost increases, labor estimate shortfalls, etc.
(2) Overhead costs cover the indirect costs associated with the Project.
(3) This cost estimate includes direct equipment, material, labor, and overheads as shown.

- Note that these estimates do not include the cost of the customer's equipment/facilities or required communication circuits for SCADA, and metering.
- Note that the overhead rates are subject to change during the year.
- 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 upon the request and completion of Transmission and Distribution Facility Studies.

## 12.0 Description of Operating Requirements

The Project shall be capable of injecting reactive power (over-excited) and absorbing reactive power (under-excited) equal to 880 kVAR at all active power output between 20% and 100% of nameplate active power rating.

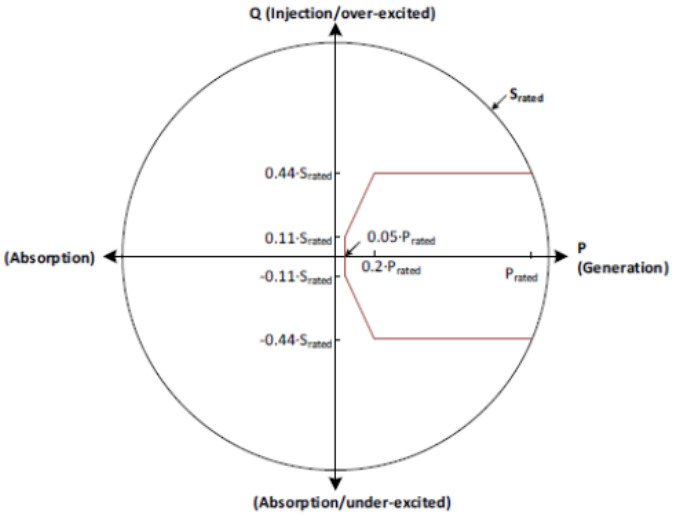

Figure 1: Operating requirements (IEEE 1547-2018)

Idaho Power has determined that the inverter selected by the Project does meet the reactive power capability requirements.

The Project will be required to control voltage in accordance with a voltage schedule as provided by Idaho Power Grid Operations. Therefore, GI #664 will be required to install a plant controller for managing the real and reactive power output of the 2 MW inverter array at the project POI.

Voltage flicker at startup and during operation will be limited to less than 5% as measured at the POI. The allowable voltage flicker limit is further reduced during operation due to multiple voltage fluctuations per hour or minute, per Idaho Power's T&D Advisory Information Manual.

The Project is required to comply with the applicable voltage fluctuation limits found in IEEE Standard 1453-2004 *IEEE Recommended Practice for Measurement and Limits of Voltage Fluctuations and Associated Light Flicker on AC Power Systems.*

The project is required to comply with the applicable Voltage and Current Distortion Limits found in IEEE Standard 519-2014 *IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems*.

Additional operating requirements for the Project may be identified in the System Impact Study when it is performed.

## 13.0 Conclusion

The requested interconnection of the [redacted] Solar Project, GI #664, to Idaho Power's system was studied. The project will need to interconnect using a [redacted] kV grounded-wye connection to the [redacted] [redacted] kV distribution circuit. The results of this study confirm that it is feasible to interconnect the [redacted] Solar Project, GI #664, to the existing Idaho Power system with the modifications listed:

- Install a four-pole [redacted] kV generation interconnection package at the POI. This includes a SEL-421 protective relay, a 3-phase PT and 3-phase CTs on the IPC side of the recloser, and a single-phase PT on the customer side of the recloser for dead-line checking prior to recloser closing
- Distribution express circuit rebuild of approximately [redacted] miles of 2/0 ASCR conductor to 795 ASCR conductor double circuited with 2/0 ASCR
- Distribution express circuit rebuild of approximately [redacted] miles of #4 ASCR conductor to 795 ASCR conductor double circuited with #4 ASCR
- Distribution circuit rebuild of approximately [redacted] miles of 2/0 ASCR to 336 ASCR conductor
- Distribution express circuit new build of approximately [redacted] miles of 795 ASCR conductor

All generation projects in the area ahead of the Project in the IPC generation interconnection queue and their associated transmission system improvements were modeled in a preliminary power flow analysis to evaluate the feasibility of interconnecting GI #664. The results and conclusions of this feasibility study are based on the realization of these projects in the unique queue/project order.

The estimated cost to interconnect GI #664 to the IPC system at the [redacted] kV point of interconnection considered in this study is approximately $723,608.

Generator interconnection service, either as an Energy Resource or a Network Resource, does not in any way convey any right to deliver electricity to any specific customer or point of delivery. Transmission requirements to integrate the Project will be determined during the System Impact Study phase of the generator interconnection process.

## APPENDIX A

### A-1.0 Method of Study

For distribution circuit analysis, Idaho Power utilizes DNV GL's Synergi Electric software and EPRI's OpenDSS 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 distribution circuit. 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 or VARs) 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 Grounding Guidance

IPC requires interconnected transformers on the distribution system to limit their ground fault current to 20 amps at the Point of Interconnection.

## A-4.0 Electrical System Protection Guidance

IPC requires electrical system protection per Requirements for Generation Interconnections found on the Idaho Power Web site,

**http://www.idahopower.com/pdfs/BusinessToBusiness/facilityRequirements.pdf**

## APPENDIX B

### B-1.0 [redacted] Solar Project GI #664 Site Locations/Upgrades

Figure 2: Location of [redacted] Solar Project – GI #664

Figure 3: Generation Integration Distribution Upgrades