**GENERATOR INTERCONNECTION**

**FEASIBILITY STUDY REPORT**

for integration of the proposed

[redacted]

**(GI #558)**

to the

**IDAHO POWER COMPANY ELECTRICAL SYSTEM**

in

**JEROME COUNTY, IDAHO**

for

[redacted]

**REPORT v.1**

**September 5, 2019**

# Revision History

| Date | Revision | Initials | Summary of Changes |
|---|---|---|---|
| 9/5/2019 | 0 | GMT | Feasibility Study Report GI #558 – Original issue |

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# 1.0 INTRODUCTION

[redacted] has contracted with Idaho Power Company (IPCo) to perform a Generator Interconnection Feasibility Study (FeS) for the integration of the proposed 120 MW [redacted] (Project) located in Idaho Power's [redacted]. Reference number GI #558 has been assigned to the Project in the IPCo GI queue.

The specific Point Of Interconnection (POI) studied is [redacted].

This report documents the basis for and the results of this FeS for the Generation Interconnection Customer. It describes the Project, the determination of interconnection feasibility and estimated costs for integrating the Project into the Idaho Power Transmission System at [redacted] kV.

## 2.0 SUMMARY

The feasibility of interconnecting the 120 MW [redacted], GI #558, to Idaho Power's [redacted] line was evaluated.

Power flow analysis indicated that interconnecting the Project is feasible. The Project will be required to control voltage in accordance with a voltage schedule as provided by Idaho Power Grid Operations. Therefore, the Project will be required to install a plant controller for managing the real and reactive power output of the 120 MW inverter array at the POI. Also, the installation of a phasor measurement unit device (PMU) at the POI and the installation and maintenance costs associated with communication circuits needed to stream PMU data will be required.

IPC Transmission Network Upgrades associated with transmission service may be necessary if firm transmission is required to deliver the Projects generation from the POI to a point of delivery. A Transmission Service Request (TSR) will be required to secure transmission rights on the IPC system, either through latent capacity, or Network Upgrades. Either the interconnection customer, or the merchant purchasing the generation from the interconnection customer, will have to make this TSR. Transmission rights are beyond the scope of this Generation Interconnection FeS. **IPC Transmission Network Upgrade costs associated with transmission service are not included in this FeS. However, these costs could be sizeable.**

A Transmission System Impact Study (SIS) is required to determine if any additional network upgrades are required to integrate the Project into the IPCo transmission system and to evaluate system impacts (thermal, voltage, transient stability, reactive margin). 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], GI #558, to Idaho Power's [redacted] system between [redacted].

The cost estimate includes direct equipment and installation labor costs, indirect labor costs and general overheads, and a 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 does not include the cost of the customer's equipment to construct the generation facility.

## 3.0 SCOPE OF INTERCONNECTION FEASIBILITY STUDY

The Interconnection FeS 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 FeS agreement, the Interconnection FeS 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; and
- preliminary description and non-bonding estimated cost of facilities required to interconnect the Large Generating Facility to the Transmission System and to address the identified short circuit and power flow issues.

Generation projects in the Generator Interconnect queue prior to this project could impact the cost of interconnection. A current list of these projects can be found in the Generation Interconnection folder located on the Idaho Power OASIS web site at the link shown below:

http://www.oasis.oati.com/ipco/index.html

## 4.0 DESCRIPTION OF PROPOSED GENERATING PROJECT

[redacted], GI #558, proposes to interconnect to the Idaho Power transmission system at [redacted] with a total injection of 120 MW (maximum project output). Inverters have not been specified. The POI is IPC's [redacted] Transmission line. This project's projected in-service date is December 01, 2020.

**Table 1: Project Specifications**

| | |
|---|---|
| **Project Location** | [redacted] |
| **Number and Type of Generators** | Solar Photovoltaic, Type TBD,<br>Quantity = 31 |
| **Individual Generator Nameplate Rating** | 3981 kW |
| **Total Output Power Rating** | 119,669 kW |
| **Rated Power Factor** | 0.9 Leading / 0.9 Lagging |
| **New Step-Up Transformer** | 87 MVA, 3-phase, 138/34.5/13.8 kV,<br>Z = 8% on 87 MVA base |
| **Interconnection Voltage** | [redacted] |

# 5.0 DESCRIPTION OF EXISTING TRANSMISSION FACILITIES

The [redacted], GI #558, interconnection to the [redacted] line was studied in this FeS. The Project is located adjacent to the proposed POI.

Preliminary power flow analysis indicated that interconnection of a 120 MW injection at the POI considered in this study is feasible. The only local transmission system improvement required will be the new 138 kV class substation for this project.

A SIS will be required to determine specific network upgrades required to transfer the Project output of 120 MW to load.

## 5.1 Transmission Line Facilities

The Project will be inserted in the [redacted] line. The POI will be the [redacted] breaker on the high side of the Project [redacted] transformer.

## 5.2 Substation Facilities

A new [redacted] substation will need to be constructed adjacent to the existing [redacted] section. IPCo will break the line adjacent to the substation and terminate the line sections in the substation as two individual lines in a manner similar to Figure 1.

**Figure 1 removed**

The new substation will consist of two [redacted] line terminals with associated protective relaying systems and a customer owned [redacted] transformer. The POI will be the [redacted] breaker on the high side of the [redacted] transformer.

## 5.3 Grounding Requirements

The proposed [redacted] Wye-Grounded/Wye-Grounded with Delta Tertiary station transformer specified in the Idaho Large Generator Interconnection Request for [redacted], GI #558, should provide an adequate ground source for transmission line protection/relaying.

Grounding requirements and acceptability criteria are found in Appendix A.

## 5.4 System Protection Assessment

<u>Short Circuit details at approximate interconnect location:</u>
Fault current contribution: the rated fault current contribution from GI #558 (as per the interconnection request) is rated at 1.00 p.u. of full load current. For a 120 MVA array this would equal 1200 amps at [redacted], and 3000 amps at [redacted]. IPCo does not anticipate that the fault current contribution will exceed any existing circuit breaker interrupter ratings.

Fault current contributions from the IPCo system to the [redacted], GI #558, buses are as follows:

Single line-to-ground (SLG) fault on the [redacted] bus POI = 12204.1 amps, 3 phase fault on the 138kV bus = 12323.4 amps

Single line-to-ground (SLG) fault on the [redacted] [redacted] bus = 18204.7 amps, 3 phase fault on the [redacted] bus = 17008.5 amps

Single line-to-ground (SLG) fault on the [redacted] bus = 9500.7 amps, 3 phase fault on the [redacted] bus = 9840 amps

A more comprehensive study will be conducted during the SIS should the interconnection customer choose to proceed to that study phase of the interconnection process.

Due to the number of generation sources in the Project area, two circuit breakers will be required in order to meet IPCO electrical system protection requirements.

## 6.0 DESCRIPTION OF POWER FLOW CASES

The 20HS3_GI558.pwb and 20LSP1sa_GI558.pwb cases were used for the power flow analysis of this FeS because they represent both peak load and light load conditions respectively. These cases were created from the similarly named WECC Base Cases with the only modification of adding the Project.

The original WECC cases provide baseline thermal flows and voltages in the IPCo area prior to adding the Project.

The levels of flow represented in the study cases are intended to capture potential impact of the Project on the existing transmission system.

## 7.0 POWER FLOW STUDY RESULTS

Power Flow Analysis was performed on both the pre- and post-Project cases described above. The base cases were used to simulate the impact of the proposed [redacted], GI #558, 120 MW Project interconnection during normal and contingency operating conditions (TPL-001) for the 2020 timeframe. Mitigation of any adverse changes in loading or voltage from pre- to post-Project was identified.

The contingencies simulated include:

- All transformers and transmission lines connected one bus away from the proposed location of Project.
- The proposed project.

The results of the power flow studies were evaluated using WECC/NERC planning standards and IPC planning standards. The power flow analysis related evaluation criteria that were used are summarized below:

- All transmission facilities must remain within their thermal limits.
- Pre-contingency bus voltages within the study area must be between 0.95 per unit and 1.05 per unit.
- Maximum voltage deviation allowed at all buses under contingency conditions will be 5% for N-1 (NERC Category B).

Power flow solution was achieved for each of the N-1 outages simulated. Key findings from the power flow analysis are as follows:

- Overloading. There were no significant overloads for the 138 kV interconnection.
- Voltage Deviation. There were no significant voltage deviations in the power flow analysis.
- Voltage Violations. There no significant voltage violations in the power flow analysis.

## 8.0 DESCRIPTION OF OPERATING 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. At full output of 120 MW, the Project would need to be able to provide approximately +/- 39.5 MVAr reactive support.

Identification of any additional equipment required at the Project to meet Idaho Power reactive power capability interconnection requirements will be provided in the SIS.

The Project will be required to control voltage in accordance with a voltage schedule as provided by Idaho Power Grid Operations. The Project is required to install a plant controller for managing the real and reactive power output of the 120 MW inverter array at the 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*.

## 9.0 COST ESTIMATE

The following upgrades will be required to facilitate the interconnection of [redacted], GI #558:

- Construct a [redacted] substation
- Install one [redacted] power circuit breaker with associated protection systems for the transmission lines.
- Install generation interconnection package at the POI. This includes one [redacted] power circuit breaker, an SEL-421 protective relay, which requires 3-phase potential transformers (PTs), 3-phase current transformers (CTs), SCADA and remote connectivity.
- Line work to break existing 138 kV line and terminate at substation.
- Note that this cost estimate does not include the cost of the customer's equipment/facilities or required communication circuits.
- These are estimated costs only and final charges to the customer will be based on the actual construction costs incurred.

**Table 2: Conceptual Cost Estimate**

| Item of Work | Estimate |
|---|---|
| Substation construction and Generation interconnection and protection package | [redacted] |
| Transmission upgrades | [redacted] |
| Unloaded costs | [redacted] |
| Contingency 20% (1) | [redacted] |
| Total unloaded costs | [redacted] |
| Overheads (2) | [redacted] |
| Total loaded costs | [redacted] |
| **Total Conceptual-level Cost Estimate in 2019 dollars** (3) | |

(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, overheads, and contingency as shown.

These are non-binding conceptual level cost estimates that will be further refined upon the request and completion of Transmission and Distribution System Impact Studies.

## 10.0 CONCLUSIONS

The requested interconnection of the [redacted], GI #558, to Idaho Power's system was studied.

The results of this study work confirm that it is feasible to interconnect the Project to the existing Idaho Power system. The results from the power flow analysis and short-circuit analysis confirm that the interconnection of the Project will have a negligible impact on the surrounding local transmission system.

A SIS is required to determine the specific Transmission Network Upgrades required to integrate the Project as a Network Resource and to evaluate the system impacts (thermal overload, voltage, transient stability, reactive margin).

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 SIS phase of the generator interconnection process.

# APPENDIX A

## A-1.0 Method of Study

The FeS 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 POI, 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 Grounding Guidance**

IPC requires interconnected transformers to limit their ground fault current to 20 amps at the POI.

**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**

**A-5.0 WECC Coordinated Off-Nominal Frequency Load Shedding and Restoration Requirements**

IPC requires frequency operational limits to adhere to WECC Under-frequency and Over-frequency Limits per the WECC Coordinated Off-Nominal Frequency Load Shedding and Restoration Requirements available upon request.

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

# APPENDIX B. PROJECT LOCATION

**Figure 1 - Project Location**