GENERATOR INTERCONNECTION

SYSTEM IMPACT STUDY REPORT

for integration of the proposed

[redacted] PROJECT

IPC PROJECT QUEUE #546

to the

IDAHO POWER COMPANY ELECTRICAL SYSTEM

for

[redacted]

REPORT v.3

February, 2020

Revision History

Date	Revision	Initials	Summary of Changes
8/26/2019	0	AV	SISR GI #546 – Original issue.
12/30/19	1	AV	SISR GI #546 – Restudy due to a senior queue project dropping out
2/14/2020	2	AV	SISR GI #546 – Restudy due a senior queue project dropping out

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[redacted]

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1.0 Introduction

A system impact re-study was performed due to a second senior queue project dropping out of Idaho Power's queue. The second project had assigned upgrades that were modeled in the original system impact study of [redacted] A previous re-study was performed when a senior queue project dropped out of the queue. The re-study concluded that a senior queue position project to [redacted] had assigned network upgrades. The second senior queue position project also dropped out of the queue and a second re-study was necessary to identify any possible network upgrades are required to interconnect [redacted] to the IPC system.

The second re-study identified no additional network upgrades necessary to interconnect the project.

2.0 Summary

The system impact of interconnecting the [redacted] Project to IPC's [redacted] distribution circuit was evaluated.

The Project will be required to control voltage in accordance with a voltage schedule as provided by Idaho Power Grid Operations. Therefore, GI #546 will be required to install a plant controller for managing the real and reactive power output of the [redacted] inverter array at the project POI. The project will need to meet the reactive power requirements for the interconnection. The step-up transformers will need to be grounded-wye - grounded-wye or grounded-wye - wye with the grounded-wye connection on the utility side.

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] Project to the ____________ distribution circuit is $1,230,250, and includes the following tasks:

- Upgrade [redacted] Substation Transformer.
- Install a four-pole [redacted] generation interconnection package at the POI. This includes an SEL-421 protective relay, which requires 3-phase potential transformers (PTs), 3-phase current transformers (CTs), SCADA and remote connectivity.
- Install a single-phase PT and wiring for dead-line check on [redacted].
- Install a dead-line check at [redacted] substation.

The cost estimate includes direct equipment and installation labor costs, indirect labor costs and general overheads. The estimate includes estimated overheads and a 20% 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

[redacted]

$1,230,250 does not include the cost of the customer's owned equipment to construct the solar generation site or required communication circuits.

3.0 Scope of Interconnection Transmission System Impact Study

The Interconnection Transmission System Impact Study was completed, in accordance with Idaho Power Company Standard Generator Interconnection Procedures, to provide an evaluation of the system impacts of the interconnection of the proposed generating project to the Idaho Power system. As listed in the Interconnection Transmission System Impact Study agreement, the Interconnection Transmission System Impact Study report provides the following information:

- identification of additional transformer load tap changer operations, voltage fluctuations (flicker) and additional feeder losses.
- identification of required reactive power support.
- identification of islanding conditions.
- identification of any circuit breaker short circuit capability limits exceeded as a result of the interconnection.
- identification of any thermal overload or voltage limit violations resulting from the interconnection.
- identification of any angular instability.
- 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 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 Description of Proposed Generating Project

The proposed [redacted] Project, GI #546, consists of a single [redacted] photovoltaic solar plant which requested to be connected to Idaho Power's [redacted] distribution circuit. The project will need to install a plant controller for managing the real and reactive power output. The supplied application shows the project using [redacted] Sungrow SG125HV, [redacted] kVA inverters. The application also indicates that the step-up transformers are grounded-wye – grounded-wye.

[redacted]

5.0 Description of Transmission Facilities

The Project's impact on the Brownlee East transmission path (WECC Path #55) was evaluated in this Transmission System Impact Study. In addition, the Idaho-Northwest transmission path (WECC Path #14) which is in series with the Brownlee East transmission path was studied at its rated West-to-East transfer capacity.

The Idaho-Northwest transmission path (WECC Path #14) is defined as the sum of the flows on the following five lines:

- [redacted] 230kV
- [redacted] 230kV
- [redacted] 230kV
- [redacted] 115kV
- [redacted] 500kV

The Brownlee East transmission path (WECC Path #55) is defined as the sum of the flows on the following seven lines:

- [redacted] 230kV
- [redacted] 230kV
- [redacted] 230kV
- [redacted] 230kV
- [redacted] 230kV
- [redacted] 138kV
- [redacted] 138kV

For this generation interconnection Transmission System Impact Study, the flow on the Path 14 Idaho-Northwest transmission path was modeled at [redacted] West-to-East and the Brownlee East transmission path was modeled at [redacted] West-to-East. The paths were stressed to these specific levels in order to determine if the addition of the Project's [redacted] degraded the existing Brownlee East path's transfer capability.

6.0 Description of Power Flow Case

This study utilized the WECC approved 19hs3a1 Heavy Summer operating case as the starting point of the studies. Two power flow cases were developed:

- The "Base Case" with projects earlier in the queue added, but not the Project.
- The "Second Case" with projects earlier in the queue and the Project added.

The pre-contingency flows across the Idaho-Northwest and the Brownlee East paths/cut-planes were modeled at their respective ratings (see Section 5.0). Flow in each path is modeled in this manner 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 will ensure that the Total Transfer Capability of the adjacent paths are not impacted by the Project.

In addition to the 19hs3a Heavy Summer operating case, two light-load operating cases were developed for the IPC 69 kV sub-transmission system. The limits used for this analysis are as follows:

1. Voltage magnitude during normal operating steady-state must remain between 0.93 per unit and 1.05 per unit. If the post-transient voltage deviates from this range during N-1 conditions and an operating procedure can be taken to return the voltage to the required range without creating a four-terminal line, then network upgrades are not required.
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 that does not exceed the emergency line rating resulting from an N-1 contingency is acceptable if an operating procedure can be taken to reduce the line loading below 100% without creating a four-terminal line.

Post-transient line loading above the emergency line rating resulting from an N-1 contingency requires network upgrades.

7.0 Power Flow Analysis Study Results

Results from the stressed Heavy summer operating case indicate the addition of the GI #546 project does not negatively impact the total transfer capability of the path

8.0 Description of Substation Facilities

Idaho Power's [redacted] substation is located in Baker County, Oregon. The existing substation transformer, [redacted] T061, is three single-phase [redacted] transformers rated for [redacted] each. The substation transformer will need to be replaced to be able to accommodate the project.

9.0 Description of Distribution Facilities

The requested POI for the Project is on the [redacted] distribution circuit. This is a grounded-wye circuit operating at [redacted] 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.

[redacted]

10.0 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.

The following upgrades will be required to IPC-owned facilities to facilitate the interconnection of GI #546:

- Upgrade [redacted] Substation Transformer.
- Install a four-pole [redacted] generation interconnection package at the POI. This includes an SEL-421 protective relay, which requires 3-phase potential transformers (PTs), 3-phase current transformers (CTs), SCADA and remote connectivity.
- Install a single-phase PT and wiring for dead-line check on [redacted].
- Install a dead-line check at [redacted] substation.

See the conceptual-level cost estimate in Table 1.

Table 1 Conceptual-level Cost Estimate for GI #546

Item of Work	Estimate
Generation interconnection and protection package	$185,600
Substation upgrades	$759,800
Distribution upgrades	$0
Transmission upgrades	$0
Unloaded costs	$945,400
Contingency 20% (1)	$189,080
Total unloaded costs	$1,134,480
Overheads (2)	$95,770
Total loaded costs	$1,230,250
Total Conceptual-level Cost Estimate in 2020 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, 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.

[redacted]

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

11.0 Description of Operating Requirements

The Project shall be capable of injecting reactive power (over-excited) and absorbing reactive power (under-excited) equal to [redacted] at all active power output between 20% and 100% of nameplate active power rating as stated by IEEE 1547-2018.

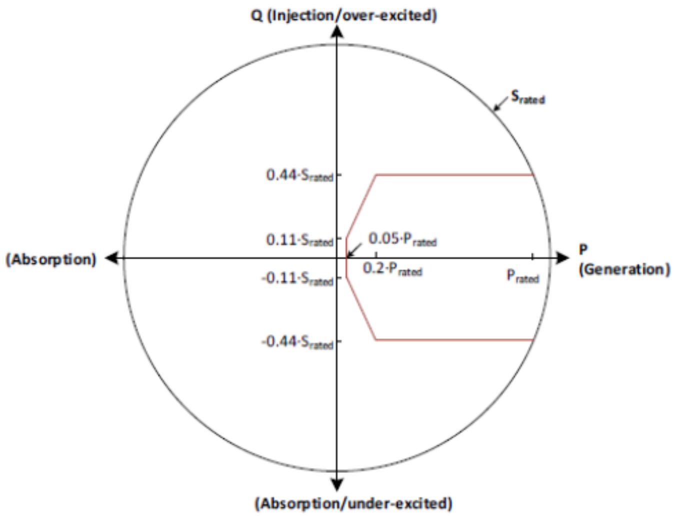

Figure 1 Operating requirements (IEEE 1547-2018)

The Project will be required to control voltage in accordance with a voltage schedule as provided by Idaho Power Grid Operations. Therefore, GI #546 will be required to install a plant controller for managing the real and reactive power output of the [redacted] inverter array at the project POI. The latest dynamic files for the inverter shall be submitted to Idaho Power one month prior to commissioning.

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.*

[redacted]

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*.

12.0 Conclusion

The requested interconnection of the [redacted] project, GI #546, to Idaho Power's system was studied for impact to the IPC electrical transmission and distribution system.

The results of this re-study list the modifications required to interconnect the [redacted] project, GI #546, to the existing Idaho Power system.

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 #546. The results and conclusions of this System Impact Study are based on the realization of these projects in the unique queue/project order.

The estimated cost to interconnect GI #546 to the IPC system at the [redacted] [redacted] point of interconnection considered in this study is approximately $1,230,250.

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.

APPENDIX A

A-1.0 Method of Study

The Transmission System Impact Study plan inserts the Project up to the maximum requested injection into the selected Western Electricity Coordinating Council (WECC) power flow case and then, using Power World Simulator or GE's Positive Sequence Load Flow (PSLF) analysis tool, examines the impacts of the new resource on Idaho Power's transmission system (lines, transformers, etc.) within the study area under various operating and outage scenarios. The WECC and Idaho Power reliability criteria and Idaho Power operating procedures were used to determine the acceptability of the configurations considered. The WECC case is a recent case modified to simulate stressed but reasonable pre-contingency energy transfers utilizing the IPC system. For distribution feeder 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. It 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 at each meter or POI 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 the starting or stopping of the generator will be limited to less than 5% as measured at the POI. 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.
>
> Idaho Power's Reliability Criteria for System Planning was used to determine proper transmission system operation.
>
> All customer generation must meet IEEE 519, IEEE1453, IEEE1547, 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 (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 currently found on the Idaho Power Web site,

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

[redacted]

APPENDIX B

B-1.0 [redacted] GI Project #546 Site Location

Figure 2 Location of [redacted] – GI #546