

**GENERATOR INTERCONNECTION  
TRANSMISSION SYSTEM IMPACT RE-STUDY REPORT**

for integration of the proposed

**3 MW [REDACTED] PROJECT  
IPC PROJECT QUEUE #510**

to the

**IDAHO POWER COMPANY ELECTRICAL SYSTEM**

for

**[REDACTED], LLC**

**REPORT**

**September 12, 2016**

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## Revision History

Date	Revision	Initials	Summary of Changes
07/01/2016	0	AV	SISR GI #510 – Original Issue.
08/29/2016	1	AV	SISR GI #510 - Restudy

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## 1.0 Introduction

██████████, LLC has contracted with Idaho Power Company (IPC) to perform a Generator Interconnection Transmission System Impact Re-Study for the integration of the proposed 3 MW ██████████ project. The re-study is due to the change in the POI coordinates.

This report documents the basis for and the results of this Transmission System Impact re-study for the GI #510 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 Idaho Power System. This report satisfies the Transmission System Impact Study requirements of the Idaho Power Tariff.

## 2.0 Summary

The system impact of interconnecting the 3 MW ██████████ project to IPC's 12.47 kV ██████████ distribution feeder was evaluated. The POI is located at ██████████.

GI #510 will be required to control voltage in accordance with a voltage schedule as provided by Idaho Power Grid Operations. Therefore, GI #510 will be required to install a plant controller for managing the real and reactive power output of the 3 MW inverter array at the project POI.

The total preliminary cost estimate to interconnect the ██████████ project to the ██████████ substation is \$475,000 and includes the following tasks:

- Install a 12.47 kV generation interconnection package at the POI. This includes SEL-421/SEL-411L protective relay package, which require 3-phase potential transformers (PTs), 3-phase current transformers (CTs), and remote connectivity. Additionally, a single-phase PT shall be installed on the interconnect customer side of the IPC 12.47 kV circuit breaker.
- Rebuild 0.72 miles of 12.47 kV feeder.

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 of \$475,000 does not include the cost of the customer's owned equipment to construct the generation site, the line connecting the 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, 3 MW ██████████ Project

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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**

██████████, GI #510, consists of a single 3 MW photovoltaic solar plant which requested to be connected to Idaho Power's 12.47 kV ██████████ distribution feeder. The Project will install an ██████████ grid connection control system for managing the real and reactive power output of the three ██████████. Each of the ██████████ inverters is connected to a 1.2 MVA transformer with fused disconnects to step-up the voltage from ██████████ to 12.47 kV.

The inverter system must be capable of remote reactive power control through various functions including voltage-dependent reactive power control as well as real power control. A plant controller and associated communications are required.

#### **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:

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- Oxbow-Lolo 230kV
- Hells Canyon-Hurricane 230kV
- North Powder-La Grande 230kV
- Hines-Harney 115kV
- Hemingway-Summer Lake 500kV

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

- Brownlee-Boise Bench #1 230kV
- Brownlee-Boise Bench #2 230kV
- Brownlee-Boise Bench #3 230kV
- Brownlee-Horse Flat #4 230kV
- Brownlee-Ontario 230kV
- Oxbow-Starkey 138kV
- Quartz-Ontario 138kV

For this generation interconnection Transmission System Impact Study, the flow on the Idaho-Northwest transmission path was modeled at [REDACTED] MW West-to-East and the Brownlee East transmission path was modeled at [REDACTED] MW West-to-East. The paths were stressed to these specific levels in order to determine if the addition of the Project's 3 MW degraded the existing Brownlee East path's transfer capability.

## 6.0 Description of Power Flow Case

This study utilized the WECC approved 15hs4a 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 15hs4a 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:

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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.
4. 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**

The addition of GI #510 does not exceed any lines ratings for any N-1 contingencies.

## **8.0 Description of Substation Facilities**

Idaho Power's [REDACTED] substation is located in Malheur County, Oregon. The existing substation transformer, [REDACTED] T061, is a three-phase 69-13.09 kV transformer rated for 12/20 MVA.

## **9.0 Description of Distribution Facilities**

The requested POI for the Project is on the [REDACTED] distribution feeder. This is a grounded-wye feeder operating at 12.47 kV at the POI.

The Project must have a grounded-wye transformer connection on the IPC side, as well as a wye connection on the Project side of the transformer.

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

## **10.0 Short Circuit Study Results**

The fault current contribution from the PV generators does not exceed any circuit breaker rating.

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## 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 in order to regulate voltage according to a voltage schedule that will be provided by Idaho Power.

Additional communications to support functions such as SCADA, Metering, GOLC, will also be required. These requirements may result in the need for additional infrastructure and are not included in the cost estimate.

The following upgrades will be required to IPC-owned facilities to facilitate the interconnection of GI #510:

- Install a 12.47 kV generation interconnection package at the POI. This includes SEL-421/SEL-411L protective relay package, which require 3-phase potential transformers (PTs), 3-phase current transformers (CTs), and remote connectivity. Additionally, a single-phase PT shall be installed on the interconnect customer side of the IPC 12.47 kV circuit breaker.
- Rebuild 0.72 miles of 12.47 kV feeder.

The results of the Transmission System Impact Study are reliant on transmission system network upgrades assigned to projects earlier in the generation interconnection queue.

See the conceptual-level cost estimate in Table 1.

**Table 1 Conceptual-level Cost Estimate for GI #510**

<b>Item of Work</b>	<b>Estimate</b>
Substation upgrades (includes generation interconnection and protection package)	\$191,400
Distribution upgrades	\$168,200
Transmission upgrades	\$0
Unloaded costs	\$359,600
Contingency 20% (1)	\$71,920
<b>Total unloaded costs</b>	<b>\$431,520</b>
Overheads (2)	\$43,480
<b>Total loaded costs</b>	<b>\$475,000</b>
<b>Total Conceptual-level Cost Estimate in 2016 dollars (3)</b>	<b>\$475,000</b>

(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.

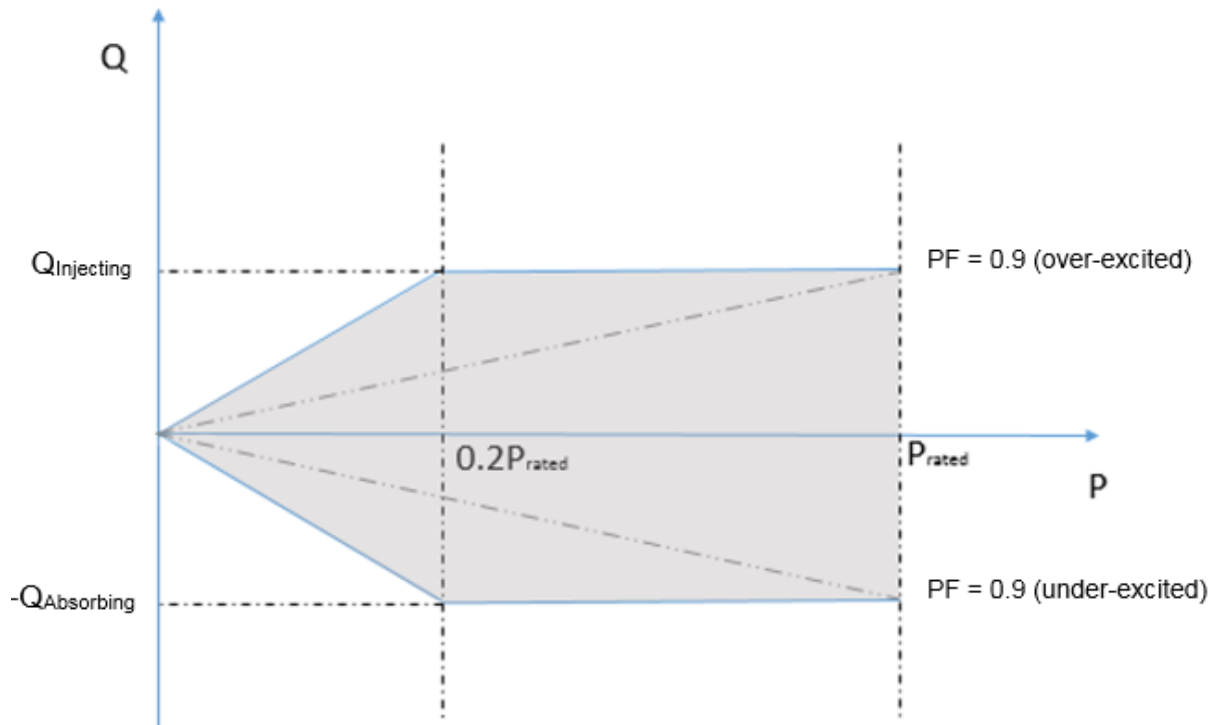
(2) Overhead costs cover the indirect costs associated with the Project.

(3) This cost estimate includes direct equipment, material, labor, overheads, and contingency as shown.

- 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.

**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 1.45 MVAR at all active power output between 20% and 100% of nameplate active power rating.



**Figure 1 Operating requirements**

Idaho Power has determined that the inverter selected by the Project meets 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 #510 will be required to install a plant controller for managing the real and reactive power output of the 3 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*.

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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*.

### **13.0 Conclusion**

The results of this study work confirm that no network upgrades will be required to interconnect the [REDACTED] project, GI #510, to the existing Idaho Power system. However, distribution upgrades are required to interconnect the project. Installation of a 12.47 kV generation interconnection package and rebuild 0.72 miles of the distribution feeder are required to integrate the 3 MW project.

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 power flow analysis to evaluate the feasibility of interconnecting GI #510. The results and conclusions of this Transmission System Impact Study are based on the realization of these projects in the unique queue/project order.

The estimated cost to interconnect GI #510 to the IPC system at POI considered in this study is approximately \$475,000.

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

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 Advantica's Synergi 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 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.

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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 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-4.0 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.

**APPENDIX B**

**B-1.0 [REDACTED] GI Project #510 Site Location**



Figure 2 Location of [REDACTED] – GI #510

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