GENERATOR INTERCONNECTION
FEASIBILITY STUDY REPORT

for integration of the proposed

71 MW [redacted] PROJECT
IPC PROJECT QUEUE # 437

to the

IDAHO POWER COMPANY ELECTRICAL SYSTEM

for

[redacted]

REPORT v.1

March 12, 2015

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Revision History

Date	Revision	Initials	Summary of Changes
03/12/2015	0	MDH	FeSR GI #437 – Original issue
03/16/2015	1	MDH	FeSR GI #437 – Final issue (Removed "Draft" Watermark)

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1.0 Introduction

[redacted] has contracted with Idaho Power Company (IPC) to perform a Generator Interconnection Feasibility Study for the integration of the proposed 71 MW [redacted] photovoltaic project (the Project). The Project is located in IPC's Capital Region in Township [redacted] in Elmore County, Idaho. The Project is Generation Interconnect (GI) queue number 437 (GI #437).

[redacted] has subcontracted with Idaho Power Company to perform a Generator Interconnection Feasibility Study for the integration of the proposed 71 MW [redacted] Project.

The Project has applied to connect to the Idaho Power transmission system for an injection of 71 MW at a single Point of Interconnection (POI) at a 230 kV line tap connection [redacted] 230 kV line approximately 11.1 miles from the [redacted] 230 kV station.

This report documents the basis for and the results of this Feasibility Study for the GI #437 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 71 MW solar generation project to Idaho Power's [redacted] 230 kV line was evaluated.

Power flow analysis indicated that interconnecting the [redacted] 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, GI #437 will be required to install a plant controller for managing the real and reactive power output of the 71MW inverter array at the project POI. Also, the installation of a phasor measurement unit device (PMU) at the POI and maintenance costs associated with communication circuits needed to stream PMU data will be required to be provided in order to interconnect GI #437.

A Transmission System Impact Study is required to determine if any additional network upgrades are required to integrate this project into the IPCo transmission system and to evaluate system impacts (thermal, voltage, transient stability, reactive margin). Generator interconnection

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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 [redacted] 230 kV line is $2,836,800. The cost estimate includes a 230 kV transmission line tap and structure, two 230 kV sectionalizing air-break switches and structures at the tap location, a 230 kV interconnection substation, and protection/control/communication equipment costs.

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 $2,836,800 does not include the cost of the customer's owned equipment to construct the solar generation site.

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; and
- preliminary description and non-binding estimated cost of facilities required to interconnect the Large 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

[redacted] GI #437, consists of a single 71 MW photovoltaic solar plant which will connect to Idaho Power's [redacted] 230 kV line. The Project will use [redacted] inverters.

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This project's projected in-service date is [redacted]

5.0 Description of Transmission Facilities

The [redacted] interconnection to the [redacted] 230 kV line was identified as the most promising option in this feasibility study. All generation projects in the area ahead of this project in the IPC generation queue and their associated transmission system improvements were modeled in a preliminary power flow analysis to evaluate the feasibility of interconnecting GI #437.

Preliminary power flow analysis indicated that interconnection of a 71 MW injection at the POI considered in this study is feasible. A Transmission System Impact Study will be required to determine the specific network upgrades required to integrate the full project output of 71 MW.

6.0 Description of Substation Facilities

Integration of GI #437 will require a 230 kV tap connection to the [redacted] 230 kV line; requiring the construction of a new 230 kV interconnection substation consisting of a single 230 kV circuit breaker, isolating air break switches, protection, control, metering, SCADA, 120V DC station battery, and communication equipment including a 48V DC battery.

The actual station layout and detailed equipment requirements will be determined in the Facility Study should the interconnection customer choose to move to that study phase of the interconnection process. The preliminary estimated cost to interconnect the Large Generating Facility (GI #437) to the IPC System is $2,836,800.

Cost estimates include direct equipment and installation labor costs, indirect labor costs and general overheads, and a contingency allowance. These are preliminary cost estimates only and final charges to the customer will be based on the actual construction costs incurred.

A conceptual single line diagram showing the interconnection option evaluated in this feasibility study is shown in Figure 1.

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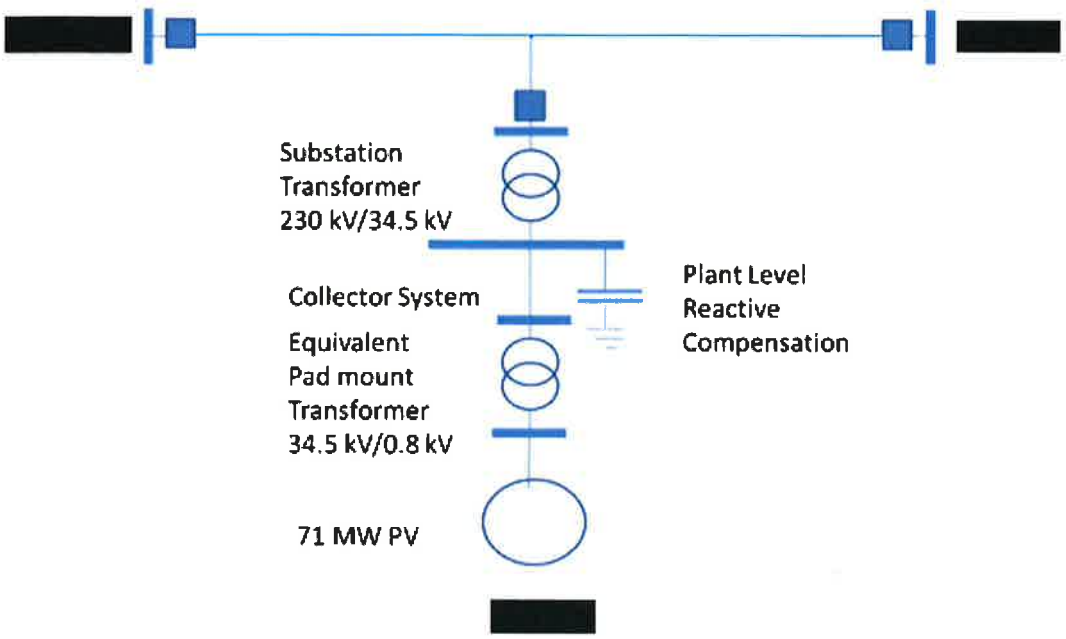

Figure 1 Conceptual Interconnection Single Line Diagram

7.0 Description of Distribution Facilities

No distribution facilities are directly impacted by this project.

8.0 Short Circuit Study Results

Studies indicate that there is adequate load and short circuit interrupting capability on the existing 230 kV breakers to serve this project. GI #437[redacted] short circuit study results are shown in the following tables:

Table 1[redacted] Terminal Fault Duty

	Terminal A =[redacted] 230 kV		
	SLG	L-L	3PH
Actual	13.63 kA	11.4 kA	13.16 kA
With GI #437	14.77 kA	11.46 kA	13.56 kA

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Table 2 [redacted] Terminal Fault Duty

	Terminal B = [redacted] 230 kV		
	SLG	L-L	3PH
Actual	9.51 kA	9.98 kA	11.53 kA
With GI #437	10 kA	10.04 kA	11.58 kA

Table 3 [redacted] Terminal Fault Duty

	POI = GI #437 [redacted] 230 kV		
	SLG	L-L	3PH
Actual (27.81% of line from Danskin)	7.72 kA	8.23 kA	9.52 kA
With GI #437	14.15 kA	8.17 kA	9.55 kA

9.0 Electric System Protection Results and Grounding Requirements

The proposed 230/34.5 kV Wye-Grounded Wye-Grounded with Delta Tertiary station transformer should provide an adequate ground source for transmission line protection and relaying. The [redacted] 230 kV line protection utilizes permissive and line differential protection schemes integrated with our existing digital communication infrastructure. Digital communication infrastructure will be required for the new [redacted] 230 kV line terminal. The [redacted] 230 kV line has an existing optical ground wire (OPWG) digital communication circuits. The station/transmission line cost estimates include the associated equipment and costs to bring this OPWG in to the new station.

Grounding requirements and acceptability criteria are found in Appendix A.

10.0 Description of Power Flow Cases

The WECC 2014 Heavy Summer operating case, approved by WECC on November 7, 2013, was chosen as the initial power flow basecase for this feasibility study. First, the power flow basecase was modified to represent a heavy summer operating case. Next, the basecase was modified to represent transfers across the Idaho transmission system during heavy load conditions. Last, the basecase was modified to include network upgrades assigned to projects ahead of GI #437 in the generation interconnection queue.

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The second case used for the study is the WECC 2014 Light Summer operating case, approved by WECC on January 16th 2014. This case was chosen as an additional power flow basecase for this feasibility study to represent a shoulder month summer condition with east to west transfers across the Idaho transmission system which generally occur in the fall. Last, the basecase was modified to include network upgrades assigned to projects ahead of GI #437 in the generation interconnection queue.

11.0 Post-Transient Study Results

A post-transient analysis was performed on the summer heavy load and light load cases to identify if any thermal overload or voltage limit violations result from the interconnection of the 71 MW maximum project output.

Pre-project studies indicate all elements are less than or equal to the continuous rating (100%) of the element for N-0 conditions for both the heavy and light load summer cases.

The pre-GI #437 heavy summer case N-1 and N-2 contingency analysis did not identify any issues in the immediate vicinity of the proposed GI #437.

The pre-GI #437 light summer case N-1 and N-2 contingency analysis results show that for:

1) The N-2 loss of the [redacted] 230 kV and [redacted] 138 kV line
   a. The [redacted] 69 kV transmission line was overloaded to 95.6% of its summer emergency rating.

Post-project studies indicate that the GI #437 71 MW generation integration to the IPC transmission system does not cause any existing system elements to exceed their continuous ratings for N-0 conditions for both the heavy and light load summer cases.

The post-GI #437 heavy summer case N-1 and N-2 contingency analysis did not identify any issues in the immediate vicinity of the proposed GI #437.

The post-GI #437 light summer case N-1 and N-2 contingency analysis results show that for:

1) The N-1 loss of the [redacted] Tap 230 kV Line (line open-end at [redacted]
   a. The [redacted] 69 kV transmission line was overloaded to 99.5% of its summer emergency rating.
   b. The [redacted] 69 kV transmission line was overloaded to 98.5% of its summer emergency rating.
2) The N-1 loss of the [redacted] 230 kV Line

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a. The [redacted] 138 kV transmission line was overloaded to 96.7% of its summer emergency rating.

3) The N-1 loss of the [redacted] 230 kV Line
   a. The [redacted] 69 kV transmission line was overloaded to 95.7% of its summer emergency rating.

4) The N-1 loss of the [redacted] 230 kV Line
   a. The [redacted] 69 kV transmission line was overloaded to 95.1% of its summer emergency rating.

Power flow and post-transient analysis indicated that interconnecting the [redacted] Project, GI #437, is feasible.

12.0 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 (up to maximum output of 71 MW).

From the inverter specification sheet provided by the developer the maximum reactive power of ± 485 kVAr per inverter. It is assumed there are two inverters per GSU transformer. The reactive capability at rated power is ≥ 0.91 PF. Hence, [redacted] at rated power should be able to provide ± 32.5 MVAr with a maximum reactive capability of ± 34.4 MVAr at less than rated power.

Preliminary power flow analysis indicates that the reactive compensation range of the proposed GI #437 just does have sufficient capacity to provide a 0.95 lagging power factor at the POI at full output. And, the leading plant reactive compensation capacity is more than sufficient to meet the operating requirement of 0.95 leading at the POI at full load.

Identification of any additional equipment required at the plant to meet Idaho Power reactive power capability interconnection requirements will be provided in the System Impact study.

GI #437 will be required to control voltage in accordance with a voltage schedule as provided by Idaho Power Grid Operations. GI #437 is required to install a plant controller for managing the real and reactive power output of the 71 MW inverter array 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*.

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Installation of a phasor measurement unit device at the POI and maintenance costs associated with communication circuits needed to stream PMU data will also be required to be provided in order to interconnect GI #437. The specific costs associated with the IPC requirements for interconnection customers with aggregate facilities larger than 20 MW to provide PMU data to IPC will be identified in the Facility Study should the interconnection customer choose to proceed to that phase of the interconnection process.

Additional operating requirements for this project may be identified in the System Impact study when it is performed.

13.0 Conclusion

The requested interconnection of the [redacted] Project, GI #437, to Idaho Power's system was studied. The project will interconnect using a 230 kV line tap connection to the [redacted] 230 kV line.

The results of this study work confirm that it is feasible to interconnect the [redacted] project, GI #437, to the existing Idaho Power system. No major transmission system improvements are required to integrate the 71 MW project. A System Impact Study 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).

All generation projects in the area ahead of this 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 #437. 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 #437 to the IPC System at the 230 kV point of interconnection considered in this study is approximately $2,836,800.

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 this project will be determined during the System Impact Study phase of the generator interconnection process.

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APPENDIX A

A-1.0 Method of Study

The Feasibility Study 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.

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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 Requirements for Generation Interconnections found on the Idaho Power Web site,

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

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