GENERATOR INTERCONNECTION

SYSTEM IMPACT STUDY REPORT

for integration of the proposed

300 MW SOLAR [redacted]

(GI PROJECT #534)

AND

375 MW WIND [redacted]

(GI PROJECT #535)

to the

IDAHO POWER COMPANY ELECTRICAL SYSTEM

in

JEROME COUNTY, IDAHO

for

[redacted]

REPORT v.0

April 15, 2018

Table of Contents

1.0 Introduction

[redacted] Idaho Power Company ("Transmission Provider") to perform a Generator Interconnection System Impact Study for the integration of the proposed 300MW [redacted] solar project and the integration of the proposed 375MW [redacted] wind project. The Project location [redacted] is in Idaho Power Company's (IPC's) Southern Region in Jerome County, Idaho. The projects are Generation Interconnect (GI) queue number 534 (GI #534) and Generation Interconnect (GI) queue number 535 (GI #535). The projects have chosen in the System Impact Study to be studied as both an Energy Resource (ER) Interconnection Service and a Network Resource (NR) Interconnection Service.

The projects have applied to connect to the Transmission Provider's transmission system for an injection of 300MW of solar and 375MW of wind with new [redacted] interconnection(s) on the Idaho Power Company's (IPC's) [redacted] substation. In addition, a request was made to study both the solar project and the wind project simultaneously. The Project's Generation Point of Interconnection (POI) is assumed to be at the [redacted] station.

IPC project queue GI #530, is a senior queued project and the facilities and subsequent cost to integrate the 300 MW [redacted] solar project, GI #534, the 375 MW [redacted] wind project, GI #535, and both [redacted] wind and solar, GI #534 and GI #535, are contingent on GI #530 facilities.

This report documents the basis for and the results of this System Impact Study for the GI #534 and #535 Generation Interconnection Customer. The report describes the proposed projects, the determination of the projects interconnection requirements and estimated costs for integration of the projects to the Transmission Provider transmission system. This report satisfies the System Impact Study requirements of the Idaho Power Tariff.

2.0 Summary

Interconnecting the 300MW generation project to the Transmission Provider's transmission system with a connection to the [redacted] Station. The Project's Generation Point of Interconnection (POI) is assumed to be at the [redacted] station.

Interconnecting the 375MW generation project to the Transmission Provider's transmission system with a connection to the [redacted] Station. The project's Generation Point of Interconnection (POI) is assumed to be at the [redacted] station.

The following is for information purposes only and does not convey Transmission Service.

Both projects will be required to control voltage in accordance with a voltage schedule as provided by Idaho Power Grid Operations. GI #534 and GI #535 will be required to manage the real power output of their generation project at the POI. Also, it may be beneficial for [redacted], for their own modeling compliance requirements, to install additional PMU devices at their facilities to monitor the generation source(s).

The total "Energy Resource Interconnection Service" generation interconnection preliminary cost estimate to interconnect the [redacted] projects is as follows:

- Single connection to the [redacted] substation - [redacted]
  - This represents an Energy Resource connection of either GI #534, GI #535, or a combined, single connection of GI #534 and GI #535.
- Two independent connections of GI #534 and GI #535 - [redacted]
  - This represents an Energy Resource connection of both GI #534 and GI #535 to the [redacted] Substation where each project has its own bay and does not share a common breaker, see Figure 2 below.

See Section 6.6 Energy Resource Cost Estimate for the required Energy Resource facilities and cost breakdowns.

The total "Network Resource Interconnection Service" generation interconnection preliminary cost estimate to interconnect the [redacted] projects is as follows:

- GI #534, solar project [redacted]
- GI #535, wind project [redacted]
- GI #534 & GI #535, solar and wind projects combined [redacted]

See Section 7.4 Network Resource Cost Estimate for the required Network Resource facilities and cost breakdowns. The cost estimate includes a 20% contingency and 10% overhead. 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 estimates do not include the cost of the customer's owned equipment.
The Transmission Provider estimates it will require approximately 36 months to design, procure, and construct the facilities described in the Energy Resource section and 42 months to design, procure, and construct the facilities described in the Network Resource section of this report following the execution of a Generation Interconnection Agreement. The schedule will be further developed and optimized during the Facility Study should the generation interconnection customer choose to move to that study phase of the interconnection process.

3.0 Scope of Interconnection System Impact Study

The Interconnection System Impact Study was done and prepared in accordance with the Transmission Provider's Standard Generator Interconnection Procedures to provide an evaluation of the system impact of the interconnection of the proposed generating project to the Idaho Power system. The scope of the Interconnection System Impact Study is detailed in the System Impact Study Agreement.

4.0 Contingent Facilities

GI #534 and GI #535 Energy Resource, ER, service is not contingent upon upgrades associated with any senior queued project.

IPC project queue GI #530, is a senior queued project. Idaho Power studied GI #534 and GI #535 with all Network Upgrades identified in GI #530 modeled as in service (Contingent Facilities). Contingent Facilities are detailed in Appendix B. Changes to GI #530, including in-service date and withdrawal from the queue, may trigger a restudy associated with GI #534 and GI #535 Network Resource, NR, service, (some or all of the network upgrades identified for GI #530 may be required by GI #534 and/or GI #535).

5.0 Description of Proposed Generating Project

Assumptions

The point of interconnection for both GI #534 and GI #535 is the [redacted] substation.

GI #534

- 300 MW Generation
  - 105 [redacted] 3.2MVA solar inverters
- All generation in voltage regulation (Reactive capability used to regulate [redacted] bus voltage – supply/absorb reactive)

GI #535

- 375 MW Generation
  - 150 [redacted] 2.8 MVA wind turbines
- All generation in voltage regulation (Reactive capability used to regulate [redacted] bus voltage – supply/absorb reactive)

6.0 Energy Resource (ER) Interconnection Service

Energy Resource (ER) Interconnection Service allows the Interconnection Customer to connect its Generating Facility to Transmission Provider's transmission system and to be eligible to deliver electric output using firm or non-firm transmission capacity on an as available basis.

The GI #534 project has applied to connect to the Idaho Power transmission system for an injection of 300 MW with a new [redacted] interconnection bay on the [redacted] substation. The Project's Generation Point of Interconnection (POI) is assumed to be at this stations [redacted] bay.

The GI #535 project has applied to connect to the Idaho Power transmission system for an injection of 375 MW with a new [redacted] interconnection bay on the [redacted] substation. The Project's Generation Point of Interconnection (POI) is assumed to be at this stations [redacted] bay.

When combined GI #534 and GI #535 would inject 300 MW and 375MW respectively with two new [redacted] interconnection bays on the [redacted] substation. The combined projects Generation Point of Interconnection (POI) is assumed to be at their respective bays at the [redacted] substation.

6.1 Description of Substation/Transmission Facilities

As an Energy Resource, a Transmission Service Request will be required to determine the specific Network Upgrades required to deliver the project output to a designated point of delivery. Listed below are the required transmission facilities to interconnect the Project;

Substation Interconnection Facilities:

The proposed interconnection of GI #534 or GI #535 at [redacted] substation will require a new rung on the double bus, breaker-and-a-half topology of the existing station with two [redacted] breakers.

The proposed interconnection of GI #534 and GI #535 at [redacted] substation will require a new rung on the double bus, breaker-and-a-half topology of the existing station with three [redacted] breakers and a line move to avoid a shared breaker.

The actual station layouts 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.

A conceptual diagram of the integrated GI #534 or GI #535 project is shown below in Figure 1. A conceptual diagram of the integrated GI #534 and GI #535 is shown below in Figure 2.

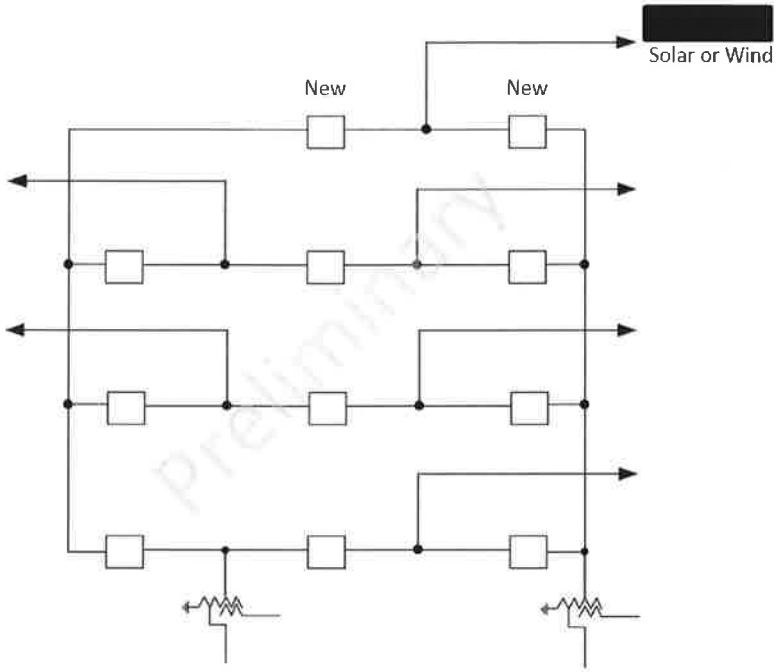

Figure 1 [redacted] Connection [redacted]

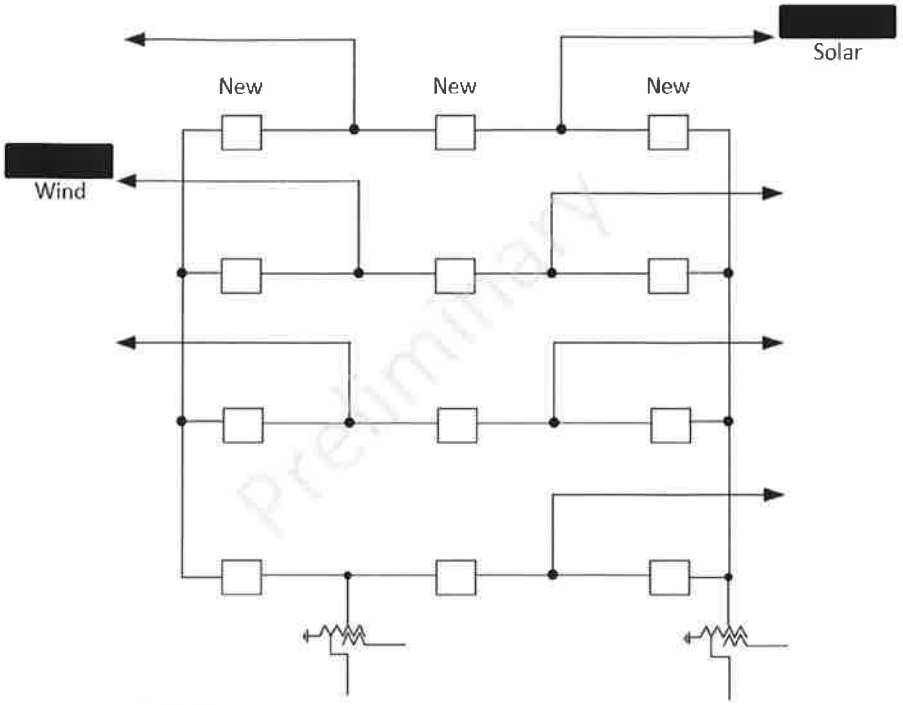

Figure 2 [redacted] Solar & Wind Connection [redacted]

6.3 Description of Distribution Facilities

No distribution facilities are directly impacted by this project.

6.4 Short Circuit Study Results

Studies indicate that there is adequate load and short circuit interrupting capability on the Transmission Provider's existing [redacted] breakers to serve this project.

6.5 Electric System Protection Results and Grounding Requirements

For [redacted] line protection, the Transmission Provider's System Protection Department utilizes permissive and line differential protection schemes integrated with our existing digital communication infrastructure. Digital communication infrastructure for the interconnection customers [redacted] line will be the responsibility of said interconnection customer. It is strongly recommended that the customer owned line be constructed with an optical ground wire (OPGW) digital communication circuits for system protection and communication.

Grounding requirements and acceptability criteria are found in Appendix A.

6.6 Energy Resource Cost Estimate

In Table 1 below a summary is provided of the generation interconnection facilities and conceptual costs required to interconnect the GI #534 [redacted] solar project or GI #535 [redacted] wind project to the Transmission Provider's transmission system as an Energy Resource.

GI #534 or GI #535 [redacted] Projects POI – [redacted] Station Energy Resource Generation Interconnection Facilities	
Direct Assigned	**Cost**
New [redacted] rung and breakers at [redacted] Station Air break switches, metering, relaying, etc.	[redacted]
Subtotal	[redacted]
Contingencies (~20%)	[redacted]
Subtotal	[redacted]
Overheads (~10.0%)	[redacted]
Energy Resource – Total Estimated Cost	[redacted]

Table 1. Estimated GI #534 Project's Energy Resource Generation Interconnection Costs

In Table 2 below a summary is provided of the generation interconnection facilities and conceptual costs required to interconnect GI #534 [redacted] solar project and GI #535 [redacted] wind project to the Transmission Provider's transmission system as an Energy Resource.

GI #534 [redacted] 300MW Solar & GI #535 [redacted] Wind Projects POI – [redacted] Station Energy Resource Generation Interconnection Facilities	
Direct Assigned	**Cost**
New [redacted] rung with two new bays, three [redacted] breakers, and a line move at [redacted] Station	[redacted]

Air break switches, metering, relaying, etc.	
Subtotal	[redacted]
Contingencies (~20%)	[redacted]
Subtotal	[redacted]
Overheads (~10.0%)	[redacted]
Energy Resource – Total Estimated Cost	[redacted]

Table 2. Estimated GI #534 & GI #535 Energy Resource Generation Interconnection Costs

The cost estimates include 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 estimates do not include the cost of the customer's owned equipment.

The Transmission Provider estimates it will require approximately 36 months to design, procure, and construct the facilities described in the Energy Resource section of this report following the execution of a Generation Interconnection Agreement. The schedule will be further developed and optimized during the Facility Study should the generation interconnection customer choose to move to that study phase of the interconnection process.

7.0 Network Resource (NR) Interconnection Service

Network Resource Interconnection Service allows the Interconnection Customer to integrate its Generating Facility with the Transmission Provider's Transmission System in a manner comparable to that in which the Transmission Provider integrated its generating facilities to serve native load customers. The transmission system is studied under a variety of severely stressed conditions to determine the transmission improvements/upgrades which are necessary to deliver the aggregate generation around the Point of Interconnection to the Transmission Provider's aggregate load. Network Resource Interconnection Service in and of itself does not convey Transmission Service.

7.1 Network Resource Single Event Exposure

[redacted] requested that both the 300 MW of solar and the 375 MW of wind be studied together. If the full 675 MW, solar and wind project elects to move forward as an Idaho Power Network Resource, consideration must be given to the amount of generation that can be lost due to a single event (for example a common tower outage, bus fault, or breaker-failure).

If being integrated as a Network Resource, Idaho Power will require two separate lines, preferably geographically diverse, between the solar substation and the [redacted] Station and between the wind substation and the [redacted] Station. At the [redacted] substation, a configuration has been selected that can withstand a breaker failure operation without losing both the solar project and the wind project. If a common GI #534 solar and GI #535 wind substation is used to collect the 34.5kV energy from the wind and solar installations, a substation configuration should be selected that can withstand a breaker failure operation without losing both projects. In addition, the customer owned line(s) shall be constructed with optical ground wire (OPGW) digital communication circuits for system protection and communication between the POI and collector station(s).

Idaho Power recommends that the [redacted] transmission lines from the collector stations to the [redacted] substation be bundled to avoid potential corona effects.

7.2 Description of Power Flow Cases

For the Network Resource Interconnection Service study, two power flow cases were used to study the Transmission Provider's transmission system with westbound and eastbound transmission flows to determine the required Network Transmission Upgrades.

The WECC 2019 Light Winter operating case, was chosen as the initial power flow base case for this System Impact Study. It has been extensively modified to represent a shoulder month condition with high wind, solar, and gas generation east of Boise, and high east to west (westbound) transfers across the Transmission Provider's transmission system which generally occurs in the fall/winter. In addition, this case was modified to remove gas generation east of Boise to study high east to west (westbound) transfers west of Midpoint.

The second case used for the study is the WECC 2019 Light Summer operating case. This case was modified to represent a summer month with high west to east (eastbound) transfers across the Transmission Provider's transmission system.

7.3 Network Resource Transmission Upgrades

From the power flow/contingency analysis, the following Network Transmission upgrades were identified for the integration of either GI #534, 300 MW of solar, or GI #535, 375 MW

of wind, or both GI #534 and GI #535 in addition to the Energy Resource generation interconnection facilities.

Boise Bench – Midpoint Remedial Action Scheme (RAS)

- Partial bypass of series compensation at Midpoint for a detected overload of the capacitors or conductor on the Midpoint Boise Bench #2 and/or #3 230kV transmission line.

The following Network Transmission Upgrades were identified as needed to deliver GI #534 and GI #535, a combined 675 MW of proposed generation, to the Transmission Provider's network load. These are in addition to the Energy Resource generation interconnection facilities and the identified Boise Bench – Midpoint RAS.

[redacted] **substation**

- Addition and integration of [redacted] solar and [redacted] wind plus a third [redacted], 700 MVA transformer
  - Three new [redacted] bay positions
    - Five [redacted] breakers
  - New [redacted] Bay position to avoid common points of failure
    - Three new [redacted] breakers and a line move

A conceptual diagram of the integrated GI #534 and GI #535 project is shown in Figure 3.

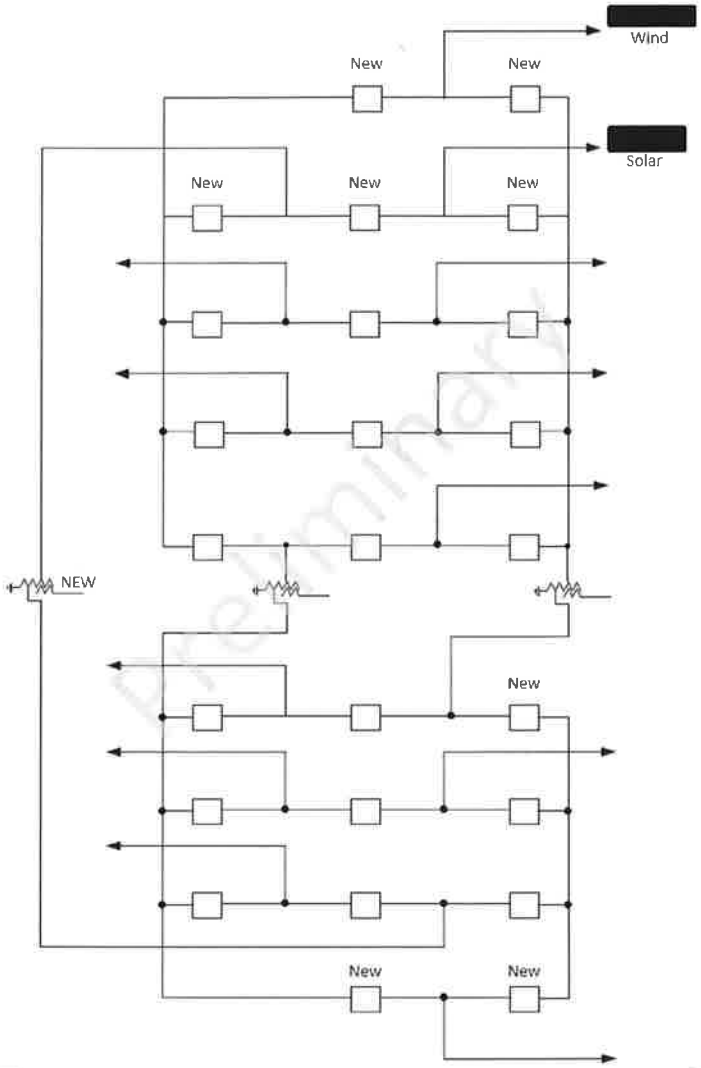

Figure 3 [redacted] Solar & Wind Network Resource Connection to [redacted]

7.4 Network Resource Cost Estimate

Table 3 below is a summary of the Network Transmission generation interconnection facilities and conceptual costs required to interconnect the GI #534 or GI #535 [redacted] Energy projects to the Transmission Provider's transmission system as a Network Resource.

GI #534 [redacted] 300MW Solar or GI #535 [redacted] Wind Projects **POI – [redacted] Station** **Energy Resource Generation Interconnection Facilities**

Network Resource Transmission Upgrades:	**Cost**
Midpoint – Boise Bench 230kV RAS	[redacted]
Subtotal	[redacted]
Contingencies (~20%)	[redacted]
Subtotal	[redacted]
Overheads (~10.0%)	[redacted]
Network Transmission – Total Estimated Cost	[redacted]
Energy Resource – Total Estimated Cost	[redacted]
Network Resource – Total Estimated Cost	[redacted]

Table 3. Estimated GI #534 or GI #535 Network Resource Generation Interconnection Costs

Table 4 below is a summary of the Network Transmission generation interconnection facilities and conceptual costs required to interconnect the GI #534 and GI #535 [redacted] Energy projects to the Transmission Provider's transmission system as a Network Resource. The Energy Resource estimate, reference Table 2, is not included as the integration of the 700MVA transformer necessitates a different topology, reference Figure 3, and the cost are captured below in Table 4.

GI #534 [redacted] 300MW Solar or GI #535 [redacted] Wind Projects POI – [redacted] Station Energy Resource Generation Interconnection Facilities	
Network Resource Transmission Upgrades:	**Cost**
Midpoint – Boise Bench 230kV RAS	[redacted]
Two new [redacted] rungs, associated breakers, purchase and integration of new 700MVA transformer	[redacted]
Subtotal	[redacted]
Contingencies (~20%)	[redacted]
Subtotal	[redacted]
Overheads (~10.0%)	[redacted]
Network Resource – Total Estimated Cost	[redacted]

Table 4. Estimated GI #534 and GI #535 Network Resource Generation Interconnection Costs

8.0 Transient Stability Analysis

The WECC 2019 Light Winter operating case and GE's Positive Sequence Load Flow (PSLF) analysis tool were used to perform the transient stability analysis.

When studied together the wind and solar plant controllers were set to control to the 34.5kV side of their respective GSU transformer for voltage control diversification else hunted against each other. The results showed no transient stability violations. The developer should validate their dynamic modeling data. It is their responsibility (per NERC Standard Requirements) to ensure the modeling data utilized reflects the wind turbines and inverters operations, and to provide updates to Idaho Power if they don't.

9.0 Description of Operating Requirements

It is the generation project's responsibility to provide reactive power capability of the project to have a power factor operating range of 0.95 leading (absorbing) to 0.95 lagging (supplying) at the POI over the range of real power output (up to maximum output of the project(s)).

GI #534, GI #535, and both GI #534 and GI #535 will be required to control voltage in accordance with a voltage schedule as provided by Idaho Power Grid Operations. And, GI #534, GI #535, and both GI #534 and GI #535 will be required to manage the real power output of their stated generation at the project's POI.

The project(s) 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*.

Installation of phasor measurement unit devices at the POI and maintenance costs associated with communication circuits needed to stream PMU data will also be required to be provided to interconnect GI #534, GI #535, or both GI #534 and GI #535. 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 generation interconnection customer choose to proceed to that phase of the interconnection process. Also, it may be beneficial for [redacted], for their own modeling compliance requirements, to install additional PMU devices at their facilities to monitor the generations sources separately.

10.0 Conclusion

GI #534 and/or GI #535 can be interconnected to the Idaho Power transmission system.

Interconnection requirements, detailed in Section 6.6 totaling [redacted] are required to interconnect one project as an Energy Resource. To connect both projects independently to the [redacted] Substation as an Energy Resource the cost is [redacted]. If the projects connect as a Network Resource, the cost to integrate one project is [redacted]. To connect both projects independently to the [redacted] Substation as a Network Resource the cost is [redacted]. If the project(s) connect to Idaho Power as a Network Resource, additional consideration is also required related to the interconnecting lines and station in the customer side of the POI as detailed in Section 7.1.

APPENDIX A

A-1.0 Method of Study

The System Impact 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 state, 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.

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 soon. 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

APPENDIX B

Table B2 is a summary of the Network Transmission generation interconnection facilities and conceptual costs required to interconnect the GI #530 Project to the Transmission Provider's transmission system as a Network Resource.

GI #530 Project	
Network Resource Transmission Upgrades:	**Cost**
Rattlesnake – Dram 230kV Line Rebuild 35.6 miles of 230kV line with 1590 MCM ACSR "Lapwing" Conductor	[redacted]
Dram – Boise Bench 230kV Line Rebuild 3.1 miles of 230kV line with 1590 MCM ACSR "Lapwing" Conductor	[redacted]
Boise Bench – Hubbard 230kV Line Loop in-and-out of Dram Station Build 1.25 miles 230kV Double Circuit Line with 1272 MCM ACSR "Bittern" Conductor	[redacted]
Dram 230kV Station Add two 230kV Line Terminals	[redacted]
Justice – Mountain Air Tap 230kV Line Rebuild 31.7 miles of 230kV line with 1272 MCM ACSR "Bittern" Conductor	[redacted]
Subtotal	[redacted]
Contingencies (~20%)	[redacted]
Subtotal	[redacted]
Overheads (~10.0%)	[redacted]
Network Transmission – Total Estimated Cost	[redacted]
Energy Resource – Total Estimated Cost	[redacted]
Network Resource – Total Estimated Cost	[redacted]

Table B2 GI #530 Network Resource

Revision History

Date	Revision	Initials	Summary of Changes
04/12/2019	0	ELS	Description