GENERATOR INTERCONNECTION

SYSTEM IMPACT STUDY REPORT

for integration of the proposed

IPC PROJECT QUEUE #618

to the

IDAHO POWER COMPANY ELECTRICAL SYSTEM

for

Idaho Power Company

REPORT v.1

Feb, 2022

Revision History

Date	Revision	Initials	Summary of Changes
2022	1	DLJ	SIS GI #618 – Updated Substation Transformer LTC Controller and its cost

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1.0 Introduction

[redacted] has contracted with Idaho Power Company (IPC) to perform a Generator Interconnection System Impact Study for the integration of the proposed 2.0 MW [redacted] Battery Energy Storage System (BESS) project (the Project). The Project is located in IPC's Southern Region at [redacted] in Township 10S, Range 16E, Section 8 in Twin Falls County, Idaho (See Figure 2, Figure 3, Figure 4, and Figure 5 in Appendix B). The Project is Generation Interconnect queue number 618 (GI #618).

The Project has applied to connect to the IPC distribution system for an injection of 2.0 MW at a single Point of Interconnection (POI) at a [redacted] voltage level. The POI is located at the [redacted] substation at [redacted].

This report documents the basis for and the results of this system impact study for the GI #618 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 system impact of interconnecting the 2.0 MW Project to IPC's [redacted] substation was evaluated.

The [redacted] 2.0 MW BESS will connect to the [redacted] in the [redacted] Substation.

The preliminary power flow analysis indicated that interconnecting the [redacted] Project to the [redacted] Substation will not adversely impact the IPC system with the upgrades detailed in this report. Additionally, Operating Requirements will require the generator to provide leading and lagging reactive power as detailed in section 12.0 of this report.

The Project will be required to control voltage in accordance with a voltage schedule as provided by Idaho Power Grid Operations.

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.

Idaho Power will repurpose the existing SEL 351-6/breaker in the metalcald mobile transformer bay location for BESS protection and isolation control.

The total preliminary cost estimate to interconnect the [redacted] project to the primary POI at [redacted] at the [redacted] substation is $ 366,409 and includes the following tasks:

- Substation Upgrades:
    - 150 kVA axillary power transformer
    - Install a [redacted] generation interconnection package at the POI
        - This includes an SEL-651 protective relay, which requires 3-phase PTs, 3-phase CTs, and remote connectivity
    - Install new load tap changer (LTC) controls on the substation transformer for generation reverse power flow.

The cost estimate includes direct equipment and installation labor costs, indirect labor costs and general overheads. 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 to construct 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, 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.
- 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

[redacted], GI #618, consists of a single POI with a 2.0MW BESS inverter and has requested to connect to Idaho Power's [redacted]. [redacted] requested that 2.0 MW total injection at the POI be studied.

5.0 Description of Transmission Facilities

The Project, GI #618, is in IPCO's Southern load serving area and does not directly impact any monitored transmission path. However due to its proximity to both the [redacted] this Transmission System Impact Study was studied with high flows on both paths and studied under heavy and light load conditions.

6.0 Description of Power Flow Case

The Project was studied using DNV Synergi load flow analysis software to analyze the impact to the [redacted] Substation. The Project was studied at peak load and minimum load conditions with all generators on the feeder generating at 100% output.

The Project was also reviewed for potential impacts on the IPC transmission system. This study utilized the WECC approved 21LW1 case as the starting point for the high path flow case, the 21HS3 case for the heavy load conditions, and the 20LSP1 case for the light load conditions of the studies.

The pre-contingency flows across the [redacted]/cut-planes were modeled near their respective ratings 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 ensure that the Total Transfer Capability of the adjacent paths are not impacted by the Project.

The heavy and light load cases were used to study the impact to the local 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.
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

There are no required upgrades to the distribution system. The BESS will connect directly into distribution substation bus and voltages will operate within operational guidelines, even during periods of light load and peak project output.

The impact of the proposed Project on the IPC transmission system was analyzed. Results from the studies performed indicate the addition of the Project, GI #618, will not result in N-1 contingency violations impacting either transmission path or any local transmission system elements.

8.0 Description of Substation Facilities

Idaho Power's [redacted] station is located in Twin Falls County, Idaho. [redacted] Substation is fed by a 46 kV transmission line. The substation transformer, [redacted], is a three-phase [redacted] delta wye-grounded transformer rated for [redacted]. [redacted] currently serves three [redacted] feeders: [redacted].

9.0 Description of Distribution Facilities

The Project was studied with a [redacted] connection to [redacted] Substation bus. This is a grounded-wye bus operating at [redacted]. The Project must have a grounded-wye transformer connection on the IPC side, as well as a delta connection on the Project side of the transformer.

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

10.0 Short Circuit Study Results

Fault Study: [redacted] *				
Configuration	**SLG (A)**	**3I0 (A)**	**LTL (A)**	**3PH (A)**
Existing System	5083.2	5083.2	3793.7	4381.0
Add 2MW BESS	6228.7	6228.7	4716.4	5446.4

*NOTE: All [redacted] feeder breakers are rated at [redacted] interrupt. Addition of 2MW of BESS to [redacted] does not exceed breaker ratings.

Table 1: GI #618 Short Circuit Currents, POI

The protection package will utilize the existing SEL 351-6/breaker in the metalcald mobile transformer bay location for BESS protection and isolation.

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

11.0 Description of Required Facility Upgrades

The following upgrades will be required to IPC-owned facilities to facilitate the interconnection of GI #618:

- Substation Upgrades:
  - 150 kVA axillary power transformer
  - Install a [redacted] generation interconnection package at the POI
    - This includes an SEL-651 protective relay, which requires 3-phase PTs, 3-phase CTs, and remote connectivity
  - Install new load tap changer (LTC) controls on the substation transformer for generation reverse power flow.

See the conceptual-level cost estimate in Table 1.

Item of Work	Estimate
Substation, Generation interconnection, and protection package	$ 284,354
Distribution upgrades	$ 0
Transmission upgrades	$ 0
Unloaded costs (1)	$ 284,354
20% Contingency	$ 56,871
Total unloaded costs	$ 341,225
Overheads (2)	$ 25,184
Total Conceptual-level Cost Estimate in 2019 dollars (3)	**$ 366,409**

Table 2: Conceptual-level Primary POI Cost Estimate for GI #618

(1) This cost estimate does not include any contingency to cover unknown events and occurrences or any changed circumstances. Idaho Power typically applies a contingency that ranges from 10-30% of the project cost, depending on the intricacies of the project and the status of the design, but no such amount is included in this cost estimate. Actual costs could deviate from the estimate.

(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 this estimate does not include the cost of the customer's equipment/facilities.
- 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.
- These are non-binding conceptual level cost estimates that will be further refined upon the request and completion of Transmission and Distribution Facility Studies.

12.0 Description of Operating Requirements

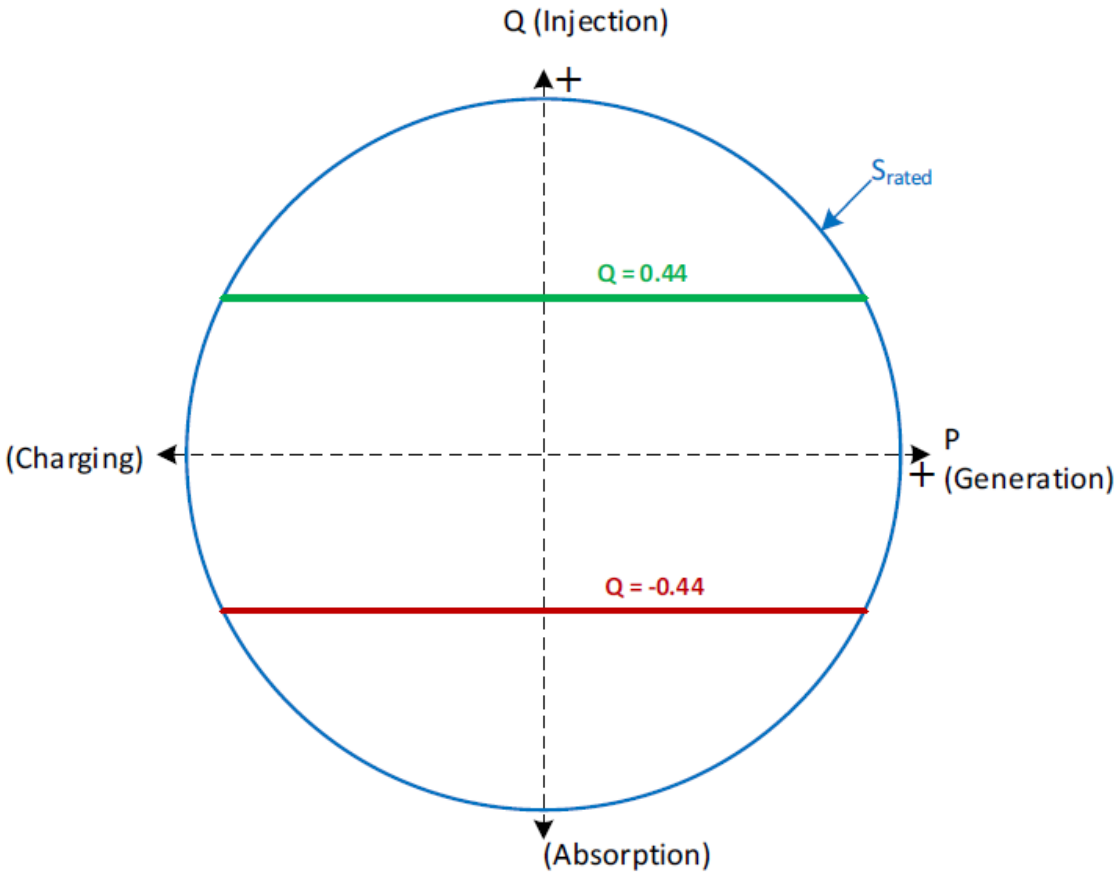

Figure 1: Operating Requirements

The Project shall be capable of operating in all four quadrants of the PQ plane. Figure 1 illustrates operating in the PQ plan with varying source voltage with Q(V) and P(V) functions enabled. The project shall be capable then of injecting reactive power (over-excited) equal to [redacted] and absorbing reactive power (under-excited) equal to [redacted] at all active power output between +/-100% of nameplate active power rating (whether charging or generating).

The Project will be required to control voltage in accordance with a voltage schedule and control charging in accordance with a load schedule as provided by Idaho Power Grid Operations.

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.*

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*.

Additional operating requirements for the Project may be identified in the System Impact Study when it is performed.

13.0 Conclusion

The requested interconnection of the [redacted] Project, GI #618, to Idaho Power's system was studied. The Project will interconnect to [redacted] Substation [redacted] bus.

The results of this study confirm that GI #618, [redacted] will not adversely impact the IPC system with the upgrades detailed in this report. A generation interconnect package at the POI is required to integrate the 2.0 MW project. Operating Requirements will require the generator to provide leading and lagging reactive power as detailed in section 12.0 of this report.

All generation Projects in the area ahead of the Project in the IPC generation interconnection queue and their associated transmission system improvements were included in this study.

The estimated cost to interconnect GI #618 to the IPC system at the [redacted] bus in the [redacted] Substation POI considered in this study is approximately $ 366,409.

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 DNV·GL's Synergi Electric 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 that, in part, 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 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.

APPENDIX B

Figure 2: [redacted] GI #618 Site Location

Figure 3: [redacted] Single Line 1/2 (Auxiliary Power Connection)

Figure 4: [redacted] Single Line 2/2 (BESS Connection)

Figure 5: [redacted] GI #618 Substation Layout Location