GENERATOR INTERCONNECTION
FEASIBILITY STUDY REPORT

for integration of the proposed

266 MW XXXXXXXXX
(GI #580)

to the

PACIFICORP ELECTRICAL SYSTEM

in

XXXXXXXX

for

XXXXXXXX

REPORT v.1

August 31, 2020

Revision History

Date	Revision	Initials	Summary of Changes
8/31/2020	1	GMT	Feasibility Study Report GI #580 – Original issue

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1.0 INTRODUCTION

XXXXXXXX has contracted with Idaho Power to perform a Generator Interconnection Feasibility Study (FeS) for the integration of the proposed 266 MW XXXXXXXX (Project) located in PacifiCorp's Eastern Idaho service territory in XXXXXXXX. Reference number GI #580 has been assigned to the Project in the Idaho Power GI queue.

The specific Point Of Interconnection (POI) studied is a 161 kV ring-bus substation inserting the Project into the existing 161 kV XXXXXXXX transmission line, jointly owned by PacifiCorp and Idaho Power and operated by PacifiCorp, approximately mid-way between XXXXXXXX and XXXXXXXX substations.

This report documents the basis for and the results of this FeS for the Generation Interconnection Customer. It describes the Project, the determination of interconnection feasibility and estimated costs for integrating the Project into the PacifiCorp Transmission System at 161 kV. This report was reviewed by PacifiCorp.

2.0 SUMMARY

The feasibility of interconnecting the 266 MW XXXXXXXX, GI #580, to the XXXXXXXX 161 kV line was evaluated.

Power flow analysis indicated that interconnecting the Project is feasible with the identified system upgrades. The Project will be required to control voltage in accordance with a voltage schedule as provided by PacifiCorp's Grid Operations. Therefore, the Project will be required to install a plant controller for managing the real and reactive power output of 266 MW Project at the POI. As an interconnection in the PacifiCorp territory on a transmission line operated by them a phasor measurement unit device (PMU) at the POI and the installation and maintenance costs associated with communication circuits needed to stream PMU data may be required.

A System Impact Study (SIS) is required to determine if any additional network upgrades are required to integrate the Project into PacifiCorp's transmission system. 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 Network Upgrades associated with transmission service may be necessary if firm transmission is required to deliver the Projects generation from the POI to a point of delivery. A Transmission Service Request (TSR) will be required to secure transmission rights on either the Idaho Power or PacifiCorp system, either through latent capacity, or Network Upgrades. Either the interconnection customer, or the merchant purchasing the generation from the interconnection customer, will have to make this TSR. Transmission rights are beyond the scope of this Generation Interconnection FeS. **Transmission Network Upgrade costs associated with transmission service are not included in this FeS. However, these costs could be sizeable.**

The total preliminary cost estimate to interconnect the XXXXXXXX, GI #580, as requested to the 161 kV line between XXXXXXXX and XXXXXXXX substations is **$22,228,800**.

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 does not include the cost of the customer's equipment to construct the generation facility.

3.0 SCOPE OF INTERCONNECTION FEASIBILITY STUDY

The Interconnection FeS was performed and prepared in accordance with Idaho Power Standard Generator Interconnection Procedures, to provide a preliminary evaluation of the feasibility of the interconnection of the proposed generating project to the local transmission system. As listed in the Interconnection FeS agreement, the Interconnection FeS 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 Transmission System and to address the identified short circuit and power flow issues.

Generation projects in the Generator Interconnect queue prior to this project could impact the cost of interconnection. A current list of projects in Idaho Power's queue can be found in the Generation Interconnection folder located on the Idaho Power OASIS web site at the link shown below:

http://www.oasis.oati.com/ipco/index.html

4.0 DESCRIPTION OF PROPOSED GENERATING PROJECT

XXXXXXXX, GI #580, proposes to interconnect to the PacifiCorp transmission system on a jointly owned Idaho Power and PacifiCorp facility at 161 kV with a total injection of 266 MW (maximum project output). The POI is XXXXXX on the 161 kV XXXXXXXX transmission line. This project's requested in-service date is November 30, 2022.

Table 1: Project Specifications

POI Location	XXXXXXXXXX
Number and Type of Generators	Vestas (V5.6-166m) Quantity = 49
Individual Generator Nameplate Rating	5.6 MW 7000 kVA
Total Output Power Rating	274.4 MW
Rated Power Factor	0.9 Leading / 0.9 Lagging
New Step-Up Transformer	#1: 150 MVA, 3-phase, 161/34.5/13.8 kV, Z = 10%, X/R = 36.1 #2: 155 MVA, 3-phase, 161/34.5/13.8 kV, Z = 10%, X/R = 36.6
Interconnection Voltage	161 kV

5.0 DESCRIPTION OF EXISTING TRANSMISSION FACILITIES

The XXXXXXXX, GI #580, interconnection to the XXXXXXXX 161 kV line was studied in this FeS. The Project is located approximately 12.9 miles west of the proposed POI.

Preliminary power flow analysis indicated that interconnection of a 266 MW injection at the POI considered in this study is feasible with the following transmission system improvements: a new 161 kV class substation with a three-position ring bus; rebuilding the existing 161 kV line from XXXXXXXX to XXXXXXXX and the existing 161 kV line from XXXXXXXX to XXXXX, both with 954 Cardinal ACSR conductor.

A SIS will be required to determine specific network upgrades required to transfer the Project output of 266 MW to load.

5.1 Transmission Line Facilities

The Project will be inserted in the XXXXXXXX 161 kV line.

5.2 Substation Facilities

A new 161 kV substation will need to be constructed adjacent to the existing XXXXXXXX 161 kV line. The line will be broken adjacent to the new substation and the line sections will be terminated in the substation as two individual lines along with the customer owned line in a three-position ring bus in a manner similar to Figure 1.

Figure removed

Figure 1 - Proposed interconnection station

The new substation will include protective relaying systems for all three lines, SCADA, communications, and a Generation Interconnection metering package. The POI will be the circuit breakers for the customer's line.

5.3 Grounding Requirements

The proposed 161 kV Wye-Grounded/Wye-Grounded with Delta Tertiary transformers specified in the Idaho Large Generator Interconnection Request for XXXXXXXX, GI #580, should provide an adequate ground source for transmission line protection/relaying.

Grounding requirements and acceptability criteria are found in Appendix A.

5.4 System Protection Assessment

Short Circuit details at approximate interconnect location:

PacifiCorp will need to verify fault currents are within all device ratings.

Fault duty at each of the breakers with and without the generation.

Table Removed

Fault duty at each of the buses with and without generation.

Table Removed

6.0 DESCRIPTION OF POWER FLOW CASES

PowerWorld simulator software was used to evaluate several power flow cases and determine the impact of the Project. The 24HS2a1_GI580_Path_18_N-S.pwb and 21HW2a_GI580_Path_18_S-N.pwb cases were used because they represent Summer and Winter peak loads and flows respectively in opposite directions for Path 18. 24LSPa1_GI580_Path_18_N-S.pwb was used to study the impact during lighter load seasons. These cases were created from the similarly named WECC Base Cases and modified to add the Project and other projects in the local area and stress Path 18 near it's limit.

The original WECC cases provide baseline loads and voltages in the area prior to adding the Projects.

The levels of flow represented in the study cases are intended to capture potential impact of the Project on the existing transmission system.

7.0 POWER FLOW STUDY RESULTS

Power Flow Analysis was performed on the cases described above. The base cases were used to simulate the impact of the proposed XXXXXXXX, GI #580, 266 MW Project interconnection during normal and contingency operating conditions (TPL-001). Mitigation of any adverse changes in loading or voltage from pre- to post-Project was identified.

The contingencies simulated include:

- All transformers and transmission lines in the local area of the proposed Project.
- The proposed project.

The results of the power flow studies were evaluated using WECC/NERC planning standards and Idaho Power planning standards. The power flow analysis related evaluation criteria that were used are summarized below:

- All transmission facilities must remain within their thermal limits.
- Pre-contingency bus voltages within the study area must be between 0.95 per unit and 1.05 per unit.
- Maximum voltage deviation allowed at all buses under contingency conditions will be 5% for N-1 (NERC Category B).

Power flow solution was achieved for each of the N-1 outages simulated. Key findings from the power flow analysis are as follows:

- Overloading. When the 161 kV lines connected to the POI substation were removed one at a time; the remaining line overloaded beyond its emergency rating. Also, the XXXXXXXX-XXXXX line experienced significant overloads when the line from the POI substation to XXXXXXXX was removed.
- Voltage Deviation. There were no significant voltage deviations in the power flow analysis.
- Voltage Violations. There no significant voltage violations in the power flow analysis.

8.0 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. At full output of 266 MW, the Project would need to be able to provide approximately +/- 83.06 MVAr reactive support plus the reactive energy consumed by the customer's own facilities. Detailed information of the customer's collector system was not evaluated for this Feasibility Study.

Identification of any additional equipment required at the Project to meet reactive power capability interconnection requirements will be provided in the SIS.

The Project will be required to control voltage in accordance with a voltage schedule as provided by PacifiCorp Grid Operations. The Project is required to install a plant controller for managing the real and reactive power output of the 266 MW Project at the 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*.

9.0 COST ESTIMATE

The following two sections describe first, the cost estimate for the Project as the customer's application requests and second, the cost estimate if the customer reduced the size of their request to approximately 200 MW.

9.1 Cost Estimate at 266 MW at POI.

The following upgrades will be required to facilitate the interconnection of XXXXXXXX, GI #580:

- Construct a new 161 kV three-position ring bus substation.
- Install generation interconnection package at the POI. This includes two 161 kV power circuit breaker, SEL-421 protective relay, which requires 3-phase potential transformers (PTs), 3-phase current transformers (CTs) for each circuit breaker, SCADA and remote connectivity.
- Install a 161 kV power circuit breaker to form the remainder of the ring bus and the associated protection systems for the two lines.
- Line work to break existing 161 kV line and terminate each end at substation.
- Rebuild both sections of the existing XXXXXXXX 161 kV Line.
- Rebuild the existing XXXXXXXX-XXXXX 161 kV line.
- Note that this cost estimate does not include the cost of the customer's equipment/facilities or required communication circuits.
- These are estimated costs only and final charges to the customer will be based on the actual construction costs incurred.

Table 2: Conceptual Cost Estimate

Item of Work	Estimate
Substation construction and Generation interconnection and protection package	$5,015,000
Transmission upgrades	$11,825,000
Unloaded costs	$16,840,000
Contingency 20% (1)	$3,368,000
Total unloaded costs	$20,208,000
Overheads (2)	$2,020,800
Total Conceptual-level Cost Estimate in 2020 dollars (3)	**$22,228,800**

(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.

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

9.2 Cost Estimate at approximately 200 MW at POI.

Alternately, if the project were to reduce the output for its application to approximately 200 MW at the POI, the project could be interconnected to the XXXXXXXX line without having to rebuild the XXXXXXXX 161 kV line; the following upgrades will be required to facilitate the interconnection of XXXXXXXX, GI #580:

- Construct a new 161 kV three-position ring bus substation.
- Install generation interconnection package at the POI. This includes two 161 kV power circuit breaker, SEL-421 protective relay, which requires 3-phase potential transformers (PTs), 3-phase current transformers (CTs) for each circuit breaker, SCADA and remote connectivity.
- Install a 161 kV power circuit breaker to form the remainder of the ring bus and the associated protection systems for the two lines.
- Line work to break existing 161 kV line and terminate each end at substation.
- Rebuild the existing XXXXXXXX-XXXXX 161 kV line.
- Note that this cost estimate does not include the cost of the customer's equipment/facilities or required communication circuits.

Table 3: Alternate Conceptual Cost Estimate

Item of Work	Estimate
Substation construction and Generation interconnection and protection package	$5,015,000
Transmission upgrades	$4,375,000
Unloaded costs	$9,390,000
Contingency 20%	$1,878,000
Total unloaded costs	$11,268,000
Overheads	$1,126,800
Total Conceptual-level Cost Estimate in 2020 dollars	**$12,394,800**

10.0 CONCLUSIONS

The requested interconnection of the XXXXXXXX, GI #580, to the XXXXXXXX 161 kV line in PacifiCorp's Eastern Idaho operating area was studied.

The results of this study work confirm that it is feasible to interconnect the Project to the existing XXXXXXXX 161 kV line. The results from the power flow analysis and short-circuit analysis confirm that the interconnection of the Project with the identified upgrades will not have significant impact on the local transmission system.

A SIS 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).

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 SIS phase of the generator interconnection process.

APPENDIX A

A-1.0 Method of Study

The FeS 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 PacifiCorp'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 and PacifiCorp. 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 specifies, 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 POI, 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 Idaho Power or PacifiCorp 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

Idaho Power requires interconnected transformers to limit their ground fault current to 20 amps at the POI.

A-4.0 Electrical System Protection Guidance

Idaho Power 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-5.0 WECC Coordinated Off-Nominal Frequency Load Shedding and Restoration Requirements

Idaho Power 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.

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

APPENDIX B. PROJECT LOCATION

XXXXXXXX was studied with a POI just north of where the XXXXXXXX 161 kV line crosses XXXX, west of XXXXXX.

Figure was removed

Figure 2 - Project Location