Small Generator Interconnection System Impact Study Report

Completed for
Interconnection Customer
SGIQ0333

Proposed Interconnection
PacifiCorp's 24.9-kV Circuit, SML21, out of South Milford Substation

October 15, 2010
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1.0 Description of the Generating Facility

The Interconnection Customer has proposed interconnecting 2.8 MW of new biomass generation to PacifiCorp’s (“Distribution Provider”) PacifiCorp's 24.9-kV circuit, SML21, out of South Milford Substation located in Beaver County, Utah. The project will consist of two (2) 1,400 kW synchronous generators for a total output of 2.8 MW. The two generator units will be tied into the grid through a single point of interconnection. Each generator will be stepped-up through a 2000 kVA 277/480V to 24.94-kV step-up transformer. The requested commercial operation date is approximately October 1, 2011.

Interconnection Customer will NOT operate this generator as a Qualified Facility as defined by the Public Utility Regulatory Policies Act of 1978 (PURPA).

The Distribution Provider has assigned the project “Q0333.”

2.0 Scope of the Study

The System Impact Study Report shall consist of a short circuit analysis, a stability analysis, a power flow analysis, voltage drop and flicker studies, protection and set point coordination studies, and grounding reviews, as necessary. The System Impact Study shall state the assumptions upon which it is based, state the results of the analyses, and provide the requirement or potential impediments to providing the requested interconnection service, including a preliminary indication of the cost and length of time that would be necessary to correct any problems identified in those analyses and implement the interconnection. The System Impact Study shall provide a list of facilities that are required as a result of the Interconnection Request and non-binding good faith estimates of cost responsibility and time to construct.

3.0 Point of Interconnection

The proposed generation facility is to be interconnected, through two (2) 2000 kVA 277/480V to 24.94 kV step-up transformers. The customer has requested to interconnect to Distribution Provider’s 24.9-kV circuit, SML21, out of South Milford Substation.

4.0 Study Assumptions

- All active higher priority transmission service and/or generator interconnection requests will be considered in this study and are listed in Appendix 1. If any of these requests are withdrawn, Distribution Provider reserves the right to restudy this request, and the results and conclusions could significantly change.

- For study purposes there are two separate queues:
  - Transmission Service Queue: to the extent practical, all network upgrades that are required to accommodate active transmission service requests and are expected to be in-service on or after the Interconnection Customer’s requested in-service date for the Project will be modeled in this study.
  - Generation Interconnection Queue: when relevant, interconnection facilities associated with higher queue interconnection requests will be modeled in this study. No generation will be simulated from any higher queued project unless a commitment has been made to obtain transmission service.

- The Interconnection Customer’s request for interconnection service in and of itself does not convey transmission service.
• This study assumes the Project will be integrated into Distribution Provider’s system at the agreed upon and/or proposed point of interconnection.

• The Interconnection Customer will construct and own the any facilities required between the point of interconnection and the Project.

• Generator tripping may be required for certain outages.

• All facilities will meet or exceed the minimum WECC, NERC, and Distribution Provider performance and design standards.

5.0 Study Results

5.1 Generating Facility Modifications

The step-up transformers at the generating facility with need delta windings on the 480 V side and wye windings with the neutral grounded on the 24.9-kV side. This is different than that shown on the customer’s one line diagram. On the 24.9-kV side the customer will need a circuit breaker or recloser. These facilities are shown in Figure 1.

Figure 1: System One Line Diagram
5.2 **Distribution Modifications**

The line voltage regulators between this project and Distribution Provider’s South Milford Substation will need to be upgraded to at least 500 kVA. The Blue Mountain line voltage regulators will not need to be upgraded. Since the interconnection point is beyond Distribution Provider’s Skyline West line recloser, a setting change to the line recloser to accommodate the possibility of reverse power flow may be needed.

**NOTE:** This is a very long and exposed circuit and is prone to outages, both momentary and extended. Line personnel are located some distance from the circuit and restoration times can be extended to hours or even days. System upgrades that would be necessary to guarantee circuit reliability are very costly and not economically feasible for normal operation of this circuit. Rocky Mountain Power makes no representations that this circuit will be reliable enough to assure economical operation of the generation proposed herein.

The area is also sensitive to voltage control and the Transmission Customer would be expected to follow the voltage control requirements outlined below:

The Interconnection Customer shall design its generating facility to operate reactive compensation, under voltage control mode, with the voltage sensed electrically at the point of interconnection and to have sufficient reactive capacity to enable the facility to deliver 100 percent of the plant output to the point of interconnection at unity power factor measured at 1.0 per unit voltage.

The voltage control shall be designed to include a voltage control band, nominally set to 1.01 and 1.04 per unit (actual voltage band may be adjusted depending on typical voltage at the interconnection or other area local conditions), such that if the actual voltage is above the upper band setting, capacitor increments will be automatically removed and if the actual voltage is below the lower band setting, capacitor increments will be automatically be added. The control scheme should be designed so as to avoid hunting when switching between modes (i.e., effectively power factor control inside the band, voltage control outside the band). Inside the voltage bandwidth, the facility shall operate as much as possible to a unity power factor. Settings must be coordinated with the Distribution Provider who may, from time to time, request changes in response to operating conditions or actual operating experience. The reactive compensation must be designed such that the capacitor switching does not cause step voltage changes greater than +/-3% on the Distribution Provider’s system.

5.3 **Existing Breaker Modifications – Short-Circuit**

The increase in the fault duty on the system as a result of the addition of the generation facility, comprised of two 1750 kVA generators connected to the transmission system through two (2) MVA 24.9-kV – 480 V transformers with an impedance of 5.25%, will not require the replacement of any of the existing fault interrupting devices.
5.4 Protection Requirements

The one line diagram in Figure 1 shows how the generator facility will be connected to the 24.9-kV distribution feeder out of South Milford substation. South Milford substation is fed off of the 46-kV line from Cameron substation. The Q0162 generation facility is already connected to the Blue Mountain Feeder out of South Milford substation and the Q0322 project is planned to be connected to the same feeder. The generators at all of the projects need to disconnect from the system when the breaker at Cameron substation is opened due to a problem on the 46-kV system. In some cases the amount of load on the isolated power system will cause the generators to disconnect but during light load periods, the potential power output from the combination of generation facilities will be greater than the load on the connected 46-kV line. In those cases the load cannot be depended upon to cause the disconnection of the generators.

To accomplish this function, protective relays have been installed at South Milford substation to detect faults on the 46-kV system. When a fault occurs on the 46-kV system the generators must be disconnected in less than 10 cycles so that the 46-kV breakers at Cameron substation can automatically reclose thus re-energizing the line. Most faults are not permanent and the fast interruption of the fault and the re-energizing of the system will restore service to the connected load. To accomplish the high speed disconnection of the generators, the protective relays send a transfer trip signal from South Milford substation to the Q0162 facility over an optical fiber communication system. The transfer trip signal will also be triggered any time that the breaker 21 at South Milford substation is opened. The optical fiber used to communicate between South Milford substation and the Q0162 facility will need to be spliced at the location nearest to the Q0333 project and continued on to the new generation facility. The same transfer trip signal being sent to the other generation facilities on the Blue Mountain Feeder will also need to disconnect the Q0333 project.

Due to the length of the Blue Mountain Feeder a line recloser has been installed in the line about 12.1 miles from South Milford substation. This line reclose, labeled Circle 4 Recloser on Figure 1, operates for faults on the feeder beyond the recloser. The Q0333 project will be connected 2.6 miles beyond the recloser. The reclosers present protection relaying functions are non-direction overcurrents. The Q0333 project will contribute to faults between the recloser and South Milford substation at a level to cause the recloser to operate. This type of operation will not be acceptable and the recloser controls will need to be modified to make the overcurrent functions directional. This modification will configure the recloser to only operate for feeder faults in the opposite direction from South Milford substation. The recloser will also need to be equipped with dead line detection. This function will block the reclosing of the recloser for faults beyond the recloser until the Q0333 generators have disconnected from the line.

The generators at the Q0333 project must disconnect from the system any time the Circle 4 Recloser operates for faults on the feeder. This disconnection of the generation must occur in 10 cycles or less so that the recloser can automatically re-energize the line. Most faults are not permanent and the fast interruption of the fault and the re-energizing of the system will restore service to the connected load. To accomplish the high speed
disconnection of the generators a communication circuit between the Circle 4 Recloser and the Q0333 substation will need to be installed to carry a transfer trip signal from the recloser to the Q0333 substation any time the recloser opens.

The Distribution Provider will design and supply a relay system to be installed at the generation facility tie breaker. This relay which will be connected to current transformers on the 24.9-kV generation facility breaker and 24.9-kV voltage transformers and will perform the following protective relaying functions:

1. Communication with the relay at South Milford substation and the Circle 4 Recloser to receive the transfer trip signals.
2. Monitoring the voltage magnitude and frequency. If the magnitude or frequency of the voltage is outside of normal range of operation the 24.9-kV tie breaker will be tripped.
3. Monitoring the current and the voltage to detect faults on the 24.9-kV distribution line between South Milford substation and the generation facility. This fault detection will be a backup to the transfer trip for the opening of breaker 21 at South Milford substation and the Circle 4 Recloser. The relaying will be time delayed to coordinate with the existing protective equipment on the distribution line.

The South Milford #2 transformer is rated for 14 MVA and with the additional of the proposed generation on the circuit connected to the low side of this transformer there is the potential for overload during light local load periods of the year. The transformer could be replaced with a larger transformer or a less expensive option has been identified with the installation of a Remedial Action Scheme (“RAS”) to transfer trip the Q0333 project generators when it is detected at South Milford substation that the transformer is overloaded.

All of the protective relaying that has been noted in this report is for the protection and safe, reliable operation of the transmission facility. Additional relaying will be needed for detecting problems in the generation facility. The relaying for the plant is the responsibility of the Interconnection Customer.

5.5 Operational Data Requirements (RTU)

Data for the operation of the power system will be needed from the Interconnection Customer’s generation facility. This data can be acquired by installing a RTU. The following is a listed of the data that will be acquired:

Analogs:
- Net Interchange Real Power
- Net Interchange Reactive Power
- Real power flow from Generator 1
- Reactive power flow from Generator 1
- Real power flow from Generator 2
- Reactive power flow from Generator 2
- 24.9-kV A phase voltage
- 24.9-kV B phase voltage
- 24.9-kV C phase voltage

Accumulator Pulses:
- Interchange metering kWh

Status:
- Generator 1 480 V breaker
- Generator 2 480 V breaker
- 24.9-kV System Tie breaker
- Line Relay Alarm

5.6 Communication Requirements for Line Protection

Single mode, fiber optic cable is required between the Q0333 substation and the Q0162 facility interconnection tap point. This line will need to be installed by the Distribution Provider and meet the Distribution Provider’s technical standards.

The fiber node required in the C0333 substation will need to be interconnected to the Circle 4 Recloser, the South Milford substation, and the Thermo substation (Q0162) fiber nodes. Four (4) fibers, out of twelve (12) fibers, are allocated for the Distribution Provider’s use on the existing fiber node communications between South Milford substation and Thermo substation on existing fiber over the 24.9-kV line between Thermo substation and South Milford substation. Note that the existing twelve (12) fiber cable was purchased by the Q0162 and installed and owned by South Central Communications. It will be the responsibility of the Interconnection Customer to obtain an agreement from South Central Communications for tapping into the fiber at the Intermountain Renewable tap point. If an agreement cannot be obtained, a 960 MHz microwave radio system to the Distribution Provider’s Rowberry communications site will be required to either the Q0333 substation or the Circle 4 Recloser location. New fiber would then only be required between the Circle 4 Recloser location and the Q0333 substation.

Distribution Provider will supply and install a fiber node and multiplex equipment in the Q0333 substation and at the Circle 4 Recloser location. This equipment will be used to provide relay protection from South Milford substation and from the Circle 4 Recloser location to the Q0333 substation. It will also be used for connecting the Q0333 RTU to the Distribution Provider’s control center as well as for voice, relay, and data OPX circuits. The Interconnection Customer is to supply 130 V DC, battery backed up power for the communications equipment to be located in the Q0333 substation. The Distribution Provider will need to supply a building, battery, charger, and miscellaneous equipment at the Circle 4 Recloser location to house and power the fiber node and multiplex equipment installed at this location.

In addition to the two new locations, channel work will be required at South Milford substation, Rowberry communications site, Scipio Pass communications site, SCC, and PCC.
5.7 Substation Requirements

The South Milford #2 transformer is rated for 14 MVA and with the additional of the proposed generation on the circuit connected to the low side of this transformer there is the potential for overload during light load periods of the year. Because of this potential for overload, a generator tripping scheme will be implemented with all the necessary equipment. If it is determined that the occasional tripping of the generation for the overloading the South Milford #2 transformer is unacceptable then the transformer will need to be replaced with a larger transformer.

5.8 Metering Requirements

The revenue metering options are that it can be either underground or overhead. It is anticipated that the project will utilize an underground option. Should the customer determine that overhead is desired, that change can be modified and incorporated in the next study. The metering will be designed and installed to the Distribution Provider’s specifications.

An underground metering service will require an underground feed and will require a primary metering station. The approved primary metering requirements are described in the Six States Electric Service Requirements manual. The primary metering facility can be either a switchgear or standalone meter design.

If a building is provided the metering package will consists of a standard meter panel. If there is no building then the metering can be located inside an outdoor meter enclosure. In both cases the metering must be located near the communication equipment. The metering package must be mounted in close proximity to the RTU for communications.

6.0 Cost Estimate

The following estimate represents only scopes of work that will be performed by the Distribution Provider. Costs for any work being performed by the Interconnection Customer are not included.

**Direct Assigned**

Interconnection Customers Substation $476,000

Metering, structures for tap into line, switches, and communications including 5 miles of fiber to interconnect the generation facility.

Subtotal Direct Assigned $476,000

**Network Upgrades**

Circle 4 Regulator Upgrade $100,000

Upgrade the existing regulator including structure modifications.
Circle 4 Regulator Communications $ 579,000
  Communications and relaying to interconnect the generation facility.
Various Communications Sites $ 160,000
  Communications to interconnect the generation facility.

Subtotal Network Upgrades $ 839,000

Estimated Total Project Costs $ 1,315,000

Note: This estimate is as accurate as possibly given the level of detailed study that has been completed to date and approximates the costs incurred by Distribution Provider to interconnecting this generator to Distribution Provider’s electrical distribution system.

Assumptions:
- All costs are anticipated to be incurred in 2011.
- Design costs are included and engineering is based on in-house labor with all major construction work performed by in-house crews.
- The customer substation is assumed to be constructed next to Distribution Provider’s existing distribution line.
- The estimate is for normal construction weather or unusual conditions. Engineering and construction labor are assumed readily available to work on this project. Construction is assumed to occur during non-winter periods.
- One outage will be required to complete the final tie-in of the 24.9-kV to the SML21 distribution line.

A more detailed estimate is calculated during the Facilities Study. The Interconnection Customer will be responsible for all actual costs, regardless of the estimated costs communicated to or approved by the Interconnection Customer.

7.0 Schedule
It is estimated that it will take approximately eighteen (18) months from the date of an executed small generation interconnection agreement or an engineering and procurements agreement, to design, procure and construct the facilities requested to accommodate this interconnection request. The schedule will be further developed and optimized during the system impact study.

The schedule is driven by the date that the Small Generator Interconnect Agreement is signed. Changes in this date affect the entire schedule. Please note that this timeframe does not support the Interconnection Customer’s requested in-service date of October 1, 2011.

8.0 Participation by Affected Systems
No Affected Systems were identified in relation to this Interconnection Request.

9.0 Appendices
Appendix 1: Higher Priority Requests
APPENDIX 1: HIGHER PRIORITY REQUESTS

All active higher priority transmission service and/or generator interconnection requests will be considered in this study and are identified below. If any of these requests are withdrawn, the Distribution Provider reserves the right to restudy this request, as the results and conclusions contained within this study could significantly change.

Transmission/Generation Interconnection Queue Requests considered:

Q0332 (2.8MW)
Q1210 (3MW)