TRANSMISSION PLANNING

GENERATION INTERCONNECTION REPORT

Feasibility Study (IFES)

G0598

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1 Introduction

This Interconnection Feasibility Study (FES) examines the transmission system electrical impacts of integrating 160 MW of solar generation at the Bonneville Power Administration Transmission Service (BPA-TS) Knight substation located six miles northwest of the town of Goldendale in Klickitat County, WA. This customer request was entered into the BPA-TS Interconnection Queue as Request G0598. The requested energization date is December 2021.

The proposed solar plant would generate up to 160 MW(ac) of solar generation along with 63 MW(ac), 250 MWh of battery storage. The primary point of interconnection is on the North Bonneville-Midway 230 kV line at the existing Knight substation. An alternative point of interconnection is at Knight 500 kV with a 500/230 kV transformer.

This FES consists of powerflow and short circuit analysis and provides a list of facilities and non-binding good faith estimates of cost and a non-binding good faith estimated time to construct. The purpose is to quickly identify any major adverse system impacts resulting from the requested interconnection and to help the customer determine the best location for interconnection.

The Customer requested this project be considered for both Energy Resource Interconnection Service (ERIS) and Network Resource Interconnection Service (NRIS). The NRIS impact will be evaluated in a system impact study.

No other parties are impacted by this request.

2 Conclusions

This FES concludes that it is feasible to interconnect the full 160 MW of proposed solar generation with the primary plan of service, a 230 kV connection to the Midway-North Bonneville 230 kV line. A good faith, non-binding estimated cost for this interconnection of G0598 is $27.2 million.

It is also feasible to interconnect the full 160 MW of proposed solar generation with the alternate plan of service, which assumes a new 500/230 kV transformer connected to an existing 500 kV bay at Knight substation. A non-binding estimated cost for this alternative interconnection of G0598 is $56.6 million if BPA installs and owns the transformer and a new 230 kV yard at Knight Substation. If the customer installs and owns the transformer the estimated cost to interconnect to Knight Substation at 500 kV is $9.4 million.

Due to the interconnection requiring significant transmission infrastructure, a non-binding good faith estimate to interconnect is 36 to 48 months after a signed construction agreement, based on typical timelines. This schedule would be further refined in a Facilities Study. Meeting the desired energization of December 2021 will be difficult if not impossible.

The technical study results included in this document are for generator interconnection only. Technical studies for transmission service for delivery of output beyond the point of interconnection are not included. Any transmission service for delivery beyond the point of interconnection must be requested and arranged for separately. In addition, the technical studies included in this document only address generator interconnection capacity and do not address generator balancing services such as Generation Imbalance Service or Balancing Service for Solar Resources.

These studies were conducted using the best available information at the time of the study. Findings and recommendations are based on assumptions, which could change. BPA-TS reserves the right to modify any content in this report.

3 Facilities

3.1 High Voltage Plan of Service

The primary plan of service develops a Knight 230 kV yard with a three breaker ring bus looping in the North Bonneville-Midway 230 kV line as well as interconnecting a 230 kV generation tie line to the proposed Solar collector station. The Knight 230 kV yard remains isolated from the existing Knight 500 kV yard.

An alternative plan of service would build out an existing Knight 500 kV bay connecting to a 500/230 kV transformer connected to the proposed Solar generation tie line. The Knight 230 kV equipment would be isolated from the North Bonneville-Midway 230 kV line.

This study assumes all equipment beyond Knight substation will be installed by the Customer.

3.2 Communications Plan of Service

The communications plan of service for this Study relies on the existing communication facilities at Knight which are WECC-compliant and fully-redundant.

3.2.1 Interconnection Station

For the proposed Solar request G0598, BPA-TS will use the existing communication facilities at Knight which are WECC-compliant and fully-redundant.

The solar plant will be required to participate in the main grid RAS, and the Customer must provide WECC-compliant, fully redundant communications circuits from the proposed Solar collector station to Knight substation to be interconnected with BPA's communications network.

BPA will install, own, and operate the control and communications (C&C) equipment at the Knight substation point of interconnection. BPA-TS will provide incremental additions on its existing communications system to provide the required connectivity for the added circuits for the project.

3.2.2 Collector Station

The Customer will install, own, and operate all equipment including the metering at the Customer's proposed Solar collector station. Customer will work with BPA-TS to grant BPA-TS access to the Customer's meter via either a cellular gateway or over IP.

3.2.3 Control Centers

BPA-TS will update the existing SCADA, SEMM, and RAS masters at Dittmer and Munro Control Centers. BPA-TS will install relays to interface with the relays at the proposed Solar collector station for RAS.

3.2.4 Network Communications Expansion

Communications network expansion is not anticipated for this project.

3.3 Remedial Action Schemes (RAS)

In order to maximize transfer capabilities across the transmission system and maintain flexibility and effectiveness of the main grid RAS, this project will be required to be available for generator tripping under the DC RAS. The alternate plan of service would also require generator tripping under the AC RAS. Redundant communication circuits for RAS are required to meet WECC requirements.

3.4 Plant Reactive Requirements

To maintain existing transfer capabilities across the main grid transmission system BPA-TS requires a 0.95 lead or lag power factor at the POI (Knight). The reactive compensation will be on voltage control using line drop compensation (LDC) with BPA-TS providing voltage schedules.

3.5 Protection, Control, and Monitoring Requirements

3.5.1 Relaying, Transfer Trip, and Auto-reclosing

Current-differential relaying equipment will be required between Knight substation and the proposed Solar collector station. These relays will not automatically reclose. No transfer trip will be required.

3.5.2 Metering and SCADA

The proposed Solar generation must be reported to SCADA. Access to the Customer's meter is required.

3.5.3 Phasor Measurement Unit

A Phasor Measurement Unit (PMU) will be required at the proposed Solar collector station. This study assumes the Customer will acquire and install the PMU.

4 Estimates

4.1 Estimated Cost

The following are non-binding good faith cost estimates based on previous estimates for other similar projects. Communication and Control (C&C) costs apply to either of the following plans of service.

"Back of Envelope" C&C estimates (in $k)

Equipment Costs	
Collector Site	$209
POI Substation	$92
Control Centers	$30
Misc Sites	$2
Total C&C Material	**$333**
Overhead 26%	$87
Labor Costs	
Collector Site	$332
POI Substation	$139
Control Centers	$44
Misc Sites	$9
Total C&C Material	**$524**
Overhead 57%	$299
Sub-Total	**$1,242**
Contingency 40%	$497
Total	**$1,739**

4.1.1 Primary POI on North Bonneville-Midway 230 kV Line

For interconnection to a new Knight 230 kV terminal with a loop in of the existing 230 kV line:

Estimate for similar work (S3-1170-1-1)		(in $k)
Equipment Costs		
BPA Material		$59
C&C Material (BOE estimate)		$333
Collector Site	$209	
POI Substation	$92	
Control Centers	$30	
Misc Sites	$2	
Contract Material		$3,318
Overhead 26%		$878
Labor Costs		
BPA Labor		$889
C&C Labor (BOE estimate)		$524
Collector Site	$332	
POI Substation	$139	
Control Centers	$44	
Misc Sites	$9	
Contract Labor		$8,778
Overhead 57%		$5,054
Sub-Total		**$18,174**
Contingency 40%		$7,270
C&C Costs		$1,739
Total		**$27,183**

4.1.2 Alternate POI at Knight Substation

For interconnection to a existing Knight 500 kV terminal, assuming the customer installs and owns a 500/230 kV transformer:

Estimate for similar work (SX-2938-1-0)	(in $k)
Equipment Costs	
BPA Material	$329
Contract Material	$1,129
Overhead 26%	$379
Labor Costs	
BPA Labor	$811
Contract Labor	$1,487
Overhead 57%	$1,310
Sub-Total	**$5,445**
Contingency 40%	$2,178
C&C Costs	$1,739
Total	**$9,362**

For interconnection to a new Knight 230 kV terminal, assuming BPA installs and owns a 500/230 kV transformer connected to an existing 500 kV bay:

Estimate for similar work (SX-2390-1-0)	(in $k)
Equipment Costs	
BPA Material	$18,230
Contract Material	$1,619
Overhead 26%	$5,161
Labor Costs	
BPA Labor	$3,087
Contract Labor	$5,921
Overhead 57%	$5,135
Sub-Total	**$39,154**
Contingency 40%	$15,662
C&C Costs	$1,739
Total	**$56,555**

4.2 Estimated Schedule

The schedule is dependent on BPA-TS' ability to fit the project into its construction work plan, and on the Customer completing the necessary permitting for the project.

A non-binding good faith estimate to construct the interconnection facilities is 36 to 42 months after a signed agreement to proceed. Subsequent to the Large Generation Interconnection

Process, BPA-TS will make the decision to proceed with this interconnection based on an environmental evaluation as required by the National Environmental Policy Act. For this project, it is likely that a categorical exclusion would apply. The BPA-TS NEPA process is contingent upon the Customer having obtained all state or county environmental approvals for the transmission line required to interconnect as well as the permitting of the project site itself.

5 Technical Analysis

5.1 Methodology and Assumptions

WECC base cases, as modified for use in the 2018 system assessment, were used for this analysis.

For the primary plan of service, the proposed solar plant was modeled as typical generation connected via a 0.5 mile 230 kV line to a new Knight 230 kV bus looping in the North Bonneville-Midway 230 kV line. The Knight 230 kV bus remains isolated from the Knight 500 kV bus. To evaluate high flows from Knight toward North Bonneville, a peak 2022 Heavy Summer base case was modified to reflect high east-west flows. To evaluate high flows from Knight toward Midway, a peak 2022 Heavy Summer base case was modified to reflect high west-east flows by opening the North Bonneville end of the line. The Lower Columbia wind generation was assumed at full nameplate. Other area wind was assumed at approximately 30%. The proposed Solar project was modeled at 160 MW.

For the alternative plan of service, the proposed solar plant was similarly modeled as typical generation connected via a 0.5 mile 500 kV line to an existing Knight 500 kV bay. For this alternative the North Bonneville-Midway 230 kV line remains electrically isolated from any other facilities at Knight. A peak 2022 Heavy Summer base case was used to model the impacts of the interconnected generation. The California-Oregon AC Intertie (COI) and the Pacific DC Intertie (PDCI) were loaded within 15% of their reliability limit (4,212MW and 3220MW respectively).

5.2 Study Results

A steady state analysis examined the equipment and line loading and steady state voltage for all lines in service as well as for various contingencies, with the full 160 MW of generation connected at Knight substation under either plan of service.

5.2.1 Primary Plan of Service

Applicable contingencies were screened for thermal overloads on the North Bonneville-Midway 230 kV line (east-west direction). The North Bonneville to Alfalfa section of this line is currently de-rated to 50^{o}C. Remediation is expected to be complete in Spring 2019, and this study assumes the line is rated to 100^{o}C, which corresponds to a summer rating of 430 MW. No overloads were observed under the fairly extreme generation and interchange pattern modeled.

Applicable contingencies were screened for voltage violations. No voltage violations were observed as a result of this generation interconnection.

In the west-east direction, the North Bonneville end of the North Bonneville-Midway 230 kV line was opened such that all generation flowed back toward Midway. No overloads were observed under the fairly extreme generation and interchange pattern modeled.

5.2.2 Alternate Plan of Service

Applicable contingencies were screened for thermal in the area of Knight substation. No overloads were observed under the fairly extreme generation and interchange pattern modeled.

Applicable contingencies were screened for voltage violations. No voltage violations were observed as a result of this generation interconnection.

5.3 Voltage Stability Analysis

The 2018 Mid-Columbia area system assessment identified voltage stability issues on loss of the Outlook 230/115 kV transformer. However, the proposed Solar generation will provide additional reactive support for the area. Therefore, this study concludes that no additional reinforcements are required to resolve voltage stability issues.

5.4 Transient Stability Analysis

The 2018 Mid-Columbia area system assessment demonstrated that the area is not transient stability limited and this study concludes that no additional reinforcements are required to resolve transient stability issues. This will be verified in a system impact study of the primary plan of service, specifically for the Midway to North Bonneville path. The proposed Solar generation will be required to meet all WECC Standards, FERC requirements, and BPA LGI requirements for low voltage ride-through (LVRT). All Inverter-based resources, of any size and voltage class, are not allowed to utilize "momentary cessation" as a form of LVRT for voltages outside the continuous operating range. Inverter-based LVRT solutions shall include current injection that accounts for active power (current-based frequency controls) and reactive power (current-based voltage controls). Inverter-based interconnections shall follow the latest NERC Performance Guidelines and NERC Alerts related to inverter-based resource performance.

5.5 Short Circuit Analysis

G0598 is not expected to significantly affect fault duty at Knight Substation. Comparison of existing fault duty to existing equipment ratings indicates sufficient margin for this and future interconnections. However, for the system impact study the fault duty will be re-studied.

5.6 NRIS Analysis

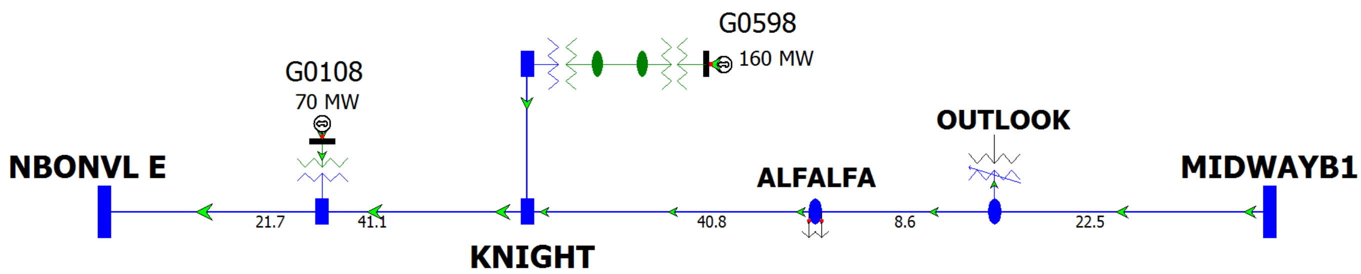
The LGIP defines Network Resource Interconnection Service as allowing the Interconnection Customer to integrate its Large Generating Facility with the transmission Provider's transmission system in a manner comparable to that in which the Transmission provider would integrate new generating facilities to serve native load customers. FERC has stated that the Interconnection Customer may designate their Large Generating Facility as a Network Resource any time before the commercial operation date (COD). Further, the LGIP states that Network Resource Interconnection Service does not convey in and of itself transmission service. A new or existing Network Customer of the Transmission Provider must file a Transmission Service Request to designate the Large Generating facility as a Network Resource. Once the Interconnection Customer has obtained Network Interconnection Service, requests for Network Integration Transmission Service from the Generating Facility to points inside the Transmission Provider's transmission system will not require additional Interconnection studies or additional upgrades. However, requests for delivery service inside the Transmission Provider's transmission system may require additional studies and upgrades if they are necessary to reduce congestion to acceptable levels.

Presently, there are more generation interconnection requests in the interconnection queue that have requested NRIS than the aggregate network load obligations for the Federal Columbia River Power System (FCRPS), which is presently being served by existing generation. Therefore, NRIS may not be available since at full output the aggregate of generation in the local area exceeds the aggregate of network load on the transmission provider's system.

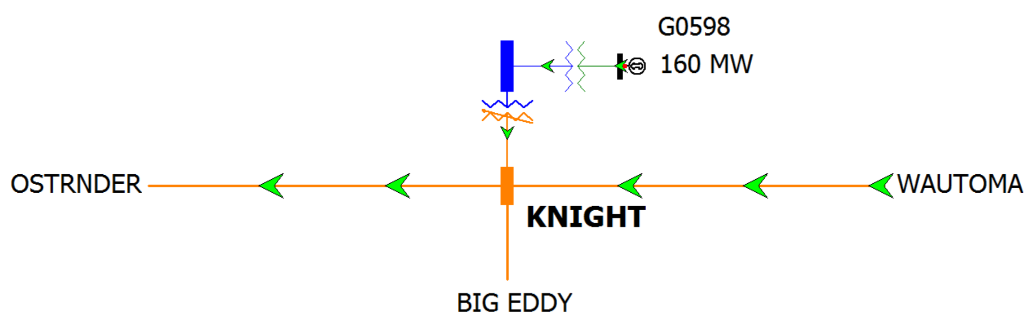
6 Appendices

6.1 One-line Diagrams

Primary Plan of Service



Alternate Plan of Service



6.2 Project Team

The project team for this request is as follows:

Role	**Person**
Account Executive	Eric Taylor
Contract Specialist	Anna Cosola
Customer Service Engineer	Cherilyn Randall
Planning Process Manager	Ryan Jones
Network Planning Engineer	Ron Messinger
Network Planning Engineer	Jon Vlas
Communication Planning Engineer	Ken Owen