NorthWestern[™] Energy

Project #139

Generation Interconnection System Impact Study Report

July 15, 2011

Electric Transmission Planning

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Executive Summary

NorthWestern Energy ("NWE") has completed the System Impact Study ("SIS") for Project 139 ("Generation Project") near Barber, MT. NWE studied your project as a Energy Resource Interconnection Service ("ERIS"). The SIS is an in-depth analysis that examines the response of the transmission system to a variety of system operating conditions. NWE is responsible for maintaining acceptable system reliability, and must be certain that system reliability is maintained with the addition of the Generation Project. NWE uses tolerance levels outlined by FERC, NERC, and/or WECC.

The SIS uses the following types of analyses:

- Steady-State Power Flow
- Post Transient Steady-State Power Flow
- Transient Stability
- Fault Duty
- Reactive Margin

The results of the SIS confirm that with all the senior queue projects and their associated mitigation in place, the addition of 10 MW interconnected to the NWE 100 kV transmission system between Broadview switchyard and Harlowton substation is feasible without additional network system improvements beyond the Point of Interconnection (POI) for this ERIS interconnection. Note, a senior queue Project, (#118) is also interconnected at this location; it is assumed all facilities required for Project #118 are in place.

With senior queue projects and associated mitigation in service, the system impact study indicated that 10 MW can be interconnected at the point of interconnection without any additional network upgrades. Under normal operating conditions (N-0) no voltage, thermal, or stability problems are caused by project. Under outage conditions, no new voltage, thermal, or stability problems occur due to the project, however, pre-existing problems may become worse with this project, and curtailment of this project and other senior queue projects may be required to alleviate adverse thermal conditions.

The findings included in this study do not assure the Interconnection Customer that the planned Generation Project will be allowed to operate at full capacity under all operating conditions. NWE cannot guarantee that future analysis will not identify additional problems.

A non-binding cost estimate to interconnect your project as a Energy Resource is summarized in Table I. It is assumed Project #118 has the same point of interconnection; costs included in this report are the additional costs required for the Project 139 interconnection. This point of interconnection was assumed to have two feeders; one for project #118 and one for Project #139. Project #139 and Project #118 would each require separate metering. The cost for low side metering for Project #139 and Project #118 is reflected in Table I. Customer is to provide and install CT and PT sets needed for low side metering on each generator feeder per NWE specifications . NWE will own all metering equipment with associated devices.

If there is a change in the queue, a restudy of this project may be required and mitigation requirements may change.

	Cost(\$K)	
Transmission	\$0.00	
Substation	\$0.00	
Relay	\$0.00	
Communications ¹	\$0.00	
Metering	\$28.00	
EMS	\$17.60	
Total	\$45.60	

Table I. High level non-binding cost estimate Non-Binding, Cost Estimate

- 1. The Customer will be responsible for providing the following communications:

 - a. Telephone circuit to meterb. Data channel to NWE SOCC centerc. Ring down circuit to the generation control center

Generator and Interconnection Data

The proposed generator and interconnection data used in the studies was based on the information received from the Interconnection Customer. From the initial application, NWE identified the following project information.

- Project Name Project 139
- Size (Rated) -- 10 MW total
- Location -- approximately 3.5 miles west of Barber, Montana, in Wheatland County
- Special Resources/Technology -- 4 Nordex N100 2.5 MW Wind Turbines
- Proposed Commercial Operation Date -- August, 2012
- Facilities -- NWE 100 kV line between Broadview Switchyard and Harlowton Substation Assumptions
 - \circ MW Output = 10 MW
 - \circ Scheduled Voltage (pu) = 1.00 at the at the Point of Interconnection
 - The generator is assumed to have operational characteristics either through internal or external capabilities to operate throughout a power factor range of 0.95 leading to 0.95 lagging at the Point of Interconnection.

Study Parameters

In analyzing the Generation Project, NWE utilized "PSS/E" software to conduct the System Impact Study with the proposed Generation Project. These studies "connected" the Generation Project to NWE's Transmission System in a computer model to simulate the interaction of the Generation Project with other resources and loads.

Two WECC base cases adjusted to include the NWE Transmission System detail representing 2010 light autumn and 2012 heavy summer loads were used for this study.

Senior Queue Generator Assumptions

In addition to existing generators, senior queue resources were also included in this study. (See Table II). Senior queued generation and existing generation dispatch were varied as needed to emulate stress on the system for various scenarios

Table II.				
Project Number	Size (MW)	Point of Interconnection		
31	396	Wilsall-Shorey Road 230 kV Line		
39	22	Billings Steam Plant Switchyard		
46	10	Loweth - Two Dot 100 kV line		
47	20	69 kV line at Chester		
49	23	Rainbow Switchyard		
57	85	Bradley Creek Substation		
60	20	Bradley Creek - Three Forks S. 100 kV line		
61	2	Phillipsburg - Anaconda 25 kV line		
63-69	30 (total)	69 kV line near Sumatra (9 requests, 5 MW each)		
75	75.6	161 kV line approx 5 mi. N of Bradley Creek sub.		
76	75.6	100 kV line approx 5 mi. N of Bradley Creek sub.		
80	80	North River Road		
81	12	Near 100 kV Rainbow Switchyard		
82	Efficiency Improvement	Near 100 kV Rainbow Switchyard		
88	20	Near Livingston City Substation		
89	20	100 kV line between Loweth and Two Dot at Groveland		
99	200	Near Ringling		
100	Efficiency Improvement	Near 100 kV Rainbow Switchyard		
102	18.9	Dutton 69 kV Substation		
103	120	Great Falls 230 kV Switchyard		
104-106	15 (total)	69 kV line near Sumatra (9 requests, 5 MW each)		
114	19.5	Two Dot Substation Distribution		
115	460	230 kV line near Judith Gap South		
116	0.225	Yellowstone National Park		
118	18.4	100 kV line between Harlowton and Broadview		
123	4.7	161 kV line near Clark Canyon Dam		
126	25	100 kV line West of Geyser		
127	10	69 kV East of Bole Substation		
129	0.455	Dry Creek, Montana		
133	10	69 kV line East of Bole Substation		
134	10	69 kV line East of Bole Substation		

135	16	100 kV line West of Geyser
136	20	Mill Creek Substation 100 kV
137	10	100 kV line between Columbus Rapelje and Columbus

Steady State Power Flow Analysis

The steady-state power flow analysis examines steady state, system normal, operating conditions with no lines out of service (i.e., N-0 Conditions) and with various lines out of service (i.e., N-1 and N-2 conditions). A power flow simulation is completed before and after the addition of the Generation Project to identify any unacceptable thermal overloads and voltage excursions the project may cause.

Method

NWE simulated an extensive set of 500 kV and non-500 kV N-1 and N-2 outages. Power flow contingencies were simulated for both operating conditions (2010 light autumn and 2012 heavy summer). Local area contingencies were the primary focus of this analysis.

Results

- With all senior queue generation projects and their associated mitigation in service the addition of this project to NWE's Transmission System under N-0 conditions (all lines in service) causes no voltage, thermal, or stability problems.
- With all senior queue generation projects and their associated mitigation in service the addition of this project to NWE's Transmission System under N-1 conditions (single line outages) causes no additional voltage, thermal, or stability problems. Curtailment of this project and/or other senior queue projects may be required to alleviate pre-existing problems under outage conditions.
- With all senior queue generation projects and their associated mitigation in service the addition of this project to NWE's Transmission System under N-2 conditions (credible double line outages) causes no additional voltage, thermal, or stability problems. Curtailment of this project and/or other senior queue projects may be required to alleviate pre-existing problems under outage conditions.

Mitigation

In order for the Generation Project to interconnect and operate at full capacity, the following mitigation is required:

• No mitigation is required.

Transient Stability Analysis

When a line fault occurs, the protective relaying must respond by opening circuit breakers to remove the affected transmission line from service. This can result in a system disturbance. The credible "worst case" fault events must be simulated to determine if the transmission system will recover to acceptable steady state operating conditions. Events that were studied include single-phase and three-phase faults causing either single or multiple line outages or generator failures. The dynamic simulations performed for this project include an assortment of events that are intended to provide a robust test of the impact of the Generation Project.

The results from the Transient Stability Analysis are designed to reveal:

- Whether or not regional electric transmission systems remain stable with each event;
- Whether or not WECC criteria are met for each outage condition; and
- Identify where problems are located on the Transmission System.

Method

NWE simulated an extensive set of 500 kV and non-500 kV faults. The term "fault" refers to a short-circuit between either a single-phase conductor to ground or all three phases. The list of simulated events is included in Attachment B.

Results

All of the events simulated showed stable results and met WECC criteria. The list of simulated events and results is included in Attachment B.

Mitigation

In order for the Generation Project to interconnect and operate at full capacity, no mitigation is required with respect to transient stability analysis.

PV Analysis

The SIS examined the reactive margin at critical buses on NWE's Transmission System. In addition, the PV and QV reactive margin identifies potential voltage collapse issues under maximum operating conditions. This analysis includes the addition of the Generation Project.

PV Analysis

Voltage security margins were evaluated using PV analysis. For this type of study, the security margin (distance to the voltage collapse) is defined by the amount of additional power transfer that can occur before voltage collapse is reached on a predefined bus. Voltage collapse occurs at the "knee point" of the PV curve where the voltage drops rapidly with an increase in the transfer power flow. Operation at or near the stability limit is impractical and a satisfactory operation condition must be ensured to prevent voltage collapse.

Method

The output of the Generation Project was increased to 5% of the nameplate rating. This increased power output was off-set by reducing the generation output at Colstrip.

Results

The Generation Project was modeled with all co-existing generation projects and their required mitigation. Results indicate that the available reactive power compensation is sufficient to cope with the steady-state requirements for all scenarios and contingencies analyzed.

Mitigation

No mitigation is required.

Fault Duty Analysis

When a fault occurs on a power line, protective relaying equipment detects the fault current flowing and signals the associated circuit breakers to open. When the circuit breakers open, they must be capable of interrupting the fault current. If the magnitude of the fault current exceeds the interrupt rating of the circuit breakers, the fault may not be cleared, and damage to system equipment and voltage collapse may result.

Method

To perform a fault duty analysis, busses at or near the point of interconnection of this project are faulted in a PSS/E model to determine the magnitude of fault current anticipated with the Generation Project in service. The results of this analysis determine whether standard circuit breaker fault duty ratings would be exceeded with the addition of the Generation Project. The events that were analyzed are listed below.

- 1. A single-phase fault at the point of interconnection.
- 2. A three-phase fault at the point of interconnection.

Results

The breakers in the area have sufficient interrupting capability. A breaker interrupt rating of 40,000 amps was assumed. The highest fault current observed was less than 3200 amps at the Point of Interconnection. See attachment C.

Mitigation

No mitigation is required.

Conclusions

The results of this analysis confirm that the addition of 10 MW of generation interconnected to the NWE 100 kV transmission system between 100 kV line between Broadview Switchyard and Harlowton Substation as an ERIS resource is feasible. With senior queue projects and associated mitigation in service, the system impact study indicated that 10 MW can be interconnected at the point of interconnection without any additional system upgrades. Under normal operating conditions (N-0) no voltage, thermal, or stability problems are caused by project. Under outage conditions, no new voltage, thermal, or stability problems occur due to the project, however, pre-existing problems may become worse with this project, and curtailment of this project and other senior queue projects may be required.

N-0 Mitigation

No mitigation is required.

N-1 Mitigation

No mitigation is required. Curtailment of this project and/or other senior queue projects may be required to alleviate pre-existing problems under outage conditions.

N-2 Mitigation

No mitigation is required. Curtailment of this project and/or other senior queue projects may be required to alleviate pre-existing problems under outage conditions.

The findings included in this study do not assure the Interconnection Customer that the planned Generation Project will be allowed to operate at full capacity under all operating conditions. NWE cannot guarantee that future analysis will not identify additional problems. If there is a change in the queue, a restudy of this project may be required and mitigation requirements may change.

Next Steps

NWE will be scheduling a meeting to discuss the findings of the SIS with the Interconnection Customer. If, after the meeting, the Interconnection Customer wishes to continue with the project, a Facility Study specific to the project will then be carried out to determine the final details of the interconnection.

This study does not constitute a request for transmission service. The study examined the physics of the electrical system and does not imply that you will receive any transmission required to deliver the generation output to load. You must follow the procedures described in the transmission tariff available on (<u>http://www.oatioasis.com/NWMT/index.html</u>) to request and/or receive transmission service.

Attachments

Attachment A – System One-Line Diagram Attachment B – Transient Stability Results Attachment C – Fault Duty Analysis Result