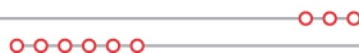


GEN-2008-123N
Impact Restudy for
Generator Modification
(Turbine Change)

April 2017
Generator Interconnection



Revision History

Date	Author	Change Description
4/28/2017	SPP	GEN-2008-123N Impact Restudy for Generator Modification (Turbine Change) issued.

Executive Summary

The Interconnection Customer for GEN-2008-123N has requested a wind turbine generator modification to its Generator Interconnection Request. GEN-2008-123N was previously studied¹ with forty-eight (48) GE 1.715MW wind turbine generators and four (4) GE 1.79MW wind turbines (aggregate power of 89.48MW). In this current modification study the interconnection customer has requested to study GEN-2008-123N with thirty-five (35) GE 2.3MW wind turbine generators, one (1) GE 2.0MW wind turbine generators, and four (4) GE 1.79MW wind turbine generators (aggregate power of 89.66MW).

The Interconnection Customer provided a PSSE raw data file that incorporated the modifications for GEN-2008-123N. The point of interconnection (POI) remains unchanged and is the Nebraska Public Power District (NPPD) Rosemont Substation 115kV.

The proposed new wind turbine generators, GE 2.0MW and GE 2.3MW, are electrically equivalent to the GE 1.715MW being replaced, and the dynamic characteristics are essentially the same. The project topology changed due to fewer wind turbines needed to maintain the original (or near original) nameplate power output of the project. This study analyzed the change in system impedance between the original project and the modified project and found it to be 3.03%. This change is considered insignificant, and, therefore, the modified project will have a dynamic performance similar to the original study. The requested change is not a material modification. The results of the previous turbine restudy, except for the results of the reactor analysis, are still valid for GEN-2008-123N with the wind turbine modifications requested by the interconnection customer.

A low-wind/no-wind condition analysis was performed for this modification request. GEN-2008-123N will be required to install approximately 4.7 Mvars of shunt reactors on its substation 34.5kV bus. This is necessary to offset the capacitive effect on the transmission network caused by the project's transmission line and collector system during low-wind/no-wind conditions. The Interconnection Customer may utilize the G.E. "WindFREE" option to meet this requirement.

With the assumptions outlined in this report and with all required network upgrades in place, GEN-2008-123N with thirty-five (35) GE 2.3MW wind turbine generators, one (1) GE 2.0MW wind turbine generators, and four (4) GE 1.79MW wind turbine generators (aggregate power of 89.66MW) should be able to reliably interconnect to the SPP transmission grid.

Nothing in this study should be construed as a guarantee of transmission service. If the Customer wishes to obtain deliverability to a specific customer, a separate request for transmission service shall be requested on Southwest Power Pool's OASIS.

¹ See "GEN-2008-123N Impact Restudy for Generator Modification (Turbine Change)" report produced by SPP staff, dated September 2014.

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1. Introduction

The Interconnection Customer for GEN-2008-123N has requested a change in wind turbine generators. Table 1-1 shows the interconnection requests as previously studied. Table 1-2 shows the requested wind turbine modification.

Table 1-1: Interconnection Request (Previous Study)

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2008-123N	89.48	48 x GE 1.715MW and 4 x GE 1.79MW	NPPD Rosemont 115kV Substation (tap on Guide Rock to Pauline 115kV line)

Table 1-2: Interconnection Request (Modification)

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2008-123N	89.66	35 x GE 2.3MW, 1 x GE 2.0MW, and 4 x GE 1.79MW	NPPD Rosemont 115kV Substation (tap on Guide Rock to Pauline 115kV line)

The proposed new wind turbine generators, GE 2.0MW and GE 2.3MW, are electrically equivalent to the GE 1.715MW wind turbines generators being replaced, and the dynamic characteristics are essentially the same. The topology of the project must change in order to accommodate the reduced number of wind turbine generators necessary to maintain the original (or near original) power output of the project. The change in topology was analyzed.

The low-wind/no-wind analysis determines the capacitive effect at the POI caused by the project’s collector system and transmission line. A shunt reactor size was determined to offset the capacitive effect and to maintain approximately zero Mvar flow at the POI when the plant generators and capacitors are off-line such as might be seen in low-wind or no-wind conditions.

Nothing in this study constitutes a request for transmission service or grants the Interconnection Customer any rights to transmission service.

2. Facilities

Generating Facility

The point of interconnection (POI) for the GEN-2008-123N interconnection requests is a tap on the Nebraska City to Sibley 345 line. The interconnection requests as originally studied are shown in Figure 2-1.

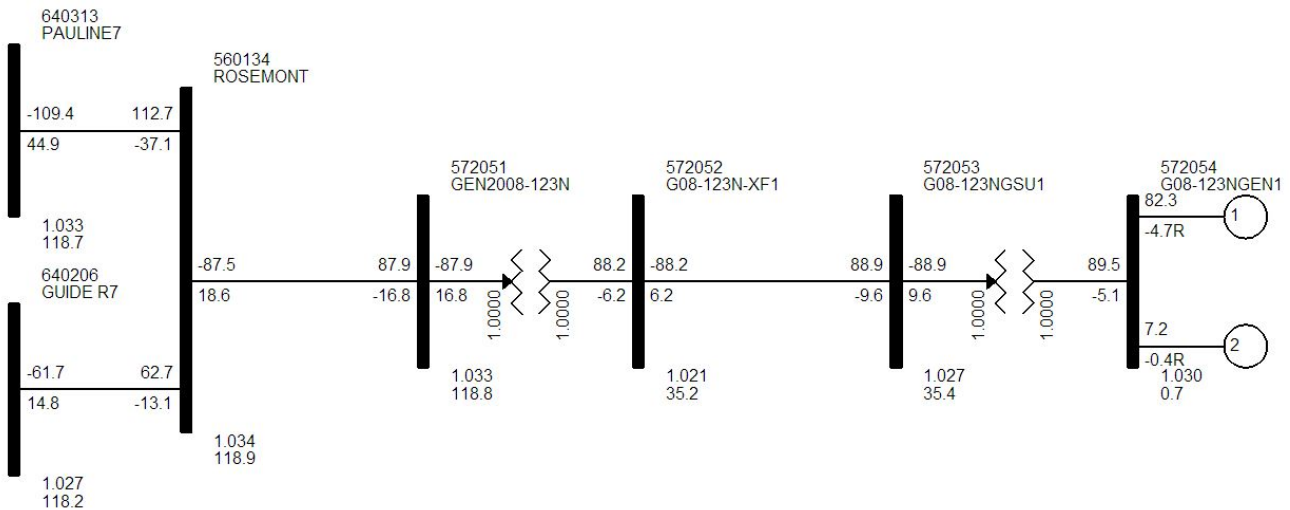


Figure 2-1: Power Flow Model and POI for GEN-2008-123N as previously studied

The Interconnection Customer provided a PSSE raw data file that contained the modified request. An equivalent power flow model was developed from the PSSE raw data and is shown in Figure 2-2.

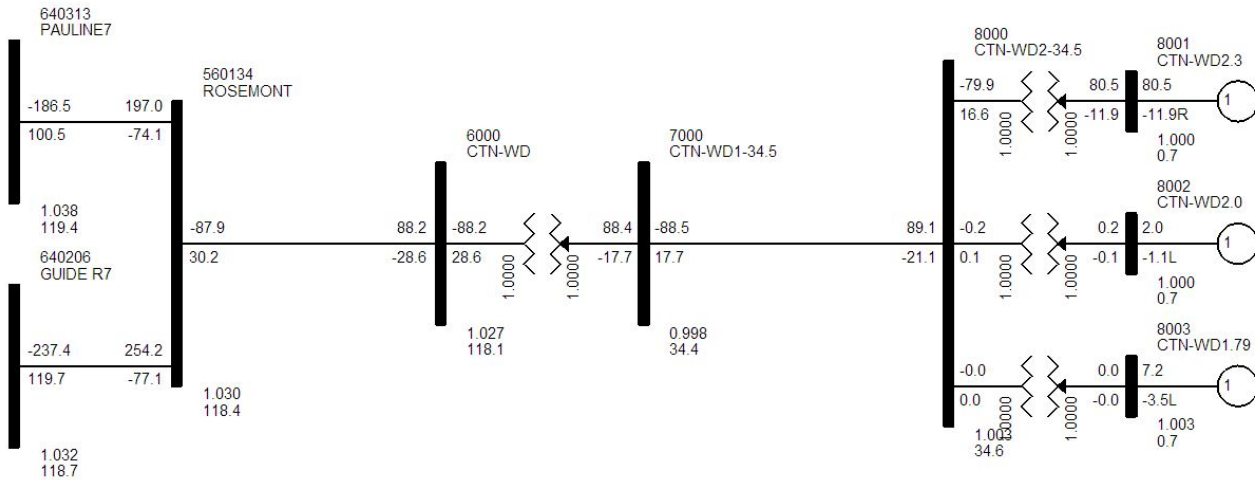


Figure 2-2: Power Flow Model and POI for the Modified GEN-2008-123N request

3. Modification Evaluation

The electrical characteristics and the dynamic response of the GE 2.1MW and the GE 2.3MW wind turbine generators are nearly identical to the GEN 1.715MW being replaced. The circuit topology for the project changed due to the reduction in wind turbines required to retain the original (or near original) nameplate power of 89.7MW. The change in topology was analyzed to determine how much the system impedance changed from the previous topology to the modified topology. This was done by using the ASCC feature of PSSÉ to determine the Thevenin equivalent impedances for the original and the modified topologies.

The equivalent Thevenin impedance was determined for the original and modified topologies from the project under study to the POI which includes:

- The generator step units,
- The equivalent collector system,
- The substation transformer, and
- The transmission line from the POI to project under study.

The equivalent impedances are shown in Table 3-1. The change in impedance is a 3.03% decrease, and the modification will have minimal impact on the previous study results. The requested change is not a Material Modification.

Table 3-1: GEN-2008-123N to POI			
	Rz (Ohm)	Xz (Ohm)	Z (Ohm)
MODIFICATION	3.434	139.866	139.908
ORIGINAL	2.827	135.626	135.655
		%change	%change
		-3.031	-3.040

4. Stability Analysis

Since the change in impedance is a 3.03% decrease, the modification will have minimal impact on the stability results reported in the previous study. The results of the previous stability analysis for this interconnection request are still valid.

5. Power Factor Analysis

The results of the power factor analysis from the previous study are still valid.

6. Reduced Generation Analysis

Interconnection requests for wind generation projects that interconnect on the SPP system are analyzed for the capacitive charging effects during reduced generation conditions (unsuitable wind speeds, curtailment, etc.) at the generation site.

Shunt reactor requirements for the interconnection requests are shown below in Table 6-1.

Table 6-1: Summary of Shunt Reactor Requirements

Request	Capacity	POI	Approximate Shunt Reactor Required
GEN-2008-123N	89.66MW	NPPD Rosemont 115kV Substation (tap on Guide Rock to Pauline 115kV line)	4.7Mvar

Figure 6-1 shows the capacitive effect that GEN-2008-123N has on the POI when the generators are offline and the rest of the facilities remain online. The capacitive effect is due to the charging of the collector system and the charging on the transmission lead to the POI.

To offset the reactive injection at the POI during reduced generation conditions reactors (or other reactive means such as the “WindFree” option available on GE wind turbine generators) will be needed at the generation facility. For GEN-2008-123N the reactor required is approximately 4.7Mvar (4.34Mvar from the collector system and 0.36Mvar from the generator lead to the POI). Figure 6-2 shows the result of placing a 4.7Mvar reactor at the low side bus of the 34.5/345kV transformer in GEN-2008-123N.

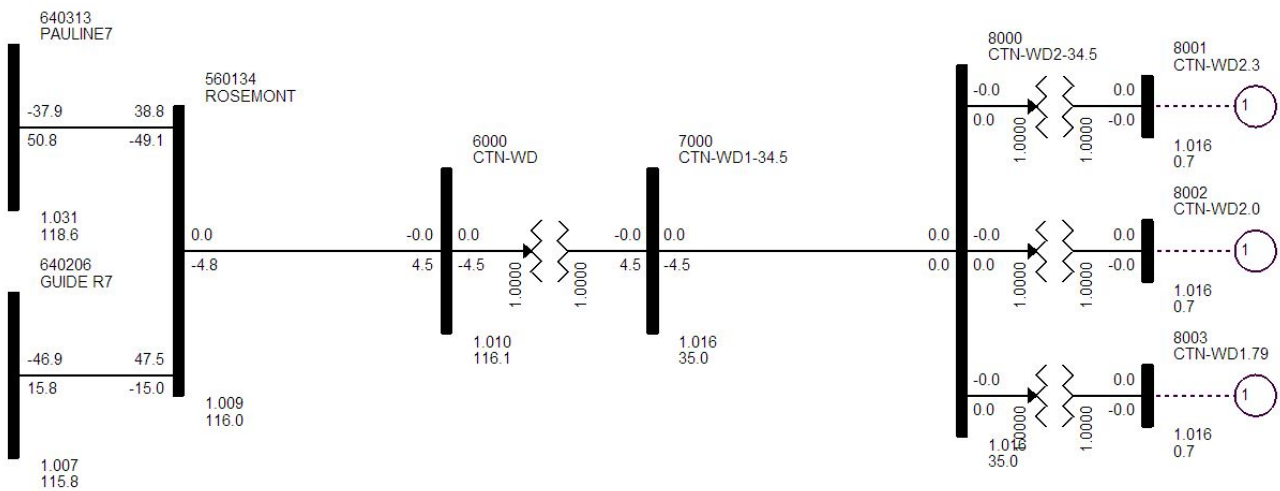


Figure 6-1: GEN-2008-123N with generators off and no shunt reactors

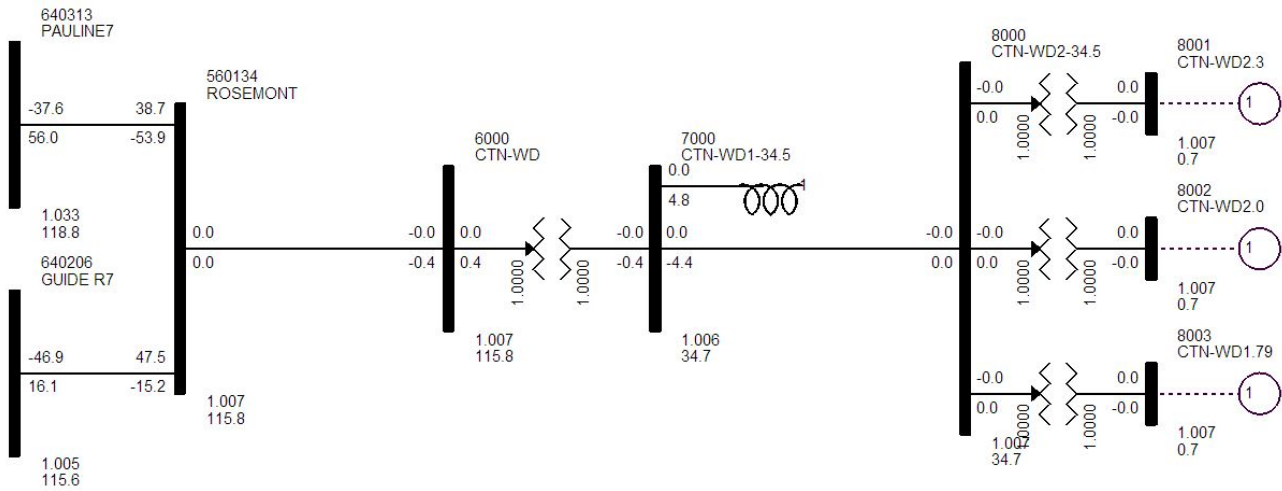


Figure 6-2: GEN-2008-123N with generators off and with shunt reactor

7. Short Circuit Analysis

A short circuit analysis was not performed for this modification request.

8. Conclusion

The Interconnection Customer for GEN-2008-123N has requested a modification to its Interconnection Request to use the wind turbine generators as shown in Table 1-2.

The analysis has shown that the requested wind turbine modification to GEN-2008-123N does not constitute a Material Modification. With exception of the reactor requirements the results of the previous Material Modification Request Study for GEN-2008-123N are still valid for the requested wind turbine modification.

A low-wind/no-wind condition analysis was performed for this wind turbine modification request. GEN-2008-123N will be required to install approximately 4.7 Mvars of shunt reactors on its substation 34.5kV bus). This is necessary to offset the capacitive effect on the transmission network caused by the project's transmission line to the POI and the collector system during low-

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wind/no-wind conditions. The Interconnection Customer may utilize the G.E. “WindFREE” option to meet this requirement.

Any changes to the assumptions made in this study, for example, one or more of the previously queued requests withdraw, may require a re-study at the expense of the Customer.

Nothing in this study should be construed as a guarantee of transmission service or delivery rights. If the customer wishes to obtain deliverability to final customers, a separate request for transmission service must be requested on Southwest Power Pool’s OASIS by the customer.