GEN-2012-033
Impact Restudy for Generator Modification (Turbine Change)

July 2015
Generator Interconnection

SPP Southwest Power Pool

Executive Summary

Interconnection Customer GEN-2012-033 has requested a modification to its Generator Interconnection Request to change from sixty-one (61) General Electric (GE) 1.62MW wind turbine generators (aggregate power of 98.82MW) to a combination of fifty-three (53) GE 1.715MW and four (4) GE 1.79MW wind turbine generators (aggregate power of 98.06MW). Since the GE 1.715MW and 1.179MW wind turbine generators have identical electrical characteristics as the GE 1.62MW wind turbine generator, a detailed stability analysis assessment was not performed for this change request. The results of the system impact study[1] performed for GEN-2012-033 are still valid for this generation interconnection request. As the original request for interconnection is for 98.82MW, the requested change is not considered a Material Modification.

Even though a restudy of the stability analysis was not performed for this interconnection change request, a reduced generation analysis was performed to account for collector system changes. The reduced generation (due to unsuitable wind speeds, curtailment, etc.) analysis shows the need for approximately 4.5Mvar of reactive power support to be located on the 34.5kV side of the Customer's substation transformer. The reactive power support may be in the form of external reactive devices or through the use of the equivalent technologies like GE's wind turbine WindFREE™ Reactive Power option.

Power factor requirements for GEN-2012-033 can be found in the previous system impact study, are listed in its Generator Interconnection Agreement, and are still valid for this change request. The short circuit analysis performed earlier[2] for GEN-2012-033 is still valid.

With the assumptions outlined in this report and with all required network upgrades shown in the previous system impact study in place, GEN-2012-033 comprised of fifty-three (53) GE 1.715MW and four (4) GE 1.79MW wind turbine generators should be able to reliably interconnect to the transmission system.

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.

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[1] *DISIS-2012-002 (Group 8) Definitive Impact Study* performed by Mitsubishi Electric Power Products, Inc. for the Southwest Power Pool (SPP) *Definitive Interconnection System Impact Study DISIS-2012-002* posted 2/8/2013.

[2] *Facility Study For Generation Interconnection Request GEN-2012-033*, dated 5/22/2013, performed by OG&E Electric Services, and published in SPP's *Facility Study for Generator Interconnection Request GEN-2012-033*, dated July 2013.

1. Introduction

Interconnection Customer GEN-2012-033 has requested a modification to its Generator Interconnection Request to change from utilizing sixty-one (61) General Electric (GE) 1.62MW wind turbine generators (aggregate power of 98.82MW) to a combination of fifty-three (53) GE 1.715MW and four (4) GE 1.79MW wind turbine generators (aggregate power of 98.06MW). Since the GE 1.62MW, 1.715MW and 1.79MW wind turbine generators have identical electrical characteristics, a detailed restudy of the stability analysis was not performed for this modification request. The results of the previous system impact study performed for GEN-2012-033 are still valid for this generation interconnection request. As the original request for interconnection is for 73.5MW, the requested change is not considered a Material Modification.

Even though a stability analysis was not performed for this interconnection change request, a reduced generation analysis was performed to account for the change in the collector system. This analysis can be found in Section 5.

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-2012-033 interconnection request is the Transmission Owner's new Breckinridge 138kV substation, located in Garfield County, Oklahoma.

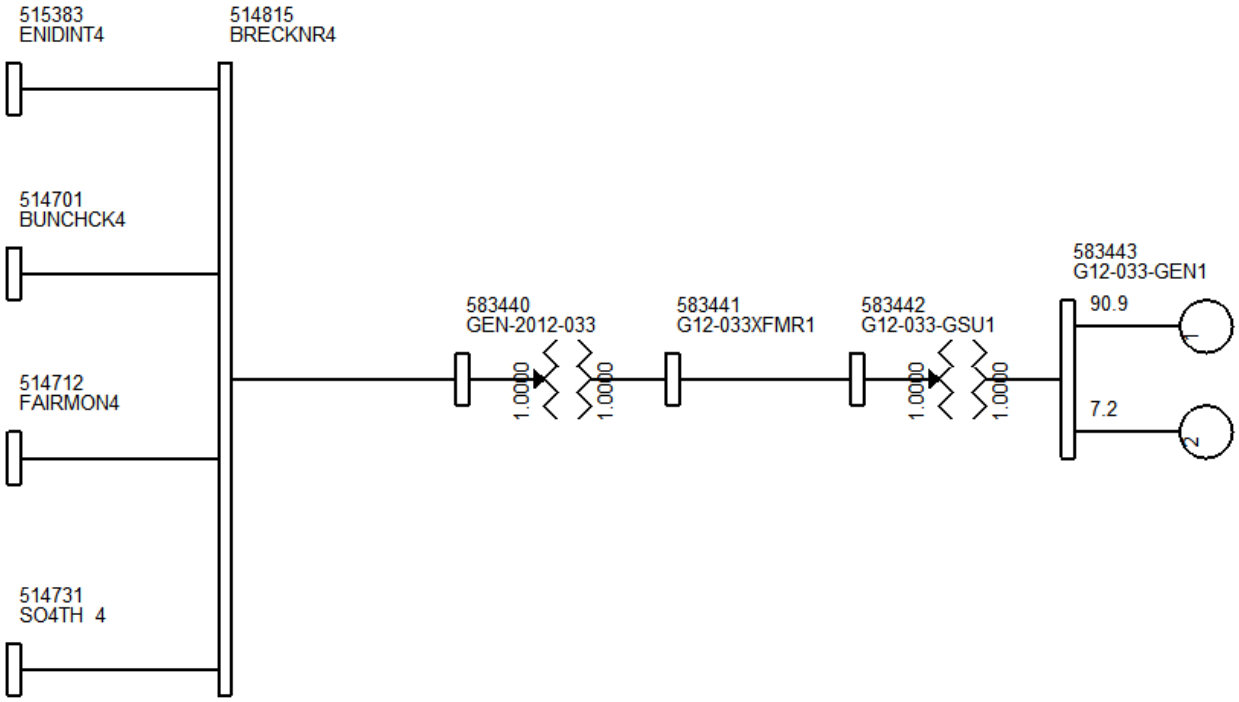

Figure 2-1: Area Transmission and Point of Interconnection for GEN-2012-033

Figure 2-1 depicts the one-line diagram of the local transmission system including the POI as well as the power flow model representing the request.

The original Generating Facility was comprised of (61) GE 1.62MW wind turbine generators (aggregate power of 98.82MW). The new configuration, pictured above, is comprised of fifty-three (53) GE 1.715MW and four (4) GE 1.79MW wind turbine generators (aggregate power of 98.06MW).

3. Stability Analysis

Transient stability analysis is used to determine if the transmission system can maintain angular stability and ensure bus voltages stay within planning criteria bandwidth during and after a disturbance while considering the addition of a generator interconnection request. Since the GE 1.715MW and 1.79MW wind turbine generator is electrically similar to the GE 1.62MW wind turbine generator, a stability analysis was not performed. The analysis performed in the previous study is still valid.

4. Power Factor Analysis

The power factor analysis was not performed for this change request. The power factor analysis performed in the previous study is still valid. The final power factor requirement for GEN-2012-033 will be the pro-forma 95% lagging to 95% leading at the POI and are listed in the Generator Interconnection Agreement for GEN-2012-033.

5. Reduced Generation Analysis

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

Model Preparation

The project generators and capacitors (if any), and all other wind projects that share the same POI, were turned off in the base case. The resulting reactive power injection into the transmission network is due to the capacitance of the project's transmission lines and collector cables. This reactive power injection is measured at the POI. Its capacitive contribution is measured at the bus identified as the POI; (bus 514815 shown in *Figures 2-1, 5-1* through *5-4*). Shunt reactors were added at the study project substation low voltage bus to bring the Mvar flow into the POI bus down to approximately zero.

Results

A final shunt reactor requirement for each of the studied interconnection requests is shown in *Table 5-1*.

Table 5-1: Summary of Shunt Reactor Requirements for GEN-2012-033

Season	Approximate Shunt Reactor (or equivalent) Required
2015 Light Load	4.5Mvar
2015 Summer Peak	
2015 Winter Peak	
2025 Summer Peak	

One line drawings used in the analysis are shown in *Figures 5-1* through *5-4*.

To prevent the injection of reactive power into the transmission system, approximately 4.5Mvar of reactive support will be required. This will need to be available to the system even when the generators are offline or when not generating. This can be accomplished through the installation of bus shunt reactors, or an equivalent means such as the optional WindFree™ Reactive Power package from GE. However accomplished, controlling the reactive power into the transmission system will be required to prevent high voltage issues during system operations.

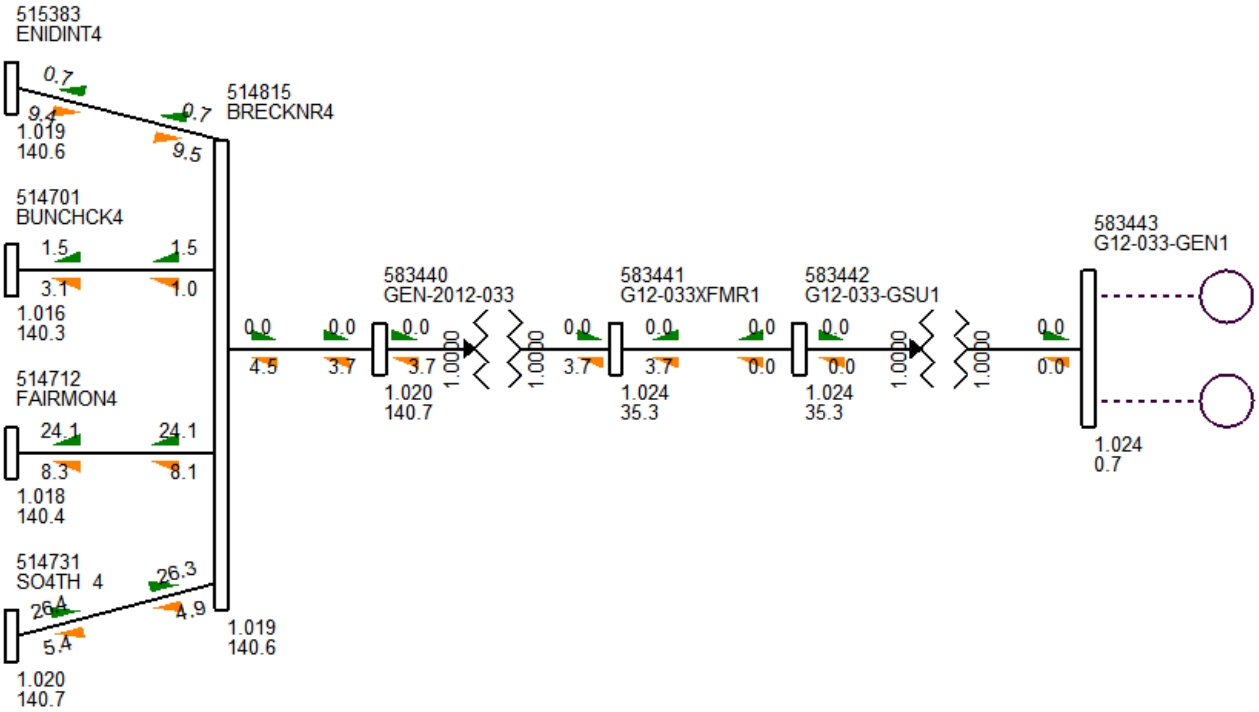

Figure 5-1: (2015 Light Load Season) GEN-2012-033 with generators off and no shunt reactor

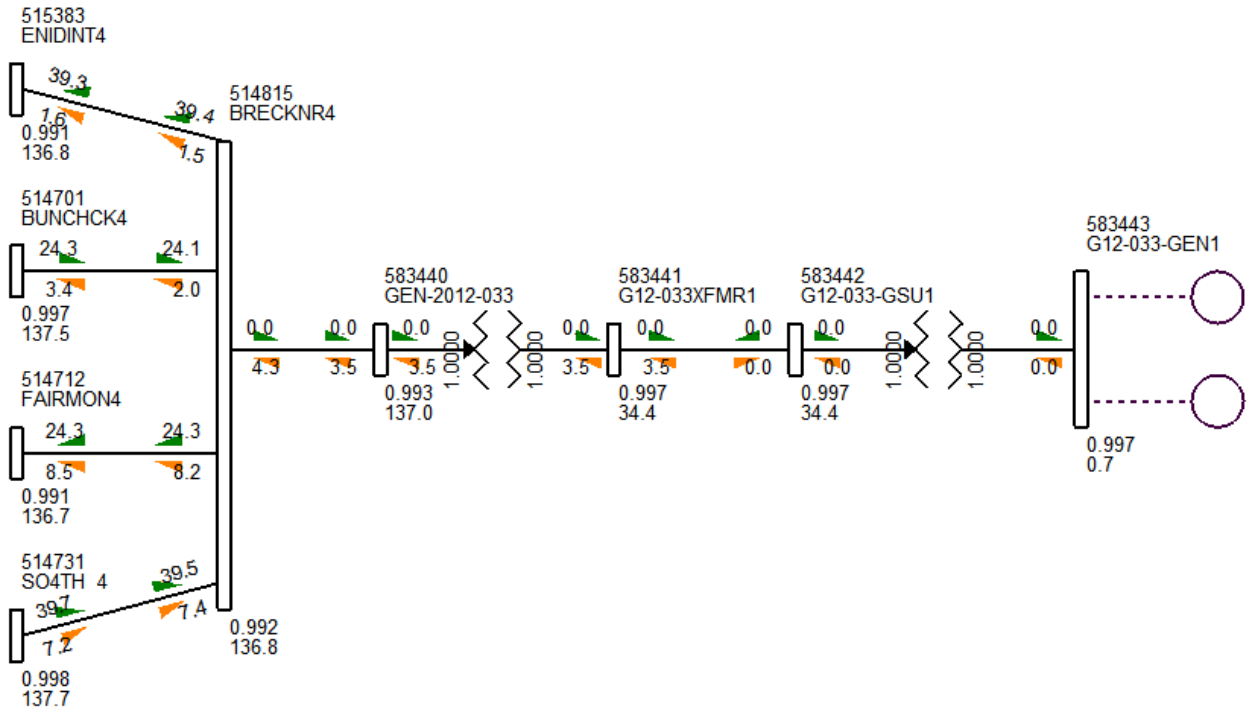

Figure 5-2: (2015 Summer Peak Season) GEN-2012-033 with generators off and no shunt reactor

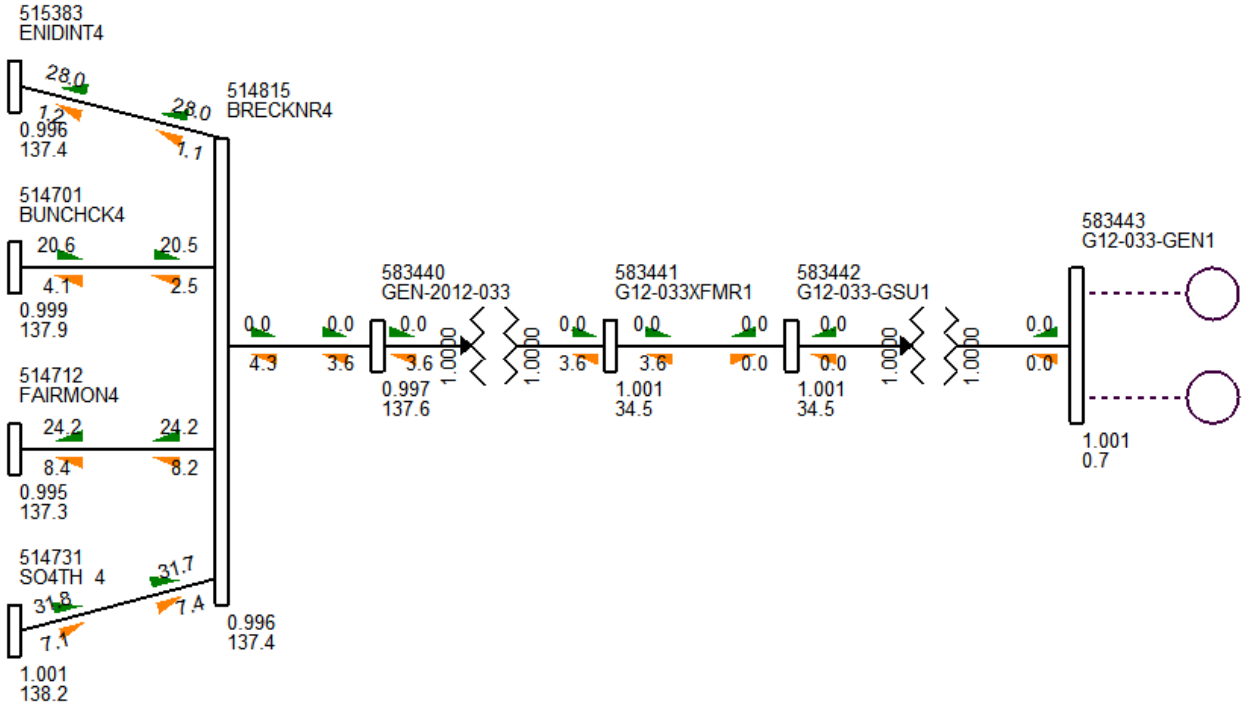

Figure 5-3: (2015 Winter Peak Season) GEN-2012-033 with generators off and no shunt reactor

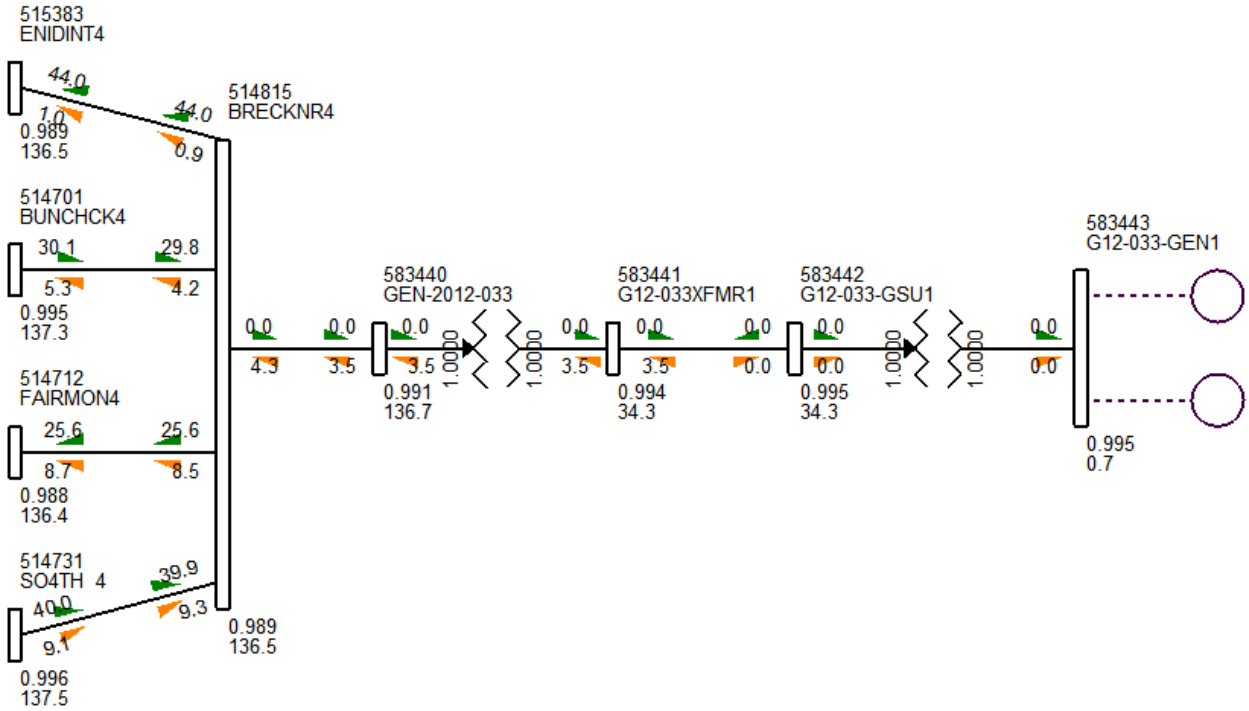

Figure 5-4: (2015 Summer Peak Season) GEN-2012-033 with generators off and no shunt reactor

6. Short Circuit Analysis

The short circuit analysis was performed by OG&E and the results are still valid for this change request.

7. Conclusion

The GEN-2012-033 Interconnection Customer has requested a modification to its Generator Interconnection request to change from GE 1.62MW wind turbine generators to a combination of GE 1.715MW and 1.79MW wind turbine generators. Since GEN-2012-033 was studied previously using the GE 1.62MW wind turbine generators, the results of that transient stability study are still applicable to GEN-2012-033 using the GE 1.715 and 1.79MW wind turbine generators.

A reduced generation analysis was performed for the interconnection request to account for the changes in the collector system. GEN-2012-033 will be required to install approximately 4.5MVAR of reactive power support. The reactor requirements can be implemented by external reactor banks or other means such as the GE WindFREE™ Reactive Power option.

OKG&E performed the short circuit analysis for the original GEN-2012-033 request. The results of the short circuit analysis are still valid for this change request.

Power factor requirements for GEN-2012-033 from the previous impact study and listed within the Generator Interconnection Agreement for GEN-2012-033 remain valid. The interconnection request will be required to maintain the pro-forma +/- 0.95 power factor at the POI.

Nothing in this study should be construed as a guarantee of delivery or transmission service. If the customer wishes to sell power from the facility, a separate request for transmission service must be requested on Southwest Power Pool's OASIS by the Customer.