GEN-2014-057 Impact Restudy for Generator Modification (Turbine Change)

May 2016
Generator Interconnection

SPP Southwest Power Pool

Revision History

Date	Author	Change Description
05/25/2016	SPP	GEN-2014-057 Impact Restudy for Generator Modification (Turbine Change) issued.

Executive Summary

The GEN-2014-057 Interconnection Customer has requested a modification to its Generator Interconnection Request to change from one hundred twenty-five (125) GE 2.0MW wind turbine generators (aggregate power of 250.0MW) to one hundred nineteen (119) GE 2.1MW wind turbine generators (aggregate power of 249.9MW). A summary of the findings is presented here.

The point of interconnection (POI) is a tap on Lawton Eastside (American Electric Power (AEP)) – Sunnyside (Oklahoma Gas and Electric (OKGE)) 345kV transmission line. Figure 2-1 shows the one-line diagram of the Interconnection Request.

The study models used were the 2016 winter, the 2017 summer, and the 2025 summer cases and included Interconnection Requests through DISIS-2015-001. The study showed that no stability problems were found with the contingencies studied during the summer and the winter peak conditions as a result of changing to the GE 2.1MW wind turbine generators. Additionally, the project wind farm was found to stay connected during the contingencies that were studied and, therefore, will meet the Low Voltage Ride Through (LVRT) requirements of FERC Order #661A.

A short circuit analysis was performed.

A low-wind/no-wind condition analysis was performed for this modification request. The project will be required to install approximately 35.3 Mvars of shunt reactors on its substation 34.5kV bus(es). 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-2014-057 with the GE 2.1MW wind turbine generators should be able to reliably interconnect to the SPP transmission grid.

It should be noted that this study analyzed the requested modification to change generator technology, manufacturer, and layout. This study analyzed many of the most probable contingencies, but it is not an all-inclusive list and cannot account for every operational situation. It is likely that the customer may be required to reduce its generation output to 0 MW, also known as curtailment, under certain system conditions to allow system operators to maintain the reliability of the transmission network.

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. Introduction

The GEN-2014-057 Interconnection Customer has requested a modification to its Generator Interconnection Request to change from one hundred twenty-five (125) GE 2.0MW wind turbine generators (aggregate power of 250.0MW) to one hundred nineteen (119) GE 2.1MW wind turbine generators (aggregate power of 249.9MW). The point of interconnection (POI) is a tap on Lawton Eastside (American Electric Power (AEP)) – Sunnyside (Oklahoma Gas and Electric (OKGE)) 345kV transmission line. Table 1-1 shows the interconnection request.

Table 1-1: Interconnection Request

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2014-057	249.9	GE 2.1MW	Tap Lawton Eastside – Sunnyside 345kV

The study included a stability analysis of the interconnection request. Contingencies that resulted in a prior-queued project tripping off-line, if any, were re-run with the prior-queued project's voltage and frequency tripping relays disabled. Also a low-wind/no-wind analysis was performed on this project since it is a wind farm. The analyses were performed on three seasonal models, the modified versions of the 2016 winter peak, the 2017 summer peak, and the 2025 summer peak cases. The models included Interconnection Requests through DISIS-2015-001.

The stability analysis determines the impacts of the new interconnecting project on the stability and voltage recovery of the nearby systems and the ability of the interconnecting project to meet FERC Order 661A. If problems with power flow, stability or voltage recovery are identified, the need for reactive compensation or system upgrades is investigated.

A short circuit analysis was performed on busses up to five levels away from the POI.

The low-wind/no-wind analysis determines the capacitive effect at the POI caused by the project's collector system and transmission line capacitance. 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-2014-057 interconnection request is a tap on Lawton Eastside (American Electric Power (AEP)) - Sunnyside (Oklahoma Gas and Electric (OKGE)) 345kV Transmission line.

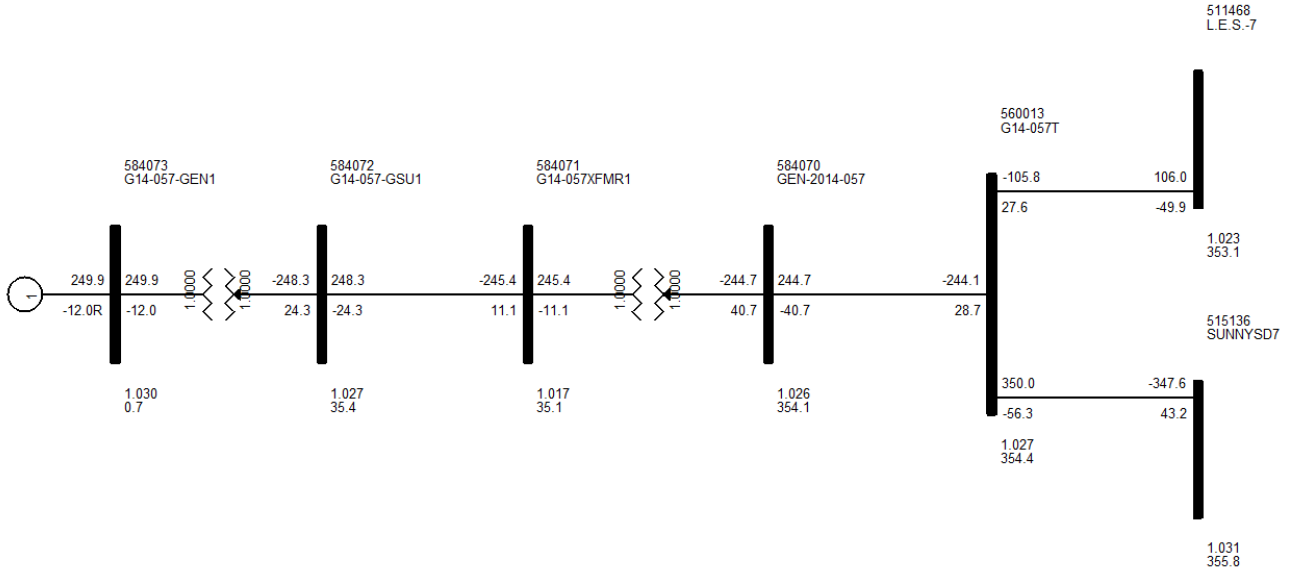

Figure 2-1: Proposed POI and Power Flow Model for GEN-2014-057

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.

Results

Based on the stability results and with all network upgrades in service, GEN-2014-057 did not cause any stability problems and remained stable for all faults studied. No generators tripped or went unstable, and voltages recovered to acceptable levels.

A complete set of plots for the stability analysis are available on request

4. Power Factor Analysis

Results

Refer to Appendix U for Group 14 in the original posting of DISIS-2014-002.

5. 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.

Results

A shunt reactor requirement for the interconnection request is shown below in Table 5-1.

Table 5-1: Summary of Shunt Reactor Requirements

Request	Capacity	POI	Approximate Shunt Reactor Required
GEN-2014-057	249.9MW	Tap Lawton Eastside – Sunnyside 345kV	35.3Mvar

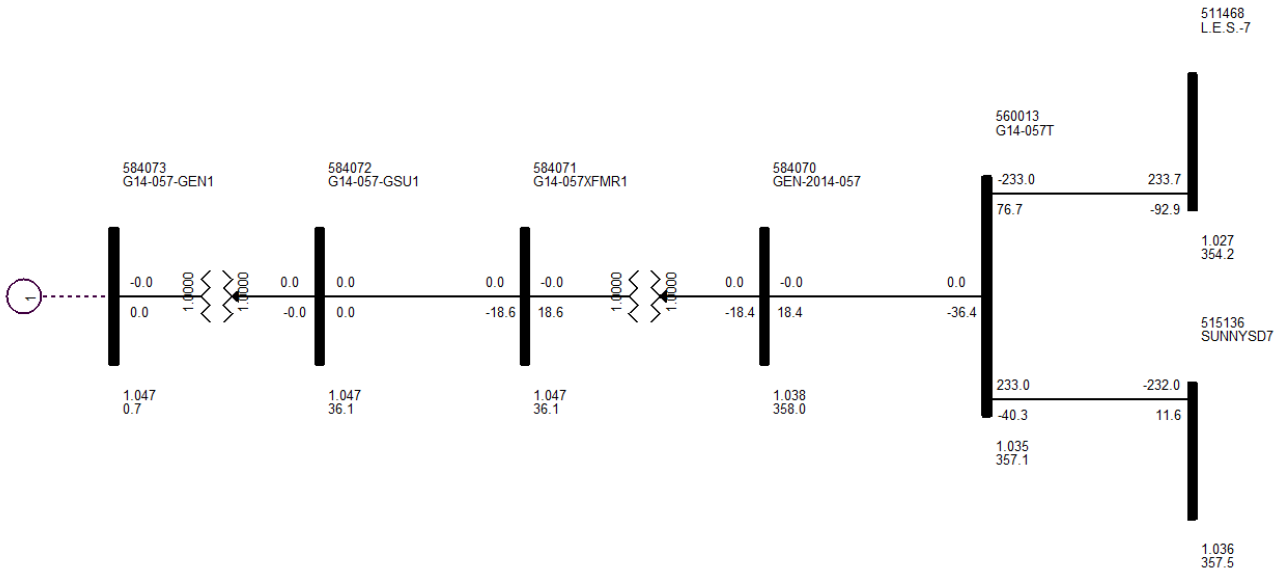

Figure 5-2: GEN-2014-057 with generators off and no shunt reactors

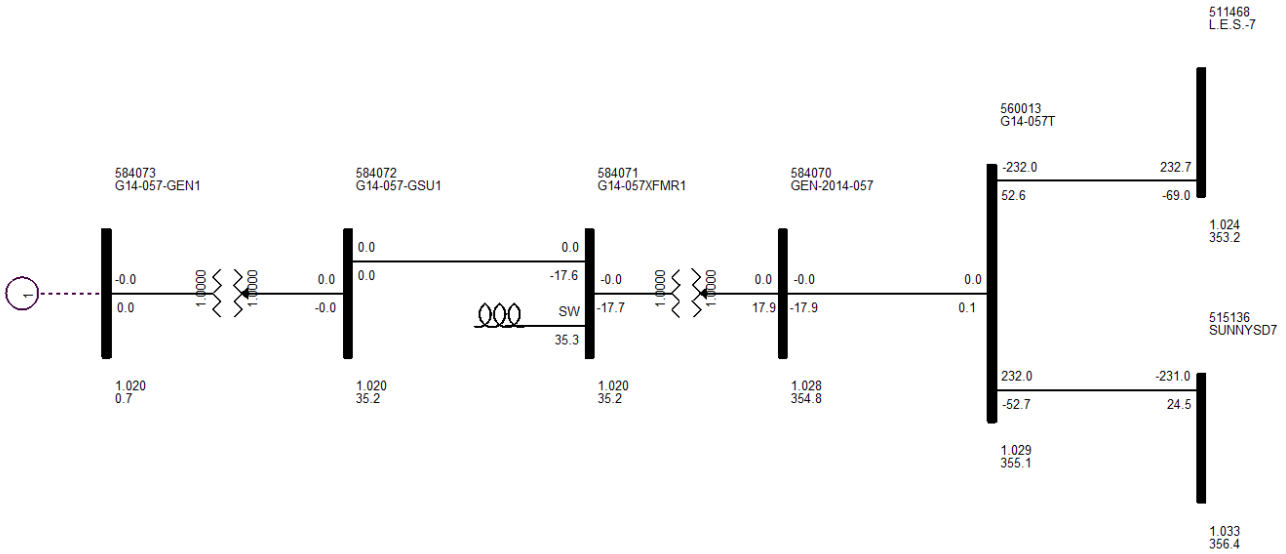

Figure 5-3: GEN-2014-057 with generator turned off and shunt reactor added to the low side of the substation 345/34.5kV transformer

6. Short Circuit Analysis

Results

The short circuit analysis was performed on the 2025 Summer Peak power flow case using the PSS/E ASCC program. Since the power flow model does not contain negative and zero sequence data, only three-phase symmetrical fault current levels were calculated at the point of interconnection up to and including five levels away. The following pages list the results of the analysis.

PSS®E-32.2.0 ASCC SHORT CIRCUIT CURRENTS WED, MAY 25 2016 10:15
2015 MDWG FINAL WITH 2013 MMWG, UPDATED WITH 2014 SERC & MRO
MDWG 2025S WITH MMWG 2024S, MRO & SERC 2025 SUMMER

THREE PHASE FAULT
X---------- BUS ----------X /I+/ AN(I+)
560013 [G14-057T 345.00] AMP 8992.1 -84.84
511468 [L.E.S.-7 345.00] AMP 11860.0 -84.65
515136 [SUNNYSD7 345.00] AMP 9722.9 -84.44
584070 [GEN-2014-057345.00] AMP 6097.7 -84.86

7. Conclusion

The GEN-2014-057 Interconnection Customer has requested a modification to its Interconnection Request to change wind turbine generators from GE 2.0MW to GE 2.1MW wind turbine generators as shown in Table 7-1.

Table 7-1: Interconnection Request

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2014-057	249.9	GE 2.1MW	Tap Lawton Eastside – Sunnyside 345kV

With all Base Case Network Upgrades in service, previously assigned Network Upgrades in service, and required capacitor banks in service, the GEN-2014-057 project was found to remain on line, and the transmission system was found to remain stable for all conditions studied.

A low-wind/no-wind condition analysis was performed for this modification request. The project will be required to install a total of approximately 35.3Mvar of reactor shunts on its substation 34.5kV buses. This is necessary to offset the capacitive effect on the transmission network cause by the project's transmission line and collector system during low-wind or no-wind conditions.

A power factor analysis was not performed for this study. Refer to Appendix U for Group 14 in the original posting of DISIS 2014-002.

Low Voltage Ride Through (LVRT) analysis showed the study generators did not trip offline due to low voltage when all Network Upgrades are in service, and therefore, GEN-2014-057 will meet the requirements of FERC Order #661A.

All generators in the monitored areas remained stable for all of the modeled disturbances.

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.

It should be noted that this study analyzed the requested modification to change generator technology, manufacturer, and layout. This study analyzed many of the most probable contingencies, but it is not an all-inclusive list and cannot account for every operational situation. It is likely that the customer may be required to reduce its generation output to 0 MW, also known as curtailment, under certain system conditions to allow system operators to maintain the reliability of the transmission network.

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.