GEN-2015-001
Impact Restudy for Generator Modification (Turbine Change)

November 2015
Generator Interconnection

SPP Southwest Power Pool

Revision History

Date	Author	Change Description
11/6/2015	SPP	GEN-2015-001 Impact Restudy for Generator Modification (Turbine Change) issued.

Executive Summary

The GEN-2015-001 Interconnection Customer has requested a modification to its Generator Interconnection Request to change from one hundred (100) Vestas V110 2.0MW wind turbine generators (aggregate power of 200.0MW) to fifty-six (56) Vestas V126 3.3MW and five (5) Vestas V126 3.0MW wind turbine generators (aggregate power of 199.8MW). The study of this modification request was completed as part of the analysis for the restudy of DISIS-2015-001[1]. A summary of the findings is presented here.

The point of interconnection (POI) is the Oklahoma Gas and Electric (OKGE) Ranch Road 345kV substation. Figure 2-1 shows the one-line diagram of the Interconnection Request.

The study models used were the 2015 summer, the 2015 winter, 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 Vestas V126 3.3MW and the Vestas V126 3.0MW 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 power factor analysis was performed and GEN-2015-001 will be required to meet the 0.95 power factor lagging (providing vars) to 0.95 power factor leading (absorbing vars) at the POI. A short circuit analysis was performed and detailed in the MEPPI report.

A low-wind/no-wind condition analysis was performed for this modification request. The project will be required to install approximately 9.3 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.

With the assumptions outlined in this report and with all required network upgrades in place, GEN-2015-001 with the Vestas V126 3.3MW and the Vestas V126 3.0 MW 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

[1] Mitsubishi Electric Power Products (MEPPI) was contracted by SPP to perform the stability study for the DISIS-2015-001-1 Group 8 analysis in which GEN-2015-001 was a part. MEPPI has provided SPP a final report which SPP will include in the DISIS-2015-001-1 Impact Study to be posted in the near future.

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-2015-001 Interconnection Customer has requested a modification to its Generator Interconnection Request to change from one hundred (100) Vestas V110 2.0MW wind turbine generators (aggregate power of 200.0MW) to fifty-six (56) Vestas V126 3.3MW wind turbine generators and five (5) Vestas V126 3.0MW wind turbine generators (aggregate power of 199.8MW). The point of interconnection (POI) is the Oklahoma Gas and Electric (OKGE) Ranch Road 345kV substation. Table 1-1 shows the interconnection request.

Table 1-1: Interconnection Request

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2015-001	199.8	56 x Vestas V126 3.3MW and 5 x Vestas V126 3.0MW	Ranch Road 345kV

The prior-queued, equally-queued and later queued requests shown in Table 1-2 were included in this study and the wind farms were dispatched to 100% of rated capacity.

Table 1-2: Prior and Later Queued Interconnection Requests

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2002-004	199.5	GE.1.5MW	Latham 345kV (532800)
GEN-2005-013	199.8	Vestas V90 1.8MW	Caney River 345kV (532780)
GEN-2007-025	299.2	GE 1.6MW	Viola 345kV (532798)
GEN-2008-013	299.04	GE 1.68MW	Hunter 345kV (515476)
GEN-2008-021	1283	GENROU	Wolf Creek 345kV (532797)
GEN-2008-098	100.0	Gamesa G114 2.0MW	Tap on the Wolf Creek – LaCygne 345kV line (Waverly 345kV, 532799)
GEN-2009-025	59.8	Siemens 2.3MW	Tap on the Deerck – Sincblk 69KV line (515528)
GEN-2010-003	100.0	Gamesa G114 2.0MW	Tap on the Wolf Creek – LaCygne 345kV line (Waverly 345kV, 532799)
GEN-2010-005	299.2	GE 1.6MW	Viola 345kV (532798)
ASGI-2010-006	150	GE1.5MW	Remington 138kV (301369)
GEN-2010-055	4.8	GENROU	Wekiwa 138kV (509757)
GEN-2011-057	150.0	Vestas V110 2.0MW	Creswell 138kV (532981)
GEN-2012-027	150.7	GE 1.62MW	Shidler 138kV (510403)
GEN-2012-032	299	Siemens 2.3MW	Tap Rose Hill-Sooner 345kV (562318)
GEN-2012-033	98.8	GE 1.62MW	Tap Bunch Creek-South 4th 138kV(562303)
GEN-2012-040	76.5	GE 1.7MW	Chilocco 138kV (521198)

Table 1-2: Prior and Later Queued Interconnection Requests

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2012-041	85 Summer 121.5 Winter	GENROU	Tap Rose Hill-Sooner 345kV (562318)
GEN-2013-012	4 x 168.0MW Summer 4 x 215MW Winter	GENROU (514910) (514911) (514912) (514942)	Redbud 345kV (514909)
GEN-2013-028	516.4 Summer 559.5 Winter	GENROU (583743, 583746)	Tap on Tulsa N to GRDA1 345kV (562423)
GEN-2013-029	300	Vestas V100 VCSS 2MW (583753, 583756)	Renfrow 345kV(515543)
GEN-2014-001	200.6	GE 1.7MW 100m (583853,583856)	Tap Wichita to Emporia Energy Center 345kV (562476)
GEN-2014-028	35 (Uprate) (Pgen=259W /256S)	GENROU	Riverton 161kV (547469)
GEN-2014-064	248.4	GE 2.3MW	Otter 138kV (514708)
ASGI-2014-014	56.4W/54.3S	GENROU	Ferguson 69kV (512664)
GEN-2015-015	154.6	Siemens 2.3MW with Power Boost (115kW => 2.415MW)	Tap Medford Tap – Coyote 138kV
GEN-2015-016	200.0	Vestas V110 2.0MW	Tap Centerville – Marmaton 161kV
GEN-2015-024	220.0	GE 2.0MW	Tap on Thistle to Wichita 345kV, ckt1&2 (560033)
GEN-2015-025	220.0	GE 2.0MW	Tap on Thistle to Wichita 345kV, ckt1&2 (560033)
GEN-2015-028	3.0 uprate to GEN-2009-025 for total 62.8MW	Siemens 2.3MW with Power Boost (115kW => 2.415MW)	Nardins 69kV
GEN-2015-030	200.1	GE 2.3MW	Sooner 345kV
ASGI-2015-004	54.300 Summer 56.364 Winter	GENSAL	Coffeyville Municipal Light & Power Northern Industrial Park Substation 69kV (512735)

The study included both a power flow and 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 2015 summer peak, the 2015 winter peak, and

the 2025 summer peak cases. The models included Interconnection Requests through DISIS-2015-001.

The power flow analysis determines the impacts of the interconnecting new Generating Facilities to the transmission system by identifying any thermal overloads or voltage issues. 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 power factor analysis at the POI was performed and 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-2015-001 interconnection request is the Oklahoma Gas and Gas and Electric (OKGE) Ranch Road 345kV substation.

Figure 2-1 depicts the one-line diagram of the POI and the power flow model representing the request.

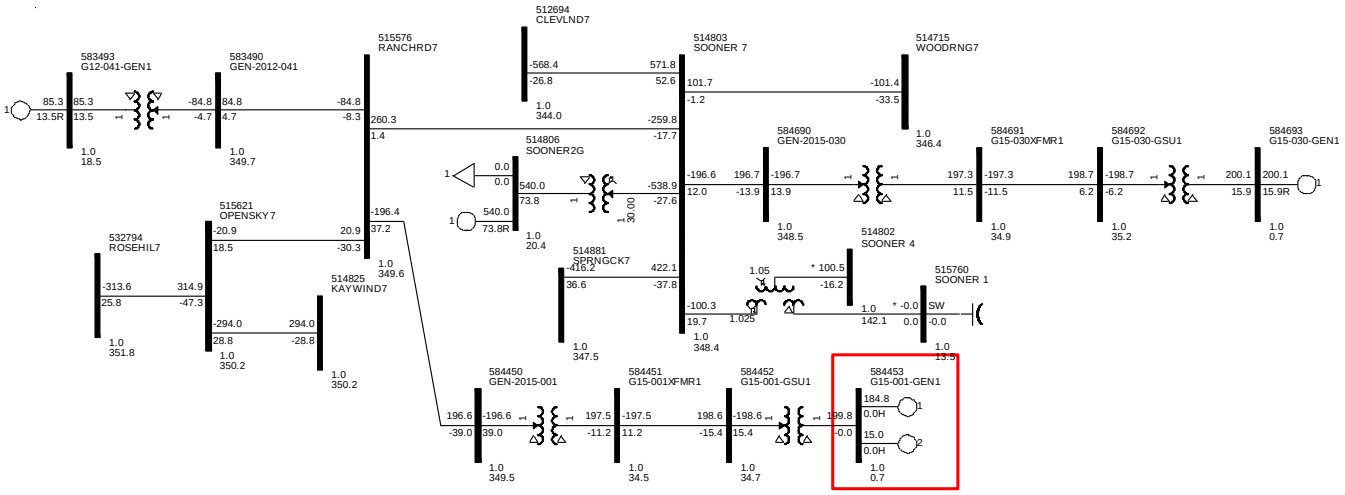

Figure 2-1: Proposed POI and Power Flow Model for GEN-2015-001[2]

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.

The stability analysis will be made available in the report of DISIS-2015-001-1.

Results

All results have been summarized in the Executive Summary section of this report and will be able to be found within the DISIS-2015-001-1 restudy report.

4. Power Factor Analysis

The power factor analysis will be made available in the report of DISIS-2015-001-1.

[2] This figure is from "DISIS-2015-001-1 (Group 08) Definitive Impact Study, Final Report", October 2015, submitted by MEPPI.

Results

All results have been summarized in the Executive Summary section of this report and will be able to be found within the DISIS-2015-001-1 restudy report.

5. Reduced Generation Analysis

The reduced generation analysis will be made available in the report of DISIS-2015-001-1.

Results

All results have been summarized in the Executive Summary section of this report and will be able to be found within the DISIS-2015-001-1 restudy report.

6. Short Circuit Analysis

The reduced generation analysis will be made available in the report of DISIS-2015-001-1.

Results

All results have been summarized in the Executive Summary section of this report and will be able to be found within the DISIS-2015-001-1 restudy report.

7. Conclusion

The GEN-2015-001 Interconnection Customer has requested a modification to its Interconnection Request to change wind turbine generators from Vestas V110 2.0MW to a combination of Vestas V126 3.3MW and Vestas V126 3.0MW wind turbine generators as shown in Table 7-1.

Table 7-1: Interconnection Request

Request	Capacity (MW)	Generator Model	Point of Interconnection
GEN-2015-001	199.8	56 x Vestas V126 3.3MW and 5 x Vestas V126 3.0MW	Ranch Road 345kV

The analysis for this modification study was incorporated into the DISIS-2015-001-1 that will be posted to the SPP Generation Interconnection website in the near future.

With all Base Case Network Upgrades in service, previously assigned Network Upgrades in service, and required capacitor banks in service, the GEN-2015-001 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 9.3Mvar 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 performed for this study. GEN-2015-001 will be required to meet 0.95 power factor lagging (providing vars) to 0.95 power factor leading (absorbing vars) at the POI.

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-2015-001 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.