



GEN-2016-071

Impact Restudy for Generator Modification (Turbine Change)

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By Generator Interconnection

REVISION HISTORY

| DATE OR VERSION NUMBER | AUTHOR | CHANGE DESCRIPTION | COMMENTS |
|---------------------------|------------------------------|-----------------------|----------|
| 10/30/2018 | Generator Interconnection | | |
| | | | |
| | | | |

EXECUTIVE SUMMARY

The GEN-2016-071 Interconnection Customer has requested a modification to its Interconnection Request. SPP has performed this system impact restudy to determine the effects of changing wind turbine generators from the previously studied eighty (80) GE 2.5 MW wind turbine generators to seventy-one (71) GE 2.5MW and nine (9) GE 2.3MW wind turbine generators as well as a POI change from WFEC Chilocco to OKGE Middleton Tap (one bus away). The total nameplate goes from 200 MW to 198.2 MW.

Because the turbine changes were all from GE turbines to GE turbines and the total change in collector system impedance was deemed negligible, no stability analysis was performed.

Due to the change in POI, the rebuild of Middleton Tap – Chilocco upgrade is no longer necessary. Cost Allocation remains the same for all other upgrades. No additional upgrades were identified.

A low-wind/no-wind condition analysis were performed for this modification request, and the project will be required to install approximately 6.8 MVar of reactor shunts on its substation 138 kV 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 the required network upgrades from the DISIS 2015-002 in place, GEN-2016-071 with the seventy-one (71) GE 2.5MW and nine (9) GE 2.3MW wind turbine generators should be able to interconnect reliably 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 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.

CONTENTS

| | |
|--|----|
| Revision History..... | i |
| Executive Summary..... | ii |
| Section 1: Introduction..... | 4 |
| Table 1-1: Interconnection Request | 4 |
| Table 1-2: Group 8 Prior, equally and Later Queued Interconnection Requests..... | 4 |
| Section 2: Facilities | 7 |
| Figure 2-1: GEN-2016-071 One-line Diagram | 7 |
| Section 3: Power Flow Analysis..... | 8 |
| Table 3-1: GEN-2016-071 Network Upgrades..... | 8 |
| Section 3: Stability Analysis | 9 |
| Section 4: Reduced Generation Analysis..... | 10 |
| Model Preparation..... | 10 |
| Results..... | 10 |
| Table 4-1: Summary of Shunt Reactor Requirements | 10 |
| Section 5: Conclusion..... | 11 |
| Table 5-1: Interconnection Request | 11 |
| Appendix A: Low Wind Analysis | 12 |
| Figure A-1: GEN-2016-071 with Generation Off and no Shunt Reactor | 12 |
| Figure A-1: GEN-2016-071 with Generation Off and Shunt Reactor | 12 |

SECTION 1: INTRODUCTION

GEN-2016-071 Impact Restudy is a generation interconnection study performed to study the impacts of interconnecting the project shown in Table I-1. This restudy evaluates the requested modification to change from eighty (80) GE 2.5 MW wind turbine generators to seventy-one (71) GE 2.5MW and nine (9) GE 2.3MW wind turbine generators, as well as a POI change from WFEC Chilocco to OKGE Middleton Tap (one bus away). The total output of GEN-2016-071 went from 200.1 MW to 198.2 MW.

TABLE 1-1: INTERCONNECTION REQUEST

| Request | Capacity (MW) | Generator Model | Point of Interconnection |
|--------------|---------------|--------------------------|--------------------------|
| GEN-2016-071 | 198.2 | GE 2.5MW & GE 2.3 (wind) | Middleton Tap (532984) |

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

TABLE 1-2: GROUP 8 PRIOR, EQUALLY AND LATER QUEUED INTERCONNECTION REQUESTS

| Request | Capacity (MW) | Generator Model | Point of Interconnection |
|---------------|---|---------------------------|---|
| GEN-2016-009 | 29 | GENROU | Osage 69Kv (514742) |
| GEN-2016-022 | 151.8 | Vestas V126 3.45MW | Ranch Road 345kv (515576) |
| GEN-2016-031 | 1.5MW uprate of GEN-2015-001(total = 201.3MW) | Vestas V126 3.3MW | Ranch Road 345kv (515576) |
| GEN-2016-032 | 200 | Vestas V110 2MW | Tap Marshall (514733)- Cottonwood Creek (514827) 138kv, (G16-032-TAP, 560077) |
| GEN -2016-048 | 82.3 | Sunny Central 2940 2.94MW | Sooner 138kv (514802) |
| GEN-2016-060 | 25.3 | G.E. 2.3MW | Belle Plain 138kv (533063) |
| GEN-2016-061 | 250.7 | GE 2.3 MW | Tap Woodring (514715) – Sooner (514803) 345kv (G16-061-TAP, 560084) |
| GEN-2016-068 | 250 | GE 2.0MW | Woodring 345kv (514715) |
| GEN-2016-073 | 220 | GE 2.0MW | Tap on Thistle (539801) to Wichita (532796) 345kv, ckt1&2 (Buffalo Flats 345kv; 560033) |
| 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 | 300 | G.E. 1.68MW | Hunter 345kv (515476) |
| GEN-2008-021 | 1261 Summer 1283 Winter | GENROU | Wolf Creek 345kv (532797) |

| Request | Capacity (MW) | Generator Model | Point of Interconnection |
|------------------------------|--|---|---|
| GEN-2008-098 | 100.8 | Vestas V100 1.8MW | Tap on the Wolf Creek – LaCygne 345kV line (560004) |
| GEN-2009-025 | 59.8 | Siemens 2.3MW | Tap on the Deerck – Sinck 69kV line (515528) |
| GEN-2010-003 | 100.8 | Vestas V100 1.8MW | Tap on the Wolf Creek – LaCygne 345kV line (560004) |
| 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 | 150.4 | GE 1.6MW | Creswell 138kV (532981) |
| KCPL Distributed: Osawatomie | 76.0 | GENROU (543078) | Paola 161kV |
| GEN-2012-032 | 300 | Vestas V112 3.0MW | Tap Rose Hill-Sooner 345kV (562318) |
| GEN-2012-033 | 98.8 | GE 1.62MW | Tap Bunch Creek-South 4th 138kV(562303) |
| 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/256 S) | 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-2015-001 | 200.0 | Vestas V110 2.0MW | Ranch Road 345kV |
| 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-2015-030 | 200.1 | GE 2.3MW | Sooner 345kV |
| GEN-2015-034 | 200 | Vestas V112- 2MW | Ranch Road 345kV (515576) |
| ASGI-2015-004 | 54.300 Summer 56.364 Winter | GENSAL | Coffeyville Municipal Light & Power Northern Industrial Park Substation 69kV (512735) |
| GEN-2015-047 | 300 | Vestas V110-2MW | Sooner 345kV Tap (514803) |

| Request | Capacity (MW) | Generator Model | Point of Interconnection |
|--------------|---------------|-----------------|---|
| GEN-2015-052 | 300 | Vestas V110-2MW | Tap on Opensky (515621) to RoseHill (532794) 345 kV (560053) |
| GEN-2015-062 | 4.5 | G.E. 1.79MW | Breckenridge 138kV (514815) |
| GEN-2015-063 | 300 | Vestas V110-2MW | Tap on Woodring (514715) to Matthewson (515497) 345 kV (560055) |
| GEN-2015-069 | 300 | Vestas V110-2MW | Union Ridge 230kV (532874) |
| GEN-2015-073 | 200.1 | Siemens 2.3MW | Emporia/Lang 345kV (532768) |
| GEN-2015-066 | 248 | G.E. 2.3MW | Tap on Cleveland (512694) to Sooner (514803) 345 kV (560056) |
| GEN-2015-083 | 125 | GE 2.3MW | Belle Plain 138kV (533063) |
| GEN-2015-090 | 220 | G.E. 2MW | Wichita (532796)-Thistle (539801) 345kV Tap (GEN-2015-024 (560033) 345kV) |

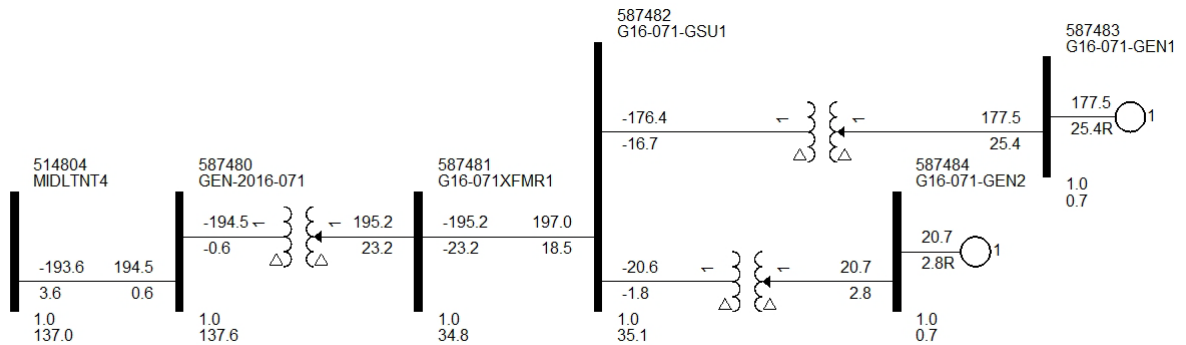
Because the turbine changes were all from GE turbines to GE turbines and the total change in collector system impedance was deemed negligible, no stability analysis was performed.

A low-wind/no-wind analysis was performed on this project since it is a non-synchronous resource. 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 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.

SECTION 2: FACILITIES

A one-line drawing for the GEN-2016-071 generation interconnection request is shown in Figure 2-1. The POI is a new tap on the OKGE Middleton Tap 138kVsubstation.

FIGURE 2-1: GEN-2016-071 ONE-LINE DIAGRAM



SECTION 3: POWER FLOW ANALYSIS

By moving the POI to Middleton Tap, the assigned upgrade to rebuild Middleton Tap to Chilocco 138 kV is no longer required. The Cost Allocation for all other upgrades assigned to GEN-2016-071 remains the same.

TABLE 3-1: GEN-2016-071 NETWORK UPGRADES

| Network Upgrade | POI at Chilocco 138kV | New POI at Middleton Tap 138kV |
|---|------------------------------|---------------------------------------|
| Rebuild Farber – Belle Plains 138 kV CKT 1 (Current Study) | ✓ | ✓ |
| GEN-2015-063 Tap_Matthewson 345 kV CKT 1 (Previously Allocated) | ✓ | ✓ |
| Rebuild Kildare - White Eagle 138kV CKT 1 (Current Study) | ✓ | ✓ |
| Rebuild Middleton Tap - Chilocco 138kV CKT 1 (Current Study) | ✓ | |
| Rebuild Osage - Webb Tap 138kV CKT 1 (Current Study) | ✓ | ✓ |
| Rebuild Osage - White Eagle 138kV CKT 1 (Current Study) | ✓ | ✓ |

SECTION 3: STABILITY ANALYSIS

Because the turbine changes were all from GE turbines to GE turbines and the total change in collector system impedance was deemed negligible, no stability analysis was performed.

SECTION 4: 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.

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 comes from the capacitance of the project's transmission lines and collector cables. This reactive power injection is measured at the POI. Shunt reactors were added at the study project substation low voltage bus to bring the MVar flow into the POI down to approximately zero.

RESULTS

A final shunt reactor requirement for each of the studied interconnection requests is shown in Table 4-1. One line drawings used in the analysis are shown in Appendix A: Low Wind Analysis.

TABLE 4-1: SUMMARY OF SHUNT REACTOR REQUIREMENTS

| Request | Capacity | POI | Approximate Shunt Reactor Required |
|--------------|----------|------------------------|------------------------------------|
| GEN-2016-071 | 198.2MW | Middleton Tap (514804) | 6.8 MVar |

The results shown are for the 2025 summer case. The other two cases (2016 winter and 2017 summer) were almost identical since the generation plant design is the same in all cases.

SECTION 5: CONCLUSION

The SPP GEN-2016-071 Impact Restudy evaluated the impact of interconnecting the project shown below in Table 5-1.

TABLE 5-1: INTERCONNECTION REQUEST

| Request | Capacity (MW) | Generator Model | Point of Interconnection |
|--------------|---------------|--------------------------------------|--------------------------|
| GEN-2016-071 | 198.2 MW | 9 GE 2.3 MW & 71 GE 2.5MW generators | Middleton Tap (514804) |

Because the turbine changes were all from GE turbines to GE turbines and the total change in collector system impedance was deemed negligible, no stability analysis was performed.

Due to the change in POI, the rebuild of Middleton Tap – Chilocco upgrade is no longer necessary. Cost Allocation remains the same for all other upgrades. No additional upgrades were identified.

A low-wind/no-wind condition analysis was performed for this modification request. The project will be required to install a total of approximately 6.8 MVAR of reactor shunts on its substation 138kV bus. 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.

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 System Impact Study constitutes a request for transmission service or confers upon

APPENDIX A: LOW WIND ANALYSIS

FIGURE A-1: GEN-2016-071 WITH GENERATION OFF AND NO SHUNT REACTOR

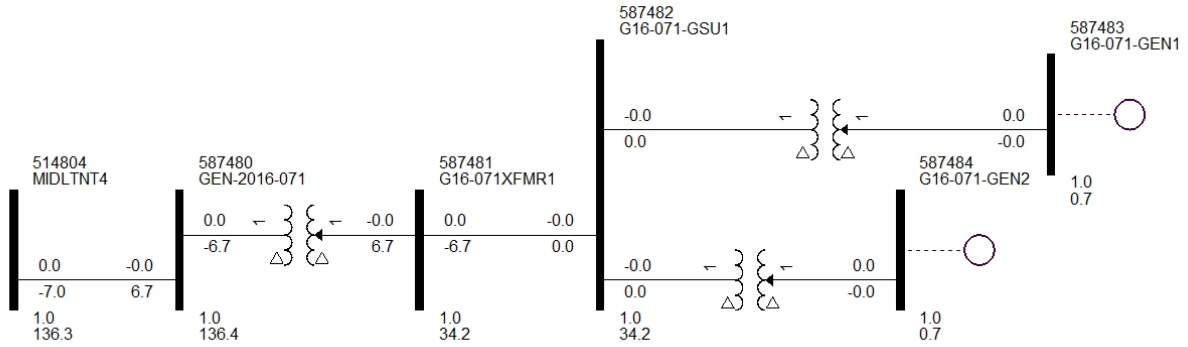


FIGURE A-1: GEN-2016-071 WITH GENERATION OFF AND SHUNT REACTOR

