Impact Study for Generation Interconnection Request

GEN-2006-044

February, 2012
Generation Interconnection

SPP Southwest Power Pool

Executive Summary

The following Impact Study has been performed under the Southwest Power Pool Open Access Transmission Tariff (OATT) for interconnection of 370 MW of wind generation within the balancing authority of Southwestern Public Service (SPS) in Hansford County, Texas. This Impact Study was performed to determine the impacts of the withdrawal of higher queued interconnection customers to the interconnection of the generating facility to the transmission system.

A power flow analysis shows that the Customer's wind facility can interconnect its full 370 MW of interconnection capacity. Power flow analysis was based on both summer and winter peak conditions and light loading cases. The previously assigned Finney-Holcomb 345kV transmission circuit is no longer required for interconnection.

The wind generation facility was studied as a 370 MW with a total of one hundred eighty-five (185) Dewind turbine generators. This Impact study addresses the dynamic stability effects of interconnecting the plant to the rest of the SPS transmission system. Two seasonal base cases were used in the study to analyze the stability impacts of the proposed generation facility.

The seasonal cases studied were modified 2012 spring, 2012 summer peak and winter peak, 2017 summer peak and winter peak cases that were adjusted to reflect system conditions at the requested in-service date. Each case was modified to include prior queued projects that are listed in the body of the report. Forty-one (41) contingencies were identified for use in this study. The Dewind 2.0 MW wind turbines were modeled using information provided by the Customer.

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

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Introduction

The following Impact Study has been performed under the Southwest Power Pool Open Access Transmission Tariff (OATT) for interconnection of 370 MW of wind generation within the balancing authority of Southwestern Public Service (SPS) in Hansford County, Texas. This Impact Study was performed to determine the impacts of the withdrawal of higher queued interconnection customers to the interconnection of the generating facility to the transmission system

The wind generation facility was studied as a 370 MW request with a total of with one hundred eighty-five (185) Dewind 2.0 MW wind turbine generators. Two seasonal base cases were used in the study to analyze the stability impacts of the proposed generation facility. The cases studied were modified versions of the 2012 spring, 2012 summer and winter peaks, and 2017 summer and winter peaks to reflect the system conditions at the requested in-service date. Each case was modified to include prior queued projects that are listed in the body of the report. Fourteen (14) contingencies were tested in this study.

Purpose

The purpose of this Impact Study is to evaluate the impact of the proposed interconnection on the reliability of the Transmission System for the withdrawal of higher queued request GEN-2005-017. The Impact Study considers the Base Case as well as all Generating Facilities (and with respect to (b) below, any identified Network Upgrades associated with such higher queued interconnection) that, on the date the original study is commenced:

a) are directly interconnected to the Transmission System;
b) are interconnected to Affected Systems and may have an impact on the Interconnection Request;
c) Have no Queue Position but have executed an LGIA or requested that an unexecuted LGIA be filed with FERC.

Any changes to these assumptions, for example, one or more of the previously queued projects not included in this study signing an interconnection agreement, may require a re-study of this request at the expense of the customer.

Nothing in this System Impact Study constitutes a request for transmission service or confers upon the Interconnection Customer any right to receive transmission service.

Facilities

Generating Facility

The project was modeled with the existing plant as an equivalent wind turbine generator of 370 MW output. The wind turbine is connected to three equivalent 0.69/34.5KV generator step unit (GSU). The high side of the GSU is connected to two 115/345kV substation transformes. A 345kV transmission line connects the Customer's substation transformer to the POI.

Interconnection Facility

The Point of Interconnection will be at Hitchland 345kV switching station. Figure 1 shows a one-line illustration of the facility and the POI. Figure 2 shows a one-line bus interconnection of the Point of Interconnection.

Cost to interconnect the GEN-2006-044 Interconnection Request is estimated at $3,415,054.

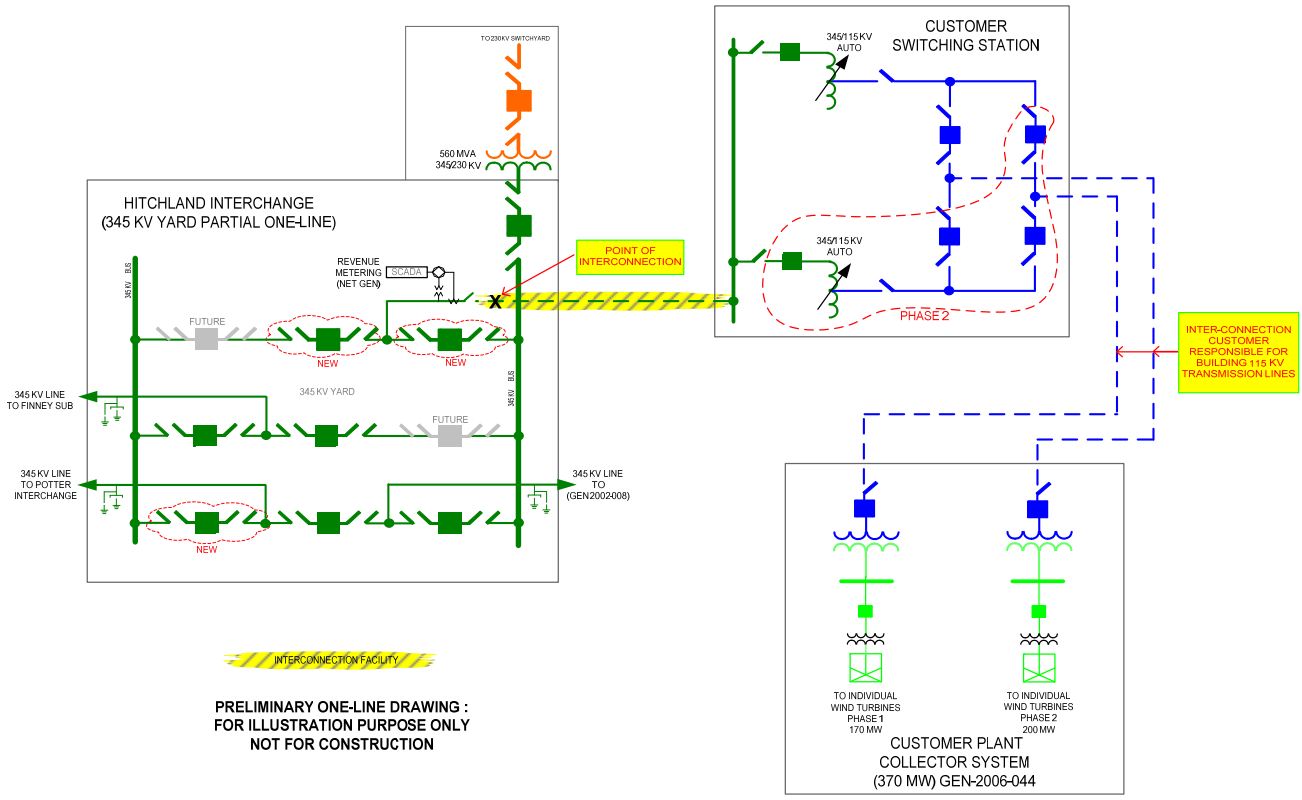

Figure 1: *GEN-2006-044*
Facility and Proposed Interconnection Configuration

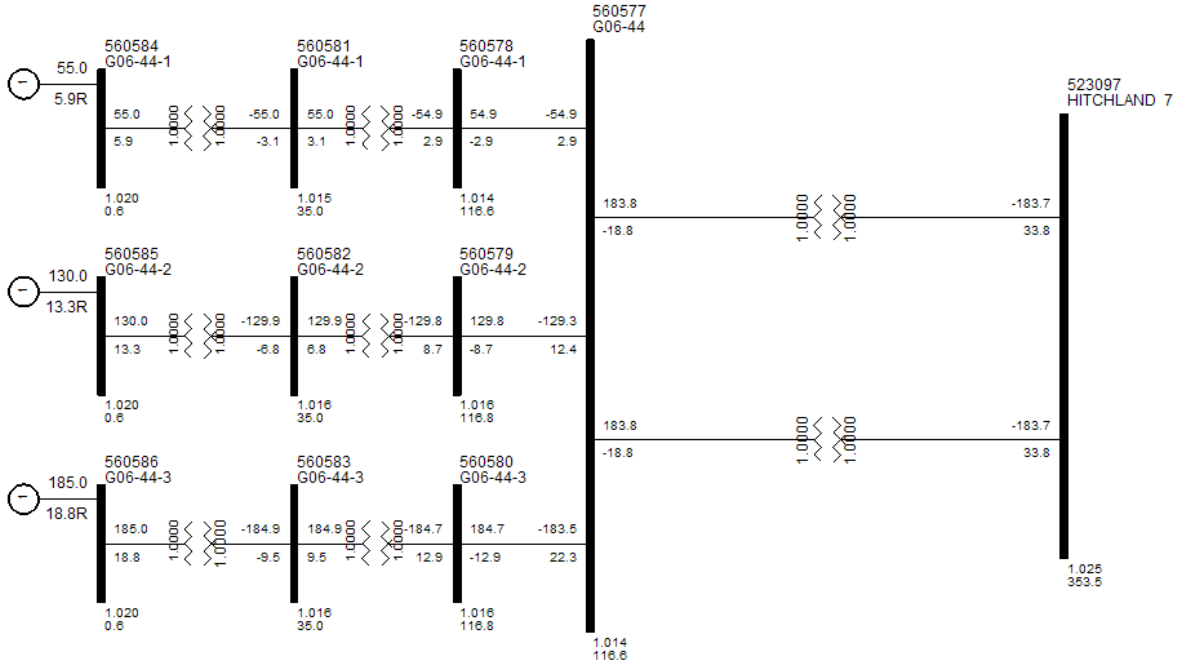

Figure 2: *GEN-2006-044 Bus Interconnection*

Power flow Analysis

A power flow analysis was conducted for the Interconnection Customer's facility using a modified version of the 2012 spring, 2012 summer and winter, and 2017 summer and winter seasonal models. The output of the Interconnection Customer's facility was offset in the model by a reduction in output of existing online SPP generation. This method allows the request to be studied as an Energy Resource (ERIS) Interconnection Request. This analysis was conducted assuming that previous queued requests listed in Table 3 were in-service.

The Southwest Power Pool (SPP) Criteria states that:

> "The transmission system of the SPP region shall be planned and constructed so that the contingencies as set forth in the Criteria will meet the applicable NERC Reliability Standards for transmission planning. All MDWG power flow models shall be tested to verify compliance with the System Performance Standards from NERC Table 1 – Category A."

The ACCC function of PSS/E was used to simulate single contingencies in portions of or all of the control area of SPP and other control areas within SPP and the resulting data analyzed. This satisfies the "more probable" contingency testing criteria mandated by NERC and the SPP criteria.

The ACCC analysis indicates that the Customer's project can interconnect 370 MW of generation into the SPS transmission system.

***Table 1**: ACCC Analysis for GEN-2006-044*

SEASON	SOURCE	DIRECTION	MONTCOMMONNAME	RATEA	RATEB	TDF	TC%LOADING	MW Available	CONTNAME
			No Interconnection Constraints for Mitigation						

Stability Analysis

Executive Summary

A transient stability study has been performed by Southwest Power Pool (SPP) to evaluate the interconnection requests in the Southwestern Public Service Company (SPS) area, to re-evaluate the dynamic stability of the system due to withdrawn of the prior queued request GEN-2005-017 (339 MW).

The GEN-2006-044 restudy has four (4) prior queued interconnection requests in the SPS area. The interconnection requests include GEN-2002-008, GEN-2002-009, GEN-2003-020, and GEN-2006-020. The interconnection requests in the SPS area total 869.3 MW.

The results of a stability analysis determined that for the addition of the interconnection requests, the transmission system was found to remain stable for both summer and winter peak conditions.. Additionally, the projects that were wind farms were found to stay connected during the contingencies that were studied, meeting the Low Voltage Ride Through (LVRT) requirements of FERC Order #661A.

Should any previously queued projects that were included in this study withdraw from the queue, then this System Impact Study may have to be revised to determine the impacts of this Interconnection Customer's project on transmission facilities.

Introduction

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The GEN-2006-044 restudy has four (4) prior queued interconnection requests in the SPS area. The interconnection requests include GEN-2002-008, GEN-2002-009, GEN-2003-020, and GEN-2006-020. The interconnection requests in the SPS area total 869.3 MW.

Two seasonal base cases were used in the study to analyze the stability impacts of the proposed generation facility. A 2011 summer peak case and a 2011 winter peak case which were both modified to include the prior queued projects shown in Table 2.

Purpose

The purpose of this Impact Study is to re-evaluate the impact of the proposed interconnection on the reliability of the Transmission System. Table 2 below lists the requests that were analyzed in this study.

***Table 2**: GEN-2006-044 Impact Study Request Table*

Request	MW
GEN-2002-008	240
GEN-2002-009	79.8
GEN-2003-020	159
GEN-2006-020	20
GEN-2006-044	370.5

Should any previously queued projects that were included in this study withdraw, then this GEN-2006-044 Impact Study may require a re-study of this request at the expense of the customer.

Facilities

Generating Facility

Table 3 lists the point of interconnection and machines used in this impact study to simulate the contingencies.

***Table 3**: Point of Interconnection and machine type*

Request	Turbine	Point of Interconnection
GEN-2002-008	GE 1.5	Hitchland 345 kV (523097)
GEN-2002-009	Suzlon 2.1	Hansford 115 kV (523195)
GEN-2003-020	GE 1.5	Martin 115 kV (523928)
GEN-2006-020	Dewind 2.0	DWS Frisco 115 kV (523160)
GEN-2006-044	Dewind 2.0	Hitchland 345kV (523097)

Stability Study Criteria

Contingencies Simulated

Fourteen (14) contingencies were considered for the transient stability simulations. The faults that were defined and simulated are listed in Table 4. These contingencies included three phase faults and single phase line faults at locations defined by SPP. Single-phase line faults were simulated by applying a fault impedance to the positive sequence network at the fault location to represent the effect of the negative and zero sequence networks on the positive sequence network. The fault impedance was computed to give a positive sequence voltage at the specified fault location of approximately 60% of pre-fault voltage. This method is in agreement with SPP current practice.

***Table 4**: Contingencies Evaluated*

Cont. No.	Cont. Name	Description
1	FLT1_3PH	3 phase fault on the Hitchland (523097) to Finney (523853) 345kV line, near Hitchland. a. Apply fault at the Hitchland 345 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
2	FLT2_1PH	*Single phase fault and sequence like previous*
3	FLT3_3PH	3 phase fault on the Hitchland (523097) to Potter (523961) 345kV line, near Hitchland. a. Apply fault at the Hitchland 345 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
4	FLT4_1PH	*Single phase fault and sequence like previous*
5	FLT5_3PH	3 phase fault on the Hitchland 230/345 kV autotransformer near 230kV bus. a. Apply fault at the Hitchland 230kV bus (523095). b. Clear fault after 5 cycles by tripping the faulted transformer.
6	FLT6_3PH	3 phase fault on the Hitchland 230/345 kV autotransformer near 345kV bus. a. Apply fault at the Hitchland 345kV bus (523097). b. Clear fault after 5 cycles by tripping the faulted transformer.
7	FLT7_3PH	3 phase fault on the Potter 230/345 kV autotransformer near 345kV bus. a. Apply fault at the Potter 345kV bus (523961). b. Clear fault after 5 cycles by tripping the faulted transformer.
8	FLT8_3PH	3 phase fault on the Finney (523853) to Holcomb (531449) 345kV line, near Finney. a. Apply fault at the Finney 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
9	FLT9_1PH	*Single phase fault and sequence like previous*
10	FLT10_3PH	3 phase fault on the Spearville 230/345 kV autotransformer near 345kV bus. a. Apply fault at the Spearville 345kV bus (531469). b. Clear fault after 5 cycles by tripping the faulted transformer.
11	FLT11_3PH	3 phase fault on the Holcomb (531449) to Spearville (531469) 345kV line, near Holcomb. a. Apply fault at the Holcomb 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
12	FLT12_1PH	*Single phase fault and sequence like previous*
13	FLT13_3PH	3 phase fault on the Holcomb (531449) to Setab (531465) 345kV line, near Holcomb. a. Apply fault at the Holcomb 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.
14	FLT14_1PH	*Single phase fault and sequence like previous*

Further Model Preparation

The base cases contain prior queued projects as shown in Table 2. All prior queued projects are dispatched at 100% nameplate.

The wind generation from the study customer and the previously queued customers were dispatched into the SPP footprint.

Initial simulations were carried out on both base cases and cases with the added generation for a no-disturbance run of 20 seconds to verify the numerical stability of the model. All cases were confirmed to be stable.

Results

Results of the stability analysis are summarized in Table 5. The results indicate that the transmission system is stable for all contingencies tested summer and winter cases.

***Table 5**: Results of Simulated Contingencies*

Cont. No.	Cont. Name	Description	Summer	Winter
1	FLT1_3PH	3 phase fault on the Hitchland (523097) to Finney (523853) 345kV line, near Hitchland. a. Apply fault at the Hitchland 345 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.	Stable	Stable
2	FLT2_1PH	*Single phase fault and sequence like previous*	Stable	Stable
3	FLT3_3PH	3 phase fault on the Hitchland (523097) to Potter (523961) 345kV line, near Hitchland. a. Apply fault at the Hitchland 345 kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.	Stable	Stable
4	FL4_1PH	*Single phase fault and sequence like previous*	Stable	Stable
5	FLT5_3PH	3 phase fault on the Hitchland 230/345 kV autotransformer near 230kV bus. a. Apply fault at the Hitchland 230kV bus (523095). b. Clear fault after 5 cycles by tripping the faulted transformer.	Stable	Stable
6	FLT6_3PH	3 phase fault on the Hitchland 230/345 kV autotransformer near 345kV bus. a. Apply fault at the Hitchland 345kV bus (523097). b. Clear fault after 5 cycles by tripping the faulted transformer.	Stable	Stable
7	FL7_3PH	3 phase fault on the Potter 230/345 kV autotransformer near 345kV bus. a. Apply fault at the Potter 345kV bus (523961). b. Clear fault after 5 cycles by tripping the faulted transformer.	Stable	Stable
8	FLT8_3PH	3 phase fault on the Finney (523853) to Holcomb (531449) 345kV line, near Finney. a. Apply fault at the Finney 345kV bus. b. Clear fault after 5 cycles by tripping the faulted line. c. Wait 20 cycles, and then re-close the line in (b) back into the fault. d. Leave fault on for 5 cycles, then trip the line in (b) and remove fault.	Stable	Stable
9	FLT9_1PH	*Single phase fault and sequence like previous*	Stable	Stable
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14	FLT14_1PH	*Single phase fault and sequence like previous*	Stable	Stable

FERC LVRT Compliance

FERC Order 661A Low Voltage Ride-Through Provisions (LVRT), which went into effect January 1, 2006, requires that wind generating plants remain in-service during 3-phase faults at the point of interconnection that draw the voltage down at the POI to 0.0 pu.

Conclusion

A transient stability study has been performed by Southwest Power Pool (SPP) to evaluate the interconnection requests in the Southwestern Public Service Company (SPS) area, to re-evaluate the dynamic stability of the system due to withdrawn of the prior queued request GEN-2005-017 (339 MW).

The GEN-2006-044 restudy has four (4) prior queued interconnection requests in the SPS area. The interconnection requests include GEN-2002-008, GEN-2002-009, GEN-2003-020, and GEN-2006-020. The interconnection requests in the SPS area total 869.3 MW.

The results of a stability analysis determined that for the addition of the interconnection requests, the transmission system was found to remain stable for both summer and winter peak conditions.. Additionally, the projects that were wind farms were found to stay connected during the contingencies that were studied, meeting the Low Voltage Ride Through (LVRT) requirements of FERC Order #661A.

The estimates do not include any costs associated with the deliverability of the energy to final customers. These costs are determined by separate studies if the Customer requests transmission service through Southwest Power Pool's OASIS. It should be noted that the models used for simulation do not contain all SPP transmission service.

All plots are available on request.