SPP Southwest Power Pool

Modification Request For Facility Study Generation Interconnection Request GEN-2011-027

SPP Generator Interconnection Studies

(#GEN-2011-027)

May 2013

Revision History

Date	Author	Change Description
8/30/2011	SPP	Facility Study Report Issued
05/22/2013	SPP	Modification Request

Summary
Nebraska Public Power District (NPPD) performed the following Facility Study at the request of the Southwest Power Pool for Generation Interconnection Request GEN-2011-027. This study was performed to evaluate a request for modification to the GEN-2011-027 interconnection request for interconnecting directly into the Hoskins substation rather than interconnecting into a new substation on the Hoskins-Twin Church 230kV line

Interconnection Customer Interconnection Facilities
The Interconnection Customers will be responsible for all of the transmission facilities connecting the customers owned substation to the Point of Interconnection (POI). The Point of Interconnection (POI) for GEN-2011-027 will be at the existing Hoskins substation. The Interconnection Customer will also be responsible for any equipment located at the Interconnection Customer's substation necessary to maintain a power factor of 0.95 lagging to 0.95 leading at the POI.

Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades
To allow interconnection for GEN-2011-027 the Transmission Owner will need to expand the existing Hoskins substation which will include an additional circuit breaker at Hoskins 230kV substation and construction of any associated equipment for acceptance of the Customer's Interconnection Facilities. At this time the Interconnection Customer, GEN-2011-027 is responsible for $4,200,000.00 of Transmission Owner Interconnection Facilities and Network Upgrades as well as an addition $500,000.00 of Non-Shared Network Upgrades beyond the Point of Interconnection.

Shared Network Upgrades
The Interconnection Customer GEN-2011-027 was studied within the DISIS-2011-001-3 Impact Restudy. At this time, the Interconnection Customer GEN-2011-027 is allocated $0 for Shared Network Upgrades.

If higher queued interconnection customers withdraw from the queue, suspend or terminate their GIA, restudies will have to be conducted to determine the Interconnection Customers' allocation of Shared Network Upgrades. All studies have been conducted on the basis of higher queued interconnection requests and the upgrades associated with those higher queued interconnection requests being placed in-service.

Other Network Upgrades
Certain Other Network Upgrades that are currently not the cost responsibility of the Interconnection Customer, GEN-2011-027, but will be required for full Interconnection Service. These Network Upgrades include:

1. Albion – Petersburg 115kV circuit 1, rerate, assigned to DISIS-2009-001 Customers (placed In-Service in 2011)
2. Twin Church – Dixon County 230kV, conductor clearance increase, assigned to DISIS-2010-002 Customers

Depending upon the status of higher or equally queued customers, the Interconnection Customer's in-service date is at risk of being delayed or their Interconnection Service is at risk of being reduced until the in-service date of these Other Network Upgrades.

Affected System Facilities
There were possible Western Area Power Administration (WAPA) and MidAmerican Energy Company (MEC) Affected System Facilities were identified in the Phase 1 through Phase 4 Load flow Analysis of the Facility Study.

Conclusion

Interconnection Service for GEN-2011-027 will be delayed until the Transmission Owner Interconnection Facilities and Non-Shared Upgrades are constructed. The Interconnection Customer, GEN-2011-027, is responsible for $4,200,000.00 of Transmission Owner Interconnection Facilities and Non-Shared Network Uprades and an additional 500,000.00 for Non-Shared Network Upgrades beyond the Point of Interconnection. At this time, the Interconnection Customer, GEN-2011-027 is allocated $0 for Shared Network Upgrades. After all Interconnection Facilities and Network Upgrades have been placed into service, interconnection service for GEN-2011-027 (120MW/Wind) can be allowed. At this time the total allocation of costs of interconnection service for GEN-2011-027 is estimated at $4,700,000.00.

This study was performed in response to the Interconnection Customer under GIP 4.4.2 to evaluate the modification of its request. In accordance with GIP 4.4.2, the Interconnection Customer may choose to withdraw this request for modification.

DISIS-2011-001-3
GENERATION INTERCONNECTION FACILITY RE-STUDY

SPP GEN-2011-018 **73.6 MW Wind Generation Facility at Steele City 115 kV**

SPP GEN-2011-027 **120.0 MW Wind Generation Facility at Hoskins 230 kV**

MARCH 2013

PREPARED FOR:
SOUTHWEST POWER POOL

PREPARED BY:
NEBRASKA PUBLIC POWER DISTRICT OPERATIONS
TRANSMISSION ASSET PLANNING
T&D ASSET MANAGEMENT
T&D ENGINEERING

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1.0 Introduction

In November 2012, NPPD was notified that one of the generation interconnection requests in the DISIS-2011-001 study desired to change its point-of-interconnection from the proposed Dixon County 230 kV substation to the existing Hoskins 230 kV substation. This material modification required a re-study to determine the interconnection facilities and network upgrades required to accommodate the modified request. The two generation interconnection requests remaining in the NPPD area in DISIS-2011-001 are listed below:

Project	MW	Point-of-Interconnection
GEN-2011-018	73.6	Steele City 115 kV
GEN-2011-027	120.0	Hoskins 230 kV
	193.6	

A list of interconnection and network upgrades identified in the System Impact Study as required for these two generation interconnection projects is below:

- GEN-2011-018 Interconnection Facilities – Expansion of Steele City 115 kV substation to accommodate new interconnection.

- GEN-2011-027 Interconnection Facilities – Expansion of Hoskins 230 kV substation to accommodate new interconnection.

2.0 Study Scope

Overview

This Facility Study will re-evaluate two proposed wind generator interconnection projects on the NPPD transmission system. This study will evaluate two generator interconnection requests in the SPP Generator Interconnection Queue which were studied in the SPP Definitive Interconnection System Impact Study, SPP DISIS-2011-001, and progressed to the facilities study stage. The two GI projects on the NPPD transmission system included in the DISIS-2011-001 study are as follows:

Project	MW	Point-of-Interconnection
GEN-2011-018	73.6	Steele City 115 kV
GEN-2011-027	120.0	Hoskins 230 kV
	193.6	

At the time of this facility re-study, there were several active generation interconnection requests in the SPP GI queue in the Nebraska area. These GI projects are currently at various stages in the SPP GI process. Due to time constraints, this facility study must proceed assuming the following generation interconnection projects and associated network upgrades remain active projects in the SPP GI process. If any of these GI projects or network upgrades withdraw from the SPP GI queue, then a re-study of this DISIS-2011-001 facility study will be required. The previously queued GI projects and network upgrades in the NPPD area are as follows:

Previously queued SPP GI projects

GEN-2006-044N (Petersburg.N)	=	40.5 MW
GEN-2008-086N02 (Madison.Co)	=	200.0 MW
GEN-2006-037N1 (Broken Bow II)	=	75.0 MW
GEN-2006-044N02 (Madison.Co)	=	100.8 MW
GEN-2008-123N (Rosemont)	=	89.7 MW
GEN-2010-051 (Dixon County)	=	200.0 MW
		706.0 MW

Previously allocated interconnection facilities & network upgrades

- Upgrade Neligh–Petersburg.N–Petersburg–Albion 115 kV to 137 MVA
- Upgrade Ft. Randall–Madison County–Kelly 230 kV to 320 MVA
- Madison County 230 kV substation
- Rosemont 115 kV substation
- Upgrade Madison County – Kelly 230 kV to 478 MVA
- Dixon County 230 kV substation
- Upgrade Twin Church – Dixon County 230 kV line to 320 MVA

This facility study will assess the new system state with the proposed wind facilities and associated transmission upgrades. The facility study will also identify any additional transmission issues that would require mitigation to meet mandatory NERC reliability standards following the addition of the new generation facilities and associated transmission projects. The Facility Study will include the following study phases:

1. Loadflow Analysis
2. Short Circuit Analysis

The loadflow analysis will be an assessment of the transmission system following the addition of the proposed generation requests and associated transmission projects. The loadflow analysis will evaluate the transmission system for compliance with NERC Reliability Standards and identify any thermal and voltage issues that would require mitigation. The short circuit analysis will evaluate the impacts of the wind facilities and associated transmission on existing fault currents in the area and determine if the capability of existing fault interrupting devices are adequate.

The intent of the facility study is to perform a detailed assessment of the proposed generation interconnection facilities and associated transmission and validate adherence to system reliability criteria. This study will be performed in accordance with NERC Reliability Standards and the criteria set forth under those standards. This facility study will document the required transmission facility interconnection plan for the two proposed generation interconnection facilities and be performed in accordance with the methodologies described in NPPD's Facility Connection Requirements Document.

Loadflow Analysis

NPPD Transmission Planning will perform a loadflow analysis to screen the steady state performance of the network following the addition of the wind facilities and associated transmission. The powerflow models used for the loadflow analysis will be 2011 Series SPP MDWG models (Build 1). These models will represent system conditions close to the expected in-service date of the proposed wind projects and will adequately represent a variety of worst-case seasonal conditions. The powerflow models utilized for the analysis will be:

2011 Spring Peak Load Case
2017 Summer 100% Peak Load Case
2017 Winter 100% Peak Load Case

The base SPP MDWG powerflow models will be updated with planned transmission facility additions in the 2011 – 2017 timeframe and other system changes consistent with the latest SPP Transmission Expansion Plan.

The loadflow study will be split into four phases:

Phase 1 : System-wide Single Contingency N-1 Analysis

Phase 2 : System-wide Multiple Element Contingency N-2 Analysis

Phase 3 : Local Area Full Accredited Generation Capacity N-1 & N-2 Contingency Analysis

Phase 4 : System-wide Single Contingency N-1 Analysis under heavy transfer conditions

PHASE 1: This Phase is considered a comprehensive single contingency analysis of the entire Nebraska subregion. Every single element rated from 115 kV – 345 kV in the NPPD, OPPD, LES, MEC and WAPA areas will be outaged and monitored through activity ACCC. The results of the contingency screening will be assessed and documented. Phase 1 will also further investigate all critical contingencies identified from the ACCC contingency screening. Phase 1 will be utilized to document the performance characteristics of the system in accordance with NERC Reliability Standards, TPL-001 and TPL-002.

PHASE 2: This Phase is considered a comprehensive multiple element contingency analysis of the entire Nebraska region. Multiple element contingencies rated from 115 kV – 345 kV will be outaged and monitored through activity ACCC. The multiple element contingencies consist of stuck breaker contingencies and double circuit tower contingencies identified by Nebraska transmission owners and utilized during MRO and SPP screening processes. The results of the contingency screening will be assessed and documented. Phase 2 will also further investigate all critical contingencies identified from the ACCC contingency screening comparison. Phase 2 will be utilized to document the performance characteristics of the system in accordance with NERC Reliability Standards, TPL-003 and TPL-004.

PHASE 3: This Phase will evaluate the impacts of worst case N-1 single contingency and independent N-2 double contingency conditions for the local area transmission outlet paths associated with the wind projects. The 2011 Series 2011 Spring Peak load case will be utilized to show the impacts of the worst case local area contingencies. All of the local area generation including the wind additions will be redispatched off-system. The purpose of this Phase will be to document sufficient generator outlet transmission capacity for the new wind generators concurrent with the existing approved accredited generation in the area.

This Phase will be used to evaluate the Nebraska area transmission capacity with respect to delivering the fully accredited generating capability out of the local area resources for load levels at and above 70% of peak. The Spring Peak Load case is approximately 65% of summer peak for the Nebraska region. To stress the generation outlet capacity, the maximum accredited generation is modeled in two separate cluster areas and exported into the surrounding MAPP & SPP regions. The following maximum accredited net generation levels will be modeled in this phase:

<u>Northeast NE Cluster</u>		
GEN-2011-027 (Hoskins 230 kV)	=	120.0 MW
GEN-2010-051 (Dixon.Co)	=	200.0 MW
GEN-2006-044N02 (Madison.Co)	=	100.8 MW
GEN-2006-037N1 (Broken Bow)	=	75.0 MW
GEN-2006-044N (Petersburg.N)	=	40.5 MW
GEN-2008-086N02 (Madison.Co)	=	200.0 MW
Petersburg Wind	=	80.0 MW
Broken Bow Wind	=	80.0 MW
Bloomfield Crofton Bluffs Wind	=	42.0 MW
Bloomfield Elkhorn Ridge Wind	=	81.0 MW
Monroe Hydro	=	4.0 MW
Ainsworth Wind	=	75.0 MW
Gavins Point #1-3	=	102.0 MW
Ft. Randall #1-6	=	360.0 MW
Neal #1-4	=	1680.0 MW
Columbus Hydro #1-3	=	45.0 MW
Columbus ADM Co-Gen #1	=	75.0 MW
Emerson	=	12.0 MW
West Point	=	7.4 MW
<u>Southeast NE Cluster</u>		
GEN-2011-018 (Steele City)	=	73.6 MW
GEN-2008-123N (Rosemont)	=	89.7 MW
Hebron #1	=	52.0 MW
Deshler Units #1-4	=	2.3 MW
Belleville Units #4-8	=	13.9 MW
Fairbury Units #2-3	=	15.3 MW
Red Cloud Units #1-5	=	4.0 MW
Sheldon #1	=	105.0 MW
Sheldon #2	=	120.0 MW
Hallam #1	=	52.0 MW
Beatrice Power Station #1	=	80.0 MW
Beatrice Power Station #2	=	80.0 MW
Beatrice Power Station #3	=	90.0 MW
Cooper #1	=	850.0 MW
Nebraska City #1	=	646.0 MW

Nebraska City #2	=	700.0 MW
Cass County #1	=	160.0 MW
Cass County #2	=	160.0 MW
Flat Water Wind	=	60.0 MW
GEN-2010-041 (Flat Water exp.)	=	10.5 MW

All of the incremental generation adjustments were made to external Nebraska resources to effect these schedules. Additional non-firm schedules into the MAPP and SPP regions made up the transfers. This type of operational mode is highly unlikely, but was utilized to demonstrate the transmission capacity available to deliver the fully accredited generation out of the Nebraska area under emergency conditions.

PHASE 4: This Phase is considered a comprehensive single contingency analysis of the entire Nebraska subregion under transfer conditions. This Phase will assess the performance of the NPPD transmission system under heavy north-to-south transfer conditions. Transfer cases will be established to evaluate north-to-south transfer limits with the wind generation interconnection projects at maximum output levels. Every single element rated from 115 kV – 345 kV in the NPPD, OPPD, LES, MEC and WAPA areas will be outaged and monitored through activity ACCC. The results of the contingency screening will be assessed and documented. Phase 4 will also further investigate all critical contingencies identified from the ACCC contingency screening. Phase 4 will be utilized to document the performance characteristics of the system in accordance with NERC Reliability Standards, TPL-001 and TPL-002.

Short Circuit Analysis

The purpose of the Short Circuit Analysis will be to evaluate the two proposed generation interconnection projects and associated transmission on the existing substation equipment fault duty ratings in the area. The substations to be evaluated are those electrically close to the interconnection points (Steele City 115 kV Sub and Hoskins 230 kV Sub) of the wind projects.

The Short Circuit Analysis will include short circuit calculations, an evaluation of the adequacy of existing circuit breaker interrupting ratings and an evaluation of the adequacy of the fault withstand capability of other substation equipment located at the monitored substations. The Short Circuit Analysis will be performed by NPPD Engineering Protection & Control personnel.

Detailed Cost Estimates & Project Schedule

NPPD Engineering, Asset Management, and Project Management departments will review the transmission upgrades identified in the SPP DISIS-2011-001 re-study. Detailed cost estimates and project schedules will be developed by these groups to

implement the proposed transmission upgrades using standard NPPD construction and procurement practices. If any additional transmission upgrades are identified in this facility study, a detailed cost estimate and project schedule for these additional upgrades will also be developed and provided as required.

3.0 Model Development

This study was conducted using Rev 32.1 of Power Technology Inc.'s (PTI's) Power System Simulator (PSS/E) software package and the following SPP MDWG 2011 series build 1 powerflow models:

2011 Spring Peak Load Case
2017 Summer 100% Peak Load Case
2017 Winter 100% Peak Load Case

The powerflow models were updated based on previously approved generation interconnection projects in the area. The following generation interconnection projects were included in the base powerflow models:

Petersburg Wind	=	80.0 MW
Broken Bow Wind	=	80.0 MW
Bloomfield Crofton Bluffs Wind	=	42.0 MW
Bloomfield Elkhorn Ridge Wind	=	81.0 MW
Ainsworth Wind	=	75.0 MW
Gavins Point #1-3	=	92.0 MW
Ft. Randall #1-6	=	347.0 MW
GEN-2006-044N (Petersburg.N)	=	40.5 MW
GEN-2008-086N02 (Madison.Co)	=	200.0 MW
GEN-2006-037N1 (Broken Bow II)	=	75.0 MW
GEN-2006-044N02 (Madison.Co)	=	100.8 MW
GEN-2008-123N (Rosemont)	=	89.7 MW
GEN-2010-051 (Dixon Co.)	=	200.0 MW

The previously approved generation resources listed above were dispatched at 100% and other generation resources in the same balancing authority (BA) were reduced to account for the increased generation. The two new generation interconnection projects listed below were then added to the models and dispatched at 100%. The total output (193.6 MW) from the new generation interconnection projects was dispatched off-system to all other balancing authorities within the SPP footprint on a pro rata basis.

GEN-2011-018 (Steele City)	= 73.6 MW
GEN-2011-027 (Hoskins)	= 120.0 MW

Wind Generation Models

Each of the new wind generation interconnection projects were modeled with a +/- 0.95 power factor range with voltage control capability at the designated point-of-interconnection. Some of the new projects may have a larger reactive power range

available, but the reactive capability of each generation interconnection project was limited to +/- 0.95 power factor to be conservative in this study.

4.0 Study Criteria

Facility Loading Criteria

Overloads of equipment are defined as greater than 100% of the normal continuous rating (Rate A).

Voltage Criteria

Normal steady-state voltage levels are defined as 0.95 to 1.05 pu. Emergency steady-state voltage levels are defined as 0.90 – 1.10 pu and may be utilized for less than 30 minutes.

5.0 Loadflow Analysis

5.1 Phase 1 Results (System-wide N-1 Screening)

PSS/E activity ACCC was used as a screening tool on each of the base cases to identify those contingencies which deserve closer study. ACCC analyzed the system by sequentially taking each transmission element greater than 100kV in the NPPD, OPPD, LES, MEC, and WAPA control areas out of service. Transmission facilities in the NPPD, OPPD, LES, MEC, and WAPA control areas were then monitored for violations of loading or bus voltage criteria. Contingencies which resulted in facility loadings or bus voltages outside of acceptable limits will be discussed in the summary of each case. The Phase 1 ACCC analysis is performed to assess the performance of the transmission system following the addition of the wind generation interconnection projects according to TPL-001 and TPL-002 standards.

Phase 1 analysis further addressed contingencies flagged in the screened ACCC run with additional AC powerflow analysis as required. In the NPPD area, there are loadflow solution issues associated with voltage regulation bandwidths. Consequently, most of the capacitors and reactors are modeled as fixed mode switched shunts, which must be manually switched to achieve optimal voltage profiles.

Powerflow activities VCHK and RATE were used to identify voltage and loading issues in the NPPD, OPPD, LES, WAPA, and MEC control areas for the full AC solution contingency runs. Activity VCHK produced a listing of those buses whose voltage magnitude was greater than 1.10 PU, followed by a listing of buses whose voltage was less than 0.90 PU. Activity RATE reported any branch whose current loading, including line charging and line connected shunt components, exceeded the specified percentage of RATE A.

<u>Phase 1 – 2011 Spring Peak</u>

System Intact Results (TPL-001):

There were no transmission facility overloads or bus voltages outside of limits under system intact or base case conditions for the 2011 Spring model.

N-1 Contingency Results (TPL-002):

Three overloaded transmission facilities were discovered in the monitored study areas in the N-1 ACCC analysis of the 2011 Spring Peak case with the wind facility additions and reported in the table. The post-contingency facility overloads that were discovered are summarized in Table 1 below.

Table 1. 2011 Spring Peak: N-1 Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
640287	N.PLATT7 115.00	640365	STOCKVL7 115.00	1	SINGLE 346	137	108.2
659105	LELANDO3 345.00	659201	LELND1TY 345.00	1	SINGLE 871	250	116.5
659106	LELANDO4 230.00	659201	LELND1TY 345.00	1	SINGLE 871	250	116.5

The North Platte – Stockville 115 kV line was overloaded for loss of the GGS – Red Willow 345 kV line. This contingency / monitored element pair are the limiting elements associated with the WNE_WKS PTDF flowgate. The post-contingency loading on the North Platte – Stockville 115 kV line is less than the 30-minute short-term emergency rating of 151 MVA. The Axtell-PostRock-Spearville 345 kV is expected to help mitigate this constraint which was energized in December 2012. The wind projects may be required to mitigate flows on this constraint through re-dispatch or system upgrades.

The Leland Olds 345/230 kV transformer was found to load above its 250 MVA rating for loss of the parallel 345/230 kV transformer. The post-contingency loading of this facility would need further review and coordination by the facility owner (BEPC) and the transmission planner (WAPA UGP) for this facility.

There were several bus voltage violations identified in the monitored study areas in the N-1 ACCC screening analysis. Any bus voltage violations located in the NPPD area could be mitigated with existing switched shunt devices and/or transformer tap adjustments. The remaining bus voltage violation issues are outside of the NPPD system and would need to be coordinated with external entities for further review.

Phase 1 – 2017 Summer Peak

System Intact Results (TPL-001):

There were no transmission facility overloads or bus voltages outside of limits under system intact or base case conditions for the 2017 Summer Peak model.

N-1 Contingency Results (TPL-002):

Four overloaded transmission facilities were discovered in the monitored study areas in the N-1 ACCC analysis of the 2017 Summer Peak case with the wind generation additions and reported in the table. Two of the facility overloads were on the NPPD transmission system. The post-contingency facility overloads that were discovered are summarized in Table 2 below.

Table 2. 2017 Summer Peak: N-1 Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
652405	FTPECK 4 230.00	652406	FTPECK 7 115.00	1	SINGLE 627	67	107.2
652477	ELSWRTH7 115.00	652485	NUNDRWD7 115.00	1	SINGLE 754	80	108.3
659105	LELANDO3 345.00	659201	LELND1TY 345.00	1	SINGLE 902	250	141.9
659106	LELANDO4 230.00	659201	LELND1TY 345.00	1	SINGLE 902	250	141.9

There were four additional facility overloads discovered during the ACCC analysis of the 2017 Summer Peak model with the wind generation additions. These additional facility overloads are all located in the WAPA area and this would require further coordination with WAPA to determine if any mitigation is required of the proposed wind generation facility additions.

There were several bus voltage violations identified in the monitored study areas in the N-1 ACCC screening analysis of the 2017 Summer Peak model with the wind additions. Any bus voltage violations located in the NPPD area could be mitigated with existing switched shunt devices and/or transformer tap adjustments. The remaining bus voltage violation issues are outside of the NPPD system and would need to be coordinated with external entities for further review.

Phase 1 – 2017 Winter Peak

System Intact Results (TPL-001):

There were no transmission facility overloads or bus voltages outside of limits under system intact or base case conditions for the 2017 Winter Peak model.

N-1 Contingency Results (TPL-002):

Six overloaded transmission facilities were discovered in the monitored study areas in the N-1 ACCC analysis of the 2017 Winter Peak case with the wind generation additions and reported in the table. None of the facility overloads were on the NPPD transmission system. The post-contingency facility overloads that were discovered are summarized in Table 3 below.

Table 3. 2017 Winter Peak: N-1 Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
652405	FTPECK 4 230.00	652406	FTPECK 7 115.00	1	SINGLE 627	67	101.3
652477	ELSWRTH7 115.00	652485	NUNDRWD7 115.00	1	SINGLE 754	80	123.2
659105	LELANDO3 345.00	659201	LELND1TY 345.00	1	SINGLE 902	250	162.0
659106	LELANDO4 230.00	659201	LELND1TY 345.00	1	SINGLE 902	250	162.0
652473	ELKCRK 7 115.00	652490	RAPIDCY7 115.00	1	SINGLE 751	60	106.7
652477	ELSWRTH7 115.00	652490	RAPIDCY7 115.00	1	SINGLE 754	80	107.1

There were six additional facility overloads discovered during the ACCC analysis of the 2017 Winter Peak model with the wind generation additions. The facility overloads are located in the WAPA area and this would require further coordination with WAPA to determine if any mitigation is required of the proposed wind generation facility additions.

There were several bus voltage violations identified in the monitored study areas in the N-1 ACCC screening analysis of the 2017 Winter Peak model with the wind additions. Any bus voltage violations located in the NPPD area could be mitigated with existing switched shunt devices and/or transformer tap adjustments. The remaining bus voltage violation issues are outside of the NPPD system and would need to be coordinated with external entities for further review.

Phase 1 Results Summary

The Phase 1 screening did not discover any overloads in the NPPD system. All of the transmission facility overloads were found on external systems and would need further coordination and investigation with the affected party (WAPA).

5.2 Phase 2 Results (System-wide Multiple Element Screening)

PSS/E activity ACCC was used as a screening tool on each of the base cases to identify those multiple element contingencies which deserve closer study. ACCC analyzed the system by sequentially taking select multiple element contingencies in the Nebraska area out-of-service. Transmission facilities in the NPPD, OPPD, LES, WAPA and MEC control areas were then monitored for violations of loading or bus voltage criteria. The Phase 2 ACCC analysis is performed to assess the performance of the transmission system following the addition of the wind generation interconnection projects according to TPL-003 and TPL-004 standards.

Phase 2 – 2011 Spring Peak

Category C Results (TPL-003):

There were two facility overloads discovered in the Category C ACCC analysis of the 2011 Spring Peak case with the wind generation interconnection facilities and reported in the table. The post-contingency facility overloads that were discovered are summarized in Table 5 below.

Table 5. 2011 Spring Peak: Category C Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
640183	GENTLMN3 345.00	640184	GENTLMN4 230.00	2	BKR-GGS-3304	336	104.8
640287	N.PLATT7 115.00	640365	STOCKVL7 115.00	1	TWR-GS-GRW	137	115.4

The North Platte – Stockville 115 kV line was overloaded for loss of the GGS – Red Willow 345 kV and GGS – Sweetwater 345 kV #2 double circuit. This contingency / monitored element pair are some of the limiting elements associated with the WNE_WKS PTDF flowgate. Loading on this facility would be limited in real-time operations to the TTC of the WNE_WKS flowgate. The Axtell-PostRock-Spearville 345 kV is expected to help mitigate this constraint which was energized in December 2012. The wind projects may be required to mitigate flows on this constraint through re-dispatch or system upgrades.

The Gentleman 345/230 kV transformer was overloaded for loss of the parallel Gentleman 345/230 kV transformer and GGS Unit #2 GSU for a stuck breaker outage. This constraint is a known limitation and the dispatch of GGS Unit #1 can be adjusted within 30 minutes to reduce the loading on this transformer to within normal limits. The overload does not exceed the 30-minute emergency rating of 420 MVA.

There were several bus voltage violations identified in the monitored study areas in the screening analysis of the 2011 Spring Peak model with the wind additions. Any bus

voltage violations located in the NPPD area could be mitigated with existing switched shunt devices and/or transformer tap adjustments.

Category D Results (TPL-004):

There were ten facility overloads discovered in the Category D ACCC analysis of the 2011 Spring Peak case with the wind generation interconnection facilities and reported in the table. The post-contingency facility overloads that were discovered are summarized in Table 6 below.

Table 6. 2011 Spring Peak: Category D Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
640103	CANADAY7 115.00	640161	ELMCRK_7 115.00	1	CSPT-GS1-GS2	80	104.7
652572	SIDNEY 7 115.00	659238	COLTON 7 115.00	1	CSPT-SK-SO	120	108.9
652300	CHAPPEL7 115.00	659238	COLTON 7 115.00	1	CSPT-SK-SO	120	107.9
659135	STEGALL3 345.00	659207	STEGALTY 345.00	1	CSPT-SK-SO	400	104.1
640246	JULSTAP7 115.00	652300	CHAPPEL7 115.00	1	CSPT-SK-SO	120	104.5
652573	STEGALL4 230.00	659206	STGXFMR4 230.00	1	CSPT-SK-SO	400	103.0
659206	STGXFMR4 230.00	659207	STEGALTY 345.00	1	CSPT-SK-SO	400	100.8
635001	CBLUFFS5 161.00	635030	RIVRBND5 161.00	1	INT-CF-CSJ	199	110.2
635030	RIVRBND5 161.00	635031	BUNGE 5 161.00	1	INT-CF-CSJ	199	107.2
635031	BUNGE 5 161.00	635032	HASTING5 161.00	1	INT-CF-CSJ	199	102.1

There was one facility overload identified for the CSPT-GS1-GS2 (GGS – Sweetwater 345 kV ckt 1 and GGS – Sweetwater 345 kV ckt 2) contingency. This contingency would require generation reductions at GGS, LRS and DC tie limitations in western NE/SD.

There were several facility overloads identified for the CSPT-SK-SO (Sidney – Keystone 345 kV & Sidney – Ogallala 230 kV) contingency. This contingency would require generation reductions at LRS and DC tie limitations in western NE/SD.

There were several facility overloads identified for the INT-CF-CSJ (Cooper – Fairport 345 kV and Cooper – St. Joe 345 kV) contingency. The limiting facilities are in the MEC system and are scheduled to be upgraded in the future.

There were several bus voltage violations identified in the monitored study areas in the screening analysis of the 2011 Spring Peak model with the wind additions. Any bus voltage violations located in the NPPD area could be mitigated with system re-adjustments.

Phase 2 – 2017 Summer Peak

Category C Results (TPL-003):

There were three facility overloads discovered in the Category C ACCC analysis of the 2017 Summer Peak case with the wind generation interconnection facilities are reported in the table. The post-contingency facility overloads that were discovered are summarized in Table 7 below.

Table 7. 2017 Summer Peak: Category C Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
640173	FREMONT7 115.00	647976	S976 8 69.000	4	CBFREM-A	56	106.5
640171	FIRTH 7 115.00	640278	SHELDON7 115.00	1	CB1263-BUS	76	108.3
640362	STERLNG7 115.00	647974	S974 8 69.000	1	CB1263-BUS	56	109.3

There were several bus voltage violations identified in the monitored study areas in the screening analysis of the 2017 Summer Peak model with the wind additions. Any bus voltage violations located in the NPPD area could be mitigated with system re-adjustments.

Category D Results (TPL-004):

There were five facility overloads discovered in the Category D ACCC analysis of the 2017 Summer Peak case with the wind generation interconnection facilities and reported in the table. The post-contingency facility overloads that were discovered are summarized in Table 8 below.

Table 8. 2017 Summer Peak: Category D Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
640362	STERLNG7 115.00	647974	S974 8 69.000	1	OPPD_CIP20	56	106.3
640171	FIRTH 7 115.00	640278	SHELDON7 115.00	1	OPPD_CIP20	76	108.1
635001	CBLUFFS5 161.00	635030	RIVRBND5 161.00	1	INT-CF-CSJ	199	100.0
646201	S1201 5 161.00	646206	S1206 5 161.00	1	OPPD_CIP21	221	101.9
646201	S1201 5 161.00	646206	S1206 5 161.00	1	OPPD_CIP21	221	101.9

There were several bus voltage violations identified in the monitored study areas in the screening analysis of the 2017 Summer Peak model with the wind additions. Any bus voltage violations located in the NPPD area could be mitigated with system re-adjustments.

Phase 2 – 2017 Winter Peak

Category C Results (TPL-003):

There was one facility overload discovered in the Category C ACCC analysis of the 2016 Winter Peak case with the wind generation interconnection facilities and reported in the table. The post-contingency facility overload that was discovered is summarized in Table 9 below.

Table 9. 2017 Winter Peak: Category C Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
640171	FIRTH 7 115.00	640278	SHELDON7 115.00	1	CB1263-BUS	76	104.7

There were several bus voltage violations identified in the monitored study areas in the screening analysis of the 2017 Winter Peak model with the wind additions. Any bus voltage violations located in the NPPD area could be mitigated with system re-adjustments.

Category D Results (TPL-004):

There were five facility overloads discovered in the Category D ACCC analysis of the 2017 Winter Peak case with the wind generation interconnection facilities and reported in the table. The post-contingency facility overloads that were discovered are summarized in Table 10 below.

Table 10. 2017 Winter Peak: Category D Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
640103	CANADAY7 115.00	640161	ELMCRK_7 115.00	1	CSPT-GS1-GS2	80	108.8
640093	C.CREEK4 230.00	640286	N.PLATT4 230.00	1	CSPT-GS1-GS2	402	103.3
640238	JEFFREY7 115.00	640287	N.PLATT7 115.00	1	CSPT-GS1-GS2	160	104.2
640171	FIRTH 7 115.00	640278	SHELDON7 115.00	1	OPPD_CIP20	76	100.0
640103	CANADAY7 115.00	640161	ELMCRK_7 115.00	1	CSPT-SA-CCR	80	100.8

There were several bus voltage violations identified in the monitored study areas in the screening analysis of the 2017 Winter Peak model with the wind additions. Any bus voltage violations located in the NPPD area could be mitigated with system re-adjustments.

Phase 2 Results Summary

Overall, there were several transmission facility overloads discovered in the Phase 2 screening for NERC category C and D contingencies.

5.3 Phase 3 Results (Local Area Full Accredited Generation Capacity N-1 & N-2 Contingency Analysis)

5.3.1 Phase 3 – N-1 Contingency Screening Analysis Results

PSS/E activity ACCC was used as a screening tool on the maximum generation powerflow model to identify those contingencies which deserve closer study. It should be noted that the powerflow models utilized in this phase of the loadflow study represent extreme worst-case generation outlet conditions. The powerflow models represent a highly unlikely maximum simultaneous generation dispatch scenario of generation facilities in the area. In order to evaluate the new generation interconnection requests, separate clusters were dispatched to evaluate worst-case generation outlet conditions for each new request. Northeast NE and southeast NE clusters were established to evaluate the new requests. Only the Northeast NE cluster was restudied in this evaluation due to the point of interconnection change. ACCC was utilized to analyze the system by sequentially taking contingencies in the NPPD, LES, OPPD, WAPA, and MEC areas out-of-service and monitoring facilities in the NPPD, LES, OPPD, WAPA and MEC areas for violations of loading or bus voltage criteria.

Phase 3 – 2011 Spring Peak – Northeast Cluster (N-1)

System Intact Results (TPL-001):

There were no transmission facility overloads or bus voltages outside of limits under system intact or base case conditions for the 2011 Spring model with maximum northeast cluster generation.

N-1 Contingency Results (TPL-002):

Five overloaded transmission facilities were discovered in the monitored study areas in the N-1 ACCC analysis of the 2011 Spring Peak North East Cluster Maximum Generation case with the wind facility additions. The post-contingency facility overloads that were discovered are summarized in Table 13 below.

Table 13. 2011 Spring Peak (northeast cluster max gen): N-1 Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
640287	N.PLATT7 115.00	640365	STOCKVL7 115.00	1	SINGLE 347	137	115.0
635201	RAUN 5 161.00	635203	NEAL N 5 161.00	2	SINGLE 49	335	103.7
635201	RAUN 5 161.00	635203	NEAL N 5 161.00	1	SINGLE 50	335	103.7
659105	LELANDO3 345.00	659201	LELND1TY 345.00	1	SINGLE 872	250	115.3
659106	LELANDO4 230.00	659201	LELND1TY 345.00	1	SINGLE 872	250	115.3

The North Platte – Stockville 115 kV line was overloaded for loss of the GGS – Red Willow 345 kV line. This contingency / monitored element pair are the limiting elements associated with the WNE_WKS PTDF flowgate. The post-contingency loading on the North Platte – Stockville 115 kV line is greater than the 30-minute short-term emergency rating of 151 MVA. The Axtell-PostRock-Spearville 345 kV is expected to help mitigate this constraint was energized in December 2012. The wind projects may be required to mitigate flows on this constraint through re-dispatch or system upgrades.

The Raun – Neal North 161 kV circuits 1 & 2 were found to load above the 335 MVA rating for loss of either parallel 161 kV circuit. The post-contingency loading of this facility would need further review and coordination by the transmission planner (MEC) for this facility.

The Leland Olds 345/230 kV transformer was found to load above its 250 MVA rating for loss of the parallel 345/230 kV transformer. The post-contingency loading of this facility would need further review and coordination by the transmission planner (WAPA UGP) for this facility.

There were several bus voltage violations identified in the monitored study areas in the N-1 ACCC screening analysis. Any bus voltage violations located in the NPPD area could be mitigated with existing switched shunt devices and/or transformer tap adjustments. The remaining bus voltage violation issues are outside of the NPPD system and would need to be coordinated with external entities for further review.

Additional Nucor Load Sensitivity Analysis

For this phase of the analysis, an additional iteration was performed with the Nucor DC arc furnace load served directly from the Hoskins 230 kV bus was reduced to 0 MW. This non-conforming load is connected to the point-of-interconnection bus and can range from 0 MW to 85 MW depending on its mode of operation. As a sensitivity, the N-1 maximum generation screening was re-ran with the Nucor load at 0 MW as to fully stress the generation outlet capability of the Hoskins 230 kV system. The results of this additional screening did not reveal any additional overloads or bus voltage violations than what was discovered in the initial analysis. The previously identified overloads in Table 13 did not change significantly.

5.3.2 Phase 3 – Multiple Element Contingency Analysis Results

This phase of the analysis evaluated all worst-case stuck breaker and double circuit contingencies in the local areas with the wind facility additions. PSS/E activity ACCC was used as a screening tool on the northeast maximum generation base cases with the additions to identify those contingencies which deserve closer study. ACCC analyzed the system by sequentially taking stuck breaker and double circuit contingencies in the areas near the wind generation additions and monitoring facilities in the NPPD, OPPD, LES, MEC, and WAPA areas for violations of loading or bus voltage criteria.

The stuck breaker and double circuit contingencies that were evaluated in this analysis are listed below.

Northeast Cluster
Stuck PCB at Hoskins 230 kV
Stuck PCB 3302 at Hoskins 345 kV
Stuck PCB 3308 at Hoskins 345 kV
Stuck PCB 3310 at Hoskins 345 kV
Stuck PCB 3312 at Hoskins 345 kV
Stuck PCB at Hoskins 115 kV north bus
Stuck PCB at Hoskins 115 kV south bus
Stuck PCB at Twin Church 230 kV north bus
Stuck PCB at Twin Church 230 kV south bus
Stuck PCB at Twin Church 115 kV
Stuck PCB at Twin Church 115 kV

Phase 3 – 2011 Spring Peak – Northeast Cluster (Stuck PCB / Double Circuit)

There were no transmission facility overloads identified during this phase of the analysis and there were no voltage violations for any of the multiple element contingencies studied.

Additional Nucor Load Sensitivity Analysis (Nucor @ 0 MW)

There were no transmission facility overloads identified during this phase of the analysis and there were no voltage violations for any of the multiple element contingencies studied.

5.3.3 Phase 3 – Independent N-2 Contingency Analysis Results

This phase of the analysis evaluated select set of independent N-2 contingencies in the areas with the wind facility additions. PSS/E activity ACCC was used as a screening tool on the 2011 Spring Peak Maximum Generation powerflow models with the wind facility additions to identify those contingencies which deserve closer study. ACCC analyzed the system by sequentially taking out all independent N-2 contingencies in the cluster areas and monitoring facilities in the NPPD, OPPD, LES, WAPA, and MEC areas for violations of loading or bus voltage criteria. A total of 561 independent N-2 contingencies were evaluated in the analysis of the northeast cluster.

Phase 3 – 2010 Spring Peak – North East Cluster (Independent N-2)

There were a number of overloaded transmission facilities discovered in the monitored study areas in the independent N-2 ACCC analysis of the 2011 Spring Peak Northeast Cluster case with the wind facility additions. The worst-case facility overloads identified in the ACCC analysis are summarized in Table 15 below. It should be noted that the Hoskins – Dixon County – Twin Church 230 kV line rating was assumed to be upgraded as required in the N-1 contingency screening. Prior outage generation restrictions would be required to ensure the transmission system is able to be operated reliably when certain transmission lines are taken out-of-service. The wind project curtailments will be subject to "first on, last off" curtailment priorities and operating guides will need to be developed to ensure the transmission system is operated in accordance with mandatory reliability standards. Based on a review of the N-2 contingencies that were flagged in the ACCC analysis, the following list was prepared of transmission facilities that would need detailed prior outage review or operating guides established. These transmission facilities were found to be part of an N-2 contingency pairing that resulted in a facility overload on the NPPD transmission system.

Limiting Prior Outage Facilities

1. Twin Church – Dixon County 230 kV
2. Hoskins 345/230 kV Transformer
3. Hoskins 230/115 kV Transformer

Table 15. 2011 Spring Peak (northeast max gen): Independent N-2 Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
640227	HOSKINS4 230.00	640228	HOSKINS7 115.00	1	DOUBLE 40	187	127.9
Sensitivity Results: Nucor Load @ 0 MW							
640227	HOSKINS4 230.00	640228	HOSKINS7 115.00	1	DOUBLE 40	187	171.7
560347	G10-51T 230.00	640386	TWIN CH4 230.00	1	DOUBLE 239	320	100.3

There were several bus voltage violations identified in the monitored study areas in the N-2 ACCC screening analysis. Any bus voltage violations located in the NPPD area

could be mitigated with existing switched shunt devices and/or transformer tap adjustments. The remaining bus voltage violation issues are outside of the NPPD system and would need to be coordinated with external entities for further review.

5.4 Phase 4 Results (System-wide N-1 Screening w/ transfer conditions)

The Phase 4 ACCC analysis is performed to assess the performance of the transmission system under stressed heavy transfer conditions following the addition of the wind generation interconnection projects according to TPL-001 and TPL-002 standards. This phase utilized the 2011 Spring Peak case as the base system topology. Generation in western Nebraska and Iowa were then increased to stress the existing north-south flowgates (WNE_WKS & COOPER_S) in Nebraska to existing transfer limits. The proposed wind generation interconnection projects (193.6 MW total) and associated transmission upgrades were then added to the case. The new wind generation was exported off-system to other modeling areas in SPP on a pro rata basis. PSS/E activity ACCC was then used as a screening tool on the base case to identify those contingencies which deserve closer study. ACCC analyzed the system by sequentially taking each transmission element greater than 100kV in the NPPD, OPPD, LES, MEC, and WAPA control areas out of service. Transmission facilities in the NPPD, OPPD, LES, MEC, and WAPA control areas were then monitored for violations of loading or bus voltage criteria. Contingencies which resulted in facility loadings or bus voltages outside of acceptable limits will be discussed in the summary of each case.

System Intact Results (TPL-001):

There were no transmission facility overloads or bus voltages outside of limits under system intact or base case conditions for the 2011 Spring Peak case with transfers.

N-1 Contingency Results (TPL-002):

Eleven overloaded transmission facilities were discovered in the monitored study areas in the N-1 ACCC analysis of the 2011 Spring Peak case with transfers and the wind facility additions and reported in the table. The post-contingency facility overloads that were discovered are summarized in Table 17 below.

Table 17. 2011 Spring Peak (w/ transfers): N-1 Facility Overloads

From Bus	From Bus Name	To Bus	To Bus Name	CKT	CONTINGENCY	RATING	%
541199	ST JOE 3 345.00	640139	COOPER 3 345.00	1	LN-FAIRPORT	1073	107.5
635001	CBLUFFS5 161.00	635030	RIVRBND5 161.00	1	LN-FAIRPORT	199	105.5
635030	RIVRBND5 161.00	635031	BUNGE 5 161.00	1	LN-FAIRPORT	199	102.5
541199	ST JOE 3 345.00	640139	COOPER 3 345.00	1	SINGLE 2	1073	109.3
635001	CBLUFFS5 161.00	635030	RIVRBND5 161.00	1	SINGLE 2	199	101.8
635001	CBLUFFS5 161.00	635030	RIVRBND5 161.00	1	SINGLE 5	199	106.7
635030	RIVRBND5 161.00	635031	BUNGE 5 161.00	1	SINGLE 5	199	103.7
635001	CBLUFFS5 161.00	635030	RIVRBND5 161.00	1	SINGLE 315	199	101.8
640287	N.PLATT7 115.00	640365	STOCKVL7 115.00	1	SINGLE 347	137	113.7
635201	RAUN 5 161.00	635203	NEAL N 5 161.00	2	SINGLE 50	335	106.6
635201	RAUN 5 161.00	635203	NEAL N 5 161.00	1	SINGLE 51	335	106.6

The North Platte – Stockville 115 kV line was overloaded for loss of the GGS – Red Willow 345 kV line. This contingency / monitored element pair are the limiting elements associated with the WNE_WKS PTDF flowgate. The post-contingency loading on the North Platte – Stockville 115 kV line is above 110% of the facility rating. The Axtell – Post Rock – Spearville 345 kV line will help mitigate congestion associated with the WNE_WKS PTDF flowgate. The Axtell-PostRock-Spearville 345 kV was energized in December 2012. The wind projects may be required to mitigate flows on this constraint through re-dispatch or system upgrades.

The Cooper – St. Joe 345 kV line was overloaded above the 1073 MVA rating for loss of the Cooper – Fairport – St. Joe 345 kV line. The Council Bluffs – Riverbend 161 kV line was also overloaded above the 199 MVA rating for this contingency. The Council Bluffs – Riverbend 161 kV line is scheduled to be upgraded to a higher facility rating in the near future.

The Raun – Neal North 161 kV circuits 1 & 2 were found to load above the 335 MVA rating for loss of either parallel 161 kV circuit. The post-contingency loading of this facility would need further review and coordination by the transmission planner (MEC) for this facility.

There were several bus voltage violations identified in the monitored study areas in the screening analysis of the 2010 Spring Peak model with transfers. Any bus voltage violations located in the NPPD area could be mitigated with system re-adjustments. Bus voltage violations outside of the NPPD system would need to be coordinated with external entities for further review.

Phase 4 Results Summary

Overall, there were several transmission facility overloads discovered in the Phase 4 screening that were associated with north-south transfer limitations in western and eastern Nebraska. It should also be noted that the additional wind generation interconnections in Nebraska continue to have an adverse impact on these north-south flowgates and transmission limitations. Increased generation on the north end of these constraints will continue to increase congestion and number of hours in curtailment. The Axtell – Post Rock – Spearville 345 kV line will help mitigate the issues associated with the WNE_WKS flowgate, but additional studies are required to determine the relief this project will provide. Additional points of congestion were noted on several 161 kV paths in Iowa and Kansas as well as on the Cooper-St.Joe 345 kV line.

6.0 Short Circuit Analysis

NPPD Protection and Controls Department completed a re-study of the DISIS-2011-001 Short Circuit Analysis using the same model with the point-of-interconnection change. The GEN-2011-027 point-of-interconnection change from the proposed "Dixon County 230kV substation" to the Hoskins 230kV substation does not significantly change the results from the original Short Circuit Analysis. The original DISIS-2011-001 Short Circuit Study concluded that there were no interrupting devices which should be charged to the transmission system changes required to serve the new wind farms. The conclusion of the original study is still valid and no interrupting devices need to be replaced to interconnect the wind farms.

The Hoskins 230kV bus feeds a large steel plant. This steel plant has a very large D.C. arc furnace and several smaller A.C. arc furnaces. The arc furnace load causes an increase of voltage flicker on the transmission system. A Static Var Compensator is installed on the 34.5kV bus at the Hoskins Substation feeding the steel plant to help mitigate the voltage flicker. The voltage flicker levels on the Hoskins 230kV bus can be expected to be below an Pst level of 1.0 with all transmission lines/transformers in service. However, the flicker level will increase if transmission lines/transformers are out of service. The voltage flicker for a worst case single contingency can be expected to increase the Pst level to 1.35 or less. It should be known, that D.C. arc furnaces and A.C. arc furnaces produce non integer and integer harmonics. The Static Var Compensator has filter banks which absorbs the majority of these harmonics, however there are occasions where non integer and integer harmonics in excess of IEEE 519 standard will flow out onto the Hoskins 230kV transmission system.

7.0 Detailed Cost Estimates & Project Schedule

NPPD's Engineering, Asset Management, and Project Management groups have reviewed the list of interconnection facilities and network upgrades that are required for interconnection of the two wind generation projects. Detailed cost estimates have been prepared for each of the interconnection facilities and network upgrades that were identified in the SPP DISIS-2011-001 system impact study and this facility re-study. It should be noted that the costs associated with any radial transmission facilities required to connect remote generation interconnection facilities to the designated point-of-interconnection to the NPPD transmission system are NOT included in these estimates. The project costs and schedule associated with any radial transmission facilities will be developed during the development of the generation interconnection agreement with the interconnection customer. The prepared cost estimates are high-level budgetary estimates (+75%/-25%) and assume implementation of standard NPPD construction and procurement practices. The cost estimates for the interconnection facilities and network upgrades are below:

- GEN-2011-018 Interconnection Facilities – Steele City 115 kV substation expansion to accommodate new 115 kV interconnection.
  $ 0.9 Million

- GEN-2011-027 Interconnection Facilities – Hoskins 230 kV substation expansion to accommodate new 230 kV interconnection.
  $ 4.2 Million

- Hoskins – Dixon County – Twin Church 230 kV Line Upgrade – Increase clearances on Hoskins – Dixon County – Twin Church 230 kV line and terminal upgrades to accommodate increased facility rating to address N-1 contingency loading issues identified in DISIS-2011-001 Facility Study. **$ 0.5 Million**

Total Interconnection & Network Upgrades: $5.6 Million

Proposed one-line diagrams of the interconnection and network upgrades are on the following pages. NPPD will work with the wind generation facility projects to develop project schedules for the interconnection facilities and network upgrade projects listed above during the development of the generation interconnection agreement. Typical implementation schedules for new transmission lines (≥ 115 kV) are roughly 4 years to accommodate the public routing process and construction schedules. Substation additions require less land acquisition and typically can be implemented in less time or approximately 2-3 years. Project schedule details will be further discussed in the

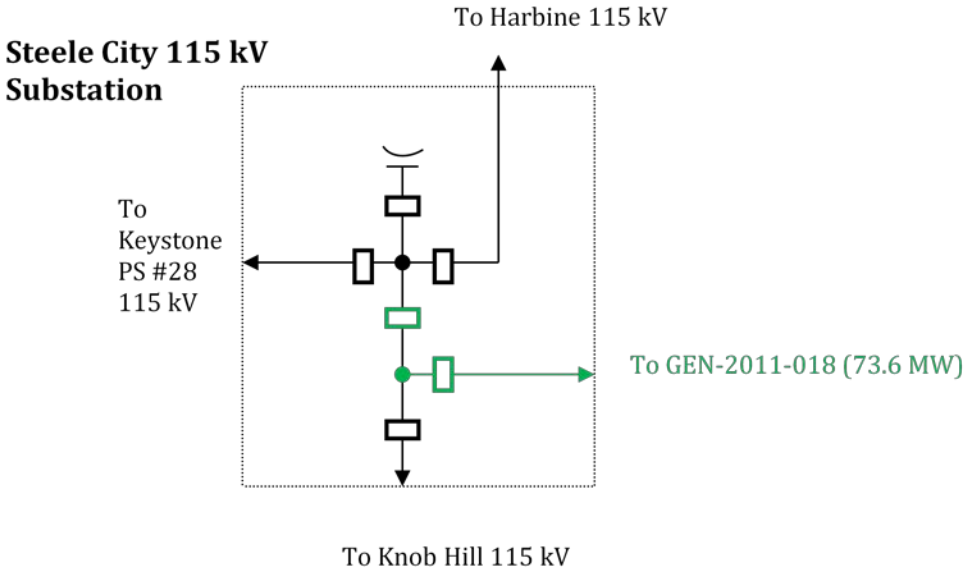
development of the generator interconnection agreement (GIA) and the milestones associated with the generation interconnection projects.

It should be noted that the projects listed above do not include any third party facilities that were identified as overloaded in the facility study. SPP will need to coordinate the results of this facility study with these external entities to determine the appropriate mitigations and necessary transmission upgrades. Detailed costs and project schedules would then be developed by SPP and the external entity and communicated to the wind generation interconnection customers.

It should also be noted that the interconnection plan for the DISIS-2011-001 generation projects are dependent on the transmission upgrades/additions that are required as part of the DISIS-2010-002, DISIS-2010-001 and DISIS-2009-001 interconnection plans. If there are any modifications to the DISIS-2010-002, DISIS-2010-001 and DISIS-2009-001 generation or transmission projects, then the interconnection plan for the DISIS-2011-001 projects could be affected. This issue would need to be re-studied and evaluated if for any reason any of the DISIS-2010-002, DISIS-2010-001 or DISIS-2009-001 generation or transmission projects to not move forward.

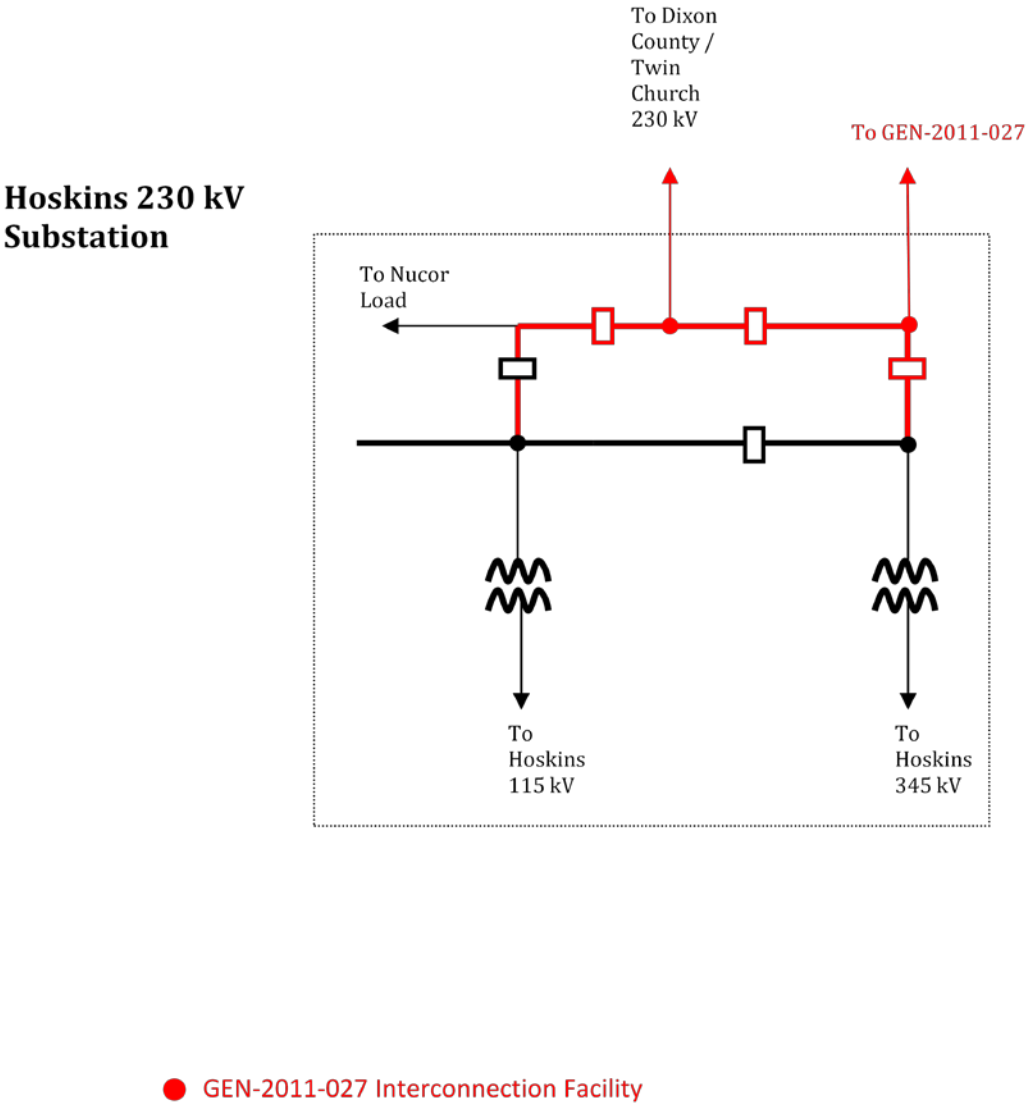
The new point of interconnection at the existing Hoskins 230 kV substation for GEN-2011-027 presents many challenges from a construction / outage standpoint. The Hoskins 230 kV bus serves a large steel plant that would experience an outage to accommodate the new interconnection. Any outage of the 230 kV bus at Hoskins would need to be coordinated with the steel plant and will be limited to mutually agreed upon outage schedules.

GEN-2011-018



• GEN-2011-018 Interconnection Facility

GEN-2011-027


To Dixon County / Twin Church 230 kV
To GEN-2011-027
Hoskins 230 kV Substation
To Nucor Load
To Hoskins 115 kV
To Hoskins 345 kV
GEN-2011-027 Interconnection Facility