

# INTERCONNECTION FACILITIES STUDY REPORT

GEN-2016-029 IFS-2016-001-09

Published January 2020

By SPP Generator Interconnections Dept.

# **REVISION HISTORY**

DATE OR VERSION NUMBER	AUTHOR	CHANGE DESCRIPTION
12/5/2019	SPP	Initial draft report issued.
1/6/2020	SPP	Final report issued.

Southwest Power Pool, Inc.

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## SUMMARY

### INTRODUCTION

This Interconnection Facilities Study (IFS) for Interconnection Request <u>GEN-2016-029/IFS-2016-001-09</u> is for a <u>150.5</u> MW generating facility located in <u>Platte County, Wyoming</u>. The Interconnection Request was studied in the <u>DISIS 2016-001</u> Impact Study and Restudies for <u>Energy Resource</u> <u>Interconnection Service (ERIS)</u>. The Interconnection Customer's requested in-service date is <u>12/2017</u> and the revised commercial operation date in the Facility Study Agreement is <u>11/01/2019</u>.

The interconnecting Transmission Owner, <u>Basin Electric Power Cooperative (BEPC)</u> performed a detailed IFS at the request of SPP. The full report is included in Appendix A. SPP has determined that full Interconnection Service will be available after the assigned Transmission Owner Interconnect Facilities (TOIF), Non-Shared Network Upgrades, Shared Network Upgrades, Previous Upgrades, and Affected System Upgrades that are required for full interconnection service are completed.

The primary objective of the IFS is to identify necessary Transmission Owner Interconnection Facilities, Network Upgrades, other direct assigned upgrades, cost estimates, and associated upgrade lead times needed to grant the requested Interconnection Service.

### PHASE(S) OF INTERCONNECTION SERVICE

It is not expected that Interconnection Service will occur in phases. However, Interconnection Service will not be available until all Interconnection Facilities and Network Upgrade(s) can be placed in service.

### CREDITS/COMPENSATION FOR AMOUNTS ADVANCED FOR NETWORK UPGRADE(S)

Interconnection Customer shall be entitled to compensation in accordance with Attachment Z2 of the SPP OATT for the cost of SPP creditable-type Network Upgrades, including any tax gross-up or any other tax-related payments associated with the Network Upgrades, that are not otherwise refunded to the Interconnection Customer. Compensation shall be in the form of either revenue credits or incremental Long Term Congestion Rights (iLTCR).

Southwest Power Pool, Inc.

### INTERCONNECTION CUSTOMER INTERCONNECTION FACILITIES

The Generating Facility is proposed to consist of <u>sixty-nine (69) GE 2.0 MW wind generators and seven</u> (7) GE 1.79 MW wind generators for a total generating nameplate capacity of <u>150.5 MW</u>.

The Interconnection Customer's Interconnection Facilities to be designed, procured, constructed, installed, maintained, and owned by the Interconnection Customer at its sole expense include:

- 34.5 kV underground cable collector circuits;
- 34.5 kV to 345 kV transformation substation with associated 34.5 kV and 345 kV switchgear;
- One (1) 345/34.5 kV 102/136/170 MVA (ONAN/ONAF/ONAF) step-up transformer to be owned and maintained by the Interconnecting Customer at the Interconnection Customer's substation;
- A twelve (12) mile overhead 345 kV line to connect the Interconnection Customer's substation to the Point of Interconnection ("POI") at the 345 kV bus at new Transmission Owner Switchyard Tap Laramine River Sidney 345 kV that is owned and maintained by Transmission Owner;
- All transmission facilities required to connect the Interconnection Customer's substation to the POI;
- Equipment at the Interconnection Customer's substation necessary to maintain a composite power delivery at continuous rated power output at the high-side of the generator substation at a power factor within the range of 95% lagging and 95% leading in accordance with Federal Energy Regulatory Commission (FERC) Order 827. Additionally approximately 12.4 Mvars<sup>1</sup> of reactors will be required to compensate for injection of reactive power into the transmission system under no/reduced generating conditions. The Interconnection Customer may use turbine manufacturing options for providing reactive power under no/reduced generation conditions. The Interconnection Customer will be required to provide documentation and design specifications demonstrating how the requirements are met; and,
- All necessary relay, protection, control and communication systems required to protect Interconnection Customer's Interconnection Facilities and Generating Facilities and coordinate with Transmission Owner's relay, protection, control and communication systems.

<sup>&</sup>lt;sup>1</sup> This approximate minimum reactor amount is needed for the current configuration of GEN-2016-029 as studied in the DISIS-2016-001 Impact Study and Restudies.

Interconnection Facilities Study Report GEN-2016-029/IFS-2016-001-09

### TRANSMISSION OWNER INTERCONNECTION FACILITIES AND NON-SHARED NETWORK UPGRADE(S)

To facilitate interconnection, the interconnecting Transmission Owner will perform work as shown below necessary for the acceptance of the Interconnection Customer's Interconnection Facilities.

**Table 1** and **Table 2** lists the Interconnection Customer's estimated cost responsibility forTransmission Owner Interconnection Facilities (TOIF) and Non-Shared Network Upgrade(s) andprovides an estimated lead time for completion of construction. The estimated lead time begins whenthe Generator Interconnection Agreement has been fully executed.

Transmission Owner Interconnection Facilities (TOIF)	Total Cost Estimate (\$)	Allocated Percent (%)	Allocated Cost Estimate (\$)	Estimated Lead Time
Transmission Owner Tap Laramie River – Sidney 345 kV Interconnection Substation: Construct one (1) 345 kV line terminal, line switches, dead end structure, line relaying, communications, revenue metering, line arrestor, and all associated equipment and facilities necessary to accept transmission line from Interconnection Customer's Generating Facility.	\$120,000*	100%	\$120,000*	3 Months
Total	\$120,000*		\$120,000*	

### Table 1: Transmission Owner Interconnection Facilities (TOIF)

\* GEN-2016-029 will utilize GEN-2016-023 facilities and generator lead to the POI. If for any reason GEN-2016-023 does not proceed with interconnection, all cost associated with GEN-2016-023 interconnection will still be required for the remaining request(s).

Non-Shared Network Upgrades Description	Z2 Type <sup>2</sup>	Total Cost Estimate (\$)	Allocated Percent (%)	Allocated Cost Estimate (\$)	Estimated Lead Time
None	N/A	\$0	N/A	\$0	N/A
Total		\$0		\$0	

### Table 2: Non-Shared Network Upgrade(s)

<sup>&</sup>lt;sup>2</sup> Indicates the method used for calculating credits impacts under Attachment Z2 of the Tariff. Interconnection Facilities Study Report GEN-2016-029/IFS-2016-001-09

### SHARED NETWORK UPGRADE(S)

The Interconnection Customer's share of costs for Shared Network Upgrades is estimated in **Table 3** below.

Shared Network Upgrades Description	Z2 Type	Total Cost Estimate (\$)	Allocated Percent (%)	Allocated Cost Estimate (\$)	Estimated Lead Time
Nebraska Public Power District (NPPD): Keystone - Gentleman 345 <u>kV CKT 2:</u> Build approximately 30 miles of 345 kV from Gentleman to Keystone, build new bays at Keystone and Gentleman to achieve minimum Rate A of 956 MVA. Gentleman reconfiguration	creditable	\$74,500,000	50.0	\$37,250,000	72 Months
<b>NPPD: Sidney - Keystone 345 kV CKT</b> <u><b>2:</b></u> Build approximately 47.5 miles of 345 kV from Sidney to Keystone, build new bays at Keystone and Sidney to achieve minimum Rate A of 956 MVA.	creditable	\$90,500,000*	50.0	\$42,250,000	72 Months
<b>BEPC: Sidney - Keystone 345 kV CKT</b> <u>2:</u> Build approximately 47.5 miles of 345 kV from Sidney to Keystone, build new bays at Keystone and Sidney to achieve minimum Rate A of 956 MVA.	creditable	\$84,007,534*	50.0	\$42,003,767	48 Months
Total		\$249,007,537		\$121,503,767	

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Table 2. Interconnection	Customor	Sharod	Notwork	Ilnarados
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\* Estimate is half of TO report estimates for 95 mile length total.

All studies have been conducted assuming that higher-queued Interconnection Request(s) and the associated Network Upgrade(s) will be placed into service. If higher-queued Interconnection Request(s) withdraw from the queue, suspend or terminate service, the Interconnection Customer's share of costs may be revised. Restudies, conducted at the customer's expense, will determine the Interconnection Customer's revised allocation of Shared Network Upgrades.

### PREVIOUS NETWORK UPGRADE(S)

Certain Previous Network Upgrades are **currently not the cost responsibility** of the Interconnection Customer but will be required for full Interconnection Service.

Previous Network Upgrade(s) Description	Current Cost Assignment	Estimate In- Service Date
<b>SPP-NTC-200220 - R-Plan:</b> Build new 222 mile, 345 kV line from Gentleman - Cherry Co - Holt Co. Build new 345 kV substations at Cherry Co and Holt Co. Terminal upgrades at Gentleman.	\$412,074,343	5/01/2021

Depending upon the status of higher- or equally-queued customers, the Interconnection Request's inservice date is at risk of being delayed or Interconnection Service is at risk of being reduced until the inservice date of these Previous Network Upgrades.

### AFFECTED SYSTEM UPGRADE(S)

To facilitate interconnection, the Affected System Transmission Owner will be required to perform the facilities study work as shown below necessary for the acceptance of the Interconnection Customer's Interconnection Facilities. **Table 5** displays the current impact study costs as part of the Affected System Impact review. The Affected System facilities study could provide revised costs and will provide each Interconnection Customer's allocation responsibilities for the upgrades.

### Table 5: Interconnection Customer Affected System Upgrade(s)

Affected System Upgrades Description	Total Cost Estimate (\$)	Allocated Share (%)	Allocated Cost Estimate (\$)
None	\$0	N/A	\$0
Total	\$0		\$0

### CONCLUSION

After all Interconnection Facilities and Network Upgrades have been placed into service, Interconnection Service for 150.5 MW can be granted. Interconnection Service will be delayed until the Transmission Owner Interconnect Facilities (TOIF), Non-Shared Network Upgrades, Shared Network Upgrades, Previous Network Upgrades, and Affected System Upgrades that are required for full interconnection service are completed. The Interconnection Customer's estimated cost responsibility is summarized in the table below.

### Table 6: Cost Summary

Description	<b>Allocated Cost Estimate</b>
Transmission Owner Interconnection Facilities	\$120,000*
Network Upgrades	\$121,503,767
Total	\$121,623,767

\* GEN-2016-029 will utilize GEN-2016-023 facilities and generator lead to the POI. If for any reason GEN-2016-023 does not proceed with interconnection, all cost associated with GEN-2016-023 interconnection will still be required for the remaining request(s).

A draft Generator Interconnection Agreement will be provided to the Interconnection Customer consistent with the final results of this IFS report. The Transmission Owner and Interconnection Customer will have 60 days to negotiate the terms of the GIA consistent with the SPP Open Access Transmission Tariff (OATT).



# A: TRANSMISSION OWNER'S INTERCONNECTION FACILITIES STUDY REPORT AND NETWORK UPGRADES REPORT(S)

See next page for the Transmission Owner's Interconnection Facilities Study Report and Network Upgrades Report(s).

### Basin Electric Power Cooperative Interconnection Facilities Study IFS-2016-001-09

### 1. Background:

**1.1** Per SPP Generation Interconnection Process 2019 revision<sup>1</sup>, Basin Electric Power Cooperative (Basin Electric) received a request to perform an Interconnection Facility Study Analysis for the following Interconnection Requests:

GI Request #	Point of Interconnection	Capacity (MW)	Fuel Type
GEN-2016-023	Laramie River – Sidney, Laramie River - Stegall	150.5	Wind
GI Request #	Point of Interconnection	Capacity (MW)	Fuel Type

<sup>1</sup> SPP Tariff Attachment V Generator Interconnection Procedures (GIP) Section 8.4.4

### 2. Status of Existing Studies Applicable to Request:

GEN-2016-029 will utilize GEN-2016-023 facilities and generator lead to the Point of Interconnection (POI).

### 3. Study Requirements:

Basin Electric has performed this Interconnection Facility Study Analysis in accordance with SPP Tariff Attachment V, Generator Interconnection Procedures (GIP) Section 8.4.4 for the Interconnection Request(s) as described in Section 1.

- **3.1.** The Interconnection Facility Study Analysis includes an evaluation of the following:
  - **3.1.1.** Perform/develop a substation layout, perform a preliminary bus design, determine all electrical equipment requirements, and determine a suitable site location to accommodate the Request. Develop/compile cost estimates for all Basin Electric labor, overheads, equipment additions, modifications, etc. to accommodate the generator interconnection.
  - **3.1.2.** Develop an overall construction schedule for completion of the necessary additions and/or modifications.

- **3.1.3.** Point Of Change of Ownership. For the purposes of this Study Analysis, the Point of Change of Ownership location is defined as the take-off structure(s) at the Basin Electric Substation/Switching Station where the Interconnection Customer's transmission line(s) connects to the take-off structure(s). Interconnection Customer will furnish and install the conductor jumper and insulator assembly to the take-off structure(s).
- **3.1.4.** Other Interconnection/Metering Requirements. Basic indication, metering, monitoring, control, and relaying requirements due to a generator interconnection are included in the cost estimate. Basin Electric's generation metering requirements, as an SPP Transmission Owner, must be met. A list of specific needs will be provided by Basin Electric once design has progressed.
- 3.2. Section breakdown for Study Results as follows:
  - Section 4: GEN-2016-023
  - Section 5: GEN-2016-029

### 4. Study Results for GEN-2016-023:

**4.1** The following results document the analysis of the required facilities for this Interconnection Request as outlined in Section 1 for a new 345kV Switchyard. Basin Electric has determined that the following additions and improvements are required to maintain a safe and reliable interconnection to Basin Electric's transmission system.

### 4.2. Transmission Line/Transmission Structures

The proposed interconnection substation includes cut-ins to two existing 345kV circuits (LRS2E-SDQ-345 and LRS2E-SGQ-345). Attachment A shows an example location with approximate cut-in distances. This location was selected for proximity to the existing transmission lines and existing access roads. The example location is different than the customer-proposed location. Both sites are shown in Attachment B.

To facilitate clear transmission access to the substation for the Interconnection Customer, the estimate assumes separate single-circuit cut-ins and removal of existing transmission. This will also eliminate 345kV transmission crossings. Final location and transmission distances will be subject to detailed design and land acquisition. Moving the switchyard closer to either line will likely increase one of the circuit lengths while reducing the other, resulting in offsetting cost changes.

The conductor selection for the new 345kv transmission would be evaluated during detailed design and project planning. For purposes of this estimate, BEPC standard 345kV conductor, 2312 ACSR Thrasher, has been assumed.

BEPC anticipates utilizing galvanized steel monopoles with a delta configuration for the line. The steel poles will have davit arms with glass suspension insulators. All structures will be installed on drilled pier foundations. During detailed design and routing, it may be necessary to consider other structure types and configurations. For purposes of this estimate, the standard tangent structure design would be for 1000' ruling span with 1200' wind spans, but an average span length of 800' has been assumed. A total distance of 17000 feet has been assumed for new transmission construction and ROW acquisition. NESC, ASCE and BEPC standard loading requirements will apply. Deadend quantities have been assumed based on the example routes shown in Attachment A.

### 4.3. Substation/Switchyard

A new 345kV Switchyard will be built to accommodate the new generation resource interconnection. This switchyard will initially be built in a 9 breaker, breaker and a half configuration with future potential to be expanded with 10 total line terminals. Reference Attachments C and D. The grading plan, control building, and any common infrastructure will be sized appropriately for the ultimate build out configuration. All equipment will follow Basin Electric's internal design standards for minimum BIL, ampacity, and fault capabilities.

The associated work at the new 345kV Switchyard includes the following major additions:

- (5) 345kV Line Take-Off
- (9) 345kV Breakers
- (18) 345kV Breaker Disconnect Switches
- (5) Sets of Line Potential Transformers
- (1) Set of Current Transformers
- (5) Sets of Line Surge Arrestors

Additional associated work will include a review and update to relay/protection schemes and SCADA RTU configurations at the Sidney, Stegall, and Laramie River line terminals.

This cost estimate assumes existing access is available up to the property line of the substation. Depending on the final selected location, additional access construction may be required. The cost estimate includes acquisition for up to 160 acres of property for the substation. Detailed design and site selection may allow for less property.

### 4.4. Environmental Requirements

Compliance with all applicable federal, state and local regulations will be strictly adhered to. Additionally, all applicable and required permits and approvals will be obtained prior to construction. For the purposes of this Study, it is anticipated that this new 345kV Switchyard will require incidental minor local permitting.

### 4.5. Cost Estimate

GEN-2016-023 Estimated Costs	Current Year \$
Line Costs	
Engineering Labor	\$606,000
Construction Labor	\$3,382,850
Material	\$2,477,000
Right of Way	\$231,258
Sub Total	\$6,697,108
IDC	\$0
Contingency	\$1,339,422
Sub Total	\$1,339,442
Line Total	8,036,530
Station Costs	
Engineering Labor	\$870,600
Construction Labor	\$9,258,718
Material	\$10,049,571
Right of Way	\$600,000
Sub Total	\$20,778,889
IDC	\$0
Contingency	\$6,919,276
Sub Total	\$6,919,276
Station Total	\$27,698,165
Total Interconnection Costs	\$35,734,695

### 4.6. Construction Schedule

The preliminary project schedule provided is for planning level purposes only and will be adjusted with additional project definition. If it is determined that NEPA and/or ROW condemnation is required, 12-18 months will be added to the In-Service date.

Activity	Duration	Estimated Start	Estimated Finish
Receive NTC From SPP		Month 0	
Project Planning	1 Month	Month 0	Month 1
Land Acquisition/Environmental	6 Months	Month 1	Month 7
Engineering Design	6-9 Months	Month 1	Month 10
Equipment Procurement	12-14 Months	Month 2	Month 16
Advertise and Award Construction Contracts	2-3 Months	Month 9	Month 12
Construction	10-14 Months	Month 12	Month 26
Energize and In-Service Date	1 Month	Month 26	Month 27

### 5. Study Results for GEN-2016-029

The following results document the analysis of the required facilities for this Interconnection Request as outlined in Section 1. Based on Customer provided DISIS information, GEN-2016-029 will utilize GEN-2016-023 facilities and generator lead to the POI. This study includes the estimate to complete a review for any potential relay/protection scheme concerns/requirements.

Basin Electric has determined that the following additions and improvements are required to maintain a safe and reliable interconnection to Basin Electric's transmission system.

### 5.2. Transmission Line/Transmission Structures

None.

### 5.3. Substation/Switchyard

The work required at the GEN-2016-023 Switchyard consists of the following:

All device configurations will be evaluated and modified if required. These include relay settings, communication channel configuration and access, RTU configuration and communication ports, revenue meter configurations and any other SCADA points that may be affected with additional generation being connected to the collector station. If any configurations or settings require modification, the appropriate technicians will modify those configurations as directed by Basin Electric and such changes will be tested and commissioned to Basin Electric standards. Basin Electric to approve all final testing and commissioning results prior to any configuration or setting changes being put into service

### 5.4. Environmental Requirements

None.

### 5.5. Cost Estimate

GEN-2016-029 Estimated Costs	Current Year \$
Engineering Labor	\$100,000
Construction Labor	\$0
Material	\$0
Contingency	\$20,000
Sub-Total	\$120,000

### 5.6. Construction Schedule

Activity	Duration	Estimated Start	Estimated Finish
Receive NTC From SPP		Month 0	
Project Planning	1 Month	Month 0	Month 1
Engineering Design	1 Month	Month 1	Month 2
Energize and In-Service Date	1 Month	Month 2	Month 3

**ATTACHMENT A** 

# IFS-2016-001-09 - Facility Study Estimate Basis



# **Map Features**

- Substation Bays
- Proposed 345kV Transmission
- Transmission to be Removed
  - Existing 230kV Circuits
  - Existing 345kV Circuits
  - **GI** Customer Lines
  - Substation Location
  - Sections Date: 10/23/2019

Proposed Substation and new transmission locations are for cost estimate purposes only.

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# ATTACHMENT B



### ATTACHMENT C IFS-2016-001-09





W S E

### LEGEND:

■ EXISTING EQUIPMENT

- NON SHARED NETWORK UPGRADES
- SHARED NETWORK UPGRADES
- TRANSMISSION OWNERS INTERCONNECTION FACILITIES
- **INTERCONNECTION CUSTOMER INTERCONNECTION FACILITIES**
- **FUTURE**



### IFS-2016-001-09





POINT OF INTERCONNECTION DETAIL

# DISIS-2016-001-4 GENERATION INTERCONNECTION FACILITY STUDY

### <u>NPPD</u>

SPP GEN-2016-021	300.0 MW at Hoskins 345 kV Substation
SPP GEN-2016-043	230.0 MW at Hoskins 345 kV Substation
SPP GEN-2016-050	250.7 MW at Macon 345 kV Substation

### WAPA/BEPC

SPP GEN-2015-089	200.00 MW at Utica Junction 230kV
SPP GEN-2016-023	150.50 MW at Banner County 345kV
SPP GEN-2016-029	150.00 MW at Banner County 345kV
SPP GEN-2016-075	50.00 MW at Grand Prairie 345kV

## **AUGUST 2019**

### PREPARED FOR: SOUTHWEST POWER POOL

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



## **Executive Summary**

The *NPPD DISIS-2016-001-4 Facility Study* was performed to document the reliability impacts of generation projects that are proposed to interconnect to the NPPD transmission system. These projects have developed through the SPP Definitive Interconnection System Impact Study process and have advanced to the facility study stage. SPP has requested that NPPD perform the Facility Study associated with the generation interconnection projects listed below:

Project	MW	Type	Point-of-Interconnection
GEN-2015-089	200.00	Wind	WAPA Utica Junction 230kV
GEN-2016-021	300.00	Wind	NPPD Hoskins 345kV
GEN-2016-023	150.50	Wind	WAPA Interconnect Laramie River - Sidney (Banner Co) 345kV
GEN-2016-029	150.00	Wind	WAPA Interconnect Laramie River - Sidney (Banner Co) 345kV
GEN-2016-043	230.00	Wind	NPPD Hoskins 345kV
GEN-2016-050	250.70	Wind	NPPD Interconnect Axtell- Post Rock (Macon) 345kV
GEN-2016-075	<u>50.00</u>	Wind	WAPA Grand Prairie 345kV
	1331.2		

SPP entered into a facility study agreement with each of the generation interconnection customers and subsequently requested that NPPD perform the Facility Study for each request. This facility study focused on the impacts of the generation interconnection projects which included a detailed loadflow analysis, short circuit analysis and stability analysis. The Facility Study also includes detailed cost estimates and estimated project schedules for the interconnection and network upgrades identified in the System Impact and Facility Study.

The DISIS-2016-001-4 Facility Study includes a loadflow analysis, short circuit analysis and stability analysis.

The Loadflow Analysis documents the steady-state performance of the network following the generation interconnection projects. The loadflow analysis was split into three phases.

Phase 1 of the loadflow analysis was a system intact and N-1 contingency analysis of the Nebraska transmission system in accordance with NERC Standard TPL-001-4. The Phase 1 screening did not identify any significantly impacted NPPD facilities for system intact conditions. Four facilities were found to overload for N-1 conditions. See *NPPD DISIS-2016-001-1 Facility Study* report for more details.

- NPPD Twin Church Sioux City\* 230 kV Line \*(WAPA Owns Sioux City terminal)
- NPPD Columbus East 230/115 kV Transformer
- NPPD Ogallala Ogallala TSGT\*\* 115 kV Substation Tie \*\*(TSGT Owns Ogallala TSGT terminal)
- TSGT Ogallala Grant 115 kV Line #1 (TSGT Owned Facility)

The Phase 1 screening did not discover any impacted bus voltages outside of limits for system intact or N-1 conditions.

Phase 2 of the loadflow analysis involved a comprehensive multiple element contingency analysis of the Nebraska transmission system in accordance with NERC Standard TPL-001-4. The Phase 2 screening identified several facilities that were loaded in excess of facility ratings for multiple element contingencies. Each of the contingencies and overloaded facilities may require curtailment of firm transmission and/or load shed to mitigate these issues. The Phase 2 screening did not discover any impacted bus voltages outside of limits for multiple element contingency conditions. See *NPPD DISIS-2016-001-1 Facility Study* report for more details.

Phase 3 of the loadflow analysis evaluated the impacts of worst case independent N-2 double contingency conditions for the local area transmission outlet paths associated with the generation interconnection projects. This phase did identify several independent N-2 contingencies that would require prior outage generation limitations of the proposed generation interconnection projects. These prior outage limitations would be developed through an operational study and/or operational guides if all the projects continue to be developed. The limiting prior outages are listed below. See *NPPD DISIS-2016-001-1 Facility Study* report for more details.

### Limiting Prior Outage Facilities

1.	POSTROCK7 345.00-G16-050-TAP 345.00	38.	HOSKINS4 230.00-HOSK.T89 34.500
2.	KNOB HL3 115.00-STEELEC7 115.00	39.	HOSKINS7 115.00-NORFK.N7 115.00
3.	G15087 T 115.00-FAIRBRY7 115.00	40.	HOSKINS7 115.00-NORFOLK7 115.00
4.	G15087_T 115.00-HEBRN N7 115.00	41.	HOSKINS7 115.00-STNTN.N7 115.00
5.	G15088_T 345.00-MOORE 3 345.00	42.	KEYSTON3 345.00-SIDNEY1-LNX3345.00
6.	G15088 T 345.00-PAULINE3 345.00	43.	MCCOOL 3 345.00-MOORE 3 345.00
7.	G1623&1629-T345.00-KEYSTON3 345.00	44.	NELIGH 7 115.00-PETERSBRG.N7115.00
8.	G1623&1629-T345.00-LARAMIE3 345.00	45.	NELIGH 7 115.00-ANTELOPE 7115.00
9.	G1623&1629-T345.00-SIDNEY2-LNX3345.00	46.	NORFK.N7 115.00-NORFOLK7 115.00
10.	G16-050-TAP 345.00-AXTELL 3 345.00	47.	PETRSBG7 115.00-PETERSBRG.N7115.00
11.	G10-51T 230.00-HOSKINS4 230.00	48.	TWIN CH7 115.00-S.SIOUXCITY7115.00
12.	G10-51T 230.00-TWIN CH4 230.00	49.	VICTRYH4 230.00-STEGALL4 230.00
13.	ALBION 7 115.00-FULERTN7 115.00	50.	WAYSIDE4 230.00-NUNDRWD4 230.00
14.	ALBION 7 115.00-GENOA 7 115.00	51.	THEDFRD3 345.00-HOLT.CO3 345.00
15.	ALBION 7 115.00-PETRSBG7 115.00	52.	HOLT.CO3 345.00-GR ISLD-LNX3345.00
16.	ALBION 7 115.00-SPALDNG7 115.00	53.	STEGALL4 230.00-STEGALL-LNX3230.00
17.	AXTELL 3 345.00-PAULINE3 345.00	54.	LARAMIE3 345.00-STEGALL3 345.00
18.	AXTELL 3 345.00-SWEET W3 345.00	55.	HARBINE7 115.00-STEELEC7 115.00
19.	BATTLCR7 115.00-CO.LINE7 115.00	56.	HEBRN N7 115.00-HEBRON 7 115.00
20.	BATTLCR7 115.00-NORFK.N7 115.00	57.	MOORE 3 345.00-SHELDON7 115.00
21.	BEATRCE7 115.00-HARBINE7 115.00	58.	MOORE 3 345.00-NW68HOLDRG3 345.00
22.	BEATRCE7 115.00-STEINER7 115.00	59.	PAULINE3 345.00-PAULINE7 115.00
23.	BELDEN 7 115.00-HARTGTN7 115.00	60.	SIDNEY 3 345.00-SIDNEY1-LNX3345.00
24.	BELDEN 7 115.00-HOSKINS7 115.00	61.	SIDNEY 3 345.00-STEGALL3 345.00
25.	BELDEN 7 115.00-TWIN CH7 115.00	62.	HOSKINS3 345.00-HOSKINS4 230.00
26.	BLMFLD 7 115.00-CREITON7 115.00	63.	HOSKINS3 345.00-HOSKINS7 115.00
27.	BLMFLD 7 115.00-GAVINS 7 115.00	64.	HOSKINS4 230.00-HOSKINS7 115.00
28.	CARLJCT7 115.00-HEBRN N7 115.00	65.	TWIN CH4 230.00-TWIN CH7 115.00
29.	CLRWATR7 115.00-NELIGH 7 115.00	66.	HOLT.CO3 345.00-GRPRAR1-LNX3345.00
30.	CO.LINE7 115.00-ANTELOPE 7115.00	67.	ANTELOPE 3345.00-ANTELOPE 7115.00
31.	COOPER 3 345.00-MOORE 3 345.00	68.	GR PRAIRIE 3345.00-GRPRAR1-LNX3345.00
32.	CREITON7 115.00-ANTELOPE 7115.00	69.	GR PRAIRIE 3345.00-GRPRAR2-LNX3345.00
33.	EMERSON7 115.00-TWIN CH7 115.00	70.	STEGALL4 230.00-STGXFMR4 230.00
34.	FAIRBRY7 115.00-HARBINE7 115.00	71.	WAYSIDE4 230.00-STEGALL-LNX3230.00
35.	GENTLMN3 345.00-KEYSTON3 345.00	72.	STEGALL7 115.00-STEGALL3 345.00
36.	HARTGTN7 115.00-GAVINS 7 115.00	73.	STEGALL3 345.00-STGXFMR4 230.00
37.	HOSKINS3 345.00-ANTELOPE 3345.00		

The Short Circuit Analysis was performed to evaluate the fault interrupting capability of existing devices in the area and protection coordination issues following the generation interconnection projects and network upgrades. The original analysis for DISIS-2016-001-1 showed that two existing protective devices (Columbus East 1110 & 1112 Circuit Switchers) were subject to replacement due to the proposed interconnection projects, however, further review of the circuit switcher ratings revealed this equipment was replaced and the new equipment can accommodate the projected fault currents with the proposed GI projects. See NPPD DISIS-2016-001-1 Facility Study report for more details.

The Stability Analysis was performed to evaluate the impact of the proposed generation interconnection projects and network upgrades on the existing GGS Stability constrained interface in Nebraska. Based on the results of this analysis, the NPPD transmission system with the current planned future projects meets the stability performance requirements for all Planning Event and Extreme Event conditions that were considered in this study. See NPPD DISIS-2016-001-1 Facility Study report for more details.

Overall, the *NPPD DISIS-2016-001-4 Facility Study* documents the performance of the network following the addition of the generation interconnection projects and network upgrades. The Facility Study has documented the transmission plan required for interconnection to the NPPD transmission system and the details of this plan are listed below. There is no generation interconnection capability available until the projects listed below are completed as required.

### **DISIS-2016-001-4 Interconnection Plan**

Interconnection Facilities

• GEN-2016-021: Construct satellite 345 kV Substation near Hoskins 345 kV substation to accommodate new GI.

### \$7,250,000\*

• GEN-2016-043: Construct satellite 345 kV Substation near Hoskins 345 kV substation to accommodate new GI.

### \$7,250,000\*

• GEN-2016-050: Construct Macon 345 kV Substation to accommodate new GI.

### \$ 16,500,000

\*Total Cost for satellite substation is \$14,500,000

### Network Upgrades

• Expand Sidney substation expansion (BEPC portion).
\$ TBD
• Construct Sidney – Keystone 345 kV line & Keystone substation expansion.
\$ 181,000,000
• Construct Keystone – GGS 345 kV line & substation expansions.
\$ 74,500,000
• Upgrade Columbus East 230/115 kV Transformer.
\$ 4,250,000
• Upgrade Twin Church – Sioux City 230 kV Line (NPPD portion).
\$ 3,300,000
• Upgrade Twin Church – Sioux City 230 kV Line (WAPA portion).
\$ TBD
• Upgrade Ogallala NPPD – Ogallala TSGT 115 kV substation tie (NPPD portion).
\$ 50,000
• Upgrade Ogallala NPPD – Ogallala TSGT 115 kV substation tie (TSGT portion).
\$ TBD
• Upgrade Ogallala – Grant 115 kV Line #1 (TSGT portion).
\$ TBD

### Previously-allocated Network Upgrades

- Hoskins Neligh (Antelope) 345/115 kV Transmission expansion project
- Gentleman Thedford Holt County (R-Project) and Thedford 345/115 kV Transformer project

- Uprate Belvidere-Fairbury 115 kV line.
- Uprate Beatrice-Harbine 115 kV line.
- Reconductor Albion Petersburg North Petersburg 115 kV
- Rebuild Gavins Point Yankton Junction 115 kV (WAPA upgrade)
- Antelope 115 kV substation expansion (for GEN-2015-053)
- Belden 115 kV substation expansion (for GEN-2015-076)
- Construct Belvidere 115 kV Substation (for GEN-2015-087)
- Construct Tobias 345 kV Substation (for GEN-2015-088)
- Dixon County 230 kV substation (for GEN-2010-051)
- Upgrade Twin Church-DixonCounty-Hoskins 230kV line
- Antelope 115 kV substation expansion (for GEN-2013-032)
- Upgrade Antelope-County Line-Battle Creek 115 kV line
- Upgrade Meadow Grove-Prairie Breeze 230 kV Gen-Tie line
- Friend 115 kV substation (for GEN-2014-039)
- Rosemont 115 kV substation (for GEN-2008-123N)
- Hoskins 345 kV substation expansion (for GEN-2015-007)
- Holt County 345 kV substation expansion (for GEN-2015-023)

# Basin Electric Power Cooperative IFS-2016-001-4 Sidney-Keystone

### 1. <u>Background:</u>

**1.1.** Per SPP Generation Interconnection Procedures (GIP)<sup>1</sup>, Basin Electric Power Cooperative (Basin Electric) received a request to perform an Interconnection Facility Study (IFS) in accordance with the Scope of Interconnection Facilities Study in GIP 8.10 and the interconnection Facility Study Procedures in accordance with GIP 8.13 for the following Network Upgrades:

Network Upgrade	Amount Needed <sup>2</sup>	Description
Laramie Stability Limit (BEPC)		Confirm that the LRS stability issue is not observed with Keystone – Sydney 345 kV.
Sidney (BEPC) - Keystone (NPPD) 345kV CKT 2	Minimum normal/emergency rating of 956 MVA	Build ~95 miles of 345kV from Sidney to Keystone, build new bays at Keystone and Sidney to achieve minimum Rate A of 956 MVA.

### 2. <u>Status of Existing Studies Applicable to Request:</u>

**2.1.** Network upgrades are required as a consequence of previous interconnections. The cost estimate and preliminary schedule have been developed and are detailed below.

### 3. <u>Study Requirements:</u>

- **3.1.** Basin Electric has performed this Interconnection Facility Study Analysis in accordance with SPP Tariff Attachment V, Generator Interconnection Procedures (GIP) Section 8.10 and 8.13 for the Network Upgrades as described in Section 1.
- **3.2.** The Integrated Facility Study Analysis includes an evaluation of the following:
  - **3.2.1.** Perform/develop a substation layout, perform a preliminary bus design, and determine all electrical equipment requirements for the Sidney 345 kV substation addition. Develop cost estimates for all Basin Electric labor, overheads, equipment additions, modifications, etc. to accommodate the Network Upgrades. Document study area for transmission line routing, develop preliminary transmission line design, and develop cost estimates for all Basin Electric labor, overheads, contract labor and material for transmission line construction.
  - **3.2.2.** Develop an overall construction schedule for completion of the necessary additions and/or modifications.
  - **3.2.3.** Other Interconnection/Metering Requirements. Basic indication, metering, monitoring, control, and relaying requirements are included in the cost estimate. Basin Electric's generation metering requirements, as an SPP Transmission Owner, must be met. A list of specific needs will be provided by Basin Electric once design has progressed.

### 4. <u>Study Results for Network Upgrades:</u>

**4.1.** The following results document the analysis of the required facilities for this Network Upgrade as outlined in Section 1. Basin Electric has determined that the following additions and improvements are required to maintain a safe and reliable expansion of the Basin Electric's transmission system.

### 4.2. Transmission Line/Transmission Structures

Per the Network Upgrade request, a distance of 95 miles is assumed for the new 345kV transmission line from Sidney to Keystone. Final distance will be subject to detailed routing and ROW acquisition. Section 4.7 Attachment A shows the study area.

A width of 150 feet will be required for the new transmission line right-of-way. The proposed corridor will likely include a high proportion of cropland as well as a heavily irrigated valley. This may increase easement acquisition rates and require additional angle structures for alignment selection based on landowner feedback.

The conductor selection for 345kv for BEPC to meet 956 MVA would be evaluated during detailed design and project planning. For purposes of this estimate, BEPC standard 345kV conductor, 2312 ACSR Thrasher, has been assumed. This conductor would meet the 956 MVA requirement.

BEPC anticipates utilizing galvanized steel monopoles with a delta configuration for the line. The steel poles will have davit arms with glass suspension insulators. All structures will be installed on drilled pier foundations. During detailed design and routing, it may be necessary to consider other structure types and configurations. For purposes of this estimate, the standard tangent structure design would be for 1000' ruling span with 1200' wind spans, but an average span length of 900' has been assumed.

Based on the potential for numerous alignment angle points, it is assumed 10% of structures will be full-tension deadend structures. NESC, ASCE and BEPC standard loading requirements will apply.

### 4.3. Substation/Switchyard

The scope of the work to be completed at the Sidney 345kV Switchyard includes the addition of one line terminal. This line terminal will be built to replicate the breaker and a half bus configuration. All equipment will be specified to meet or exceed equipment ratings at the present switchyard or 956 MVA whichever is greater. Equipment will be arranged and installed so as to match the existing configuration as closely as possible. All protection and control equipment will match current Basin Electrics standard designs.

The associated work at the Sidney 345 KV Switchyard is shown in Exhibit A and includes the following major additions:

- 345kV Line Take-Off
- 345kV Breaker
- 345kV Breaker Disconnect Switches
- 345kV Line Disconnect Switch
- Set of Line Potential Transformers
- Set of Line Surge Arrestors

Additional work will include a review and update to relay/protection schemes and SCADA RTU configurations.

Exhibit A: Proposed Sidney 345 kV Substation Bus Layout



### 4.4. Environmental Requirements

### 4.4.1. Transmission Line

In addition to compliance with all applicable federal regulations, permits and approvals must be granted by the state of Nebraska. The Nebraska Power Review Board review process includes a solicitation of comments from other state agencies and a public hearing.

### 4.4.2. Terminal Addition

No major environmental requirements are expected as part of this line terminal addition within an existing substation. It is anticipated that all work will be completed within the existing substation perimeter and thus permitting will be limited to incidental minor local permitting.

### 4.5. Cost Estimate

Network Upgrades Estimated Costs	Current Year \$	
Line Costs		
Engineering Labor	\$19,133,000	
Construction Labor	\$53,076,000	
Material	\$42,680,000	
Right of Way	\$10,929,000	
Sub Total	\$125,818,000	
IDC	\$9,435,000	
Contingency	\$27,053,000	
Sub Total	\$36,488,000	
Line Total	\$162,306,000	
Station Costs		
Engineering Labor	\$566,100	
Construction Labor	\$1,730,790	
Material	\$1,858,415	
Sub Total	\$4,155,305	
IDC	\$207,765	
Contingency	\$1,345,997	
Sub Total	\$1,553,762	
Station Total	\$5,709,067	
Total Interconnection Costs	\$168,015,067	

### 4.6. Construction Schedule

The preliminary project schedule provided is for planning level purposes only and will be adjusted with additional project definition. Line construction schedule was the controlling element of the project. Terminal addition activities will be happening in parallel of Transmission activities but are not specifically identified.

ACTIVITY	DURATION	ESTIMATED START	ESTIMATED FINISH *
RECEIVE NTC FROM SPP		MONTH 0	
AREA STUDIES, TITLE WORK, DEVELOP PERMITTING PLAN	2-3 MONTHS	MONTH 0	MONTH 3
SURVEY PERMISSION AND ROW ACQUISITION	12-24 MONTHS	MONTH 2	MONTH 26
DETAILED ROUTING, ACCESS ROAD IDENTIFICATION, ALIGNMENT DEFINITION, AND FINAL DESIGN	12-24 MONTHS	MONTH 3	MONTH 27
PERMITTING	12-24 MONTHS	MONTH 3	MONTH 27
ADVERTISE AND AWARD CONSTRUCTION CONTRACTS	2-3 MONTHS	MONTH 27	MONTH 30
CONSTRUCTION	12-16 MONTHS	MONTH 30	MONTH 46
ENERGIZATION AND IN- SERVICE DATE	2 MONTHS	MONTH 46	MONTH 48



4.7. Attachment A: Map for Sidney - Keystone Transmission line

### 4.8. Attachment B: Location Map for Sidney 345kV Substation

