INTERCONNECTION FACILITIES STUDY REPORT

GEN-2020-011

Published November 2025

By SPP Generator Interconnections Dept.

REVISION HISTORY

DATE OR VERSION NUMBER	AUTHOR	CHANGE DESCRIPTION
November 19, 2025	SPP	Initial draft report issued.
December 9, 2025	SPP	Final report issued.

CONTENTS

SUMMARY

INTRODUCTION

This Interconnection Facilities Study (IFS) for Interconnection Request GEN-2020-011 is for a 320 MW generating facility located in Funk County, NE. The Interconnection Request was studied in the DISIS-2020-001 Impact Study for NRIS. The Interconnection Customer's requested in-service date is 6/1/2027.

The interconnecting Transmission Owner, Nebraska Public Power District (NPPD), 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 Interconnection Facilities (TOIF), Non-Shared Network Upgrades, Shared Network Upgrades, Contingent Network 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, full Interconnection Service will not be available until all Interconnection Facilities and Network Upgrade(s) can be placed in service.

COMPENSATION FOR AMOUNTS ADVANCED FOR NETWORK UPGRADE(S)

FERC Order ER20-1687-000 eliminated the use of Attachment Z2 revenue crediting as an option for compensation. The Incremental Long Term Congestion Right (ILTCR) process will be the sole process to compensate upgrade sponsors as of July 1st, 2020.

INTERCONNECTION CUSTOMER INTERCONNECTION FACILITIES

The Generating Facility is proposed to consist of one-hundred sixteen (116) Power Electronics 3.15 MW PCSK FP3150K inverters for a total generating nameplate capacity of 320 MW.

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 collection circuits;
- 34.5 kV to 345 kV transformation substation with associated 34.5 kV and 345 kV switchgear;
- Four 345 kV/34.5 kV 55.1/72.98/91.35 MVA (ONAN/ONAF/ONAF) step-up transformers to be owned and maintained by the Interconnection Customer at the Interconnection Customer's substation;
- An Approximately 100 foot overhead 345 kV line to connect the Interconnection Customer's substation to the Point of Interconnection ("POI") at the 345 kV bus at existing Transmission Owner substation ("Axtell-Sweetwater Substation 345kV") 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. The Interconnection Customer may use inverter 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.

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** list the Interconnection Customer's estimated cost responsibility for Transmission Owner Interconnection Facilities (TOIF) and Non-Shared Network Upgrade(s) and provides an estimated lead time for completion of construction. The estimated lead time begins when the Generator Interconnection Agreement has been fully executed.

Table 1: Transmission Owner Interconnection Facilities (TOIF)

Transmission Owner Interconnection Facilities (TOIF)	Total Cost Estimate ($)	Allocated Percent (%)	Allocated Cost Estimate ($)
Transmission Owner's Axtell-Sweetwater Substation 345kV GEN-2020-011 Interconnection (TOIF) (UID156882): Interconnection upgrades and cost estimates needed to interconnect the following Interconnection Customer facility, GEN-2020-011 (320/Hybrid), into the Point of Interconnection (POI) at Axtell-Sweetwater Substation 345kV. Estimated Lead Time: 60 Months	$1,000,000	100.00%	$1,000,000
Total	**$1,000,000**		**$1,000,000**

Table 2: Non-Shared Network Upgrade(s)

Non-Shared Network Upgrades Description	ILTCR	Total Cost Estimate ($)	Allocated Percent (%)	Allocated Cost Estimate ($)
Transmission Owner's Axtell-Sweetwater Substation 345kV GEN-2020-011 Interconnection (UID156881): Interconnection upgrades and cost estimates needed to interconnect the following Interconnection Customer facility, GEN-2020-011 (320/Hybrid), into the Point of Interconnection (POI) at Axtell-Sweetwater Substation 345kV. Estimated Lead Time: 60 Months	Ineligible	$21,300,000	100.00%	$21,300,000
Total		**$21,300,000**		**$21,300,000**

SHARED NETWORK UPGRADE(S)

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

Table 3: Interconnection Customer Shared Network Upgrade(s)

Shared Network Upgrades Description	ILTCR	Total Cost Estimate ($)	Allocated Percent (%)	Allocated Cost Estimate ($)
NA				
Total		**$0**		**$0**

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.

CONTINGENT NETWORK UPGRADE(S)

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

Table 4: Interconnection Customer Contingent Network Upgrade(s)

Contingent Network Upgrade(s) Description	Current Cost Assignment	Estimated In-Service Date
NA		

Depending upon the status of higher- or equally-queued customers, the Interconnection Request's in-service date is at risk of being delayed or Interconnection Service is at risk of being reduced until the in-service date of these Contingent 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 provided by either MISO or AECI 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 ($)	Allocated Percent (%)	Allocated Cost Estimate ($)
NA			
Total	**$0**		**$0**

CONCLUSION

After all Interconnection Facilities and Network Upgrades have been placed into service, Interconnection Service for 320 MW can be granted. Full Interconnection Service will be delayed until the TOIF, Non-Shared NU, Shared NU, Contingent NU, Affected System Upgrades that are required for full interconnection service are completed. The Interconnection Customer's estimated cost responsibility for full interconnection service is summarized in the table below.

Table 6: Cost Summary

Description	Allocated Cost Estimate
Transmission Owner Interconnection Facilities Upgrade(s)	$1,000,000
Non-Shared Network Upgrade(s)	$21,300,000
Shared Network Upgrade(s)	$0
Affected System Upgrade(s)	$0
Total	**$22,300,000**

Use the following link for Quarterly Updates on upgrades from this report: https://spp.org/spp-documents-filings/?id=18641

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).

APPENDICES

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).

NPPD
DISIS-2020-001
FACILITY STUDY

NOVEMBER 2025

PREPARED FOR:
SOUTHWEST POWER POOL

PREPARED BY:
NEBRASKA PUBLIC POWER DISTRICT
ENERGY DELIVERY
TRANSMISSION ASSET PLANNING
ENGINEERING & ASSET MANAGEMENT

Nebraska Public Power District

"Always there when you need us"

The *NPPD DISIS-2020-001 Facility Study* was performed to document the interconnection facilities and network upgrades identified by SPP in Phase 2 of the SPP DISIS-2020-001 Study. NPPD also reviewed the proposed interconnection facilities and network upgrades and associated generation interconnection request impacts on the Short Circuit capability of the NPPD system. The NPPD Facility Study includes detailed cost estimates and estimated project schedules for the upgrades identified in the SPP studies.

Interconnection Facility Upgrades

NPPD's Engineering, Asset Management, and Project Management groups have reviewed the interconnection facility upgrades that are required for SPP DISIS-2020-001 Generation Interconnection projects. Detailed cost estimates have been prepared for the facility upgrades that were identified in the system impact study for the requests. The prepared cost estimates are study level estimates (+20%/-20%) and assume implementation of standard NPPD construction and procurement practices. The cost estimates for the interconnection facilities are below:

- Axtell 345 kV Substation
  - GEN-2020-011
    - 320 MW Hybrid (Solar/Storage)
  - Expand Axtell 345 kV substation.
  - 60 Month Lead Time

$ 22,300,000

- Orleans 115 kV Substation
  - GEN-2020-013
    - 215 MW Hybrid (Solar/Storage)
  - Construct 115 kV substation at Orleans on the Holdrege-Orleans 115 kV line.
  - 36 Month Lead Time

$ 8,300,000

- Kilgore 115 kV Substation
  - GEN-2020-069
    - 52.85 MW Wind
  - Build new 115 kV ring substation at an acceptable location on the Valentine West – Cody 115 kV line.
  - 36 Month Lead Time

$17,400,000

Preliminary one-line diagrams for each generation interconnection project are in Appendix 2.

Generator Interconnection Reactive Compensation Requirements (MVAR)

The SPP DISIS-2020-001 Phase 2 study documented the GI customer reactive compensation requirements for each POI. The following reactive compensation requirements should be included in the generation interconnection agreement as GI customer reactive power requirements to ensure the reliability of the SPP transmission system is maintained following the proposed GI projects.

Gen Number	Fuel Type	MW Amount	Reactive Compensation Requirement (MVAR)	POI
GEN-2020-011	Hybrid	320	-3.00	Axtell 345 kV Substation
GEN-2020-013	Hybrid	215	-1.80	Orleans 115 kV Substation
GEN-2020-069	Wind	52.85	-0.64	Kilgore 115 kV Substation (Cody-Valentine 115 kV)

Network Upgrades

NPPD's Engineering, Asset Management, and Project Management groups have reviewed the network upgrades that are required for SPP DISIS-2020-001 Generation Interconnection projects. Detailed cost estimates have been prepared for the facility upgrades that were identified in the system impact study for the requests. The prepared cost estimates are study level estimates (+20%/-20%) and assume implementation of standard NPPD construction and procurement practices. The cost estimates for the network upgrades are below:

- Orleans – Holdrege 115 kV Line Rebuild
  - Rebuild Orleans – Holdrege 115 kV Line Rebuild and any necessary terminal upgrades to accommodate the rebuilt line.
  - At least 240 MVA
  - 36 Month Lead Time

$ 18,600,000

Network Upgrade project schedule details will be further discussed in the development of the generator interconnection agreements (GIA) and the milestones associated with the generation interconnection projects.

Contingent Upgrades

The results of DISIS-2020-001 documented that several Generation Interconnection requests are contingent on the completion of the following previously allocated required network upgrades:

- Gentleman – Thedford - Holt County (R-Project) and Thedford 345/115 kV Transformer project (2012 ITP10/HPILS)

NPPD requested SPP perform the stability analysis portion of the DISIS-2020-001 generation interconnection study for GEN-2020-011 to comply with NPPD Facility Connection Requirements associated with the GGS Stability Interface and IROL flowgate (6006). The point-of-interconnection of GEN-2020-011 at the Axtell 345 kV substation is directly impactful to the GGS Stability Interface, IROL flowgate (6006) and potentially the GGS Remedial Action Scheme (RAS). In support of this study request, SPP and EPE performed additional study work to meet this requirement. Several future transmission projects were embedded in the study models and required to maintain GGS stability. Also, several prior queued generation interconnection projects were studied at a reduced generation output which have also been identified to impact the GGS stability interface. This results in an imputed generation dispatch limit for neighboring generation interconnection projects (Etna (GGS-Sweetwater) & Sweetwater) due to the use of SPP's dispatch methodologies. As a result, the future generation interconnection projects in this area may have generation limits imposed to ensure grid stability is maintained. The following transmission projects included in the GGS stability models are listed below and should be considered contingent upgrades:

- Gentleman – Thedford - Holt County (R-Project) and Thedford 345/115 kV Transformer project (2012 ITP10/HPILS)

- Laramie River Station – New Underwood – Maurine – Belfeld 345 kV project (2024 ITP)

If the generation interconnection projects proceed to the generation interconnection agreement, then an operating study may need to be performed to fully assess and evaluate the operation of the generation facility and network upgrades in accordance with NERC Standards. The operating study requirement will be included in the generation

interconnection agreement with NPPD. If any generation interconnection projects are identified to have significant impact on the GGS Stability Interface (Flowgate #6006) and LRS/DC stability limitations in western NE, then the operating study will need to take these issues into account. The operating study may also need to evaluate the reactive power control requirements and associated equipment necessary to meet operational voltage requirements at the requested point of interconnection.

Short Circuit Study

NPPD's Engineering group has reviewed the short circuit impacts of the SPP DISIS-2020-001 Generation Interconnection projects and associated network upgrades interconnected to the NPPD transmission system. The result of this study is documented in Appendix 1. No new network upgrades or interconnection facilities were required as a result of the NPPD Short Circuit study.

Appendix 1

NPPD Short Circuit Study Report

DISIS-2020-001

Short Circuit Study

Model Development

Computer Programs

The Aspen OneLiner software program was utilized to perform short circuit simulations and studies on the transmission system. Where elements were added to the short-circuit model, best estimates for impedance parameters were used based on available data and typical modeling practices. Short-circuit calculation options used were as follows:

- Flat voltage profile with V(pu) = 1.0
- Generator Impedance = Subtransient
- Ignore loads, transmission line G+jB, and shunts with positive sequence values

OneLiner was used to calculate three-phase (3PH) and single-line-to-ground (SLG) system-intact bus fault currents for all system buses associated with interrupting devices being evaluated in this study. For devices that the full bus fault current approached or exceeded the device's interrupting rating, more detailed fault calculations were done, calculating the maximum phase current through the breaker for close-in faults, close-in faults with the remote end open, and bus faults with all other branches to the bus open. The maximum phase current of these faults was recorded. For comparison with the breaker interrupting ratings, maximum phase current was multiplied by a factor of 1.05 to account for the possibility of the system operating at up to the maximum normal operating voltage of 1.05 per-unit.

Base System Model Additions ("Base Case")

The base system model used by the transmission system protection department as of October 27, 2025 was used as the starting point for the short-circuit model used for this study. The base system model included all projects that were in-service at the time the model was copied. All Nebraska-area generation in the short-circuit model was enabled in order to provide maximum short-circuit current. For the study base case, planned system upgrades in the area of the studied projects and prior-queued large generator interconnections expected to be in-service prior to the projects being studied were added to the base case model. Table 1 lists the prior-queued large generator interconnections that were added to the base model for this study.

Table 1: Prior Queued Large Generator Interconnections

Queue Designation	Proposed POI	Capacity (MW)
GEN-2013-002	Hallam 115kV / Panama WF to Olive Creek	50.6
GEN-2013-019	Hallam 115kV / Panama WF to Olive Creek	73.6
GEN-2016-074	Sweetwater 345kV (Expand substation)	200
GEN-2017-144	Holt County 345kV Substation (Expand substation)	200
GEN-2017-181	Tobias 345kV Substation (Expand substation)	300
GEN-2017-182	Tobias 345kV Substation (Expand substation)	128
GEN-2017-201	Turtle Creek 345kV connect at Sholes WF	250
GEN-2017-234	Greeley 115kV Substation (New substation)	115
GEN-2018-060	Macon 345kV Substation (Expand substation)	50
GEN-2018-125	Etna 345kV (New substation)	231
GEN-2018-131	Pierce County 115kV (New substation)	221.4
GEN-2018-132	Pierce County 115kV (New substation)	201.6
GEN-2019-039	Butler County 115kV (New substation)	174.5
GEN-2019-041	Olive Creek 115kV (Expand substation)	78

In addition to the prior-queued large generator interconnections, planned system upgrades in the area of the studied projects were added to the base model. These include:

- The planned 345kV line from GGS – Thedford – Holt County "RPLAN" was included with a 345kV/115kV tie transformer at Thedford 115 kV
- New 345kV line from Antelope to Holt County
- New Olive Creek sub addition near Mark Moore/Sheldon
- Upgrade of the Columbus East T3 to 336MVA
- Stanton North expansion for a new 100MVA load-serving transformer, future 115kV line Stanton North to Norfolk, Hoskins T1 replaced with a 336MVA
- Upgrade of Mark Moore T1 replacement with a 417MVA
- Rebuild of L1153B Columbus SE to new collector sub for G19-39-TAP (Butler County) to Rising City

Model Additions for Projects Being Studied ("Study Case")

The base-case study model was modified to include the new generation interconnections being considered in this study as well as the system upgrades identified to accommodate this additional generation. Table 2 lists the large generator interconnections that were added to the study-case model for this study.

Table 2: Large Generator Interconnections Added to Study Case

Queue Designation	Proposed POI	Capacity (MW)
GEN-2020-011	Axtell 345kV Substation (Expand substation)	320
GEN-2020-013	Orleans 115kV Substation (Expand substation)	215
GEN-2020-069	Kilgore 115kV Substation (New substation)	52.85

In addition to the DISIS-2020-001 generator interconnections, network system upgrades in the area of the studied projects were added to the base model. These include:

- Rebuild of L1132 Holdrege-Orleans to new collector sub for G20-13 at/near Orleans

Study Methodology

Circuit breaker, circuit switcher, and fuse ratings were identified by querying NPPD's SAP equipment database and extracting equipment data including short-circuit ratings. Breaker ratings given on an asymmetrical (total current) basis were converted to symmetrical current ratings using an assumed maximum system operating voltage of 1.05 per unit.

The calculated short-circuit current at the equipment bus was extracted from the short-circuit results from Aspen OneLiner and compared against the interrupting device interrupting rating. It is recommended that all equipment be replaced if it is found to be at or above 95% of its interrupting rating and seeing an increase of 1% or more in its interrupting duty as a result of the studied projects.

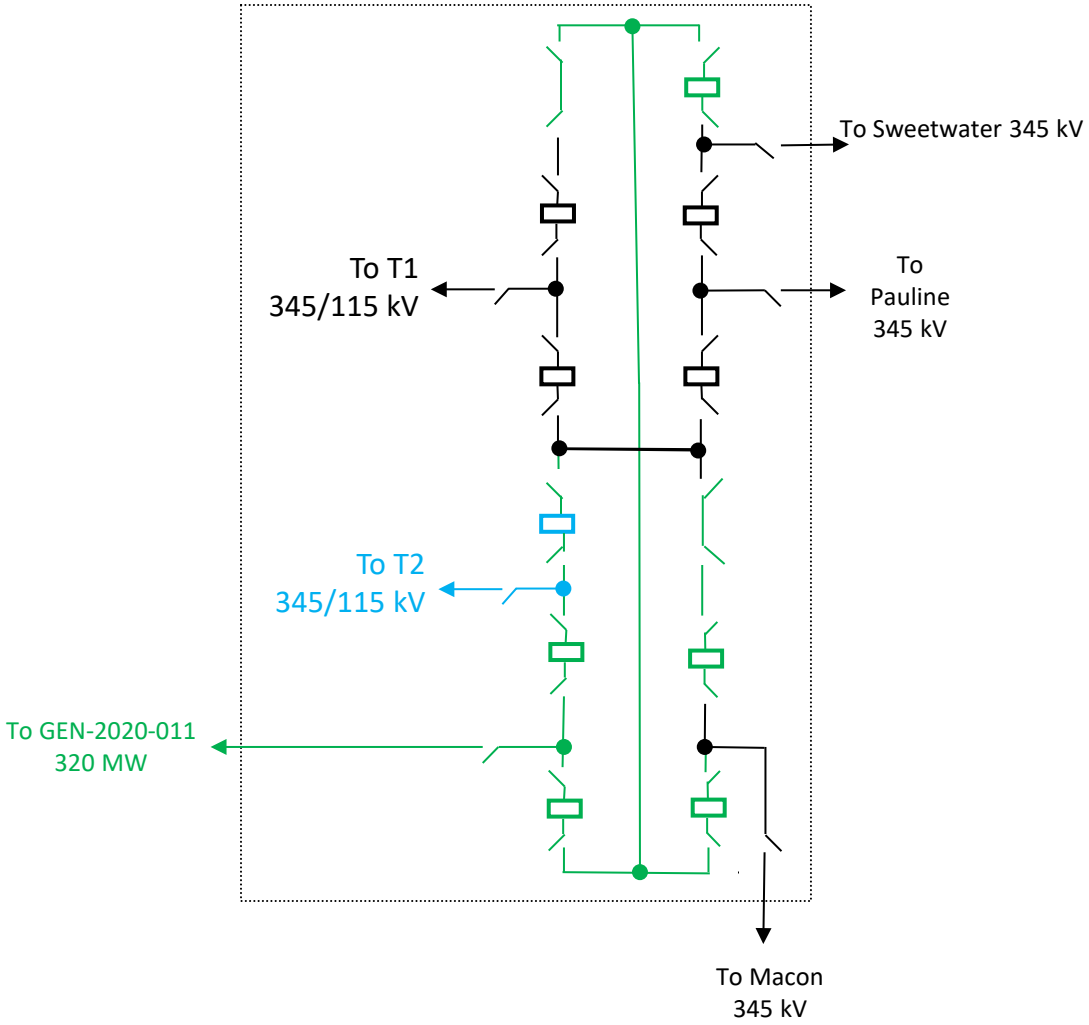
Results

No devices were found to be above 95% of their interrupting rating due to the additions in this study.

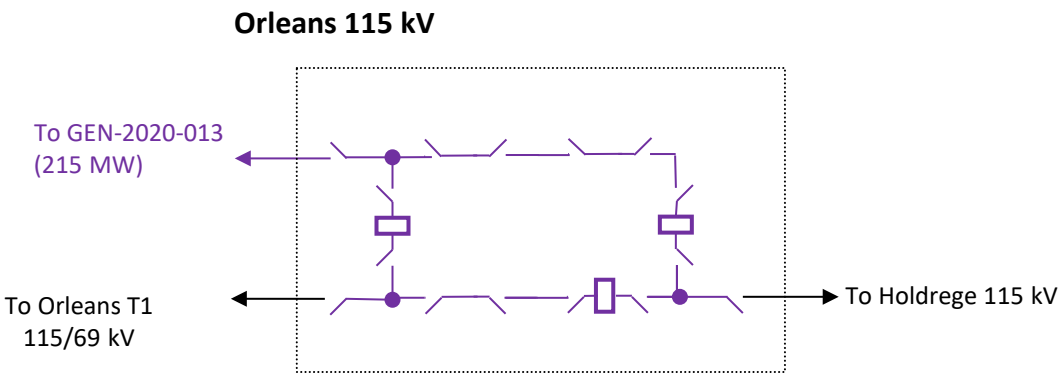
Appendix 2

Generation Interconnection Facilities One-Line Diagrams

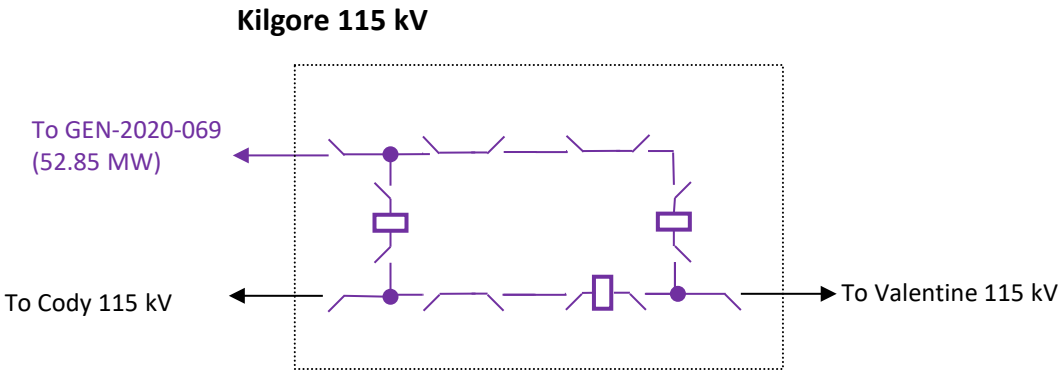
Axtell 345 kV



- DISIS-2020-001 Interconnection Facilities for GEN-2020-011
- DISIS-2021-001 Network Upgrade: 2nd Axtell 345/115 kV Transformer



- DISIS-2020-001 Interconnection Facilities for GEN-2020-013



- DISIS-2020-001 Interconnection Facilities for GEN-2020-069