Attachment G

LGE-GIS-2019-029 GI Feasibility Study Report

LGE-GIS-2019-029
Generation Interconnection Request
Feasibility Study Report

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1. Introduction

TranServ International, Inc. (TranServ), as an Independent Transmission Organization (ITO) of Louisville Gas & Electric/Kentucky Utilities (LG&E and KU), has received the following Generation Interconnection (GI) Request to provide Network Resource Interconnection Service (NRIS) and Energy Resource Interconnection Service (ERIS) to the LG&E and KU Transmission Network. After the scoping meeting, the customer decided to proceed with a Feasibility Study (FeS). TranServ has performed the GI FeS to evaluate the impact of the addition of the new generation on the LG&E and KU Transmission Network. TranServ has evaluated the GI Request listed in Table 1-1. This report contains the FeS results for Generation Interconnection Request LGE-GIS-2019-029.

Table 1-1
Request Details

Queue Position	Queue Date	County	State	Max Output (MW)	Point of Inter-connection	In-Service Date	Inter-connection Service Type	Generator Type
LGE-GIS-2019-029	11/08/2019	Hardin County	KY	100	Black Branch-Hardinsburg 138kV	12/31/2021	NRIS/ERIS	Solar

As shown in Table 1-1, the LGE-GIS-2019-029 request seeks to interconnect a generator by tapping the Black Branch to Hardinsburg 138 kV line. The customer may choose to proceed with the GI System Impact Study (SIS) on completion of the Feasibility Study (FeS) and review of the results. The in-service date of the LGE-GIS-2019-029 request is December 31, 2021. A one-line diagram of the proposed interconnection is given in Figure 1-1. This FeS analyzed the impact of this addition, located in Hardin County, Kentucky, in accordance with the LG&E and KU Generator Interconnection Study Criteria and LG&E and KU Planning Guidelines. Both of these documents are posted on the LG&E and KU OASIS.

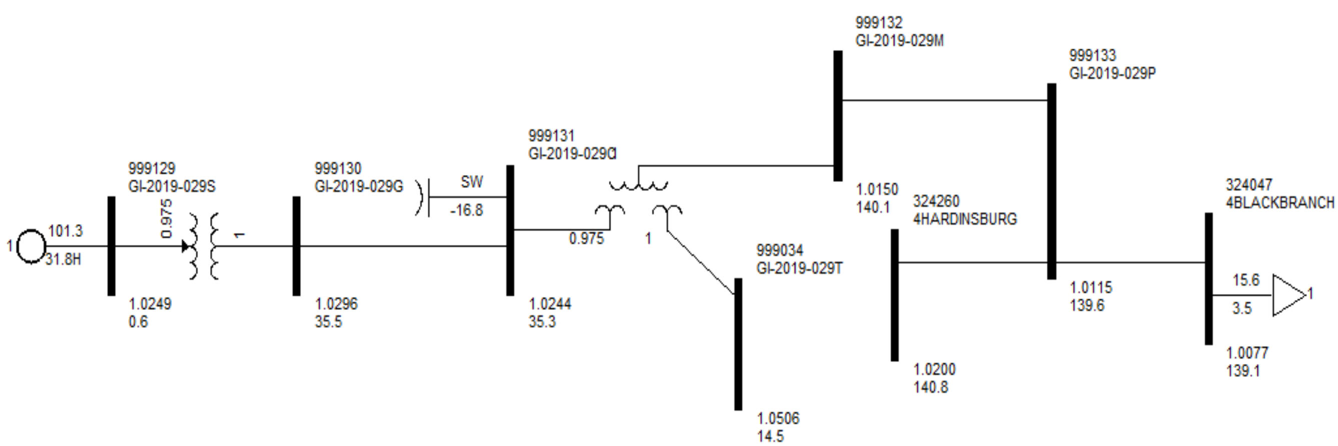
An Ad Hoc Study Group was not involved in the FeS study process as is consistent with the FeS study procedure given in the LG&E and KU GI Study Criteria document.

The GI request, LGE-GIS-2019-029, is a NRIS and an ERIS request and thus was studied as sourced from the new generation connecting to the Black Branch to Hardinsburg 138 kV line and then sunk into the LG&E and KU system in merit order (NRIS) or beyond the LG&E and KU BA equally in 4 directions (North, South, East, and West) (ERIS). TranServ performed this FeS to determine the impact of this GI on the transmission network. This analysis considered the subject request's impact on system intact (P0 Events), single-event (P1, P2 EHV, and P4 EHV Events) and selected double-event (P3 Events) contingency conditions.

This study included the effect of all earlier queued LG&E and KU GI requests. This study also included the effect of all confirmed Transmission Service Requests (TSRs) except confirmed TSRs which are associated with later queued GI requests. Representation of these GI and TSR requests may also have necessitated representation of associated planned transmission improvements. As part of the SIS, a Contingent Facilities Analysis will be performed if needed. If it is determined that an interconnection facility or network upgrade associated with a prior-queued GI Request is also required for the GI-2019-029 Request, then that interconnection facility and/or network upgrade will be identified as a Contingent Facility in the GI-2019-029 SIS report and included in the GI-2019-029 LGIA. There is no Contingent Facilities Analysis performed as part of the FeS.

Figure 1-1 illustrates the assumed connections of the subject request to the existing transmission system.

Figure 1-1
GIS-2019-029 One-line Diagram



2. Description of Request and Additional Requirements

The request indicates that a generating plant will be installed with a net generation total capacity of 100 MW. The solar plant was modeled at 0.954 Power Factor (PF) at the GI-2019-029 Generator in the steady-state analysis.

In order to obtain 100 MW injection at the Point of Interconnection (POI), the study determined that the gross generation at the plant inverter bus would need to be 101.3 MW. The solar plant gross generation of 101.3 MW was modeled for this FeS. The data provided by the customer supports the 101.3 MW gross generation level.

The study determined that the inverters' 0.954 PF capability did not meet the +/- 0.95 power factor at the high side of the customer main transformer requirement. The study found that the customer would also need to provide a 16 MVAR capacitor at the collector bus to meet the at least +/- 0.95 power factor at the high side of the customer main transformer requirement. A 16 MVAR capacitor was included in the study models. The 16 MVAR capacitor is required to have automatic voltage control based on monitoring the voltage at the 138 kV bus.

If the LGE-GIS-2019-029 request is granted, the new generation will have interconnection rights for 100 MW net output into the POI. The in-service date of the LGE-GIS-2019-029 request is December 31, 2021.

The SIS and the Facility Study (FS) may identify further requirements.

3. Study Criteria, Methodology, and Assumptions

3.1 Ad Hoc Study Group

An Ad Hoc Study Group was not involved in the FeS study process as is consistent with the FeS study procedure given in the LG&E and KU GI Study Criteria document.

3.2 Computer Programs Used

The thermal and voltage analyses were performed using Siemens Power Technologies, Inc.'s (PTI's) Power System Simulator for Engineering (PSS/E®) Version 33 computer powerflow program and evaluation software. In addition, other programs were used to assist the engineers with processing and evaluating the system contingencies and special generation dispatch scenarios. The off-line flowgate analysis was performed using PTI's PSS/E® Version 33 and Power System Simulator for Managing and Utilizing System Transmission (MUST®) Version 12.2.1 computer powerflow programs and evaluation software.

Power system analyses, utilizing PSS/E® and ASPEN, were performed to determine whether the subject request's impact on the existing transmission system is within applicable limits in accordance with the study procedure, as defined in the LG&E and KU GI Study Criteria. The network analyses were used to predict both near-term and long-term monitored element performance. PSS/E® activity Alternative Current Contingency Calculation (ACCC) was used to determine system thermal and voltage performance with and without the subject request. Automated software consistent with the LG&E and KU planning process was used to run the ACCC activity for numerous dispatch scenarios. A short circuit analysis utilizing ASPEN was performed to determine the subject request's impact on breaker duty levels.

3.3 Study Procedures

Power system analyses, utilizing PSSE, MUST, and ASPEN, were performed to determine whether the subject request's impact on the transmission system is within applicable limits in accordance with the study procedure as defined in the GI Study Criteria document posted on the LG&E and KU OASIS. The network analyses results were used to predict both near-term and long-term, both constrained interface and monitored element performance. PSSE activity ACCC were used to determine system thermal and voltage performance with and without the subject request. Automated software consistent with the LG&E and KU planning process, were used to run the ACCC activity for numerous dispatch scenarios. A MUST AC activity was used to evaluate the impact of the subject request on the constrained interfaces. Short circuit analysis utilizing ASPEN was performed to determine the subject request's impact on available fault currents.

This request was evaluated by comparing the equipment and flowgate loading levels, voltage levels and available fault current levels of a Pre GI-2019-029 model to the equipment and flowgate loading levels, voltage levels and available fault current levels of a Post GI-2019-029 model. Numerous dispatch scenarios were evaluated to determine system thermal and voltage performance with and without the subject request. The dispatch scenarios were analyzed in accordance with the LG&E and KU GI Study Criteria.

3.4 Monitored Elements and Study Area

All study area elements as defined in Table 3-1 were monitored for the thermal and voltage analyses. Generator Step-Up Transformers (GSUs) were not monitored.

Table 3-1
Study Area

Owner	Area	Contingencies			Monitored Elements P1 and P3		Monitored Element P2 and P4	
		Explicitly Included	Broad All Singles/Ties Commands					
			kV min	kV max	kV min	kV max	kV min	kV max
EKPC	320	As submitted by EKPC to LG&E and KU for TEP	69	500	69	800	100	800
BREC	314	As submitted by MISO to LG&E and KU for TEP			100	800	100	800
OVEC	206	As Submitted by PJM to LG&E and KU for TEP	69	500	100	800	100	800
DEI	208	As submitted by MISO to LG&E and KU for TEP			100	800	100	800
LG&E and KU	363	As determined by LG&E and KU for use in TEP	69	500	69	800	100	800
OMU	364	As determined by LG&E and KU for use in TEP	69	500	69	800	100	800
TVA	347	As submitted by TVA to LG&E and KU for TEP			100	800	100	800
HE	207	As submitted by MISO to LG&E and KU for TEP			100	800	100	800
SIGE	210	As submitted by MISO to LG&E and KU for TEP			100	800	100	800
IPL	216	As submitted by MISO to LG&E and KU for TEP			100	800	100	800
NIPS	217	As submitted by MISO to LG&E and KU for TEP			100	800	100	800
AEP	205	As Submitted by PJM to LG&E and KU for TEP			100	800	100	800
DEO&	212	As Submitted by PJM to LG&E and KU for TEP			100	800	100	800

3.5 Contingencies Considered

In addition, to broadly define single element contingencies indicated in Table 3-1, all area 363 North American Electric Reliability Corporation (NERC) Category P0, P1, P3, P2 EHV, and P4 EHV contingencies were analyzed as well as selected NERC Category P1 and P3 contingencies outside of area 363. All generation contingencies considered by LG&E and KU in its TEP process were considered. The same contingencies were analyzed for the Pre LGE-GIS-2019-029 models and the Post LGE-GIS-2019-029 models, to the extent practical.

For NERC Category P0, the system is intact (no contingencies). Generators off-line for economic reasons were not considered a contingency. For NERC Category P1, P2 EHV, and P4 EHV, a single contingency is considered. Only the following Category P3 contingencies as identified in the LG&E and KU Transmission System Planning Guidelines were considered:

- An outage of one generator followed by another generator
- An outage of one generator followed by one transmission circuit
- An outage of one generator followed by one transmission transformer

For an outage of one transmission circuit or transformer with one generator outage, the replacement generation required to offset the unit outage was simulated from the most restrictive of internal sources and/or MISO and/or TVA and/or PJM.

3.6 Dispatch Scenarios Considered

Several generation dispatch scenarios were evaluated. Appendix C shows the generation dispatch codes and the generation changes for each dispatch scenario. Each single dispatch was analyzed in combination with each study area contingency. Double dispatches were analyzed as one generator outage followed by another generator outage only.

3.7 Powerflow Model Development Details

3.7.1 Pre LGE-GIS-2019-029 Model Development

The following Pre GI 2019-029 models were developed for this study:

- 2022 Summer Peak Pre GI 2019-029_NRIS
- 2022 Summer Peak Pre GI 2019-029_ERIS
- 2030 Summer Peak Pre GI 2019-029_NRIS
- 2030 Summer Peak Pre GI 2019-029_ERIS

The Pre GI LGE-2019-029 models were created from the LG&E and KU 2021 Transmission Expansion Plan (TEP) Base Case Study (BCS) models which were provided to the ITO on August

13, 2020. The August 13, 2020 LG&E and KU 2021 TEP BCS models were named 2021 BCS 20200812 by LG&E and KU and are referred to as the 2021 TEP BCS models throughout the remainder of this document. These models reflect the LSEs' August 2019 MOD-032 Load Forecast submittal. These models also reflect LG&E and KU's 2020 TEP Attachment 21 projects and project changes approved prior to August 10, 2020.

Additional approved changes to projects were included in the GI-2019-029 Models as shown in Table 3-2.

Table 3-2
ITO Approved TEP Project Changes

Project Number	Original Project	Modification
992 1003	Construct a new 69 kV line from Lebanon to Lebanon South and a ring bus at Lebanon South. Move the Lebanon Industrial and Lebanon East Loads to the new line.	Construct a new 69 kV line from Lebanon to a point just south of EKPC's Lebanon station. Move the Lebanon Industrial and Lebanon East Loads to the new line. The new line will be operated with a motor operated normally open switch between Lebanon East and the new tap point.
952	Install a second West Lexington 450 MVA, 345/138 kV transformer and necessary 345 kV breakers to create a four breaker 345 kV ring bus configured such that the two transformers do not share a single breaker. Reconfigure the Brown N to West Lexington and Ghent to W Lexington 345 kV lines as necessary.	1164: Install a second 345/138kV transformer at Brown North. 830: Install a 138kV, 60 MVAr capacitor at West Lexington
975	Conductor replacement of 2.80 miles of 392.5 MCM 24X13 ACAR conductor in the Upper Mill Creek to Riverport 69 kV line section, using 397.5 MCM 26X7 ACSR or better conductor.	Some of the load currently served at Terry #2 will be shifted to International and Pleasure Ridge 138 kV.
1117	Conductor replacement of the 1.2 miles of 392.5 ACAR in the Terry to Riverport 69 kV line with 397.5 ACSR.	Some of the load currently served at Terry #2 will be shifted to International and Pleasure Ridge 138 kV

As shown in Table 3-3, some rating updates were applied to the Pre GI-2019-029 models.

Table 3-3
Rating Updates applied to All GI-2019-029 Models

From Bus Name	From Bus Number	To Bus Name	To Bus Number	Circuit ID	Season	Updated Rate A	2021 TEP Rate A	Updated Rate B	2021 TEP Rate B
2VINE STREET69.000	324984	2WEST HIGH 69.000	324988	1	Winter	77.2	95	85	96
2W HIGH T1 69.000	324766	2WEST HIGH 69.000	324988	1	Winter	92	95	YTBD	96
2RACE STREET69.000	324934	2VINE STREET69.000	324984	1	Off-Peak	69	69	81	69
2RACE STREET69.000	324934	2VINE STREET69.000	324984	1	Summer	69	55	81	69
2RACE STREET69.000	324934	2VINE STREET69.000	324984	1	Winter	69	69	81	69
5CALVERT KY 161.00	360125	5LIVNGSTN CO161.00	324151	1	Off-Peak	335	328	335	328
5CALVERT KY 161.00	360125	5LIVNGSTN CO161.00	324151	1	Summer	265	265	314	299

As appropriate, all long-term firm network TSRs which were confirmed at the time of the 2021 TEP SPM build were included in the 2021 TEP BCS power flow models. Additional TSRs have been confirmed and those TSRs were included in the GI-2019-029 models. The TSRs which were added to the 2021 TEP BCS models to create the Pre GI LGE-2019-029 models are listed in Table 3-4.

Table 3-4
Confirmed TSRs added to the
2021 TEP BCS models to form the Pre GI-2019-029 Models

NITS on OASIS Number	SIS	MW	Type
88965179	2019-004	7.5	ADD NITS LOAD
89475755	2019-007	28	ADD NITS LOAD
90030484	2019-009	-13	Terminate NITS DNR
90030485	2019-009	13	ADD NITS DNR
90089795	2019-010	11	MODIFY NITS LOAD
90089812	2019-010	11	MODIFY NITS LOAD
90089821	2019-010	-11	MODIFY NITS LOAD
90089823	2019-010	-11	MODIFY NITS LOAD
90221160	2019-011	15	MODIFY NITS LOAD
90401751	2019-012	17	MODIFY NITS LOAD

All LG&E and KU prior queued generators were included in the Pre GI-2019-029 power flow models. All LG&E and KU prior queued generators to be added to the 2021 TEP BCS models to form the Pre GI-2019-029 models are shown in Table 3-5.

Table 3-5
Prior Queued generators added to the
2021 TEP BCS models to form the Pre GI-2019-029 Models

Queue Position	Queue Date	County	State	Max Output (MW)	Point of Inter-connection	In-Service Date	Inter-connection Service Type
LGE-GIS-2017-002	03/01/2017	Lyon	KY	86	North Princeton-Livingston County 161 kV	12/01/2022	NRIS
LGE-GIS-2017-003	04/27/2017	Harrison	KY	35	Cynthiana EK Tap - Millersburg 69 kV	06/01/2021	NRIS/ERIS
LGE-GIS-2017-006	08/18/2017	Muhlenberg	KY	100	Green River 138 kV substation	08/31/2019	NRIS/ERIS
LGE-GIS-2019-001	01/15/2019	Washington	KY	110	Lebanon-Danville Tap 138 kV Line	12/01/2023	NRIS/ERIS
LGE-GIS-2019-002	02/06/2019	Ballard	KY	104	Grahamville-Wickliffe 161 kV Line	06/01/2023	NRIS/ERIS
LGE-GIS-2019-003	02/07/2019	Meade	KY	121	Cloverport-Tip Top 138 kV Line	12/01/2022	NRIS/ERIS
LGE-GIS-2019-004	02/07/2019	Breckinridge	KY	200	Hardinsburg 138 kV Substation	12/01/2022	NRIS/ERIS
LGE-GIS-2019-008	03/22/2019	Caldwell	KY	100	North Princeton 161 kV Substation	12/31/2021	NRIS/ERIS
LGE-GIS-2019-015	03/22/2019	Grayson	KY	100	Ohio County to Shrewsbury 138 kV	12/31/2021	NRIS/ERIS
LGE-GIS-2019-020	03/22/2019	Hopkins	KY	85	Corydon Tap to Green River 161 kV	12/31/2021	NRIS/ERIS
LGE-GIS-2019-023	03/29/2019	Lyon	KY	150	Livingston Co. to North Princeton 161 kV line	12/15/2021	NRIS/ERIS
LGE-GIS-2019-025	05/02/2019	Mercer	KY	98.42	Bardstown-Brown CT 138 kV line	12/01/2022	NRIS/ERIS
LGE-GIS-2019-028	08/30/2019	Caldwell	KY	150	North Princeton 161 kV Substation	12/31/2022	NRIS/ERIS

As per the LG&E and KU Generation interconnection Study Criteria document no winter models were studied and all solar generation within Area 363, exclusive of the request under study, were modeled at 80% in the summer models.

Non-solar generation in the vicinity of the Point of Interconnection (POI) of the subject request was maximized in the Pre GI 2019-029 models to the extent possible within the area in which they are connected. The specific generators that were maximized are given in Table 3-6.

Table 3-6
2021 TEP BCS modeling of Generation in the vicinity of the GI 2019-029 POI to be maximized

Bus Number	Bus Name	Id	Area	2022S Pgen	2022S Pmax	2030S Pgen	2030S Pmax
324024	1MILL CRK 1 22.000	1	LGEE	333	333	333	333
324025	1MILL CRK 2 22.000	2	LGEE	336	336	336	336
324026	1MILL CRK 3 22.000	3	LGEE	425	425	425	425
324027	1MILL CRK 4 22.000	4	LGEE	526	526	526	526
325093	1CANERUN7CT118.000	71	LGEE	231.5	231.5	231.5	231.5
325094	1CANERUN7CT218.000	72	LGEE	231.5	231.5	231.5	231.5
325095	1CANERUN7ST 18.000	7S	LGEE	241	241	241	241
253625	10CAN_G1 6.9000	1	SIGE	8.74	30	8.74	30
253626	10CAN_G2 6.9000	2	SIGE	8.74	30	8.74	30
253627	10CAN_G3 6.9000	3	SIGE	8.74	30	8.74	30

3.7.2 Post LGE-GIS-2019-029 Model Development

The following Post GI 2019-029 models were developed for this study:

- 2022 Summer Peak Post GI 2019-029_NRIS
- 2022 Summer Peak Post GI 2019-029_ERIS
- 2030 Summer Peak Post GI 2019-029_NRIS
- 2030 Summer Peak Post GI 2019-029_ERIS

The Pre GI-2019-029 NRIS Models were modified to include the GI-2019-029 generation, sinking into the LG&E and KU generation fleet in merit order to form the Post GI-2019-029 NRIS Models. The Pre GI-2019-029 ERIS Models were modified to include the GI-2019-029 generation, sinking based on scaling the generation of the local Balancing Authorities to the north, south, east, and west of the LG&E and KU control area each by 25% of the request to form the Post GI-2019-029 ERIS Models.

Before the start of the study, preliminary GI-2019-029 models were sent to the LG&E and KU for review. Modeling adjustments as indicated by LG&E and KU were applied as appropriate.

3.8 Network Analysis Criteria

A Network analysis was performed to determine the impact of the subject request on all Study Area system intact and post-contingent branch loadings and bus voltages as well as flowgate impacts. This analysis was performed in accordance with criteria and methodology given in the LG&E and KU Large GI Study Criteria posted on the LG&E and KU OASIS. The Study area is defined in Section 3.4 of this report. When provided by the applicable transmission owner (TO), TO criteria was used to identify non-LG&E and KU constraints. If TO criteria was not available, criteria given in the LG&E and KU Large GI Study Criteria document was applied by default.

3.9 Reliability Margins for LG&E and KU Flowgates

Requests for Capacity Benefit Margin (CBM) set-aside that go beyond the 18 month Available Transfer Capability (ATC) calculation horizon were accounted for by developing additional generation scenarios that mimic the requesting entities original request which must include the assumed sources of the CBM. No requests for CBM that go beyond the 18 month ATC calculation horizon have been received. Therefore, no LG&E and KU CBM analysis were performed for this study.

The Transmission Reserve Margin (TRM) outside of the 18 month ATC calculation horizon were accounted for by the generation replacement scenarios that include both internal and Contingency Reserve Sharing Group Agreement (CRSG) partner sources for the replacement generation.

3.10 Flowgate Analysis

A flowgate analysis was not be performed in conjunction with the ERIS portion of this study. For the NRIS analysis, a Non-LG&E and KU flowgate analysis was performed to determine if sufficient Available Flowgate Capability (AFC) would exist on regional Non- LG&E and KU flowgates with the addition of the subject request. An impact analysis on Reciprocally Coordinated flowgates (RCF) was performed to determine if the subject request significantly impacted those posted flowgates in accordance with the LG&E and KU TSR Study Criteria posted on the LG&E and KU OASIS. There are two types of flowgates, Power Transfer Distribution Factor (PTDF) flowgates and Outage Transfer Distribution Factor (OTDF) flowgates. A PTDF flowgate monitors a system intact condition and an OTDF flowgate monitors a contingency condition. All Non- LG&E and KU flowgates that exceed the PTDF and OTDF thresholds of 5% and 20% respectively and are loaded beyond their flowgate ratings were identified in the report.

4. Powerflow Analysis Results

4.1 Contingency Analysis

Contingency analyses were performed using models, criteria, and methodology described in Section 3. The incremental impact of the LGE-GIS-2019-029 request was evaluated by comparing flows and voltages with and without the requested interconnection. Analyses were performed using Siemen's PSS/E® and programs to assist engineers with processing and evaluating the system contingencies and special generation dispatch scenarios.

It is also important to note that not all contingencies considered resulted in a convergent powerflow solution. Most initially divergent contingencies converged when other solution techniques, some of which included locking switched shunts, were applied. If potential constraints were identified through a shunts locked solution, further analysis was performed to obtain a powerflow solution with shunts enabled. Only the results obtained through a shunts enabled powerflow solution were considered as valid results. The contingencies that were divergent in both the initial shunts enabled and shunt locked solution attempts were solved using other solution techniques. Appendix B lists those solution techniques which required model modifications.

4.1.1 Thermal Analysis Results

The LG&E and KU potential GI 2019-029 NRIS thermal constraints due to the subject request are given in Table 4-1. These constraints were found for many dispatch/contingency combinations. Only the result with the highest post project loading for each scenario is shown in Table 4-1.

Table 4-1
GI 2019-029 LG&E and KU NRIS Thermal Constraints

Year/ Season	Dispatch	Facility	Rating	Pre Project		Post Project		DF	Contingency
				MVA	%	MVA	%		
2030S NRIS	mtc_nits	BLACKBRANCH TO GI-2019-029P 138 kV	208	163.0	78.4	243.4	117.0	80.4%	None
2030S NRIS	wbnp1_s	BLACKBRANCH TO GI-2019-029P 138 kV	265	214.3	80.9	291.7	110.1	77.4%	DAVIESS To HARDIN CO 345 kV 1
2030S NRIS	mtc_nits	BLACKBRANCH TO CENT HARDIN 138 kV	227	148.5	65.4	227.04	100.02	78.5%	None
2030S NRIS	wilson_w	HARDINSBURG TO N.HARD 138 kV	191	152.7	79.9	220.2	115.3	67.5%	BLACKBRANCH To GI-2019-029P 138 kV
2030S NRIS	wbnp1_s	ETOWN KU TO KARGLE 69 kV	86	62.8	73.1	101.1	117.5	38.2%	HARDIN CO To CENT HARDIN 138 kV

A Third Party potential GI 2019-029 NRIS thermal constraint due to the subject request is given in Table 4-2. This constraint was found for many dispatch/contingency combinations. Only the result with the highest post project loading for each scenario is shown in Table 4-2.

Table 4-2
GI 2019-029 Third Party NRIS Thermal Constraints

Year/Season	Dispatch	Facility	Rating	Pre Project		Post Project		DF	Contingency
				MVA	%	MVA	%		
2030S NRIS	wbnp1_s	CENT HARDIN TO KARGLE 69 kV	98	79.4	81.0	119.4	121.8	40.0%	HARDIN CO To CENT HARDIN 138 kV

The LG&E and KU potential GI 2019-029 ERIS thermal constraints due to the subject request are given in Table 4-3. These constraints were found for many dispatch/contingency combinations. Only the result with the highest post project loading for each scenario is shown in Table 4-3.

Table 4-3
GI 2019-029 LG&E and KU ERIS Thermal Constraints

Year/Season	Dispatch	Facility	Rating	Pre Project		Post Project		DF	Contingency
				MVA	%	MVA	%		
2030S ERIS	mtc_nits	BLACKBRANCH TO GI-2019-029P 138 kV	208	152.6	73.4	232.2	111.6	79.6%	None
2030S ERIS	wbnp1_s	BLACKBRANCH TO GI-2019-029P 138 kV	265	197.5	74.5	274.9	103.7	77.3%	DAVIESS To HARDIN CO 345 kV
2030S ERIS	wilson_w	HARDINSBURG TO N.HARD 138 kV	191	150.4	78.7	218.3	114.3	68.0%	BLACKBRANCH To GI-2019-029P 138 kV
2030S ERIS	wbnp1_s	ETOWN KU TO KARGLE 69 kV	86	54.4	63.2	91.7	106.7	37.3%	HARDIN CO To CENT HARDIN 138 kV

A Third Party potential GI 2019-029 ERIS thermal constraint due to the subject request is given in Table 4-4. This constraint was found for many dispatch/contingency combinations. Only the result with the highest post project loading for each scenario is shown in Table 4-4.

Table 4-4
GI 2019-029 Third Party ERIS Thermal Constraints

Year/Season	Dispatch	Facility	Rating	Pre Project		Post Project		DF	Contingency
				MVA	%	MVA	%		
2030S ERIS	wbnp1_s	CENT HARDIN TO KARGLE 69 kV	98	70.9	72.4	110.1	112.4	39.2%	HARDIN CO To CENT HARDIN 138 kV

4.1.2 Voltage Analysis Results

No LG&E and KU or third party potential voltage constraints due to the subject request were identified.

4.1.3 Constraint Sensitivity to GI-2017-006 LGIA Termination Request

After the completion of the GI-2019-029 FeS steady state models and initiation of the steady state analysis, the GI-2017-006 customer requested to terminate the GI-2017-006 LGIA. The TO will be filing this LGIA termination request with FERC. No termination shall become effective until the

Parties have complied with all Applicable Laws and Regulations applicable to such a termination, including the filing with FERC of a notice of termination of this LGIA, and the notice has been accepted for filing by FERC. Thus a sensitivity analysis was performed to determine the impact of a possible GI-2017-006 LGIA termination on the constraints identified in Section 4.1.1. The LG&E and KU potential GI 2019-029 NRIS thermal constraints due to the subject request with the GI-2017-006 request removed from the models are given in Table 4-5. These constraints were found for many dispatch/contingency combinations. Only the result with the highest post project loading for each scenario is shown in Table 4-5.

Table 4-5
GI 2019-029 LG&E and KU NRIS Thermal Constraints with GI-2017-006 Off-line

Year/ Season	Dispatch	Facility	Rating	Pre Project		Post Project		DF	Contingency
				MVA	%	MVA	%		
2030S NRIS	mtc_nits	BLACKBRANCH TO GI-2019-029P 138 kV	208	158.7	76.3	240.9	115.8	80.4%	None
2030S NRIS	wbnp1_s	BLACKBRANCH TO GI-2019-029P 138 kV	265	210.5	79.4	287.9	108.6	77.4%	DAVIESS To HARDIN CO 345 kV 1
2030S NRIS	wilson_w	HARDINSBURG TO N.HARD 138 kV	191	153.5	80.3	220.9	115.7	67.5%	BLACKBRANCH To GI-2019-029P 138 kV
2030S NRIS	wbnp1_s	ETOWN KU TO KARGLE 69 kV	86	60.4	70.2	98.6	114.6	38.2%	HARDIN CO To CENT HARDIN 138 kV

A Third Party potential GI 2019-029 NRIS thermal constraint due to the subject request with the GI-2017-006 request removed from the models is given in Table 4-6. This constraint was found for many dispatch/contingency combinations. Only the result with the highest post project loading for each scenario is shown in Table 4-6.

Table 4-6
GI 2019-029 Third Party NRIS Thermal Constraints with GI-2017-006 Off-line

Years/ Season	Dispatch	Facility	Rating	Pre Project		Post Project		DF	Contingency
				MVA	%	MVA	%		
2030S NRIS	wbnp1_s	CENT HARDIN TO KARGLE 69 kV	98	77.0	78.5	117.0	119.3	40.0%	HARDIN CO To CENT HARDIN 138 kV

The LG&E and KU potential GI 2019-029 ERIS thermal constraints due to the subject request with the GI-2017-006 request removed from the models are given in Table 4-7. These constraints were found for many dispatch/contingency combinations. Only the result with the highest post project loading for each scenario is shown in Table 4-7.

Table 4-7
GI 2019-029 LG&E and KU ERIS Thermal Constraints with GI-2017-006 Off-line

Year/ Season	Dispatch	Facility	Rating	Pre Project		Post Project		DF	Contingency
				MVA	%	MVA	%		
2030S ERIS	mtc_nits	BLACKBRANCH TO GI-2019-029P 138 kV	208	149.3	71.8	228.8	110.0	79.5%	None
2030S ERIS	br3_merit_miso	BLACKBRANCH TO GI-2019-029P 138 kV	265	192.7	72.7	270.2	102.0	77.5%	DAVIESS To HARDIN CO 345 kV
2030S ERIS	wilson_w	HARDINSBURG TO N.HARD 138 kV	191	150.7	78.9	218.7	114.5	68.1%	BLACKBRANCH To GI-2019-029P 138 kV
2030S ERIS	wbnp1_s	ETOWN KU TO KARGLE 69 kV	86	51.6	60.0	89.0	103.4	37.3%	HARDIN CO To CENT HARDIN 138 kV

A Third Party potential GI 2019-029 ERIS thermal constraint due to the subject request with the GI-2017-006 request removed from the models is given in Table 4-8. This constraint was found for many dispatch/contingency combinations. Only the result with the highest post project loading for each scenario is shown in Table 4-8.

Table 4-8
GI 2019-029 Third Party NRIS Thermal Constraints with GI-2017-006 Off-line

Year/ Season	Dispatch	Facility	Rating	Pre Project		Post Project		DF	Contingency
				MVA	%	MVA	%		
2030S ERIS	wbnp1_s	CENT HARDIN TO KARGLE 69 kV	98	68.2	69.6	107.4	109.6	39.2%	HARDIN CO To CENT HARDIN 138 kV

A comparison of the constraints with and without the GI-2017-006 generation is provided in Table 4-9. These constraints were found for many dispatch/contingency combinations. Only the result with the highest post project loading for each scenario is shown in Table 4-9.

Table 4-9
Comparison of the Constraints with and without the GI-2017-006 Generation

Year / Season	Facility	Rating	Post Project				Delta MVA
			with GI-2017-006		without GI-2017-006		
			MVA	%	MVA	%	
2030S NRIS	BLACKBRANCH TO GI-2019-029P 138 kV	208*	243	117	241	116	-3
2030S NRIS	BLACKBRANCH TO GI-2019-029P 138 kV	265**	292	110	288	109	-4
2030S NRIS	BLACKBRANCH TO CENT HARDIN 138 kV	227	227.04	100.02	N/A	N/A	N/A
2030S NRIS	HARDINSBURG TO N.HARD 138 kV	191	220	115	221	116	1
2030S NRIS	ETOWN KU TO KARGLE 69 kV	86	101	118	99	115	-3
2030S NRIS	CENT HARDIN TO KARGLE 69 kV	98	119	122	117	119	-2
2030S ERIS	BLACKBRANCH TO GI-2019-029P 138 kV	208*	232	112	229	110	-3
2030S ERIS	BLACKBRANCH TO GI-2019-029P 138 kV	265**	275	104	270	102	-5
2030S ERIS	HARDINSBURG TO N.HARD 138 kV	191	218	114	219	115	0
2030S ERIS	ETOWN KU TO KARGLE 69 kV	86	92	107	89	103	-3
2030S ERIS	CENT HARDIN TO KARGLE 69 kV	98	110	112	107	110	-3

As can be seen from Table 4-9, although loadings on the constraints would generally be slightly reduced if the GI-2017-006 LGIA is terminated, most of the constraints and mitigations would not be impacted. The only impact would be that the Black Branch – Central Hardin 138 kV line would not overload if the GI-2017-006 LGIA is terminated and thus would not be considered a constraint.

4.2 Flowgate Analysis Results

As per the LG&E and KU GI Study Criteria document, the flowgate analysis is limited to the NRIS request. Reciprocally coordinated Non-LG&E and KU constrained interface analyses were performed using models, criteria, and methodology described in Section 3. The incremental impact was evaluated by comparing interface MW flows with and without the subject request. No Flowgates which have a Distribution Factor (DF) greater than the 20%/5% OTDF/PTDF criteria due to the subject request were found.

A complete listing of all reciprocally coordinated Non-LG&E and KU constrained interface results is given in Appendix E.

4.3 Results Deemed Invalid

No results were deemed invalid

4.4 Steady State Results Conclusion

4.4.1 NRIS Steady State Results Conclusion

LG&E and KU NRIS thermal constraints, as shown in Table 4-1 for NRIS scenarios, were identified. No LG&E and KU NRIS voltage or flowgate constraints due to the subject request were identified. A third party NRIS thermal constraint, as shown in Table 4-2 for NRIS scenarios, was identified. No third party NRIS voltage or flowgate constraints due to the subject request were identified. If the customer proceeds to the SIS, the SIS results could differ. The customer would need to mitigate any constraints identified in the SIS.

LG&E and KU NRIS thermal constraints if the GI-2017-006 LGIA is terminated, as shown in Table 4-5 for NRIS scenarios, were identified. No LG&E and KU NRIS voltage or flowgate constraints due to the subject request were identified. A third party NRIS thermal constraint, if the GI-2017-006 LGIA is terminated, as shown in Table 4-6 for NRIS scenarios, was identified. No third party NRIS voltage or flowgate constraints due to the subject request were identified. If the customer proceeds to the SIS, the SIS results could differ. The customer would need to mitigate any constraints identified in the SIS.

4.4.2 ERIS Steady State Results Conclusion

LG&E and KU ERIS thermal constraints, as shown in Table 4-3 for ERIS scenarios, were identified. No LG&E and KU ERIS voltage or flowgate constraints due to the subject request were identified. A third party ERIS thermal constraint, as shown in Table 4-4 for ERIS scenarios, was identified. No third party ERIS voltage or flowgate constraints due to the subject request were identified. If the customer proceeds to the SIS, the SIS results could differ. The customer would need to mitigate any constraints identified in the SIS.

LG&E and KU ERIS thermal constraints, if the GI-2017-006 LGIA is terminated, as shown in Table 4-7 for ERIS scenarios, were identified. No LG&E and KU ERIS voltage or flowgate constraints due to the subject request were identified. A third party ERIS thermal constraint, if the GI-2017-006 LGIA is terminated, as shown in Table 4-8 for ERIS scenarios, was identified. No third party ERIS voltage or flowgate constraints due to the subject request were identified. If the customer proceeds to the SIS, the SIS results could differ. The customer would need to mitigate any constraints identified in the SIS.

5. Short Circuit Analysis

A short circuit analysis was performed using ASPEN by simulating three-phase faults and single line-to-ground faults for buses within a five-bus radius of the POI to determine the breaker duty in both the pre and post LGE-GIS-2019-029 models. The breaker duty for these simulations was compared to the rated breaker interrupting capability to determine whether or not the circuit breakers may be overstressed. A breaker is considered a Significantly Affected Facility (SAF), if the breaker duty at that breaker is equal to or greater than the rated breaker interrupting capability, and the impact of the new generation is greater than or equal to 5% of the rated breaker interrupting capability. The short circuit models emulated the steady-state modeling as closely as practical and appropriate. The analysis results are summarized in Table 5-2.

5.1 Model Development

The GIS-2019-028 POST.olr model was modified by adding the GIS-2019-029 POI bus to form the Pre GIS-2019-029 model. The Pre GIS-2019-029 model was modified by adding the GIS-2019-029 generation to form the Post GIS-2019-029 model. The invertor was modeled as a voltage controlled current source.

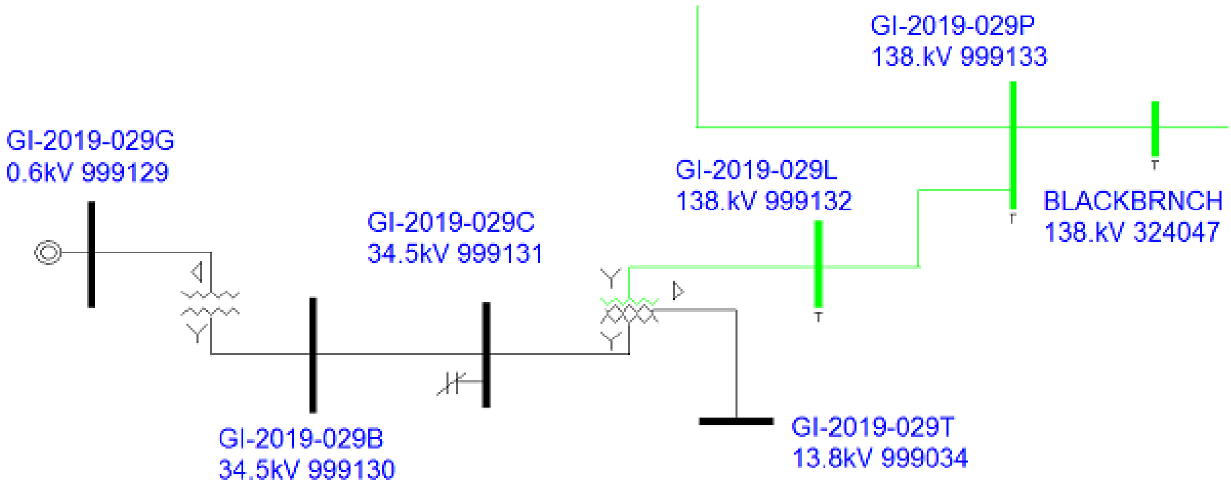
The GIS-2019-029 project data is given in Table 5-1.

Table 5-1
GIS-2019-029 Generator Data (Solar)

Voltage (PU)	Current (A)	PF Angle (deg)
1	112832	0
0.9	115067	-11.31
0.7	132013	-33.06
0.5	152323	-65.3
0.3	152323	-65.38
0.1	152323	-90

Figures 5-1 illustrates the connection of the GIS-2019-029 request at the new POI in the Post GIS-2019-029 short circuit model.

Figure 5-1
Post GIS-2019-029 New POI One-line Diagram



5.2 Short Circuit Calculations

Short circuit calculations were performed to determine the impact of the proposed project on the breaker duties at nearby substations (within five buses). Single-phase and three-phase symmetrical breaker duty levels were calculated at local area buses, both with and without the proposed project.

No breakers were found to be overstressed in the Post GIS-FES-2019-029 short circuit analysis. For informational purposes only, Table 5-2 lists the breakers near the POI and shows the impacts of the GIS-FES-2019-029 generation addition on their breaker duties. The impact of the GIS-FES-2019-029 generation is given in the "Impact of Request as a % of Breaker Capability" column. The maximum breaker duty for all faults tested is given for each breaker in both Amperes and as a percentage of the applicable breaker interrupting capability rating.

Table 5-2
Pre and Post POI GIS-2019-029 Breaker Duty for Substations near POI

BKR_ID	Bus	BKR Capacity	Pre		Post		Impact as a % of Breaker Duty
			Duty Ampere	% Duty	Duty Ampere	% Duty	
178-712	"HARDN CO 138.kV"	40000	23315.2	58.3	23821.3	59.6	1%
178-714	"HARDN CO 138.kV"	40000	23315.2	58.3	23821.3	59.6	1%
178-724	"HARDN CO 138.kV"	40000	23290.2	58.2	23790.3	59.5	1%
178-722	"HARDN CO 138.kV"	40000	23954.6	59.9	24393.7	61	1%
178-754	"HARDN CO 138.kV"	40000	23954.6	59.9	24393.7	61	1%
178-702	"HARDN CO 138.kV"	40000	23239.9	58.1	23669.3	59.2	1%
178-704	"HARDN CO 138.kV"	63000	23239.9	36.9	23669.3	37.6	1%
178-728	"HARDN CO 138.kV"	63000	19142.7	30.4	19516.8	31	1%
178-624	"HARDN CO 69.kV"	34755.6	30819.4	88.7	31020	89.3	1%
178-718	"HARDN CO 138.kV"	63000	18850.8	29.9	19205.9	30.5	1%
178-604	"HARDN CO 69.kV"	34755.6	29971.9	86.2	30165.4	86.8	1%
178-618	"HARDN CO 69.kV"	40000	25012.6	62.5	25219.7	63	1%
178-602	"HARDN CO 69.kV"	40000	23299.5	58.2	23490.1	58.7	0%
178-634	"HARDN CO 69.kV"	40000	29513.8	73.8	29702.4	74.3	0%
178-614	"HARDN CO 69.kV"	40000	29510.5	73.8	29693.1	74.2	0%
034-644	"ETOWN 69.kV"	34755.6	28502.9	82	28645	82.4	0%
034-654	"ETOWN 69.kV"	34755.6	27630.9	79.5	27765.9	79.9	0%
034-602	"ETOWN 69.kV"	40000	28502.6	71.3	28644.8	71.6	0%
034-634	"ETOWN 69.kV"	40000	28502.8	71.3	28645	71.6	0%
034-624	"ETOWN 69.kV"	40000	28048.9	70.1	28190.2	70.5	0%
034-614	"ETOWN 69.kV"	40000	27631.5	69.1	27770.8	69.4	0%
034-674	"ETOWN 69.kV"	40000	26738.7	66.8	26865.8	67.2	0%
178-608	"HARDN CO 69.kV"	40000	25098	62.7	25222.2	63.1	0%
034-604	"ETOWN 69.kV"	40000	26168.2	65.4	26253.2	65.6	0%
034-714	"ETOWN 138.kV"	19484.2	17843.2	91.6	17877.3	91.8	0%
184-704	"HARDINSB 138.kV"	19484.2	12071	62	12091.7	62.1	0%
184-724	"HARDINSB 138.kV"	40000	11255	28.1	11254.8	28.1	0%
184-714	"HARDINSB 138.kV"	19484.2	8964.2	46	8964	46	0%
178-744	"HARDN CO 138.kV"	40000	22845.5	57.1	22843	57.1	0%
034-704	"ETOWN 138.kV"	63000	17000.8	27	16959.9	26.9	0%
455-708	"BLACKBRNCH 138.kV"	63000	15659.7	24.9	15617.2	24.8	0%
034-608	"ETOWN 69.kV"	40000	23264.5	58.2	23232	58.1	0%

As shown in Table 5-2, the breaker duties seen by all breakers listed are less than their rated interrupting capabilities in both the pre project and post project analyses. Thus, if the same results are shown in the SIS no breaker replacements would be required.

5.3 Conclusion

No short circuit impacts due to the subject request have been identified.

6. Conceptual Cost Estimate

There were no LG&E and KU constraints identified in the short circuit analysis. Thus, no cost estimate to mitigate LG&E and KU short circuit constraints is provided. LG&E and KU network constraints were identified in the steady state analysis as detailed in Section 4. Constraints were identified in both the NRIS and ERIS analyses. Non-binding good faith cost estimates to mitigate the LG&E and KU network constraints are provided. In addition, a non-binding good faith cost estimate is provided for interconnection facilities of request LGE-GIS-2019-029. The same interconnection facilities were identified for both NRIS and ERIS. However the network upgrade facilities differ between NRIS and ERIS. These are only conceptual cost estimates for planning purposes. These costs were compiled by LG&E and KU and will be further developed and refined in the SIS and the FS. In addition to these costs if additional constraints are identified in the SIS, additional costs may be incurred.

6.1 Methodology

The cost estimates are allocated based on the "*Allocation of Costs for Generator Interconnections*" dated January 01, 2018 posted on OASIS.

6.2 Generator Owner Facilities

The generator owner is responsible for the installation and costs for the generator, step up transformer, and customer protective devices up to the Transmission Owner (TO) metering equipment. The generator owner is also responsible for the costs of reactive power capability required to meet +/- 0.95 power factor at the POI. The customer is responsible for determining the generator owner costs for the facilities owned and operated by the customer.

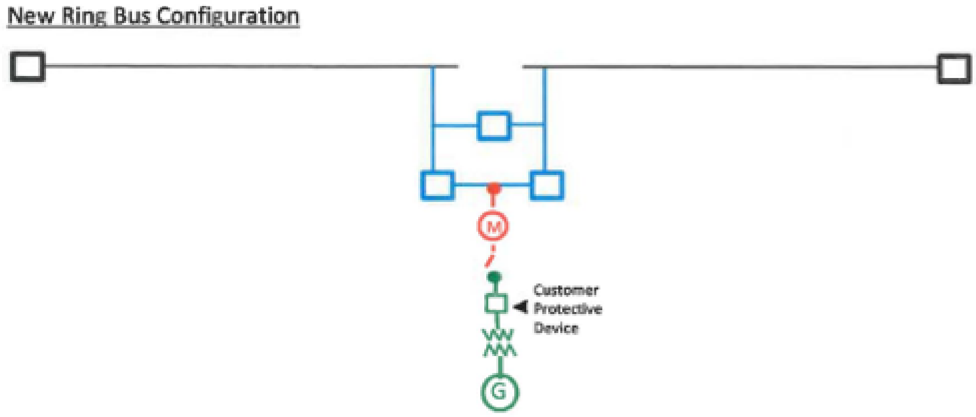
6.3 Total Conceptual Cost Estimate

Total Conceptual Facilities Cost Estimate		
Service Type	**GI-2017-006 Status**	**Estimate Cost**
NRIS	On	$14,978,382
NRIS	Off	$12,711,811
ERIS	On	$12,711,811
ERIS	Off	$12,711,811

The costs and facilities identified are as follows.

Unless the customer chooses a more reliable interconnection, the minimum generator interconnection facilities are shown in Figure 6-1.

Figure 6-1: Minimum Generator Interconnection Facilities



Legend:

Black = Existing Transmission Facilities
Blue = New Network Facilities
Red = Transmission Interconnection Facilities
M = Interconnection Metering and Associated Equipment
Green = Generation Facilities
● = Point of Interconnection
● = Point of Change of Ownership

6.3.1 Transmission Interconnection Facilities: (Total Estimated Cost $1,151,967)

The customer is responsible for transmission interconnection facilities between the generator owner facilities and the point of interconnection. The LG&E and KU non-binding planning level cost estimate for transmission interconnection facilities is shown in Table 6-1 and includes the following:

- Face of Steel (FOS) structure: A-frame, switch stand, metering supports, etc. for GI exit
- (1) set of 138kV motor-operated disconnect switches
- (1) set of 138kV line arresters
- (1) set of 138kV Metering instrument potential transformers (PTs)
- (1) set of 138kV Metering instrument current transformers (CTs)
- (1) New Control House Space Allocation consisting of below relay panels:
    - (1) line protection panel for GI Interconnect
    - (1) metering panel for GI
    - (1) RTU panel
    - AC/DC systems

Table 6-1
Transmission Interconnection Facility Cost Estimate

Description	TIF Subs
Company Labor	$81,587
Contract Labor	$609,103
Materials	$356,553
Contingency	$104,724
Total	$1,151,967

6.3.2 Network Facilities

Network Facilities Cost Estimate		
Service Type	**GI-2017-006 Status**	**Estimate Cost**
NRIS	On	$13,826,415
NRIS	Off	$11,559,844
ERIS	On	$11,559,844
ERIS	Off	$11,559,844

6.3.2.1 Network Interconnection Facilities: (Total Estimated Cost $7,463,541)

The same network interconnection facilities are required for both NRIS and ERIS. The LG&E/KU non-binding planning level cost estimate for network interconnection facilities is shown in Table 6-2 and includes the following:

- Ring bus configuration with (3) 138kV lines (EKP Central Hardin, Hardinsburg, & GI Interconnect)
- (3) 138kV circuit breakers
- Steel structures: A-frames, switch stands, bus supports, etc.
- (6) sets of 138kV manually operated disconnect switches
- (2) sets of 138kV line arresters
- (2) sets of 138kV Line potential transformers (PTs)
- (2) 138kV substation voltage transformers (SSVTs)
- (1) set of metering equipment for the GI
- (1) Medium control house consisting of below relay panels:
    - (3) line protection panels for EKP Central Hardin, Hardinsburg & GI Interconnect
    - (2) Digital communications paths, (1) associated with the EKP Central Hardin line and (1) associated with the Hardinsburg line
    - (1) metering panel for GI
    - (1) RTU panel
    - (1) DFR panel
    - AC/DC systems

This cost estimate was prepared with the assumption that the customer would purchase land and perform site preparations for the substation at the POI.

Table 6-2
Network Interconnection Facility Cost Estimate

Description	NNF Lines	NNF Subs	NNF Total Cost
Company Labor	$70,121	$481,900	$552,021
Contract Labor	$650,947	$3,120,007	$3,770,954
Materials	$126,895	$2,335,168	$2,462,063
Contingency	$84,796	$593,707	$678,503
Total	$932,759	$6,530,782	$7,463,541

LG&E and KU has indicated that the interconnection facilities can be completed within 24 months after the GIA is signed and the Customer provides a construction-ready site.

6.3.2.2 Network Upgrade Facilities

Network Upgrade Facilities Cost Estimate		
Service Type	**GI-2017-006 Status**	**Estimate Cost**
NRIS	On	$6,362,874
NRIS	Off	$4,096,303
ERIS	On	$4,096,303
ERIS	Off	$4,096,303

LG&E and KU potential network thermal constraints were identified in the NRIS and ERIS steady state analyses as shown in Tables 4-1 and 4-3. The constraint mitigation is detailed in Table 6-3.

Table 6-3
LG&E and KU Constraint Mitigation Description

Item #	Overloaded Facility	Mitigation Description
1	BLACKBRANCH TO GI-2019-029P 138 kV	Replace 2.002 miles of line from Black Branch to GI-2019-029 POI 138 kV in the Black Branch to Hardinsburg 138 kV line with 1272 MCM 45x7 ACSR conductor or better
2	BLACKBRANCH TO CENT HARDIN 138 kV	Replace 0.83 miles of 954 MCM 45X7 ACSR in the Black Branch to Central Hardin 138 kV line with 1272 MCM 45x7 ACSR conductor or better.
3	HARDINSBURG TO N.HARD 138 kV	Replace all 138 kV terminal equipment rated less than 993 Amps (237 MVA) summer emergency rating associated with the Hardinsburg to New Hardinsburg 138 kV line.
4	ETOWN KU TO KARGLE 69 kV	Replace all 69 kV terminal equipment rated less than 953 Amps (114 MVA) summer emergency rating associated with the Elizabethtown to Kargle 69 kV line.

The LG&E/KU non-binding planning level cost estimate for network upgrade facilities is shown in Tables 6-4 and 6-5.

Table 6-4
LG&E and KU Network Upgrade Facilities Cost

Item	Overloaded Facility	Mitigation			
		NRIS		ERIS	
		Need Date	Cost	Need Date	Cost
1	BLACKBRANCH TO GI-2019-029P 138 kV	5/31/2023	$3,727,815	5/31/2023	$3,727,815
2	BLACKBRANCH TO CENT HARDIN 138 kV	5/31/2023	$2,266,571	N/A	N/A
3	HARDINSBURG TO N.HARD 138 kV	5/31/2023	$273,075	5/31/2023	$273,075
4	ETOWN KU TO KARGLE 69 kV	5/31/2023	$95,413	5/31/2023	$95,413
Total Network Upgrade Cost			$6,362,874		$4,096,303

It is important to note that the need date of the mitigation is dependent on the in-service date of the prior queued GI-2019-004 request. LG&E and KU has indicated that the network upgrade facilities can be completed within 30 months after the GIA is signed.

Table 6-5
LG&E and KU Network Upgrade Facilities Cost Details

Item	Overloaded Facility	Mitigation Description	Company Labor	Contract Labor	Materials	Contingency	Total
1	BLACKBRANCH TO GI-2019-029P 138 kV	Replace 2.002 miles of line from Black Branch to GI-2019-029 POI 138 kV in the Black Branch to Hardinsburg 138 kV line with 1272 MCM 45x7 ACSR conductor or better	$334,356	$2,256,789	$797,778	$338,892	$3,727,815
2	BLACKBRANCH TO CENT HARDIN 138 kV	Replace 0.83 miles of 954 MCM 45X7 ACSR in the Black Branch to Central Hardin 138 kV line with 1272 MCM 45x7 ACSR conductor or better.	$211,284	$1,397,467	$451,768	$206,052	$2,266,571
3	HARDINSBURG TO N.HARD 138 kV	Replace all 138 kV terminal equipment rated less than 993 Amps (237 MVA) summer emergency rating associated with the Hardinsburg to New Hardinsburg 138 kV line.	$37,105	$143,268	$67,877	$24,825	$273,075
4	ETOWN KU TO KARGLE 69 kV	Replace all 69 kV terminal equipment rated less than 953 Amps (114 MVA) summer emergency rating associated with the Elizabethtown to Kargle 69 kV line.	$30,614	$43,710	$12,415	$8,674	$95,413

Service could be granted without mitigation if the MW output of the GI-2019-029 generation were reduced. Table 6-6 details the MW limitations required.

Table 6-6
MW of Service Available without Upgrades

Overloaded Facility	GI-2019-029 MW limit for no Mitigation Required			
	with GI-2017-006 on-line		with GI-2017-006 off-line	
	NRIS	ERIS	NRIS	ERIS
BLACKBRANCH TO GI-2019-029P 138 kV	55	69	59	74
BLACKBRANCH TO CENT HARDIN 138 kV	99	NA	NA	NA
HARDINSBURG TO N.HARD 138 kV	56	59	56	59
ETOWN KU 69.000 TO KARGLE 69 kV	60	84	67	92
CENT HARDIN TO KARGLE 69 kV	46	69	53	76
Overall MW Limit	**46**	**59**	**53**	**59**

6.3.3 Distribution Facilities: (Total Estimated Cost $0)

No distribution facility upgrades have been identified

Appendix A: Powerflow Model Documentation

Table A-1
Area 363 Generation Modeling in the Pre-TSR GI-2019-029-ERIS Models

Bus Number	Bus Name	Id	2022S Pre		2030S Pre	
			Pgen	Pmax	Pgen	Pmax
324002	1BROWN 3 24.000	3	459	459	459	459
324003	1BROWN 5 13.800	5	0	131	0	131
324004	1BROWN 6 18.000	6	106	155	106	155
324005	1BROWN 7 18.000	7	0	154	0	154
324006	1BROWN 8 13.800	8	0	122	0	122
324007	1BROWN 9 13.800	9	0	122	0	122
324008	1BROWN 10 13.800	10	0	122	0	122
324009	1BROWN 11 13.800	11	0	122	0	122
324014	1DIX DAM 1 13.200	1	11	11	11	11
324015	1DIX DAM 2 13.200	2	11	11	11	11
324016	1DIX DAM 3 13.200	3	11	11	11	11
324017	1GHENT 1 18.000	1	526	526	526	526
324018	1GHENT 2 22.000	2	530	530	530	530
324019	1GHENT 3 22.000	3	538	538	538	538
324020	1GHENT 4 22.000	4	538	538	538	538
324023	1HAEFLING 13.800	1	0	13	0	13
324023	1HAEFLING 13.800	2	0	13	0	13
324024	1MILL CRK 1 22.000	1	333	333	333	333
324025	1MILL CRK 2 22.000	2	336	336	336	336
324026	1MILL CRK 3 22.000	3	425	425	425	425
324027	1MILL CRK 4 22.000	4	526	526	526	526
324031	1PADDY RN 1316.000	13	0	152	0	152
324034	1TRIM CO 1 22.000	1	530	530	530	530
324035	1TRIM CO 2 24.000	2	781	781	781	781
324036	1TRIM CO 5 18.000	5	160	160	160	160
324037	1TRIM CO 6 18.000	6	171	171	171	171
324038	1TRIM CO 7 18.000	7	81	163	96	163
324039	1TRIM CO 8 18.000	8	81	160	81	160
324040	1TRIM CO 9 18.000	9	81	166	81	166
324041	1TRIM CO 10 18.000	10	83	164	81	164
324043	1ZORN 13.800	1	0	14	0	14
324044	1BLUEGRASS 118.000	1	166	166	166	166
324045	1BLUEGRASS 218.000	2	166	166	166	166
324046	1BLUEGRASS 318.000	3	166	166	166	166
324052	1LOCK 7 2.4000	1	2	2	2	2
324234	1OHIO FALL 114.000	1	9	9	9	9
324234	1OHIO FALL 114.000	2	9	9	9	9
324234	1OHIO FALL 114.000	3	9	9	9	9

Bus Number	Bus Name	Id	2022S Pre		2030S Pre	
			Pgen	Pmax	Pgen	Pmax
324234	1OHIO FALL 114.000	4	9	9	9	9
324235	1OHIO FALL 214.000	5	9	9	9	9
324235	1OHIO FALL 214.000	6	9	9	9	9
324235	1OHIO FALL 214.000	7	9	9	9	9
324235	1OHIO FALL 214.000	8	9	9	9	9
324677	2PARIS 12 69.000	1	0	11	11	11
324697	1KMPA PAD2 13.800	2	43	54	20	54
324933	1KMPA PAD1 13.800	1	43	54	20	54
325012	1BROWN SOLAR13.200	S1	8	8	8	8
325029	G2017-02 GEN0.6450	1	0	86	69	86
325030	G2017-03 GEN0.5750	1	29	35	29	35
325036	G2017-06 GEN0.6300	1	82	100	82	100
325093	1CANERUN7CT118.000	71	232	232	232	232
325094	1CANERUN7CT218.000	72	232	232	232	232
325095	1CANERUN7ST 18.000	7S	241	241	241	241
326514	1PADDY RN 1114.000	11	0	12	0	12
326515	1PADDY RN 1214.000	12	0	23	0	23
326541	2EKPC OFFICE69.000	P1	7	9	7	9
911005	GI2019-004GS0.6450	1	0	264	211	264
911008	GI2019-004GB0.6450	2	0	65	-6	65
990105	GI2019-003GS0.6450	1	0	163	130	163
990108	GI2019-003GB0.6450	2	0	38	-6	38
991044	2019-GI002 G0.5500	1	0	125	84	125
991160	2019-GI001 G0.6600	1	0	112	89	112
999100	2019-GI008 G0.6600	1	81	110	81	110
999104	2019-GI015 G0.7000	1	81	104	81	104
999119	2019-GI020G 0.7000	1	69	104	69	104
999139	2019-GI023 G0.7000	1	121	164	121	164
999144	2019-GI025G 0.6000	1	0	100	80	100
999154	2019-GI028G 0.6300	1	0	154	122	154

Table A-2
Area 363 Generation Modeling in the Post-TSR GI-2019-029-ERIS Models

Bus Number	Bus Name	Id	2022S Post		2030S Post	
			Pgen	Pmax	Pgen	Pmax
324002	1BROWN 3 24.000	3	459	459	459	459
324003	1BROWN 5 13.800	5	0	131	0	131
324004	1BROWN 6 18.000	6	106	155	106	155
324005	1BROWN 7 18.000	7	0	154	0	154
324006	1BROWN 8 13.800	8	0	122	0	122
324007	1BROWN 9 13.800	9	0	122	0	122
324008	1BROWN 10 13.800	10	0	122	0	122
324009	1BROWN 11 13.800	11	0	122	0	122
324014	1DIX DAM 1 13.200	1	11	11	11	11
324015	1DIX DAM 2 13.200	2	11	11	11	11
324016	1DIX DAM 3 13.200	3	11	11	11	11
324017	1GHENT 1 18.000	1	526	526	526	526
324018	1GHENT 2 22.000	2	530	530	530	530
324019	1GHENT 3 22.000	3	538	538	538	538
324020	1GHENT 4 22.000	4	538	538	538	538
324023	1HAEFLING 13.800	1	0	13	0	13
324023	1HAEFLING 13.800	2	0	13	0	13
324024	1MILL CRK 1 22.000	1	333	333	333	333
324025	1MILL CRK 2 22.000	2	336	336	336	336
324026	1MILL CRK 3 22.000	3	425	425	425	425
324027	1MILL CRK 4 22.000	4	526	526	526	526
324031	1PADDY RN 1316.000	13	0	152	0	152
324034	1TRIM CO 1 22.000	1	530	530	530	530
324035	1TRIM CO 2 24.000	2	781	781	781	781
324036	1TRIM CO 5 18.000	5	160	160	160	160
324037	1TRIM CO 6 18.000	6	171	171	171	171
324038	1TRIM CO 7 18.000	7	82	163	96	163
324039	1TRIM CO 8 18.000	8	81	160	81	160
324040	1TRIM CO 9 18.000	9	81	166	81	166
324041	1TRIM CO 10 18.000	10	81	164	81	164
324043	1ZORN 13.800	1	0	14	0	14
324044	1BLUEGRASS 118.000	1	166	166	166	166
324045	1BLUEGRASS 218.000	2	166	166	166	166
324046	1BLUEGRASS 318.000	3	166	166	166	166
324052	1LOCK 7 2.4000	1	2	2	2	2
324234	1OHIO FALL 114.000	1	9	9	9	9
324234	1OHIO FALL 114.000	2	9	9	9	9
324234	1OHIO FALL 114.000	3	9	9	9	9
324234	1OHIO FALL 114.000	4	9	9	9	9

Bus Number	Bus Name	Id	2022S Post		2030S Post	
			Pgen	Pmax	Pgen	Pmax
324235	1OHIO FALL 214.000	5	9	9	9	9
324235	1OHIO FALL 214.000	6	9	9	9	9
324235	1OHIO FALL 214.000	7	9	9	9	9
324235	1OHIO FALL 214.000	8	9	9	9	9
324677	2PARIS 12 69.000	1	0	11	11	11
324697	1KMPA PAD2 13.800	2	43	54	20	54
324933	1KMPA PAD1 13.800	1	43	54	20	54
325012	1BROWN SOLAR13.200	S1	8	8	8	8
325029	G2017-02 GEN0.6450	1	0	86	69	86
325030	G2017-03 GEN0.5750	1	29	35	29	35
325036	G2017-06 GEN0.6300	1	82	100	82	100
325093	1CANERUN7CT118.000	71	232	232	232	232
325094	1CANERUN7CT218.000	72	232	232	232	232
325095	1CANERUN7ST 18.000	7S	241	241	241	241
326514	1PADDY RN 1114.000	11	0	12	0	12
326515	1PADDY RN 1214.000	12	0	23	0	23
326541	2EKPC OFFICE69.000	P1	7	9	7	9
911005	GI2019-004GS0.6450	1	0	264	211	264
911008	GI2019-004GB0.6450	2	0	65	-6	65
990105	GI2019-003GS0.6450	1	0	163	130	163
990108	GI2019-003GB0.6450	2	0	38	-6	38
991044	2019-GI002 G0.5500	1	0	125	84	125
991160	2019-GI001 G0.6600	1	0	112	89	112
999100	2019-GI008 G0.6600	1	81	110	81	110
999104	2019-GI015 G0.7000	1	81	104	81	104
999119	2019-GI020G 0.7000	1	69	104	69	104
999129	GI-2019-029S0.5500	1	101	108	101	108
999139	2019-GI023 G0.7000	1	121	164	121	164
999144	2019-GI025G 0.6000	1	0	100	80	100
999154	2019-GI028G 0.6300	1	0	154	122	154

Table A-3
Area 363 Generation Modeling in the Pre-TSR GI-2019-029-NRIS Models

Bus Number	Bus Name	Id	2022S Pre		2030S Pre	
			Pgen	Pmax	Pgen	Pmax
324002	1BROWN 3 24.000	3	439	459	183	459
324003	1BROWN 5 13.800	5	0	131	0	131
324004	1BROWN 6 18.000	6	0	155	0	155
324005	1BROWN 7 18.000	7	0	154	0	154
324006	1BROWN 8 13.800	8	0	122	0	122
324007	1BROWN 9 13.800	9	0	122	0	122
324008	1BROWN 10 13.800	10	0	122	0	122
324009	1BROWN 11 13.800	11	0	122	0	122
324014	1DIX DAM 1 13.200	1	11	11	11	11
324015	1DIX DAM 2 13.200	2	11	11	11	11
324016	1DIX DAM 3 13.200	3	11	11	11	11
324017	1GHENT 1 18.000	1	526	526	526	526
324018	1GHENT 2 22.000	2	530	530	530	530
324019	1GHENT 3 22.000	3	538	538	367	538
324020	1GHENT 4 22.000	4	538	538	538	538
324023	1HAEFLING 13.800	1	0	13	0	13
324023	1HAEFLING 13.800	2	0	13	0	13
324024	1MILL CRK 1 22.000	1	333	333	333	333
324025	1MILL CRK 2 22.000	2	336	336	336	336
324026	1MILL CRK 3 22.000	3	425	425	425	425
324027	1MILL CRK 4 22.000	4	526	526	526	526
324031	1PADDY RN 1316.000	13	0	152	0	152
324034	1TRIM CO 1 22.000	1	530	530	530	530
324035	1TRIM CO 2 24.000	2	781	781	781	781
324036	1TRIM CO 5 18.000	5	81	160	0	160
324037	1TRIM CO 6 18.000	6	81	171	0	171
324038	1TRIM CO 7 18.000	7	81	163	0	163
324039	1TRIM CO 8 18.000	8	81	160	0	160
324040	1TRIM CO 9 18.000	9	0	166	0	166
324041	1TRIM CO 10 18.000	10	0	164	0	164
324043	1ZORN 13.800	1	0	14	0	14
324044	1BLUEGRASS 118.000	1	166	166	166	166
324045	1BLUEGRASS 218.000	2	166	166	166	166
324046	1BLUEGRASS 318.000	3	166	166	166	166
324052	1LOCK 7 2.4000	1	2	2	2	2
324234	1OHIO FALL 114.000	1	9	9	9	9
324234	1OHIO FALL 114.000	2	9	9	9	9
324234	1OHIO FALL 114.000	3	9	9	9	9
324234	1OHIO FALL 114.000	4	9	9	9	9

Bus Number	Bus Name	Id	2022S Pre		2030S Pre	
			Pgen	Pmax	Pgen	Pmax
324235	1OHIO FALL 214.000	5	9	9	9	9
324235	1OHIO FALL 214.000	6	9	9	9	9
324235	1OHIO FALL 214.000	7	9	9	9	9
324235	1OHIO FALL 214.000	8	9	9	9	9
324677	2PARIS 12 69.000	1	0	11	11	11
324697	1KMPA PAD2 13.800	2	43	54	20	54
324933	1KMPA PAD1 13.800	1	43	54	20	54
325012	1BROWN SOLAR13.200	S1	8	8	8	8
325029	G2017-02 GEN0.6450	1	0	86	69	86
325030	G2017-03 GEN0.5750	1	29	35	29	35
325036	G2017-06 GEN0.6300	1	82	100	82	100
325093	1CANERUN7CT118.000	71	232	232	232	232
325094	1CANERUN7CT218.000	72	232	232	232	232
325095	1CANERUN7ST 18.000	7S	241	241	241	241
326514	1PADDY RN 1114.000	11	0	12	0	12
326515	1PADDY RN 1214.000	12	0	23	0	23
326541	2EKPC OFFICE69.000	P1	7	9	7	9
911005	GI2019-004GS0.6450	1	0	264	211	264
911008	GI2019-004GB0.6450	2	0	65	-6	65
990105	GI2019-003GS0.6450	1	0	163	130	163
990108	GI2019-003GB0.6450	2	0	38	-6	38
991044	2019-GI002 G0.5500	1	0	125	84	125
991160	2019-GI001 G0.6600	1	0	112	89	112
999100	2019-GI008 G0.6600	1	81	110	81	110
999104	2019-GI015 G0.7000	1	81	104	81	104
999119	2019-GI020G 0.7000	1	69	104	69	104
999139	2019-GI023 G0.7000	1	121	164	121	164
999144	2019-GI025G 0.6000	1	0	100	80	100
999154	2019-GI028G 0.6300	1	0	154	122	154

Table A-4
Area 363 Generation Modeling in the Post-TSR GI-2019-029-NRIS Models

Bus Number	Bus Name	Id	2022S Post		2030S Post	
			Pgen	Pmax	Pgen	Pmax
324002	1BROWN 3 24.000	3	339	459	183	459
324003	1BROWN 5 13.800	5	0	131	0	131
324004	1BROWN 6 18.000	6	0	155	0	155
324005	1BROWN 7 18.000	7	0	154	0	154
324006	1BROWN 8 13.800	8	0	122	0	122
324007	1BROWN 9 13.800	9	0	122	0	122
324008	1BROWN 10 13.800	10	0	122	0	122
324009	1BROWN 11 13.800	11	0	122	0	122
324014	1DIX DAM 1 13.200	1	11	11	11	11
324015	1DIX DAM 2 13.200	2	11	11	11	11
324016	1DIX DAM 3 13.200	3	11	11	11	11
324017	1GHENT 1 18.000	1	526	526	526	526
324018	1GHENT 2 22.000	2	530	530	530	530
324019	1GHENT 3 22.000	3	538	538	265	538
324020	1GHENT 4 22.000	4	538	538	538	538
324023	1HAEFLING 13.800	1	0	13	0	13
324023	1HAEFLING 13.800	2	0	13	0	13
324024	1MILL CRK 1 22.000	1	333	333	333	333
324025	1MILL CRK 2 22.000	2	336	336	336	336
324026	1MILL CRK 3 22.000	3	425	425	425	425
324027	1MILL CRK 4 22.000	4	526	526	526	526
324031	1PADDY RN 1316.000	13	0	152	0	152
324034	1TRIM CO 1 22.000	1	530	530	530	530
324035	1TRIM CO 2 24.000	2	781	781	781	781
324036	1TRIM CO 5 18.000	5	81	160	0	160
324037	1TRIM CO 6 18.000	6	81	171	0	171
324038	1TRIM CO 7 18.000	7	81	163	0	163
324039	1TRIM CO 8 18.000	8	81	160	0	160
324040	1TRIM CO 9 18.000	9	0	166	0	166
324041	1TRIM CO 10 18.000	10	0	164	0	164
324043	1ZORN 13.800	1	0	14	0	14
324044	1BLUEGRASS 118.000	1	166	166	166	166
324045	1BLUEGRASS 218.000	2	166	166	166	166
324046	1BLUEGRASS 318.000	3	166	166	166	166
324052	1LOCK 7 2.4000	1	2	2	2	2
324234	1OHIO FALL 114.000	1	9	9	9	9
324234	1OHIO FALL 114.000	2	9	9	9	9
324234	1OHIO FALL 114.000	3	9	9	9	9
324234	1OHIO FALL 114.000	4	9	9	9	9

Bus Number	Bus Name	Id	2022S Post		2030S Post	
			Pgen	Pmax	Pgen	Pmax
324235	1OHIO FALL 214.000	5	9	9	9	9
324235	1OHIO FALL 214.000	6	9	9	9	9
324235	1OHIO FALL 214.000	7	9	9	9	9
324235	1OHIO FALL 214.000	8	9	9	9	9
324677	2PARIS 12 69.000	1	0	11	11	11
324697	1KMPA PAD2 13.800	2	43	54	20	54
324933	1KMPA PAD1 13.800	1	43	54	20	54
325012	1BROWN SOLAR13.200	S1	8	8	8	8
325029	G2017-02 GEN0.6450	1	0	86	69	86
325030	G2017-03 GEN0.5750	1	29	35	29	35
325036	G2017-06 GEN0.6300	1	82	100	82	100
325093	1CANERUN7CT118.000	71	232	232	232	232
325094	1CANERUN7CT218.000	72	232	232	232	232
325095	1CANERUN7ST 18.000	7S	241	241	241	241
326514	1PADDY RN 1114.000	11	0	12	0	12
326515	1PADDY RN 1214.000	12	0	23	0	23
326541	2EKPC OFFICE69.000	P1	7	9	7	9
911005	GI2019-004GS0.6450	1	0	264	211	264
911008	GI2019-004GB0.6450	2	0	65	-6	65
990105	GI2019-003GS0.6450	1	0	163	130	163
990108	GI2019-003GB0.6450	2	0	38	-6	38
991044	2019-GI002 G0.5500	1	0	125	84	125
991160	2019-GI001 G0.6600	1	0	112	89	112
999100	2019-GI008 G0.6600	1	81	110	81	110
999104	2019-GI015 G0.7000	1	81	104	81	104
999119	2019-GI020G 0.7000	1	69	104	69	104
999129	GI-2019-029S0.5500	1	101	108	101	108
999139	2019-GI023 G0.7000	1	121	164	121	164
999144	2019-GI025G 0.6000	1	0	100	80	100
999154	2019-GI028G 0.6300	1	0	154	122	154

Appendix B: Divergent Contingencies

There were numerous contingency and dispatch conditions for which a convergent solution could not be obtained with switched shunts enabled. For these contingencies, a solution was attempted with switched shunts locked. If constraints were found to exist for any of these contingencies using the locked switched shunts solution method, further analysis was performed. For those contingencies and dispatches, the solution methods are as stated in Table B-1.

Table B-1
Solution Techniques Applied to Solve the Remaining Divergent Contingencies and Dispatches

Year/Season	Dispatches	Contingencies	Solution
2030S ERIS/NRIS	Many	Many	Increased the Area 627 ALTW Sched Voltage of the Generator on bus 627034 (J407 G1 0.7000) from 1.0190 to 1.020 pu

Appendix C: Dispatch Scenarios

Table C-1
Generation Dispatch Scenarios Studied

Dispatch Code	Description
S_CR7_MERIT_MISO	Start up of Cane Run 7, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL).
S_CR7_MERIT_TVA	Start up of Cane Run 7, replace with LGEE units greater than 50 MW in merit order and import from TVA.
S_CR7_MERIT_PJM	Start up of Cane Run 7, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP).
S_GH1_MERIT_MISO	Start up of Ghent 1, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL).
S_GH1_MERIT_TVA	Start up of Ghent 1, replace with LGEE units greater than 50 MW in merit order and import from TVA.
S_GH1_MERIT_PJM	Start up of Ghent 1, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP).
S_GH3_MERIT_MISO	Start up of Ghent 3, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL).
S_GH3_MERIT_TVA	Start up of Ghent 3, replace with LGEE units greater than 50 MW in merit order and import from TVA.
S_GH3_MERIT_PJM	Start up of Ghent 3, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP).
S_MC4_MERIT_MISO	Start up of Mill Creek 4, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL).
S_MC4_MERIT_TVA	Start up of Mill Creek 4, replace with LGEE units greater than 50 MW in merit order and import from TVA.
S_MC4_MERIT_PJM	Start up of Mill Creek 4, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP).
BR3_MERIT_MISO	Outage of Brown 3, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL).
BR3_MERIT_TVA	Outage of Brown 3, replace with LGEE units greater than 50 MW in merit order and import from TVA.
BR3_MERIT_PJM	Outage of Brown 3, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP).

Dispatch Code	Description
BR7_MERIT_MISO	Outage of Brown 7, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL).
BR7_MERIT_TVA	Outage of Brown 7, replace with LGEE units greater than 50 MW in merit order and import from TVA.
BR7_MERIT_PJM	Outage of Brown 7, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP).
CR7_MERIT_MISO	Outage of Cane Run 7, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL).
CR7_MERIT_TVA	Outage of Cane Run 7, replace with LGEE units greater than 50 MW in merit order and import from TVA.
CR7_MERIT_PJM	Outage of Cane Run 7, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP).
GH1_MERIT_MISO	Outage of Ghent 1, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL).
GH1_MERIT_TVA	Outage of Ghent 1, replace with LGEE units greater than 50 MW in merit order and import from TVA.
GH1_MERIT_PJM	Outage of Ghent 1, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP).
GH3_MERIT_MISO	Outage of Ghent 3, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL).
GH3_MERIT_TVA	Outage of Ghent 3, replace with LGEE units greater than 50 MW in merit order and import from TVA.
GH3_MERIT_PJM	Outage of Ghent 3, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP).
MC4_MERIT_MISO	Outage of Mill Creek 4, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL).
MC4_MERIT_TVA	Outage of Mill Creek 4, replace with LGEE units greater than 50 MW in merit order and import from TVA.
MC4_MERIT_PJM	Outage of Mill Creek 4, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP).
PR13_MERIT_MISO	Outage of Paddy’s Run 13, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL).
PR13_MERIT_TVA	Outage of Paddy’s Run 13, replace with LGEE units greater than 50 MW in merit order and import from TVA.

Dispatch Code	Description
PR13_MERIT_PJM	Outage of Paddy's Run 13, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP).
TC2_MERIT_MISO	Outage of Trimble County 2, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL).
TC2_MERIT_TVA	Outage of Trimble County 2, replace with LGEE units greater than 50 MW in merit order and import from TVA.
TC2_MERIT_PJM	Outage of Trimble County 2, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP).
OHF_MERIT_MISO	Outage of Ohio Falls Hydro 1-4, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL).
OHF_MERIT_TVA	Outage of Ohio Falls Hydro 1-4, replace with LGEE units greater than 50 MW in merit order and import from TVA.
OHF_MERIT_PJM	Outage of Ohio Falls Hydro 1-4, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP).
ASHW_MISO	Outage of Ashwood Solar, replace with import from MISO (XEL).
ASHW_TVA	Outage of Ashwood Solar, replace with import from TVA.
ASHW_PJM	Outage of Ashwood Solar, replace with import from PJM (AP).
s_GH1_3_MERIT_PJM_2U	Two unit outage - Start up of Ghent 1 and an outage of Ghent 3, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
s_GH1_3_MERIT_MISO_2U	Two unit outage - Start up of Ghent 1 and an outage of Ghent 3, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
s_GH1_3_MERIT_TVA_2U	Two unit outage - Start up of Ghent 1 and an outage of Ghent 3, replace with LGEE units greater than 50 MW in merit order and import from TVA
s_GH3_1_MERIT_PJM_2U	Two unit outage - Start up of Ghent 3 and an outage of Ghent 1, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
s_GH3_1_MERIT_MISO_2U	Two unit outage - Start up of Ghent 3 and an outage of Ghent 1, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
s_GH3_1_MERIT_TVA_2U	Two unit outage - Start up of Ghent 3 and an outage of Ghent 1, replace with LGEE units greater than 50 MW in merit order and import from TVA
s_GH3_4_MERIT_PJM_2U	Two unit outage - Start up of Ghent 3 and an outage of Ghent 4, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)

Dispatch Code	Description
s_GH3_4_MERIT_MISO_2U	Two unit outage - Start up of Ghent 3 and an outage of Ghent 4, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
s_GH3_4_MERIT_TVA_2U	Two unit outage - Start up of Ghent 3 and an outage of Ghent 4, replace with LGEE units greater than 50 MW in merit order and import from TVA
s_GH3_BR3_MERIT_PJM_2U	Two unit outage - Start up of Ghent 3 and an outage of Brown 3, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
s_GH3_BR3_MERIT_MISO_2U	Two unit outage - Start up of Ghent 3 and an outage of Brown 3, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
s_GH3_BR3_MERIT_TVA_2U	Two unit outage - Start up of Ghent 3 and an outage of Brown 3, replace with LGEE units greater than 50 MW in merit order and import from TVA
s_MC4_MC3_MERIT_PJM_2U	Two unit outage - Start up of Mill Creek 4 and an outage of Mill Creek 3, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
s_MC4_MC3_MERIT_MISO_2U	Two unit outage - Start up of Mill Creek 4 and an outage of Mill Creek 3, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
s_MC4_MC3_MERIT_TVA_2U	Two unit outage - Start up of Mill Creek 4 and an outage of Mill Creek 3, replace with LGEE units greater than 50 MW in merit order and import from TVA
s_MC4_TC2_MERIT_PJM_2U	Two unit outage - Start up of Mill Creek 4 and an outage of Trimble Co 2, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
s_MC4_TC2_MERIT_MISO_2U	Two unit outage - Start up of Mill Creek 4 and an outage of Trimble Co 2, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
s_MC4_TC2_MERIT_TVA_2U	Two unit outage - Start up of Mill Creek 4 and an outage of Trimble Co 2, replace with LGEE units greater than 50 MW in merit order and import from TVA
s_CR7_PR_MERIT_PJM_2U	Two unit outage - Start up of Cane Run 7 and an outage of Paddy's Run 13, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
s_CR7_PR_MERIT_MISO_2U	Two unit outage - Start up of Cane Run 7 and an outage of Paddy's Run 13, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)

Dispatch Code	Description
s_CR7_PR_MERIT_TVA_2U	Two unit outage - Start up of Cane Run 7 and an outage of Paddy's Run 13, replace with LGEE units greater than 50 MW in merit order and import from TVA
s_CR7_MC4_MERIT_PJM_2U	Two unit outage - Start up of Cane Run 7 and an outage of Mill Creek 4, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
s_CR7_MC4_MERIT_TVA_2U	Two unit outage - Start up of Cane Run 7 and an outage of Mill Creek 4, replace with LGEE units greater than 50 MW in merit order and import from TVA
s_CR7_MC4_MERIT_MISO_2U	Two unit outage - Start up of Cane Run 7 and an outage of Mill Creek 4, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
s_MC4_CR7_MERIT_PJM_2U	Two unit outage - Start up of Mill Creek 4 and an outage of Cane Run 7, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
s_MC4_CR7_MERIT_TVA_2U	Two unit outage - Start up of Mill Creek 4 and an outage of Cane Run 7, replace with LGEE units greater than 50 MW in merit order and import from TVA
s_MC4_CR7_MERIT_MISO_2U	Two unit outage - Start up of Mill Creek 4 and an outage of Cane Run 7, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
s_GH1_BR3_MERIT_PJM_2U	Two unit outage - Start up of Ghent 1 and an outage of Brown 3, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
s_GH1_BR3_MERIT_MISO_2U	Two unit outage - Start up of Ghent 1 and an outage of Brown 3, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
s_GH1_BR3_MERIT_TVA_2U	Two unit outage - Start up of Ghent 1 and an outage of Brown 3, replace with LGEE units greater than 50 MW in merit order and import from TVA
s_GH3_TC2_MERIT_PJM_2U	Two unit outage - Start up of Ghent 3 and an outage of Trimble Co 2, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
s_GH3_TC2_MERIT_MISO_2U	Two unit outage - Start up of Ghent 3 and an outage of Trimble Co 2, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
s_GH3_TC2_MERIT_TVA_2U	Two unit outage - Start up of Ghent 3 and an outage of Trimble Co 2, replace with LGEE units greater than 50 MW in merit order and import from TVA

Dispatch Code	Description
s_MC4_MERIT_PJM_BG12_PJM_2U	Two unit outage - Start up of Mill Creek 4,replace with LGEE units greater than 50 MW in merit order and import from PJM (AP) and an outage of Bluegrass 1 & 2, import from PJM (AP)
s_MC4_MERIT_MISO_BG12_PJM_2U	Two unit outage - Start up of Mill Creek 4,replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL) and an outage of Bluegrass 1 & 2, import from PJM (AP)
s_MC4_MERIT_TVA_BG12_PJM_2U	Two unit outage - Start up of Mill Creek 4,replace with LGEE units greater than 50 MW in merit order and import from TVA and an outage of Bluegrass 1 & 2, import from PJM (AP)
s_CR7_MERIT_PJM_BG12_PJM_2U	Two unit outage - Start up of Cane Run 7,replace with LGEE units greater than 50 MW in merit order and import from PJM (AP) and an outage of Bluegrass 1 & 2, import from PJM (AP)
s_CR7_MERIT_MISO_BG12_PJM_2U	Two unit outage - Start up of Cane Run 7,replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL) and an outage of Bluegrass 1 & 2, import from PJM (AP)
s_CR7_MERIT_TVA_BG12_PJM_2U	Two unit outage - Start up of Cane Run 7,replace with LGEE units greater than 50 MW in merit order and import from TVA and an outage of Bluegrass 1 & 2, import from PJM (AP)
CR7_PR_MERIT_MISO_2U	Two unit outage - Cane Run 7 and Paddy’s Run 13, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
CR7_PR_MERIT_TVA_2U	Two unit outage - Cane Run 7 and Paddys Run 13, replace with LGEE units greater than 50 MW in merit order and import from TVA
CR7_PR_MERIT_PJM_2U	Two unit outage - Cane Run 7 and Paddy’s Run 13, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
CR7_BR3_MERIT_MISO_2U	Two unit outage - Cane Run 7 and Brown 3, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
CR7_BR3_MERIT_TVA_2U	Two unit outage - Cane Run 7 and Brown 3, replace with LGEE units greater than 50 MW in merit order and import from TVA
CR7_BR3_MERIT_PJM_2U	Two unit outage - Cane Run 7 and Brown 3, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
Gh1_3_MERIT_MISO_2U	Two unit outage - Ghent 1 and Ghent 3, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)

Dispatch Code	Description
Gh1_3_MERIT_TVA_2U	Two unit outage - Ghent 1 and Ghent 3, replace with LGEE units greater than 50 MW in merit order and import from TVA
Gh1_3_MERIT_PJM_2U	Two unit outage - Ghent 1 and Ghent 3, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
Gh4_3_MERIT_MISO_2U	Two unit outage - Ghent 3 and Ghent 4, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
Gh4_3_MERIT_TVA_2U	Two unit outage - Ghent 3 and Ghent 4, replace with LGEE units greater than 50 MW in merit order and import from TVA
Gh4_3_MERIT_PJM_2U	Two unit outage - Ghent 3 and Ghent 4, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
Br3_Gh3_MERIT_MISO_2U	Two unit outage - Brown 3 and Ghent 3, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
Br3_Gh3_MERIT_TVA_2U	Two unit outage - Brown 3 and Ghent 3, replace with LGEE units greater than 50 MW in merit order and import from TVA
Br3_Gh3_MERIT_PJM_2U	Two unit outage - Brown 3 and Ghent 3, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
Br3_Br6_MERIT_MISO_2U	Two unit outage - Brown 3 and Brown 6, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
Br3_Br6_MERIT_TVA_2U	Two unit outage - Brown 3 and Brown 6, replace with LGEE units greater than 50 MW in merit order and import from TVA
Br3_Br6_MERIT_PJM_2U	Two unit outage - Brown 3 and Brown 6, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
Br7_Br6_MERIT_MISO_2U	Two unit outage - Brown 7 and Brown 6, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
Br7_Br6_MERIT_TVA_2U	Two unit outage - Brown 7 and Brown 6, replace with LGEE units greater than 50 MW in merit order and import from TVA
Br7_Br6_MERIT_PJM_2U	Two unit outage - Brown 7 and Brown 6, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
MC4_MC3_MERIT_MISO_2U	Two unit outage - Mill Creek 4 and Mill Creek 3, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
MC4_MC3_MERIT_TVA_2U	Two unit outage - Mill Creek 4 and Mill Creek 3, replace with LGEE units greater than 50 MW in merit order and import from TVA

Dispatch Code	Description
MC4_MC3_MERIT_PJM_2U	Two unit outage - Mill Creek 4 and Mill Creek 3, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
TC2_TC1_MERIT_MISO_2U	Two unit outage - Trimble Co 2 and Trimble Co 1, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
TC2_TC1_MERIT_TVA_2U	Two unit outage - Trimble Co 2 and Trimble Co 1, replace with LGEE units greater than 50 MW in merit order and import from TVA
TC2_TC1_MERIT_PJM_2U	Two unit outage - Trimble Co 2 and Trimble Co 1, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
CR7_TC2_MERIT_MISO_2U	Two unit outage - Cane Run 7 and Trimble Co 2, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
CR7_TC2_MERIT_TVA_2U	Two unit outage - Cane Run 7 and Trimble Co 2, replace with LGEE units greater than 50 MW in merit order and import from TVA
CR7_TC2_MERIT_PJM_2U	Two unit outage - Cane Run 7 and Trimble Co 2, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
CR7_MC4_MERIT_MISO_2U	Two unit outage - Cane Run 7 and Mill Creek 4, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
CR7_MC4_MERIT_TVA_2U	Two unit outage - Cane Run 7 and Mill Creek 4, replace with LGEE units greater than 50 MW in merit order and import from TVA
CR7_MC4_MERIT_PJM_2U	Two unit outage - Cane Run 7 and Mill Creek 4, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
MC4_TC2_MERIT_MISO_2U	Two unit outage - Trimble Co 2 and Mill Creek 4, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
MC4_TC2_MERIT_TVA_2U	Two unit outage - Trimble Co 2 and Mill Creek 4, replace with LGEE units greater than 50 MW in merit order and import from PJM
MC4_TC2_MERIT_PJM_2U	Two unit outage - Trimble Co 2 and Mill Creek 4, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
Br3_Gh1_MERIT_MISO_2U	Two unit outage - Brown 3 and Ghent 1, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
Br3_Gh1_MERIT_TVA_2U	Two unit outage - Brown 3 and Ghent 1, replace with LGEE units greater than 50 MW in merit order and import from TVA
Br3_Gh1_MERIT_PJM_2U	Two unit outage - Brown 3 and Ghent 1, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)

Dispatch Code	Description
TC2_GH3_MERIT_MISO_2U	Two unit outage - Trimble Co 2 and Ghent 3, replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL)
TC2_GH3_MERIT_TVA_2U	Two unit outage - Trimble Co 2 and Ghent 3, replace with LGEE units greater than 50 MW in merit order and import from TVA
TC2_GH3_MERIT_PJM_2U	Two unit outage - Trimble Co 2 and Ghent 3, replace with LGEE units greater than 50 MW in merit order and import from PJM (AP)
TC2_MERIT_MISO_BG12_PJM_2U	Two unit outage - Trimble Co 2,replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL) and an outage of Bluegrass 1 & 2, import from PJM (AP)
TC2_MERIT_TVA_BG12_PJM_2U	Two unit outage - Trimble Co 2,replace with LGEE units greater than 50 MW in merit order and import from TVA and an outage of Bluegrass 1 & 2, import from PJM (AP)
TC2_MERIT_PJM_BG12_PJM_2U	Two unit outage - Trimble Co 2,replace with LGEE units greater than 50 MW in merit order and import from PJM (AP) and an outage of Bluegrass 1 & 2, import from PJM (AP)
MC4_MERIT_MISO_BG12_PJM_2U	Two unit outage - Mill Creek 4,replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL) and an outage of Bluegrass 1 & 2, import from PJM (AP)
MC4_MERIT_TVA_BG12_PJM_2U	Two unit outage - Mill Creek 4,replace with LGEE units greater than 50 MW in merit order and import from TVA and an outage of Bluegrass 1 & 2, import from PJM (AP)
MC4_MERIT_PJM_BG12_PJM_2U	Two unit outage - Mill Creek 4,replace with LGEE units greater than 50 MW in merit order and import from PJM (AP) and an outage of Bluegrass 1 & 2, import from PJM (AP)
CR7_MERIT_MISO_BG12_PJM_2U	Two unit outage - Cane Run 7,replace with LGEE units greater than 50 MW in merit order and import from MISO (XEL) and an outage of Bluegrass 1 & 2, import from PJM (AP)
CR7_MERIT_TVA_BG12_PJM_2U	Two unit outage - Cane Run 7,replace with LGEE units greater than 50 MW in merit order and import from TVA and an outage of Bluegrass 1 & 2, import from PJM (AP)
CR7_MERIT_PJM_BG12_PJM_2U	Two unit outage - Cane Run 7,replace with LGEE units greater than 50 MW in merit order and import from PJM (AP) and an outage of Bluegrass 1 & 2, import from PJM (AP)
BG12_PJM	Outage Bluegrass units 1 & 2, replace with import from PJM (AP)

Dispatch Code	Description
MBG_NITS	Maximize Bluegrass units, reduce import from PJM (AP).
MBR_NITS	Maximize Brown and proportionally decrease generation at the remaining LG&E/KU affiliate generating plants
MCR_NITS	Maximize Cane Run units and proportionally decrease generation at the remaining LG&E/KU affiliate generating plants.
MDX_NITS	Maximize Dix Dam units and proportionally decrease generation at the remaining LG&E/KU affiliate generating plants.
MGH_NITS	Maximize Ghent units and proportionally decrease generation at the remaining LG&E/KU affiliate generating plants.
MHF_NITS	Maximize Haefling units and proportionally decrease generation at the remaining LG&E/KU affiliate generating plants.
MMC_NITS	Maximize Mill Creek units and proportionally decrease generation at the remaining LG&E/KU affiliate generating plants.
MOF_NITS	Maximize Ohio Falls units and proportionally decrease generation at the remaining LG&E/KU affiliate generating plants.
MPD_NITS	Maximize Paducah Power units, reduce import from MISO (XEL).
MPR_NITS	Maximize Paddy's Run units and proportionally decrease generation at the remaining LG&E/KU affiliate generating plants.
MPS_NITS	Maximize Paris units, reduce import from MISO (XEL).
MTC_NITS	Maximize Trimble Co Plant and proportionally decrease generation at the remaining LG&E/KU affiliate generating plants.
MZR_NITS	Maximize Zorn and proportionally decrease generation at the remaining LG&E/KU affiliate generating plants.
PP12_MISO	Outage Paducah Power units and replace with import from MISO (XEL)
PP12_PJM	Outage Paducah Power units and replace with import from PJM (AP)
PP12_TVA	Outage Paducah Power units and replace with import from TVA
BG12_BG3_PJM_2U	Two unit outage - Bluegrass 1&2 and Bluegrass 3, replace with import from PJM (AP)
BULLRUN1_S	Outage of TVA's Bull Run F 1 L, replacing with units in TVA and import from SOCO
CANNELTON_W	Outage of SIGE's Cannelton Hydro units, replacing with import from MISO (XEL)

Dispatch Code	Description
CLIFTY_N	Outage of OVEC's Clifty 7, replacing with import from PJM (AP)
CPR2_N	Outage of EKPC's Cooper 2, replacing with import from PJM (AP)
CRG2H_N	Outage of AEP's Clinch River 2 (H&L), replacing with import from PJM (AP)
EBND2_N	Outage of DEO&K's East Bend 2, replacing with import from PJM (AP)
GALL2_W	Outage of DEI's Gallagher 2, replacing with import from MISO (XEL)
GALL4_W	Outage of DEI's Gallagher 4, replacing with import from MISO (XEL)
GALLATIN1_S	Outage of TVA's Gallatin 1, replacing with units in TVA and import from SOCO
GIB2_W	Outage of DEI's Gibson 2, replacing with import from MISO (XEL)
GREEN1_W	Outage of BREC's Green 1, replacing with import from MISO (XEL)
INDDRV_N	Outage of AEP's Industrial Drive, replacing with import from PJM (AP)
JKCT9_N	Outage of EKPC's JK Smith 9, replacing with import from PJM (AP)
JOPPA2_W	Outage of EEI's Joppa 2, replacing with import from MISO (XEL)
JOPPA4_W	Outage of EEI's Joppa 4, replacing with import from MISO (XEL)
JOPPAG45_W	Outage of EEI's Joppa G 4&5, replacing with import from MISO (XEL)
KILLEN_N	Outage of Dayton PL Killen 2, replacing with import from PJM (AP)
KYGER_N	Outage of OVEC's Kyger 6, replacing with import from PJM (AP)
LAUREL_N	Outage of EKPC's Laurel Lake, replacing with import from PJM (AP)
LAWBG1_N	Outage of AEP's Lawrenceburg 1A/B/C, replacing with import from PJM (AP)
MERMOM_W	Outage of HE's Merom 2, replacing with import from MISO (XEL)
MFRT8_N	Outage of DEO&K's Miami Fort 8, replacing with import from PJM (AP)
NORRIS1_S	Outage of TVA's Norris, replacing with units in TVA and import from SOCO
PARADISCT3S1_S	Outage of TVA's Paradise CT 3, replacing with units in TVA and import from SOCO
RKG2_N	Outage of AEP's Rockport 1, replacing with import from PJM (AP)
SEQ2_S	Outage of TVA's Sequoyah 2, replacing with units in TVA and import from SOCO
SHAWNEE2_S	Outage of TVA's Shawnee 2, replacing with units in TVA and import from SOCO

Dispatch Code	Description
SHAWNEE9_S	Outage of TVA's Shawnee 9, replacing with units in TVA and import from SOCO
SPLK1_N	Outage of EKPC's Spurlock 1, replacing with import from PJM (AP)
SPLK2_N	Outage of EKPC's Spurlock 2, replacing with import from PJM (AP)
STUART_N	Outage of Dayton P&L Stuart, replacing with import from PJM (AP)
VACITY_SE	Outage of AEP's Virginia City, replacing with import from PJM (DVP)
WBNP1_S	Outage of TVA's Watts Bar 1, replacing with units in TVA and import from SOCO
WILSON_W	Outage of BREC's Wilson, replacing with import from MISO (XEL)
WOLFCR1_S	Outage of TVA's Wolf Creek, replacing with units in TVA and import from SOCO
AMG2_N	Outage of AEP's John Amos #2, replacing with import from PJM (AP)
WTRG1S_N	Outage of AEP's Waterford 1S, replacing with import from PJM (AP)
V3-007_N	Outage of new PJM unit V3-007 1C, replacing with import from PJM (AP)
MFTGT1_N	Outage of DEO&K's Miami Fort GT1, replacing with import from PJM (AP)
Z1-079_N	Outage of new PJM unit Z1-079 CT & ST, replacing with import from PJM (AP)
AB1-169COP_N	Outage of new PJM unit ZAB1-169 C OP #1, replacing with import from PJM (AP)
JKCT1_N	Outage of EKPC's JK Smith 1, replacing with import from PJM (AP)
MADSN_W	Outage of DEI's Madison 1-8, replacing with import from MISO (XEL)
WHTLD_W	Outage of DEI's Wheatland #3 & #4, replacing with import from MISO (XEL)
CUL_G3_W	Outage of SIGE's FB Culley #3, replacing with import from MISO (XEL)
ABB_G2_W	Outage of SIGE's AB Brown #2, replacing with import from MISO (XEL)
PETERSBURG_W	Outage of IPL's Petersburg #4, replacing with import from MISO (XEL)
REID_W	Outage of BREC's Reid CT C, replacing with import from MISO (XEL)
SKILLMAN_W	Outage of BREC's Skillman #1, replacing with import from MISO (XEL)
SMITH_G_W	Outage of BREC's Smithland Hydro 1-3, replacing with import from MISO (XEL)

Dispatch Code	Description
MARION_W	Outage of SIPC's Marion Generation Unit 1, replacing with import from MISO (XEL)
CUMBRL_S	Outage of TVA's Cumberland Fossil 1HL U1 & U2, replacing with units in TVA and import from SOCO
SEQ1_S	Outage of TVA's Sequoyah 1, replacing with units in TVA and import from SOCO
DOUGLAS_S	Outage of TVA's Douglas Hydro #1 & #2, replacing with units in TVA and import from SOCO
J_SEVIER_S	Outage of TVA's John Sevier C3 & S4, replacing with units in TVA and import from SOCO
BARKLEY_S	Outage of TVA's Barkley Hydro #3 & #4, replacing with units in TVA and import from SOCO
CHEROKEE_S	Outage of TVA's Cherokee Hydro #1 & #2, replacing with units in TVA and import from SOCO
KY_HYDRO_S	Outage of TVA's Kentucky Hydro #4 & #5, replacing with units in TVA and import from SOCO
MARSHALL_S	Outage of TVA's Marshall Turbine 1-4, replacing with units in TVA and import from SOCO

Appendix D: Powerflow Model Detailed Analysis

Thermal Analysis Results

The LG&E and KU and Third party potential thermal constraints, impacted by the subject request are shown in Tables D-1, Table D-2, Table D-3 and Table D-4. These constraints were found for many dispatch/contingency combination in all ERIS and NRIS Analyses. Only the result with the highest post project loading for each contingency/year/service type are shown in Table D-1, Table D-2, Table D-3 and Table D-4.

Table D-1
GI 2019-029 LG&E and KU NRIS Thermal Constraints

Year/ Season	Dispatch	Facility	Rating	Pre Project		Post Project		DF	Contingency
				MVA	%	MVA	%		
2030S NRIS	mtc_nits	BLACKBRANCH TO GI-2019-029P 138 kV	208	163.0	78.4	243.4	117.0	80.4%	None
	wbnp1_s		265	214.3	80.9	291.7	110.1	77.4%	DAVIESS To HARDIN CO 345 kV
	Base Dispatch		265	202.3	0.8	280.1	105.7	77.8%	DAVIESS To HARDIN CO 345 kV : DAVIESS To SMITH 345 kV
			265	203.3	76.7	281.0	106.0	77.8%	DAVIESS To HARDIN CO 345 kV : DAVIESS To WILSON 345 kV
			265	202.3	76.3	280.1	105.7	77.8%	DAVIESS To SMITH 345 kV :DAVIESS To HARDIN CO 345 kV
			265	210.2	79.3	287.6	108.5	77.4%	HARDIN CO To DAVIESS 345 kV
2030S NRIS	mtc_nits	BLACKBRANCH TO CENT HARDIN 138 kV	227	148.5	65.4	227.04	100.02	78.5%	None
2030S NRIS	wilson_w	HARDINSBURG TO N.HARD 138 kV	191	142.0	74.3	209.7	109.8	67.7%	BLACKBRANCH To CENT HARDIN 138 kV
				152.7	79.9	220.2	115.3	67.5%	BLACKBRANCH To GI-2019-029P 138 kV
				152.5	79.9	220.1	115.2	67.5%	BLACKBRANCH To GI-2019-029P138 kV: BLACKBRANCH To CENT HARDIN 138 kV
2030S NRIS	wbnp1_s	ETOWN KU TO KARGLE 69 kV	86	62.8	73.1	101.1	117.5	38.2%	HARDIN CO To CENT HARDIN 138 kV

Table D-2
GI 2019-029 Third Party NRIS Thermal Constraints

Year/Season	Dispatch	Facility	Rating	Pre Project		Post Project		DF	Contingency
				MVA	%	MVA	%		
2030S NRIS	wbnp1_s	CENT HARDIN TO KARGLE 69 kV	98	79.4	81.0	119.4	121.8	40.0%	HARDIN CO To CENT HARDIN 138 kV

Table D-3
GI 2019-029 LG&E and KU ERIS Thermal Constraints

Year/ Season	Dispatch	Facility	Ratin g	Pre Project		Post Project		DF	Contingency
				MVA	%	MVA	%		
2030S ERIS	mtc_nits	BLACKBRANC H TO GI-2019-029P 138 kV	208	152.6	73.4	232.2	111.6	79.6%	None
2030S ERIS	wbnp1_s		265	197.5	74.5	274.9	103.7	77.3%	DAVIESS To HARDIN CO 345 kV
2030S ERIS	Base Dispatch		265	193.4	73.0	270.7	102.2	77.3%	HARDIN CO To DAVIESS 345 kV
2030S ERIS	wilson_w	HARDINSBUR G TO N.HARD 138 kV	191	139.5	73.0	207.8	108.8	68.3%	BLACKBRANCH To CENT HARDIN 138 kV
2030S ERIS			191	150.4	78.7	218.3	114.3	68.0%	BLACKBRANCH To GI-2019-029P 138 kV
2030S ERIS			191	150.2	78.6	218.2	114.2	68.0%	BLACKBRANCH To GI-2019-029P138 kV: BLACKBRANCH To CENT HARDIN 138 kV
2030S ERIS	wbnp1_s	ETOWN KU TO KARGLE 69 kV	86	54.4	63.2	91.7	106.7	37.3%	HARDIN CO To CENT HARDIN 138 kV

Table D-4
GI 2019-029 Third Party ERIS Thermal Constraints

Year/ Season	Dispatch	Facility	Rating	Pre Project		Post Project		DF	Contingency
				MVA	%	MVA	%		
2030S ERIS	wbnp1_s	CENT HARDIN TO KARGLE 69 kV	98	70.9	72.4	110.1	112.4	39.2%	HARDIN CO To CENT HARDIN 138 kV

The LG&E and KU potential GI 2019-029 NRIS thermal constraints due to the subject request with the GI-2017-006 request removed from the models are given in Table D-5. These constraints were found for many dispatch/contingency combinations. Only the result with the highest post project loading for each contingency/year/service type are shown in Table D-5,

Table D-5
GI 2019-029 LG&E and KU NRIS Thermal Constraints with GI-2017-006 Off-line

Year/ Season	Dispatch	Facility	Rating	Pre Project		Post Project		DF	Contingency
				MVA	%	MVA	%		
2030S NRIS	wbnp1_s	BLACKBRANCH TO GI-2019-029P 138 kV	265	210.5	79.4	287.9	108.6	77.4%	DAVIESS To HARDIN CO 345 kV
	Base Dispatch		208	158.7	76.3	239.0	114.9	80.4%	None
2030S NRIS	wilson_w	HARDINSBURG TO N.HARD 138 kV	191	142.7	74.7	210.4	110.1	67.7%	BLACKBRANCH To CENT HARDIN 138 kV
			191	153.5	80.3	220.9	115.7	67.5%	BLACKBRANCH To GI-2019-029P 138 kV
			191	153.3	80.3	220.8	115.6	67.5%	BLACKBRANCH To GI-2019-029P138 kV: BLACKBRANCH To CENT HARDIN 138 kV
2030S NRIS	wbnp1_s	ETOWN KU TO KARGLE 69 kV	86	60.4	70.2	98.6	114.6	38.2%	HARDIN CO To CENT HARDIN 138 kV

A Third Party potential GI 2019-029 NRIS thermal constraint due to the subject request with the GI-2017-006 request removed from the models is given in Table D-6. This constraint was found for many dispatch/contingency combinations. Only the result with the highest post project loading for each contingency/year/service type are shown in Table D-6,

Table D-6
GI 2019-029 Third Party NRIS Thermal Constraints with GI-2017-006 Off-line

Years/ Season	Dispatch	Facility	Rating	Pre Project		Post Project		DF	Contingency
				MVA	%	MVA	%		
2030S NRIS	wbnp1_s	CENT HARDIN TO KARGLE 69 kV	98	77.0	78.5	117.0	119.3	40.0%	HARDIN CO To CENT HARDIN 138 kV

The LG&E and KU potential GI 2019-029 ERIS thermal constraints due to the subject request with the GI-2017-006 request removed from the models are given in Table D-7. These constraints were found for many dispatch/contingency combinations. Only the result with the highest post project loading for each contingency/year/service type are shown in Table D-7,

Table D-7
GI 2019-029 LG&E and KU ERIS Thermal Constraints with GI-2017-006 Off-line

Year/ Season	Dispatch	Facility	Rating	Pre Project		Post Project		DF	Contingency
				MVA	%	MVA	%		
2030S ERIS	br3_merit_miso	BLACKBRANCH TO GI-2019-029P 138 kV	265	192.7	72.7	270.2	102.0	77.5%	DAVIESS To HARDIN CO 345 kV
2030S ERIS	mtc_nits	BLACKBRANCH TO GI-2019-029P 138 kV	208	149.3	71.8	228.8	110.0	79.5%	None
2030S ERIS	wilson_w	HARDINSBURG TO N.HARD 138 kV	191	139.8	73.2	208.1	109.0	68.4%	BLACKBRANCH To CENT HARDIN 138 kV
2030S ERIS	wilson_w	HARDINSBURG TO N.HARD 138 kV	191	150.7	78.9	218.7	114.5	68.1%	BLACKBRANCH TO GI-2019-029P 138 kV 1
2030S ERIS	wilson_w	HARDINSBURG TO N.HARD 138 kV	191	150.5	78.8	218.6	114.4	68.1%	BLACKBRANCH To GI-2019-029P138 kV: BLACKBRANCH To CENT HARDIN 138 kV
2030S ERIS	wbnp1_s	ETOWN KU TO KARGLE 69 kV	86	51.6	60.0	89.0	103.4	37.3%	HARDIN CO To CENT HARDIN 138 kV

A Third Party potential GI 2019-029 ERIS thermal constraint due to the subject request with the GI-2017-006 request removed from the models is given in Table D-8. This constraint was found for many dispatch/contingency combinations. Only the result with the highest post project loading for each contingency/year/service type are shown in Table D-8,

Table D-8
GI 2019-029 Third Party ERIS Thermal Constraints with GI-2017-006 Off-line

Year/ Season	Dispatch	Facility	Rating	Pre Project		Post Project		DF	Contingency
				MVA	%	MVA	%		
2030S ERIS	wbnp1_s	CENT HARDIN TO KARGLE 69 kV	98	68.2	69.6	107.4	109.6	39.2%	HARDIN CO To CENT HARDIN 138 kV

Voltage Analysis Results

No LG&E and KU or third party potential voltage constraints due to the subject request were identified.

Flowgate Analysis Results

No flowgate constraints due to the subject request were identified.

All non LG&E and KU Flowgate results are provided in Appendix E.

Appendix E: Flowgate Analysis Results

Table E-1
NRIS Flowgate Detailed Analysis Results

Year/Season	Constrained Interface					Pre Project	Post Project	DF	Loading
	NERC Id	NERC Name	OWNER	Type	Rating	MW	MW		
2030S	2047	GIBPETGIBBDF	MISO	OTDF	970	578	582	4%	60%
2022S	2614	BULVOLWBNVOL	TVA	OTDF	2447	1821	1825	4%	75%
2022S	1024	VOLPHBCONMOS	TVA	OTDF	1768	1392	1396	3%	79%
2022S	24583	VOLPHIANTJAC	TVA	OTDF	1897	1232	1235	3%	65%
2022S	1613	VOLPHB__PTDF	TVA	PTDF	1733	1218	1221	3%	70%
2022S	17564	VOLPHIMOUNTA	TVA	OTDF	1774	1283	1286	3%	73%
2022S	17884	VOLPHBCULWYO	TVA	OTDF	1772	1255	1258	3%	71%
2022S	23687	VOLPHIGAVIN2	TVA	OTDF	1774	1284	1287	3%	73%
2022S	2047	GIBPETGIBBDF	MISO	OTDF	970	826	829	3%	85%
2022S	1644	BLLVOL__PTDF	TVA	PTDF	2414	1270	1273	3%	53%
2030S	1613	VOLPHB__PTDF	TVA	PTDF	1733	1153	1155	2%	67%
2030S	24583	VOLPHIANTJAC	TVA	OTDF	1897	1153	1155	2%	61%
2030S	1024	VOLPHBCONMOS	TVA	OTDF	1768	1318	1320	2%	75%
2030S	2973	SMIXFMHBGHCO	OMU	OTDF	308	-35	-33	2%	-11%
2030S	17884	VOLPHBCULWYO	TVA	OTDF	1772	1189	1191	2%	67%
2030S	1023	VOLPHBJEFROC	TVA	OTDF	1770	1247	1249	2%	71%
2030S	2614	BULVOLWBNVOL	TVA	OTDF	2447	1800	1802	2%	74%
2030S	17564	VOLPHIMOUNTA	TVA	OTDF	1774	1148	1150	2%	65%
2030S	20603	SMTXFRCOLNEW	OMU	OTDF	308	-16	-14	2%	-4%
2030S	23687	VOLPHIGAVIN2	TVA	OTDF	1774	1148	1150	2%	65%
2030S	1644	BLLVOL__PTDF	TVA	PTDF	2414	1186	1187	2%	49%
2022S	2973	SMIXFMHBGHCO	OMU	OTDF	308	-85	-84	2%	-27%
2022S	20603	SMTXFRCOLNEW	OMU	OTDF	308	-66	-64	2%	-21%
2022S	2244	PDRSSHBAKBRO	TVA	OTDF	181	44	45	1%	25%
2022S	2837	WILGRVMATWIL	MISO	OTDF	496	186	186	0%	38%
2030S	2244	PDRSSHBAKBRO	TVA	OTDF	181	51	51	0%	28%
2030S	19146	SMTXFRGRSCLV	OMU	OTDF	308	-68	-68	0%	-22%
2022S	1095	SMIXFRWILDAV	OMU	OTDF	308	-17	-18	-1%	-6%
2022S	19146	SMTXFRGRSCLV	OMU	OTDF	308	-79	-80	-1%	-26%
2030S	1095	SMIXFRWILDAV	OMU	OTDF	308	-65	-66	-1%	-21%
2030S	2837	WILGRVMATWIL	MISO	OTDF	496	107	104	-3%	21%
2022S	3322	4CL4NH4CL4HA	MISO	OTDF	187	43	35	-8%	19%
2030S	3322	4CL4NH4CL4HA	MISO	OTDF	187	-17	-26	-9%	-14%
2022S	1023	VOLPHBJEFROC	TVA	OTDF	1770	1312	1315	3%	74%

Appendix F: Switching Procedures

The LGE-GIS-2019-029 powerflow analysis has used 9 Switching Procedures (SP) to mitigate criteria violations. The SPs used are as follows:

Table F-1
Switching Procedure Summary

Number	Definition	Contingency
SP2	Restore service to the delivery points along the Fawkes to Okonite 69 kV line by opening 542-605 at Richmond Industrial and closing 871-605 at Richmond #4.	OPEN [2RICHMND SO 69.000][2RICHMND 3 69.000] CKT 1
SP6	Restore service to the delivery points along the Earlington North to Nebo 69 kV line by closing 755-605 (755-615, if switch is moved per project 820) at Madisonville Hospital and opening switch 443-605 at Madisonville GE and Madisonville West.	OPEN [2MADSNV LP W69.000][2NEBO 69.000] CKT 1 OPEN [2EARLINGTN N69.000][2MADSNV LP W69.000] CKT 1
SP13	Restore service to the delivery points along the Higby Mill to Fawkes 69 kV line by opening 126-625 at Spears Station, close W53-615 at EKPC Davis.	OPEN [2SOUTH POINT69.000][2ASHLND PIPE69.000] CKT 1 OPEN [2SOUTH POINT69.000][2WIL DOWN T269.000] CKT 1
SP15	Restore service to the delivery points along the Lake Reba to Okonite 69 kV line by opening 729-625 at Berea North and closing 729-605 at Paint Lick	OPEN [2BEREA TAP 69.000][2LAKE REBA 69.000] CKT 1
SP44	Do not re-energize the West Frankfort 138/69 kV transformer.	OPEN [4E FRANKFORT138.00][4W FRANKFORT138.00] CKT 1
SP54	Do not restore to service any individual 138 kV line section from Ohio County to Shrewsbury to Meredith, after the breaker-to-breaker outage of the Ohio County-Shrewsbury-Meredith 138 kV line.	OPEN [4SHREWSBURY 138.00] [4MERE TVA 138.00] CKT 1
SP69	Restore service to the delivery points along the Earlington North to Green River 69 kV line by closing 755-605 (755-615, if switch is moved per project 820) at Madisonville Hospital and opening 816-635 at McCoy Avenue.	OPEN [2FIES CITY 69.000][2KEN AMERI 269.000] CKT 1 OPEN [2MADSNV LP E69.000][2FIES CITY 69.000] CKT 1 OPEN [2EARLINGTN N69.000][2MADSNV LP E69.000] CKT 1
SP71	Open Pocket North to Pineville 500 kV #1 line.	OPEN [8POCKET N 500.00][8PHIPPS B NP500.00] CKT 1
SP72	Do not restore service to the Crittenden 161/69 kV transformer during an outage of either the Livingston to Crittenden 161 kV line section or Morganfield to Crittenden 161 kV line section of the Livingston to Crittenden to Morganfield 161 kV line.	OPEN [5CRITTENDEN 161.00][5MORGANFIELD161.00] CKT 1 OPEN [5CRITTENDEN 161.00][5LIVNGSTN CO161.00] CKT 1