Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AC1-074

Jacksonville 138kV

February 2017

Preface

The intent of the feasibility study is to determine a plan, with ballpark cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system.

In some instances a generator interconnection may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the feasibility study, but the actual allocation will be deferred until the impact study is performed.

The Feasibility Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

General

Bluebird Solar LLC, the Interconnection Customer (IC), has proposed a solar generating facility located in Harrison County, Kentucky. The installed facilities will have a total capability of 80 MW with 56 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is June 1, 2019. **This study does not imply a EKPC commitment to this in-service date.**

Point of Interconnection

AC1-074 will interconnect with the EKPC Transmission system at one of the two following points of interconnection:

Option 1 will connect along the Jacksonville – Renaker 138kV line

Option 2 will connect at the Jacksonville 138kV substation

Cost Summary

The AC1-074 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 0
Direct Connection Network Upgrades	$ 3,200,000
Non Direct Connection Network Upgrades	$ 100,000
Total Costs	**$ 3,300,000**

In addition, the AC1-074 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	$ 100,000
Previously Identified Upgrades	$ 2,500,000
Total Costs	**$ 2,600,000**

Cost allocations for these upgrades will be provided in the System Impact Study Report.

Attachment Facilities

No Attachment Facilities are required to support this interconnection request.

Direct Connection Cost Estimate

The total preliminary cost estimate for the Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Build 138kv switching station at Jacksonville Tap including associated transmission line work. Estimated Time: 18 months	$ 3,200,000
Total Direct Connection Facility Costs	**$ 3,200,000**

Non-Direct Connection Cost Estimate

The total preliminary cost estimate for the Non-Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Adjust remote, relaying, and metering settings.	$ 100,000
Total Non-Direct Connection Facility Costs	**$ 100,000**

Interconnection Customer Requirements

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

3. The Interconnection Customer seeking to interconnect a wind generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per item 5.iv. of Schedule H to the Interconnection Service Agreement.

Revenue Metering and SCADA Requirements

PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

EKPC Requirements

The Interconnection Customer will be required to comply with all EKPC Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "EKPC Facility Connection Requirements" document located at the following link:

http://www.pjm.com/planning/design-engineering/to-tech-standards/ekpc.aspx

Network Impacts

Option 1

The Queue Project AC1-074 was evaluated as a 80.0 MW (Capacity 56.0 MW) injection tapping the Jacksonville-Renaker 138kV line in the EKPC area. Project AC1-074 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-074 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis - 2020

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK	CONTINGENCY 'P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK' OPEN BRANCH FROM BUS 342838 TO BUS 249581 CKT 1 OPEN BRANCH FROM BUS 253077 TO BUS 342838 CKT 1 END

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

None.

Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

	Contingency		Affected		Bus			Power	Loading %		Rating		MW	
#	Type	Name	Area	Facility Description	From	To	Circuit	Flow	Initial	Final	Type	MVA	Contribution	Ref
1	DCTL	P7-1..C5	AEP	AC1-089 TAP-05HILLSB 138 kV line	926100	243019	1	DC	84.47	85.67	ER	185	4.91	1

Note: Please see Attachment 2 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

	Contingency		Affected		Bus			Power	Loading %		Rating		MW	
#	Type	Name	Area	Facility Description	From	To	Circuit	Flow	Initial	Final	Type	MVA	Contribution	Ref
2	DCTL	P7-1..C5	EKPC - LGEE	4SPUR-KENT-R-4KENTON 138 kV line	342661	324267	1	DC	104.33	105.07	ER	281	4.61	2
3	DCTL	P7-1..C5	EKPC	4SPURLOCK-4SPUR-KENT-R 138 kV line	342664	342661	1	DC	104.62	105.36	ER	281	4.61	3

Note: Please see Attachment 2 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Short Circuit

(Summary of impacted circuit breakers)

None.

Light Load Analysis - 2020

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

Stability and Reactive Power Requirement

Stability and Reactive study to be completed during later study phases

Steady-State Voltage Requirements

Steady-State Voltage study to be completed during later study phases

Affected System Analysis & Mitigation

LGEE Impacts:

LGEE Impacts to be determined during later study phases (as applicable).

MISO Impacts:

MISO Impacts to be determined during later study phases (as applicable).

Duke, Progress & TVA Impacts:

Duke Carolina, Progress, & TVA Impacts to be determined during later study phases (as applicable).

OVEC Impacts:

OVEC Impacts to be determined during later study phases (as applicable).

Potential Congestion due to Local Energy Deliverability

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.

None.

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
#1	AC1-089 TAP-05HILLSB 138 kV line	In order to mitigate the overloads of facilities above, the following reinforcements are required: • Reconductor/Rebuild 100 ft section of line. New ratings will be S/N: 383 S/E: 448 The estimated schedule duration is 24-36 months. Cost: $100,000	TBD	**$** 100,000
			Total New Network Upgrades	**$ 100,000**

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
#2, 3	4SPUR-KENT-R-4KENTON 138 kV line	In order to mitigate the overloads of facilities above, the following reinforcements are required: • Upgrade Spurlock-KU Kenton 138kv series reactor from 1200A at 5% impedance to 1600A at 6.5% impedance; (note: project submitted to 2016 RTEP Window 2; IDV provided). New ratings will be S/N: 259 MVA, S/E: 291 MVA The estimated schedule duration is 24 months. Cost: $2.5 million	TBD	**$ 2,500,000**
			Total New Network Upgrades	**$ 2,500,000**

Network Impacts

Option 2

The Queue Project AC1-074 was evaluated as a 80.0 MW (Capacity 56.0 MW) injection at the Jacksonville 138kV substation in the EKPC area. Project AC1-074 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-074 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis - 2020

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK	CONTINGENCY 'P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK' OPEN BRANCH FROM BUS 342838 TO BUS 249581 CKT 1 OPEN BRANCH FROM BUS 253077 TO BUS 342838 CKT 1 END

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

None.

Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Circuit	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Ref
1	DCTL	P7-1..C5	AEP	AC1-089 TAP-05HILLSB 138 kV line	926100	243019	1	DC	84.47	85.66	ER	185	4.9	1

Note: Please see Attachment 3 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Circuit	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Ref
2	DCTL	P7-1..C5	EKPC - LGEE	4SPUR-KENT-R-4KENTON 138 kV line	342661	324267	1	DC	104.33	105.07	ER	281	4.59	2
3	DCTL	P7-1..C5	EKPC	4SPURLOCK-4SPUR-KENT-R 138 kV line	342664	342661	1	DC	104.62	105.35	ER	281	4.59	3

Note: Please see Attachment 3 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Short Circuit *(Summary of impacted circuit breakers)*

None.

Light Load Analysis - 2020

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

Stability and Reactive Power Requirement

Stability and Reactive study to be completed during later study phases

Steady-State Voltage Requirements

Steady-State Voltage study to be completed during later study phases

Affected System Analysis & Mitigation

LGEE Impacts:

LGEE Impacts to be determined during later study phases (as applicable).

MISO Impacts:

MISO Impacts to be determined during later study phases (as applicable).

Duke, Progress & TVA Impacts:

Duke Carolina, Progress, & TVA Impacts to be determined during later study phases (as applicable).

OVEC Impacts:

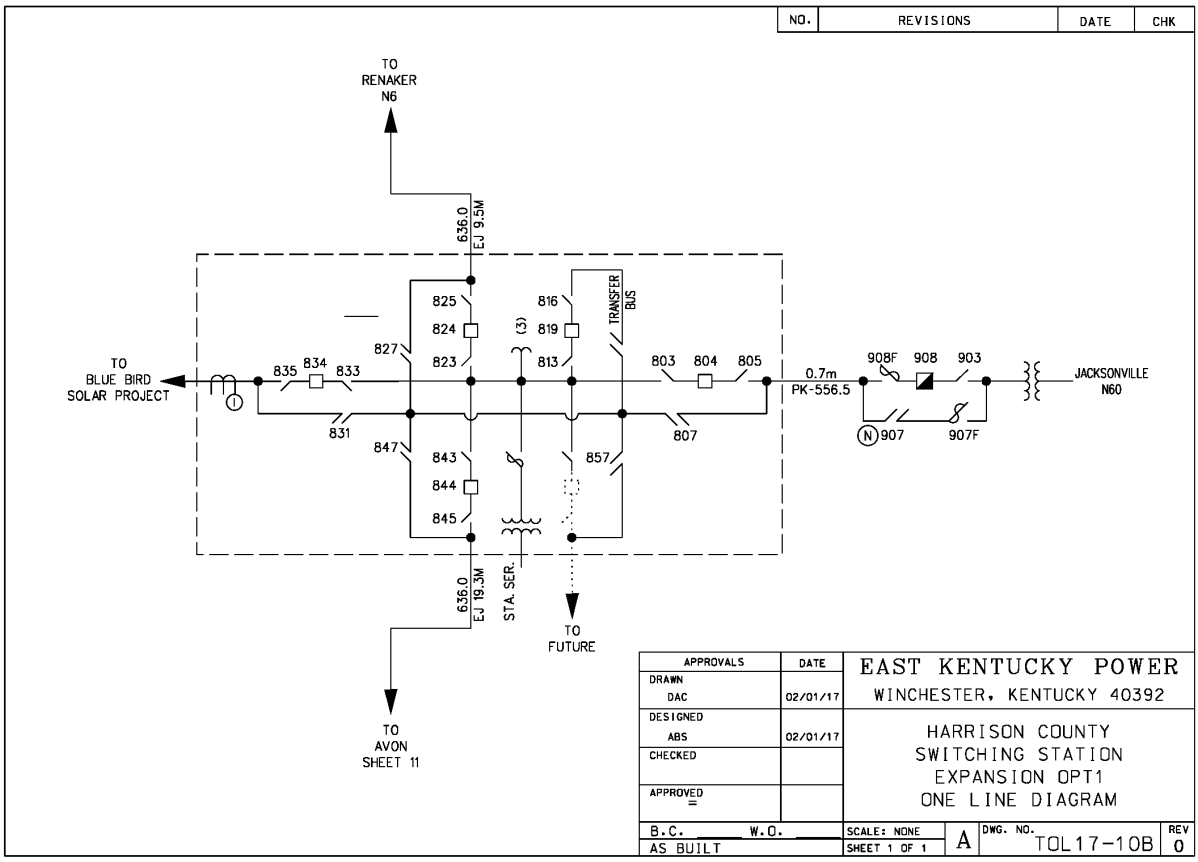
OVEC Impacts to be determined during later study phases (as applicable).

Potential Congestion due to Local Energy Deliverability

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

None.

Attachment 1. Single Line Diagram



Attachment 2. Flowgate Details (Option 1)

Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact.

It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

Appendix 1

(AEP - AEP) The AC1-089 TAP-05HILLSB 138 kV line (from bus 926100 to bus 243019 ckt 1) loads from 84.47% to 85.67% (**DC power flow**) of its emergency rating (185 MVA) for the tower line contingency outage of 'P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK'. This project contributes approximately 4.91 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
342910	1DALE 3G	3.78
342911	1DALE 4G	3.88
342957	1SPURLK1G	5.73
916272	Z1-080 E	0.58
924101	AB2-054	26.3

Bus Number	Bus Name	Full Contribution
925981	AC1-074 C OP	3.44
925982	AC1-074 E OP	1.47
926101	AC1-089 C	42.72
926102	AC1-089 E	69.71

Appendix 2

(EKPC - LGEE) The 4SPUR-KENT-R-4KENTON 138 kV line (from bus 342661 to bus 324267 ckt 1) loads from 104.33% to 105.07% (**DC power flow**) of its emergency rating (281 MVA) for the tower line contingency outage of 'P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK'. This project contributes approximately 4.61 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
342957	1SPURLK1G	9.88
342960	1SPURLK2G	14.39
342963	1SPURLK3G	7.56
342966	1SPURLK4G	7.56

Bus Number	Bus Name	Full Contribution
924101	AB2-054	30.14
925981	AC1-074 C OP	3.23
925982	AC1-074 E OP	1.38

Appendix 3

(EKPC - EKPC) The 4SPURLOCK-4SPUR-KENT-R 138 kV line (from bus 342664 to bus 342661 ckt 1) loads from 104.62% to 105.36% (**DC power flow**) of its emergency rating (281 MVA) for the tower line contingency outage of 'P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK'. This project contributes approximately 4.61 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
342957	1SPURLK1G	9.88
342960	1SPURLK2G	14.39
342963	1SPURLK3G	7.56
342966	1SPURLK4G	7.56

Bus Number	Bus Name	Full Contribution
924101	AB2-054	30.14
925981	AC1-074 C OP	3.23
925982	AC1-074 E OP	1.38

Attachment 3. Flowgate Details (Option 2)

Appendix 1

(AEP - AEP) The AC1-089 TAP-05HILLSB 138 kV line (from bus 926100 to bus 243019 ckt 1) loads from 84.47% to 85.66% (**DC power flow**) of its emergency rating (185 MVA) for the tower line contingency outage of 'P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK'. This project contributes approximately 4.9 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
342910	1DALE 3G	3.78
342911	1DALE 4G	3.88
342957	1SPURLK1G	5.73
916272	Z1-080 E	0.58
924101	AB2-054	26.3

Bus Number	Bus Name	Full Contribution
925981	AC1-074 C OP	3.43
925982	AC1-074 E OP	1.47
926101	AC1-089 C	42.72
926102	AC1-089 E	69.71

Appendix 2

(EKPC - LGEE) The 4SPUR-KENT-R-4KENTON 138 kV line (from bus 342661 to bus 324267 ckt 1) loads from 104.33% to 105.07% (**DC power flow**) of its emergency rating (281 MVA) for the tower line contingency outage of 'P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK'. This project contributes approximately 4.59 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
342957	1SPURLK1G	9.88
342960	1SPURLK2G	14.39
342963	1SPURLK3G	7.56
342966	1SPURLK4G	7.56

Bus Number	Bus Name	Full Contribution
924101	AB2-054	30.14
925981	AC1-074 C OP	3.21
925982	AC1-074 E OP	1.38

Appendix 3

(EKPC - EKPC) The 4SPURLOCK-4SPUR-KENT-R 138 kV line (from bus 342664 to bus 342661 ckt 1) loads from 104.62% to 105.35% (**DC power flow**) of its emergency rating (281 MVA) for the tower line contingency outage of 'P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK'. This project contributes approximately 4.59 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
342957	1SPURLK1G	9.88
342960	1SPURLK2G	14.39
342963	1SPURLK3G	7.56
342966	1SPURLK4G	7.56

Bus Number	Bus Name	Full Contribution
924101	AB2-054	30.14
925981	AC1-074 C OP	3.21
925982	AC1-074 E OP	1.38

Revised Generation Interconnection System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AC1-074

Jacksonville – Renaker 138kV

October 2017

Revised: November 2020

Preface

The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

In some instances an Interconnection Customer may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the Feasibility Study, but the actual allocation will be deferred until the System Impact Study is performed.

The System Impact Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

General

Bluebird Solar LLC, the Interconnection Customer (IC), has proposed a solar generating facility located in Harrison County, Kentucky. The installed facilities will have a total capability of 80 MW with 56 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is June 1, 2019. **This study does not imply a EKPC commitment to this in-service date.**

Point of Interconnection

AC1-074 will interconnect with the EKPC Transmission system along the Jacksonville – Renaker 138kV line.

Cost Summary

The AC1-074 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 0
Direct Connection Network Upgrades	$ 3,200,000
Non Direct Connection Network Upgrades	$ 100,000
Allocation for New System Upgrades	$ 0
Contribution for Previously Identified Upgrades	$ 0
Total Costs	**$ 3,300,000**

Attachment Facilities

No Attachment Facilities are required to support this interconnection request.

Direct Connection Cost Estimate

The total preliminary cost estimate for the Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Build 138kv switching station at Jacksonville Tap including associated transmission line work. Estimated Time: 18 months. PJM network Upgrade # n5929	$ 3,200,000
Total Direct Connection Facility Costs	**$ 3,200,000**

Non-Direct Connection Cost Estimate

The total preliminary cost estimate for the Non-Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Adjust remote, relaying, and metering settings at Jacksonville 138kV Sub. PJM network Upgrade # n5930	$ 50,000
Adjust remote, relaying, and metering settings at Renaker 138kV Sub. PJM network Upgrade # n5931	$ 50,000
Total Non-Direct Connection Facility Costs	**$ 100,000**

Interconnection Customer Requirements

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

3. The Interconnection Customer seeking to interconnect a wind generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per item 5.iv. of Schedule H to the Interconnection Service Agreement.

Revenue Metering and SCADA Requirements

PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

EKPC Requirements

The Interconnection Customer will be required to comply with all EKPC Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "EKPC Facility Connection Requirements" document located at the following link:

http://www.pjm.com/planning/design-engineering/to-tech-standards/ekpc.aspx

Network Impacts

The Queue Project AC1-074 was evaluated as a 80.0 MW (Capacity 56.0 MW) injection into a tap of the Jacksonville Tap – Renaker 138 kV line in the EKPC area. Project AC1-074 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-074 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2020

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
363_B2_TOR1682	CONTINGENCY '363_B2_TOR1682' OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1 END
4812_B2_TOR8931	CONTINGENCY '4812_B2_TOR8931' OPEN BRANCH FROM BUS 242921 TO BUS 242924 CKT 1 / 242921 05CORNU 765 242924 05HANG R 765 1 END
P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK	CONTINGENCY 'P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK' OPEN BRANCH FROM BUS 342838 TO BUS 249581 CKT 1 OPEN BRANCH FROM BUS 253077 TO BUS 342838 CKT 1 END

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

None.

Light Load Analysis

Light Load Studies to be conducted during later study phases (applicable to wind, coal, nuclear, and pumped storage projects).

Multiple Facility Contingency

(Double Circuit Tower Line contingencies were studied for the full energy output. The contingencies of Line with Failed Breaker and Bus Fault will be performed for the Impact Study.)

None.

Short Circuit

(Summary of impacted circuit breakers)

None.

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Circuit	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Ref
1	N-1	363_B2_TOR1682	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	DC	149.41	149.76	ER	1370	4.9	3
2	Non	Non	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	AC	127.48	127.75	NR	1134	5.04	
3	N-1	4812_B2_TOR8931	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	AC	114.12	114.34	ER	1370	5.01	
4	DCTL	P7-1..C5 4541MELD AHLSPRL CKSTUAR TSPURLO CKDPLEK	EKPC - LGEE	4SPUR-KENT-R-4KENTON 138 kV line	342661	324267	1	AC	100.48	101.9	ER	281	4.68	4
5	DCTL	P7-1..C5 4541MELD AHLSPRL CKSTUAR TSPURLO CKDPLEK	EKPC - EKPC	4SPURLOCK-4SPUR-KENT-R 138 kV line	342664	342661	1	AC	100.48	101.89	ER	281	4.68	5

Note: Please see 0 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Potential Congestion due to Local Energy Deliverability

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Circuit	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Ref
6	N-1	363_B2_TOR1682	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	AC	156.62	157.05	ER	1370	7.01	
7	Non	Non	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	AC	122.14	122.68	NR	1134	7.2	

Note: Please see 0 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Steady-State Voltage Requirements

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

None.

Stability and Reactive Power Requirement for Low Voltage Ride Through

(Summary of the VAR requirements based upon the results of the dynamic studies)

No network impacts were identified in the Stability Study. See Attachment 3 for details

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

None.

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost	AC1-074 Allocation
#1, 2, 3	7TRIMBLE-06CLIFTY 345 kV line	A potential constraint was identified by PJM on the Trimble – Clifty 345 kV line (LG&E/OVEC tie line). An LG&E affected system study is required to determine if the AC1-074 queue project causes any impacts on the LG&E system, including the Trimble-Clifty LG&E-OVEC tie line. The LG&E Affected System Study results conclude that there are no LG&E system impacts due to AC1-074. Note: although there are no required upgrades on the Trimble – Clifty 345 kV line, PJM has identified potential congestion on the line as summarized in the Energy Delivery section above.	N/A	**$ 0**	**$ 0**
#4, 5	4SPUR-KENT-R-4KENTON 138 kV line	To relieve the 4SPUR-KENT-R-4KENTON 138 kV line & 4SPURLOCK-4SPUR-KENT-R 138 kV line overloads: EKPC: 2021 Baseline Upgrade B2827: Upgrade Spurlock-KU Kenton 138kv series reactor from 1200A at 5% impedance to 1600A at 6.5% impedance. New EKPC rating will be 291 MVA SE for both branches. EKPC would charge a $62,500 acceleration cost to place baseline upgrade B2827 into service one year earlier than required (advancing it from summer 2021 to summer 2020). The AC1-074 customer would need to provide EKPC with enough notice (at least 18 months in advance) to meet a summer 2020 in-service date. LG&E: The LG&E-end SE rating on the 4SPUR-KENT-R-4KENTON 138 kV line is 306 MVA and is sufficient. No LG&E end upgrade required.	b2827 / N6041	**$ 0**	**$ 0**
			Total New Network Upgrades		**$ 0**

Potential Congestion due to Local Energy Deliverability

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Circuit	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Ref
6	N-1	363_B2_TOR1682	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	AC	156.62	157.05	ER	1370	7.01	
7	Non	Non	LGEE - OVEC	7TRIMBLE-06CLIFTY 345 kV line	324114	248000	1	AC	122.14	122.68	NR	1134	7.2	

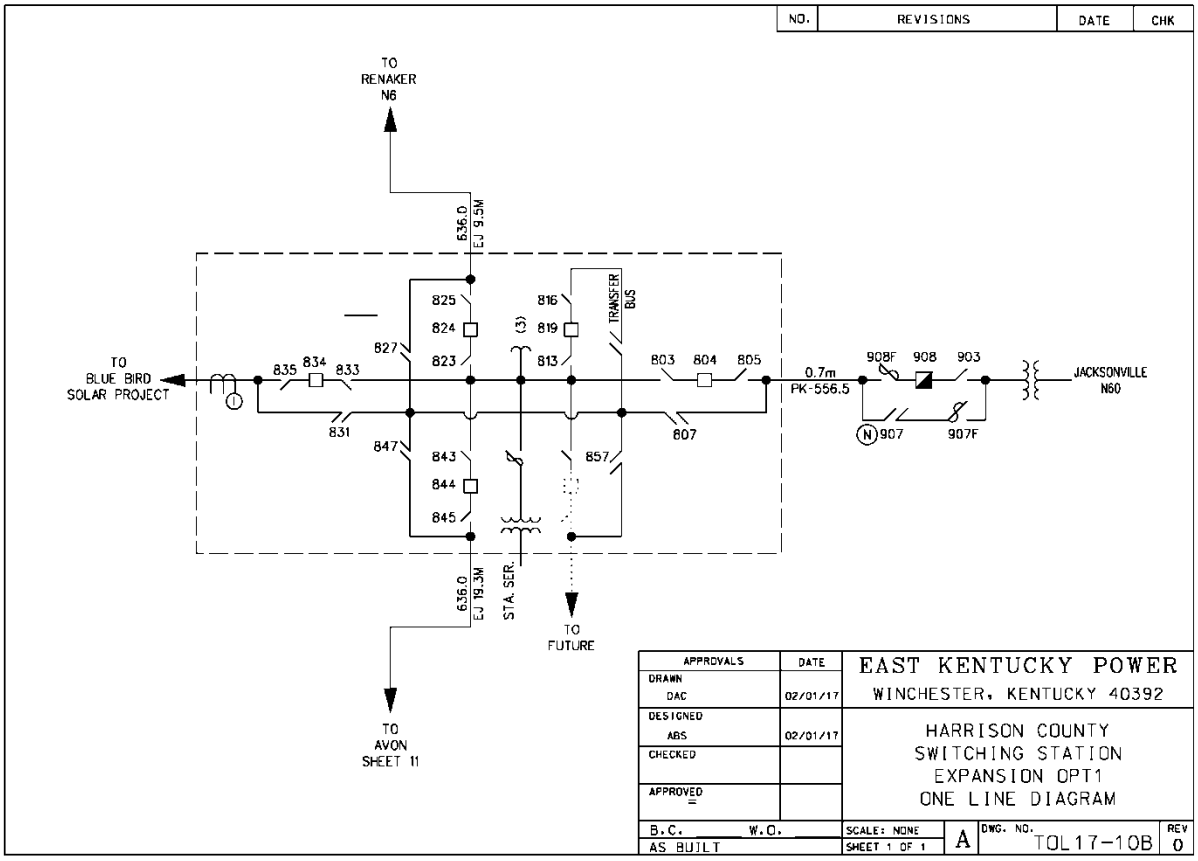
Note: Please see 0 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Affected Systems Analysis

Based on the LG&E KU Affected Systems Study dated 6/12/20:

No Mitigations Required

Attachment 1. Single Line Diagram



Attachment 2. Single Line Diagram

Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact.

It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

Appendix 3

(LGEE - OVEC) The 7TRIMBLE-06CLIFTY 345 kV line (from bus 324114 to bus 248000 ckt 1) loads from 149.41% to 149.76% (DC power flow) of its emergency rating (1370 MVA) for the single line contingency outage of '363_B2_TOR1682'. This project contributes approximately 4.9 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
247286	05AND G2	0.41
247287	05AND G3	0.85
243442	05RKG1	19.63
243443	05RKG2	19.33
342900	1COOPER1 G	3.29
342903	1COOPER2 G	6.37
342918	1JKCT 1G	2.6
342921	1JKCT 2G	2.6
342924	1JKCT 3G	2.6
342927	1JKCT 4G	1.72
342930	1JKCT 5G	1.72
342933	1JKCT 6G	1.72
342936	1JKCT 7G	1.72
342939	1JKCT 9G	1.77
342942	1JKCT 10G	1.77
342945	1LAUREL 1G	1.86

Bus Number	Bus Name	Full Contribution
900404	X3-028 C	112.82
LTF	Y2-006	16.65
247629	Y3-038	0.53
LTF	Z1-046	19.5
LTF	AA1-001	5.68
LTF	AA1-004	15.81
922982	AB1-087 C OP	41.37
922992	AB1-088 C OP	41.37
LTF	AC1-002	39.8
926391	AC1-040 C	4.28
926731	AC1-074 C OP	4.9
971181	AC1-248	48.36
971521	AC1-282	11.37
971531	AC1-283	35.01
971571	AC1-287	11.24

Appendix 4

(EKPC - LGEE) The 4SPUR-KENT-R-4KENTON 138 kV line (from bus 342661 to bus 324267 ckt 1) loads from 100.48% to 101.9% (AC power flow) of its emergency rating (281 MVA) for the tower line contingency outage of 'P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK'. This project contributes approximately 4.68 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
342957	1SPURLK1G	10.07
342960	1SPURLK2G	14.67
342963	1SPURLK3G	7.71

Bus Number	Bus Name	Full Contribution
342966	1SPURLK4G	7.71
926731	AC1-074 C OP	3.28
926732	AC1-074 E OP	1.4

Appendix 5

(EKPC - EKPC) The 4SPURLOCK-4SPUR-KENT-R 138 kV line (from bus 342664 to bus 342661 ckt 1) loads from 100.48% to 101.89% (AC power flow) of its emergency rating (281 MVA) for the tower line contingency outage of 'P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK'. This project contributes approximately 4.68 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
342957	1SPURLK1G	10.07
342960	1SPURLK2G	14.67
342963	1SPURLK3G	7.71

Bus Number	Bus Name	Full Contribution
342966	1SPURLK4G	7.71
926731	AC1-074 C OP	3.28
926732	AC1-074 E OP	1.4

Attachment 3. Dynamic Simulation Analysis

Executive Summary

PJM Queue project AC1-074 is a request for 80.0 MW Maximum Facility Output (MFO) Solar Generation Plant. The Point of Interconnection is a new three breaker ring station by tapping in/out Renaker – Jacksonville 138 kV circuit in the East Kentucky Power (EKPC) transmission system, Harrison County, Kentucky. AC1-074 project consist 33 TMEIC Solar Ware 2.5 MW Inverters.

The dynamic model for the AC1-074 plant is based on the 'PVGU1' and 'PVEU1' TMEIC standard PSS/E user models provided by the developer in the System Impact Study Data package.

This study is based on the 2020_SP summer peak load case and modified to include applicable queue projects. PJM queue project AC1-074 was dispatched at a maximum power transfer of 80.0 MW and POI voltage of 138.4 kV, consistent with the default generator reference voltage specified in PJM Manual 03 *Transmission Operations* Section 3.3.3 for generator connections to the PJM 138.0 kV system.

AC1-074 was tested for compliance with NERC, PJM and other applicable criteria. 62 contingencies were studied, each with a 15 second simulation time period.

Based on the contingencies tested, AC1-074 meets for all criteria contingencies tested.

Description

This study evaluates the stability, low voltage ride-through (LVRT) and dynamics for PJM queue project AC1-074 which is 80.0 MW MFO Solar Farm. The proposed POI is a three breaker ring bus which taps in/out existing Renaker – Jacksonville 138 kV circuit in EKPC area. The AC1-074 project is a Solar Farm made up of 33 TMEIC 2.5 MW Solar Ware Inverters. The solar inverters facility is modeled at 82.5 MW gross output of which 2.5 MW is consumed as auxiliaries. For this stability study, the AC1-074 project was studied for a total net injection of 80.0 MW into the 138.0 kV Transmission System.

The dynamic model for the AC1-074 plant is based on the 'PVGU1' and 'PVEU1' TMEIC standard PSS/E user models provided by the developer in the System Impact Study Data package.

Criteria

The stability study for AC1-074 was performed on a RTEP SP_2020 Summer Peak load case for normal operating conditions, and modified to include applicable queue projects. The range of contingencies evaluated was limited to those necessary to assess compliance with NERC, PJM and other applicable criteria. Simulation time was 15 seconds for all faults.

Simulated NERC Standard TPL-001faults include:

1. Three-phase (3ph) fault with normal clearing (Category P1)
2. Single-line-to-ground on bus (slg) with normal clearing (Category P2)
3. Single-line-to-ground (slg) with delayed clearing as a result of breaker failure (Category P4)
4. Single-line-to-ground (slg) with delayed clearing as a result of protection failure (Category P5) – not performed for this study
5. Single-line-to-ground (slg) with normal clearing for common structure (Category P7)

Note: For generator interconnection studies, Category P2, P3 and P6 faults will be studied on an as needed basis.

Other applicable criteria tested include:

1. TO specific criteria
2. Other criteria

The system was tested for an all lines in service condition and the faults listed above. Specific fault descriptions and breaker clearing times used for this study are provided in Appendix A.

All generators were monitored to assess transient stability and satisfactory post-contingency conditions.

Case Setup

Generators within 5 to 8 buses from the generator(s) under study are dispatched at their

maximum power output and set at unity power factor at the high side of the generator step up transformer. Alternatively, generators can be adjusted to hold scheduled voltages.

Specific dispatch conditions at the generator terminals for the AC1-074 generator, as obtained in the power flow solution, are illustrated below:

	33 TMEIC Solar War 2.5 MW Inverters
Gross power output (MW)	82.5
Reactive power output (MVARS)	-0.2
Auxiliary Load (MW/MVARS)	2.5, 0.0
Station Service Load (MW/MVARS)	
Net real power injection (MW)	80.0
Voltage at the POI (P.U.)	1.00

Results

Simulation Initialization
The case was initialized successfully. No errors were reported.

20 second no fault test (Steady State evaluation)
The system successfully met the 20 second run test without any significant deviations in system states.

Simulation Results
Dynamics and stability was tested using Siemens/PTI PSS/E Version 33.0, the 2020 case with a Summer Peak Load condition and the data supplied by the developer.

Transient Stability: For all contingencies studied, transient stability is maintained, with all oscillations stabilized in less than 15 seconds. Also, the voltage levels returned to acceptable levels for all contingencies following the fault clearance. Hence, no transient stability issues were identified for contingencies tested.

LVRT: For the cases studied, the queue project rides through the faults shown in Appendix A thus meeting the LVRT test specified in FERC order 661 and 661A.

Small Signal (if applicable):

SPS:

Maintenance outage: No maintenance outage conditions were evaluated.

Conclusion

Transient stability is maintained for all contingencies tested.

Mitigations:

None

Recommendations:
None

Appendix A: Fault Table

No.	Contingency ID	Type of Fault	Clearing time (cycles)		Results
			Normal	Delayed	
Criteria = TPL 001-4_P1					
01	AC1-074-TAP-P1-01	3ph fault on AC1-074 Tap – Renaker 138 kV	6.0	N/A	OK
02	AC1-074-TAP-P1-01	3ph fault on AC1-074 Tap – Jacksonville – Avon 138 kV	6.0	N/A	OK
03	AC1-074-RENA-P1-01	3ph fault on Renaker – Spurlock 138 kV	6.0	N/A	OK
04	AC1-074-RENA-P1-02	3ph fault on Renaker – Bavarian / Boone 138 kV	6.0	N/A	OK
05	AC1-074-RENA-P1-03	3ph fault on Renaker 138/69 kV TF	6.0	N/A	OK
06	AC1-074-RENA-P1-04	3ph fault on Renaker – Colemansville– Bracken Co 69 kV	8.0	N/A	OK
07	AC1-074-RENA-P1-05	3ph fault on Renaker – KU Cynthiana – KU Millersburg 69 kV	8.0	N/A	OK
08	AC1-074-RENA-P1-06	3ph fault on Renaker – Three M - Headquarters69 kV	8.0	N/A	OK
09	AC1-074-RENA-P1-07	3ph fault on Renaker – Williamstown 69 kV	8.0	N/A	OK
10	AC1-074-RENA-P1-08	3ph fault on Renaker – Lees Lick – KU Scott 69 kV	8.0	N/A	OK
11	AC1-074-SPUR-P1-01	3ph fault on Spurlock – Stanley Parker 138 kV (N Bus)	6.0	N/A	OK
12	AC1-074-SPUR-P1-02	3ph fault on Spurlock – Renaker 138 kV (S Bus)	6.0	N/A	OK
13	AC1-074-SPUR-P1-03	3ph fault on Spurlock – Maysville – Plumville 138 kV (N Bus)	6.0	N/A	OK
14	AC1-074-SPUR-P1-04	3ph fault on Spurlock – Flemingsburg / Goddard 138 kV (S Bus)	6.0	N/A	OK
15	AC1-074-SPUR-P1-05	3ph fault on Spurlock – Kenton 138 kV (N Bus)	6.0	N/A	OK
16	AC1-074-SPUR-P1-06	3ph fault on Spurlock – Inland 138 kV (S Bus)	6.0	N/A	OK
17	AC1-074-SPUR-P1-07	3ph fault on Spurlock G1	6.0	N/A	OK
18	AC1-074-SPUR-P1-08	3ph fault on Spurlock 138/345 kV TF 9	6.0	N/A	OK
19	AC1-074-SPUR-P1-09	3ph fault on Spurlock 138/345 kV TF 10	6.0	N/A	OK
20	AC1-074-SPUR-P1-10	3ph fault on Spurlock 138/345 kV TF 12	6.0	N/A	OK
21	AC1-074-AVON-P1-01	3ph fault on Avon – Jacksonville – AC1-074 Tap 138 kV	6.0	N/A	OK
22	AC1-074-AVON-P1-02	3ph fault on Avon – Fayette 138 kV	6.0	N/A	OK
23	AC1-074-AVON-P1-03	3ph fault on Avon – Beck – Boonesboro N – Dale 138 kV	6.0	N/A	OK
24	AC1-074-AVON-P1-04	3ph fault on Avon 138/345 kV TF	6.0	N/A	OK
25	AC1-074-AVON-P1-04	3ph fault on Avon – KU Loudon 138kV	6.0	N/A	OK
Criteria = TPL 001-4_P2					

No.	Contingency ID	Type of Fault	Clearing time (cycles)		Results
			Normal	Delayed	
26	AC1-074-TAP-P2-01	SLG fault on AC1-074 Tap, Loss of AC1-074 Tap 138 kV Bus	6.0	N/A	OK
27	AC1-074-RENA-P2-01	SLG fault on Renaker 138 kV Bus, Loss of Renaker 138 kV Bus	6.0	N/A	OK
28	AC1-074-RENA-P2-02	SLG fault on Renaker 69 kV Bus, Loss of Renaker 69 kV Bus	8.0	N/A	OK
29	AC1-074-SPUR-P2-01	SLG fault on Spurlock 138 kV North Bus, Loss of Spurlock 138 kV North Bus (11,13,15,17 and 18)	8.0	N/A	OK
30	AC1-074-SPUR-P2-02	SLG fault on Spurlock 138 kV South Bus, Loss of Spurlock 138 kV South Bus (12,14,16 and 19,20)	8.0	N/A	OK
		Avon is Ring Bus. Bus fault will impact one element / circuit at a time			
Criteria = TPL 001-4_P4					
31	AC1-074-TAP-P4-01	SLG fault on AC1-074 Tap – Renaker 138 kV, SB '824' at AC1-074, Loss of AC1-074 138 kV Bus	6.0	14.0	OK
32	AC1-074-TAP-P4-02	SLG fault on AC1-074 Tap – Jacksonville – Avon 138 kV, SB '844' at AC1-074, Loss of AC1-074 138 kV Bus	6.0	14.0	OK
33	AC1-074-TAP-P4-03	SLG fault on AC1-074 Tap – unit 138 kV, SB '834' at AC1-074, Loss of AC1-074 138 kV Bus	6.0	14.0	OK
34	AC1-074-RENA-P4-01	SLG fault on Renaker – Spurlock 138 kV, SB '844' at Renaker 138 kV, Loss of Renaker 138 kV Bus	6.0	15.0	OK
35	AC1-074-RENA-P4-02	SLG fault on Renaker – Bavarian / Boone 138 kV, SB '824' at Renaker 138 kV, Loss of Renaker 138 kV Bus	6.0	15.0	OK
36	AC1-074-RENA-P4-03	SLG fault on Renaker 138/69 kV TF, SB '808' at Renaker 138 kV, Loss of Renaker 138 kV Bus	6.0	15.0	OK
37	AC1-074-RENA-P4-04	SLG fault on Renaker – AC1-074 Tap 138 kV, SB '814' at Renaker 138 kV, Loss of Renaker 138 kV Bus	6.0	15.0	OK
38	AC1-074-RENA-P4-05	SLG fault on Renaker 69/138 kV TF, SB '648' at Renaker 69 kV, Loss of Renaker 69 kV Bus	8.0	19.0	OK
39	AC1-074-RENA-P4-06	SLG fault on Renaker – Colemansville –Bracken Co69 kV, SB '624' at Renaker 69 kV, Loss of Renaker 69 kV Bus	8.0	19.0	OK
40	AC1-074-RENA-P4-07	SLG fault on Renaker – KU Cynthiana 69 kV, SB '664' at Renaker 69 kV, Loss of Renaker 69 kV Bus	8.0	19.0	OK
41	AC1-074-RENA-P4-08	SLG fault on Renaker – Three M - Headquarters69 kV, SB '604' at Renaker 69 kV, Loss of Renaker 69 kV Bus	8.0	19.0	OK
42	AC1-074-RENA-P4-09	SLG fault on Renaker-Williamstown 69kV, SB '634' at Renaker 69kV, Loss of Renaker 69kV Bus	8.0	19.0	OK
43	AC1-074-RENA-P4-10	SLG fault on Renaker – Lees Lick – KU Scott 69 kV, SB '614' at Renaker 69 kV, Loss of Renaker 69 kV Bus	8.0	19.0	OK
44	AC1-074-SPUR-P4-01	SLG fault on Spurlock – Stanley Parker 138 kV (N Bus), SB '814' at Spurlock 138 kV North Bus, Loss of Spurlock 138 kV North Bus	6.0	14.0	OK
46	AC1-074-SPUR-P4-02	SLG fault on Spurlock – Maysville – Plumville 138 kV (N Bus), SB '834' at Spurlock 138 kV North Bus, Loss of Spurlock 138 kV North Bus	6.0	14.0	OK
47	AC1-074-SPUR-P4-03	SLG fault on Spurlock – Kenton 138 kV (N Bus), SB '854' at Spurlock 138 kV North Bus, Loss of Spurlock 138 kV North Bus	6.0	14.0	OK
48	AC1-074-SPUR-P4-04	SLG fault on Spurlock G1, SB '18G' at Spurlock 138 kV South Bus, Loss of Spurlock 138 kV South Bus	6.0	14.0	OK
49	AC1-074-SPUR-P4-05	SLG fault on Spurlock 138/345 kV TF 9, SB '878' at Spurlock 138 kV North Bus, Loss of Spurlock 138 kV North Bus	6.0	14.0	OK
50	AC1-074-SPUR-P4-05	SLG fault on Spurlock – Renaker 138 kV (S Bus), SB '824' at Spurlock 138 kV South Bus, Loss of Spurlock 138 kV South Bus	6.0	15.0	OK
50	AC1-074-SPUR-P4-05	SLG fault on Spurlock – Flemingsburg / Godard 138 kV (S Bus), SB '844' at Spurlock 138 kV South Bus, Loss of Spurlock 138 kV South Bus	6.0	15.0	OK

No.	Contingency ID	Type of Fault	Clearing time (cycles)		Results
			Normal	Delayed	
51	AC1-074-SPUR-P4-05	SLG fault on Spurlock – Inland 138 kV (S Bus), SB '864' at Spurlock 138 kV South Bus, Loss of Spurlock 138 kV South Bus	6.0	15.0	OK
52	AC1-074-SPUR-P4-05	SLG fault on Spurlock 138/345 kV TF 10, SB '888' at Spurlock 138 kV S Bus, Loss of Spurlock 138 kV South Bus	6.0	15.0	OK
53	AC1-074-AVON-P4-01	SLG fault on Avon – Jacksonville – AC1-074 Tap 138 kV, SB '844' at Avon 138 kV, Loss of Avon-KU Loudon 138kV line	6.0	15.0	OK
54	AC1-074-AVON-P4-02	SLG fault on Avon – Jacksonville – AC1-074 Tap 138 kV, SB '834' at Avon 138 kV, Loss of Avon 138/345 kV TF	6.0	15.0	OK
55	AC1-074-AVON-P4-03	SLG fault on Avon 138/345 kV TF, SB '834' at Avon 138 kV, Loss of Avon – Jacksonville – AC1-074 Tap 138 kV	6.0	15.0	OK
56	AC1-074-AVON-P4-04	SLG fault on Avon 138/345 kV TF, SB '814' at Avon 138 kV, Loss of Avon – Becknerville – Boonesboro – Dale 138 kV	6.0	15.0	OK
57	AC1-074-AVON-P4-05	SLG fault on Avon – Becknerville – Boonesboro – Dale 138 kV, SB '814' at Avon 138 kV, Loss of Avon 138/345 kV TF	6.0	15.0	OK
58	AC1-074-AVON-P4-06	SLG fault on Avon – Becknerville – Boonesboro – Dale 138 kV, SB '824' at Avon 138 kV, Loss of Avon – Fayette 138 kV	6.0	15.0	OK
59	AC1-074-AVON-P4-07	SLG fault on Avon – Fayette 138 kV, SB '824' at Avon 138 kV, Loss of Avon – Becknerville – Boonesboro – Dale 138 kV	6.0	15.0	OK
60	AC1-074-AVON-P4-08	SLG fault on Avon-Fayette 138kV, SB '864' at Avon 138kV, Loss of Avon – KU Loudon 138kV	6.0	15.0	OK
Criteria = TPL 001-4_P5					
		Not required – Communication redundancy			
Criteria = TPL 001-4_P7					
61	AC1-074-SPUR-P7-01	SLG fault on Spurlock – Stanley Parker 138 kV (N Bus) + Spurlock – Renaker 138 kV (S Bus)	6.0	N/A	OK
62	AC1-074-SPUR-P7-02	SLG fault on Spurlock – Maysville – Plumville 138 kV (N Bus) + Spurlock – Flemingsburg / Goddard 138 kV (S Bus)	6.0	N/A	OK

Appendix B: Project Model

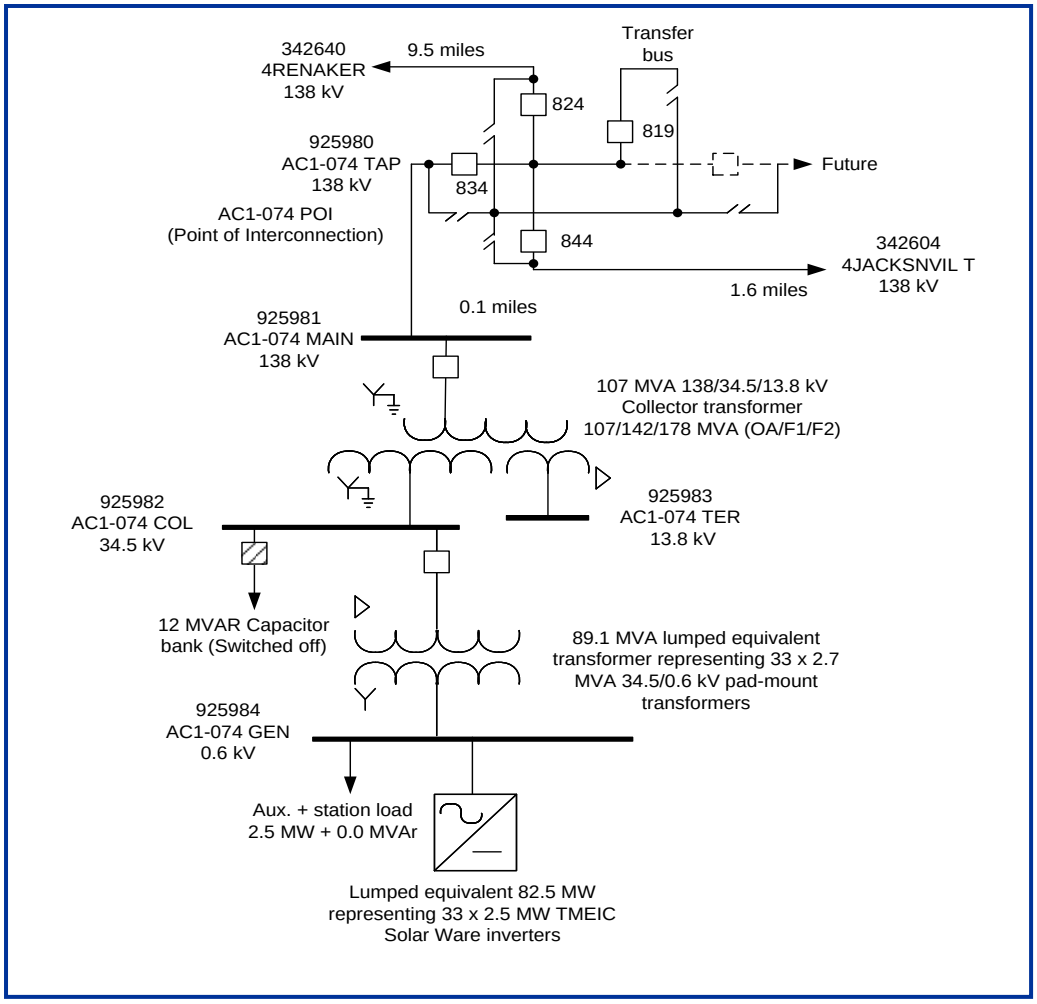


Figure B-1: PJM AC1-074 modeling details

Table 1: AC1-074 Plant Model

	Impact Study Data	Model
Solar inverters	33 x 2.5 MW TMEIC Solar Ware inverters MVA base = 2.7 MVA Vt = 0.6 kV Unsaturated sub-transient reactance = N/A	Lumped equivalent representing 33 x 2.5 MW TMEIC Solar Ware inverters Pgen 82.5 MW Pmax 82.5 MW Pmin 0 MW Qgen 5.224 MVAr Qmax 33.65 MVAr Qmin -33.65 MVAr Mbase 89.1 MVA Zsorce j999999.0 pu @ Mbase
Solar inverter GSU transformers	33 x 34.5/0.6 kV two winding transformers Rating = 2.7 MVA Transformer base = 2.7 MVA Impedance = 0.0045 + j0.057 pu @ MVA base Number of taps = NA Tap step size = NA	Lumped equivalent representing 33 x 34.5/0.6 kV two winding transformers Rating = 89.1 MVA Transformer base = 89.1 MVA Impedance = 0.0045 + j0.057 pu @ MVA base Number of taps = 5 Tap step size = 2.5 %
Collector step-up transformer	1 x 138/34.5/13.8 kV three winding transformer Rating = 107/142/178 MVA (OA/F1/F2) Transformer base = 107 MVA Impedances: High to low = 0.0019 + j0.09 pu High to tertiary = 0.0046 + j0.1278 pu Low to tertiary = 0.0032 + j0.0252 pu All impedances @ MVA base Number of taps = 5 Tap step size = 2.5%	1 x 138/34.5/13.8 kV three winding transformer Rating = 107/142/178 MVA (OA/F1/F2) Transformer base = 107 MVA Impedances: High to low = 0.0019 + j0.09 pu High to tertiary = 0.0046 + j0.1278 pu Low to tertiary = 0.0032 + j0.0252 pu All impedances @ MVA base Number of taps = 5 Tap step size = 2.5%
Capacitor banks	34.5 kV level two 6 MVAR cap banks	12 MVAR capacitor bank (Switched off)
Auxiliary and station load	2.5 MW + 0.00 MVAr	2.5 MW + 0.00 MVAr at low voltage side of GSU
Transmission line	138kV 0.1 Miles Positive sequence impedance = 0.00031+0.00293j pu Charging susceptance = 0.0001 pu @ 100 MVA base	Positive sequence impedance = 0.00031+0.00293j pu Charging susceptance = 0.0001 pu @ 100 MVA base

Appendix C: Power Flow and Dynamic Models

C.1) Power Flow Model Data

```
VERSION 33

BAT_PURGBRN,342640,342604,'1'

RDCH

1

925980,'AC1-074 TAP ', 138.0000,1, 320,   6, 340,1.01087,
1.9962,1.10000,0.90000,1.10000,0.90000

925981,'AC1-074 MAIN', 138.0000,1, 320,   1,   1,1.01100,
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925982,'AC1-074 COL ',  34.5000,1, 320,   1,   1,1.01126,
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925983,'AC1-074 TER ',  13.8000,1, 320,   1,   1,1.01116, -
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925984,'AC1-074 GEN ',   0.6000,2, 320,   1,   1,1.01728, -
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1,1,0

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 1.90000E-3, 9.00000E-2,   107.00, 3.20000E-3, 2.52000E-2,   107.00, 4.60000E-3, 1.27800E-1,
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1.00000, 138.000,   0.000,   107.00,   142.00,   178.00, 0,      0, 1.05000, 0.95000, 1.05000,
0.95000,   5, 0, 0.00000, 0.00000,  0.000

1.00000,  34.500,   0.000,   107.00,   142.00,   178.00, 0,      0, 1.05000, 0.95000, 1.05000,
0.95000,   5, 0, 0.00000, 0.00000,  0.000
```

Dynamic Data

```
/*************************************************************************
************************

/*** Project:       AC1-074 - 80 MW MFO

/*** POI:           Renaker – Jacksonville Tap 138 kV (EKPC)

/*** Type:          Solar

/*** Size:          33 x 2.5 MW TMEIC inverters

/*** PSSE Version:  33

/*************************************************************************
************************

/Generator/ Converter (Inverter)

925984 'USRMDL' '1' 'PVGU1' 101    1 0 9 3 3

0.02      0.02      0.0  0.1  2.0

2         1.0  2.0  0.02 /


/Electrical Control Model for the PV converter

925984 'USRMDL' '1' 'PVEU1' 102 0 4 24 10 4

0    0    1    0

0.1       13        2              0              0

0         0.08      0.415          -0.415         0.926

0.02           1         -1               0.05          0.1
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C.2) PSS/E Single Line Diagram

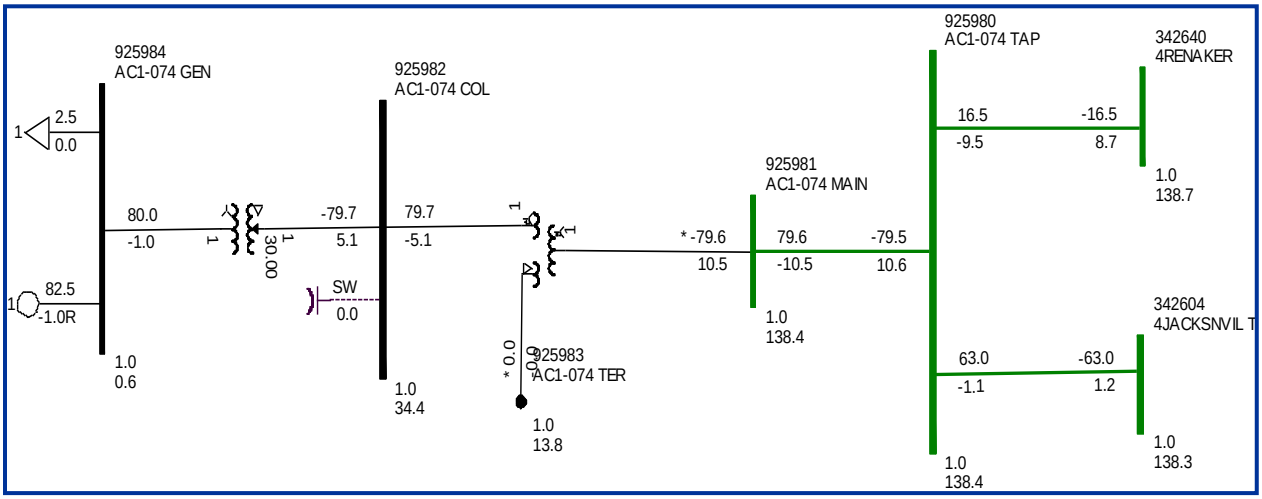


Figure C-1: Single-line diagram for AC1-074 2020-SP case (Breaker information not shown)

C.3) Area Generation

C.4)

Bus Number	Bus Name	Id	VSched (pu)	Remote Bus Number	In Service	PGen (MW)	PMax (MW)	PMin (MW)	QGen (Mvar)	QMax (Mvar)	QMin (Mvar)	Mbase (MVA)
248005	06KYGER 345.00	1	1.02	0	1	72.0	72.6	22.2	11.8	20.3	-22.6	100.0
248005	06KYGER 345.00	2	1.02	0	1	72.0	72.6	22.2	11.8	20.3	-22.6	95.0
248005	06KYGER 345.00	3	1.02	0	1	72.0	72.6	22.2	11.8	20.3	-22.6	95.0
248005	06KYGER 345.00	4	1.02	0	1	72.0	72.6	22.2	11.8	20.3	-22.6	95.0
248005	06KYGER 345.00	5	1.02	0	1	72.0	72.6	22.2	11.8	20.3	-22.6	95.0
248005	06KYGER 345.00	6	1.02	0	1	123.0	123.6	37.8	20.2	34.5	-38.6	117.7
248005	06KYGER 345.00	7	1.02	0	1	123.0	123.6	37.8	20.2	34.5	-38.6	123.4
248005	06KYGER 345.00	8	1.02	0	1	123.0	123.6	37.8	20.2	34.5	-38.6	123.4
248005	06KYGER 345.00	9	1.02	0	1	123.0	123.6	37.8	20.2	34.5	-38.6	123.4
248005	06KYGER 345.00	A	1.02	0	1	123.0	123.6	37.8	20.2	34.5	-38.6	123.4
251968	08ZIMRHP 26.000	1	1.0261	249577	1	870.0	872.0	420.0	205.0	205.0	-86.6	975.0
251969	08ZIMRLP 22.000	1	1.0261	249577	1	476.0	478.0	230.0	102.1	102.1	-43.1	780.0
253038	09KILLEN 345.00	2	1.0377	0	1	610.0	612.0	230.0	199.0	199.0	-63.0	734.0
253038	09KILLEN 345.00	3	1.0377	0	1	16.9	18.0	15.7	18.0	18.0	-10.2	33.7
253077	09STUART 345.00	1	1.0145	0	1	580.0	580.6	300.0	5.6	280.0	-17.0	678.0
253077	09STUART 345.00	2	1.0145	0	1	580.0	580.0	300.0	5.6	280.0	-30.0	678.0
253077	09STUART 345.00	3	1.0145	0	1	580.0	580.4	300.0	8.0	280.0	8.0	678.0
253077	09STUART 345.00	4	1.0145	0	1	577.0	577.0	300.0	5.6	280.0	-30.0	678.0
253077	09STUART 345.00	5	1.0145	0	1	7.7	9.2	0.0	0.1	8.8	-5.2	13.0
253110	09ADKINS 345.00	1	1.0022	0	1	82.0	82.0	38.0	24.0	24.0	-15.0	108.0

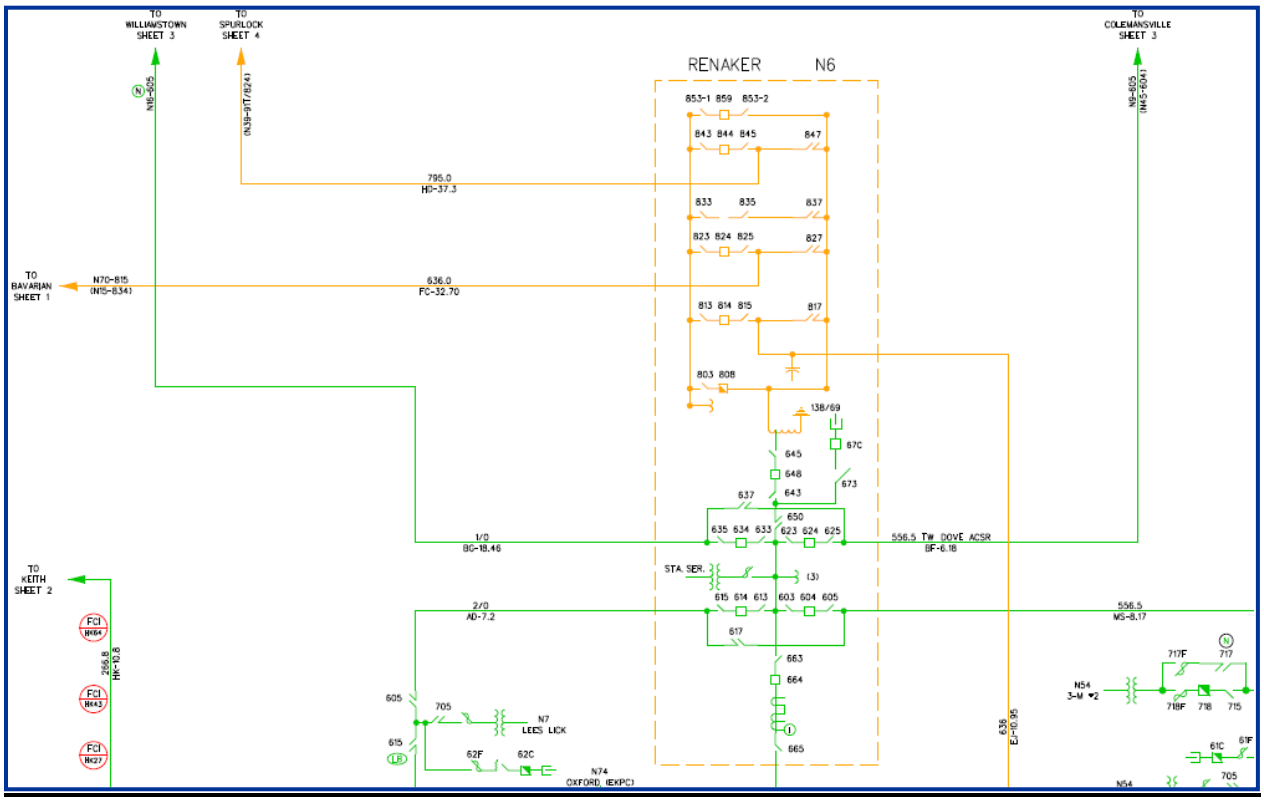
Bus Number	Bus Name	Id	VSched (pu)	Remote Bus Number	In Service	PGen (MW)	PMax (MW)	PMin (MW)	QGen (Mvar)	QMax (Mvar)	QMin (Mvar)	Mbase (MVA)
253110	09ADKINS 345.00	2	1.0022	0	1	82.0	82.0	38.0	22.0	22.0	-16.0	108.0
253110	09ADKINS 345.00	3	1.0022	0	1	81.0	81.0	38.0	22.0	22.0	-13.0	108.0
253110	09ADKINS 345.00	4	1.0022	0	1	80.0	80.0	38.0	22.0	22.0	-14.0	108.0
253110	09ADKINS 345.00	5	1.0022	0	1	82.0	82.0	38.0	27.0	27.0	-13.0	108.0
253110	09ADKINS 345.00	6	1.0022	0	1	79.0	79.0	38.0	25.0	25.0	-14.0	108.0
324017	1GHNT 1 18.000	1	1.018	324253	1	519.0	519.0	180.0	115.4	226.0	-156.0	640.0
342018	1GHNT 2 22.000	2	1.0203	324105	1	528.0	528.0	168.0	96.5	255.0	-68.0	618.2
342019	1GHNT 3 22.000	3	1.0203	324105	1	528.0	528.0	168.0	96.5	255.0	-68.0	618.2
342020	1GHNT 24 22.000	4	1.0203	324105	1	512.0	512.0	181.0	96.5	268	-43.0	618.0
342918	1JKCT 1G 13.800	1	1	0	1	110.0	110.0	0.0	-2.3	78.0	-60.3	140.0
342921	1JKCT 2G 13.800	1	1	0	1	110.0	110.0	0.0	-2.4	78.0	-60.3	140.0
342924	1JKCT 3G 13.800	1	1	0	1	110.0	110.0	0.0	-2.4	78.0	-60.3	140.0
342927	1JKCT 4G 13.800	1	1	0	1	73.0	73.0	0.0	18.5	40.0	-34.5	103.0
342930	1JKCT 5G 13.800	1	1	0	1	73.0	73.0	0.0	18.5	40.0	-34.5	103.0
342933	1JKCT 6G 13.800	1	1	0	1	73.0	73.0	0.0	17.7	72.5	-42.7	103.0
342936	1JKCT 7G 13.800	1	1	0	1	73.0	73.0	0.0	17.7	72.5	-42.7	103.0
342939	1JKCT 9G 13.800	1	1	0	1	73.0	76.0	0.0	38.8	41.8	-76.0	127.3
342942	1JKCT 10G 13.800	1	1	0	1	76.0	76.0	0.0	39.3	41.8	-76.0	127.3
342957	1SPURLK1G 22.000	1	1	0	1	344.0	344.0	100.0	127.4	175.0	-142.0	360.0
342960	1SPURLK2G 22.000	1	1	0	1	554.0	555.0	210.0	208.0	290.0	-227.0	636.6
342963	1SPURLK3G 18.000	1	1	0	1	304.0	306.0	80.0	128.6	268.0	-138.2	387.5
342966	1SPURLK4G 18.000	1	1	0	1	304.0	306.0	80.0	128.6	268.0	-138.2	387.5
894753	V3-045 G1 13.800	1	1.0109	250154	1	37.3	37.3	0.0	1.4	16.0	-16.0	40.3
894754	V3-045 G2 13.800	1	1.0109	250154	1	37.3	37.3	0.0	1.4	16.0	-16.0	40.3
894755	V3-045 G3 13.800	1	1.0109	250154	1	37.3	37.3	0.0	1.4	16.0	-16.0	40.3
925984	AC1-074 GEN 0.6000	1	1	0	1	82.5	82.5	0.0	-1.0	33.7	-33.7	89.1
931183	AB1-169 CT1 25.000	1	1.0145	253077	1	341.0	341.0	0.0	99.7	165.6	-112.4	380.0
931184	AB1-169 ST1 25.000	1	1.0145	253077	1	243.6	243.6	0.0	99.7	300.0	-177.0	437.0
931185	AB1-169 CT2 25.000	1	1.0145	253077	1	341.0	341.0	0.0	99.7	165.6	-112.4	380.0
931186	AB1-169 ST2 25.000	1	1.0145	253077	1	243.6	243.6	0.0	99.7	300.0	-177.0	437.0

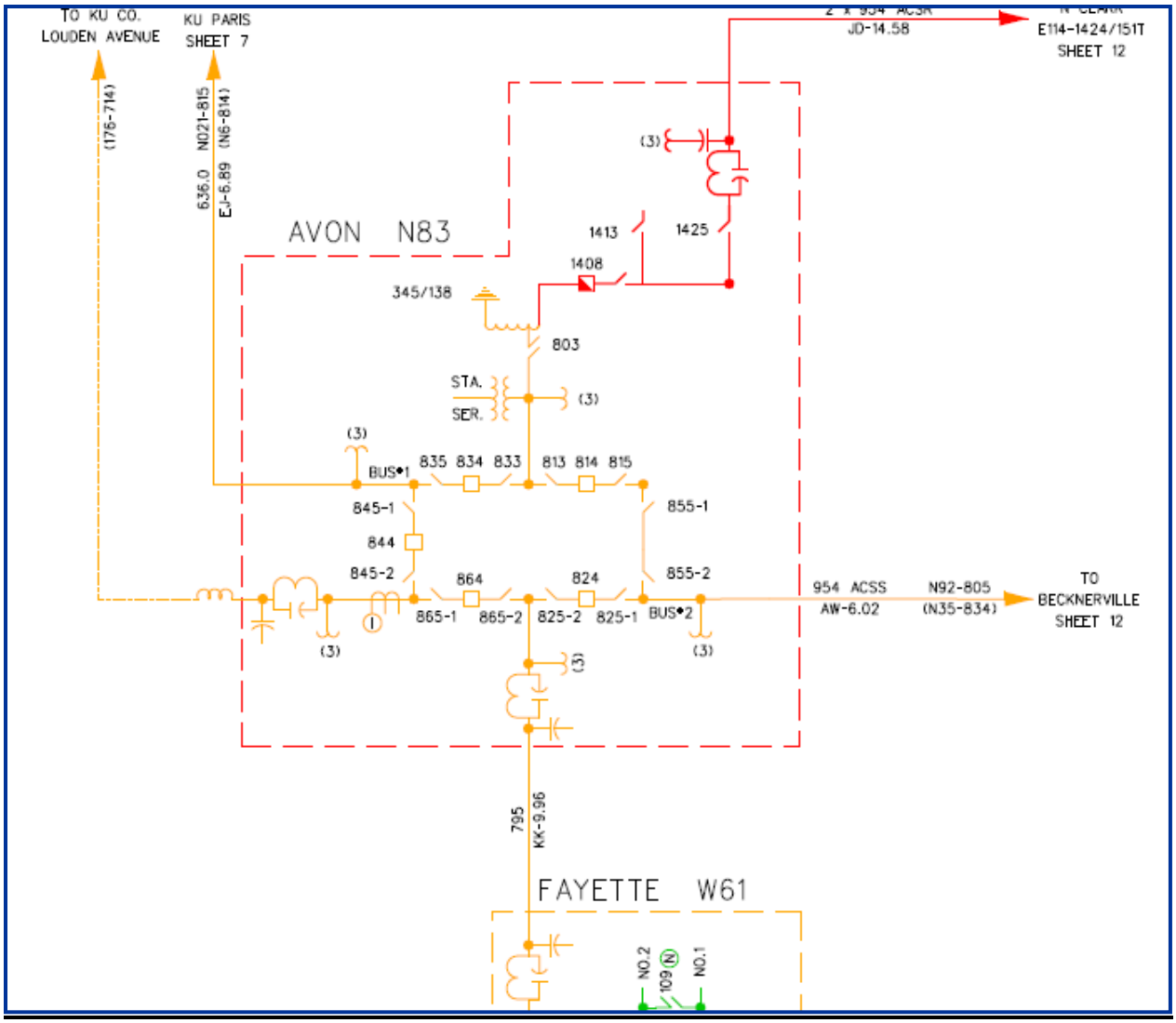
C.5) Area Plants

Bus Number	Bus Name	Code	PGen (MW)	QGen (Mvar)	QMax (Mvar)	QMin (Mvar)	VSched (pu)	Remote Bus Number	Remote Bus Name	Voltage (pu)	RMPCT
248005	06KYGER 345.00	2	975	160	274	-306	1.02	0		1.02	100
251968	08ZIMRHP 26.000	-2	870	205	205	-86.6	1.0261	249577	08ZIMER 345.00	1.0166	58
251969	08ZIMRLP 22.000	-2	476	102.1	102.1	-43.1	1.0261	249577	08ZIMER 345.00	1.0166	42
253038	09KILLEN 345.00	-2	626.9	217	217	-73.2	1.0377	0		1.025	100

Bus Number	Bus Name	Code	PGen (MW)	QGen (Mvar)	QMax (Mvar)	QMin (Mvar)	VSched (pu)	Remote Bus Number	Remote Bus Name	Voltage (pu)	RMPCT
253077	09STUART 345.00	2	2324.7	24.9	1128.8	-74.2	1.0145	0		1.0145	25
253110	09ADKINS 345.00	-2	486	142	142	-85	1.0022	0		0.9981	100
324017	1GHNT 1 18.000	2	519	115.4	226	-156	1.018	324253	4GHENT 138.00	1.018	100
342918	1JKCT 1G 13.800	2	110	-2.3	78	-60.3	1	0		1	100
342921	1JKCT 2G 13.800	2	110	-2.4	78	-60.3	1	0		1	100
342924	1JKCT 3G 13.800	2	110	-2.4	78	-60.3	1	0		1	100
342927	1JKCT 4G 13.800	2	73	18.5	40	-34.5	1	0		1	100
342930	1JKCT 5G 13.800	2	73	18.5	40	-34.5	1	0		1	100
342933	1JKCT 6G 13.800	2	73	17.7	72.5	-42.7	1	0		1	100
342936	1JKCT 7G 13.800	2	73	17.7	72.5	-42.7	1	0		1	100
342939	1JKCT 9G 13.800	2	73	38.8	41.8	-76	1	0		1	10
342942	1JKCT 10G 13.800	2	76	39.3	41.8	-76	1	0		1	10
342957	1SPURLK1G 22.000	2	344	127.4	175	-142	1	0		1	100
342960	1SPURLK2G 22.000	2	554	208	290	-227	1	0		1	100
342963	1SPURLK3G 18.000	2	304	128.6	268	-138.2	1	0		1	100
342966	1SPURLK4G 18.000	2	304	128.6	268	-138.2	1	0		1	100
894753	V3-045 G1 13.800	2	37.3	1.4	16	-16	1.0109	250154	08MELDLS 138.00	1.0109	100
894754	V3-045 G2 13.800	2	37.3	1.4	16	-16	1.0109	250154	08MELDLS 138.00	1.0109	100
894755	V3-045 G3 13.800	2	37.3	1.4	16	-16	1.0109	250154	08MELDLS 138.00	1.0109	100
925984	AC1-074 GEN 0.6000	2	82.5	-1	33.6	-33.6	1	0		1	100
931183	AB1-169 CT1 25.000	2	341	99.7	165.6	-112.4	1.0145	253077	09STUART 345.00	1.0145	100
931184	AB1-169 ST1 25.000	2	243.6	99.7	300	-177	1.0145	253077	09STUART 345.00	1.0145	100
931185	AB1-169 CT2 25.000	2	341	99.7	165.6	-112.4	1.0145	253077	09STUART 345.00	1.0145	100
931186	AB1-169 ST2 25.000	2	243.6	99.7	300	-177	1.0145	253077	09STUART 345.00	1.0145	100

C.6) Switching Diagrams





Generation Interconnection Facility Study Report

For

PJM Generation Interconnection Request Queue Position - AC1-074

Bluebird Solar – 80 MW

November 2020

General

Bluebird Solar LLC, the Interconnection Customer (IC), has proposed a solar generating facility located in Harrison County, Kentucky. The installed facilities will have a total capability of 80 MW with 56 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is June 1, 2019. **This study does not imply an EKPC commitment to this in-service date.**

This new commercial operation date for this project is November 30, 2022. Please note that this Facilities Study Report was prepared based on an older commercial operation date.

Point of Interconnection

AC1-074 shall interconnect with the EKPC's system at the new proposed Harrison County Substation, located along the Jacksonville – Renaker 138 kV line.

Cost Summary

The AC1-074 project shall be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 350,000
Direct Connection Network Upgrades	$ 6,810,000
Non Direct Connection Network Upgrades	$ 130,000
Allocation for New System Upgrades	$ 0
Contribution for Previously Identified Upgrades	$ 0
Total Costs	**$ 7,290,000**

A. Transmission Owner Facilities Study Summary

1. General Description of Project

Bluebird Solar LLC (Solar), the Interconnection Customer (IC), has proposed an 80 MW solar powered generating facility located near Leesburg, in Harrison County, Kentucky. PJM studied AC1-074 as an 80 MW injection into the East Kentucky Power Cooperative ("EKPC") Transmission System at a newly constructed 138 kV switching station, and evaluated it for compliance with reliability criteria for summer peak conditions in 2020. The proposed in-service date is June 1, 2019.

The intent of this study is to define the cost and construction schedule for EKPC and other transmission facilities, necessary system reinforcements, and protection requirements to accommodate the above Generator Interconnection Request.

2. Amendments to the System Impact Study Data or System Impact Study Results

The project costs and construction schedule have been refined in this report for increased accuracy and thereby differ from that which was presented in the Feasibility and System Impact Study reports. All estimates have been created based on meeting the earliest in-service date possible at the request of the IC. From EKPC's perspective, subject to the assumptions tabulated throughout this study, the requested in-service date of June 1, 2020 cannot be met, with the EKPC portion of the project expected to be complete by **November 30, 2021**. In order to maintain this schedule, an executed Construction Service Agreement (CSA) is required no later than **December 13, 2019**. Any delay to the execution of this CSA shall result in a delay to the projected in-service date.

3. Interconnection Customer's Milestone Schedule

IC's requested Commercial Operation Date (COD) for the generation facility is **June 1, 2020**. Milestone details were not provided for the IC's schedule.

4. Scope of Interconnection Customer's Work

The Point of Interconnection ("POI") will be the IC side of a 138 kV disconnect switch. The location of this switch will be determined during project scoping, and EKPC may require that this switch be located in the IC's substation. The IC substation shall be constructed adjacent to the new EKPC switching station (referred to as "Harrison County" herein). The IC customer will install 138 kV bus work or conductor from this 138 kV disconnect switch to their associated equipment. The IC will be responsible for acquiring all right of way, easements, and environmental approvals and permits for both the IC required facilities and any facilities that are to be constructed by EKPC. The IC will be responsible for constructing, owning, operating, and maintaining its facilities, and EKPC will have no responsibility for any of these activities.

5. Description of Facilities Included in the Facilities Study

This report describes the electrical facilities and system upgrades necessary to support the IC's project.

EKPC will construct a 138 kV switching station to include a new loop in tap on the EKPC Renaker to Jacksonville 138 kV line section to accommodate the direct connection of the IC's substation. EKPC will also construct a 138 kV disconnect switch structure which will be the POI. A temporary one line diagram and proposed draft layout of the EKPC substation is included in Attachment I of this study.

EKPC will also complete the required non direct connection network upgrades which includes relay upgrades at both Renaker and Avon to accommodate the addition of this new facility.

6. Total Costs of Transmission Owner Facilities included in Facilities Study

The costs estimated below are in 2018 dollars and do not include a Contribution in Aid of Construction ("CIAC") Federal Income Tax Gross Up charge. This tax may or may not be charged based on IRS requirements.

Description	Total Cost
Attachment Facilities	$ 350,000
Direct Connection Network Upgrades	$ 6,810,000
Non Direct Connection Network Upgrades	$ 130,000
Total Costs	**$ 7,290,000**

7. Summary of Milestone Schedules for Completion of Work Included in Facilities Study:

A proposed twenty-two (22) month direct connection construction schedule is estimated from the date of a fully executed Interconnection Service Agreement and Construction Kick-Off Meeting to complete construction and the associated activities listed. This schedule assumes that all issues covered by the "Environmental, Real Estate, and Permitting Issues" section of this document are resolved, relevant PJM RTEP baseline projects will be completed as needed and all required outages occur as planned. A more detailed construction schedule will be developed for the Interconnection Construction Service Agreement. Construction shall not begin until all applicable permits and/or easements and land rights have been obtained.

This proposed schedule assumes the following:

1. Required transmission line outages can be scheduled as planned. Transmission line outages are:

a. Typically not taken from June to August or December to February,
b. Discouraged during extreme weather conditions, and
c. In some cases, transmission outages must be scheduled twelve (12) months or more in advance.

2. No delays due to equipment delivery, environmental, regulatory, permitting, real estate, extreme weather, or similar events.
3. No significant rock is encountered during construction, and soil conditions are suitable for EKPC standard ground grid and foundation installations.
4. Required access and line easements are acquired by the IC and conveyed to EKPC in a timely manner.
5. Required substation property is acquired by the IC and conveyed to EKPC in a timely manner.
6. Environmental permits and requirements are completed by the IC in a timely manner.

EKPC's proposed schedule, as shown below, does not match the IC's requested schedule. The following schedule is contingent upon receipt of an executed ICSA by **December 13, 2019.** A project meeting must occur no later than **January 1**, **2020** to meet EKPC's Milestone Schedule.

Description	**Start Date**	**Completion Date**
Design (Including Site Grading Design)	2/2020	5/2020
Procure Materials and Equipment	5/2020	5/2021
Site Preparation	7/2020	1/2021
Line Upgrade – OPGW	1/2021	5/2021
Substation Construction	2/2021	9/2021
Tap Line Construction	8/2021	10/2021
Commissioning and Testing	10/2021	11/2021

B. Transmission Owner Facilities Study Results

The facilities identified to be installed, replaced, and/or upgraded by EKPC to accommodate the proposed project are described in this section. During detailed design and analysis, other components may be identified for installation or replacement due to this project.

1. Transmission Lines – New

A new loop-in tap line will be constructed from EKPC's existing Jacksonville to Renaker 138 kV transmission line to the new switching station as shown in Attachment I of this study, which will be owned, operated, and maintained by EKPC. Several new transmission poles will be installed to tap the existing line section and bring the two ends into the new switching station. The loop from the Jacksonville to Renaker 138 kV circuit to the new substation is expected to extend approximately 500 feet.

The estimated cost for the new line construction for this project is $520,000.

Transmission Line Assumptions:

The following general assumptions have been included for the transmission line information provided:

1. Required transmission line outages can be scheduled as planned. Transmission line outages are:
    a. typically not taken from June to August or December to February,
    b. discouraged during extreme weather conditions, and
    c. in some cases, must be scheduled twelve (12) or more months in advance.
2. No delays due to equipment or material delivery, environmental, regulatory, permitting, real estate, extreme weather, or similar events.
3. No significant rock encountered during construction, and soil conditions suitable for standard foundation installations.

The following engineering assumptions have been included for the transmission line information provided:

1. Neither foundation nor tower structural analyses have been performed.
2. Construction will be scheduled to avoid summer and winter peak load periods (June-August or December - February).
3. Schedule assumes no issues with obtaining transmission outages.
4. Material and equipment costs are based on current (May 2018) pricing.
5. Easements shall be acquired by the IC and conveyed to EKPC.
6. Environmental permits and requirements shall be completed by the IC.

2. Transmission Line – Upgrades

OPGW installation will be required to meet communications requirements for this facility. This OPGW will provide communications to the new facility on the line section to Renaker Switchyard. OPGW will be installed on the Harrison County – Renaker line section, which is approximately 9.35 miles in length.

The estimated cost for the new OPGW installation for this project is $1,270,000.

3. New Substation/Switchyard Facilities

EKPC will build a new 138 kV switching station adjacent to the IC's substation.

The project will be connected to a new 138 kV switching station which will be owned, operated, and maintained by EKPC. The new interconnection substation is to be constructed adjacent to the Jacksonville to Renaker 138 kV transmission line, approximately 1.6 miles from Jacksonville Substation.

Below is a list of the major equipment and material associated with the new substation:

QTY	Unit	DESCRIPTION
1	Each	138 kV High Profile Substation Structure
4	Each	138 kV, 2000 Amp Circuit Breakers
15	Each	138 kV GOAB Switches
1	Lot	Electrical Material (insulators, terminals, etc.)
1	Each	Station Service Transformer, 100 KVA (138000-120/240V)
9	Each	Arresters, Lightning 108Kv Station 88Mcov Polymer Upright
3	Each	CT's, 138 kV
3	Each	CCVT's , 138 kV

For attachment facilities, EKPC will also construct a 138 kV switch structure. The exact location of the switch structure will be determined at project scoping, and it may be determined that the location should be in the IC's substation. EKPC will own, operate, and maintain this switch and its associated structure. EKPC will require permanent access to the IC substation for this switch if the switch is located in the IC substation.

The IC is responsible for construction of all of the facilities on its side of the POI, as shown in the attached one-line diagram.

The IC is responsible for obtaining property rights for the EKPC switching station site, and all necessary easements for a permanent drive to provide substation access. This substation access shall be from an existing county road. The IC shall convey these rights to EKPC.

System Protection

The following system protection scope applies for this project. All system protection equipment in this section will be owned, operated, and maintained by EKPC.

Control House: EKPC shall procure and install a drop-in style control building fully furnished and complete with one Bus Differential Panel, three Line Panels, one Transfer Line Panel, two 125VDC battery banks, and all required operating equipment.

Relay Panels: EKPC shall install a standard bus panel complete with P1 & P2 SEL-587Z relays tripping a P1 & P2 lock out relay. Line Transfer Panel (819) – EKPC shall install a standard transfer line panel with P1 & P2 SEL-421 relays. A SEL-451 relay shall be utilized for breaker control, breaker failure, and reclosing. The line panel shall have the capability to transfer breakers 834, 844, & 854. Line Panel (834) – EKPC shall install a standard line panel with P1 & P2 SEL-421 relays. These relays shall utilize step distance protection to reach into the Bluebird Solar GSU transformer impedance with an instantaneous zone 1. A SEL-451 relay shall be utilized for breaker control, breaker failure, and reclosing. Line Panel (844) – EKPC shall install a standard line panel with P1 & P2 SEL-421 relays. The P1 relay shall utilize a high speed POTT scheme over fiber. A SEL-451 relay shall be utilized for breaker control, breaker failure, and reclosing. Line Panel (854) – EKPC shall install a standard line panel with P1 & P2 SEL-421 relays. The P1 relay shall utilize a high speed POTT scheme over fiber. A SEL-451 relay shall be utilized for breaker control, breaker failure, and reclosing.

EKPC requires the IC to utilize all Schweitzer Engineering Laboratories (SEL) relays and related protective equipment that will be interconnecting or communicating with EKPC relaying. EKPC reserves the right to specify relays or other protection equipment utilized in the IC substation as required based on the protection schemes utilized. All protection system designs shall be reviewed by EKPC System Protection during the design phase to ensure proper clearing times, coordination, and compliance with any applicable NERC regulations.

Control cable shall be pulled from new breakers and other required equipment to the control house.

Commissioning: Each relay panel shall be fully commissioned prior to being placed in service. Commissioning shall include AC current and potential circuits, DC functional, relay testing, and end-to-end testing where required. Each of the remote line ends (Renaker and Avon/KU Paris) shall be commissioned using end-to-end testing prior to energizing the POTT scheme to Harrison County. The end-to-end testing shall require coordination with neighboring utilities during commissioning.

The estimated cost for the substation and system protection construction for this project is $5,370,000. This estimate includes $350,000 for the previously mentioned attachment facilities

between the IC substation and the EKPC substation. This estimate also includes costs for metering and telecommunications equipment that will be located inside the EKPC substation.

Substation & System Protection Assumptions:

The following general assumptions have been included for the substation information provided:

1. No delays due to equipment or material delivery, environmental, regulatory, permitting, real estate, extreme weather, or similar events.
2. No significant rock encountered during construction, and soil conditions suitable for standard ground-grid and foundation installations.
3. IC shall acquire adequate land size to accommodate EKPC's interconnection substation, as mentioned above.
4. The IC shall obtain property rights for all necessary easements for a permanent drive to provide substation access. This access shall be from an existing county road.

The following engineering assumptions have been included for the substation information provided:

1. Neither foundation nor structural analyses have been performed.
2. Schedule assumes no issues with outages.
3. Schedule assumes no coordination issues with neighboring systems for relay testing and commissioning.
4. Material and equipment related costs are based on current (May 2018) pricing.
5. Environmental permits and requirements will be completed by the IC in a timely manner.

4. Upgrades to Substation/Switchyard Facilities

EKPC shall complete the required non-direct connection network upgrades which may include relay upgrades at both Renaker and Avon to accommodate the addition of this new facility.

Renaker – Relay settings shall be reviewed for the Renaker line to accommodate the new switching station and relay files updated accordingly.

Avon/KU Paris Line – Relay settings shall be reviewed for the three terminal Avon/KU Paris line to accommodate the new switching station and relay files updated accordingly.

The estimated cost for the relay upgrades required for this project is $130,000.

5. Metering & Communications

Metering:

Metering requirements for this facility include the installation of EKPC's standard revenue quality metering package, including potential transformers, current transformers and the associated SCADA equipment.

The cost for installation of the metering facilities contained in the new EKPC substation are included in the substation costs above.

Metering Assumptions:

The following assumptions have been included for the metering information provided:

1. No delays due to equipment or material delivery, environmental, regulatory, permitting, real estate, extreme weather, or similar events..
2. Fiber installation is completed as scheduled.
3. Material and equipment related costs are based on current (May 2018) pricing.
4. Once fiber installation is complete, the fiber will not be damaged.

Communications:

EKPC shall use telecom equipment that matches its current network and equipment requirements. The scope shall also include a standard 48VDC charger and battery system to power the communications equipment in the control house

A 48-count ADSS fiber will be installed between the EKPC substation control house and the IC facility for relaying, metering, and/or SCADA circuit requirements. Exact details and installation plans for this fiber will be developed during project scoping.

The cost for installation of the telecommunications facilities contained in the new EKPC substation are included in the substation costs above.

Communications Assumptions:

The following assumptions have been included for the communications information provided:

1. No delays due to equipment or material delivery, environmental, regulatory, permitting, real estate, extreme weather, or similar events.
2. Material and equipment related costs are based on current (May 2018) pricing.
3. Once fiber installation is complete, the fiber will not be damaged

Other Required Upgrades

PJM has indicated the need for the Spurlock Reactor Resize project, (PJM upgrade id b2827) to be completed before the AC1-074 project can be placed in service. The cost to accelerate the completion date of baseline project b2827 is not included in this Facilities study since the expected commercial operation date of b2827 (6/1/2021) is before the commercial operation date of the AC1-074 project (11/30/2021).

6. Environmental, Real Estate and Permitting Issues

The IC is responsible for obtaining all of the required property rights to provide EKPC ownership of the new switching station site, as well as, any permanent easements needed for the switching station access road and the transmission tap line. The IC shall convey these rights to EKPC. The IC shall work directly with EKPC when acquiring these rights to ensure that they meet EKPC requirements and standards.

In addition, the IC is responsible for performing, any and all environmental assessments, as well as obtaining any and all permits needed to construct the interconnection facilities.

7. Summary of Results of Study

The following schedule corresponds with the schedule in Section A.7 of this Facilities Study Report:

Description	Start Month	End Month
Design (Including Site Grading Design)	1	3
Procure Materials and Equipment	3	15
Site Preparation	5	11
Line Upgrade – OPGW	11	15
Substation Construction	12	19
Tap Line Construction	18	20
Commissioning and Testing	20	21

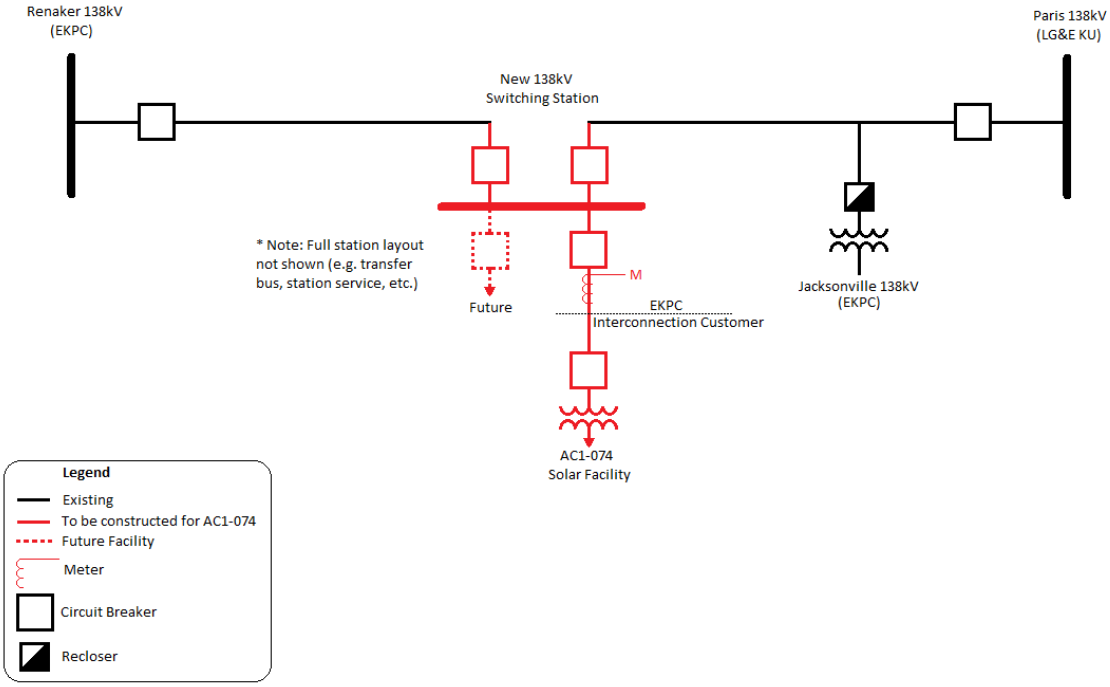
Below is a summary of costs for the AC1-074 project:

Description	Direct Labor	Direct Material	Indirect Labor	Indirect Material	Total
Attachment Facilities					
Install an Attachment facility line from the Queue #AC1-074 interconnection substation to the first structure located outside of the switchyard (Point of Interconnection structure). And install revenue metering. PJM Network Upgrade Number n6274.	$159,145	$145,215	$24,220	$21,420	$350,000
Direct Connection					

Description	Direct Labor	Direct Material	Indirect Labor	Indirect Material	Total
AC1-074 138kV Interconnection Substation – Build a new 138kV switching station along the Jacksonville – Renaker 138kV line to interconnect the Queue #AC1-074 solar generating facility. PJM Network Upgrade Number n5929.	$1,594,779	$2,672,400	$419,099	$333,722	$5,020,000
Non-Direct Connection					
Jacksonville – Renaker 138kV – A new loop-in tap line will be constructed from EKPC's existing Jacksonville to Renaker 138 kV transmission line to the new switching station. PJM Network Upgrade n6275.	$339,589	$108,160	$56,589	$15,662	$520,000
Avon 138kV Substation – Upgrade line relaying. PJM Network Upgrade Number n5630	$38,811	$0	$26,189	$0	$65,000
Renaker 138kV Substation – Upgrade line relaying. PJM Network Upgrade Number n5931	$38,811	$0	$26,189	$0	$65,000
Install OPGW fiber from on the Harrison County – Renaker line section, which is approximately 9.35 miles in length. PJM Network Upgrade n6276.	$829,381	$264,160	$138,208	$38,251	$1,270,000
Total Facility Costs	**$3,000,516**	**$3,189,935**	**$690,494**	**$409,055**	**$7,290,000**

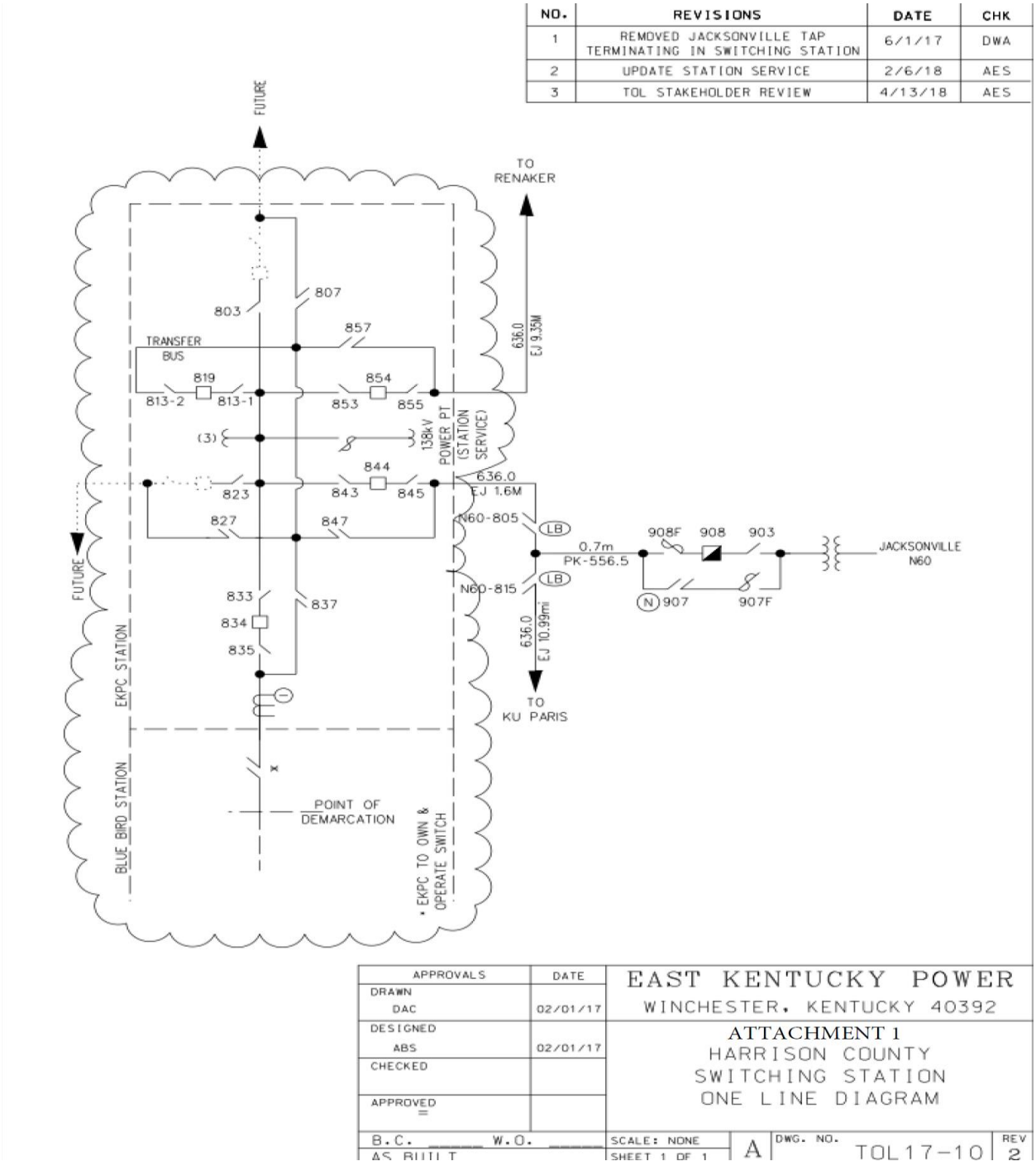
Attachment 1:

Planning One Line Diagram



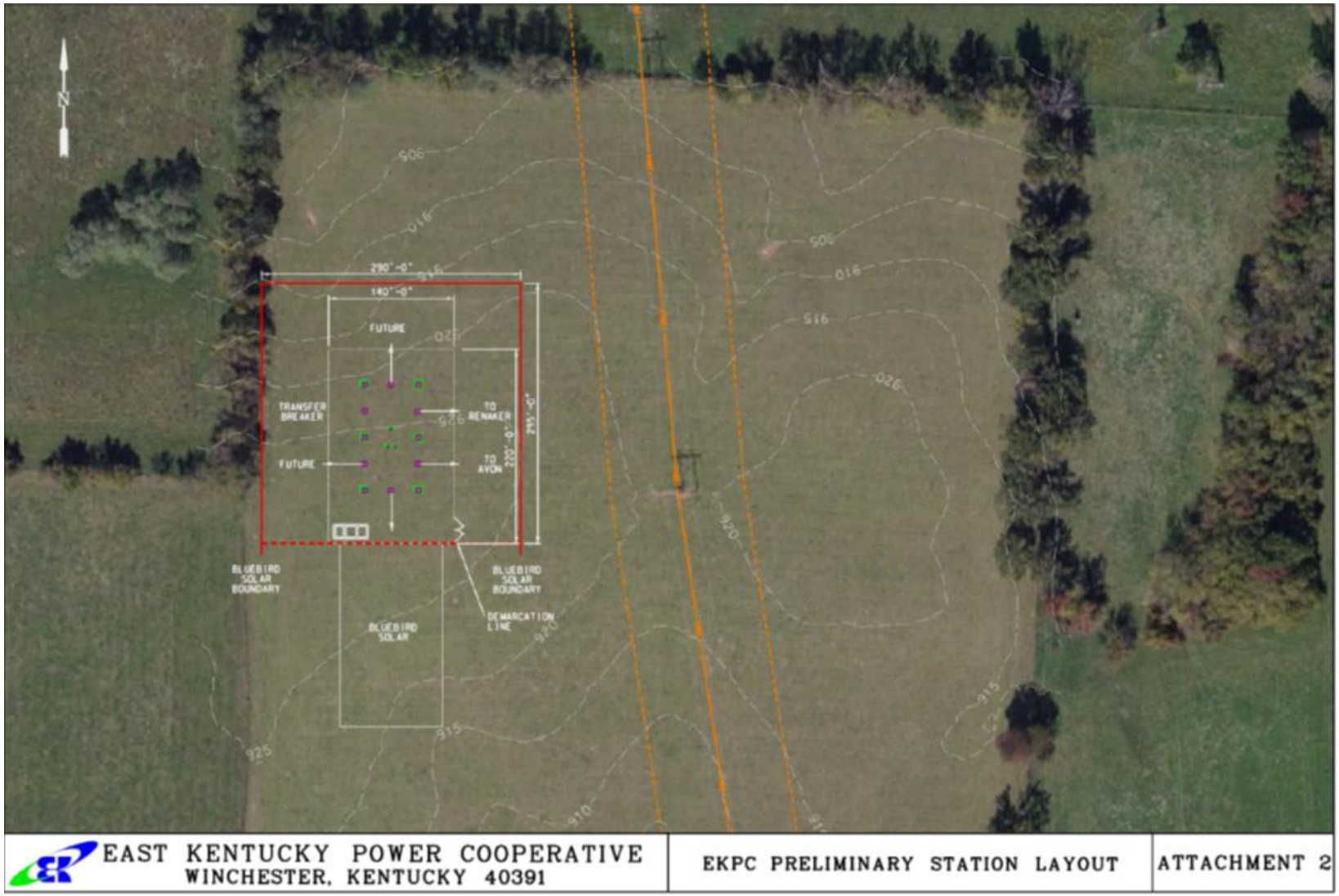
Attachment 2:

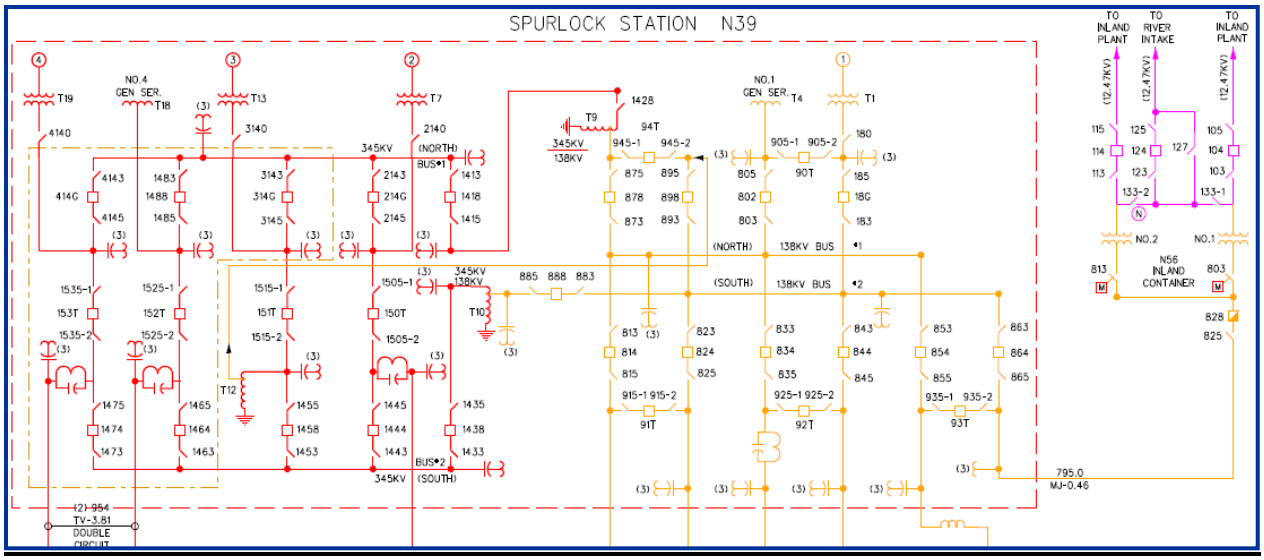
Engineering One Line Diagram



Attachment 3:

EKPC Preliminary Station Layout




SPURLOCK STATION N39
TO INLAND PLANT
TO RIVER INTAKE
TO INLAND PLANT
(12.47KV)
NO.4 GEN. SER.
NO.1 GEN. SER.
T19
T18
T13
T7
T9
T4
T1
T12
T10
4140
3140
2140
1428
94T
90T
91T
92T
93T
345KV
138KV
(NORTH) BUS•1
(SOUTH) BUS•2
(NORTH) 138KV BUS •1
(SOUTH) 138KV BUS •2
N56 INLAND CONTAINER
NO.2
NO.1
795.0 MJ-0.46
(2)-954 TV-3.81 DOUBLE CIRCUIT