Generation Interconnection
Revised System Impact Study Report

For

PJM Generation Interconnection Request
Queue Position AD2-048

Cynthia-Headquarters 69 kV

September 2021

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

Blue Moon 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 70 MW with 46.7 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is June 1, 2020. **This study does not imply a EKPC commitment to this in-service date.**

Point of Interconnection

AD2-048 will interconnect with the EKPC transmission system along the Cynthiana - Headquarters 69 kV line.

Cost Summary

The AD2-048 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 250,000
Direct Connection Network Upgrades	$ 2,800,000
Non Direct Connection Network Upgrades	$ 100,000
Allocation for New System Upgrades	$ 1,350,000
Contribution for Previously Identified Upgrades	$ 0
Total Costs	**$ 4,500,000**

Attachment Facilities

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

Description	Total Cost
Install a 69 kV switch structure at the point of demarcation. Estimated Time: 18 months.	$ 250,000
Total Direct Connection Facility Costs	**$ 250,000**

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 69kv switching station along the Cynthiana - Headquarters 69 kV line including associated transmission line work. Estimated Time: 18 months.	$ 2,800,000
Total Direct Connection Facility Costs	**$ 2,800,000**

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 Cynthiana 69kV Sub.	$ 50,000
Adjust remote, relaying, and metering settings at Headquarters 69kV Sub.	$ 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.

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 AD2-048 was evaluated as a 70.0 MW (Capacity 46.7 MW) injection into a tap of the Cynthia – Headquarters 69 kV line in the EKPC area. Project AD2-048 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-048 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2021

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)

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)

1. (AEP - AEP) The 05WLDCAT-05HILLSB 138 kV line (from bus 246946 to bus 243019 ckt 1) loads from 133.73% to 136.45% (AC power flow) of its emergency rating (185 MVA) for the tower line contingency outage of 'EKPC_P7-1_SPUR 345 DBL'. This project contributes approximately 5.92 MW to the thermal violation.

```
CONTINGENCY 'EKPC_P7-1_SPUR 345 DBL'                    /* SPURLOCK -
STUART 345 & SPURLOCK - MELDAHL 345
  OPEN BRANCH FROM BUS 249581 TO BUS 342838 CKT 1          /* 249581
08MELDAL 345.00 342838 7SPURLOCK 345.00
  OPEN BRANCH FROM BUS 253077 TO BUS 342838 CKT 1          /* 253077
09STUART 345.00 342838 7SPURLOCK 345.00
  END
```

Please refer to Appendix 1 for a table containing the generators having contribution to this flowgate.

2. (AEP - AEP) The 05WLDCAT-05HILLSB 138 kV line (from bus 246946 to bus 243019 ckt 1) loads from 110.27% to 112.33% (AC power flow) of its emergency rating (185 MVA) for the line fault with failed breaker contingency outage of 'DAY_P4_L34553-1'. This project contributes approximately 4.48 MW to the thermal violation.

CONTINGENCY 'DAY_P4_L34553-1'
OPEN LINE FROM BUS 253077 TO BUS 342838 CKT 1 /* 09STUART 345 - 20SPURLK 345 /* BUS 342525 -> 342623.
OPEN LINE FROM BUS 253077 TO BUS 253076 CKT 1 /* 09STUART 345 - 09STUART 138
END

3. (LGEE - OVEC) The 7TRIMBLE-06CLIFTY 345 kV line (from bus 324114 to bus 248000 ckt 1) loads from 193.16% to 193.49% (AC power flow) of its emergency rating (1370 MVA) for the single line contingency outage of 'AEP_P1-2_#363'. This project contributes approximately 3.96 MW to the thermal violation.

CONTINGENCY 'AEP_P1-2_#363'
OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1
END

Please refer to Appendix 2 for a table containing the generators having contribution to this flowgate.

4. (LGEE - OVEC) The 7TRIMBLE-06CLIFTY 345 kV line (from bus 324114 to bus 248000 ckt 1) loads from 135.54% to 135.9% (AC power flow) of its normal rating (1134 MVA) for non-contingency condition. This project contributes approximately 3.81 MW to the thermal violation.

5. (LGEE - OVEC) The 7TRIMBLE-06CLIFTY 345 kV line (from bus 324114 to bus 248000 ckt 1) loads from 117.89% to 118.19% (AC power flow) of its emergency rating (1370 MVA) for the single line contingency outage of 'AEP_P1-2_#4812'. This project contributes approximately 3.81 MW to the thermal violation.

CONTINGENCY 'AEP_P1-2_#4812'

OPEN BRANCH FROM BUS 242921 TO BUS 242924 CKT 1 / 242921 05CORNU 765 242924 05HANG R 765 1
END

TO Local Identified Overloads

1. Monitored Line : Headquarters - Snow Hill 69kV (341602-342280)
   Contingency: Cynthiana Tie - AD2-048 Tap 69kV (341377-936380)

   Thermal Overload: 40.61 MVA (119.43%)

2. Monitored Line: Snow Hill - Murphysville 69kV (342280-341923)
   Contingency: Cynthiana Tie - AD2-048 Tap 69kV (341377-936380)

   Thermal Overload: 36.62 MVA (107.70%)

Steady-State Voltage Requirements
(Results of the steady-state voltage studies should be inserted here)

None

Short Circuit
(Summary of impacted circuit breakers)

None

Affected System Analysis & Mitigation

LGEE Impacts:

LG&E has determiend there are no LG&E system impacts.

MISO Impacts:

None.

Duke, Progress & TVA Impacts:

None

OVEC Impacts:

None

Delivery of Energy Portion of Interconnection Request

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.
Only the most severely overloaded conditions are listed. 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 will study all overload conditions associated with the overloaded element(s) identified.

1. (AEP - AEP) The 05WLDCAT-05HILLSB 138 kV line (from bus 246946 to bus 243019 ckt 1) loads from 114.07% to 116.13% (AC power flow) of its emergency rating (185 MVA) for the single line contingency outage of 'EKPC_P1-2_SPUR-STU345'. This project contributes approximately 4.49 MW to the thermal violation.

CONTINGENCY 'EKPC_P1-2_SPUR-STU345' /* SPURLOCK - STUART
OPEN BRANCH FROM BUS 253077 TO BUS 342838 CKT 1 /* 253077 09STUART 345.00 342838 7SPURLOCK 345.00
END

2. (LGEE - OVEC) The 7TRIMBLE-06CLIFTY 345 kV line (from bus 324114 to bus 248000 ckt 1) loads from 179.25% to 179.64% (AC power flow) of its emergency rating (1370 MVA) for the single line contingency outage of 'AEP_P1-2_#363'. This project contributes approximately 5.94 MW to the thermal violation.

CONTINGENCY 'AEP_P1-2_#363'
OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1
END

3. (LGEE - OVEC) The 7TRIMBLE-06CLIFTY 345 kV line (from bus 324114 to bus 248000 ckt 1) loads from 137.39% to 137.83% (AC power flow) of its normal rating (1134 MVA) for non-contingency condition. This project contributes approximately 5.71 MW to the thermal violation.

Light Load Analysis

Not Applicable

Summer Peak Load Flow Analysis Reinforcements

New System Reinforcements

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

1. To resolve the Headquarters – Snow Hill 69 kV overload:

   Project: Increase MOT of 3/0 conductor on Headquarters-Snow Hill 69kV line section to 212°F (3.8 miles)

   New Ratings: 42/46/48 (N/LTE/LD)

   Estimated Cost: $250,000

   Estimated Time:12 months

   PJM Network Upgrade N5858

2. To resolve the Snow Hill – Murphysville 69 kV line:
   Project: Increase MOT of 3/0 conductor on Snow Hill-Murphysville 69kV line section to 212°F (16.1 miles)

   New Ratings: 42/46/48 (N/LTE/LD)

   Estimated Cost: $1,100,000

   Estimated Time: 12 months

   PJM Network Upgrade N5859

   It should be noted that EKPC has not completed any evaluation to determine if either of these line sections can be upgraded to an operating temperature of 212°F. If either line section has constraints that will make the upgrade unfeasible, EKPC would then recommend a rebuild of the line section. The estimated cost for the line rebuild of the Headquarters - Snow Hill 69 kV line section is $3.2 Million and estimated time of 12 months. The estimated cost for the rebuild of the Snow Hill - Murphysville 69 kV line section is $13.6 Million and estimated time of 30 months. EKPC would need to complete

a LiDAR survey of each line section, and an initial design review to determine if the high temperature upgrade is possible on these line sections.

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)

(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

1. To resolve the Wildcat – Hillsboro 138 kV line overloads:

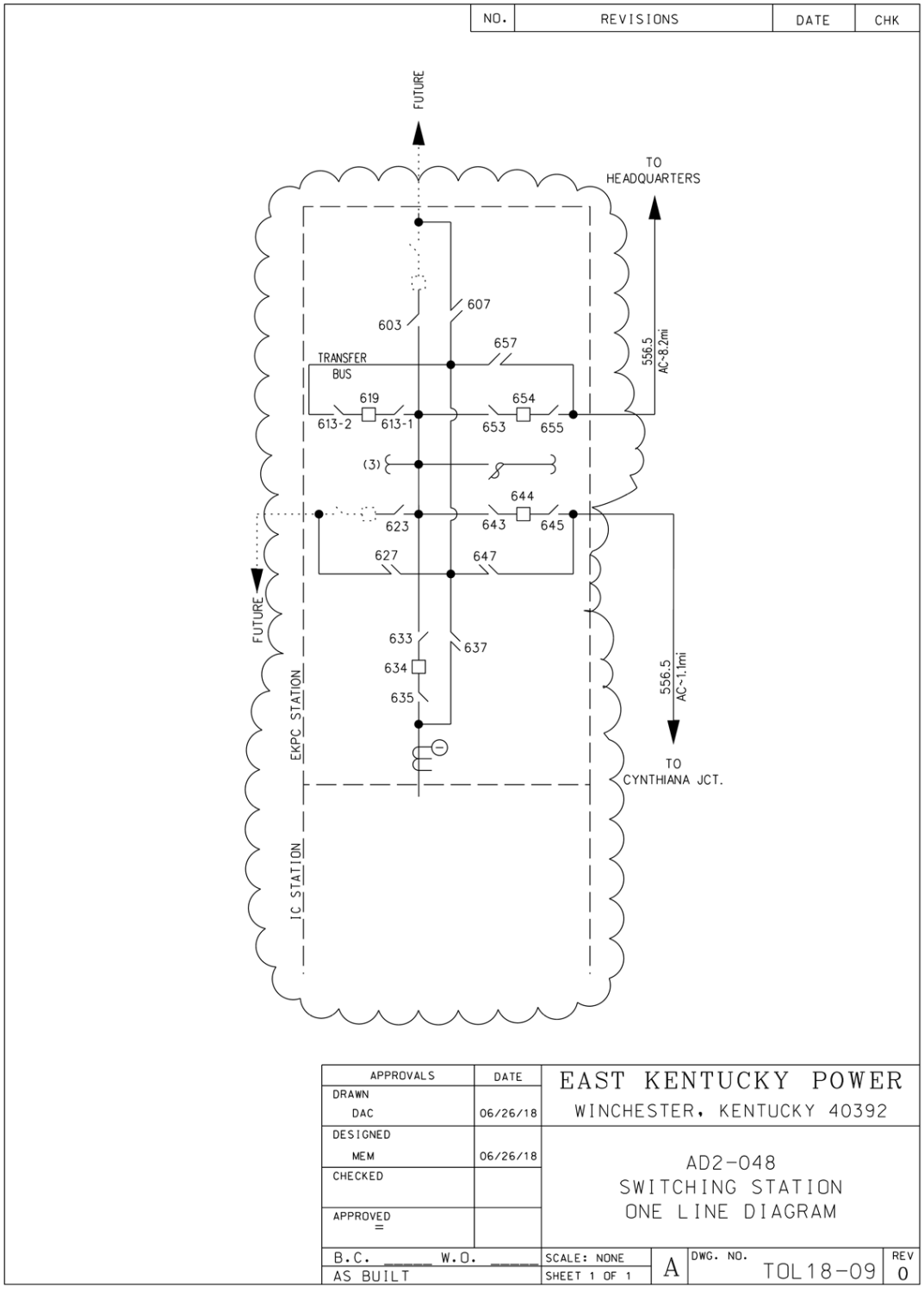
   The SE rating is 185 MVA and the upgrade is to perform a sag check for the ACSR ~ 477 ~ 26/7 ~ HAWK - Conductor Section 1 to determine if the line section can be operated above its emergency rating of 185 MVA. The result could prove that no additional upgrades are necessary, that some upgrades on the circuit are necessary, or that the entire 10.0 mile section of line would need to be rebuilt. An approximate time for the sag study is 6 to 12 months after signing an interconnection agreement. Estimated Cost is $40K. PJM Network Upgrade N5472.

   Queue Project AD2-048 presently does not receive cost allocation for this upgrade.
   Note 1: as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, Queue Project AD2-048 could receive cost allocation.
   Note 2: Although Queue Project AD2-048 may not have cost responsibility for this upgrade, Queue Project AD2-048 may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AD2-048 comes into service prior to completion of the upgrade, Queue Project AD2-048 will need an interim study.

2. To resolve the Trimble – Clifty 345 kv line overloads:

   A potential constraint was identified by PJM on the Trimble – Clifty 345 kV line (LG&E/OVEC tie line). LG&E has concluded that there are no LG&E system impacts, including no LG&E upgrade required on the Trimble-Clifty 345 kV line.

Attachment 1. Single Line Diagram



Attachment 2. Flowgate Details

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. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the Appendices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the Appendices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators.

It should be noted the project/generator MW contributions presented in the body of the report and appendices sections are full contributions, whereas the loading percentages reported in the body of the report, take into consideration the commercial probability of each project as well as the ramping impact of "Adder" contributions.

Appendix 1

(AEP - AEP) The 05WLDCAT-05HILLSB 138 kV line (from bus 246946 to bus 243019 ckt 1) loads from 133.73% to 136.45% (AC power flow) of its emergency rating (185 MVA) for the tower line contingency outage of 'EKPC_P7-1_SPUR 345 DBL'. This project contributes approximately 5.92 MW to the thermal violation.

CONTINGENCY 'EKPC_P7-1_SPUR 345 DBL' /* SPURLOCK - STUART 345 & SPURLOCK - MELDAHL 345
OPEN BRANCH FROM BUS 249581 TO BUS 342838 CKT 1 /* 249581 08MELDAL 345.00 342838 7SPURLOCK 345.00
OPEN BRANCH FROM BUS 253077 TO BUS 342838 CKT 1 /* 253077 09STUART 345.00 342838 7SPURLOCK 345.00
END

Bus Number	Bus Name	Full Contribution
932551	AC2-075 C	0.81
932552	AC2-075 E	0.4
~~936281~~	~~AD2-036 C~~	~~2.41~~
~~936282~~	~~AD2-036 E~~	~~1.2~~
936381	AD2-048 C	3.95
936382	AD2-048 E	1.97
LTF	CARR	0.06
LTF	CBM-S1	2.75
LTF	CBM-S2	0.81
LTF	CBM-W1	1.91
LTF	CBM-W2	9.6
LTF	CIN	0.99
LTF	CPLE	0.14
LTF	DEARBORN	0.12
LTF	G-007	0.14
LTF	IPL	0.68
LTF	LGEE	0.87
LTF	MEC	1.64
LTF	O-066	0.93
LTF	RENSSELAER	0.05
LTF	WEC	0.15
916272	Z1-080 E	0.58
918802	AA1-099 E	0.38
925981	AC1-074 C	3.37
925982	AC1-074 E	1.44
926101	AC1-089 C	38.36
926102	AC1-089 E	62.59

Appendix 2

(LGEE - OVEC) The 7TRIMBLE-06CLIFTY 345 kV line (from bus 324114 to bus 248000 ckt 1) loads from 193.16% to 193.49% (AC power flow) of its emergency rating (1370 MVA) for the single line contingency outage of 'AEP_P1-2_#363'. This project contributes approximately 3.96 MW to the thermal violation.

CONTINGENCY 'AEP_P1-2_#363'
OPEN BRANCH FROM BUS 243208 TO BUS 243209 CKT 1 / 243208 05JEFRSO 765 243209 05ROCKPT 765 1
END

Bus Number	Bus Name	Full Contribution
247287	05AND G3	0.84
243442	05RKG1	40.89
243443	05RKG2	40.27
342900	1COOPER1 G	3.28
342903	1COOPER2 G	6.36
342918	1JKCT 1G	2.57
342921	1JKCT 2G	2.57
342924	1JKCT 3G	2.57
342927	1JKCT 4G	1.71
342930	1JKCT 5G	1.7
342933	1JKCT 6G	1.71
342936	1JKCT 7G	1.71
342939	1JKCT 9G	1.75
342942	1JKCT 10G	1.75
342945	1LAUREL 1G	1.85
932551	AC2-075 C	1.09
933441	AC2-157 C	8.17
935011	AD1-134	8.11
935141	AD1-148	2.48
936281	AD2-036 C	3.24
936381	AD2-048 C	3.96
936571	AD2-072 C O1	11.61
936771	AD2-100 C O1	6.98
936821	AD2-105 C O1	3.75
936831	AD2-106 C O1	2.
936841	AD2-107 C O1	1.29
LTF	CARR	0.32
LTF	CBM-S1	40.53
LTF	CBM-S2	6.92
LTF	CBM-W1	21.77

LTF	CBM-W2	141.51
LTF	CIN	25.76
LTF	CLIFTY	94.95
LTF	CPLE	1.19
LTF	DEARBORN	0.5
LTF	IPL	15.71
981181	J708	40.83
981521	J759	9.26
981531	J762	29.44
981571	J783	9.26
938311	J795	3.67
938731	J800	15.73
938861	J829	12.54
938921	J842 C	3.98
938931	J843 C	4.32
939021	J856	9.33
274650	KINCAID ;1U	6.51
274651	KINCAID ;2U	6.49
LTF	LGEE	19.02
LTF	MEC	21.91
LTF	RENSSELAER	0.25
LTF	ROWAN /* 35% REVERSE 4479078	< 0.01
LTF	WEC	1.75
900404	X3-028 C	161.28
LTF	Z1-043	8.41
930461	AB1-087	59.14
930471	AB1-088	59.14
LTF	AB2-013	5.12
925981	AC1-074 C	4.54

Attachment 3. Dynamic Simulation Analysis

Executive Summary

Generator Interconnection Request AD2-048 is for a 70 MW Maximum Facility Output (MFO) solar facility. AD2-048 consists of 32 x 2.211 MW SMA Sunny Central 2500-US Solar Inverters with a Point of Interconnection (POI) tapping the Cynthiana Tie to Headquarters 69 kV line with a new interconnection switching station in Harrison County, Kentucky, in the East Kentucky Power Cooperative (EKPC) transmission system.

The power flow scenario for the analysis was based on the RTEP 2021 summer peak load case, modified to include applicable queue projects. AD2-048 has been dispatched online at maximum facility output, with approximately unity power factor at the high-side of the station transformer.

AD2-048 was tested for compliance with NERC, PJM, Transmission Owner and other applicable criteria. For this study, 40 contingencies were simulated, each with a 20 second simulation time period. Studied faults included:

- Steady-state operation (20 second simulation)
- Three-phase faults with normal clearing time
- Single-phase faults with a stuck breaker
- Single-phase faults placed at 80% of the line with delayed (Zone 2) clearing at remote line end because of primary communications/relaying failure

The 40 fault contingencies tested on the 2021 summer peak load case met the recovery criteria:

- The AD2-048 generators were able to ride through the faults except for faults where protective actions trip one or more generator(s).
- All generators maintained synchronism and any post-contingency oscillations are positively damped with a damping margin of at least 3%.
- All bus voltages recover to 0.7 p.u. within 2.5 seconds and the final voltage is within the range of 0.92 p.u. to 1.05 p.u. for buses other than 500 kV . The final voltages for 500 kV buses should be within 1.02 p.u. to 1.08 p.u.
- No transmission element trips, other than those either directly connected or designated to trip as a consequence of the fault.

The AD2-048 queue project met both the 0.95 leading and 0.95 lagging power factor.

TABLE OF CONTENTS

1. Introduction

Generator Interconnection Request AD2-048 is for a 70 MW Maximum Facility Output (MFO) solar facility. AD2-048 consists of 32 x 2.211 MW SMA Sunny Central 2500-US Solar Inverters with a Point of Interconnection (POI) tapping the Cynthiana Tie to Headquarters 69 kV line with a new interconnection switching station in Harrison County, Kentucky, in the East Kentucky Power Cooperative (EKPC) transmission system.

This analysis is effectively a screening study to determine whether the addition of AD2-048 will meet the dynamic requirements of the NERC, PJM and Transmission Owner reliability standards.

This report describes the following:

- A description of the AD2-048 project and how it is proposed to be connected to the grid
- A description of how the project is modeled in this study
- A description of the fault cases analyzed in this study
- A discussion of the results

2. Description of Project

AD2-048 consists of 32 x 2.211 MW SMA Sunny Central 2500-US Solar Inverters that are connected to 32 x 34.5/0.55 kV inverter based generator step up (GSU) transformers each with a rating of 2.5 MVA. The GSU transformers connect to a 69/34.5/13.8 kV main station transformer through a collector system equivalent, with a rating of 45/60/75 MVA. A 0.05 mile 69 kV generator tie connects the AD2-048 POI to the tap between Cynthiana and Headquarters 69 kV substations. Refer to Figure 1 for a one-line diagram of the generation.

Table 1 lists the parameters given in the impact study data and the corresponding parameters of the AD2-048 power flow model. The dynamic model for the AD2-048 plant is based on user written models for PSS/E with the parameters supplied by the developer.

Additional project details are provided in the following appendices and attachments:

- Appendix A: PSS/E slider diagram for AD2-048
- Appendix B: PSS/E power flow and dynamic model for AD2-048
- Attachment 1: System Impact Study data for AD2-048
- Attachment 2: Transmission one-line diagrams of the EKPC network in the vicinity of AD2-048

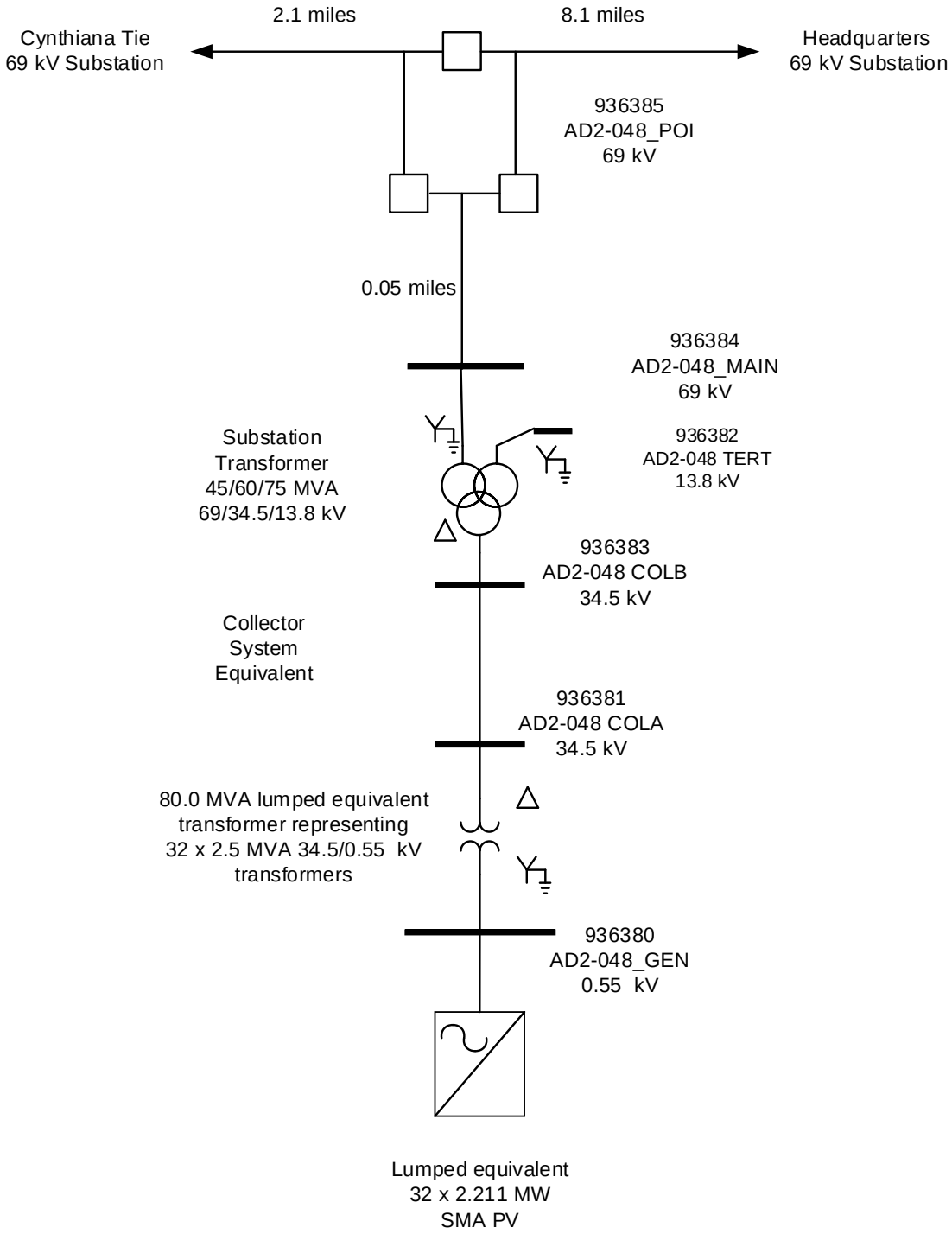


Figure 1: AD2-048 Plant Model.

Table 1: AD2-048 Plant Model

	Impact Study Data	Model
Solar Inverters Lumped Equivalent (PV)	32 x 2.211 MW SMA Sunny Central 2500-US 2.5 MVA Solar Inverters MVA base = 2.5 MVA Vt = 0.55 kV Stator resistance = 0 Saturated sub-transient reactance = 10000 p.u.	1 Lumped equivalent representing 32 x 2.211 MW SMA Sunny Central 2500-US 2.5 MVA Solar Inverters Pgen = 70.752 MW Pmax = 70.752 MW Pmin = 0 MW Qmax = 38.5 Mvar Qmin = - 38.5 Mvar Mbase = 80.0 MVA R = 0 p.u. X = 10000 p.u.
Inverter Based Step-Up Transformer (T1)	32 x 34.5/0.55 kV solar inverter step-up transformers Rating = 2.5 MVA Transformer MVA base = 2.5 MVA Impedance = 0.0045 + j0.067 p.u. Number of taps = N/A Tap step size = N/A	1 x Lumped equivalent representing 32 x 34.5/0.55 kV solar inverter step-up transformers Rating = 80.0 MVA Transformer MVA base = 80.0 MVA Impedance = 0.0045 + j0.067 p.u. Number of taps = N/A Tap step size = N/A

	Impact Study Data	Model
Inverter Based Main Transformer (MPT-1)	1 x 69/34.5/13.8 kV Rating = 45/60/75 MVA Transformer MVA base = 45 MVA Impedance: High to Low = 0.0019 + j 0.09 p.u. High to Tert = 0.0046 + j 0.1278 p.u. Low to Tert = 0.0032 + j 0.0252 p.u. Number of taps = N/A Tap step size = N/A	1 x 69/34.5/13.8 kV Rating = 45/60/75 MVA Transformer MVA base = 45 MVA Impedance: High to Low = 0.0019 + j 0.09 p.u. High to Tert = 0.0046 + j 0.1278 p.u. Low to Tert = 0.0032 + j 0.0252 p.u. Number of taps = N/A Tap step size = N/A
Auxiliary Load (AX)	0.04 MW + 0.01 Mvar at low side of the GSU	0.04 MW + 0.01 Mvar at low side of the GSU (switched offline)
Station Load (SS)	0.01 MW + 0.002 Mvar at low side of the GSU	0.01 MW + 0.002 Mvar at low side of the GSU (switched offline)
Collector System Equivalent (Collector 1)	34.5 kV line Impedance = 0.002640 + j0.002570 p.u. Charging susceptance = j0.009550 p.u. (Impedance on 100 MVA Base)	34.5 kV line Impedance = 0.002640 + j0.002570 p.u. Charging susceptance = j0.009550 p.u. (Impedance on 100 MVA Base)
Attachment Line	0.05 mile 69 kV line Impedance = 0.000490 + j0.003140 p.u. Charging susceptance = j0.000050 p.u. (Impedance on 100 MVA Base)	0.05 mile 69 kV line Impedance = 0.000490 + j0.003140 p.u. Charging susceptance = j0.000050 p.u. (Impedance on 100 MVA Base)

2.1 Power Factor Assessment

A power factor assessment was performed for the AD2-048 project evaluating if the plant meets PJM's power factor requirement for a non-synchronous generator. PJM requires a non-synchronous generator to provide 0.95 lagging power factor and 0.95 leading power factor measured at the high side of the station transformer. The reactive capability curve shown in Figures 2 provided by SMA, was used to determine the reactive power for the plant. Table 2 summarizes the results for the power factor assessment for the AD2-048 queue project.

The AD2-048 queue project met both the 0.95 leading and 0.95 lagging power factor.

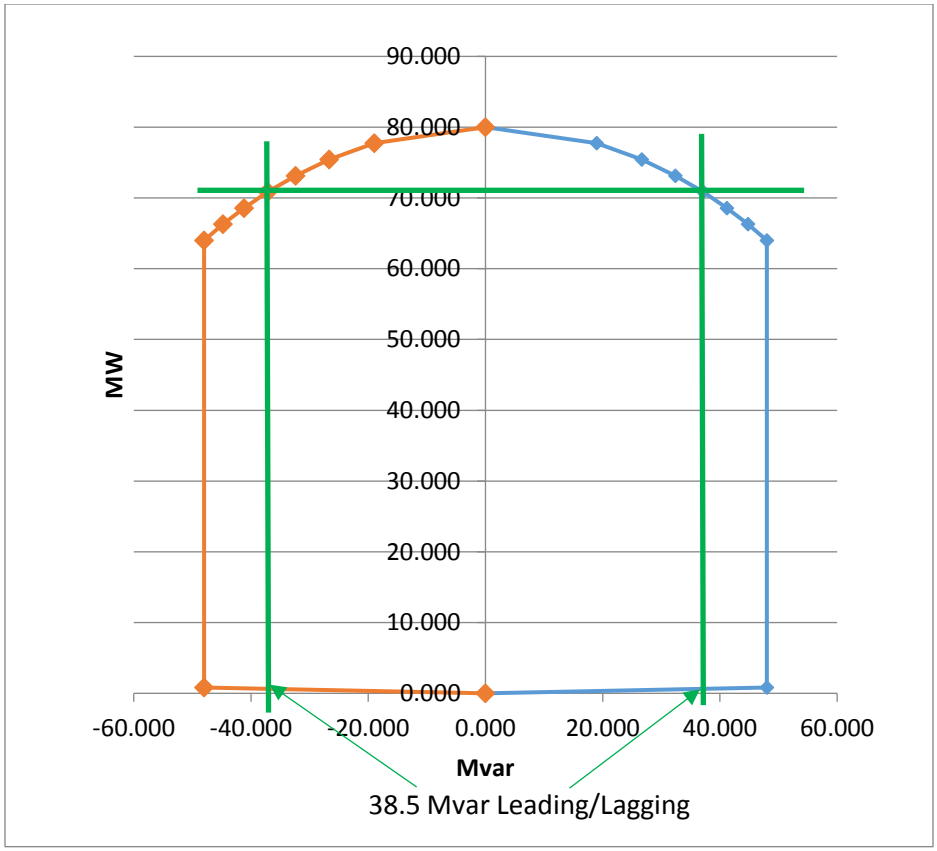


Figure 2: Reactive capability for the AD2-048 queue project with SMA Sunny Central 2500-US solar inverters.

Table 2: Power Factor Assessment for the AD2-048 Queue Project

Generator	MFO (MW)	Required Power Factor Range		Maximum Lagging (Mvar)	Minimum Leading (Mvar)
		Lagging	Leading		
AD2-048	70.00	0.95	0.95		
Total Reactive Power Required				23.01	-23.01
Reactive Power from Generator				**Qmax**	**Qmin**
				38.50	-38.50
Customer Planned Compensation				0	0
Reactive Power Losses				-12.55	-12.55
Total Available Reactive Power at High Side of Main Transformer				25.95	-51.05
Deficiency in Reactive Power				Meet	Meet

3. Power Flow and Dynamics Case Setup

The dynamic simulation analysis was performed using PSS/E Version 33.7.0.

The power flow scenario and fault cases for this study are based on PJM's Regional Transmission Planning Process[1].

The selected power flow scenario is the RTEP 2021 summer peak load case with the following modifications:

- Addition of all applicable queue projects prior to AD2-048
- Addition of the AD2-048 queue project
- Dispatch of units within 5 buses of the POI of the AD2-048 queue project
    - Generators set to their maximum power output
    - The reactive power output of each unit set near unity power factor at the high side of the station transformer

The AD2-048 initial conditions are listed in Table , indicating maximum power output, with approximately unity power factor at the highside of the station transformer.

Table 3: AD2-048 Machine Initial Conditions

Bus	Name	Unit	PGEN (MW)	QGEN (Mvar)	ETERM (p.u.)	POI Voltage (p.u.)
936380	AD2-048_GEN	1	70.75	7.45	1.0100	1.0233

Generation within the vicinity of AD2-048 (5 bus radius) has been dispatched online at maximum output (PMAX). The dispatch of generation in the vicinity of AD2-048 is given in Appendix C.

[1] Manual 14B: PJM Region Transmission Planning Process, Rev 33, May 5 2016, Attachment G : PJM Stability, Short Circuit, and Special RTEP Practices and Procedures.

4. Fault Cases

Tables 5 through 8 list the contingencies that were studied, with representative worst case total clearing times provided by PJM. Each contingency was studied over a 20 second simulation time interval.

The studied contingencies include:

- Steady-state operation (20 second simulation)
- Three-phase faults with normal clearing time
- Single-phase faults with a stuck breaker
- Single-phase faults placed at 80% of the line with delayed (Zone 2) clearing at remote line end because of primary communications/relaying failure

Contingencies were created for the following buses:

- AD2-048 Tap 69 kV
- Renaker 69 kV
- AC1-074 Tap 138 kV
- Scott Co. 69 kV
- Bracken County 69 kV
- Murphysville 69 kV
- Dale Station 69 kV
- Headquarters 69 kV
- Renaker 138 kV

Clearing times were modeled based on PJM's "2017 Revised Clearing times for each PJM company" spreadsheet revision 20.

Attachment 2 contains one-line diagrams of the EKPC network in the vicinity of AD2-048, showing where faults were applied.

The positive sequence fault impedances for single-phase faults were modeled using a zero sequence to positive sequence impedance ratios of 0.5 for buses in the EKPC area derived from a separate short-circuit case. The ratio was applied to the posive sequence value in PSS/E and the single-phase fault impedance was calculated.

5. Evaluation Criteria

This study is focused on AD2-048, along with the rest of the PJM system, maintaining synchronism and having all states return to an acceptable new condition following the disturbance. The recovery criteria applicable to this study are as per PJM's Regional Transmission Planning Process and Transmission Owner criteria:

- The AD2-048 generators were able to ride through the faults except for faults where protective actions trip one or more generator(s).
- All generators maintained synchronism and any post-contingency oscillations are positively damped with a damping margin of at least 3%.
- All bus voltages recover to 0.7 p.u. within 2.5 seconds and the final voltage is within the range of 0.92 p.u. to 1.05 p.u. for buses other than 500 kV. The final voltages for 500 kV buses should be within 1.02 p.u. to 1.08 p.u.
- No transmission element trips, other than those either directly connected or designated to trip as a consequence of the fault.

6. Summary of Results

Plots from the dynamic simulations are provided in Attachment 3 with results summarized in Tables 5 through 8.

The 40 fault contingencies tested on the 2021 summer peak load case met the recovery criteria:

- The AD2-048 generators were able to ride through the faults except for faults where protective actions trip one or more generator(s).
- All generators maintained synchronism and any post-contingency oscillations are positively damped with a damping margin of at least 3%.
- All bus voltages recover to 0.7 p.u. within 2.5 seconds and the final voltage is within the range of 0.92 p.u. to 1.05 p.u. for buses other than 500 kV. The final voltages for 500 kV buses should be within 1.02 p.u. to 1.08 p.u.
- No transmission element trips, other than those either directly connected or designated to trip as a consequence of the fault.

The AD2-048 queue project met both the 0.95 leading and 0.95 lagging power factor.

No mitigation or system upgrades were identified to interconnect the AD2-048 generation. No additional costs associated with the addition of the AD2-048 were identified in the System Impact Study.

The reactive power output of the AD2-036, AC2-075, AC1-074 queue project was not settling to a steady state value. The three queue projects share a gen tie line, but the three units controlled different buses using the ICON M in the PVEU1 model. AD2-036, AC2-075 and AC1-074 were updated by changing ICON M in the PVEU1 model to the POI bus number, 925980, allowing the reactive power output to settle.

Changes were also made to Con J+22 in the PVEU1 model for the AD2-036, AC2-075, AC1-074 queue projects reducing the hard reactive current limit identified during the dynamic analysis performed for the AD2-036 queue project. Table 9 shows the updated hard reactive current limits Con J+22 in the PVEU1 Model. Note the Con J+22 values were changed to equal the Con J+7 QMX value.

Table 5: Steady-State Operation

Fault ID	Fault Description	AD2-048
SS.01	Steady State 20 sec (No Fault)	Stable

Table 6: Three-Phase Faults with Normal Clearing Time

Fault ID	Fault Description	Clearing Time (Cycles)	AD2-048
P1.01	Fault at AD2-048 Tap 69 kV on Cynthiana Jct. to Renaker circuit 1.	8	Stable
P1.02	Fault at AD2-048 Tap 69 kV on Headquarters circuit 1 and Headquarters 6.12 Mvar capacitor bank.	8	Stable
P1.03	Fault at Renaker 69 kV on Lees Lick to Penn to Scott Co. circuit 1.	8	Stable
P1.04	Fault at Renaker 69 kV on Colemansville to Four Oaks to Bracken County circuit 1.	8	Stable
P1.05	Fault at Renaker 69 kV on Cynthiana circuit 1.	8	Stable
P1.06	Fault at Renaker 69 kV on Renaker 138/69 kV Transformer #1	8	Stable
P1.07	Fault at Renaker 69 kV on 27 Mvar Capacitor Bank.	8	Stable
P1.08	Fault at Headquarters 69 kV on Snow Hill to Murphysville circuit 1.	8	Stable
P1.09	Fault at Headquarters 69 kV on Millerburg to Crane Ridge to Sideview to Reid Village to Miller Hunt to Hunt to Dale Station circuit 1.	8	Stable
P1.10	Fault at Renaker 138 kV on Spurlock circuit 1.	6	Stable
P1.11	Fault at Renaker 138 kV on Bavarian to Boone circuit 1.	6	Stable
P1.12	Fault at Renaker 138 kV on AC1-074 Tap circuit 1.	6	Stable
P1.13	Fault at AC1-074 Tap 138 kV on Jacksonville to Paris to Avon circuit 1.	6	Stable
P1.14	Fault at Bracken County 69 kV on Sharon toKenton circuit 1.	8	Stable
P1.15	Fault at Bracken County 69 kV on Griffin Jct. to Grants Lick to Stanley Parker circuit 1.	8	Stable
P1.16	Fault at Bracken County 69 kV on Carntown circuit 1.	8	Stable
P1.17	Fault at Murphysville 69 kV on Kenton circuit 1.	8	Stable

Fault ID	Fault Description	Clearing Time (Cycles)	AD2-048
P1.18	Fault at Murphysville 69 kV on Plumville circuit 1.	8	Stable
P1.19	Fault at Dale Station 69 kV on Dale Station 138/69 kV Transformer #1	8	Stable
P1.20	Fault at Dale Station 69 kV on to Newby to Toddville to Ballard to Hunt Farm circuit 1.	8	Stable
P1.21	Fault at Dale Station 69 kV on Lancaster to Garrard County circuit 1.	8	Stable
P1.22	Fault at Dale Station 69 kV on Hunt to J.K. Smith to Trapp to Hargett to Clay City to Hardwicks Creek to Powell County circuit 1.	8	Stable

Table 7: Single-Phase Faults with Stuck Breakers

Fault ID	Fault Description	Clearing Time Normal/Delayed (Cycles)	AD2-048
P4.01	Fault at AD2-048 Tap 69 kV on Headquarters circuit 1 and Headquarters 6.12 Mvar capacitor bank. Breaker A is stuck. Fault is cleared with loss of AD2-048 Tap to Cynthiana Jct. to Renaker 69 kV circuit 1. (Trips AD2-048 generator)	8/19	Stable
P4.02	Fault at AD2-048 Tap 69 kV on Cynthiana Jct. to Renaker circuit 1. Breaker A is stuck. Fault is cleared with loss of AD2-048 Tap to Headquarters 69 kV circuit 1 and Headquarters 6.12 Mvar capacitor bank. (Trips AD2-048 generator)	8/19	Stable
P4.03	Fault at AD2-048 Tap 69 kV on Cynthiana Jct. to Renaker circuit 1. Breaker B is stuck. Fault is cleared with loss of AD2-048 queue project. (Trips AD2-048 generator)	8/19	Stable
P4.04	Fault at AD2-048 Tap 69 kV on Headquarters circuit 1 and Headquarters 6.12 Mvar capacitor bank. Breaker C is stuck. Fault is cleared with loss of AD2-048 queue project. (Trips AD2-048 generation)	8/19	Stable

Fault ID	Fault Description	Clearing Time Normal/Delayed (Cycles)	AD2-048
P4.05	Fault at Renaker 69 kV on Colemansville to Four Oaks to Bracken County circuit 1. Breaker 624 is stuck. Fault is cleared with loss of Renaker to Lees Lick to Penn to Scott County 69 kV circuit 1, Renaker to AD2-048 Tap 69 kV circuit 1, Renaker 138/69 kV Transformer #1, Renaker 27 Mvar Capacitor Bank, and Renaker to Cynthiana 69 kV circuit 1	8/19	Stable
P4.06	Fault at Renaker 69 kV on Lees Lick to Penn to Scott County circuit 1. Breaker 614 is stuck. Fault is cleared with loss of Renaker to Colemansville to Four Oaks to Bracken County 69 kV circuit 1, Renaker to AD2-048 Tap 69 kV circuit 1, Renaker 138/69 kV Transformer #1, Renaker 27 Mvar Capacitor Bank, and Renaker to Cynthiana 69 kV circuit 1.	8/19	Stable
P4.07	Fault at Renaker 69 kV on Cythiana Jct. to AD2-048 Tap circuit 1. Breaker 604 is stuck. Fault is cleared with loss of Renaker to Colemansville to Four Oaks to Bracken County 69 kV circuit 1, Renaker to Lees Lick to Penn to Scott County 69 kV circuit 1, Renaker 138/69 kV Transformer #1, Renaker 27 Mvar Capacitor Bank, and Renaker to Cynthiana 69 kV circuit 1.	8/19	Stable
P4.08	Fault at Renaker 69 kV on Cythiana circuit 1. Breaker 664 is stuck. Fault is cleared with loss of Renaker to Cythiana Jct. to AD2-048 Tap circuit 1, Renaker to Colemansville to Four Oaks to Bracken County 69 kV circuit 1, Renaker to Lees Lick to Penn to Scott County 69 kV circuit 1, Renaker 138/69 kV Transformer #1, and Renaker 27 Mvar Capacitor Bank.	8/19	Stable

Fault ID	Fault Description	Clearing Time Normal/Delayed (Cycles)	AD2-048
P4.09	Fault at Renaker 69 kV on 138/69 kV Transformer #1. Breaker 664 is stuck. Fault is cleared with loss of Renaker to Cythiana Jct. to AD2-048 Tap circuit 1, Renaker to Colemansville to Four Oaks to Bracken County 69 kV circuit 1, Renaker to Lees Lick to Penn to Scott County 69 kV circuit 1, Renaker to Cythiana circuit 1, and Renaker 27 Mvar Capacitor Bank.	8/19	Stable
P4.10	Fault at Renaker 69 kV on 27 Mvar Capacitor Bank. Breaker 664 is stuck. Fault is cleared with loss of Renaker to Cythiana Jct. to AD2-048 Tap circuit 1, Renaker to Colemansville to Four Oaks to Bracken County 69 kV circuit 1, Renaker to Lees Lick to Penn to Scott County 69 kV circuit 1, Renaker to Cythiana circuit 1, and Renaker 138/69 kV Transformer #1.	8/19	Stable
P4.11	Fault at Headquarters 69 kV on AD2-048 Tap circuit 1 and Headquarter 69 kV 6.16 Mvar capacitor bank. Breaker 614 is stuck. Fault is cleared with loss of Headquarters to Snow Hill to Murphysville 69 kV circuit 1, and Headquarters to Millerburg to Crane Ridge to Sideview to Reid Village to Miller Hunt to Hunt to Dale Station 69 kV circuit 1.	8/19	Stable

Fault ID	Fault Description	Clearing Time Normal/Delayed (Cycles)	AD2-048
P4.12	Fault at Headquarters 69 kV on Snow Hill to Murphysville circuit 1. Breaker 624 is stuck. Fault is cleared with loss of Headquarters to AD2-048 Tap 69 kV circuit 1, Headquarter 6.16 Mvar capacitor bank, and Headquarters to Millerburg to Crane Ridge to Sideview to Reid Village to Miller Hunt to Hunt to Dale Station 69 kV circuit 1.	8/19	Stable
P4.13	Fault at Headquarters 69 kV on Millerburg to Crane Ridge to Sideview to Reid Village to Miller Hunt to Hunt to Dale Station circuit 1. Breaker 644 is stuck. Fault is cleared with loss of Headquarters to AD2-048 Tap 69 kV circuit 1, Headquarters 6.12 Mvar capacitor bank, and Headquarters to Snow Hill to Murphysville 69 kV circuit 1.	8/19	Stable

Table 8: Single-Phase Faults with Delayed Clearing at Remote End

Fault ID	Fault Description	Clearing Time Normal/Delayed (Cycles)	AD2-048
P5.01	Fault at 80% of 69 kV line from AD2-048 Tap to Headquarters circuit 1. Delayed clearing at AD2-048 Tap and loss of Headquarters 6.12 Mvar capacitor bank.	8/45	Stable
P5.02	Fault at 80% of 69 kV line from Headquarters to AD2-048 Tap circuit 1. Delayed clearing at Headquarters and loss of Headquarters 6.12 Mvar capacitor bank.	8/45	Stable
P5.03	Fault at 80% of 69 kV line from AD2-048 to Cynthiana Jct. to Renaker circuit 1. Delayed clearing at AD2-048 Tap.	8/45	Stable
P5.04	Fault at 80% of 69 kV line from Renaker to Cynthiana Jct. to AD2-048 Tap circuit 1. Delayed clearing at Renaker.	8/45	Stable

Table 9: Updated Hard Reactive Current Limits for AD2-036, AC2-075, AC1-074

Queue Project	QMX (J+7)	Old Iqhl (J+22)	New Iqhl (J+22)
AC1-074	0.4150	1.0	0.4150
AC2-075	0.4150	1.0	0.4150
AD2-036	0.3777	1.0	0.3777

APPENDIX A
PSS/E ONE- LINE DIAGRAM

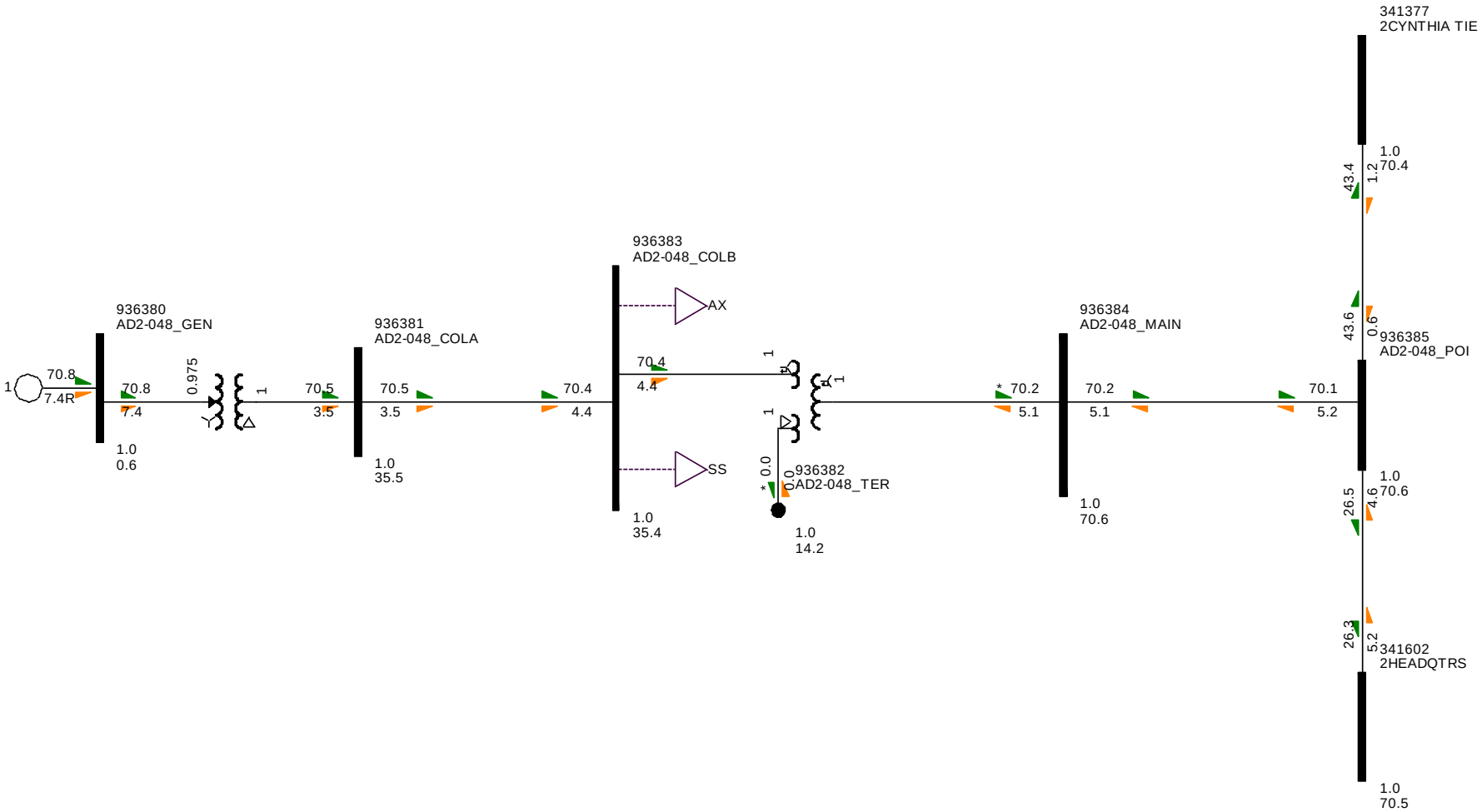


Figure A-2: PSS/E Slider Diagram for AD2-048.

APPENDIX B
PSS/E DYNAMIC MODEL AND IDEV FILE

/***Addition of AD2-048 Queue Project***/

BAT_PURGBRN 341377 341602 '1'

RDCH

1

936380,'AD2-048_GEN ', 0.5500,2, 320,1315, 340,1.01000,
22.0096,1.10000,0.90000,1.10000,0.90000

936381,'AD2-048_COLA', 34.5000,1, 320,1315, 340,1.02760,
18.8411,1.10000,0.90000,1.10000,0.90000

936382,'AD2-048_TER ', 13.8000,1, 320,1315, 340,1.02596,
19.2861,1.10000,0.90000,1.10000,0.90000

936383,'AD2-048_COLB', 34.5000,1, 320,1315, 340,1.02570,
18.7484,1.10000,0.90000,1.10000,0.90000

936384,'AD2-048_MAIN', 69.0000,1, 320,1315, 340,1.02347,
11.0547,1.10000,0.90000,1.10000,0.90000

936385,'AD2-048_POI ', 69.0000,1, 320,1315, 340,1.02329,
10.9328,1.10000,0.90000,1.10000,0.90000

0 / END OF BUS DATA, BEGIN LOAD DATA

936383,'AX',0, 320,1315, 0.040, 0.010, 0.000, 0.000, 0.000, 0.000, 340,1,0

936383,'SS',0, 320,1315, 0.010, 0.002, 0.000, 0.000, 0.000, 0.000, 340,1,0

0 / END OF LOAD DATA, BEGIN FIXED SHUNT DATA

0 / END OF FIXED SHUNT DATA, BEGIN GENERATOR DATA

936380,'1 ', 70.752, 7.448, 38.500, -38.500,1.01000, 0, 80.000, 0.00000E+0,
1.00000E+4, 0.00000E+0, 0.00000E+0,1.00000,1, 100.0, 70.752, 0.000, 340,1.0000

0 / END OF GENERATOR DATA, BEGIN BRANCH DATA

341377,936385,'1 ', 8.13717E-3, 3.24910E-2, 0.00051, 73.00, 76.00, 77.00, 0.00000,
0.00000, 0.00000, 0.00000,1,2, 1.96, 340,1.0000

341602,936385,'1 ', 3.13828E-2, 1.25309E-1, 0.00196, 73.00, 76.00, 77.00, 0.00000,
0.00000, 0.00000, 0.00000,1,1, 7.54, 340,1.0000

936381,936383,'1 ', 2.64000E-3, 2.57000E-3, 0.00955, 0.00, 0.00, 0.00, 0.00000,
0.00000, 0.00000, 0.00000,1,1, 0.00, 340,1.0000

936384,936385,'1 ', 4.90000E-4, 3.14000E-3, 0.00005, 0.00, 0.00, 0.00, 0.00000,
0.00000, 0.00000, 0.00000,1,1, 0.00, 340,1.0000

0 / END OF BRANCH DATA, BEGIN TRANSFORMER DATA

936380,936381, 0,'1 ',1,2,1, 0.00000E+0, 0.00000E+0,2,' ',1, 340,1.0000, 0,1.0000, 0,1.0000, 0,1.0000,'Yd1 '

4.50000E-3, 6.70000E-2, 80.00

0.97500, 0.000, 0.000, 0.00, 0.00, 0.00, 0, 0, 1.10000, 0.90000, 1.10000, 0.90000, 33, 0, 0.00000, 0.00000, 0.000

1.00000, 0.000

936384,936383,936382,'1 ',1,2,1, 0.00000E+0, 0.00000E+0,2,' ',1, 340,1.0000, 0,1.0000, 0,1.0000, 0,1.0000,'YN0yn0d1 '

1.90000E-3, 9.00000E-2, 45.00, 3.20000E-3, 2.52000E-2, 45.00, 4.60000E-3, 1.27800E-1, 45.00,1.02596, 19.2861

1.00000, 0.000, 0.000, 45.00, 60.00, 75.00, 0, 0, 1.10000, 0.90000, 1.10000, 0.90000, 33, 0, 0.00000, 0.00000, 0.000

1.00000, 0.000, 0.000, 45.00, 60.00, 75.00, 0, 0, 1.10000, 0.90000, 1.10000, 0.90000, 33, 0, 0.00000, 0.00000, 0.000

1.00000, 0.000, 0.000, 45.00, 60.00, 75.00, 0, 0, 1.10000, 0.90000, 1.10000, 0.90000, 33, 0, 0.00000, 0.00000, 0.000

0 / END OF TRANSFORMER DATA, BEGIN AREA DATA

320, 0, 0.000, 10.000,'EKPC '

0 / END OF AREA DATA, BEGIN TWO-TERMINAL DC DATA

0 / END OF TWO-TERMINAL DC DATA, BEGIN VSC DC LINE DATA

0 / END OF VSC DC LINE DATA, BEGIN IMPEDANCE CORRECTION DATA

0 / END OF IMPEDANCE CORRECTION DATA, BEGIN MULTI-TERMINAL DC DATA

0 / END OF MULTI-TERMINAL DC DATA, BEGIN MULTI-SECTION LINE DATA

0 / END OF MULTI-SECTION LINE DATA, BEGIN ZONE DATA

1315,'EKPC '

0 / END OF ZONE DATA, BEGIN INTER-AREA TRANSFER DATA

0 / END OF INTER-AREA TRANSFER DATA, BEGIN OWNER DATA

340,'EK NATIVE '

0 / END OF OWNER DATA, BEGIN FACTS DEVICE DATA

0 / END OF FACTS DEVICE DATA, BEGIN SWITCHED SHUNT DATA

0 / END OF SWITCHED SHUNT DATA, BEGIN GNE DATA

0 / END OF GNE DATA, BEGIN INDUCTION MACHINE DATA

0 / END OF INDUCTION MACHINE DATA

Q

```
/*****************************************************
/*** Project: AD2-048 - 70.0 MW MFO
/*** POI: Tap on Roxbury – Greene 138 kV circuit
/*** Inverter:  SMA Sunny Central 2500-US inverters
/*** Size: 32 x 2.211 MW  Solar PV
/*** PSSE Version 33
/*****************************************************

936380 'USRMDL' 1 'SMAPPC18' 4 0 4 28 9 21 936384 936385 1 1
                2 0.5 0.25 0.04 0.0 0.1 1.0 0.04 0
                0 1 0 10 -0.001
                0.1 1.0 0.04 0 1 0.2 0.2
                0.8 0.91 0.915 1.09 1.085 0.3 1.0/
/               CtlMod KP_PF KI_PF PFXdcrTm PFDB KP_Vol KI_Vol VolXdcrTm VolDB
/               PFNomTot VolNomTot QNomTot VolDroop HybCtlTun
/               KP_P KI_P PXdcrTm PDB PNomTot QCommTm PCommTm
/               PFLim FRTThrhLo1 FRTThrhLo2 FRTThrhHi1 FRTThrhHi2 FRTHldTm
Reserved
936380 'USRMDL' 1 'SMASC131' 1 1 0 76 15 193
                1.0 1.0 0.0 0.8 1.0 0.0 1.0 1.0 0.35
                1.0 0.0 5.0 0.5 2.0
                0.0 0.9 0.5 1.0 0.9 0.9
                0.0 0.2 0.05 0.4
                0.35 0.35 1.0 2.0 2.0 2.0 0.1 0.098 0.1 0.098 0.2 0.2
                0.01 1.0 20.0 0.5 0.61 0.62 0.0 0.125 0.1
                1.2 0.1 1.18 1.0 1.15 2.0 0.88 12.0 0.6 5.0 0.5 3.0
                65.0 0.1 64.0 1.0 61.5 3.0 59.3 5.0 57.0 3.0 50.0 0.1
                30.0 0.0 10.0 30.0 0.0 1.0 1.0/
```

/ PPrim PWNom QVArNom PFLIM PFPF PFPFExt QVArMod QoDEna QoDQMax

/ VArCtlVol_Volref VArCtlVol_VolDB VArCtlVol_VArGra VArCtlVol_VArMax VArCtlVol_VArTm

/ PFPFExtStr PFPFStr PFWStr PFPFExtStop PFPFStop PFWStop

/ WCtlHzMod PHzStr PHzStop PWGra

/ WGra VArGra DGSMod DGSArGraNom DGSArGraNomHi DGSArGraNomLo DbVolNomMax DbVolNomMaxH DbVolNomMin DbVolNomMinH DGSqRcvrTm DGSNqRcvrTm

/ VArCmdFltTm FRTPreErrVEna FRTPreErrTm FRTSwOffTm FRTThrshld1 FRTThrshld2 VCtllCharEna VCtlllCharTm VCtlCorTm

/ VCtlMax VCtlMaxTm VCtlhhLim VCtlhhLimTm VCtlhLim VCtlhLimTm VCtllLim VCtllLimTm VCtlllLim VCtlllLimTm VCtlMin VCtlMinTm

/ HzCtlMax HzCtlMaxTm HzCtlhhLim HzCtlhhLimTm HzCtlhLim HzCtlhLimTm HzCtllLim HzCtllLimTm HzCtlllLim HzCtlllLimTm HzCtlMin HzCtlMinTm

/ KPLL1 PLLFlag KPPLL2 KIPLL2 Reserved Reserved GenTrpFlag

/**

/*** Project: AD2-048 ends

/**

APPENDIX C
FINAL GENERATION DISPATCH TABLE

Table C-1: Generation Dispatch for System Impact Study of AD2-048

Ref. No.	Bus Number	Bus Name	Voltage (kV)	Id	Area Num.	Area Name	In Serv.	PGen (MW)	PMax (MW)	PMin (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)
1	248005	06KYGER	345	1	206	OVEC	1	72.59	72.59	22.2	10.07	20.28	-22.64
2	248005	06KYGER	345	2	206	OVEC	1	72.59	72.59	22.2	10.07	20.28	-22.64
3	248005	06KYGER	345	3	206	OVEC	1	72.59	72.59	22.2	10.07	20.28	-22.64
4	248005	06KYGER	345	4	206	OVEC	1	72.59	72.59	22.2	10.07	20.28	-22.64
5	248005	06KYGER	345	5	206	OVEC	1	72.59	72.59	22.2	10.07	20.28	-22.64
6	248005	06KYGER	345	6	206	OVEC	1	123.61	123.61	37.8	17.15	34.52	-38.56
7	248005	06KYGER	345	7	206	OVEC	1	123.61	123.61	37.8	17.15	34.52	-38.56
8	248005	06KYGER	345	8	206	OVEC	1	123.61	123.61	37.8	17.15	34.52	-38.56
9	248005	06KYGER	345	9	206	OVEC	1	123.61	123.61	37.8	17.15	34.52	-38.56
10	248005	06KYGER	345	A	206	OVEC	1	123.61	123.61	37.8	17.15	34.52	-38.56
11	253038	09KILLEN	345	2	209	DAY	1	612	612	230	199.00	199.00	-63.00
12	253038	09KILLEN	345	3	209	DAY	1	18	18	15.66	18.00	18.00	-10.20
13	253077	09STUART	345	1	209	DAY	1	580.6	580.6	300	-0.75	280.00	-17.00
14	253077	09STUART	345	2	209	DAY	1	580	580	300	-0.75	280.00	-30.00
15	253077	09STUART	345	3	209	DAY	1	580.4	580.4	300	8.00	280.00	8.00
16	253077	09STUART	345	4	209	DAY	1	577	577	300	-0.75	280.00	-30.00

Ref. No.	Bus Number	Bus Name	Voltage (kV)	Id	Area Num.	Area Name	In Serv.	PGen (MW)	PMax (MW)	PMin (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)
17	253077	09STUART	345	5	209	DAY	1	9.2	9.2	0	-0.01	8.80	-5.20
18	324918	1JKCT 1G	13.8	1	320	EKPC	1	110	110	0	-3.56	78.00	-60.30
19	342921	1JKCT 2G	13.8	1	320	EKPC	1	110	110	0	-3.63	78.00	-60.30
20	342924	1JKCT 3G	13.8	1	320	EKPC	1	110	110	0	-3.65	78.00	-60.30
21	342927	1JKCT 4G	13.8	1	320	EKPC	1	73	73	0	17.41	40.00	-34.45
22	342930	1JKCT 5G	13.8	1	320	EKPC	1	72.6	72.6	0	17.42	40.00	-34.45
23	342933	1JKCT 6G	13.8	1	320	EKPC	1	73	73	0	16.70	72.50	-42.70
24	342936	1JKCT 7G	13.8	1	320	EKPC	1	73	73	0	16.66	72.50	-42.70
25	342939	1JKCT 9G	13.8	1	320	EKPC	1	76	76	0	38.52	41.80	-76.00
26	342942	1JKCT 10G	13.8	1	320	EKPC	1	76	76	0	38.88	41.80	-76.00
27	342957	1SPURLK1G	22	1	320	EKPC	1	300	300	100	98.38	175.00	-142.00
28	342960	1SPURLK2G	22	1	320	EKPC	1	510	510	210	182.68	290.00	-227.00
29	342963	1SPURLK3G	18	1	320	EKPC	1	268	268	80	106.94	268.00	-138.20
30	342966	1SPURLK4G	18	1	320	EKPC	1	268	268	80	106.94	268.00	-138.20
31	925984	AC1-074 GEN	0.6	1	320	EKPC	1	82.5	82.5	0	4.58	33.65	-33.65
32	926063	AC1-085 GENA	0.6	1	209	DAY	1	200	200	0	34.78	81.40	-81.40
33	926065	AC1-085 GENB	0.6	1	209	DAY	1	200	200	0	34.78	81.40	-81.40
34	931183	AB1-169 CT1	25	1	209	DAY	1	341	341	0	87.29	165.63	-112.41

Ref. No.	Bus Number	Bus Name	Voltage (kV)	Id	Area Num.	Area Name	In Serv.	PGen (MW)	PMax (MW)	PMin (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)
35	931184	AB1-169 ST1	25	1	209	DAY	1	243.6	243.6	0	100.39	300.00	-177.00
36	931185	AB1-169 CT2	25	1	209	DAY	1	341	341	0	87.29	165.63	-112.41
37	931186	AB1-169 ST2	25	1	209	DAY	1	243.6	243.6	0	100.39	300.00	-177.00
38	932553	AC2-075 GEN1	0.6	1	320	EKPC	1	20.7	20.7	0	4.58	6.83	-6.83
39	936282	AD2-036 GEN	0.6	1	320	EKPC	1	61.25	61.25	0	4.58	25.50	-25.50
40	936380	AD2-048_GEN	0.55	1	320	EKPC	1	70.75	70.75	0	7.45	38.50	-38.50

Attachment 1. Impact Study Data

Attachment 2. EKPC One Line Diagram

Attachment 3. Plots from Dynamic Simulations