# *Generation Interconnection Feasibility Study Report*

# *For*

# *PJM Generation Interconnection Request Queue Position AD2-062*

# *Roxbury-Greene 138 kV*

**July 2018**

# 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

The Interconnection Customer (IC), has proposed a solar generating facility located in Franklin County, Pennsylvania. The installed facilities will have a total capability of 80.3 MW with 53.4 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 Mid-Atlantic Interstate Transmission (MAIT) commitment to this in-service date.**

## Point of Interconnection

AD2-062 will interconnect with the MAIT transmission system along one of the following points of interconnection:

- Grand Point – Roxbury 138 kV line
- Roxbury 138 kV Bus

## Cost Summary

The AD2-062 project will be responsible for the following costs:

| Description | Total Cost |
|---|---|
| Attachment Facilities | $ 0 |
| Direct Connection Network Upgrades | $ 5,388,300 |
| Non Direct Connection Network Upgrades | $ 3,198,000 |
| **Total Costs** | **$ 8,586,300** |

In addition, the AD2-062 project may be responsible for a contribution to the following costs:

| Description | Total Cost |
|---|---|
| New System Upgrades | $ 0 |
| Previously Identified Upgrades | $ 0 |
| **Total Costs** | **$ 0** |

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

## General Information

Queue Position: AD2-062

Interconnected Transmission Owner ("TO"): Mid-Atlantic Interstate Transmission, LLC ("MAIT")

Affected TO(s) (if applicable): Mid-Atlantic Interstate Transmission, LLC ("MAIT")
West Penn Power Company ("West Penn")

PJM Zone: Penelec

FE Operating Company or Planning Region: Penelec

## Customer Connection Request

Requested Backfeed Date: 2/1/2020

Requested Commercial Operation Date: 6/1/2020

*This study does not imply a FirstEnergy commitment to these dates.*

| New Facilities | | Existing Facilities | |
|---|---|---|---|
| Capacity: | 53.4 MW | Capacity: | 0 MW |
| Energy: | 80.3 MW | Energy: | 0 MW |
| MFO[1]: | 80.3 MW | MFO: | 0 MW |
| Fuel: | Solar | Prior Queue Position(s): | |

[1] Maximum Facility Output

## 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 | Activity Cost | Tax (if applicable) | Total Cost |
|---|---|---|---|
| Construct a new 138kV ring bus and loop the Grand Point - Roxbury 138kV line into the new substation. @ AD2-062 | $ 4,824,600 | $ 2,021,600 | $ 6,846,200 |
| Loop the Grand Point-Roxbury 138kV line into the new AD2-062 substation @ Grand Point-Roxbury 138kV Line Loop to AD2-062 | $ 563,700 | $ 229,500 | $ 793,200 |
| **Total Direct Connection Facility Costs** | **$ 5,388,300** | **$ 2,251,100** | **$ 7,639,400** |

## 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 | Activity Cost | Tax (if applicable) | Total Cost |
|---|---|---|---|
| Install OPGW on the new AD2-062-Roxbury line. @ AD2-062-Roxbury 138kV OPGW Upgrade | $ 1,636,400 | $ 663,200 | $ 2,299,600 |
| Replace 138kV breaker and line relaying, add fiber to control building from OPGW on line @ Roxbury SS | $ 810,700 | $ 336,700 | $ 1,147,400 |
| Replace 138kV breaker and line relaying @ Grand Point SS | $ 750,900 | $ 312,200 | $ 1,063,100 |
| **Total Non-Direct Connection Facility Costs** | **$ 3,198,000** | **$ 1,312,100** | **$ 4,510,100** |

# Connection Facility Requirements

## Primary POI

The interconnection of the project at the Primary POI will be accomplished by constructing a new 138 kV three (3) breaker ring bus and looping the Grand Point – Roxbury 138 kV line into the new station. The new substation will be located approximately 2.25 miles from Roxbury substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection switching station and the associated attachment facilities. The IC will also be responsible for the rough grade of the property and an access road to the proposed three breaker ring bus site. The project will also require non-direct connection upgrades at Grand Point and Roxbury substations.

A summary of the connection facilities that will be required for the Primary POI and their estimated costs are shown in the following table. Based on this scope of work, it is expected to take a minimum of 22 months after the signing of an Interconnection Construction Service Agreement. This include preliminary payment that compensated FE for the first three months of the engineering design work that is related to the construction of the AD2-062 interconnection substation. This assumes that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined direct connection and network upgrades, and that PJM will allow all transmission system outages when requested.

## Secondary POI

The interconnection of the project at the Secondary POI will be accomplished by constructing a new 138 kV three (3) breaker ring bus at Roxbury substation. A full scope of work or estimated cost is not provided for the Secondary POI.

# 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 The purchase and installation of a fully rated 138 kV circuit breaker to protect the AD2-062 generator lead line. A single circuit breaker must be used to protect this line; if the project has several GSU transformers, the individual GSU transformer breakers cannot be used to protect this line.

4. The purchase and installation of the minimum required FE generation interconnection relaying and control facilities. This includes over/under voltage protection, over/under frequency protection, and zero sequence voltage protection relays.

5. The purchase and installation of supervisory control and data acquisition ("SCADA") equipment to provide information in a compatible format to the FE Transmission System Control Center.

6. Compliance with the FE and PJM generator power factor and voltage control requirements.

7. The execution of a back-up service agreement to serve the customer load supplied from the AD2-062 generation project metering point when the units are out-of-service. This assumes the intent of the IC is to net the generation with the load.

8. item 5.iv. of Schedule H to the Interconnection Service Agreement.

9. The IC shall design its non-synchronous Customer Facility with the ability to maintain a power factor of at least 0.95 leading (absorbing VARs) to 0.95 lagging (supplying VARs) measured at the high-side of the facility substation transformer(s) connected to the FE transmission system.

# Revenue Metering, SCADA & Protection 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.

## FE Requirements

The Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "FirstEnergy Requirements for Transmission Connected Facilities" document located at the following links:

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

## System Protection

The IC must design it's Customer Facilities in accordance with all applicable standards, including the standards in FE's "Requirements for Transmission Connected Facilities" document located at: http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx. Preliminary Protection requirements will be provided as part of the Facilities Study. Detailed Protection Requirements will be provided once the project enters the construction phase.

The IC will also be required to meet all PJM, ReliabilityFirst, and NERC reliability criteria and operating procedures for standards compliance. For example, the IC will need to properly locate and report the over and under voltage and over and under frequency system protection elements for its units as well as the submission of the generator model and protection data required to satisfy the PJM and ReliabilityFirst audits. Failure to comply with these requirements may result in a disconnection of service if the violation is found to compromise the reliability of the FE system.

## Metering

The IC will be require to comply with all FE revenue metering requirements for generation interconnection customers which can be found in FE's "Requirements for Transmission Connected Facilities" document located at: http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx.

# Network Impacts

## Option 1

The Queue Project AD2-062 was evaluated as a 80.3 MW (Capacity 53.5 MW) injection at the tap of the Roxbury - Greene 138 kV line in the APS area. Project AD2-062 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-062 was studied with a commercial probability of 53%. Potential network impacts were as follows:

# Summer Peak Analysis - 2021

## Contingency Descriptions

The following contingencies resulted in overloads:

| Contingency Name | Description |
|---|---|
| AP-P2-4-PE-230-025 | CONTINGENCY 'AP-P2-4-PE-230-025' /* MONOCACY A-B BUS TIE FAULTED BREAKER<br><br>REMOVE MACHINE SV FROM BUS 235488 /* 01MONOCY 230<br><br>DISCONNECT BRANCH FROM BUS 235481 TO BUS 235488 CKT 1 /* 01LIMEKN 230 01MONOCY 230<br><br>DISCONNECT BRANCH FROM BUS 235459 TO BUS 235488 CKT 1 /* 01DOUBS 230 01MONOCY 230<br><br>DISCONNECT BRANCH FROM BUS 235466 TO BUS 235488 CKT 1 /* 01FREDRK 230 01MONOCY 230<br><br>DISCONNECT BRANCH FROM BUS 235488 TO BUS 235494 CKT 1 /* 01MONOCY 230 01OLDFRM 230<br><br>CLOSE LINE FROM BUS 235487 TO BUS 235488 CKT 4 /* 01MONOCY 138 01MONOCY 230<br><br>END |

| Contingency Name | Description |
|---|---|
| AP-P7-1-PE-230-004 | CONTINGENCY 'AP-P7-1-PE-230-004' /* 120<br><br>DISCONNECT BRANCH FROM BUS 235459 TO BUS 235543 CKT 1 /* 01DOUBS 230 01FROSTN 230<br><br>DISCONNECT BRANCH FROM BUS 235506 TO BUS 235543 CKT 1 /* 01RINGLD 230 01FROSTN 230<br><br>DISCONNECT BRANCH FROM BUS 235543 TO BUS 235544 CKT 1 /* 01FROSTN 230 01BOONES 230<br><br>DISCONNECT BRANCH FROM BUS 235488 TO BUS 235494 CKT 1 /* 01MONOCY 230 01OLDFRM 230<br><br>DISCONNECT BRANCH FROM BUS 235494 TO BUS 235506 CKT 1 /* 01OLDFRM 230 01RINGLD 230<br><br>END |
| ME_P4-500-002H | CONTINGENCY 'ME_P4-500-002H' /* HUNTERSTOWN 500 KV STUCK CB - CBB11392<br><br>DISCONNECT BRANCH FROM BUS 200026 TO BUS 200004 CKT 1 /* HUNTERTN 500 CNASTONE 500<br><br>DISCONNECT BRANCH FROM BUS 200026 TO BUS 204501 CKT 1 /* HUNTERTN 500 27HUNTRSTN 230<br><br>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 | LFFB | ME_P4-500-002H | PENELEC | 26ROXBURY 138/115 kV transformer | 200532 | 200520 | 2 | DC | 93.16 | 114.09 | ER | 150 | 31.4 | 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 | | Affected | | Bus | | | Power | Loading % | | Rating | | MW | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| # | Type | Name | Area | Facility Description | From | To | Circuit | Flow | Initial | Final | Type | MVA | Contribution | Ref |
| 2 | DCTL | AP-P7-1-PE-230-004 | AP | 01RINGLD-01WOLFSVILLE 138 kV line | 235505 | 237323 | 1 | DC | 112.17 | 113.79 | ER | 192 | 6.9 | 2 |
| 3 | LFFB | AP-P2-4-PE-230-025 | AP | 01RINGLD-01WOLFSVILLE 138 kV line | 235505 | 237323 | 1 | DC | 100.36 | 101.44 | ER | 192 | 4.61 | |

| # | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | DCTL | AP-P7-1-PE-230-004 | AP | 01WOLFSVILLE-01CATOCT 138 kV line | 237323 | 235452 | 1 | DC | 109.78 | 111.4 | ER | 192 | 6.9 | 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

## 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | Non | Non | PENELEC - PL | 26LEWISTWN-JUNI BU1 230 kV line | 200513 | 208004 | 1 | DC | 100.83 | 101.52 | NR | 493 | 7.5 | |
| 6 | Non | Non | PENELEC | 26ROXBURY 138/115 kV transformer | 200532 | 200520 | 2 | DC | 75.45 | 100.81 | NR | 124 | 31.44 | |

## 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 | The 26ROXBURY 138/115 kV transformer | In order to mitigate the overloads of facilities above, the following reinforcements are required:<br>• Replace the existing Roxbury 100 MVA 138/115 kV transformer with a 224 MVA unit. Convert Roxbury 115 kV substation into a four (4) breaker ring bus. [PJM Upgrade Id: s1643]. The scheduled in-service date is 12/31/2019.<br>This reinforcement was identified as a supplemental project; Therefore this project does not have cost responsibility for this upgrade, however it may be responsible for acceleration costs. | s1643 | **$ 0** |
| | | | **Total New Network Upgrades** | **$ 23,420** |

## 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, 4 | The 01RINGLD-01WOLFSVILLE 138 kV line | In order to mitigate the overloads of facilities above, the following reinforcements are required:<br>• Reconfigure the Ringgold 230 kV substation to double bus double breaker scheme [PJM Upgrade Id: b2743.6]. The scheduled in-service date is 06/01/2020.<br>• Replace the two Ringgold 230/138 kV transformers [PJM Upgrade Id: b2743.6.1]. The scheduled in-service date is 06/01/2020.<br>• Rebuild/Reconductor the Ringgold - Catoctin 138 kV circuit and upgrade terminal equipment on both ends [PJM Upgrade Id: b2743.7]. The scheduled in-service date is 06/01/2020.<br>• Replace Ringgold Substation 138 kV breakers '138 BUS TIE' and 'RCM0' with 40 kA breakers [PJM Upgrade Id: b2743.8]. The scheduled in-service date is 06/01/2020.<br>• Install two new 230 kV positions at Ringgold for 230/138 kV transformers [PJM Upgrade Id: b2970.1]. The scheduled in-service date is 06/01/2020.<br>• Install new 230 kV position for Ringgold – Catoctin 230 kV line [PJM Upgrade Id: b2970.2]. The scheduled in-service date is 06/01/2020.<br>• Install one new 230 kV breaker at Catoctin substation [PJM Upgrade Id: b2970.3]. The scheduled in-service date is 06/01/2020.<br>• Install new 230 / 138 kV transformer at Catoctin substation. Convert Ringgold-Catoctin 138 kV Line to 230 kV operation [PJM Upgrade Id: b2970.4]. The scheduled in-service date is 06/01/2020.<br>This reinforcement was identified as a baseline project; Therefore this project does not have cost responsibility for this upgrade, however it may be responsible for acceleration costs. | Multiple | **$ 0** |
| | | | **Total New Network Upgrades** | **$ 23,420** |

# Network Impacts

## Option 2

The Queue Project AD2-062 was evaluated as a 80.3 MW (Capacity 53.5 MW) injection at the Roxbury 138kV substation in the PenElec area. Project AD2-062 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-062 was studied with a commercial probability of 53%. Potential network impacts were as follows:

# Summer Peak Analysis - 2021

## Contingency Descriptions

The following contingencies resulted in overloads:

| Contingency Name | Description |
|---|---|
| AP-P2-4-PE-230-025 | CONTINGENCY 'AP-P2-4-PE-230-025' /* MONOCACY A-B BUS TIE FAULTED BREAKER<br><br>REMOVE MACHINE SV FROM BUS 235488 /* 01MONOCY 230<br><br>DISCONNECT BRANCH FROM BUS 235481 TO BUS 235488 CKT 1 /* 01LIMEKN 230 01MONOCY 230<br><br>DISCONNECT BRANCH FROM BUS 235459 TO BUS 235488 CKT 1 /* 01DOUBS 230 01MONOCY 230<br><br>DISCONNECT BRANCH FROM BUS 235466 TO BUS 235488 CKT 1 /* 01FREDRK 230 01MONOCY 230<br><br>DISCONNECT BRANCH FROM BUS 235488 TO BUS 235494 CKT 1 /* 01MONOCY 230 01OLDFRM 230<br><br>CLOSE LINE FROM BUS 235487 TO BUS 235488 CKT 4 /* 01MONOCY 138 01MONOCY 230<br><br>END |

| Contingency Name | Description |
|---|---|
| AP-P7-1-PE-230-004 | CONTINGENCY 'AP-P7-1-PE-230-004' /* 120<br><br>DISCONNECT BRANCH FROM BUS 235459 TO BUS 235543 CKT 1 /* 01DOUBS 230 01FROSTN 230<br><br>DISCONNECT BRANCH FROM BUS 235506 TO BUS 235543 CKT 1 /* 01RINGLD 230 01FROSTN 230<br><br>DISCONNECT BRANCH FROM BUS 235543 TO BUS 235544 CKT 1 /* 01FROSTN 230 01BOONES 230<br><br>DISCONNECT BRANCH FROM BUS 235488 TO BUS 235494 CKT 1 /* 01MONOCY 230 01OLDFRM 230<br><br>DISCONNECT BRANCH FROM BUS 235494 TO BUS 235506 CKT 1 /* 01OLDFRM 230 01RINGLD 230<br><br>END |
| ME_P4-500-002H | CONTINGENCY 'ME_P4-500-002H' /* HUNTERSTOWN 500 KV STUCK CB - CBB11392<br><br>DISCONNECT BRANCH FROM BUS 200026 TO BUS 200004 CKT 1 /* HUNTERTN 500 CNASTONE 500<br><br>DISCONNECT BRANCH FROM BUS 200026 TO BUS 204501 CKT 1 /* HUNTERTN 500 27HUNTRSTN 230<br><br>END |
| ME-P2-3-ME-230-005A | CONTINGENCY 'ME-P2-3-ME-230-005A' /* HUNTRSTOWN-JACKSON_ HUNTRSTWN BK1 (HUNTRSTWN-105392)<br><br>DISCONNECT BRANCH FROM BUS 204575 TO BUS 204502 CKT 1 /* 27HUNTRST1 230 27JACKSON 230<br><br>DISCONNECT BRANCH FROM BUS 204575 TO BUS 204501 CKT 1 /* 27HUNTRST1 230 27HUNTRSTN 230<br><br>DISCONNECT BRANCH FROM BUS 200026 TO BUS 204501 CKT 1 /* HUNTERTN 500 27HUNTRSTN 230<br><br>DISCONNECT BUS 204501 /* 27HUNTRSTN 230<br><br>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 | LFFB | ME_P4-500-002H | PENELEC | 26ROXBURY 138/115 kV transformer | 200532 | 200520 | 2 | DC | 93.16 | 115.96 | ER | 150 | 34.21 | 1 |
| 2 | LFFB | ME-P2-3-ME-230-005A | PENELEC | 26ROXBURY 138/115 kV transformer | 200532 | 200520 | 2 | DC | 77.75 | 100.3 | ER | 150 | 33.82 | |

*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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | DCTL | AP-P7-1-PE-230-004 | AP | 01RINGLD-01WOLFSVILLE 138 kV line | 235505 | 237323 | 1 | DC | 112.17 | 113.69 | ER | 192 | 6.45 | 2 |

| # | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | LFFB | AP-P2-4-PE-230-025 | AP | 01RINGLD-01WOLFSVILLE 138 kV line | 235505 | 237323 | 1 | DC | 100.36 | 101.36 | ER | 192 | 4.24 | |
| 5 | DCTL | AP-P7-1-PE-230-004 | AP | 01WOLFSVILLE-01CATOCT 138 kV line | 237323 | 235452 | 1 | DC | 109.78 | 111.29 | ER | 192 | 6.45 | 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

## 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| # | 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 | Non | Non | PENELEC - PL | 26LEWISTWN-JUNI BU1 230 kV line | 200513 | 208004 | 1 | DC | 100.83 | 101.58 | NR | 493 | 8.21 | |
| 7 | Non | Non | PENELEC | 26ROXBURY 138/115 kV transformer | 200532 | 200520 | 2 | DC | 75.45 | 103.1 | NR | 124 | 34.28 | |

## Attachment 1. 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

(PENELEC - PENELEC) The 26ROXBURY 138/115 kV transformer (from bus 200532 to bus 200520 ckt 2) loads from 93.16% to 114.09% (**DC power flow**) of its emergency rating (150 MVA) for the line fault with failed breaker contingency outage of 'ME_P4-500-002H'. This project contributes approximately 31.4 MW to the thermal violation.

| Bus Number | Bus Name | Full Contribution |
|---|---|---|
| 237329 | 01CHBRG_I12 | 1.19 |
| 235723 | 01GUILF1 | 1.29 |
| 235724 | 01GUILF2 | 1.29 |
| 933251 | AC2-136 C | 0.34 |
| 933252 | AC2-136 E | 0.39 |
| 933974 | AD1-020 BAT | 1.24 |
| 934361 | AD1-060 C | 0.54 |
| 934362 | AD1-060 E | 0.88 |
| 934371 | AD1-061 C | 0.87 |
| 934372 | AD1-061 E | 1.41 |
| 936061 | AD2-009 C | 5.92 |
| 936062 | AD2-009 E | 2.7 |
| 936221 | AD2-028 C1 | 9.35 |
| 936223 | AD2-028 C2 | 1.15 |
| 936222 | AD2-028 E1 | 4.4 |
| 936224 | AD2-028 E2 | 5.73 |
| 936311 | AD2-040 | 0.23 |
| 936471 | AD2-062 C O1 | 20.92 |
| 936472 | AD2-062 E O1 | 10.48 |
| 936871 | AD2-110 | 1.89 |
| LTF | CARR | 0.4 |
| LTF | CBM-S1 | 1.59 |

| Bus Number | Bus Name | Full Contribution |
|---|---|---|
| LTF | G-007 | 1.23 |
| LTF | IPL | 0.75 |
| LTF | LGEE | 0.25 |
| LTF | MEC | 2.24 |
| LTF | MECS | 1.4 |
| LTF | O-066 | 8.06 |
| LTF | RENSSELAER | 0.32 |
| LTF | ROSETON | 2.31 |
| 905554 | W4-102 E | 0.68 |
| LTF | WEC | 0.31 |
| 918661 | AA1-080 C | 0.12 |
| 918662 | AA1-080 E | 0.06 |
| 918731 | AA1-092 C | 0.55 |
| 918732 | AA1-092 E | 0.28 |
| 918761 | AA1-095 C | 0.33 |
| 918762 | AA1-095 E | 0.17 |
| 918771 | AA1-096 C | 0.12 |
| 918772 | AA1-096 E | 0.06 |
| 930781 | AB1-123 C | 0.41 |
| 930782 | AB1-123 E | 0.43 |
| 930821 | AB1-127 C | 1.04 |
| 930822 | AB1-127 E | 1.7 |

| Bus Number | Bus Name | Full Contribution |
|---|---|---|
| LTF | CBM-S2 | 1.7 |
| LTF | CBM-W1 | 5.1 |
| LTF | CBM-W2 | 9.15 |
| LTF | CIN | 1.16 |
| LTF | CPLE | 0.45 |

| Bus Number | Bus Name | Full Contribution |
|---|---|---|
| 930831 | AB1-128 C | 1.04 |
| 930832 | AB1-128 E | 1.7 |
| 923871 | AB2-027 C | 0.18 |
| 923872 | AB2-027 E | 0.3 |
| 924482 | AB2-097 E | 0.64 |

# Appendix 2

(AP - AP) The 01RINGLD-01WOLFSVILLE 138 kV line (from bus 235505 to bus 237323 ckt 1) loads from 112.17% to 113.79% (**DC power flow**) of its emergency rating (192 MVA) for the tower line contingency outage of 'AP-P7-1-PE-230-004'. This project contributes approximately 6.9 MW to the thermal violation.

| Bus Number | Bus Name | Full Contribution |
|---|---|---|
| 237329 | 01CHBRG_I12 | 0.63 |
| 235723 | 01GUILF1 | 0.91 |
| 235724 | 01GUILF2 | 0.91 |
| 933251 | AC2-136 C | 0.95 |
| 933252 | AC2-136 E | 1.09 |
| 934361 | AD1-060 C | 0.57 |
| 934362 | AD1-060 E | 0.93 |
| 934371 | AD1-061 C | 0.74 |
| 934372 | AD1-061 E | 1.19 |
| 936061 | AD2-009 C | 4.52 |
| 936062 | AD2-009 E | 2.06 |
| 936221 | AD2-028 C1 | 6.9 |
| 936223 | AD2-028 C2 | 0.84 |
| 936222 | AD2-028 E1 | 3.25 |
| 936224 | AD2-028 E2 | 4.23 |
| 936311 | AD2-040 | 0.34 |
| 936471 | AD2-062 C O1 | 4.6 |
| 936472 | AD2-062 E O1 | 2.3 |
| 936871 | AD2-110 | 1.34 |
| LTF | AMIL | 0.06 |
| LTF | BAYOU | 0.33 |
| LTF | BIG_CAJUN1 | 0.51 |
| LTF | BIG_CAJUN2 | 1.04 |
| LTF | BLUEG | 0.34 |
| LTF | CALDERWOOD | 0.2 |
| LTF | CANNELTON | 0.06 |
| LTF | CATAWBA | 0.18 |
| LTF | CBM-N | 0.16 |
| LTF | CELEVELAND | 0.51 |
| LTF | CHEOAH | 0.18 |

| Bus Number | Bus Name | Full Contribution |
|---|---|---|
| LTF | HAMLET | 0.67 |
| LTF | MORGAN | 0.57 |
| LTF | NEWTON | 0.28 |
| LTF | NYISO | 2.41 |
| LTF | PRAIRIE | 0.59 |
| LTF | ROWAN | 0.37 |
| LTF | SANTEETLA | 0.05 |
| LTF | SMITHLAND | 0.05 |
| LTF | TATANKA | 0.13 |
| LTF | TILTON | 0.12 |
| LTF | TRIMBLE | 0.06 |
| LTF | TVA | 0.25 |
| LTF | UNIONPOWER | 0.33 |
| LTF | VFT | 4.33 |
| 901241 | W1-045C OP1 | 0.47 |
| 901242 | W1-045E OP1 | 0.77 |
| 905554 | W4-102 E | 1.08 |
| 918661 | AA1-080 C | 0.17 |
| 918662 | AA1-080 E | 0.09 |
| 918731 | AA1-092 C | 0.73 |
| 918732 | AA1-092 E | 0.37 |
| 918741 | AA1-093 C | 0.16 |
| 918742 | AA1-093 E | 0.08 |
| 918761 | AA1-095 C | 0.48 |
| 918762 | AA1-095 E | 0.24 |
| 918771 | AA1-096 C | 0.17 |
| 918772 | AA1-096 E | 0.09 |
| 920011 | AA2-085 C | 0.27 |
| 920012 | AA2-085 E | 0.43 |
| 920561 | AA2-159 C | 0.61 |

| Bus Number | Bus Name | Full Contribution |
|---|---|---|
| LTF | CHILHOWEE | 0.06 |
| LTF | CHOCTAW | 0.35 |
| LTF | CLIFTY | 1.27 |
| LTF | COTTONWOOD | 1.28 |
| LTF | DEARBORN | 0.06 |
| LTF | EDWARDS | 0.1 |
| LTF | ELMERSMITH | 0.19 |
| LTF | FARMERCITY | 0.08 |
| LTF | G-007A | 1.61 |
| LTF | GIBSON | 0.11 |

| Bus Number | Bus Name | Full Contribution |
|---|---|---|
| 920562 | AA2-159 E | 0.51 |
| 930781 | AB1-123 C | 0.59 |
| 930782 | AB1-123 E | 0.62 |
| 930821 | AB1-127 C | 0.76 |
| 930822 | AB1-127 E | 1.25 |
| 930831 | AB1-128 C | 0.76 |
| 930832 | AB1-128 E | 1.25 |
| 923871 | AB2-027 C | 0.29 |
| 923872 | AB2-027 E | 0.48 |
| 924482 | AB2-097 E | 1.15 |

# Appendix 3

(AP - AP) The 01WOLFSVILLE-01CATOCT 138 kV line (from bus 237323 to bus 235452 ckt 1) loads from 109.78% to 111.4% (**DC power flow**) of its emergency rating (192 MVA) for the tower line contingency outage of 'AP-P7-1-PE-230-004'. This project contributes approximately 6.9 MW to the thermal violation.

| Bus Number | Bus Name | Full Contribution |
|---|---|---|
| 237329 | 01CHBRG_I12 | 0.63 |
| 235723 | 01GUILF1 | 0.91 |
| 235724 | 01GUILF2 | 0.91 |
| 933251 | AC2-136 C | 0.95 |
| 933252 | AC2-136 E | 1.09 |
| 934361 | AD1-060 C | 0.57 |
| 934362 | AD1-060 E | 0.93 |
| 934371 | AD1-061 C | 0.74 |
| 934372 | AD1-061 E | 1.19 |
| 936061 | AD2-009 C | 4.52 |
| 936062 | AD2-009 E | 2.06 |
| 936221 | AD2-028 C1 | 6.9 |
| 936223 | AD2-028 C2 | 0.84 |
| 936222 | AD2-028 E1 | 3.25 |
| 936224 | AD2-028 E2 | 4.23 |
| 936311 | AD2-040 | 0.34 |
| 936471 | AD2-062 C O1 | 4.6 |
| 936472 | AD2-062 E O1 | 2.3 |
| 936871 | AD2-110 | 1.34 |
| LTF | AMIL | 0.06 |
| LTF | BAYOU | 0.33 |
| LTF | BIG_CAJUN1 | 0.51 |
| LTF | BIG_CAJUN2 | 1.04 |
| LTF | BLUEG | 0.34 |

| Bus Number | Bus Name | Full Contribution |
|---|---|---|
| LTF | HAMLET | 0.67 |
| LTF | MORGAN | 0.57 |
| LTF | NEWTON | 0.28 |
| LTF | NYISO | 2.41 |
| LTF | PRAIRIE | 0.59 |
| LTF | ROWAN | 0.37 |
| LTF | SANTEETLA | 0.05 |
| LTF | SMITHLAND | 0.05 |
| LTF | TATANKA | 0.13 |
| LTF | TILTON | 0.12 |
| LTF | TRIMBLE | 0.06 |
| LTF | TVA | 0.25 |
| LTF | UNIONPOWER | 0.33 |
| LTF | VFT | 4.33 |
| 901241 | W1-045C OP1 | 0.47 |
| 901242 | W1-045E OP1 | 0.77 |
| 905554 | W4-102 E | 1.08 |
| 918661 | AA1-080 C | 0.17 |
| 918662 | AA1-080 E | 0.09 |
| 918731 | AA1-092 C | 0.73 |
| 918732 | AA1-092 E | 0.37 |
| 918741 | AA1-093 C | 0.16 |
| 918742 | AA1-093 E | 0.08 |
| 918761 | AA1-095 C | 0.48 |

| Bus Number | Bus Name | Full Contribution |
|---|---|---|
| LTF | CALDERWOOD | 0.2 |
| LTF | CANNELTON | 0.06 |
| LTF | CATAWBA | 0.18 |
| LTF | CBM-N | 0.16 |
| LTF | CELEVELAND | 0.51 |
| LTF | CHEOAH | 0.18 |
| LTF | CHILHOWEE | 0.06 |
| LTF | CHOCTAW | 0.35 |
| LTF | CLIFTY | 1.27 |
| LTF | COTTONWOOD | 1.28 |
| LTF | DEARBORN | 0.06 |
| LTF | EDWARDS | 0.1 |
| LTF | ELMERSMITH | 0.19 |
| LTF | FARMERCITY | 0.08 |
| LTF | G-007A | 1.61 |
| LTF | GIBSON | 0.11 |

| Bus Number | Bus Name | Full Contribution |
|---|---|---|
| 918762 | AA1-095 E | 0.24 |
| 918771 | AA1-096 C | 0.17 |
| 918772 | AA1-096 E | 0.09 |
| 920011 | AA2-085 C | 0.27 |
| 920012 | AA2-085 E | 0.43 |
| 920561 | AA2-159 C | 0.61 |
| 920562 | AA2-159 E | 0.51 |
| 930781 | AB1-123 C | 0.59 |
| 930782 | AB1-123 E | 0.62 |
| 930821 | AB1-127 C | 0.76 |
| 930822 | AB1-127 E | 1.25 |
| 930831 | AB1-128 C | 0.76 |
| 930832 | AB1-128 E | 1.25 |
| 923871 | AB2-027 C | 0.29 |
| 923872 | AB2-027 E | 0.48 |
| 924482 | AB2-097 E | 1.15 |

## Attachment 1. Flowgate Details – Option 2

# Appendix 1

(PENELEC - PENELEC) The 26ROXBURY 138/115 kV transformer (from bus 200532 to bus 200520 ckt 2) loads from 93.16% to 115.96% (**DC power flow**) of its emergency rating (150 MVA) for the line fault with failed breaker contingency outage of 'ME_P4-500-002H'. This project contributes approximately 34.21 MW to the thermal violation.

| Bus Number | Bus Name | Full Contribution |
|---|---|---|
| 237329 | 01CHBRG_I12 | 1.19 |
| 235723 | 01GUILF1 | 1.29 |
| 235724 | 01GUILF2 | 1.29 |
| 933251 | AC2-136 C | 0.34 |
| 933252 | AC2-136 E | 0.39 |
| 933974 | AD1-020 BAT | 1.24 |
| 934361 | AD1-060 C | 0.54 |
| 934362 | AD1-060 E | 0.88 |
| 934371 | AD1-061 C | 0.87 |
| 934372 | AD1-061 E | 1.41 |
| 936061 | AD2-009 C | 5.92 |
| 936062 | AD2-009 E | 2.7 |
| 936221 | AD2-028 C1 | 9.35 |
| 936223 | AD2-028 C2 | 1.15 |
| 936222 | AD2-028 E1 | 4.4 |
| 936224 | AD2-028 E2 | 5.73 |
| 936311 | AD2-040 | 0.23 |
| 936471 | AD2-062 C O2 | 22.79 |
| 936472 | AD2-062 E O2 | 11.42 |
| 936871 | AD2-110 | 1.89 |
| LTF | CARR | 0.4 |
| LTF | CBM-S1 | 1.59 |
| LTF | CBM-S2 | 1.7 |
| LTF | CBM-W1 | 5.1 |
| LTF | CBM-W2 | 9.15 |
| LTF | CIN | 1.16 |
| LTF | CPLE | 0.45 |

| Bus Number | Bus Name | Full Contribution |
|---|---|---|
| LTF | G-007 | 1.23 |
| LTF | IPL | 0.75 |
| LTF | LGEE | 0.25 |
| LTF | MEC | 2.24 |
| LTF | MECS | 1.4 |
| LTF | O-066 | 8.06 |
| LTF | RENSSELAER | 0.32 |
| LTF | ROSETON | 2.31 |
| 905554 | W4-102 E | 0.68 |
| LTF | WEC | 0.31 |
| 918661 | AA1-080 C | 0.12 |
| 918662 | AA1-080 E | 0.06 |
| 918731 | AA1-092 C | 0.55 |
| 918732 | AA1-092 E | 0.28 |
| 918761 | AA1-095 C | 0.33 |
| 918762 | AA1-095 E | 0.17 |
| 918771 | AA1-096 C | 0.12 |
| 918772 | AA1-096 E | 0.06 |
| 930781 | AB1-123 C | 0.41 |
| 930782 | AB1-123 E | 0.43 |
| 930821 | AB1-127 C | 1.04 |
| 930822 | AB1-127 E | 1.7 |
| 930831 | AB1-128 C | 1.04 |
| 930832 | AB1-128 E | 1.7 |
| 923871 | AB2-027 C | 0.18 |
| 923872 | AB2-027 E | 0.3 |
| 924482 | AB2-097 E | 0.64 |

# Appendix 2

(AP - AP) The 01RINGLD-01WOLFSVILLE 138 kV line (from bus 235505 to bus 237323 ckt 1) loads from 112.17% to 113.69% (**DC power flow**) of its emergency rating (192 MVA) for the tower line contingency outage of 'AP-P7-1-PE-230-004'. This project contributes approximately 6.45 MW to the thermal violation.

| Bus Number | Bus Name | Full Contribution |
|---|---|---|
| 237329 | 01CHBRG_I12 | 0.63 |
| 235723 | 01GUILF1 | 0.91 |
| 235724 | 01GUILF2 | 0.91 |
| 933251 | AC2-136 C | 0.95 |
| 933252 | AC2-136 E | 1.09 |
| 934361 | AD1-060 C | 0.57 |
| 934362 | AD1-060 E | 0.93 |
| 934371 | AD1-061 C | 0.74 |
| 934372 | AD1-061 E | 1.19 |
| 936061 | AD2-009 C | 4.52 |
| 936062 | AD2-009 E | 2.06 |
| 936221 | AD2-028 C1 | 6.9 |
| 936223 | AD2-028 C2 | 0.84 |
| 936222 | AD2-028 E1 | 3.25 |
| 936224 | AD2-028 E2 | 4.23 |
| 936311 | AD2-040 | 0.34 |
| 936471 | AD2-062 C O2 | 4.3 |
| 936472 | AD2-062 E O2 | 2.15 |
| 936871 | AD2-110 | 1.34 |
| LTF | AMIL | 0.06 |
| LTF | BAYOU | 0.33 |
| LTF | BIG_CAJUN1 | 0.51 |
| LTF | BIG_CAJUN2 | 1.04 |
| LTF | BLUEG | 0.34 |
| LTF | CALDERWOOD | 0.2 |
| LTF | CANNELTON | 0.06 |
| LTF | CATAWBA | 0.18 |
| LTF | CBM-N | 0.16 |
| LTF | CELEVELAND | 0.51 |
| LTF | CHEOAH | 0.18 |
| LTF | CHILHOWEE | 0.06 |
| LTF | CHOCTAW | 0.35 |
| LTF | CLIFTY | 1.27 |
| LTF | COTTONWOOD | 1.28 |
| LTF | DEARBORN | 0.06 |
| LTF | EDWARDS | 0.1 |
| LTF | ELMERSMITH | 0.19 |
| LTF | FARMERCITY | 0.08 |
| LTF | G-007A | 1.61 |
| LTF | GIBSON | 0.11 |

| Bus Number | Bus Name | Full Contribution |
|---|---|---|
| LTF | HAMLET | 0.67 |
| LTF | MORGAN | 0.57 |
| LTF | NEWTON | 0.28 |
| LTF | NYISO | 2.41 |
| LTF | PRAIRIE | 0.59 |
| LTF | ROWAN | 0.37 |
| LTF | SANTEETLA | 0.05 |
| LTF | SMITHLAND | 0.05 |
| LTF | TATANKA | 0.13 |
| LTF | TILTON | 0.12 |
| LTF | TRIMBLE | 0.06 |
| LTF | TVA | 0.25 |
| LTF | UNIONPOWER | 0.33 |
| LTF | VFT | 4.33 |
| 901241 | W1-045C OP1 | 0.47 |
| 901242 | W1-045E OP1 | 0.77 |
| 905554 | W4-102 E | 1.08 |
| 918661 | AA1-080 C | 0.17 |
| 918662 | AA1-080 E | 0.09 |
| 918731 | AA1-092 C | 0.73 |
| 918732 | AA1-092 E | 0.37 |
| 918741 | AA1-093 C | 0.16 |
| 918742 | AA1-093 E | 0.08 |
| 918761 | AA1-095 C | 0.48 |
| 918762 | AA1-095 E | 0.24 |
| 918771 | AA1-096 C | 0.17 |
| 918772 | AA1-096 E | 0.09 |
| 920011 | AA2-085 C | 0.27 |
| 920012 | AA2-085 E | 0.43 |
| 920561 | AA2-159 C | 0.61 |
| 920562 | AA2-159 E | 0.51 |
| 930781 | AB1-123 C | 0.59 |
| 930782 | AB1-123 E | 0.62 |
| 930821 | AB1-127 C | 0.76 |
| 930822 | AB1-127 E | 1.25 |
| 930831 | AB1-128 C | 0.76 |
| 930832 | AB1-128 E | 1.25 |
| 923871 | AB2-027 C | 0.29 |
| 923872 | AB2-027 E | 0.48 |
| 924482 | AB2-097 E | 1.15 |

# Appendix 3

(AP - AP) The 01WOLFSVILLE-01CATOCT 138 kV line (from bus 237323 to bus 235452 ckt 1) loads from 109.78% to 111.29% (**DC power flow**) of its emergency rating (192 MVA) for the

tower line contingency outage of 'AP-P7-1-PE-230-004'. This project contributes approximately 6.45 MW to the thermal violation.

| Bus Number | Bus Name | Full Contribution |
|---|---|---|
| 237329 | 01CHBRG_I12 | 0.63 |
| 235723 | 01GUILF1 | 0.91 |
| 235724 | 01GUILF2 | 0.91 |
| 933251 | AC2-136 C | 0.95 |
| 933252 | AC2-136 E | 1.09 |
| 934361 | AD1-060 C | 0.57 |
| 934362 | AD1-060 E | 0.93 |
| 934371 | AD1-061 C | 0.74 |
| 934372 | AD1-061 E | 1.19 |
| 936061 | AD2-009 C | 4.52 |
| 936062 | AD2-009 E | 2.06 |
| 936221 | AD2-028 C1 | 6.9 |
| 936223 | AD2-028 C2 | 0.84 |
| 936222 | AD2-028 E1 | 3.25 |
| 936224 | AD2-028 E2 | 4.23 |
| 936311 | AD2-040 | 0.34 |
| 936471 | AD2-062 C O2 | 4.3 |
| 936472 | AD2-062 E O2 | 2.15 |
| 936871 | AD2-110 | 1.34 |
| LTF | AMIL | 0.06 |
| LTF | BAYOU | 0.33 |
| LTF | BIG_CAJUN1 | 0.51 |
| LTF | BIG_CAJUN2 | 1.04 |
| LTF | BLUEG | 0.34 |
| LTF | CALDERWOOD | 0.2 |
| LTF | CANNELTON | 0.06 |
| LTF | CATAWBA | 0.18 |
| LTF | CBM-N | 0.16 |
| LTF | CELEVELAND | 0.51 |
| LTF | CHEOAH | 0.18 |
| LTF | CHILHOWEE | 0.06 |
| LTF | CHOCTAW | 0.35 |
| LTF | CLIFTY | 1.27 |
| LTF | COTTONWOOD | 1.28 |
| LTF | DEARBORN | 0.06 |
| LTF | EDWARDS | 0.1 |
| LTF | ELMERSMITH | 0.19 |
| LTF | FARMERCITY | 0.08 |
| LTF | G-007A | 1.61 |
| LTF | GIBSON | 0.11 |

| Bus Number | Bus Name | Full Contribution |
|---|---|---|
| LTF | HAMLET | 0.67 |
| LTF | MORGAN | 0.57 |
| LTF | NEWTON | 0.28 |
| LTF | NYISO | 2.41 |
| LTF | PRAIRIE | 0.59 |
| LTF | ROWAN | 0.37 |
| LTF | SANTEETLA | 0.05 |
| LTF | SMITHLAND | 0.05 |
| LTF | TATANKA | 0.13 |
| LTF | TILTON | 0.12 |
| LTF | TRIMBLE | 0.06 |
| LTF | TVA | 0.25 |
| LTF | UNIONPOWER | 0.33 |
| LTF | VFT | 4.33 |
| 901241 | W1-045C OP1 | 0.47 |
| 901242 | W1-045E OP1 | 0.77 |
| 905554 | W4-102 E | 1.08 |
| 918661 | AA1-080 C | 0.17 |
| 918662 | AA1-080 E | 0.09 |
| 918731 | AA1-092 C | 0.73 |
| 918732 | AA1-092 E | 0.37 |
| 918741 | AA1-093 C | 0.16 |
| 918742 | AA1-093 E | 0.08 |
| 918761 | AA1-095 C | 0.48 |
| 918762 | AA1-095 E | 0.24 |
| 918771 | AA1-096 C | 0.17 |
| 918772 | AA1-096 E | 0.09 |
| 920011 | AA2-085 C | 0.27 |
| 920012 | AA2-085 E | 0.43 |
| 920561 | AA2-159 C | 0.61 |
| 920562 | AA2-159 E | 0.51 |
| 930781 | AB1-123 C | 0.59 |
| 930782 | AB1-123 E | 0.62 |
| 930821 | AB1-127 C | 0.76 |
| 930822 | AB1-127 E | 1.25 |
| 930831 | AB1-128 C | 0.76 |
| 930832 | AB1-128 E | 1.25 |
| 923871 | AB2-027 C | 0.29 |
| 923872 | AB2-027 E | 0.48 |
| 924482 | AB2-097 E | 1.15 |