PJM Generator Interconnection

X2-030 Hawkins Gate 230 kV

830 MW Capacity / 830 MW Energy

Feasibility Study Report

December 2011
DMS #671195v1

Introduction

This Feasibility Study has been prepared in accordance with the PJM Open Access Transmission Tariff, §36.2, as well as the Feasibility Study Agreement between Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is PEPCO. An Affected System Operator may be SMECO. Based on the scoping meeting, IC was in discussions with SMECO.

Preface

The intent of this Feasibility Study is to determine a plan, with preliminary cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by IC. As a requirement for interconnection, IC 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 and the underlying system. All facilities required for interconnection of a generation interconnection project must be designed to meet ITO technical specifications.

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. IC is responsible for its right of way, real estate, and construction permit issues.

General

Queue project X2-030 was studied as a(n) 830.0 MW (830.0 MW of which was Capacity) injection into PEPCO's system. Project X2-030 was evaluated for compliance with reliability criteria for summer peak conditions in 2015. Two options were studied, a primary and secondary.

Primary Option

Primary option was a tap between Morgantown Bus and Hawkins Gate 076 230 kV line and tap between Morgantown bus and Hawkins Gate 077 230 kV line.

Network Impacts:

Generator Deliverability

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

1. (BG&E) The High Ridge 2316-Howard 2332 230 kV line (from bus 220941 to bus 220954 ckt 1) loads from 94.35% to 101.12% (DC power flow) of its emergency rating (941 MVA) for the single contingency 'PP1EB'. This project contributes approximately 63.88 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1           / 200003 BRIGHTON 500 200004 CNASTONE
500 1
END
```

2. (BG&E) The Sandy Spring 2314-High Ridge 2316 230 kV line (from bus 220983 to bus 220941 ckt 1) loads from 93.59% to 100.67% (DC power flow) of its emergency rating (941 MVA) for the single contingency 'PP28'. This project contributes approximately 66.68 MW to the thermal violation.

```
CONTINGENCY 'PP28'
  OPEN BRANCH FROM BUS 220984 TO BUS 223962 CKT 1           / 220984 SANDY34T 230 223962 BURT2334
230 1
END
```

3. (PEPCO) The V3-017 TAP-Talbert 068 230 kV line (from bus 894600 to bus 223990 ckt 1) loads from 97.01% to 115.96% (DC power flow) of its normal rating (608 MVA) for non contingency condition. This project contributes approximately 115.23 MW to the thermal violation.

4. (PEPCO) The X2-030 TAP-Hawkins Gate 077 230 kV line (from bus 909250 to bus 223993 ckt 1) loads from 83.32% to 105.14% (DC power flow) of its emergency rating (691 MVA) for the single contingency 'PP54_V3-017B'. This project contributes approximately 150.79 MW to the thermal violation.

```
CONTINGENCY 'PP54_V3-017B'
  OPEN BRANCH FROM BUS 223982 TO BUS 224125 CKT 1 / 223982 OAKGV230 230 224125 TALB 066 230 1
  OPEN BRANCH FROM BUS 894610 TO BUS 224125 CKT 1 / 223992 HAWK 076 230 224125 TALB 066 230 1
  OPEN BRANCH FROM BUS 223992 TO BUS 224078 CKT 1 / 223992 HAWK 076 230 224078 HAWK 69 69.0 1
END
```

5. (BG&E) The Sandy Spring 2334-High Ridge 2316 230 kV line (from bus 220984 to bus 220941 ckt 1) loads from 94.06% to 101.06% (DC power flow) of its emergency rating (941 MVA) for the single contingency 'PP27'. This project contributes approximately 65.90 MW to the thermal violation.

```
CONTINGENCY 'PP27'
  OPEN BRANCH FROM BUS 220983 TO BUS 223961 CKT 1 / 220983 SANDY14T 230 223961 BURT2314 230 1
END
```

6. (PEPCO) The Bowie 045-Burtonsville 2314 230 kV line (from bus 223978 to bus 223961 ckt 1) loads from 99.89% to 114.51% (DC power flow) of its normal rating (608 MVA) for non contingency condition. This project contributes approximately 88.87 MW to the thermal violation.

7. (PL) The Safe Harbor Units 3-4 Tap-Manor Substation 230 kV line (from bus 208071 to bus 208019 ckt 1) loads from 89.12% to 90.17% (DC power flow) of its emergency rating (579 MVA) for the single contingency 'PJM17'. This project contributes approximately 38.04 MW to the thermal violation.

```
CONTINGENCY 'PJM17'
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1     /* CNASTONE PEACHBTM 500 500
END
```

8. (PEPCO) The Oak Groove-Bowie 042 230 kV line (from bus 223982 to bus 223977 ckt 1) loads from 99.63% to 114.29% (DC power flow) of its normal rating (608 MVA) for non contingency condition. This project contributes approximately 89.17 MW to the thermal violation.

9. (PEPCO) The Bowie 042-Burtonsville 2334 230 kV line (from bus 223977 to bus 223962 ckt 1) loads from 99.30% to 113.96% (DC power flow) of its normal rating (608 MVA) for non contingency condition. This project

contributes approximately 89.17 MW to the thermal violation.

10. (PEPCO) The V3-017 TAP-Talbert 066 230 kV line (from bus 894610 to bus 224125 ckt 1) loads from 93.15% to 102.06% (DC power flow) of its normal rating (559 MVA) for non contingency condition. This project contributes approximately 49.81 MW to the thermal violation.

11. (BG&E) The Howard 2312-Granite 2311 & 2312 230 kV line (from bus 220953 to bus 220972 ckt 1) loads from 91.75% to 99.42% (DC power flow) of its emergency rating (728 MVA) for the single contingency 'PP1EB'. This project contributes approximately 55.98 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1 / 200003 BRIGHTON 500 200004 CNASTONE 500 1
END
```

12. (BG&E) The High Ridge 2316-Columbia 230 kV line (from bus 220941 to bus 221010 ckt 1) loads from 90.93% to 96.83% (DC power flow) of its emergency rating (941 MVA) for the single contingency 'PP1EB'. This project contributes approximately 55.65 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1 / 200003 BRIGHTON 500 200004 CNASTONE 500 1
END
```

Multiple Facility Contingency

(Double Circuit Tower Line Contingencies only with full energy output. Stuck Breaker and Bus Fault contingencies will be applied during the Impact Study)

No problems identified.

Contribution to Previously Identified Overloads

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

13. (PEPCO) The Talbert 068-Oak Groove 230 kV line (from bus 223990 to bus 223982 ckt 1) loads from 105.28% to 106.08% (DC power flow) of its emergency rating (691 MVA) for the single contingency 'PP54_V3-017A'. This

project contributes approximately 34.35 MW to the thermal violation.

```
CONTINGENCY 'PP54_V3-017A'
  OPEN BRANCH FROM BUS 223982 TO BUS 224125 CKT 1 / 223982 OAKGV230 230 224125 TALB 066 230 1
  OPEN BRANCH FROM BUS 223992 TO BUS 894610 CKT 1 / 223992 HAWK 076 230 224125 TALB 066 230 1
  OPEN BRANCH FROM BUS 223992 TO BUS 224078 CKT 1 / 223992 HAWK 076 230 224078 HAWK 69 69.0 1
END
```

1.

14. (BG&E/PL) The Conastone-Otter Creek Switchyard 230 kV line (from bus 220963 to bus 208048 ckt 1) loads from 122.19% to 123.48% (DC power flow) of its emergency rating (531 MVA) for the single contingency 'PJM17'. This project contributes approximately 43.14 MW to the thermal violation.

```
CONTINGENCY 'PJM17'
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1 /* CNASTONE PEACHBTM 500 500
END
```

15. (BG&E/PECO) The Graceton-Cooper 230 kV line (from bus 220964 to bus 214089 ckt 1) loads from 116.42% to 117.7% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 38.43 MW to the thermal violation.

```
CONTINGENCY 'PJM17'
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1     /* CNASTONE PEACHBTM 500 500
END
```

16. (PEPCO) The V3-017 TAP-Talbert 068 230 kV line (from bus 894600 to bus 223990 ckt 1) loads from 134.47% to 155.82% (DC power flow) of its emergency rating (691 MVA) for the single contingency 'PP54_V3-017A'. This project contributes approximately 147.52 MW to the thermal violation.

```
CONTINGENCY 'PP54_V3-017A'
  OPEN BRANCH FROM BUS 223982 TO BUS 224125 CKT 1 / 223982 OAKGV230 230 224125 TALB 066 230 1
  OPEN BRANCH FROM BUS 223992 TO BUS 894610 CKT 1 / 223992 HAWK 076 230 224125 TALB 066 230 1
  OPEN BRANCH FROM BUS 223992 TO BUS 224078 CKT 1 / 223992 HAWK 076 230 224078 HAWK 69 69.0 1
END
```

17. (PECO) The Cooper-Peach Bottom 230 kV line (from bus 214089 to bus 213869 ckt 1) loads from 113.93% to 115.21% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 38.43 MW to the thermal violation.

```
CONTINGENCY 'PJM17'
```

```
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1     /* CNASTONE PEACHBTM 500 500
END
```

18. (PEPCO) The Bowie 045-Burtonsville 2314 230 kV line (from bus 223978 to bus 223961 ckt 1) loads from 114.31% to 130.43% (DC power flow) of its emergency rating (730 MVA) for the tower contingency '5PEPCO'. This project contributes approximately 118.01 MW to the thermal violation.

```
CONTINGENCY '5PEPCO'     /* CHALK230 TO BOWIE044
  DISCONNECT BRANCH FROM BUS 223983 TO BUS 224600 CKT 1 /* OAKGV230 TO AQUASCO1
  DISCONNECT BRANCH FROM BUS 224600 TO BUS 224060 CKT 1 /* AQUASCO1 TO BOWIE044. FEB. 17, 2009.
  DISCONNECT BRANCH FROM BUS 224060 TO BUS 223979 CKT 1
  DISCONNECT BRANCH FROM BUS 223982 TO BUS 223977 CKT 1
  DISCONNECT BRANCH FROM BUS 223977 TO BUS 223962 CKT 1
END
```

19. (PEPCO) The Bowie 045-Burtonsville 2314 230 kV line (from bus 223978 to bus 223961 ckt 1) loads from 102.27% to 117.26% (DC power flow) of its emergency rating (730 MVA) for the single contingency 'PP36'. This project contributes approximately 109.42 MW to the thermal violation.

```
CONTINGENCY 'PP36'
  OPEN BRANCH FROM BUS 223962 TO BUS 223977 CKT 1 / 223962 BURT2334 230 223977 BOWIE042 230 1
END
```

20. (PEPCO) The Oak Groove-Bowie 045 230 kV line (from bus 223982 to bus 223978 ckt 1) loads from 114.43% to 130.55% (DC power flow) of its emergency rating (730 MVA) for the tower contingency '5PEPCO'. This project contributes approximately 118.01 MW to the thermal violation.

```
CONTINGENCY '5PEPCO'     /* CHALK230 TO BOWIE044
  DISCONNECT BRANCH FROM BUS 223983 TO BUS 224600 CKT 1 /* OAKGV230 TO AQUASCO1
  DISCONNECT BRANCH FROM BUS 224600 TO BUS 224060 CKT 1 /* AQUASCO1 TO BOWIE044. FEB. 17, 2009.
  DISCONNECT BRANCH FROM BUS 224060 TO BUS 223979 CKT 1
  DISCONNECT BRANCH FROM BUS 223982 TO BUS 223977 CKT 1
  DISCONNECT BRANCH FROM BUS 223977 TO BUS 223962 CKT 1
END
```

21. (PEPCO) The Oak Groove-Bowie 045 230 kV line (from bus 223982 to bus 223978 ckt 1) loads from 102.40% to 117.39% (DC power flow) of its emergency rating (730 MVA) for the single contingency 'PP36'. This project contributes approximately 109.42 MW to the thermal violation.

```
CONTINGENCY 'PP36'
  OPEN BRANCH FROM BUS 223962 TO BUS 223977 CKT 1 / 223962 BURT2334 230 223977 BOWIE042 230 1
END
```

22. (PEPCO) The Oak Groove-Bowie 045 230 kV line (from bus 223982 to bus 223978 ckt 1) loads from 100.04% to 114.66% (DC power flow) of its normal rating (608 MVA) for non contingency condition. This project contributes approximately 88.87 MW to the thermal violation.

23. (PEPCO) The Oak Groove-Bowie 042 230 kV line (from bus 223982 to bus 223977 ckt 1) loads from 113.54% to 129.58% (DC power flow) of its emergency rating (730 MVA) for the tower contingency '7PEPCO_A'. This project contributes approximately 117.41 MW to the thermal violation.

```
CONTINGENCY '7PEPCO_A'     /* BOWIE045 TO OAKGV23
  DISCONNECT BRANCH FROM BUS 223978 TO BUS 223961 CKT 1     /* OAKGV05 TO CHALK230
  DISCONNECT BRANCH FROM BUS 223982 TO BUS 223978 CKT 1
  DISCONNECT BRANCH FROM BUS 224061 TO BUS 223980 CKT 1
  DISCONNECT BRANCH FROM BUS 292454 TO BUS 224061 CKT 1     /BUS 223983 -> 292454
END
```

24. (PEPCO) The Oak Groove-Bowie 042 230 kV line (from bus 223982 to bus 223977 ckt 1) loads from 102.12% to 117.14% (DC power flow) of its emergency rating (730 MVA) for the single contingency 'PP31'. This project contributes approximately 109.62 MW to the thermal violation.

```
CONTINGENCY 'PP31'
  OPEN BRANCH FROM BUS 223961 TO BUS 223978 CKT 1           / 223961 BURT2314 230 223978 BOWIE045
230 1
END
```

25. (PEPCO) The Bowie 042-Burtonsville 2334 230 kV line (from bus 223977 to bus 223962 ckt 1) loads from 113.28% to 129.32% (DC power flow) of its emergency rating (730 MVA) for the tower contingency '7PEPCO_A'. This project contributes approximately 117.41 MW to the thermal violation.

```
CONTINGENCY '7PEPCO_A'     /* BOWIE045 TO OAKGV23
  DISCONNECT BRANCH FROM BUS 223978 TO BUS 223961 CKT 1     /* OAKGV05 TO CHALK230
  DISCONNECT BRANCH FROM BUS 223982 TO BUS 223978 CKT 1
  DISCONNECT BRANCH FROM BUS 224061 TO BUS 223980 CKT 1
  DISCONNECT BRANCH FROM BUS 292454 TO BUS 224061 CKT 1     /BUS 223983 -> 292454
END
```

26. (PEPCO) The Bowie 042-Burtonsville 2334 230 kV line (from bus 223977 to bus 223962 ckt 1) loads from 101.85% to 116.87% (DC power flow) of its emergency rating (730 MVA) for the single contingency 'PP31'. This project

contributes approximately 109.62 MW to the thermal violation.

```
CONTINGENCY 'PP31'
  OPEN BRANCH FROM BUS 223961 TO BUS 223978 CKT 1  / 223961 BURT2314 230 223978 BOWIE045 230 1
END
```

27. (BG&E) The Sollers Point 2344-Riverside 2339 230 kV line (from bus 220990 to bus 220977 ckt 1) loads from 108.03% to 108.82% (DC power flow) of its emergency rating (1036 MVA) for the single contingency 'BG_RIV230-2'. This project contributes approximately 50.89 MW to the thermal violation.

```
CONTINGENCY 'BG_RIV230-2' /* RIVERSIDE 230-2 TRANSFORMER & CKT 2345
  DISCONNECT BRANCH FROM BUS 220966 TO BUS 220988 CKT 1 /* CKT #2345 RIVERSIDE TO SOLLERS PT
  DISCONNECT BRANCH FROM BUS 220966 TO BUS 221231 CKT 1 /* RIVERSIDE 230-2 TRANSFORMER
  DISCONNECT BRANCH FROM BUS 221231 TO BUS 221147 CKT 1 /* RIVERSIDE 230-2 L/S BUS CONNECTION
END
```

28. (PEPCO) The V3-017 TAP-Talbert 066 230 kV line (from bus 894610 to bus 224125 ckt 1) loads from 114.91% to 126.5% (DC power flow) of its emergency rating (680 MVA) for the tower contingency '10PEPCO_S17_X2-030'. This project contributes approximately 113.37 MW to the thermal violation.

```
CONTINGENCY '10PEPCO_S17_X2-030'
  DISCONNECT BRANCH FROM BUS 223988 TO BUS 223990 CKT 1     / MORGNTW230 – TALB068
  DISCONNECT BRANCH FROM BUS 223990 TO BUS 223982 CKT 1     / TALB068 – OAKGV230
  DISCONNECT BRANCH FROM BUS 223992 TO BUS 224078 CKT 1     / HAWK 076 230 - HAWK 69
  DISCONNECT BRANCH FROM BUS 223990 TO BUS 290891 CKT 1     / TALB068 – S17TAP81230
  DISCONNECT BRANCH FROM BUS 223988 TO BUS 909240 CKT 1     / MORGT230 – HAWK076
  DISCONNECT BRANCH FROM BUS 909240 TO BUS 223992 CKT 1
END
```

29. (PEPCO) The V3-017 TAP-Talbert 066 230 kV line (from bus 894610 to bus 224125 ckt 1) loads from 109.97% to 124.94% (DC power flow) of its emergency rating (680 MVA) for the single contingency 'PP47'. This project contributes approximately 101.82 MW to the thermal violation.

```
CONTINGENCY 'PP47'
  OPEN BRANCH FROM BUS 223982 TO BUS 223990 CKT 1 / 223982 OAKGV230 230 223990 TALB 068 230 1
  OPEN BRANCH FROM BUS 290891 TO BUS 223990 CKT 1 / 290891 S17 230 223990 TALB 068 230 1 / S17.
END
```

30. (PJM) The Conastone-Peach Bottom 500 kV line (from bus 200004 to bus 200013 ckt 1) loads from 117.35% to 118.05% (DC power flow) of its emergency rating (2815 MVA) for the single contingency 'PJM76'. This project

contributes approximately 148.21 MW to the thermal violation.

```
CONTINGENCY 'PJM76'
  REMOVE MACHINE 1 FROM BUS 200034 /* PB2
END
```

31. (PEPCO) The Talbert 066-Oak Groove 230 kV line (from bus 224125 to bus 223982 ckt 1) loads from 156.50% to 194.62% (DC power flow) of its emergency rating (680 MVA) for the tower contingency '10PEPCO_S17_X2-030'. This project contributes approximately 306.32 MW to the thermal violation.

```
CONTINGENCY '10PEPCO_S17_X2-030'
  DISCONNECT BRANCH FROM BUS 223988 TO BUS 223990 CKT 1     / MORGNTW230 – TALB068
  DISCONNECT BRANCH FROM BUS 223990 TO BUS 223982 CKT 1     / TALB068 – OAKGV230
  DISCONNECT BRANCH FROM BUS 223992 TO BUS 224078 CKT 1     / HAWK 076 230 - HAWK 69
  DISCONNECT BRANCH FROM BUS 223990 TO BUS 290891 CKT 1     / TALB068 – S17TAP81230
  DISCONNECT BRANCH FROM BUS 223988 TO BUS 909240 CKT 1     / MORGT230 – HAWK076
  DISCONNECT BRANCH FROM BUS 909240 TO BUS 223992 CKT 1
END
```

32. (PEPCO) The Talbert 066-Oak Groove 230 kV line (from bus 224125 to bus 223982 ckt 1) loads from 145.43% to 175.47% (DC power flow) of its emergency rating (680 MVA) for the single contingency 'PP47'. This project contributes approximately 204.25 MW to the thermal violation.

```
CONTINGENCY 'PP47'
  OPEN BRANCH FROM BUS 223982 TO BUS 223990 CKT 1  / 223982 OAKGV230 230 223990 TALB 068 230 1
  OPEN BRANCH FROM BUS 290891 TO BUS 223990 CKT 1 / 290891 S17 230 223990 TALB 068 230 1 / S17.
END
```

33. (PEPCO) The Talbert 066-Oak Groove 230 kV line (from bus 224125 to bus 223982 ckt 1) loads from 123.99% to 148.67% (DC power flow) of its normal rating (559 MVA) for non contingency condition. This project contributes approximately 137.99 MW to the thermal violation.

34. (AP/PJM) The Kemptown-EMORY GR500 500 kV line (from bus 235632 to bus 200101 ckt 1) loads from 113.44% to 113.89% (DC power flow) of its emergency rating (2901 MVA) for the single contingency 'PJM67'. This project contributes approximately 90.30 MW to the thermal violation.

```
CONTINGENCY 'PJM67'
  DISCONNECT BRANCH FROM BUS 200026 TO BUS 200004 CKT 1 /* HUNTERTN CNASTONE 500 500
END
```

35. (AP/PJM) The Kemptown-EMORY GR500 500 kV line (from bus 235632 to bus 200101 ckt 1) loads from 123.56% to 124.12% (DC power flow) of its normal rating (2338 MVA) for non contingency condition. This project contributes approximately 99.72 MW to the thermal violation.

Short Circuit

(Report Overdutied breakers here)

The GSF (Morgantown) 230kV circuit breakers are overdutied by the V3-017 generation with significant contribution from X2-030 Option 1. Allocation will be determined at the System Impact Study. Total number of circuit breakers is 16 and estimated cost is $14M.

BUS_NO	BUS	BREAKER	Rating Type	Duty Percent With x2-030_PEPCO_opt1	Duty Percent Without x2-030_PEPCO_opt1	Duty Percent Difference	Note
223988	GSF 230 230.kV	WEST OCB	T	127.10%	102.60%	24.50%	Over 100%, > 3% contribution

Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of the surrounding generation. Any potential 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 Transmission Interconnection request.

Note: 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 analyzes all overload conditions associated with the overloaded element(s) identified. As a result of the aggregate energy resources in the area, the following violations were identified.

No violations identified.

ITO Analysis – Primary Option

Please note ITO sees potential Right-of-Way and permitting issues if this project were to be built that are not factored in the cost estimates provided below.

Primary Option 230kV Interconnection - These costs or base on the 230kV one-line provided by the developer. They assume that the developer would build to ITO specifications and turn over to Pepco for operations.

- Engineering review of design of new 230kV substation and construction management and testing - $2,000,000
- Replace relays at the remote terminal ends of the new substation and telecommunications - $3,600,000
- New revenue metering will be required - $500,000
- 230kV extension from existing lines to new substation with installation of two heavy duty 90 degree double circuit poles and bringing the lines to the A-frame structures in the new 230-kV substation ~ 4 miles - $14,500,000

The duration of this work is expected to be 24 - 36 months, depending on outage availability. The overall work in support of the new interconnection substation will cost approximately $20,600,000.

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. "Network Impacts", initially caused by the addition of this project generation. Numbers align with overload number from previous sections)

1. **Existing**: Circuit 2332-A is 1590 kcm ACSR @ 160 °C and length of line is 8.9 miles.

   Mitigation: Rebuild line to accommodate double bundle 1272 ACSR.

   Estimate: $ 24M and 5 years.

   Assumptions: 2+ year CPCN process required. Existing tower removal included.

2,5. **Mitigation**: Rebuild existing line using double bundle 1033 ACSR @ 125 °C (1227 MVA).

   Estimate: $10M and 5 years.

   Assumptions: Full structure replacement required, Existing structure removal included, Line length of 3.61 miles, 2+ year CPCN process required.

3,10,16,28,29. **Mitigation**: Upgrade approximately 10 miles of the line. Both circuits on the same tower are required to be upgraded.

Estimate: $14M and 2 years of engineering and construction.

4. **Mitigation**: Upgrade approximately 10 miles of the line. Both circuits on the same tower are required to be upgraded.

   Estimate: $14M and 2 years of engineering and construction.

6,9,18,19,25,26. **Existing**: Currently this circuit is an ACSR conductor, which is rated at 730 MVA Summer Emergency.

Mitigation: Upgrading this circuit will require replacing the existing conductor to an ACCC conductor, which will be rated at 3000 amps or 1200 MVA Summer Emergency.

Estimate: $8M and two years.

7. **Existing**: 795 kcmil 30/19, 140 °C line

   Mitigation: Upgrade to 1590 kcmil 45/7, 125 °C.

   Estimate: $56,000 and two years.

8,20,21,22,23,24. **Existing**: This circuit is an ACSR conductor, which is rated at 730 MVA Summer Emergency.

Mitigation: Upgrading this circuit will require replacing the existing conductor to an ACCC conductor, which will be rated at 3000 amps or 1200 MVA Summer Emergency.

Estimate: $12M and two years.

11. **Mitigation**: Replace wire-drops and upgrade structures to obtain new rating of 825 MVA.

    Estimate: 500K and 12-18 months.

12. **Existing**: This 4.4 mile 230kV line is at its full rating.

    Mitigation: Rebuild with bundle 1590 MCM rated at 1604 MVA Summer Emergency.

    Estimate: $15M, a CPCN is needed and 4-5 years to build.

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.)

13,31,32,33. **Existing**: Approximately 10 miles of double circuit line.

Mitigation: Both circuits on the same tower are required to be upgraded.

Estiamte: $14M, two years of engineering and construction.

14. **BGE Existing**: The existing circuit 2302 conductor is 1,590 kcmil 45/7 ACSR from Conastone to Gorsuch Mills and 795 kcm 30/19 ACSR from Gorsuch Mills to the PA State Line.

BGE Mitigation: Conastone to Otter Creek line can be upgraded by re-conductoring from Gorsuch Mills to the Pennsylvania State Line, where it changes ownership to PPL. Reconductor with 1,590 kcm ACSR from Gorsuch Mills to PA line to match capability of remainder of line. The length of this line section is 1.7 miles.

BGE Assumptions: Towers can be reinforced instead of replaced. Based on previous estimate by R.W.M. for PJM (B48) study on circuit 22008

BGE Estimate: $700,000 and 36 months.

PPL Mitigation: There is an existing PPL project to re-conductor Manor-Conastone with 1590 ACSR is underway. This project will increase the capability to 653/793 MVA (Summer Normal/Emergency).

PPL Estimate: $17M, expected in-service date is October 2013.

15. **Mitigation**: Rebuild Cooper to Graceton 230 kV line 1.85 miles to PA border. New rating would be 648/802 MVA (Summer Normal/Emergency).

Estimate: $7.5 million, CPCN 18 months and construction 36 months.

17. **Existing**: The line is approximately 1.4 miles long.

Mitigation: Reconductor Line 220-08 from Peach Bottom tap to Cooper Substation to get a minimum Summer Emergency rating of 741 MVA.

Estimate: $1.0M and 24 months.

27. **Mitigation**: Install one additional harbor crossing cable from Hawkins Point to Sollers Point and re-rate overhead sections to 180 °C.

Estimate: $40.25 million, 8-10 years to design and complete.

30. **Mitigation**: Install new second Peach Bottom to Conastone 500 kV line with a minimum normal and emergency rating of 2920 / 3707 MVA, respectively. The new line will be approximately 6 miles long. Replace the 5012 terminal equipment at Peach Bottom substation to achieve the conductor normal and emergency rating of 2920 / 3707 MVA, respectively.

    Assumption: This cost is for the PECO portion only and does not include right-of-way costs for new line.

    Estimate: $25M, and 60 months to complete.

34,35. **Existing**: The two breaker bay at Conastone for the Brighton line is over the continuous rating.

    Mitigation: Upgrade Conastone bay with two 4000A breakers, four 4000A breaker disconnects and a 4000 A line switch to achieve a new rating of 3710 MVA.

    Estimate: $3M and 24-36 months.

Secondary Option

The Secondary Option was a loop-in & loop-out of the Burchess and Possum Point 500 kV line. Potential transmission network impacts are as follows:

Generator Deliverability

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

1. (BG&E) The High Ridge 2316-Howard 2332 230 kV line (from bus 220941 to bus 220954 ckt 1) loads from 94.35% to 95.26% (DC power flow) of its emergency rating (941 MVA) for the single contingency 'PP1EB'. This project contributes approximately 53.05 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1 / 200003 BRIGHTON 500 200004 CNASTONE 500 1
END
```

2. (PENELEC) The Roxbury-Roxbury 138/115 kV transformer (from bus 200532 to bus 200520 ckt 1) loads from 97.32% to 98.71% (DC power flow) of its emergency rating (138 MVA) for the single contingency 'PP1EB'. This project contributes approximately 11.94 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1 / 200003 BRIGHTON 500 200004 CNASTONE 500 1
END
```

3. (PEPCO) The Bowie 045-Burtonsville 2314 230 kV line (from bus 223978 to bus 223961 ckt 1) loads from 99.89% to 100.71% (DC power flow) of its normal rating (608 MVA) for non contingency condition. This project contributes approximately 30.59 MW to the thermal violation.

4. (PL) The Safe Harbor Units 3-4 Tap-Manor Substation 230 kV line (from bus 208071 to bus 208019 ckt 1) loads from 89.12% to 90.04% (DC power flow) of its emergency rating (579 MVA) for the single contingency 'PJM17'. This project contributes approximately 33.44 MW to the thermal violation.

```
CONTINGENCY 'PJM17'
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1 /* CNASTONE PEACHBTM 500 500
END
```

5. (PEPCO) The Oak Groove-Bowie 042 230 kV line (from bus 223982 to bus 223977 ckt 1) loads from 99.63% to 100.44% (DC power flow) of its normal rating (608 MVA) for non contingency condition. This project contributes approximately 30.69 MW to the thermal violation.

6. (PEPCO) The Bowie 042-Burtonsville 2334 230 kV line (from bus 223977 to bus 223962 ckt 1) loads from 99.30% to 100.11% (DC power flow) of its normal rating (608 MVA) for non contingency condition. This project contributes approximately 30.69 MW to the thermal violation.

7. (BG&E) The Howard 2312-Granite 2311 & 2312 230 kV line (from bus 220953 to bus 220972 ckt 1) loads from 91.75% to 92.78% (DC power flow) of its emergency rating (728 MVA) for the single contingency 'PP1EB'. This project contributes approximately 46.75 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1 / 200003 BRIGHTON 500 200004 CNASTONE 500 1
END
```

8. (BG&E) The High Ridge 2316-Columbia 230 kV line (from bus 220941 to bus 221010 ckt 1) loads from 90.93% to 91.73% (DC power flow) of its emergency rating (941 MVA) for the single contingency 'PP1EB'. This project contributes approximately 46.49 MW to the thermal violation.

```
CONTINGENCY 'PP1EB'     / NO PATH
  OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1 / 200003 BRIGHTON 500 200004 CNASTONE 500 1
END
```

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only with full energy output. Stuck Breaker and Bus Fault contingencies will be applied during the Impact Study)

No violations identified.

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.)

9. (PEPCO) The Talbert 068-Oak Groove 230 kV line (from bus 223990 to bus 223982 ckt 1) loads from 100.97% to 101.87% (DC power flow) of its emergency rating (691 MVA) for the tower contingency '12PEPCO_S17'. This project contributes approximately 38.65 MW to the thermal violation.

10. (BG&E/PL) The Conastone-Otter Creek Switchyard 230 kV line (from bus 220963 to bus 208048 ckt 1) loads from 122.19% to 123.38% (DC power flow) of its emergency rating (531 MVA) for the single contingency 'PJM17'. This project contributes approximately 39.83 MW to the thermal violation.

```
CONTINGENCY 'PJM17'
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1 /* CNASTONE PEACHBTM 500 500
END
```

11. (PEPCO) The Ft Slocum Par-Ft Slocum 69 kV line (from bus 224121 to bus 224122 ckt 1) loads from 130.81% to 132.08% (DC power flow) of its emergency rating (150 MVA) for the tower contingency '7PEPCO_A'. This project contributes approximately 11.73 MW to the thermal violation.

```
CONTINGENCY '7PEPCO_A'     /* BOWIE045 TO OAKGV23
  DISCONNECT BRANCH FROM BUS 223978 TO BUS 223961 CKT 1     /* OAKGV05 TO CHALK230
  DISCONNECT BRANCH FROM BUS 223982 TO BUS 223978 CKT 1
  DISCONNECT BRANCH FROM BUS 224061 TO BUS 223980 CKT 1
  DISCONNECT BRANCH FROM BUS 292454 TO BUS 224061 CKT 1     /BUS 223983 -> 292454
END
```

12. (PEPCO) The Ft Slocum Par-Ft Slocum 69 kV line (from bus 224121 to bus 224122 ckt 1) loads from 107.95% to 109.11% (DC power flow) of its emergency rating (150 MVA) for the single contingency 'PP31'. This project contributes approximately 10.74 MW to the thermal violation.

```
CONTINGENCY 'PP31'
  OPEN BRANCH FROM BUS 223961 TO BUS 223978 CKT 1 / 223961 BURT2314 230 223978 BOWIE045 230 1
END
```

13. (BG&E/PECO) The Graceton-Cooper 230 kV line (from bus 220964 to bus 214089 ckt 1) loads from 116.42% to 117.6% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project

contributes approximately 35.37 MW to the thermal violation.

```
CONTINGENCY 'PJM17'
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1     /* CNASTONE PEACHBTM 500 500
END
```

14. (PECO) The Cooper-Peach Bottom 230 kV line (from bus 214089 to bus 213869 ckt 1) loads from 113.94% to 115.12% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 35.37 MW to the thermal violation.

```
CONTINGENCY 'PJM17'
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1 /* CNASTONE PEACHBTM 500 500
END
```

15. (PEPCO) The 12Th & Irving-Ft Slocum Par 69 kV line (from bus 224119 to bus 224121 ckt 1) loads from 166.26% to 167.77% (DC power flow) of its emergency rating (125 MVA) for the tower contingency '7PEPCO_A'. This project contributes approximately 11.73 MW to the thermal violation.

```
CONTINGENCY '7PEPCO_A'     /* BOWIE045 TO OAKGV23
  DISCONNECT BRANCH FROM BUS 223978 TO BUS 223961 CKT 1     /* OAKGV05 TO CHALK230
  DISCONNECT BRANCH FROM BUS 223982 TO BUS 223978 CKT 1
  DISCONNECT BRANCH FROM BUS 224061 TO BUS 223980 CKT 1
  DISCONNECT BRANCH FROM BUS 292454 TO BUS 224061 CKT 1     /BUS 223983 -> 292454
END
```

16. (PEPCO) The 12Th & Irving-Ft Slocum Par 69 kV line (from bus 224119 to bus 224121 ckt 1) loads from 139.93% to 141.31% (DC power flow) of its emergency rating (125 MVA) for the single contingency 'PP31'. This project contributes approximately 10.74 MW to the thermal violation.

```
CONTINGENCY 'PP31'
  OPEN BRANCH FROM BUS 223961 TO BUS 223978 CKT 1 / 223961 BURT2314 230 223978 BOWIE045 230 1
END
```

17. (PEPCO) The Bowie 045-Burtonsville 2314 230 kV line (from bus 223978 to bus 223961 ckt 1) loads from 114.31% to 115.17% (DC power flow) of its emergency rating (730 MVA) for the tower contingency '5PEPCO'. This project contributes approximately 41.08 MW to the thermal violation.

```
CONTINGENCY '5PEPCO'     /* CHALK230 TO BOWIE044
  DISCONNECT BRANCH FROM BUS 223983 TO BUS 224600 CKT 1 /* OAKGV230 TO AQUASCO1
  DISCONNECT BRANCH FROM BUS 224600 TO BUS 224060 CKT 1 /* AQUASCO1 TO BOWIE044. FEB. 17, 2009.
  DISCONNECT BRANCH FROM BUS 224060 TO BUS 223979 CKT 1
  DISCONNECT BRANCH FROM BUS 223982 TO BUS 223977 CKT 1
  DISCONNECT BRANCH FROM BUS 223977 TO BUS 223962 CKT 1
END
```

18. (PEPCO) The Bowie 045-Burtonsville 2314 230 kV line (from bus 223978 to bus 223961 ckt 1) loads from 102.26% to 103.09% (DC power flow) of its emergency rating (730 MVA) for the single contingency 'PP36'. This project contributes approximately 37.67 MW to the thermal violation.

```
CONTINGENCY 'PP36'
  OPEN BRANCH FROM BUS 223962 TO BUS 223977 CKT 1 / 223962 BURT2334 230 223977 BOWIE042 230 1
END
```

19. (PEPCO) The Oak Groove-Bowie 045 230 kV line (from bus 223982 to bus 223978 ckt 1) loads from 114.43% to 115.3% (DC power flow) of its emergency rating (730 MVA) for the tower contingency '5PEPCO'. This project contributes approximately 41.08 MW to the thermal violation.

```
CONTINGENCY '5PEPCO'     /* CHALK230 TO BOWIE044
  DISCONNECT BRANCH FROM BUS 223983 TO BUS 224600 CKT 1 /* OAKGV230 TO AQUASCO1
  DISCONNECT BRANCH FROM BUS 224600 TO BUS 224060 CKT 1 /* AQUASCO1 TO BOWIE044. FEB. 17, 2009.
  DISCONNECT BRANCH FROM BUS 224060 TO BUS 223979 CKT 1
  DISCONNECT BRANCH FROM BUS 223982 TO BUS 223977 CKT 1
  DISCONNECT BRANCH FROM BUS 223977 TO BUS 223962 CKT 1
END
```

20. (PEPCO) The Oak Groove-Bowie 045 230 kV line (from bus 223982 to bus 223978 ckt 1) loads from 102.40% to 103.23% (DC power flow) of its emergency rating (730 MVA) for the single contingency 'PP36'. This project contributes approximately 37.67 MW to the thermal violation.

```
CONTINGENCY 'PP36'
  OPEN BRANCH FROM BUS 223962 TO BUS 223977 CKT 1  / 223962 BURT2334 230 223977 BOWIE042 230 1
END
```

21. (PEPCO) The Oak Groove-Bowie 045 230 kV line (from bus 223982 to bus 223978 ckt 1) loads from 100.04% to 100.85% (DC power flow) of its normal rating (608 MVA) for non contingency condition. This project contributes approximately 30.59 MW to the thermal violation.

22. (PEPCO) The Oak Groove-Bowie 042 230 kV line (from bus 223982 to bus 223977 ckt 1) loads from 113.54% to 114.4% (DC power flow) of its emergency rating (730 MVA) for the tower contingency '7PEPCO_A'. This project contributes approximately 40.92 MW to the thermal violation.

```
CONTINGENCY '7PEPCO_A'     /* BOWIE045 TO OAKGV23
  DISCONNECT BRANCH FROM BUS 223978 TO BUS 223961 CKT 1     /* OAKGV05 TO CHALK230
  DISCONNECT BRANCH FROM BUS 223982 TO BUS 223978 CKT 1
  DISCONNECT BRANCH FROM BUS 224061 TO BUS 223980 CKT 1
  DISCONNECT BRANCH FROM BUS 292454 TO BUS 224061 CKT 1     /BUS 223983 -> 292454
END
```

23. (PEPCO) The Oak Groove-Bowie 042 230 kV line (from bus 223982 to bus 223977 ckt 1) loads from 102.11% to 102.95% (DC power flow) of its emergency rating (730 MVA) for the single contingency 'PP31'. This project contributes approximately 37.73 MW to the thermal violation.

```
CONTINGENCY 'PP31'
  OPEN BRANCH FROM BUS 223961 TO BUS 223978 CKT 1           / 223961 BURT2314 230 223978 BOWIE045
230 1
END
```

24. (PEPCO) The Bowie 042-Burtonsville 2334 230 kV line (from bus 223977 to bus 223962 ckt 1) loads from 113.28% to 114.14% (DC power flow) of its emergency rating (730 MVA) for the tower contingency '7PEPCO_A'. This project contributes approximately 40.92 MW to the thermal violation.

```
CONTINGENCY '7PEPCO_A'     /* BOWIE045 TO OAKGV23
  DISCONNECT BRANCH FROM BUS 223978 TO BUS 223961 CKT 1     /* OAKGV05 TO CHALK230
  DISCONNECT BRANCH FROM BUS 223982 TO BUS 223978 CKT 1
  DISCONNECT BRANCH FROM BUS 224061 TO BUS 223980 CKT 1
  DISCONNECT BRANCH FROM BUS 292454 TO BUS 224061 CKT 1     /BUS 223983 -> 292454
END
```

25. (PEPCO) The Bowie 042-Burtonsville 2334 230 kV line (from bus 223977 to bus 223962 ckt 1) loads from 101.84% to 102.67% (DC power flow) of its emergency rating (730 MVA) for the single contingency 'PP31'. This project contributes approximately 37.73 MW to the thermal violation.

```
CONTINGENCY 'PP31'
  OPEN BRANCH FROM BUS 223961 TO BUS 223978 CKT 1 / 223961 BURT2314 230 223978 BOWIE045 230 1
END
```

26. (PJM) The Conastone-Peach Bottom 500 kV line (from bus 200004 to bus 200013 ckt 1) loads from 117.35% to 118.02% (DC power flow) of its emergency rating (2815 MVA) for the single contingency 'PJM76'. This project contributes approximately 142.37 MW to the thermal violation.

```
CONTINGENCY 'PJM76'
  REMOVE MACHINE 1 FROM BUS 200034 /* PB2
END
```

27. (AP/PJM) The Kemptown-EMORY GR500 500 kV line (from bus 235632 to bus 200101 ckt 1) loads from 113.44% to 114.01% (DC power flow) of its emergency rating (2901 MVA) for the single contingency 'PJM67'. This project contributes approximately 112.37 MW to the thermal violation.

```
CONTINGENCY 'PJM67'
  DISCONNECT BRANCH FROM BUS 200026 TO BUS 200004 CKT 1     /* HUNTERTN CNASTONE 500 500
END
```

28. (AP/PJM) The Kemptown-EMORY GR500 500 kV line (from bus 235632 to bus 200101 ckt 1) loads from 123.57% to 124.24% (DC power flow) of its normal rating (2338 MVA) for non contingency condition. This project contributes approximately 120.05 MW to the thermal violation.

Short Circuit

(Report over-dutied breakers.)

BUS_NO	BUS	BREAKER	Rating Type	Duty Percent With x2-030_DOM_opt2	Duty Percent Without x2-030_DOM_opt2	Duty Percent Difference	Note
314922	POSSUM POINT 500.kV	H1T560	S	101.60%	97.20%	4.40%	New Over-duty
314922	POSSUM POINT 500.kV	H1T568	S	101.60%	95.60%	6.00%	New Over-duty

The estimated cost to replace both of these 40 kA breakers with 50 kA breakers is $1,360,000 and will take about 14 months including equipment order time.

ITO Analysis – Secondary Option

These cost are base on Pepco constructing a new 500kV breaker and a half sub and approximately 4 miles of Attachment 500kV line.

- Approximately 4 miles 500kV extension from existing lines to new substation with installation of two heavy duty 90 degree double circuit poles and bringing the lines to the A-frame structures in the new 500-kV substation. - $14M.
- New revenue metering - $500,000
- A breaker and a half design for the 500 kV interconnection substation. The cost for the five breaker substation $25M and will take 36 months to complete. This cost includes the loop in and out of the Burches Hill – Possum Point circuit.
- Replace relays at the remote terminal ends of the new substation and telecommunications - $3.6M.