

## **Generation Interconnection**

### **Network Impacts**

The #R08 project was studied as a 300 MW (capacity) injection at two distinct points of the Penelec system. Option #1 studies the direct connection to Central City 115 kV substation, while option #2 studies the connection to Hooversville 230 kV substation. Project #R08 was evaluated for compliance with reliability criteria for summer peak conditions in 2011.

The overloads associated with the tower outage of the Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line described below for Option #1 and for Option #2 may not require upgrades if the common tower length is less than 1 mile. The need for these upgrades will be reviewed and confirmed in the System Impact Study.

### **Cost Estimate Summary**

The costs below are based on the information contained in this Generation Interconnection Feasibility Study report.

Option #1: \$153M

Option #2: \$151M

## **Option #1:**

Direct connection to Central City 115 kV substation which is located at the end of the radial Central City West –Hooversville 115 kV line

### **Required reinforcements associated with direct connection requirements:**

1. A FirstEnergy owned three breaker 115 kV ring bus including disconnect switches, dead-end structures, bus structures, and a control house with relaying and SCADA at Central City West Substation. The estimated cost is \$1,900,000.
2. Relay and control work at Hooversville Substation. The estimated cost is \$180,000.
3. Relay and control work at Central City West Substation. The estimated cost is \$180,000.
4. New 3 mile 115 kV transmission line extending from Central City West Substation (3 breaker ring bus) to the generation plant substation. To be built, owned, and operated by FirstEnergy. Estimated to cost approximately \$1,500,000.
5. Adding the additional generation capacity may require that protective relaying coordination be reviewed. However, at the time of the Feasibility Study's completion, no additional protection changes were recommended. The System Impact Study will identify the cost, if any, to complete the coordination review, develop new settings, and implement necessary changes. This will be the responsibility of the developer.
6. A fiber optic communications channel will be required between O72 Substation and Central City West 115 kV Substation (approximately 0.25 miles), and between Central City West 115 kV Substation and R08 Substation (approximately 3 miles). The estimated cost is \$325,000.

Total cost: \$7,440,000

The attached Figure 1 provides a conceptual one-line of the direct connection facilities needed.

As requested, suggested upgrades for service at the 115 kV voltage level are provided below. **Items 1 through 5** and **Items 9 and 10** and **Items 22 through 24** below, indicated in **bold** print, are associated only with service at the 115 kV voltage level (Option 1). Items 4 through 6 and Items 9 through 20 and Items 24 through 41 occur with service at either the 115 kV or 230 kV voltage level. The local 115 kV system is not designed to accommodate generation of this magnitude and **FirstEnergy recommends service at the 230 kV voltage level.**

## **Generator Deliverability**

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

- 1. The Central City – O72 115 kV line is overloaded from -32% to 1039% (300 MVA) of its normal rating (29 MVA) for which the project R08 contributes approximately 300 MW to cause the thermal violation. To mitigate this overload requires the construction of 0.25 miles of new transmission line.**
- 2. The I13 – O72 115 kV line loads from 1% to 140% (294 MVA) of its normal rating (210 MVA) under normal operating conditions. The project R08 contributes approximately 291 MW to the normal facility loading. To mitigate this overload requires the construction of 2.86 miles of new transmission line.**
- 3. The Hooversville - I13 115 kV line loads from 144% to 1182% (331 MVA) to of its normal rating (29 MVA) under normal operating conditions. The project R08 contributes approximately 291 MW to the normal facility loading. To mitigate this overload requires the construction of 3.6 miles of new transmission line.**
- 4. The Central City – O72 115 kV line is overloaded from -28% to 909% of its emergency rating (32 MVA) for the outage of Darbytown to NorthEast 230 kV line (Cont Id. LN 2053). The R08 contributes approximately 300 MW to cause the thermal violation. To mitigate this overload requires the construction of 0.25 miles of new transmission.**
- 5. The Central City – O72 115 kV line is overloaded from -28% to 909% of its emergency rating (32 MVA) for the outage of Homer City-Shelocta 230 kV line section. The R08 contributes approximately 300 MW to cause the thermal violation. To mitigate this overload requires the construction of 0.25 miles of new transmission.**

**To mitigate the overloads listed above as items #1 – 5 under generator deliverability would require the construction of new transmission line (estimated to cost approximately \$3,355,000).**

- 6. The Garrett 138/115 kV transformer is overloaded from 65% to 121% (76 MVA) of its normal rating (63 MVA) under normal operating conditions. The R08 project contributes approximately 35 MW to cause the overload. To mitigate this overload would require the replacement/upgrade of the 138/115 transformer, circuit breaker and substation conductor (estimated to cost approximately \$2,250,000).**
- 7. The Garrett 138/115 kV transformer loads from 67% to 118% (106 MVA) of its emergency rating (90 MVA) for the outage of the Homer City –Shelocta-Keystone 230 kV circuit. The R08 project contributes approximately 46 MW to the contingency facility loading. To mitigate this overload would require the replacement/upgrade of the 138/115 kV transformer, circuit breaker and substation conductor (estimated to cost approximately \$2,250,000).**

8. The Wayne 345/115 kV transformer loads from 103% to 109% (287 MVA) of its emergency rating (263 MVA) for the outage Erie West-Wayne 345 kV circuit. The R08 project contributes approximately 16 MW to the contingency facility loading. To mitigate this overload would require the replacement/upgrade of the 345/115 kV transformer (estimated to cost \$2,500,000.)

### **Multiple Facility Contingency**

*(Double Circuit Tower Line contingencies only for the full energy output. Stuck breaker and bus fault contingencies will be performed for the Impact Study)*

9. **The 01Garrett – N33C 138 kV line is overloaded from 89% to 106% (213 MVA) of its emergency rating (201 MVA) for the tower outage of Frostburg to Ridgeley 138 kV line (Cont Id. 154). The R08 project contributes approximately 33 MW to cause the thermal violation. The estimated cost for this work is \$1,575,000 in 2009 dollars.**
10. **The Bedford North – Snake Spring 115 kV line is overloaded from 95% to 101% (151 MVA) of its emergency rating (150 MVA) for the tower outage of Frostburg to Ridgeley 138 kV line (Cont Id. 154). The R08 project contributes approximately 9 MW to cause the thermal violation. To mitigate this overload would require the upgrade/reconductor of approximately 7.05 miles of transmission line (estimated to cost approximately \$1,938,000).**
11. The Rachel Hill - Hillclay 115 kV line is overloaded from 90% to 189% (347 MVA) of its emergency rating (184 MVA) for the tower outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 183 MW cause the thermal violation. To mitigate this overload would require the construction of 3.06 miles of NEW transmission line (estimated to cost approximately \$1,530,000) and the replacement/upgrade of a disconnect switch (estimated to cost approximately \$80,000) at Hillclay Junction and the replacement/upgrade of a line/wave trap (estimated to cost approximately \$115,000), substation conductor (estimated to cost approximately \$125,000), and disconnect switch (estimated to cost approximately \$80,000) at Rachel Hill Substation.
12. The Tower51 – Hooversville 115 kV line is overloaded from 96% to 165% (241 MVA) of its emergency rating (146 MVA) for the **tower** outage of Frostburg to Ridgeley 138 kV line (Cont Id. 154). The R08 project contributes approximately 102 MW to cause the thermal violation. To mitigate this overload would require the upgrade/reconductor 9.89 miles of transmission line (estimated to cost approximately \$2,720,000) and the replacement/upgrade of a disconnect switch (estimated to cost approximately \$80,000), CT circuit (estimated to cost approximately \$125,000), a line/wave trap (estimated to cost approximately \$115,000), and substation conductor (estimated to cost approximately \$125,000) at Tower51 Substation and the replacement/upgrade of a circuit breaker (estimated to cost approximately \$225,000), a CT circuit (estimated to cost approximately \$125,000), a

- line/wave trap (estimated to cost approximately \$115,000), and substation conductor (estimated to cost approximately \$125,000) at Hooversville Substation.
13. The Hilltop – Rosedale 115 kV line is overloaded from 75% to 137% (245 MVA) of its emergency rating (179 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 112 MW to cause the thermal violation. To mitigate this overload would require the replacement/upgrade of a disconnect switch (estimated to cost approximately \$80,000), a CT circuit (estimated to cost approximately \$125,000), a line/wave trap (estimated to cost approximately \$115,000), and substation conductor (estimated to cost approximately \$125,000) at Hilltop Substation.
  14. The Seward - Tower51 115 kV line is overloaded from 72% to 135% (215 MVA) of its emergency rating (159 MVA) for the **tower** outage of Frostburg to Ridgeley 138 kV line (Cont Id. 154). The R08 project contributes approximately 101 MW to cause the thermal violation. To mitigate this overload would require the replacement/upgrade of a disconnect switch (estimated to cost approximately \$80,000), and a line/wave trap (estimated to cost approximately \$115,000) at Seward Substation and the replacement/upgrade of a disconnect switch (estimated to cost approximately \$80,000), a CT circuit (estimated to cost approximately \$125,000), and a line/wave trap (estimated to cost approximately \$115,000) at Tower51 Substation.
  15. The Rosedale – Cooper 115 kV line is overloaded from 63% to 105% (189 MVA) of its emergency rating (180 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 75 MW cause the thermal violation. To mitigate this overload would require the replacement/upgrade of a CT circuit (estimated to cost approximately \$125,000) and a line/wave trap (estimated to cost approximately \$115,000) at Cooper Substation.
  16. The Saxton – Curryville 115 kV line is overloaded from 98% to 116% (208 MVA) of its emergency rating (179 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 32 MW to cause this thermal violation. To mitigate this overload would require the replacement/upgrade of a disconnect switch (estimated to cost approximately \$80,000), CT circuit (estimated to cost approximately \$125,000) and a line/wave trap (estimated to cost approximately \$115,000) at Saxton Substation.
  17. The P60\_C – P48\_C 115 kV line is overloaded from 90% to 111% (167 MVA) of its emergency rating (150 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 32 MW to cause this thermal violation. This overload is expected to be mitigated by the

withdrawal of project #P48 which shall be confirmed during the System Impact Study of this project.

18. The Altoona – Raystown 230 kV line is overloaded from 96% to 102% (565 MVA) of its emergency rating (554 MVA) for the **generator** outage of Fordmill90 and Fordmill91 generators at buses 4565 & 4569 (Cont Id. PE506). The R08 project contributes approximately 32 MW to cause the thermal violation. To mitigate this overload would require the replacement/upgrade of a line/wave trap at Altoona Substation (estimated to cost approximately \$125,000).
19. The Claysburg – Curryville 115 kV line is overloaded from 85% to 102% (188 MVA) of its emergency rating (184 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 32 MW to cause this thermal violation. To mitigate this overload would require the replacement/upgrade of a disconnect switch (estimated to cost approximately \$80,000), a line/wave trap (estimated to cost approximately \$115,000), and substation conductor (estimated to cost approximately \$125,000) at Claysburg Substation.
20. The Shade Gap – Roxbury 115 kV line is overloaded from 95% to 101% (152 MVA) of its emergency rating (150 MVA) for the **tower** outage of Juniata to Lewistown and Juniata to Dauphin 230 kV line (Cont Id. 20PPL). The R08 project contributes approximately 8 MW to cause the thermal violation. To mitigate this overload would require the upgrade/reconductor of approximately 13.56 miles of transmission line (estimated to cost approximately \$3,750,000).
21. The Tower51 115/23 kV transformer #2 is overloaded from 60 % to 101% (29 MVA) of its emergency rating (28.5 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 12MW to this overload. To mitigate this overload would require the replacement/upgrade of the 115/23 kV transformer (estimated to cost approximately \$1,200,000).

#### **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)*

22. **The Snake Spring – Q62opt1 115 kV line is overloaded at 131% (162 MVA) of its emergency rating (124 MVA) for the tower outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 32 MW to this overload. To mitigate this overload would require the upgrade/reconductor of approximately 2 miles of transmission line (estimated to cost approximately \$550,000).**
23. **The Saxton – Q62OPT1 115 kV line is overloaded at 156% (193 MVA) of its emergency rating (124 MVA) for the tower outage of Frostburg -**

- Ridgeley 138 kV line (Cont Id. 154). The R08 project contributes approximately 9 MW to this overload. To mitigate this overload would require replacement/upgrade of substation conductor (estimated to cost \$125,000), and two disconnect switches (estimated to cost \$80,000 each) at Saxton Substation, and the upgrade/reconductor of approximately 16.1 miles of transmission line (estimated to cost approximately \$4,427,500).**
24. **The Bedford North – P48C 115 kV line is overloaded at 119% (179 MVA) of its emergency rating (150 MVA) for the tower outage of Frostburg to Ridgeley 138 kV line (Cont Id. 154). The R08 project contributes approximately 9 MW to this overload. To mitigate this overload would require replacement/upgrade of a CT circuit (estimated to cost \$125,000), at Bedford North Substation, and the upgrade/reconductor of approximately 1.76 miles of transmission line (estimated to cost approximately \$484,000).**
25. The Garrett – 01Garrett 115 kV line is overloaded at 250% (313 MVA) of its emergency rating (125 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 73 MW to this overload. To mitigate these overloads would require the replacement of substation conductor (estimated to be approximately \$125,000), the replacement of a disconnect switch (estimated to be approximately \$80,000), and the replacement of two CT circuits (estimated to be approximately \$250,000) at Garrett substation. It also requires the reconductor of 1.9 miles of 115 kV transmission line between Garrett and Garrett Tap (estimated cost approximately \$522,500).
26. The Hillclay – Hilltop 115 kV line is overloaded at 226% (404 MVA) of its emergency rating (179 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 155 MW to this overload. To mitigate this overload would require the construction of 4.73 miles of NEW transmission line (estimated to cost approximately \$2,365,000) and the replacement/upgrade of a disconnect switch (estimated to cost approximately \$80,000), CT circuit (estimated to cost approximately \$125,000), a line/wave trap (estimated to cost approximately \$115,000), a circuit breaker (estimated to cost approximately \$225,000), and substation conductor (estimated to cost approximately \$125,000) at Hilltop Substation.
27. The Scalp Level – Hooversville 115 kV line is overloaded at 221% (396 MVA) of its emergency rating (179 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 183 MW to this overload. To mitigate this overload would require the construction of 6.92 miles of NEW transmission line (estimated to cost approximately \$3,460,000) and the replacement/upgrade of a disconnect switch (estimated to cost approximately \$80,000), a CT circuit (estimated to cost approximately \$125,000), a line/wave trap (estimated to cost approximately \$115,000), a circuit breaker (estimated to cost approximately \$225,000), and substation

conductor (estimated to cost approximately \$125,000) at Hooversville Substation and the replacement/upgrade of a disconnect switch (estimated to cost approximately \$80,000), and substation conductor (estimated to cost approximately \$125,000) at Scalp Level Substation.

28. The Summit – Claysburg 115 kV line is overloaded at 163% (292 MVA) of its emergency rating (179 MVA) for the **generator** outage of Fordmill90 and Fordmill91 generators at buses 4565 & 4569 (Cont Id. PE506). The R08 project contributes approximately 15 MW to this overload. This overload is expected to be mitigated by the withdrawal of project #Q56 which shall be confirmed during the System Impact Study of this project.
29. The Rockwood – Penn-Mar 115 kV line is overloaded at 207% (296 MVA) of its emergency rating (143 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 74 MW to this overload. To mitigate this overload would require the replacement / upgrade of a disconnect switch (estimated to cost approximately \$80,000) at Rockwood substation. It also requires the replacement/upgrade of a CT circuit (estimated cost approximately \$125,000), the replacement of a circuit breaker (estimated cost approximately \$225,000) and the reconductor of approximately 14.7 miles of transmission line (estimated cost approximately \$4,042,500).
30. The Scalp Level – Rachel Hill 115 kV line is overloaded at 214% (383 MVA) of its emergency rating (179 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 183 MW to this overload. To mitigate this overload would require the construction of 2.7 miles of NEW transmission line (estimated to cost approximately \$1,350,000) and the replacement/upgrade of a disconnect switch (estimated to cost approximately \$80,000), a CT circuit (estimated to cost approximately \$125,000), a line/wave trap (estimated to cost approximately \$115,000), a circuit breaker (estimated to cost approximately \$225,000), and substation conductor (estimated to cost approximately \$125,000) at Rachel Hill Substation and the replacement/upgrade of a disconnect switch (estimated to cost approximately \$80,000), and substation conductor (estimated to cost approximately \$125,000) at Scalp Level Substation.
31. The Penn-Mar – Garrett 115 kV line is overloaded at 176% (294 MVA) of its emergency rating (167 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 74 MW to this overload. To mitigate this overload would require the reconductor of approximately 14.95 miles of transmission line between Penn Mar substation and Garrett Tap (estimated cost approximately \$4,111,250).
32. The Homer City - Shelocta 230 kV line is overloaded at 137% (1247 MVA) of its emergency rating (909 MVA) for the **tower** outage of Juniata to Lewistown and Juniata to Dauphin 230 kV line (Cont Id. 20PPL). The R08 project contributes approximately 119 MW to this overload. To mitigate this overload would require replacement/upgrade substation conductor (estimated

to cost approximately \$125,000) at Shelocta, the upgrade/reconductor of 10.73 miles of transmission line (estimated to be approximately \$5,365,000), and the replacement of a line/wave trap (estimated to cost \$125,000), a CT circuit (estimated to cost \$140,000), a circuit breaker (estimated to cost \$425,000), and substation conductor (estimated to cost \$125,000) at Homer City.

33. The Shelocta – Keystone 230 kV line is overloaded at 160% (1366 MVA) of its emergency rating (854 MVA) for the **tower** outage of Juniata to Lewistown and Juniata to Dauphin 230 kV line (Cont Id. 20PPL). The R08 project contributes approximately 142 MW to this overload. To mitigate this overload would require replacement/upgrade of a disconnect switch (estimated cost approximately \$85,000) and substation conductor (estimated to cost approximately \$125,000) at Shelocta substation, the replacement/upgrade of a disconnect switch (estimated to cost approximately \$85,000), two CT circuits (estimated to cost \$140,000 each) and substation conductor (estimated to cost approximately \$125,000) at Keystone Substation, and the upgrade/reconductor of approximately 2.26 miles of transmission line (estimated to cost \$1,130,000)
34. The 01Albright – N33C 138 kV line is overloaded to 131% (263 MVA) of its emergency rating (201 MVA) for the **tower** outage of Frostburg to Ridgeley 138 kV line (Cont Id. 154). The R08 project contributes approximately 52 MW this overload. To mitigate this overload would require reconductor of approximately 6.3 miles of the N33 (Afton) – Albright 138 kV circuit. The estimated cost for this work is \$1,575,000 in 2009 dollars.
35. The Oxbow - Lackawanna 230 kV line is overloaded at 106% (645 MVA) of its emergency rating (617 MVA) for the **tower** outage of Susquehanna to Mountain and Mountain to Stanton 230 kV line (Cont Id. 2PPL). The R08 project contributes approximately 18 MW to this overload. To mitigate this overload would require the replacement/upgrade of a disconnect switch (estimated to cost approximately \$85,000) at Oxbow Substation and the upgrade/reconductor approximately 16.33 miles of transmission line (estimated to cost approximately \$8,165,000).

In order to provide additional capacity on the Oxbow – Lackawanna 230 kV line, PPL EU is proposing to re-conductor 0.18 miles of existing line. This rebuild will also require substation terminal modifications at PPL EU's Lackawanna substation. The estimated magnitude cost for this upgrade including substation terminal equipment cost is \$550,000.

36. The Keystone 500/230 kV ckt#3 transformer is overloaded at 125% (669 MVA) of its emergency rating (534 MVA) for the **tower** outage of Juniata to Lewistown and Juniata to Dauphin 230 kV line (Cont Id. 20PPL). The R08 project contributes approximately 72 MW to this overload. The upgrade is a replacement of existing 500-230 kV transformer with a new transformer. It is estimated that this upgrade will cost \$5,500,000 and take approximately 2 years to complete.

37. The Keystone 500/230 kV ckt#4 transformer is overloaded at 123% (651 MVA) of its emergency rating (530 MVA) for the **tower** outage of Juniata to Lewistown and Juniata to Dauphin 230 kV line (Cont Id. 20PPL). The R08 project contributes approximately 71 MW to this overload. The upgrade is a replacement of existing 500-230 kV transformer with a new transformer. It is estimated that this upgrade will cost \$5,500,000 and take approximately 2 years to complete.
38. The Conemaugh – Keystone 500 kV line is overloaded at 122% (3676 MVA) of its emergency rating (3013 MVA) for the outage of Juniata to Keystone 500 kV line (Cont Id. PJM24B). The R08 project contributes approximately 38 MW to this overload. **It is estimated that approximately 26 miles of new transmission line between the Keystone and Conemaugh substations would need to be constructed (estimated to cost \$52,000,000).**
39. The Lewistown – Juniata 230 kV line is overloaded at 113% (697 MVA) of its emergency rating (617 MVA) for the **tower** outage of Peachbottom 500/230 kV transformer (Cont Id. PE500). The R08 project contributes approximately 30 MW to this overload. To mitigate this overload would require the replacement/upgrade of a disconnect switch (estimated to cost approximately \$85,000) at Juniata Substation and the upgrade/reconductor approximately 25.74 miles of transmission line (estimated to cost approximately \$12,870,000).
40. The Keystone – Jun\_Keys 500 kV line is overloaded at 106% (3710 MVA) of its emergency rating (3500 MVA) for the outage of Conemaugh to Keystone 500 kV line (Cont Id. PJM21). The R08 project contributes approximately 32 MW to this overload. **It is estimated that approximately 26 miles of new transmission line between the Keystone and Conemaugh substations would need to be constructed (estimated to cost \$52,000,000).**
41. The North Meshoppen - Oxbow 230 kV line is overloaded at 106% (654 MVA) of its emergency rating (617 MVA) for the **tower** outage of Susquehanna to Mountain and Mountain to Stanton 230 kV line (Cont Id. 2PPL). The R08 project contributes approximately 18 MW to this overload. To mitigate this overload would require the replacement/upgrade of a disconnect switch (estimated to cost approximately \$85,000) at Oxbow Substation and the upgrade/reconductor approximately 10.16 miles of transmission line (estimated to cost approximately \$5,080,000).

### **Short Circuit**

PJM analysis found no new breakers to be over-duty in First Energy's transmission area. The study also showed no significant fault current contribution to any breakers which have already been identified as over-duty. This study was performed on the 230kV and above system.

Additional short circuit study will be conducted during the System Impact Study.

## Option #2:

Direct connection to Hooversville 230 kV substation.

### Required reinforcements associated with direct connection requirements:

- A FirstEnergy owned three breaker 230 kV ring bus including disconnect switches, dead-end structures, bus structures, and a control house with relaying and SCADA at Hooversville Substation. The estimated cost is \$2,200,000.
- Relay and control work at Hooversville Substation. The estimated cost is \$325,000.
- Relay and control work at Homer City Substation. The estimated cost is \$325,000.
- New 9.71 mile 230 kV transmission line extending from Hooversville Substation (3 breaker ring bus) to the generation plant substation. To be built, owned, and operated by FirstEnergy. Estimated to cost approximately \$9,710,000.
- Adding the additional generation capacity may require that protective relaying coordination be reviewed. However, at the time of the Feasibility Study's completion, no additional protection changes were recommended. The System Impact Study will identify the cost, if any, to complete the coordination review, develop new settings, and implement necessary changes. This will be the responsibility of the developer.
- Additional communications channels will be required between Hooversville 230 kV Substation and R08 Substation (approximately 9.71 miles). The decision to use fiber optic cable or Power Line Carrier will be made during the System Impact Study.

Total cost: \$12,560,000

The attached Figure 2 provides a conceptual one-line of the direct connection facilities needed.

Suggested upgrades for service at the 230 kV voltage level are provided below. **Items 1 and Items 4 through 5** below, indicated in **bold** print, are associated with service at the 230 kV voltage level (Option 2). Items 2 through 3 and Items 7 through 39 occur with service at either the 115 kV or 230 kV voltage level. **FirstEnergy recommends service at the 230 kV voltage level.**

### Generator Deliverability

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

1. **The Hooversville 230/115 kV transformer loads from 0% to 122% (300 MVA) of its emergency rating (246 MVA) for the outage of the Quemahoning-Hooversville 230 kV circuit. The R08 project contributes approximately 300 MW to the contingency facility loading. This and other overloads would be mitigated by the construction of approximately 20 miles of new 230 kV transmission line from Hooversville to Johnstown, estimated to cost approximately \$20,000,000.**
2. The Garrett 138/115 kV transformer loads from 67% to 109% (98 MVA) of its emergency rating (90 MVA) for the outage of the Homer City –Shelocta-

Keystone 230 kV circuit. The R08 project contributes approximately 38 MW to the contingency facility loading. To mitigate this overload would require the replacement/upgrade of the 138/115 kV transformer, circuit breaker and substation conductor (estimated to cost approximately **\$2,250,000**).

3. The Wayne 345/115 kV transformer loads from 103% to 110% (290 MVA) of its emergency rating (263 MVA) for the outage Erie West-Wayne 345 kV circuit. The R08 project contributes approximately 19 MW to the contingency facility loading. To mitigate this overload would require the replacement/upgrade of the 345/115 kV transformer (estimated to cost **\$2,500,000**.)

### **Multiple Facility Contingency**

*(Double Circuit Tower Line contingencies only for the full energy output. Stuck breaker and bus fault contingencies will be performed for the Impact Study)*

4. **The Hooversville 230/115 kV transformer is overloaded from 85% to 131% (322 MVA) of its emergency rating (246 MVA) for the outage of Seward 230/115 kV transformer (Cont Id. PN23B). The R08 project contributes approximately 113 MW to cause the thermal violation. To mitigate this overload would require the installation of a circuit breaker at Seward Substation (estimated to cost approximately \$425,000).**
5. **The Hooversville 230/115 kV transformer is overloaded from 16% to 109% (269 MVA) of its emergency rating (246 MVA) for the tower outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 229MW to this overload. This and other overloads would be mitigated by the construction of approximately 20 miles of new 230 kV transmission line from Hooversville to Johnstown, estimated to cost approximately \$20,000,000.**
6. The Rachel Hill - Hillclay 115 kV line is overloaded from 90% to 189% (348 MVA) of its emergency rating (184 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 183 MW cause the thermal violation. This and other overloads would be mitigated by the construction of approximately 20 miles of new 230 kV transmission line from Hooversville to Johnstown, estimated to cost approximately \$20,000,000.
7. The Tower51 – Hooversville 115 kV line is overloaded from 96% to 135% (197 MVA) of its emergency rating (146 MVA) for the **tower** outage of Frostburg to Ridgeley 138 kV line (Cont Id. 154). The R08 project contributes approximately 57 MW to cause the thermal violation. This and other overloads would be mitigated by the construction of approximately 20 miles of new 230 kV transmission line from Hooversville to Johnstown, estimated to cost approximately \$20,000,000. To mitigate this overload would also require the replacement/upgrade of a disconnect switch (estimated to cost approximately \$80,000) and a CT circuit (estimated to cost approximately \$125,000) at Tower51 Substation and the replacement/upgrade of a CT circuit estimated to cost approximately \$125,000) at Hooversville Substation.

8. The Hilltop – Rosedale 115 kV line is overloaded from 75% to 137% (245 MVA) of its emergency rating (179 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 112 MW to cause the thermal violation. This and other overloads would be mitigated by the construction of approximately 20 miles of new 230 kV transmission line from Hooversville to Johnstown, estimated to cost approximately \$20,000,000.
9. The Seward - Tower51 115 kV line is overloaded from 72% to 108% (172 MVA) of its emergency rating (159 MVA) for the **tower** outage of Frostburg to Ridgeley 138 kV line (Cont Id. 154). The R08 project contributes approximately 56 MW to cause the thermal violation. This and other overloads would be mitigated by the construction of approximately 20 miles of new 230 kV transmission line from Hooversville to Johnstown, estimated to cost approximately \$20,000,000.
10. The Rosedale – Cooper 115 kV line is overloaded from 63% to 105% (189 MVA) of its emergency rating (180 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 75 MW cause the thermal violation. This and other overloads would be mitigated by the construction of approximately 20 miles of new 230 kV transmission line from Hooversville to Johnstown, estimated to cost approximately \$20,000,000.
11. The Garrett 138/115 kV transformer is overloaded from 65% to 121% (76 MVA) of its normal rating (63 MVA). The R08 project contributes approximately 35 MW to cause the overload. To mitigate this overload would require the replacement/upgrade of the 138/115 kV transformer, circuit breaker and substation conductor (estimated to cost approximately **\$2,250,000**).
12. The Saxton – Curryville 115 kV line is overloaded from 98% at 116% (208 MVA) of its emergency rating (179 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 32 MW to cause this thermal violation. This and other overloads would be mitigated by the construction of approximately 20 miles of new 230 kV transmission line from Hooversville to Johnstown, estimated to cost approximately \$20,000,000.
13. The P60\_C – P48\_C 115 kV line is overloaded from 90% at 111% (167 MVA) of its emergency rating (150 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 32 MW to cause this thermal violation. This overload is expected to be mitigated by the withdrawal of project #P48 which shall be confirmed during the System Impact Study of this project.
14. The Altoona – Raystown 230 kV line is overloaded from 96% at 102% (565 MVA) of its emergency rating (554 MVA) for the **generator** outage of Fordmill90 and Fordmill91 generators at buses 4565 & 4569 (Cont Id. PE506). The R08 project contributes approximately 31 MW to cause the thermal violation. To mitigate this overload would require the replacement/upgrade of a line/wave trap at Altoona Substation (estimated to cost approximately \$125,000).
15. The Claysburg – Curryville 115 kV line is overloaded from 85% at 102% (188 MVA) of its emergency rating (184 MVA) for the **tower** outage of Homer City to

- Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 32 MW to cause this thermal violation. This and other overloads would be mitigated by the construction of approximately 20 miles of new 230 kV transmission line from Hooversville to Johnstown, estimated to cost approximately \$20,000,000.
16. The Shade Gap – Roxbury 115 kV line is overloaded from 95% at 101% (152 MVA) of its emergency rating (150 MVA) for the **tower** outage of Juniata to Lewistown and Juniata to Dauphin 230 kV line (Cont Id. 20PPL). The R08 project contributes approximately 7 MW to cause the thermal violation. To mitigate this overload would require the upgrade/reconductor of approximately 13.56 miles of transmission line (estimated to cost approximately \$3,750,000).
  17. The Tower51 115/23 kV transformer #2 is overloaded from 60 % to 101% (29 MVA) of its emergency rating (28.5 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 12MW to this overload. This and other overloads would be mitigated by the construction of approximately 20 miles of new 230 kV transmission line from Hooversville to Johnstown, estimated to cost approximately \$20,000,000.

#### **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*

18. The Garrett – 01Garrett 115 kV line is overloaded at 250% (313 MVA) of its emergency rating (125 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 73 MW to this overload. To mitigate these overloads would require the replacement of substation conductor (estimated to be approximately \$125,000), the replacement of a disconnect switch (estimated to be approximately \$80,000), and the replacement of two CT circuits (estimated to be approximately \$250,000) at Garrett substation. It also requires the reconductor of 1.9 miles of 115 kV transmission line between Garrett and Garrett Tap (estimated cost approximately \$522,500).
19. The Hillclay – Hilltop 115 kV line is overloaded at 226% (405 MVA) of its emergency rating (179 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 155 MW to this overload. This and other overloads would be mitigated by the construction of approximately 20 miles of new 230 kV transmission line from Hooversville to Johnstown, estimated to cost approximately \$20,000,000.
20. The Scalp Level – Hooversville 115 kV line is overloaded at 221% (396 MVA) of its emergency rating (179 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 183 MW to this overload. This and other overloads would be mitigated by the construction of approximately 20 miles

- of new 230 kV transmission line from Hooversville to Johnstown, estimated to cost approximately \$20,000,000.
21. The Summit – Claysburg 115 kV line is overloaded at 160% (286 MVA) of its emergency rating (179 MVA) for the **generator** outage of Fordmill90 and Fordmill91 generators at buses 4565 & 4569 (Cont Id. PE506). The R08 project contributes approximately 9 MW to this overload. This overload is expected to be mitigated by the withdrawal of project #Q56 which shall be confirmed during the System Impact Study of this project.
  22. The Rockwood – Penn-Mar 115 kV line is overloaded at 207% (296 MVA) of its emergency rating (143 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 74 MW to this overload. To mitigate this overload would require the replacement / upgrade of a disconnect switch (estimated to cost approximately \$80,000) at Rockwood substation. It also requires the replacement/upgrade of a CT circuit (estimated cost approximately \$125,000), the replacement of a circuit breaker (estimated cost approximately \$225,000) and the reconductor of approximately 14.7 miles of transmission line (estimated cost approximately \$4,042,500).
  23. The Scalp Level – Rachel Hill 115 kV line is overloaded at 214% (383 MVA) of its emergency rating (179 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 183 MW to this overload. This and other overloads would be mitigated by the construction of approximately 20 miles of new 230 kV transmission line from Hooversville to Johnstown, estimated to cost approximately \$20,000,000.
  24. The Penn-Mar – Garrett 115 kV line is overloaded at 176% (294 MVA) of its emergency rating (167 MVA) for the **tower** outage of Homer City to Quemahoning 230 kV line and Seward to Tower 51 115 kV line (Cont Id. 2PN). The R08 project contributes approximately 74 MW to this overload. To mitigate this overload would require the reconductor of approximately 14.95 miles of transmission line between Penn Mar substation and Garrett Tap (estimated cost approximately \$4,111,250).
  25. The Homer City - Shelocta 230 kV line is overloaded at 139% (1264 MVA) of its emergency rating (909 MVA) for the **tower** outage of Juniata to Lewistown and Juniata to Dauphin 230 kV line (Cont Id. 20PPL). The R08 project contributes approximately 136 MW to this overload. To mitigate this overload would require replacement/upgrade of substation conductor (estimated to cost approximately \$125,000) at Shelocta, the upgrade/reconductor of 10.73 miles of transmission line (estimated to be approximately \$5,365,000), and the replacement of a line/wave trap (estimated to cost \$125,000), a CT circuit (estimated to cost \$140,000), a circuit breaker (estimated to cost \$425,000), and substation conductor (estimated to cost \$125,000) at Homer City..
  26. The Shelocta – Keystone 230 kV line is overloaded at 160% (1366 MVA) of its emergency rating (854 MVA) for the **tower** outage of Juniata to Lewistown and Juniata to Dauphin 230 kV line (Cont Id. 20PPL). The R08 project contributes approximately 142 MW to this overload. To mitigate this overload would require

- replacement/upgrade of a disconnect switch (estimated cost approximately \$85,000) and substation conductor (estimated to cost approximately \$125,000) at Shelocta substation, the replacement/upgrade of a disconnect switch (estimated to cost approximately \$85,000), two CT circuits (estimated to cost \$140,000 each) and substation conductor (estimated to cost approximately \$125,000) at Keystone Substation, and the upgrade/reconductor of approximately 2.26 miles of transmission line (estimated to cost \$1,130,000).
27. The 01Albright – N33C 138 kV line is overloaded to 125% (251 MVA) of its emergency rating (201 MVA) for the **tower** outage of Frostburg to Ridgeley 138 kV line (Cont Id. 154). The R08 project contributes approximately 20 MW this overload. To mitigate this overload would require reconductor of approximately 6.3 miles of the N33 (Afton) – Albright 138 kV circuit. The estimated cost for this work is \$1,575,000 in 2009 dollars.
  28. The Oxbow - Lackawanna 230 kV line is overloaded at 105% (650 MVA) of its emergency rating (617 MVA) for the **tower** outage of Susquehanna to Mountain and Mountain to Stanton 230 kV line (Cont Id. 2PPL). The R08 project contributes approximately 19 MW to this overload. To mitigate this overload would require the replacement/upgrade of a disconnect switch (estimated to cost approximately \$85,000) at Oxbow Substation and the upgrade/reconductor approximately 16.33 miles of transmission line (estimated to cost approximately \$8,165,000).

In order to provide additional capacity on the Oxbow – Lackawanna 230 kV line, PPL EU is proposing to re-conductor 0.18 miles of existing line. This rebuild will also require substation terminal modifications at PPL EU's Lackawanna substation. The estimated magnitude cost for this upgrade including substation terminal equipment cost is \$550,000.

29. The Keystone 500/230 kV ckt#3 transformer is overloaded at 125% (669 MVA) of its emergency rating (534 MVA) for the **tower** outage of Juniata to Lewistown and Juniata to Dauphin 230 kV line (Cont Id. 20PPL). The R08 project contributes approximately 72 MW to this overload. The upgrade is a replacement of existing 500-230 kV transformer with a new transformer. It is estimated that this upgrade will cost \$5,500,000 and take approximately 2 years to complete.
30. The Keystone 500/230 kV ckt#4 transformer is overloaded at 123% (651 MVA) of its emergency rating (530 MVA) for the **tower** outage of Juniata to Lewistown and Juniata to Dauphin 230 kV line (Cont Id. 20PPL). The R08 project contributes approximately 71 MW to this overload. The upgrade is a replacement of existing 500-230 kV transformer with a new transformer. It is estimated that this upgrade will cost \$5,500,000 and take approximately 2 years to complete.
31. The Conemaugh – Keystone 500 kV line is overloaded at 122% (3676 MVA) of its emergency rating (3013 MVA) for the outage of Juniata to Keystone 500 kV line (Cont Id. PJM24B). The R08 project contributes approximately 40 MW to this overload. **It is estimated that approximately 26 miles of new transmission line between the Keystone and Conemaugh substations would need to be constructed (estimated to cost \$52,000,000).**

32. The Lewistown – Juniata 230 kV line is overloaded at 113% (697 MVA) of its emergency rating (617 MVA) for the **tower** outage of Peachbottom 500/230 kV transformer (Cont Id. PE500). The R08 project contributes approximately 30 MW to this overload. To mitigate this overload would require the replacement/upgrade of a disconnect switch (estimated to cost approximately \$85,000) at Juniata Substation and the upgrade/reconductor approximately 25.74 miles of transmission line (estimated to cost approximately \$12,870,000).
33. The Keystone – Jun\_Keys 500 kV line is overloaded at 106% (3710 MVA) of its emergency rating (3500 MVA) for the outage of Conemaugh to Keystone 500 kV line (Cont Id. PJM21). The R08 project contributes approximately 34 MW to this overload. **It is estimated that approximately 26 miles of new transmission line between the Keystone and Conemaugh substations would need to be constructed (estimated to cost \$52,000,000).**
34. The North Meshoppen - Oxbow 230 kV line is overloaded at 106% (654 MVA) of its emergency rating (617 MVA) for the **tower** outage of Susquehanna to Mountain and Mountain to Stanton 230 kV line (Cont Id. 2PPL). The R08 project contributes approximately 18 MW to this overload. To mitigate this overload would require the replacement/upgrade of a disconnect switch (estimated to cost approximately \$85,000) at Oxbow Substation and the upgrade/reconductor approximately 10.16 miles of transmission line (estimated to cost approximately \$5,080,000).

### **New System Reinforcements**

None

### **Short Circuit**

PJM analysis found no new breakers to be over-duty in First Energy's transmission area. The study also showed no significant fault current contribution to any breakers which have already been identified as over-duty. This study was performed on the 230kV and above system.

Additional short circuit study will be conducted during the System Impact Study.

