Queue # Q56 - Claysburg 115 kV
Generation Interconnection

Network Impacts

The **#Q56 project was studied as 2 options. Option 1 considers an injection of 180 MW (36 MW of capacity) into the Claysburg 115 kV station. Option 2 considers an injection of 180 MW (36 MW of capacity) into a tap of the Claysburg-Curryville 115 kV line.** Project #Q56 was evaluated for compliance with reliability criteria for summer peak conditions in 2011. Potential network impacts were as follows:

Option 1:

Generator Deliverability – at the 36 MW capacity value level

No problems identified.

New System Reinforcements

Multiple Facility Contingency – Reliability Requirements at the 180 MW full output level

NOTE: For Feasibility Studies, only double circuit (tower) outages are evaluated – not line fault and stuck breaker.

1. The Westfall-Q53 Tap 115 kV line is overloaded at around 104% of its emergency rating (229 MVA) for the **tower outage** of the two Muddy Run 230 kV lines. The Q56 project contributes approximately 27 MW to the **contingency** facility loading.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Westfall Substation:
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**

2. The Glory-Dixonville 115 kV line is overloaded at around 102% of its emergency rating (124 MVA) for the **tower outage** of the Juniata-Lewisburg 230 kV line and the Juniata-Dauphin 230 kV line. The Q56 project contributes approximately 11 MW to the **contingency** facility loading.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Glory Substation:
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $125,000)**

3. The Raystown-Altoona 230 kV line is overloaded at around 101% of its emergency rating (554 MVA) for the **tower outage** of the two Muddy Run 230 kV lines. The Q56 project contributes approximately 23 MW to the **contingency** facility loading.

To mitigate this overload condition would require replacement/upgrade of the following:

Altoona Substation:

- **Replacement/upgrade of line/wave trap (estimated to cost approximately $125,000)**

Contribution to Previously Identified Overloads

1. The Somerset-Pride 115 kV line is overloaded at around 204% of its emergency rating (150 MVA) for the **tower outage** of the Juniata-Lewisburg 230 kV line and the Juniata-Dauphin 230 kV line. The Q56 project contributes approximately 15 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the P60, Q04 and Q53 projects.

   To mitigate this overload condition would require replacement/upgrade of the following:

   Somerset Substation:

   - **Replacement/upgrade of a disconnect switch (estimated to cost approximately $80,000)**
   - **Replacement/upgrade of a CT circuit (estimated to cost approximately $125,000)**
   - **Replacement/upgrade of line/wave trap (estimated to cost approximately $115,000)**
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**
   - **Replacement/upgrade of a circuit breaker (estimated to cost approximately $425,000)**

   Reconductor/upgrade of approximately 6.6 miles of the 11.08 miles transmission line between Somerset and Allegheny (estimated to cost approximately $1,700,000)

   Pride Substation:

   - **It is assumed that the equipment at this substation will not become a limiting component.**

2. The Garrett 138/115 kV transformer is overloaded at around 202% of its emergency rating (90 MVA) for the **tower outage** of the Juniata-Lewisburg 230 kV line and the Juniata-Dauphin 230 kV line. The Q56 project contributes approximately 16 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the P48, Q04, Q34, Q36 and Q53 projects.

To mitigate this overload condition would require replacement/upgrade of the following:
Garrett Substation:

- **Replacement/upgrade of the 138-115 kV transformer, circuit breaker and substation conductor (estimated to cost approximately $1,750,000)**

3. The Claysburg-Summit 115 kV line is overloaded at around 198% of its emergency rating (146 MVA) for the **tower outage** of the two Muddy Run 230 kV lines. The Q56 project contributes approximately 93 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the P60, Q04 and Q34 projects.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Claysburg Substation:
   - **Replacement/upgrade of a CT circuit (estimated to cost approximately $100,000)**
   - **Replacement/upgrade of line/wave trap (estimated to cost approximately $115,000)**
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**

   Reconductor/upgrade of approximately 12.13 miles transmission line between Claysburg and Summit (estimated to cost approximately $3,600,000)

   Summit Substation:
   - **Replacement/upgrade of a CT circuit (estimated to cost approximately $100,000)**
   - **Replacement/upgrade of line/wave trap (estimated to cost approximately $115,000)**
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**

4. The Garrett-Garrett 115 kV line is overloaded at around 190% of its emergency rating (125 MVA) for the **tower outage** of the Homer City-Quemahoning 230 kV line and the Seward-Tower 115 kV line. The Q56 project contributes approximately 21 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the Q04, Q34, Q36 and Q53 projects.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Garrett Substation:
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $125,000)**
   - **Replacement/upgrade of a CT circuit (estimated to cost approximately $100,000)**

- **Replacement/upgrade of a disconnect switch (estimated to cost approximately $80,000)**
- **Replacement/upgrade of a line/wave trap (estimated to cost approximately $115,000)**

Reconductor/upgrade of approximately 1.9 miles of transmission line between Garrett tap and Garrett (estimated to cost approximately $570,000)

5. The Allegheny-P60 Tap 115 kV line is overloaded at around 155% of its emergency rating (150 MVA) for the **tower outage** of the Juniata-Lewisburg 230 kV line and the Juniata-Dauphin 230 kV line. The Q56 project contributes approximately 21 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the P60, Q04 and Q53 projects.

   To mitigate this overload condition would require replacement/upgrade of the following:

   Reconductor/upgrade of approximately 5 miles of the 21.76 miles of transmission line between Allegheny and Bedford North (estimated to cost approximately $1,500,000)

6. The Allegheny-Pride 115 kV line is overloaded at around 150% of its emergency rating (150 MVA) for the **tower outage** of the Juniata-Lewisburg 230 kV line and the Juniata-Dauphin 230 kV line. The Q56 project contributes approximately 21 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the P60, Q04 and Q53 projects.

   To mitigate this overload condition would require replacement/upgrade of the following:

   Reconductor/upgrade of approximately 4.48 miles of the 11.08 miles of transmission line between Allegheny and Somerset (estimated to cost approximately $1,550,000)

7. The Rockwood-Penn Mar 115 kV line is overloaded at around 152% of its emergency rating (143 MVA) for the **tower outage** of the Homer City-Quemahoning 230 kV line and the Seward-Tower 115 kV line. The Q56 project contributes approximately 21 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the P60, Q04, Q34, Q36 and Q53 projects.

   To mitigate this overload condition would require replacement/upgrade of the following:
   <u>Rockwood Substation:</u>
   - **Replacement/upgrade of a disconnect switch (estimated to cost approximately $80,000)**
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**

Reconductor/upgrade of approximately 14.7 miles of transmission line between Rockwood and Penn Mar (estimated to cost approximately $3,500,000)

Penn Mar Substation:

- **Replacement/upgrade of a circuit breaker (estimated to cost approximately $325,000)**
- **Replacement/upgrade of a CT circuit (estimated to cost approximately $100,000)**
- **Replacement/upgrade of a line/wave trap (estimated to cost approximately $115,000)**

8. The Hillclay-Hilltop 115 kV line is overloaded at around 154% of its emergency rating (179 MVA) for the **tower outage** of the Homer City-Quemahoning 230 kV line and the Seward-Tower 115 kV line. The Q56 project contributes approximately 51 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the Q34, Q36, and Q53 projects.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Hillclay Substation:

   - **Replacement/upgrade of a CT circuit (estimated to cost approximately $100,000)**

   Hilltop Substation:

   - **Replacement/upgrade of a CT circuit (estimated to cost approximately $100,000)**
   - **Replacement/upgrade of a CT circuit (estimated to cost approximately $100,000)**
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**

9. The Penn Mar-Garrett 115 kV line is overloaded at around 133% of its emergency rating (167 MVA) for the **tower outage** of the Homer City-Quemahoning 230 kV line and the Seward-Tower 115 kV line. The Q56 project contributes approximately 21 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the Q34, Q36 and Q53 projects.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Penn Mar Substation:

   - **Replacement/upgrade of a line/wave trap (estimated to cost approximately $115,000)**
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**

Reconductor/upgrade of approximately 14.95 miles of transmission line between Penn Mar and Garrett (estimated to cost approximately $4,500,000)

10. The Shelocta-Keystone 230 kV line is overloaded at around 130% of its emergency rating (854 MVA) for the **tower outage** of the Juniata-Lewisburg 230 kV line and the Juniata-Dauphin 230 kV line. The Q56 project contributes approximately 82 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the P28, P45A, P47, P48, P60, Q04, Q34, Q36 and Q53 projects.

    To mitigate this overload condition would require replacement/upgrade of the following:
    Shelocta Substation:
    - **Replacement/upgrade of a disconnect switch (estimated to cost approximately $150,000)**
    - **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**

    Reconductor/upgrade of approximately 2.26 miles of transmission line between Shelocta and Keystone (estimated to cost approximately $1,400,000)

    Keystone Substation:
    - **Replacement/upgrade of a CT circuit (estimated to cost approximately $140,000)**
    - **Replacement/upgrade of a disconnect switch (estimated to cost approximately $150,000)**
    - **Replacement/upgrade of a CT circuit (estimated to cost approximately $140,000)**
    - **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**

11. The Homer City-Shelocta 230 kV line is overloaded at around 122% of its emergency rating (854 MVA) for the **tower outage** of the Juniata-Lewisburg 230 kV line and the Juniata-Dauphin 230 kV line. The Q56 project contributes approximately 66 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the O56, O72, P22, P28, P45A, P47, P48, P60, Q04, Q34, Q36 and Q53 projects.

    To mitigate this overload condition would require replacement/upgrade of the following:
    Shelocta Substation:
    - **Replacement/upgrade of a disconnect switch (estimated to cost approximately $150,000)**
    - **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**

Reconductor/upgrade of approximately 10.73 miles of transmission line between Homer City and Shelocta (estimated to cost approximately $5,500,000)

Homer City Substation:

- **Replacement/upgrade of a CT circuit (estimated to cost approximately $100,000)**
- **Replacement/upgrade of a line/wave trap (estimated to cost approximately $125,000)**
- **Replacement/upgrade of a circuit breaker (estimated to cost approximately $425,000)**

12. The Keystone 500/230 kV #4 transformer is overloaded at around 115% of its emergency rating (465 MVA) for the **tower outage** of the Juniata-Lewisburg 230 kV line and the Juniata-Dauphin 230 kV line. The Q53 project contributes approximately 41 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the P22, P28, P45A, P47, P48, P60, Q04, Q34, Q36 and Q53 projects.

    To mitigate this overload condition would require replacement/upgrade of the following:
    Keystone Substation:
    - **Replacement/upgrade of the 500-230 kV transformer (estimated to cost approximately $5,500,000) and will take approximately 2 years to complete.**

13. The Keystone 500/230 kV #3 transformer is overloaded at around 115% of its emergency rating (471 MVA) for the **tower outage** of the Juniata-Lewisburg 230 kV line and the Juniata-Dauphin 230 kV line. The Q53 project contributes approximately 41 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the P22, P28, P45A, P47, P48, P60, Q04, Q34, Q36 and Q53 projects.

    To mitigate this overload condition would require replacement/upgrade of the following:
    Keystone Substation:
    - **Replacement/upgrade of the 500-230 kV transformer (estimated to cost approximately $5,500,000) and will take approximately 2 years to complete.**

Contribution to Previously Identified System Reinforcements

To be determined in the System Impact Study.

Short Circuit

Detailed studies will be performed during the System Impact Study and the results will be included in the System Impact Study report.

Potential Congestion Issues

There are several wind generation plants proposed in the general area of the Q56 project, each with only 20% of their peak output level considered as a Capacity Resource, and the remaining 80% as energy only resource. If all of the wind generation plants are at their maximum out put level simultaneously, a significant number of the 115 kV and 230 kV facilities, and many underlying system facilities are likely to be overloaded, restricting operation to a lower output level.

PJM and FirstEnergy studied the delivery of the energy portion of this interconnection request. The following analysis has been performed to inform the Interconnection Customer (Queue Q56) of potential congestion issues (operational restrictions) that may occur and affect the Q56 project's ability to operate at full output for certain system conditions. **The upgrades listed below are not required reliability upgrades for the Queue Q56 interconnection.** Please note that the number of facilities identified below as requiring upgrades is quite extensive – with a number of these facilities requiring reconductoring/rebuilding of transmission lines. Some of the reconductoring/rebuilding projects can be done in a "short" time frame while others are quite extensive and will require a "long" time to complete. In general, the time necessary to design and rebuild an extensive facility upgrade will take approximately 2-3 years to complete. If the Q56 Interconnection Customer wants to pursue construction of any of these upgrades, a separate "Transmission Interconnection" request must be submitted and the upgrades must be performed as merchant transmission projects.

Category A – Transmission System Impacts (Facilities monitored and operated by PJM)

Load flow model used for analysis: Generator Deliverability dispatch with all generators (in-service or active Queue generators preceding Q56) at 100% energy output and Peak summer loading (80/20 load forecast).

Q56 Operational considerations: The facilities below (potentially overloaded) are monitored and operated by PJM. PJM rules and methods for readjusting pre-contingency (N-1) dispatch will be followed if this system condition occurs. This may or may not cause curtailment of Q56 generation to below its 100% energy output.

1. The Raystown-Altoona 230 kV line loads to approximately 100% of its emergency rating (554 MVA) for the outage of the Homer City-Keystone 230 kV line. The energy portion of Q56 contributes approximately 29 MW to this **contingency** overload condition which was previously identified as a potential congestion issue for the energy portion of the O72, P01, P22, P45A, P48, P60 and Q04 projects.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Altoona Substation:
   Replacement/upgrade of line/wave trap (estimated to cost approximately $125,000)

Category B – Underlying Transmission System Impacts (Facilities monitored and operated by Penelec)

Load flow model used for analysis: Generator Deliverability dispatch with all generators (in-service or active Queue generators preceding Q56) at 100% energy output and Peak summer loading (80/20 load forecast).

Q56 Operational considerations: The facilities below (potentially overloaded) are not monitored and operated by PJM. Penelec monitors these facilities in real time and will readjust the system according to Penelec's rules and methods if this system condition occurs. This may or may not cause curtailment of Q56 generation to below its 100% energy output.

2. The energy portion of #Q56 contributes approximately 22 MW to the previously identified **contingency** overload on the Westfall-Q53 Tap 115kV line (emergency rating 229 MVA) for the outage of the Johnstown-N39 Tap 230 kV line which was previously identified as a potential congestion issue for the energy portion of the Q53 project.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Westfall Substation:
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**

3. The Garrett-Garrett 115 kV line loads to approximately 113% of its emergency rating (125 MVA) for the outage of the Homer City-Keystone 230 kV line. The energy portion of Q56 contributes approximately 17 MW to this **contingency** overload condition which was previously identified as a potential congestion issue for the energy portion of the P60 and Q04 projects.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Garrett Substation:
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $125,000)**

4. The Glory-Dixonville 115 kV line loads to approximately 111% of its emergency rating (124 MVA) for the outage of the Homer City-Keystone 230 kV line. The energy portion of Q56 contributes approximately 15 MW to this **contingency** overload condition which was previously identified as a potential congestion issue for the energy portion of the O56, O72, P01, P22, P28, P48, P60 and Q04 projects.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Glory Substation:
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $125,000)**

Category C – Underlying Transmission System Impacts (Facilities monitored and operated by Penelec). These contingency overloads were not possible prior to the Queue Q56 project. The identified contingency overloads are caused directly by Q56 and are likely to cause Q56 curtailment to less than 100% energy output during summer and possibly winter operation.

Load flow model used for analysis: Generator Deliverability dispatch with all generators (in-service or active Queue generators preceding Q56) at 100% energy output and Peak summer loading (80/20 load forecast).

Q56 Operational considerations: The facilities below (potentially overloaded) are not monitored and operated by PJM. Penelec monitors these facilities in real time and will readjust the system according to Penelec's rules and methods if this system condition occurs. This may or may not cause curtailment of Q56 generation to below its 100% energy output.

5. The Westfall-Q53 Tap 115 kV line loads to approximately 111% of its normal rating (176 MVA). The energy portion of Q56 contributes approximately 21 MW to this **normal** overload condition.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Westfall Substation:
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**

6. The Philipsburg-Q36 Tap 115 kV line loads to approximately 109% of its emergency rating (146 MVA) for the outage of the Altoona-Lewistown 230 kV line. The energy portion of Q56 contributes approximately 18 MW to this **contingency** overload condition.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Philipsburg Substation:
   - **Replacement/upgrade of a CT circuit (estimated to cost approximately $100,000)**

7. The Summit-Q53 Tap 115 kV line loads to approximately 102% of its emergency rating (229 MVA) for the outage of the Johnstown-N39 Tap 230 kV line. The energy portion of Q56 contributes approximately 22 MW to this **contingency** overload condition.

To mitigate this overload condition would require replacement/upgrade of the following:
Summit Substation:

- **Replacement/upgrade of substation conductor (estimated to cost approximately $125,000)**

Option 2:

Generator Deliverability – at the 36 MW capacity value level
No problems identified.

New System Reinforcements

Multiple Facility Contingency– Reliability Requirements at the 180 MW full output level
NOTE: For Feasibility Studies, only double circuit (tower) outages are evaluated – not line fault and stuck breaker.

1. The Westfall-Q53 Tap 115 kV line is overloaded at around 104% of its emergency rating (229 MVA) for the **tower outage** of the two Muddy Run 230 kV lines. The Q56 project contributes approximately 26 MW to the **contingency** facility loading.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Westfall Substation:

   - **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**

2. The Glory-Dixonville 115 kV line is overloaded at around 102% of its emergency rating (124 MVA) for the **tower outage** of the Juniata-Lewisburg 230 kV line and the Juniata-Dauphin 230 kV line. The Q56 project contributes approximately 11 MW to the **contingency** facility loading.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Glory Substation:

   - **Replacement/upgrade of substation conductor (estimated to cost approximately $125,000)**

3. The Raystown-Altoona 230 kV line is overloaded at around 101% of its emergency rating (554 MVA) for the **tower outage** of the two Muddy Run 230 kV lines. The Q56 project contributes approximately 23 MW to the **contingency** facility loading.

To mitigate this overload condition would require replacement/upgrade of the following:
Altoona Substation:

- **Replacement/upgrade of line/wave trap (estimated to cost approximately $125,000)**

4. The Claysburg-Q56 Tap 115 kV line is overloaded at around 168% of its emergency rating (184 MVA) for the **tower outage** of the two Muddy Run 230 kV lines. The Q56 project contributes approximately 155 MW to the **contingency** facility loading.

To mitigate this overload condition would require replacement/upgrade of the following:
Claysburg Substation:

- **Replacement/upgrade of line/wave trap (estimated to cost approximately $115,000)**
- **Replacement/upgrade of substation conductor (estimated to cost approximately $125,000)**
- **Replacement/upgrade of a circuit breaker (estimated to cost approximately $425,000)**
- **Replacement/upgrade of a CT circuit (estimated to cost approximately $100,000)**

Reconductor/upgrade of approximately .75 miles of transmission line between Claysburg and Q56 (estimated to cost approximately $225,000)

Contribution to Previously Identified Overloads

1. The Somerset-Pride 115 kV line is overloaded at around 207% of its emergency rating (150 MVA) for the **tower outage** of the Juniata-Lewisburg 230 kV line and the Juniata-Dauphin 230 kV line. The Q56 project contributes approximately 25 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the P60, Q04 and Q53 projects.

To mitigate this overload condition would require replacement/upgrade of the following:
Somerset Substation:

- **Replacement/upgrade of a disconnect switch (estimated to cost approximately $90,000)**
- **Replacement/upgrade of a CT circuit (estimated to cost approximately $100,000)**
- **Replacement/upgrade of line/wave trap (estimated to cost approximately $115,000)**
- **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**

Reconductor/upgrade of approximately 6.6 miles of the 11.08 miles transmission line between Somerset and Allegheny (estimated to cost approximately $1,700,000).

Pride Substation:

- **It is assumed that the equipment at this substation will not become a limiting component.**

2. The Garrett 138/115 kV transformer is overloaded at around 202% of its emergency rating (90 MVA) for the **tower outage** of the Juniata-Lewisburg 230 kV line and the Juniata-Dauphin 230 kV line. The Q56 project contributes approximately 16 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the P48, Q04, Q34, Q36 and Q53 projects.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Garrett Substation:
   - **Replacement/upgrade of the 138-115 kV transformer, circuit breaker and substation conductor (estimated to cost approximately $1,750,000)**

3. The Claysburg-Summit 115 kV line is overloaded at around 196% of its emergency rating (146 MVA) for the **tower outage** of the two Muddy Run 230 kV lines. The Q56 project contributes approximately 91 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the P60, Q04 and Q34 projects.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Claysburg Substation:
   - **Replacement/upgrade of a CT circuit (estimated to cost approximately $100,000)**
   - **Replacement/upgrade of line/wave trap (estimated to cost approximately $115,000)**
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**

   Reconductor/upgrade of approximately 12.13 miles transmission line between Claysburg and Summit (estimated to cost approximately $3,750,000)

   Summit Substation:
   - **Replacement/upgrade of a CT circuit (estimated to cost approximately $125,000)**
   - **Replacement/upgrade of line/wave trap (estimated to cost approximately $115,000)**
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**

4. The Garrett-Garrett 115 kV line is overloaded at around 191% of its emergency rating (125 MVA) for the **tower outage** of the Homer City-Quemahoning 230 kV line and the Seward-Tower 115 kV line. The Q56 project contributes approximately 22 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the Q04, Q34, Q36 and Q53 projects.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Garrett Substation:
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $125,000)**
   - **Replacement/upgrade of a CT circuit (estimated to cost approximately $100,000)**
   - **Replacement/upgrade of a disconnect switch (estimated to cost approximately $80,000)**
   - **Replacement/upgrade of a line/wave trap (estimated to cost approximately $115,000)**

   Reconductor/upgrade of approximately 1.9 miles of transmission line between Garrett tap and Garrett (estimated to cost approximately $570,000)

5. The Allegheny-P60 Tap 115 kV line is overloaded at around 158% of its emergency rating (150 MVA) for the **tower outage** of the Juniata-Lewisburg 230 kV line and the Juniata-Dauphin 230 kV line. The Q56 project contributes approximately 25 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the P60, Q04 and Q53 projects.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Allegheny Substation:
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $125,000)**

   Reconductor/upgrade of approximately 5 miles of the 21.76 miles of transmission line between Allegheny and Bedford North (estimated to cost approximately $1,500,000)

6. The Allegheny-Pride 115 kV line is overloaded at around 152% of its emergency rating (150 MVA) for the **tower outage** of the Juniata-Lewisburg 230 kV line and the Juniata-Dauphin 230 kV line. The Q56 project contributes approximately 25 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the P60, Q04 and Q53 projects.

To mitigate this overload condition would require replacement/upgrade of the following:
Allegheny Substation:

- **Replacement/upgrade of substation conductor (estimated to cost approximately $125,000)**

Reconductor/upgrade of approximately 4.48 miles of the 11.08 miles of transmission line between Allegheny and Somerset (estimated to cost approximately $1,550,000).

7. The Rockwood-Penn Mar 115 kV line is overloaded at around 153% of its emergency rating (143 MVA) for the **tower outage** of the Homer City-Quemahoning 230 kV line and the Seward-Tower 115 kV line. The Q56 project contributes approximately 22 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the P60, Q04, Q34, Q36 and Q53 projects.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Rockwood Substation:
   - **Replacement/upgrade of a disconnect switch (estimated to cost approximately $80,000)**
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**

   Reconductor/upgrade of approximately 14.7 miles of transmission line between Rockwood and Penn Mar (estimated to cost approximately $3,500,000)

   Penn Mar Substation:
   - **Replacement/upgrade of a circuit breaker (estimated to cost approximately $325,000)**
   - **Replacement/upgrade of a CT circuit (estimated to cost approximately $100,000)**
   - **Replacement/upgrade of a line/wave trap (estimated to cost approximately $115,000)**

8. The Hillclay-Hilltop 115 kV line is overloaded at around 154% of its emergency rating (179 MVA) for the **tower outage** of the Homer City-Quemahoning 230 kV line and the Seward-Tower 115 kV line. The Q56 project contributes approximately 51 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the Q34, Q36 and Q53 projects.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Hillclay Substation:
   - **Replacement/upgrade of a CT circuit (estimated to cost approximately $100,000)**

Hilltop Substation:

- **Replacement/upgrade of a CT circuit (estimated to cost approximately $100,000)**
- **Replacement/upgrade of a CT circuit (estimated to cost approximately $100,000)**
- **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**

9. The Penn Mar-Garrett 115 kV line is overloaded at around 134% of its emergency rating (167 MVA) for the **tower outage** of the Homer City-Quemahoning 230 kV line and the Seward-Tower 115 kV line. The Q56 project contributes approximately 22 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the Q34, Q36 and Q53 projects.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Penn Mar Substation:
   - **Replacement/upgrade of a line/wave trap (estimated to cost approximately $115,000)**
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**

   Reconductor/upgrade of approximately 14.95 miles of transmission line between Penn Mar and Garrett (estimated to cost approximately $4,500,000)

10. The Shelocta-Keystone 230 kV line is overloaded at around 130% of its emergency rating (854 MVA) for the **tower outage** of the Juniata-Lewisburg 230 kV line and the Juniata-Dauphin 230 kV line. The Q56 project contributes approximately 82 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the P28, P45A, P47, P48, P60, Q04, Q34, Q36 and Q53 projects.

    To mitigate this overload condition would require replacement/upgrade of the following:
    Shelocta Substation:
    - **Replacement/upgrade of a disconnect switch (estimated to cost approximately $150,000)**
    - **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**

    Reconductor/upgrade of approximately 2.26 miles of transmission line between Shelocta and Keystone (estimated to cost approximately $1,400,000)

    Keystone Substation:
    - **Replacement/upgrade of a CT circuit (estimated to cost approximately $140,000)**

- **Replacement/upgrade of a disconnect switch (estimated to cost approximately $150,000)**
- **Replacement/upgrade of a CT circuit (estimated to cost approximately $140,000)**
- **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**
- **Replacement/upgrade of a disconnect switch (estimated to cost approximately $80,000)**

11. The Homer City-Shelocta 230 kV line is overloaded at around 122% of its emergency rating (854 MVA) for the **tower outage** of the Juniata-Lewisburg 230 kV line and the Juniata-Dauphin 230 kV line. The Q56 project contributes approximately 66 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the O56, O72, P22, P28, P45A, P47, P48, P60, Q04, Q34, Q36 and Q53 projects.

    To mitigate this overload condition would require replacement/upgrade of the following:
    Shelocta Substation:
    - **Replacement/upgrade of a disconnect switch (estimated to cost approximately $150,000)**

    Reconductor/upgrade of approximately 10.73 miles of transmission line between Homer City and Shelocta (estimated to cost approximately $5,500,000)

    Homer City Substation:
    - **Replacement/upgrade of a CT circuit (estimated to cost approximately $100,000)**
    - **Replacement/upgrade of a line/wave trap (estimated to cost approximately $125,000)**
    - **Replacement/upgrade of a circuit breaker (estimated to cost approximately $425,000)**

12. The Keystone 500/230 kV #4 transformer is overloaded at around 115% of its emergency rating (465 MVA) for the **tower outage** of the Juniata-Lewisburg 230 kV line and the Juniata-Dauphin 230 kV line. The Q53 project contributes approximately 41 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the P22, P28, P45A, P47, P48, P60, Q04, Q34, Q36 and Q53 projects.

    To mitigate this overload condition would require replacement/upgrade of the following:
    Keystone Substation:
    - **Replacement/upgrade of the 500-230 kV transformer (estimated to cost approximately $5,500,000) and will take approximately 2 years to complete.**

13. The Keystone 500/230 kV #3 transformer is overloaded at around 115% of its emergency rating (471 MVA) for the **tower outage** of the Juniata-Lewisburg 230 kV line and the Juniata-Dauphin 230 kV line. The Q53 project contributes approximately 41 MW to the **contingency** facility loading which was previously identified as a potential congestion issue for the energy portion of the P22, P28, P45A, P47, P48, P60, Q04, Q34, Q36 and Q53 projects.

    To mitigate this overload condition would require replacement/upgrade of the following:
    Keystone Substation:
    - **Replacement/upgrade of the 500-230 kV transformer (estimated to cost approximately $5,500,000) and will take approximately 2 years to complete.**

Contribution to Previously Identified System Reinforcements

To be determined in the System Impact Study.

Short Circuit

Detailed studies will be performed during the System Impact Study and the results will be included in the System Impact Study report.

Potential Congestion Issues

There are several wind generation plants proposed in the general area of the Q56 project, each with only 20% of their peak output level considered as a Capacity Resource, and the remaining 80% as energy only resource. If all of the wind generation plants are at their maximum out put level simultaneously, a significant number of the 115 kV and 230 kV facilities, and many underlying system facilities are likely to be overloaded, restricting operation to a lower output level.

PJM and FirstEnergy studied the delivery of the energy portion of this interconnection request. The following analysis has been performed to inform the Interconnection Customer (Queue Q56) of potential congestion issues (operational restrictions) that may occur and affect the Q56 project's ability to operate at full output for certain system conditions. **The upgrades listed below are not required reliability upgrades for the Queue Q56 interconnection.** Please note that the number of facilities identified below as requiring upgrades is quite extensive – with a number of these facilities requiring reconductoring/rebuilding of transmission lines. Some of the reconductoring/rebuilding projects can be done in a "short" time frame while others are quite extensive and will require a "long" time to complete. In general, the time necessary to design and rebuild an extensive facility upgrade will take approximately 2-3 years to complete. If the Q56 Interconnection Customer wants to pursue construction of any of these upgrades, a separate "Transmission Interconnection" request must be submitted and the upgrades must be performed as merchant transmission projects.

Category A – Transmission System Impacts (Facilities monitored and operated by PJM)

Load flow model used for analysis: Generator Deliverability dispatch with all generators (in-service or active Queue generators preceding Q56) at 100% energy output and Peak summer loading (80/20 load forecast).

Q56 Operational considerations: The facilities below (potentially overloaded) are monitored and operated by PJM. PJM rules and methods for readjusting pre-contingency (N-1) dispatch will be followed if this system condition occurs. This may or may not cause curtailment of Q56 generation to below its 100% energy output.

1. The Raystown-Altoona 230 kV line loads to approximately 100% of its emergency rating (554 MVA) for the outage of the Homer City-Keystone 230 kV line. The energy portion of Q56 contributes approximately 29 MW to this **contingency** overload condition.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Altoona Substation:
   - **Replacement/upgrade of line/wave trap (estimated to cost approximately $125,000)**

Category B – Underlying Transmission System Impacts (Facilities monitored and operated by Penelec)

Load flow model used for analysis: Generator Deliverability dispatch with all generators (in-service or active Queue generators preceding Q04) at 100% energy output and Peak summer loading (80/20 load forecast).

Q04 Operational considerations: The facilities below (potentially overloaded) are not monitored and operated by PJM. Penelec monitors these facilities in real time and will readjust the system according to Penelec's rules and methods if this system condition occurs. This may or may not cause curtailment of Q04 generation to below its 100% energy output.

2. The energy portion of #Q56 contributes approximately 21 MW to the previously identified **contingency** overload on the Westfall-Q53 Tap 115kV line (emergency rating 229 MVA) for the outage of the Johnstown-N39 Tap 230 kV line which was previously identified as a potential congestion issue for the energy portion of the Q53 project.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Westfall Substation:
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**

3. The Garrett-Garrett 115 kV line loads to approximately 113% of its emergency rating (125 MVA) for the outage of the Homer City-Keystone 230 kV line. The energy portion

of Q56 contributes approximately 17 MW to this **contingency** overload condition which was previously identified as a potential congestion issue for the energy portion of the P60 and Q04 projects.

To mitigate this overload condition would require replacement/upgrade of the following:
Garrett Substation:

- **Replacement/upgrade of substation conductor (estimated to cost approximately $125,000)**
- **Replacement/upgrade of a disconnect switch (estimated to cost approximately $80,000)**
- **Replacement/upgrade of a line/wave trap (estimated to cost approximately $115,000)**

4. The Glory-Dixonville 115 kV line loads to approximately 111% of its emergency rating (124 MVA) for the outage of the Homer City-Keystone 230 kV line. The energy portion of Q56 contributes approximately 15 MW to this **contingency** overload condition which was previously identified as a potential congestion issue for the energy portion of the O56, O72, P01, P22, P28, P48, P60 and Q04 projects.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Glory Substation:

   - **Replacement/upgrade of substation conductor (estimated to cost approximately $125,000)**

5. The Garrett 138/115 kV transformer loads to approximately 105% of its normal rating (63 MVA). The energy portion of Q56 contributes approximately 13 MW to this **normal** overload condition which was previously identified as a potential congestion issue for the energy portion of the P48 and Q04 projects.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Garrett Substation:

   - **Replacement/upgrade of the 138-115 kV transformer, circuit breaker and substation conductor (estimated to cost approximately $1,750,000)**

Category C – Underlying Transmission System Impacts (Facilities monitored and operated by Penelec). These contingency overloads were not possible prior to the Queue Q56 project. The identified contingency overloads are caused directly by Q56 and are likely to cause Q56 curtailment to less than 100% energy output during summer and possibly winter operation.

Load flow model used for analysis: Generator Deliverability dispatch with all generators (in-service or active Queue generators preceding Q56) at 100% energy output and Peak summer loading (80/20 load forecast).

Q56 Operational considerations: The facilities below (potentially overloaded) are not monitored and operated by PJM. Penelec monitors these facilities in real time and will readjust the system according to Penelec's rules and methods if this system condition occurs. This may or may not cause curtailment of Q56 generation to below its 100% energy output.

6. The Westfall-Q53 Tap 115 kV line loads to approximately 111% of its normal rating (176 MVA). The energy portion of Q56 contributes approximately 21 MW to this **normal** overload condition.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Westfall Substation:
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $100,000)**

7. The Philipsburg-Q36 Tap 115 kV line loads to approximately 109% of its emergency rating (146 MVA) for the outage of the Altoona-Lewistown 230 kV line. The energy portion of Q56 contributes approximately 17 MW to this **contingency** overload condition.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Philipsburg Substation:
   - **Replacement/upgrade of a CT circuit (estimated to cost approximately $100,000)**

8. The Summit-Q53 Tap 115 kV line loads to approximately 102% of its emergency rating (229 MVA) for the outage of the Johnstown-N39 Tap 230 kV line. The energy portion of Q56 contributes approximately 21 MW to this **contingency** overload condition.

   To mitigate this overload condition would require replacement/upgrade of the following:
   Summit Substation:
   - **Replacement/upgrade of substation conductor (estimated to cost approximately $125,000)**

9. The Claysburg-Q56 Tap 115 kV line loads to approximately 133% of its normal rating (162 MVA). The energy portion of Q56 contributes approximately 124 MW to this **normal** overload condition.

To mitigate this overload condition would require replacement/upgrade of the following:
Claysburg Substation:

- **Replacement/upgrade of line/wave trap (estimated to cost approximately $115,000)**
- **Replacement/upgrade of substation conductor (estimated to cost approximately $125,000)**
- **Replacement/upgrade of a CT circuit (estimated to cost approximately $100,000)**

Reconductor/upgrade of approximately .75 miles of transmission line between Claysburg and Q56 (estimated to cost approximately $225,000)

10. The Claysburg- Q56 Tap 115 kV line loads to approximately 122% of its emergency rating (184 MVA) for the outage of the Johnstown-N39 Tap 230 kV line. The energy portion of Q56 contributes approximately 124 MW to this **contingency** overload condition.

    To mitigate this overload condition would require replacement/upgrade of the following:
    Claysburg Substation:

    - **Replacement/upgrade of line/wave trap (estimated to cost approximately $115,000)**