#R77 – Morrisville 500kV
Generation Interconnection

This analysis was completed to assess the reliability impact for the increase in generation interconnecting to the PJM system as a capacity resource.

Preface

The intent of the Interconnection Feasibility Study is to determine a plan, with ballpark cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer (IC). As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

In some instances an IC may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the feasibility study, but the actual allocation will be deferred until the impact study is performed.

The Interconnection Feasibility Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

General

The developer has proposed a 600MW combined cycle generating facility to be installed in Warren County, Virginia at the Warren Industrial Park located in the city of Front Royal. The developer will interconnect with Allegheny Power (AP) at the new Warren 138kV interconnection Station. The generating facility will consist of 2 combustion turbines and 1 steam turbine. The proposed in-Service date for the projects is May 01, 2010.

Option 1:
The entire 600 MW project will be connected to a new Allegheny Power Warren 138 kV Station.

Option 2:
The project will be divided into two Points of Interconnection one being connected to a new Allegheny Power Warren 138 kV Station with 400 MW of injection. The second being connected to a new Front Royal 500 kV Station with 200 MW of injection.

Attachment Facilities Option 1:
Interconnection Point: New AP Warren switching station on the Kline's Mill. (AP) – Riverton (AP) 138kV line section.

The Interconnection Customer will also be required to install metering and telemetry equipment to provide revenue metering and real-time telemetry data to PJM. The requirements for this equipment are listed in Appendix 2, section 8 of Attachment O to the PJM Tariff, as well as PJM manuals 01 and 14D.

Attachment Facilities Option 2:
Interconnection Point: New AP Warren switching station (400MW) on the Kline's Mill. (AP) – Riverton (AP) 138kV line section. The other 200MW of generation will be connected to a new Front Royal switching station on the Meadow Brook 500kV (AP) - Morrisville 500kV (VP) line.

The Interconnection Customer will also be required to install metering and telemetry equipment to provide revenue metering and real-time telemetry data to PJM. The requirements for this equipment are listed in Appendix 2, section 8 of Attachment O to the PJM Tariff, as well as PJM manuals 01 and 14D.

Options 1 & 2

New AP Warren Switching-station including:

- two 138kV dead end structures
- three 138 kV circuit breakers
- seven 138 kV VB air switches
- three 138 kV metering units
- Site preparation including grading and an access road is assumed to be provided by the developer on property provided by the developer and is not included in this estimate. The station will include a control building, which will house all protective relaying, metering and SCADA RTU communications equipment required to accommodate the electrical facilities. Revenue metering will be located on the feed to the generator. The developer's station is assumed to be adjacent to the AP station.

Estimated Cost: **$2,081,000 in 2010 dollars**

Install new turning structure line facilities required to terminate the Kline's Mill – Riverton 138 kV transmission line into the proposed new Warren 138kV Switching Station for the proposed interconnection. The AP station will be located adjacent to the line.

Estimated Cost: **$149,000 in 2010 dollars**

Non-Direct Connection Network Upgrades:

Meadow Brook SS - Replace all 15 138kV breakers with 50/63 kA interrupting rating breakers. Assumptions are 1. Control cables to be replaced, 2. Foundations do not need to be replaced 3.The disconnects switches momentary ratings are sufficient and that the switches do not need to be replaced and 4. Breakers will be reused and removal cost is therefore expense.

Upgrade the Kline's Mill 138kV terminal line trap, line risers, relay circuitry and RTU.

Estimated Cost: **$2,433,000 in 2010 dollars**

Kline's Mill SS – Replace the 138kV line switches and 138kV bus tie switch. Assumptions: 1. AP crew to perform the work and 2. Mobile transformer will be used.

Estimated Cost: **$105,000 in 2010 dollars**

Riverton SS - Replace the Kline's Mill and Double Toll Gate 138kV terminal breakers, breaker disconnect switches, line traps, and line risers. Upgrade the relay circuitry and RTU. The assumption is made that one of the 138kV breakers will be kept as spare and the other will be scrapped.

Estimated Cost: **$541,000 in 2010 dollars**

Double Toll Gate SS – Upgrade the 138kV bus and bus taps, Replace the Riverton 138kV terminal line risers, breaker risers, breaker disconnect switches and line trap. Upgrade the Riverton terminal relay circuitry and RTU.

Estimated Cost: **$267,000 in 2010 dollars**

Double Toll Gate – Riverton 138kV Line: Reconductor 6.98 miles of 138kV line with 1033 ACCR. Complete rebuild of the line is assumed due to age. The cost of a Consulting engineer is included for engineering only.

Estimated Cost: **$6, 002,000 in 2010 dollars**

Meadow Brook – Riverton 138kV Line: Reconductor 8.34 miles of 138kV line with 1033 ACCR. Replacement of insulators and all hardware is assumed. Complete rebuild is not assumed. The cost of a Consulting engineer is included for engineering only.

Estimated Cost: **$6, 356,000 in 2010 dollars**

Brighton SS – Upgrade substation equipment to increase rating of equipment from 3000 Amps to 4000 Amps. Equipment to be replaced includes breakers, switches, etc.

Estimated Cost: **$25,000,000 in 2007 dollars**

Option 2:

In addition to the items described above, option 2 would require interconnection facilities to be constructed and owned by Dominion Virginia Power (DVP). A new Front Royal switching station would include:

Attachment Facilities

The IC is responsible for procurement and installation of all Attachment Facilities from the generator leads to the generator side of the 500-kV disconnect switch.

DVP's Attachment Facilities interconnection costs are estimated to be **$1,000,000 dollars (2007 dollars)**.

This cost includes metering, relays and 500 kV line work to directly connect the proposed facility from the disconnect switch to the proposed 500 kV Switching Station.

Direct Connection Network Facilities

The Direct Connection interconnection costs are estimated to be $4,500,000 dollars (2007 dollars) for the proposed 500 kV Switching Station. This cost estimate is based on the assumption that the developer will acquire the land needed for the switching station and that it will be located next to the existing Line #580 right-of-way.

The New Front Royal Switching-station includes:

- 500kV dead end structures
- three 500 kV circuit breakers
- 500 kV switches
- 500 kV metering

Site preparation including grading and an access road is assumed to be provided by the developer on property provided by the developer and is not included in this estimate. The station will include a control building, which will house all protective relaying, metering and SCADA RTU communications equipment required to accommodate the electrical facilities. Revenue metering will be located on the feed to the generator. The developer's station is assumed to be adjacent to the AP station.

The Direct Connection Network Upgrades cost is estimated at: **$ 4.5 M**

The construction duration for the Front Royal switching station is expected to be **3 years.**

COST AND TIMING SUMMARY

The estimates in this report do not include tax gross-up.

Note that the figures provided do not include construction of the line required to interconnect the customer's proposed new generating facility with the Allegheny Power Warren Substation. Route selection, line design, right-of-way acquisition and construction of such lines will be entirely the responsibility of the interconnection customer. The estimated time to provide for the interconnection of this project is 36 months after the receipt of a signed Interconnection Service Agreement and Construction Service Agreement.

While the information in this transmittal is reasonable for the scope of work defined, it should, however, be noted that the cost figures are conceptual in nature at this stage, as an engineering team has not been assigned to the project. Obviously, any change to the scope of work will require that the estimates be revisited. The costs are a best estimate, but the developer will be charged for actual costs. Any under-runs or over-runs will be reconciled at the conclusion of the project.

Estimate of total cost as discussed in this report:
Option 1: **$43 Million**
Option 2: **$48.5 Million**

Network Impacts Option 1

The #R77 option 1 project was studied as a total injection of 600 MW into a loop of AP's Kline's Mill—Riverton 138 kV circuit. Project #R77, option 1 was evaluated for compliance with reliability criteria for summer peak conditions in 2011. Potential network impacts were as follows:

Generator Deliverability* Option 1
(No contingencies, Single or N-1 contingencies for the full energy output)

This project causes the Meadow Brook-Kline's Mill (without generator 85 MW- with generator 347 MW), and the Kline's Mill-Warren 138kV (without generator 77 MW- with generator 355 MW) lines to overload to 144% and 147%, respectively, of their normal ratings (with no contingencies).

This project contributes 291 MW to cause the Double Toll Gate-Riverton 138kV line (Pre 146 MW- Post 458 MW) to overload to 295% of its emergency rating for the contingency outage of the Kline's Mill-Warren 138kV line.

This project contributes 164 MW to cause the Warren-Riverton 138kV line (Pre 77 MW-Post 241 MW) to overload to 113% of its normal rating (with no contingencies).

This project contributes 2 MW to cause the Warren-Riverton 138kV line (Pre 240-Post 242) to overload to 100% its emergency rating. This overload is for the contingency outage of the Burches-Possum 500kV line.

This project contributes an additional 237 MW to cause the Meadow Brook-Kline's Mill 138kV line (Pre 347 MW-Post 584 MW) and 245 MW to cause the Kline's Mill-Warren 138kV line (Pre 355 MW-Post 600 MW) to overload to 197% and 245% of their emergency ratings. This overload is for the contingency outage of Riverton-Warren 138kV line.

This project contributes and additional 311 MW and 354 MW to cause the Double Toll Gate-Riverton (Pre 148 MW-Post 459 MW) and the Riverton-Warren 138kV lines (Pre 242 MW-Post 600 MW) to overload to 295% and 245%, respectively of their emergency ratings for the contingency outage of the Kline's Mill-Warren 138kV line.

The corrective actions for the above overloads is to reconductor approximately 8.34 miles of line extending from Meadow Brook-Riverton and 6.98 miles from Riverton-Double Toll Gate with 1033ACCR and upgrade all necessary terminal equipment at Meadow Brook, Kline's Mill, Riverton and Double Toll Gate substations.

Network Impacts Option 2

The #R77 option 2 project was studied as a total injection of 400 MW into a loop of AP's Kline's Mill—Riverton 138 kV circuit and 200 MW into AP's Meadow Brook-VP's Morrisville 500 kV circuit. Project #R77, option 2 was evaluated for compliance with

reliability criteria for summer peak conditions in 2011. Potential network impacts were as follows:

Generator Deliverability* Option 2
(No contingencies, Single or N-1 contingencies for the full energy output)

This project contributes 187 MW to cause the Meadow Brook-Kline's Mill (Pre 202 MW-Post 389 MW) and 186 MW to the Kline's Mill-Warren 138kV (Pre 210 MW-Post 396 MW) lines to overload to 131% and 163%, respectively, of their emergency ratings for the contingency outage of the Riverton-Warren 138kV line.

This project contributes 178 MW to cause the Double Toll Gate-Riverton (Pre 103 MW-Post 281 MW) and 209 MW to the Riverton-Warren (Pre 187 MW-Post 396 MW) 138kV lines to overload to 186% and 164%, respectively, of their emergency ratings for the contingency outage of the Kline's Mill-Warren 138kV line.

The corrective actions for the above overloads is to reconductor approximately 8.34 miles of line extending from Meadow Brook-Riverton and 6.98 miles from Riverton-Double Gate with 1033ACCR and upgrade all necessary terminal equipment at Meadow Brook, Kline's Mill, Riverton and Double Toll Gate substations.

Contribution to Previously Identified Overloads (applicable to both option 1 & 2)
(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

Contribution of 99 MW further overloads the Doubs-Brighton 500 kV line from 107% to 110% of its emergency rating (3099 MVA) for the outage of the Burches - Possum 500 kV line (Cont. Id. PJM1A). The thermal violation first takes place for contribution of the R44 project.

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

None

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

Upgrade Brighton 500kV substation. Upgrade includes the replacement of breakers, disconnect switches, etc. This will increase the rating of the substation equipment from 3000 to 4000 Amps. The time required to perform this upgrade is approximately 2 – 3 years following the execution of the Interconnection Service Agreement (ISA) and Interconnection Construction Service Agreement (ICSA). The estimated costs associated with these upgrades are **$25 M**.

Short Circuit

Option 1 & 2

All 138kV breakers, MD 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 and 18, at Meadow Brook were identified for replacement in this study.

Meadow Brook SS - Replace all 15 138kV breakers with 50/63 kA interrupting rating breakers. Assumptions are:
1. Control cables to be replaced
2. Foundations do not need to be replaced
3. The disconnects switches momentary ratings are sufficient and that the switches do not need to be replaced and
4. Breakers will be reused and removal cost is therefore expense.

Upgrade the Kline's Mill 138kV terminal line trap, line risers, relay circuitry and RTU.

Total Estimated Cost **$2,433,000** in 2010 dollars.

Listed below are the positive and zero sequence source equivalent impedance at the proposed Warren CPV 138 kV site with the GSU and generators OPEN option 1.

Positive: (0.00273+j0.02492)
Zero: (0.01301+j0.05219)

Listed below are the positive and zero sequence source equivalent impedance at the proposed Warren CPV 138 kV site with the GSU and generators OPEN option 2.

Positive: (0.00272+j0.02490)
Zero: (0.01299+j0.05206)

The estimated cost for Controls Engineering to complete a coordination review of the area, develop new relay settings, and implement the required changes is approximately **$5,000 in 2010** dollars.