PJM Generator Interconnection Request
Queue #U2-042
East Lima-South Kenton (Hardin County Wind)
138kV
Feasibility Study

515329

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Preface

The intent of the feasibility study is to determine a plan, with ballpark cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system.

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

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

U2-042 East Lima-South Kenton (Hardin County Wind) 138kV Feasibility Study Report

General

The Interconnection Customer (IC) proposes to install PJM Project #U2-042, a 201 MW generating facility comprised of wind turbine generators. This generation facility would connect to the American Electric Power (AEP) East Lima – South Kenton 138 kV circuit (option 1) or the AEP East Lima – Marysville 345 kV circuit (option 2). The proposed location of the generating facilities is located in Hardin County, Ohio (See Exhibit 1). The projected in-service date is scheduled for December 2011.

Attachment Facilities

Interconnection Option #1 - East Lima-South Kenton 138kV

The proposed generation project will be consist of a new in-line switching station located on the East Lima – South Kenton 138 kV circuit.

The new in-line switching station needed for option 1 (see Exhibit 2) is to consist of three (3) 138 kV circuit breakers configured in a ring-bus arrangement with 138 kV metering. AEP will retain ownership of the proposed in-line station facilities. In addition, remote terminal relaying will need to be upgraded to facilitate the new station. It is expected that any right-of-way for line extensions, as well as a 250' x 250' (minimum) station site will be provided to AEP by IC.

It is understood that IC will be responsible for the all costs associated with construction of the interconnection substation, as well as facilities associated with connecting their 201 MW generation to the in-line facilities. Line routings were not evaluated as part of this study. Note that the IC station facilities and any facilities outside the new station were not included in the cost estimates. These are IC's responsibility.

The AEP construction scope:

- Construction of a new switching station connecting to the East Lima – South Kenton 138 kV circuit between Lynn and West Newton Switch stations, including three (3) 138 kV circuit breakers, relays, 138 kV metering, SCADA, and associated equipment.
  Estimated Cost (2008 Dollars): **$4,500,000**

- Replace line relaying with AEP standard package at East Lima station.
  Estimated Cost (2008 Dollars): **$500,000**

- Replace line relaying with AEP standard package and upgrade station RTU at South Kenton station.
  Estimated Cost (2008 Dollars): **$740,000**

Total Attachment Facilities Cost*: **$5,740,000**

*The estimates are preliminary in nature, as they were determined without the benefit of detailed engineering studies. Final estimates will require an on-site review and coordination to determine final construction requirements. It will take approximately 18 months after obtaining the authorization to construct the facilities as outlined above.

Interconnection Option #2 - East Lima-Marysville 345kV

The proposed generation project will be consist of a new in-line switching station located on the East Lima – Marysville 345 kV circuit.

The new in-line switching station needed for option 2 (see Exhibit 3) is to consist of three (3) 345 kV circuit breakers configured in a ring-bus arrangement with 345 kV metering. AEP will retain ownership of the proposed in-line station facilities. In addition, remote terminal relaying will need to be modified to facilitate the new station. It is expected that any right-of-way for line extensions, as well as a 400' x 400' (minimum) station site will be provided to AEP by IC.

It is understood that IC will be responsible for the all costs associated with construction of the interconnection substation, as well as facilities associated with connecting their 201 MW generation to the in-line facilities. Line routings were not evaluated as part of this study. Note that the IC station facilities and any facilities outside the new station were not included in the cost estimates. These are IC's responsibility.

The AEP construction scope:

- Construction of a new switching station connecting to the East Lima – Marysville 345 kV circuit, including three (3) 345 kV circuit breakers, relays, 345 kV metering, SCADA, and associated equipment.
  Estimated Cost (2008 Dollars): **$8,000,000**

- Modify line relaying with AEP standard package at Marysville and East Lima stations.
  Estimated Cost (2008 Dollars): **$200,000**

Total Attachment Facilities Cost*: **$8,200,000**

Interconnection Option #2 Alternate –U2-041 Substation 345kV

An alternative connection for option 2 was considered:

- Expand the existing 345 kV station built for PJM project U2-041 by adding a fourth 345 kV circuit breaker, relays, 345 kV metering, SCADA, and associated equipment. Estimated Cost (2008 Dollars): **$1,800,000**

- Modify line relaying with AEP standard package at Marysville and East Lima stations. Estimated Cost (2008 Dollars): **$200,000**

Total Alternative Connection Attachment Facilities Cost*: **$2,000,000**

*The estimates are preliminary in nature, as they were determined without the benefit of detailed engineering studies. Final estimates will require an on-site review and coordination to determine final construction requirements. It will take approximately 18 months after obtaining the authorization to construct the facilities as outlined above.

Network Impacts

Interconnection Option #1 - East Lima-South Kenton 138kV

Local AEP Impacts

The impact of the proposed generating facility on the AEP System was assessed for adherence with applicable reliability criteria. AEP planning criteria require that the transmission system meet single contingency performance criteria in accordance with the AEP FERC Form 715. Therefore, this criterion was used to assess the impact of the proposed facility on the AEP System. The IC project was studied as a 201 MW net capacity consistent with the interconnection application. The results are summarized below.

Normal System (2012 Summer Conditions)

- A 138 kV 600 A switch at South Kenton is overloaded to 134% of the summer normal rating of 156 MVA and 101% of the winter normal rating of 206 MVA.

- The South Kenton 138/69 transformer #1 is overloaded to 104% of the summer and winter normal rating of 41 MVA.

- The South Kenton 138/69 transformer #2 is overloaded to 118% of the summer and winter normal rating of 39 MVA.

- The entire length of 138 kV line between South Kenton and East Lima, except the portion between U1-060 and U2-042, is overloaded to more than 100% of the conductor summer normal rating of 185 MVA. The winter normal rating is not exceeded for system normal.

- Single Contingency (2012 Summer Conditions)

- The entire length of 138 kV line between South Kenton and East Lima is overloaded to more than 150% of the conductor summer emergency rating of 257 MVA for an outage on the U1-060 – West Newton 138 kV line or on the U2-042 – Lynn 138 kV line.

- A 138 kV 800 A wavetrap and risers at South Kenton station are overloaded to 197% and 162% of their summer emergency ratings of 206 MVA and 250 MVA for the outage on the U1-060 – West Newton 138 kV line.

- A 69 kV 600 A switch and 800 A wavetrap at South Kenton station are overloaded to 129% and 121% of their summer emergency ratings of 192 MVA and 205 MVA for the outage on the U1-060 – West Newton 138 kV line.

- The Nevada – Upper Sandusky 69 kV line is overloaded to 137% of the summer emergency rating of 31 MVA for the outage on the U1-060 – West Newton 138 kV line.

- The Nevada – Broken Sword 69 kV line is overloaded to 132% of the summer emergency rating of 31 MVA for the outage on the U1-060 – West Newton 138 kV line.

- The Kenton – Rockwell 69 kV line is overloaded to 145% of the summer emergency rating of 50 MVA for the outage on the U1-060 – West Newton 138 kV line.

- A 69 kV 600 A switch and 800 A wavetrap at North Waldo station are overloaded to 127% and 119% of their summer emergency ratings of 192 MVA and 205 MVA for the outage on the U1-060 – West Newton 138 kV line.

- The North Waldo – Windfall Sw. 138 kV line is overloaded to 102% of the summer emergency rating of 192 MVA for the outage on the U1-060 – West Newton 138 kV line.

- Two 69 kV 600 A switches and risers at Kenton station are overloaded to 112% and 117% of their summer emergency ratings of 96 MVA and 92 MVA for the outage on the U1-060 – West Newton 138 kV line.

- The Kenton – Ashland Pipe 69 kV line is overloaded to 108% of the summer emergency rating of 100 MVA for the outage on the U1-060 – West Newton 138 kV line.

- A 69 kV 600 A switch at Cessna Sw. is overloaded to 110% of the summer emergency rating of 96 MVA for the outage on the U1-060 – West Newton 138 kV line.

- The Cessna Sw. – Ashland Pipe 69 kV line is overloaded to 106% of the summer emergency rating of 100 MVA for the outage on the U1-060 – West Newton 138 kV line.

- Two 69 kV 600 A switches and risers at Dunkirk station are overloaded to 109% and 116% of their summer emergency ratings of 96 MVA and 90 MVA for the outage on the U1-060 – West Newton 138 kV line.

- The Cessna Sw. – Dunkirk 69 kV line is overloaded to 104% of the summer emergency rating of 100 MVA for the outage on the U1-060 – West Newton 138 kV line.

- Two 69 kV 600 A switches and risers at Dunkirk station are overloaded to 101% and 108% of their summer emergency ratings of 96 MVA and 90 MVA for the outage on the U1-060 – West Newton 138 kV line.

- Two 69 kV 600 A switches at Forest station are overloaded to 101% of their summer emergency rating of 90 MVA for the outage on the U1-060 – West Newton 138 kV line.

- The East Lima 138/69 transformer #3 is overloaded to 100% of the summer emergency rating of 85 MVA for the outage on the U2-042 – Lynn 138 kV line.

Please note that these affected facilities may appear in additional contingencies that are not mentioned.

Also note that there are several contributions to existing overloads that are not listed.

Multiple Contingency (2012 Summer Conditions)

- No problems identified

Short Circuit Analysis

- East Lima 138 kV circuit breakers C2 and D2 are overdutied to 100.4%, and 100.2% for the addition of the new generating facility, and would need to be replaced.

- It should be noted that this new generating facility contributes 2-3% to several 138 kV circuit breakers at East Lima and South Kenton stations.

Stability Analysis

- Stability studies were not performed as part of this Feasibility Study and are not normally performed as part of a Facility Study effort. The stability assessments are part of the System Impact Study. Based upon the results of this future System Impact Study, the

extent of system upgrades could change and the associated costs could be significantly different.

Local Upgrades

Upgrades cost have been estimated in bulk because of the quantity of upgrades necessary. More detailed estimates will be provided in the impact study. There are other design alternatives that could be considered. More detailed analysis would need to be completed to determine if another alternative is feasible and also less expensive.

- Reconductor approximately 34 miles of 138 kV line.
  Estimated Cost (2008 Dollars): **$51,000,000**

- Reconductor approximately 28 miles of 69 kV line.
  Estimated Cost (2008 Dollars): **$28,000,000**

- Replace station equipment including 3 138/69 kV transformers, switches, wavetraps and risers at various stations.
  Estimated Cost (2008 Dollars): **$6,500,000**

- Replace 138 kV circuit breakers C2 and D2 and associated equipment at East Lima station.
  Estimated Cost (2008 Dollars): **$1,000,000**

*For option 1, analysis was completed with U2-042 operating at 13% of capacity. For that condition, most of the upgrades are not necessary. However, the replacement of the 138 kV circuit breakers at East Lima is still required.

Network Impacts

The Queue Project U2-042 was studied as a 201MW (Capactiy=26MW) injection into the AEP system at a tap of the East Lima-South Kenton 138kV line. Project U2-042 was evaluated for compliance with reliability criteria for summer peak conditions in 2012. Potential network impacts were as follows:

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

No problems identified

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)

1. **(AEP/AEP)** The U1-060-West Newton 138kV line loads from 94.03% to 177.05% (DC power flow) of its emergency rating (192MVA) for the tower line outage (AEP_TOWER43_A_T142_U2_041_B). This project contributes approximately 159.4MW to cause this thermal violation.

2. **(AEP/AEP)** The West Newton-East Lima 138kV line loads from 91.93% to 174.95% (DC power flow) of its emergency rating (192MVA) for the tower line outage (AEP_TOWER43_A_T142_U2_041_B). This project contributes approximately 159.4MW to cause this thermal violation.

Short Circuit

No problems identified..

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

None

New System Reinforcements

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

1. The overload on the U1-060-West Newton 138kV circuit can be alleviated by replacing two (2) 138kV switches at West Newton and reconductoring approximately 6 miles of 138kV line between U1-060 and West Newton. The estimated cost is **$9,100,000**.

2. The overload on the West Newton-East Lima circuit can be alleviated by replacing a 138 kV 1200 A Switch, wavetrap, and two risers at East Lima and rconductoring approximately 13.4 miles of 138 kV line between West Newton and East Lima. The estimated cost is **$20,200,000.**

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)

None.

Delivery of Energy Portion of Interconnection Request

(PJM also studied the delivery of the energy portion of this Interconnection Request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with Network Upgrades to eliminate the operational restriction at their discretion by submitting a Transmission Interconnection Request. Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.

3. **(AEP/AEP)** The U1-060-West Newton 138kV line loads from 102.1% to 205.2% (DC power flow) of its normal rating (156MVA) for non-contingency condition. This project contributes approximately 160.8MW to the thermal congestion.

4. **(AEP/AEP)** The West Newton-East ima 138kV line loads from 99.5% to 202.6% (DC power flow) of its normal rating (156MVA) for non-contingency condition. This project contributes approximately 160.8MW to the thermal congestion.

5. **(AEP/AEP)** The R60-Robison Park 345kV line loads from 137.7% to 139.3% (DC power flow) of its normal rating (897MVA) for non-contingency condition. This project contributes approximately 14.5MW to the thermal congestion.

6. **(AEP/AEP)** The R60-Robison Park 345kV line loads from 101.7% to 102.8% (DC power flow) of its emergency rating (1301MVA) for the single line contingency outage (AEP21). This project contributes approximately 14.3MW to the thermal congestion.

Interconnection Option #2 - East Lima-Marysville 345kV

Local AEP Impacts

The impact of the proposed generating facility on the AEP System was assessed for adherence with applicable reliability criteria. AEP planning criteria require that the transmission system meet single contingency performance criteria in accordance with the AEP FERC Form 715. Therefore, this criterion was used to assess the impact of the proposed facility on the AEP System. The IC project was studied as a 201 MW net capacity consistent with the interconnection application. The results are summarized below.

Normal System (2012 Summer Conditions)

- No problems identified.

Single Contingency (2012 Summer Conditions)

- No problems identified.

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Multiple Contingency (2012 Summer Conditions)

- No problems identified.

Short Circuit Analysis

- No problems identified.

Local/Network Upgrades

- No local upgrades required

Network Impacts

The Queue Project U2-042 was studied as a 201MW (Capacity = 26MW) injection at the East Lima - Marysville 345kV lines in the AEP area. Project U2-042 was evaluated for compliance with reliability criteria for summer peak conditions in 2012. Potential network impacts were as follows:

Generator Deliverability

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

None

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)

None

Short Circuit

No problems identified..

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

1. **(AEP/AEP)** The Eastown Road-Rock Hill 138kV line (from bus 23137 to bus 23202 ckt 1) loads from 101.72% to 115.69% (DC power flow) of its emergency rating (184MVA) for the

tower line outage (AEP_TOWER44_T142B). This project contributes approximately 25.7MW to the thermal violation.

New System Reinforcements

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

See list under Local/Network Upgrades.

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)

1. The overload on the Eastown Rd-Rock Hill 138kV circuit can be alleviated by replacing the 138 kV risers at Rock Hill station terminal.

   Estimated Cost (2008 dollars): **$75,000**

Delivery of Energy Portion of Interconnection Request

(PJM also studied the delivery of the energy portion of this Interconnection Request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with Network Upgrades to eliminate the operational restriction at their discretion by submitting a Transmission Interconnection Request. Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.

2. **(AEP/AEP)** The R60-Robison Park 345kV line (from bus 96546 to bus 22670 ckt 1) loads from 136.9% to 138.0% (DC power flow) of its normal rating (897MVA) for non-contingency condition. This project contributes approximately 9.4MW to the thermal congestion. Previous project(s) Y41 contribute(s) to the loading by 14 MW(1.6%).

Exhibit 1: Approximate interconnection location of the proposed facilities

Exhibit 2: Simplified diagram of proposed 138 kV in-line switching substation – Option 1

Exhibit 3: Simplified diagram of proposed 345 kV in-line switching substation – Option 2