

***PJM Generator Interconnection Request  
Queue #U1-087  
Dequine (Fowler Ridge) 345kV  
Feasibility Study***

**492514**

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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,

# **Dequine (Fowler Ridge) Feasibility Study Report**

## **General**

The Interconnection Customer (IC) proposes to install PJM Project #U1-087, a 150 MW generating facility comprised of 100, GE, SL, 1.5 MW wind turbine generators connecting to the American Electric Power (AEP) Dequine 345 kV substation. This request is an increase in the Fowler Ridge project initially requested as projects Q01 and Q03. This increase will use the same interconnection as Q01 and Q03, a radial 345kV line from the project to Dequine 345kV substation. The proposed location of the generating facilities and switching station is in Benton County, Indiana. The projected in-service date is scheduled for December 31, 2010.

## **Attachment Facilities**

The interconnection facilities provided for Q01 and Q03 are sufficient to accommodate the additional 150 MW requested for queue position U1-087

## **Local & Network 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 project was studied as a 150 MW net energy injection (19.5 MW capacity) consistent with the interconnection application. This project was studied with PJM projects #Q01, Q03, S06, T126, T127, T183, T184 and U1-024 already in service at 100% output in the vicinity of U1-087. The results are summarized below.

### **Normal System (2011 Summer Conditions)**

- AEP Dequine – Reynolds<sup>1</sup> 345 kV line<sup>2</sup> is overloaded to 107% (997 MVA) of its normal rating under system normal conditions. Without the addition of U1-087 Project, the same facilities are loaded to 103% (960 MVA) of normal rating.
- AEP Olive – S06<sup>1</sup> 345 kV line is overloaded to 112% (950 MVA) of its normal rating under system normal conditions. Without the addition of U1-087 Project, the same facilities are loaded to 109% (924 MVA) of normal rating.

\*\*\* It was observed that the NIPSCO owned Reynolds transformer was overloaded. PJM will address this potential issue with MISO in the Impact Study as needed.

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<sup>1</sup> Please note that because these lines are overloaded under normal conditions, the same overload issues may appear for several contingencies in the following sections but may not be discussed hereafter.

<sup>2</sup> A section of AEP Dequine – Olive 345 kV line

### Single Contingency (2011 Summer Conditions)

- AEP Olive – Reynolds 345 kV line<sup>3</sup> gets overloaded to 110% (1057 MVA) of its normal rating for an outage of the AEP Olive – S06 345 kV line. Without the addition of U1-087 Project, the same facilities are loaded to 106% (1019 MVA) of normal rating under the same contingency.

### Multiple Contingency (2011 Summer Conditions)

- AEP Dequine – Reynolds<sup>4</sup> 345 kV line<sup>3</sup> gets overloaded to 156% (1454 MVA) of its emergency rating for an outage of AEP Dumont - Greentown 765 kV line and AEP Olive – S06 345 kV line. Without the addition of U1-087 Project, the same facilities are loaded to 151% (1407 MVA) of emergency rating under the same contingency.
- AEP Olive – Reynolds<sup>4</sup> 345 kV line<sup>3</sup> gets overloaded to 121% (1163 MVA) of its emergency rating for an outage of AEP Dumont – Greentown 765 kV line and AEP Olive – S06 345 kV line. Without the addition of U1-087 Project, the same facilities are loaded to 117% (1124 MVA) of emergency rating under the same contingency.
- AEP Dequine – S06<sup>4</sup> 345 kV line gets overloaded to 131% (1111 MVA) of its emergency rating for an outage of AEP Dequine – Reynolds – Olive 345 kV line and AEP Olive – S06 345 kV line. Without the addition of U1-087 Project, the same facilities are loaded to 128% (1085 MVA) of emergency rating under the same contingency.
- AEP Olive 345/138 kV Transformer #2 gets overloaded to 106% (875 MVA) of its emergency rating for an outage of AEP Cook – Olive 345 kV line and AEP Dumont – Olive 345 kV line. Without the addition of U1-087 Project, the same facilities are loaded to 103% (854 MVA) of emergency rating under the same contingency.
- Assuming that the generators at bus U1-087 are operating at unity power factor, a voltage collapse could occur at AEP Dequine 345 kV bus for an outage of AEP Olive – S06 345 kV line and AEP Eugene – U1-024 345 kV line. The voltage violation and upgrades required to address these violations will be discussed in the stability analysis, which is part of the impact study.

\*\*\* Please note that other voltage issues and collapses were observed within the Dequine area when certain contingencies were taken. These issues were not addressed in the above sections and will be studied in detail as part of the stability analysis.

### Short Circuit Analysis

- No problems identified.

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<sup>3</sup> A section of AEP Dequine – Olive 345 kV line

<sup>4</sup> The affected line may appear in multiple contingencies that are not mentioned.

## 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/Network Upgrades

The 932 MVA SN/SE rating for the Dequine – Reynolds 345 kV circuit is not correct. It is based on a relay limitation that has been eliminated. The present rating should be based on the conductor rating. However, the conductor for this circuit was installed following extensive ice storm damage and is not the original conductor. The original conductor was 1414 MCM ACSR (paper expanded), and this is what the transmission towers were designed for. However, the replacement conductor was 2303 MCM ACAR. Although similar in size, this conductor has different sag characteristics than the original conductor. Therefore, a sag study is required for the Dequine – Reynolds 345 kV circuit to determine the maximum conductor operating temperature(s), and the associated rating(s).

To address the Olive – S06 345 kV circuit overload and Dequine – S06 345 kV circuit overload, structure and sag analyses will be required to determine if the circuit can be reconductored with a higher capacity conductor. If these analyses eliminate this alternative, then Olive – S06 345 kV and Dequine – S06 345 kV circuits will need to be rebuilt. The cost of rebuilding this double circuit line will be approximately **\$1,700,000 per mile**. The cost of reconductoring will be less than rebuilding. However, the cost for reconductoring cannot be provided before the structure and sag studies are completed (some structures may still need to be replaced).

The structure and sag studies required for the Olive – S06 345 kV, Dequine – S06 345 kV and Dequine – Reynolds 345 kV overloads can be performed in the Facility Study and is estimated to cost approximately **\$350,000**. It will require approximately 20 weeks from initiation. Most of the conductor lengths for the two circuits involved are located on the same towers. Therefore, a single study should be required to address both overload issues.

AEP Olive 345/138 kV transformer gets overloaded under a double contingency involving AEP Cook – Olive 345 kV line and AEP Dumont – Olive 345 kV line. The overload condition exists even in the absence of U1-087 Project. The plans for improvement to relieve the overload condition for this facility as well as the cost estimate can be provided as part of the System Impact Study. This condition first appeared in feasibility study of PJM Project #U1-024.

## Reactive Requirements

PJM requires a power factor correction to 95% lead/lag at the point of interconnection for wind generating facilities. It is expected that IC will adhere to this standard.

## **Network Impacts**

The Queue Project #U1-87 was studied as a(n) 150MW (Capacity=19.5MW) injection at the Dequine 345 kV substation in the AEP area. Project #U1-87 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, Line with Failed Breaker and Bus Fault contingencies for the full energy output)*

None

### **Short Circuit**

*(Summary form of Cost allocation for breakers will be inserted here if any)*

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. The Dequine-Westwood 345kV line loads from 109.36% to 112.94% (DC power flow) of its emergency rating (809MVA) for the tower line outage (AEP\_TOWER33\_WITH\_S06B\_S31B). This project contributes approximately 29.0MW 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)*

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)*

1. The overload on the Dequine-Westwood 345kV circuit can be alleviated by reconductoring the circuit. Actual cost will be detailed in the Impact Study report after collaboration with MISO.

### **MISO Impacts**

Any impacts on the MISO transmission system will be identified in the Impact Study.

### **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 Merchant Transmission Interconnection request. As a result of the aggregate energy resources in the area, the following violations were identified:*

2. The S06C-Olive 345kV line loads from 138.2% to 142.9% (DC power flow) of its emergency rating (848MVA) for the single line contingency outage (AEP70). This project contributes approximately 39.2MW to the thermal congestion.
3. The Dequine-Reynolds 345kV line loads from 120.4% to 124.2% (DC power flow) of its emergency rating (932MVA) for the single line contingency outage (AEP24). This project contributes approximately 35.0MW to the thermal congestion.