

***Generation Interconnection  
PJM Impact Study Report***

***For***

***PJM Generation Interconnection Request  
Queue Position U2-073***

***Frostburg 138kV II Project***

***March, 2011***

## **Overview**

### **General**

Big Savage LLC, the Interconnection Customer (IC), has proposed a 200 MWE (26 MWC) wind power generating facility to be located in the Big Savage and Little Savage Mountain areas of Somerset County, Pennsylvania. The facility will consist of eighty (80) 2.5 MW wind turbines. The project was evaluated for compliance with reliability criteria for summer peak conditions in 2013.

### **PJM Report on the Transmission System**

This portion of the report addresses the impacts on and the required reinforcements to that part of the transmission system under PJM jurisdiction.

### **Network Impacts**

The Queue Project #U2-73 was studied as a(n) 200.0MW(Capacity=26.0MW) injection into Frostburg 138 kV substation in the APS area. Project #U2-73 was evaluated for compliance with reliability criteria for summer peak conditions in 2013. 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)

#### **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

#### **Steady-State Voltage Requirements**

None

## **Stability and Reactive Power Requirement**

Local voltage stability issue was observed for single-line-to-ground faults at Ridgeley 138 kV followed by outage of Ridgeley 138 kV bus due to breaker failure. The problem is essentially related to reactive power deficit and inability of U2-073 to provide adequate voltage support. A 30 Mvar capacitor at the 138 kV bus of U2-073 facility confirms the issue and the need to provide reactive power support. However, the voltage at the same bus shows a steady decline during the entire simulation which indicates the reactive power support should be dynamic instead of static (in the form of capacitors) in order for U2-073 to sustain the above mentioned disturbances. A 50 Mvar SVC provides adequate support during post transient voltage recovery.

See the APS portion of this report.

## **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)

(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

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 Merchant Transmission Interconnection request.

Only the most severely overloaded conditions are listed. 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 will study all overload conditions associated with the overloaded element(s) identified.

1. The 01RIDGLY-01CUMBRL 138 kV line (from bus 20504 to bus 20454 ckt 1) loads from 68.71% to 100.71% (AC power flow) of its normal rating (242 MVA) for non-contingency condition. This project contributes approximately 79.98 MW to the thermal violation.

2. The 01CUMBRL-01SHORTG 138 kV line (from bus 20454 to bus 20558 ckt 1) loads from 76.47% to 102.65% (AC power flow) of its emergency rating (297 MVA) for the single line contingency outage of Hatfield – Black Oak 500 kV line ('AP128\_OP\_NOSPS'). This project contributes approximately 76.67 MW to the thermal violation.
3. The N33 C-01ALBRIG 138 kV line (from bus 93240 to bus 20120 ckt 1) loads from 97.31% to 112.66% (AC power flow) of its emergency rating (201 MVA) for the single line contingency outage of Somerset – Q34 115 kV line ('SOMERST\_Q34'). This project contributes approximately 32.45 MW to the thermal violation.
4. The 01RIDGLY-01CUMBRL 138 kV line (from bus 20504 to bus 20454 ckt 1) loads from 90.66% to 117.22% (AC power flow) of its emergency rating (297 MVA) for the single line contingency outage of Hatfield – Black Oak 500 kV line ('AP128\_OP\_NOSPS'). This project contributes approximately 76.67 MW to the thermal violation.
5. The Q34-SOMERST 115 kV line (from bus 95280 to bus 454 ckt 1) loads from 120.35% to 123.74% (AC power flow) of its emergency rating (159 MVA) for the single line contingency outage of Keystone – South Bend 500 kV line ('PJM33A'). This project contributes approximately 11.95 MW to the thermal violation.

### **Allegheny Power Impact Analysis Report**

This portion of this System Impact Study Report has been prepared for PJM by Allegheny Power System (APS). It addresses the impacts on and required reinforcements, if needed, including the attachment and direct connection facilities. It also presents the APS standards-based requirements for interconnection.

A revised System Impact Study has been prepared for PJM queue project U2\_073 (Big Savage, LLC) to provide for the interconnection of eighty wind turbine generators for the purpose of selling up to 200 MW into the PJM market. A sketch is attached for your reference.

### **Injection at the Frostburg #1 138kV Substation**

#### **Attachment Facilities and Related Network Upgrades**

- At the Frostburg #1 substation, purchase additional property and expand the yard for an additional fenced area of approximately 210' x 70'. Install ground grid, structures, foundations, and yard stone. Extend the 138kV bus and install 1-138kV dead-end structure, 1-138kV breaker, 3-138kV disconnect switches, 138kV metering, 138kV arresters, line traps, and CVT's. Expand the existing control building to accommodate additional control panels. Install control cables and panels, transfer trip, and associated

equipment. Assume connection to the IC is by an overhead 138kV line. The IC is to install OPGW cable to their station.

**Estimated Cost: \$2,122,489 in 2011 dollars (PJM Upgrade No. n2146)**

- Install 138kV transfer trip facilities at Hazelton Substation. (Note: This is a Network Upgrade that was originally caused by project U2-030 and shared by this project. Therefore U2-073 will be responsible for 50% of the full cost of this upgrade)

**Estimated Cost (Full Cost): \$50,418 in 2011 dollars (PJM Upgrade No. n1854)**

- Install 138kV transfer trip facilities at Ridgeley Substation. (Note: This is a Network Upgrade that was originally caused by project U2-030 and shared by this project. Therefore U2-073 will be responsible for 50% of the full cost of this upgrade)

**Estimated Cost (Full Cost): \$49,476 in 2011 dollars (PJM Upgrade No. n1855)**

- Install 138kV transfer trip facilities at Four Mile Ridge Substation (proposed future).

**Estimated Cost: \$49,476 in 2011 dollars (PJM Upgrade No. n2149)**

The estimated project duration is **24 months** after the receipt of an executed Interconnection Service Agreement and Construction Service Agreement. Property purchase and permitting may delay this estimated project duration.

While the information in this report 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 IC will be charged for actual costs. Any under-runs or over-runs will be reconciled at the conclusion of the project. The estimates in this report do not include tax gross-up.

The IC will interconnect with the Allegheny Power (AP) system via overhead line from a customer owned substation located approximately 10 miles from the Frostburg #1 substation. The above cost estimates do not include construction of that line. Route selection, line design, rights-of-way acquisition and construction of such lines will be entirely the responsibility of the IC. It is assumed that the IC's main step up transformer will conform to the AP standard with delta on the low side and grounded wye on the high side as illustrated in the AP Facility Connection Manual:

<http://www.alleghenypower.com/Bus2Bus/Gen%20Trans%20AP%20Facility%20Connection%20Requirements.pdf>

**No breakers were identified as being over their maximum interrupting rating.**

AP reserves the right to review the electrical protection design and relay settings for IC facilities to ensure that the protective relaying equipment will be compatible with that installed at the new switching station. The relaying package will likely include both primary and backup protection. AP personnel must be present at the time of commissioning to inspect and witness proper function of the control scheme and related coordination. The estimated cost to perform this engineering review and field test effort is **\$10,000 in 2010 dollars**.

*Note: The purchase and installation of protective relaying and associated equipment at the generation site is the responsibility of the IC and is not included in this scope of work.*

It is assumed that a fiber optic interface will be used for the protection channel between the AP and IC stations. The IC will 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. Protective relaying and metering design and installation must comply with the AP applicable standards.

### **Overloads and Required Reinforcements**

**No Generator Deliverability overloads were identified.**

#### **Multiple Facility Contingency overloads:**

None

#### **Contribution to Previously Identified overloads:**

None

#### **Delivery of Energy overloads:**

1. The 01RIDGLY-01CUMBRL 138 kV line (from bus 20504 to bus 20454 ckt 1) loads from 68.71% to 100.71% (AC power flow) of its normal rating (242 MVA) for non-contingency condition. This project contributes approximately 79.98 MW to the thermal violation.
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### **Stability Reinforcements**

- Purchase property to expand the existing yard at Frostburg SS for an additional fenced area of approximately 250' x 150'. Extend the 138kV main bus. SVC vendor to grade the site and install 1-138kV SVC breaker and a -20/+50 MVAR 138kV SVC as a turnkey project. AP to provide field inspection, and engineering for the interface of the SVC to the AP system.

**Estimated Cost: \$13,895,582 in 2010 dollars (PJM Upgrade No. n2147)**

**Estimated Project Duration: 21 Months** after the receipt of an executed Interconnection Service Agreement and Construction Service Agreement

## SINGLE LINE DIAGRAM

