Generation Interconnection Combined Feasibility/System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AD2-205

Buck-Byllesby 69 kV

October 2018

Preface

The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. 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. 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 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 or merchant transmission upgrade, may also contribute to the need for the same network reinforcement.

The System Impact 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

Appalachian Power Company (APCo) proposes to install PJM Project #AD2-205, a 4.0 MW (0.0 MW Capacity) Lithium-ion battery which will be located at the Byllesby Hydro facility in Ivanhoe, VA (see Figure 2). The point of interconnection will be a direct connection to the existing 13 kV bus which serves both the Buck and Byllesby Hydro facilities (see Figure 1).

The requested in service date is December 31, 2018.

Important Note:

Interconnection Customer will limit the combined output of the Buck and Byllesby Hydro Project and Byllesby battery to the existing 30.1 MW Maximum Facility Output. The operation of the Buck and Byllesby Hydro Project and Byllesby battery are controlled by the American Electric Power (AEP) Generation Market Control System (GMCS), which can be used to limit a facility or an operating group of units to a specific maximum output, called the "Capacity Limit." In GMCS, the generation at the Buck and Byllesby Hydro Project and Byllesby battery are modeled as an operating group (the "Buck and Byllesby Operating Group"). The GMCS Capacity Limit for the Buck and Byllesby Operating Group restricts all other limits such that GMCS would immediately and automatically send a drop signal to the Buck and Byllesby Operating Group if the Capacity Limit is exceeded. Interconnection Customer will set the GMCS Capacity Limit for the Buck and Byllesby Operating Group at 30.0 MW maximum output.

At any time, Transmission Provider and Interconnected Transmission Owner can request documentation from Interconnection Customer verifying that the Buck and Byllesby Operating Group's Maximum Facility Output of 30.1 MW has not and is not being exceeded. Copies of this documentation shall be provided by Interconnection Customer to Transmission Provider and Interconnected Transmission Owner within fifteen (15) Business Days of Transmission Provider's or Interconnected Transmission Owner's request.

Attachment Facilities

Point of Interconnection (Byllesby 69 kV Substation)

No additional attachment facilities are required for an existing facility

Revenue Metering and SCADA Requirements

PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

AEP Requirements

The Interconnection Customer will be required to comply with all AEP Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "Requirements for Connection of New Facilities or Changes to Existing Facilities Connected to the AEP Transmission System" document located at the following link:

http://www.pjm.com/~/media/planning/plan-standards/private-aep/aep-interconnection-requirements.ashx

Please note that power quality standards are also included in the above referenced interconnection requirements document, and that AEP Transmission will be monitoring and measuring compliance with those standards accordingly. The cost of any upgrades to metering equipment necessary to provide Power Quality monitoring capability will be the responsibility of the Interconnection Customer.

Network Impacts

The Queue Project AD2-205 was evaluated as a 4.0 MW (Capacity 0.0 MW) injection at Byllesby 69 kV substation in the AEP area. Project AD2-205 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-205 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2021

Generator Deliverability

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

None

Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

None

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

(Results of the steady-state voltage studies should be inserted here)

None

Voltage Variation

Battery storage projects proposing to participate in the PJM Regulation-D market present the potential to create frequent voltage fluctuations in responding to the market signals. The AEP voltage flicker criteria is stated in the previously referenced "Requirements for Connection of New Facilities or Changes to Existing Facilities Connected to the AEP Transmission System" as:

> VOLTAGE FLICKER CRITERIA
> The random voltage fluctuations (flicker) occurring at the Compliance Point directly attributable to the Customer shall remain within the limits specified in IEEE Standard 1453-2004, "IEEE Recommended Practice for Measurement and Limits of Voltage Fluctuations and Associated Light Flicker on AC Power Systems." These limits are 0.8 and 0.6 for the PST (short term) and PLT (long term) flicker measures, respectively. PST is the standard reading of a flicker meter, obtained for each 10-minute interval; PLT is derived mathematically (cube root-mean-cube) from twelve consecutive PST readings (see Exhibit 1).
>
> The Customer agrees that under no circumstances will it permit the voltage flicker to exceed the Company criteria, whether or not complaints are received or service/operational problems are experienced on the Company sub-transmission or

transmission system. Should complaints be received by the Company or other operating problems arise, or should the Customer flicker exceed the Company criteria, the Customer agrees to take immediate action to reduce its flicker to a level at which flicker complaints and service/operational problems are eliminated. Corrective measures could include, but are not limited to, modifying production methods/ materials or installing, at the Customer's expense, voltage flicker mitigation equipment such as a static var compensator. The Company will work collaboratively with the Customer to assess problems, identify solutions and implement mutually agreed to corrective measures.

If the Customer fails to take corrective action after notice by the Company, the Company shall have such rights as currently provided for under the RTO/ISO OATT, which may include discontinuing service, until such time as the problem is corrected.

The Interconnection Customer provided indication (in the form of a Flicker Screening Study Report) that the proposed battery facility will not create voltage variations that exceed the threshold of visibility. See Figure 3 for an exhibit extracted from this report. AEP Transmission acknowledges that the study provided follows recognized methods. However, AEP Transmission observes that only MW injections were considered in the report. Any MVAR injections tied to the MW injections could worsen flicker performance. AEP Transmission will monitor and measure performance to the published flicker standards.

Therefore, acceptance of the project as proposed is conditioned on the magnitude of repetitive operating cycles remaining below the 3.0 MW cycle used in the flicker study provided, and Interconnection Customer acknowledgement of responsibility to meet the stated performance criteria if larger or more frequent cycles occur.

Short Circuit

(Summary of impacted circuit breakers)

None

Affected System Analysis & Mitigation

LGEE Impacts:

None

MISO Impacts:

None

Duke, Progress & TVA Impacts:

None

OVEC Impacts:

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.

None

Light Load Analysis - 2021

Not Applicable

System Reinforcements

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

None

Stability and Reactive Power Requirement
(Results of the dynamic studies should be inserted here)

Not required

Summer Peak Load Flow Analysis Reinforcements

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

Light Load Flow Analysis Reinforcements

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

None

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(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)

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None

Figure 1 – Single Line Diagram

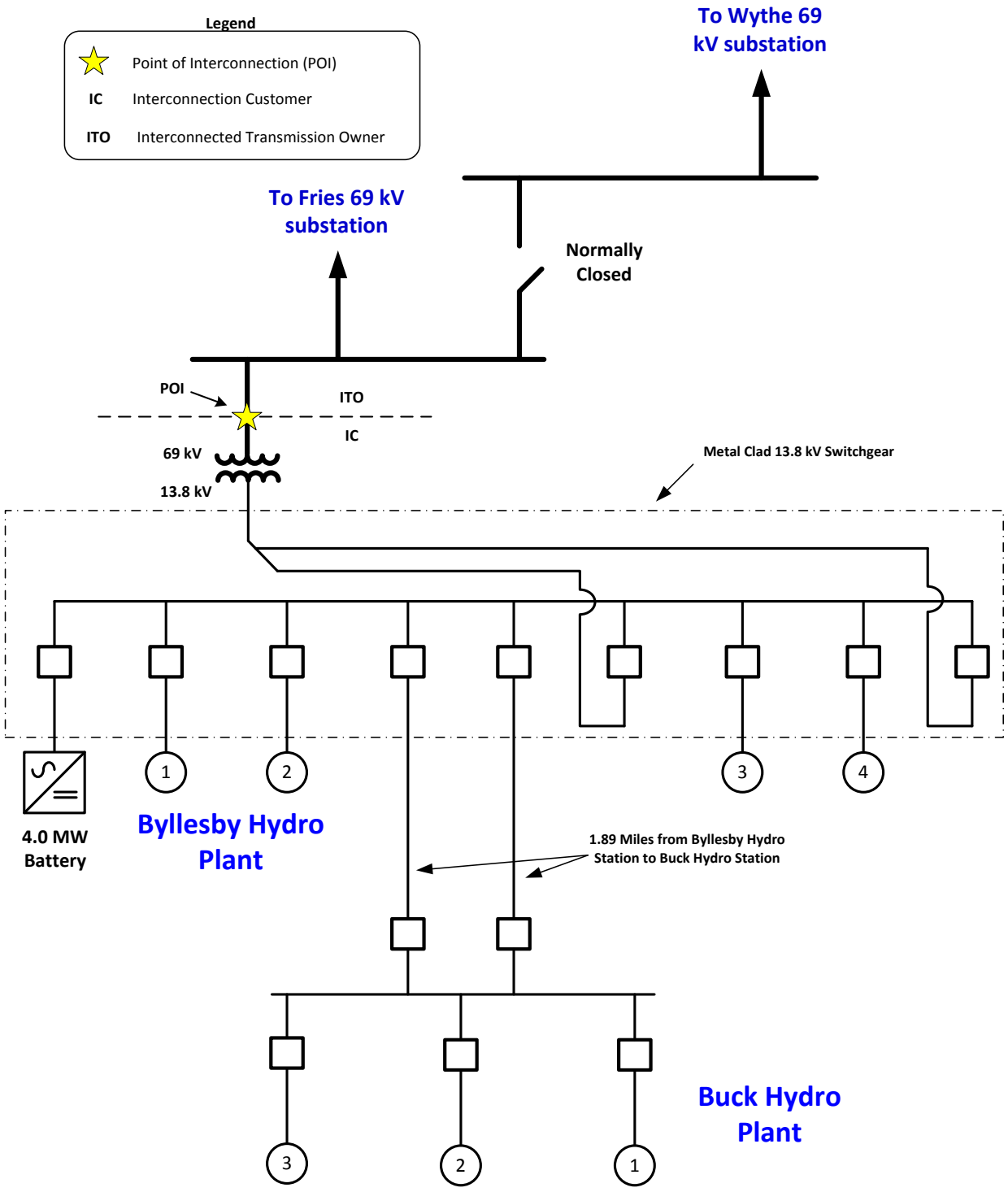

Figure 2 – Generator Location

Figure 3 – Flicker Study Exhibit