Reactive Power in PJM: Clean Energy Caucus Solution Package

Market Implementation Committee
July 12, 2023

PINEGATE RENEWABLES

Reactive compensation should be cost-based.

- Reactive is a vital reliability product. FERC Order 888 requires all transmission customers to purchase the service.

- Reactive power does not lend itself to market-based compensation mechanisms.
  - Reactive can only be supplied locally
  - All generators are required to satisfy minimum lead/lag requirements per their interconnection agreements

- Transmission owners receive cost-of-service recovery in transmission rate base for investments in reactive assets.

The AEP method reasonably estimates costs but FERC filings have become burdensome.

- The *AEP* Method is a generic means of identifying facility equipment at all types of generation that support the reactive power capability function. It can be applied to any type of generating unit.

- To date, all generating resources in PJM are receiving compensation for their investment in reactive capability based on the *AEP* Method.

- However, each generator has had to submit a specific cost-of-service based filing to FERC, which then has either settled or gone to a hearing to finalize the rate.

- Thus, the Issue Statement sought to explore a streamlined method to compensate new generation for the investment in reactive capability.

We propose a cost-based stated rate for each generation type derived from the AEP method.

- The *AEP* methodology is well known.
- Clean Energy Caucus proposes a method to streamline the process by adopting an *AEP*-derived stated rate by generation type (e.g., solar, wind, storage, etc.).
    - Stakeholders would agree on a proxy unit representing each generation type, and apply the AEP methodology to derive separate rates for each type.
    - Once developed, PJM would file the formula rates under Schedule 2.
    - PJM stakeholders would periodically revisit the rates to make adjustments for inflation and changes to technology costs.

Benefits of an AEP-derived stated rate

- **Streamlined administrative process** - no FERC filings would be required for individual generating units. Every new generator gets compensated based on the technology-specific rate in Schedule 2.

- **Comparability** - The CEC package would only apply to prospective rates per the Issue Statement. But because both new and existing rates would be based on AEP, all generation in PJM would receive “comparable” compensation.

- **Limits cost** – Payments are “capped” at the agreed-upon cost of the proxy unit; no more costs and time spent at FERC proceedings for every generator.

- **Reliability** – Cost-based compensation promotes long-term investment in reactive capability.

- **Easy Implementation** – There is no need for a transition period or any additional personnel or monitoring

Proxy costs need to be developed before rates can be finalized.

- Appendix 1 provides more detail on the AEP methodology.

- Appendix 2 shows the CEC's initial work to develop a proxy costs for wind and solar resources and indicative values for those two technology types.

    - CEC provided proxy data from (i) actual wind cases that were filed at FERC and (ii) a solar EPC developer to demonstrate how the stated rate could be derived.
    - Very few questions were received at the Task Force.
    - Similar proxy data would be gathered for other generation types.
    - Stakeholder discussions could be undertaken to refine proxy data, if desired.

Sponsoring Companies

- Algonquin Power & Utilities Corp
- Invenergy
- Jupiter Power
- Leeward Renewable Energy
- Lightsource BP
- NextEra Energy Resources, LLC
- Open Road Renewables
- Pine Gate Renewables, LLC
- Savion LLC

Thank You

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Appendix 1: AEP Method

- "The *AEP* methodology generally reflects the costs associated with four groups of plant investments including the **generator-exciter, generator step up transformers (GSU), accessory equipment and the remaining production plant investment**. Since these groups of production power plant investment involve both reactive and real power, under the *AEP* methodology, an allocation factor is developed to sort the annual revenue requirements of components between real and reactive power production." (*Dynegy*, 121 FERC P 61,025 (2007)
- "The cost of the **generator-exciter** is generally isolated from the turbine-generator-exciter costs based on a manufacturer's suggested percentage."

Appendix 1: AEP Method

- "The allocator used to determine the amount of generator-exciter investment related to reactive power is based on the ratio of $MVAR^2$ to MVA^2 (reactive allocator) where MVAR is megavolt amperes reactive capability and MVA is megavolt amperes capability at a power factor of one."
- "Because **GSUs** also facilitate the transmission of real and reactive power, GSUs are allocated using the same reactive allocator to determine the portion related to reactive power service."

Appendix 1: AEP Method

- "**Accessory equipment**, including such equipment as auxiliary generators, generator main connections, and station buses are allocated to reactive power production using the product of two allocators."
- "The first allocator is the ratio of generator-exciter auxiliary load (MW) divided by total production plant auxiliary load (MW)."
- "The second allocator used to determine the portion of accessory equipment that is reactive-related is the same reactive allocator used for generator-exciters and GSUs."

Appendix 1: AEP Method

"The **remaining production plant** investment is calculated by subtracting the generator-exciter, GSU and accessory equipment from total production plant to avoid double counting. The remaining production plant investment is allocated to reactive power service using the allocator called the remaining power plant investment allocator (RPPIA) or balance of plant (BOP) allocator . . . . ."

"Once the reactive related costs of the generator-exciter, GSUs, accessory equipment and remaining production power plant are identified, the sum of these, known as the total reactive power plant investment, is multiplied by a fixed charge rate . . . ."

Appendix 2: AEP-Stated Rate Approach

- Establish Proxy Capital Costs for Plant Components to Determined Fixed Capability Component
- Apply Proxy Reactive Allocator to Fixed Capability Component
- Determine Proxy Balance of Plant Amount
- Apply Proxy Balance of Plant Allocator to Balance of Plant Amount
- Apply Proxy Fixed Charge Rate
- Results in *AEP*-Based Stated Rate

Appendix 2: Proxy Reactive Capital Investment - Solar

- Inverters/Power Stations (SMA, Sungrow, Huawei, Power Electronics, TMEIC, ABB, etc.)
- AEE: DC collection system
- AEE: AC collection system
- AEE: LV portion of Substation
- Capacitor and/or reactor banks
- GSU

Appendix 2: Proxy Reactive Capital Investment - Wind

- Wind turbines/Transformers (GE, Vestas, Siemens, Clipper, etc.); use average of % allocation usually 10-12%
- AEE: AC collection system
- AEE: LV portion of Substation
- Capacitor and/or reactor banks
- GSU

Appendix 2: Proxy To Use For Reactive Allocator

Solar:

- SMA, Sungrow, Huawei = 0.80 Power Factor
- TMEIC = 0.85 Power Factor
- Power Electronics = 0.50 Power Factor

Wind: Ranges from 0.87 to 0.95 Power Factor

Appendix 2: Results in Proxy Reactive Capital Investment

- For Solar, if the median 0.80 Power Factor is used, results in 36.00% of Proxy Reactive Capital Investment.
- For Wind, if the median 0.90 Power Factor is used, results in 19.75% of Proxy Reactive Capital Investment.

Appendix 2: Proxy To Use For AEE Allocator

- Proxy AEE Allocator = Allocation factor applied to the various categories of AEE costs related to the investment in both real and reactive power.
- The resulting amount from multiplying the AEE costs by the AEE Allocator is then multiplied by the Reactive Allocator to determine the AEE portion of the Proxy Reactive Capital Investment.

Solar AEE:

- DC System
- AC System
- LV substation equipment

Wind AEE:

- AC System
- LV substation equipment

Appendix 2: Proxy Balance of Plant

- Proxy Balance of Plant = Proxy Total Capital Costs – Proxy Reactive Capital Investment
- The amount is then applied to a Proxy BOP Allocator, such as 0.15% as used in *AEP*.

Appendix 2: Total Proxy Reactive Capital Investment - Solar

Sum of the investment in the following items:

- Inverters/Power Station Investment x Reactive Allocator
- DC collection system x AEE Allocator x Reactive Allocator
- AC collection system x AEE Allocator x Reactive Allocator
- LV portion of Substation x AEE Allocator x Reactive Allocator
- Capacitor and/or reactor banks
- GSU x Reactive Allocator
- Balance of Plant x BOP Allocator

Appendix 2: Total Proxy Reactive Capital Investment - Wind

Sum of the investment in the following items:

- Wind turbines/Transformers x Reactive Component Cost Allocator x Reactive Allocator
- AC collection system x AEE Allocator x Reactive Allocator
- LV portion of Substation x AEE Allocator x Reactive Allocator
- Capacitor and/or reactor banks
- GSU x Reactive Allocator
- Balance of Plant x BOP Allocator

Appendix 2: Proxy Fixed Charge Rate: To Develop Levelized Rate

Typical components include:

- O&M / A&G
- Depreciation
- Cost of Capital
- Federal and State Income Tax
- ADIT
- Taxes Other Than income

For Simplicity, could include only:

- Proxy O&M / A&G (is often 1.50 to 4.00% of original CapEx)
- Straight line depreciation rate for sinking fund recovery period calculation, such as 4% or 5%
- Proxy Cost of Capital: Wide variety among PJM Transmission Owners; use a weighted average cost of capital such as 50/50 cap structure, 4.0% debt rate, 10.5% equity rate
- No federal or state income tax gross-up or ADIT offset

Appendix 2: Determine Stated Rates

- Apply FCR to Proxy Reactive Capital Investment + Proxy Balance of Plant Investment
- The same approach would be applied to classes of synchronous generation and storage to determine rates
- Established rates would be updated periodically to account for inflation
- As industry components change and costs change, new proxy inputs could be used to determine the stated rates per generation type