Clean Energy Caucus Package

Reactive Power Compensation Task Force

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Overview

- Problems with Status Quo
- Review of CEC package
- Issues with other packages
- How the CEC package would be applied in a PV solar example

Problems with Status Quo

The primary problem is administrative burden.

- The sheer number of Schedule 2 filings is daunting.
- Filings use AEP as a starting point but most rates are set by black-box settlement negotiations rather than straight application of AEP. This has been the case in PJM for the last 20 years.
- The problem statement focuses on procedural risks and litigation and administrative costs, i.e., streamlining—not reducing total overall rates or setting uniform compensation.

Key Takeaway: AEP itself is not the source of the problem.

At minimum, compensation needs to be high enough to cover costs.

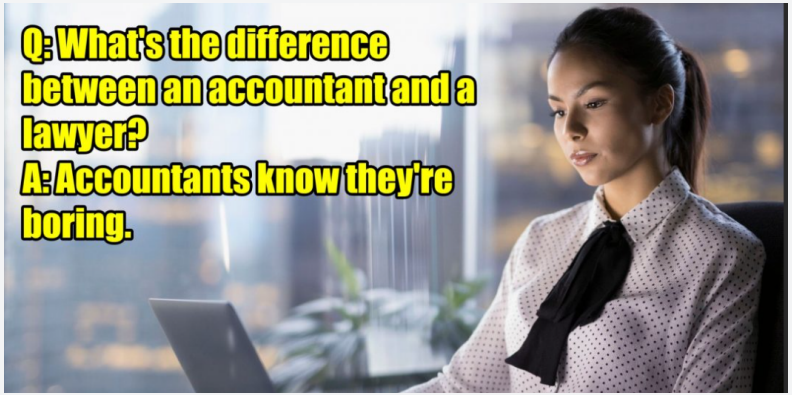
- **Renewable generation developers have the ability to enhance the reactive capability of a project.**
    - Different inverters have different capabilities.
    - Some inverters come with options for additional reactive capability.
    - Many offer Q-at-night or wind-free reactive capability which adds reactive capability.
- **More reactive capability costs more money.**
    - Absent an adequate compensation mechanism, developers will procure least-cost equipment that meets minimum ISA performance requirements.

Key Takeaway: It is in the PJM region's long-term reliability interest to incentivize investment in reactive capability.

The CEC Package

AEP is a reasonably accurate way to estimate costs.

- AEP is well-established and widely used.
    - Although initially adopted for thermal generation which was the predominant technology at the time, the AEP methodology is easily applied to inverter-based because it simply identifies the equipment that supports the reactive function.



Key Takeaway: AEP is not a windfall for any type of generator; it only allows resources to recover costs.

The CEC Package

- Set a flat rate by technology type based on cost.
    - Develop a proxy unit for each technology and apply the AEP methodology to that proxy unit to derive a rate for the whole class.
    - Applies to all new resources, synchronous and inverter-based, thermal and renewable, and storage.
- Formula would be included in PJM's Tariff, exact rates would be posted on PJM website.

The CEC welcomes discussion on what proxies to use as inputs into the formula and the frequency to review the formula and inputs

- Penalize non-performance with a MISO-like "Three Strike Rule" that FERC accepted.

The CEC agrees that a penalty for non-performance should exist and welcomes discussion on alternatives to the three-strike rule

Benefits of the CEC Package

- **Streamlined administrative process** – One flat rate per technology; no more filings at FERC by every generator.
- **Limits costs** – Payments are “capped” at the agreed-upon cost of the proxy unit; no more costs spent at FERC proceedings for every generator.
- **Reliability** – Promotes long-term investment in reactive capability.
- **Comparability** – Ensures new and existing resources are compensated on a comparable basis, i.e., AEP rates.
- **Easy Implementation** – There is no need for a transition period or any additional personnel or monitoring

Issues with Other Packages

Significant questions remain regarding the PJM and IMM packages.

- **PJM**
  - Premise
  - Testing
  - Performance
  - How the rate should be calculated
  - Comparability
  - Transition

- **IMM**
  - Synchronization of revenue to capacity
    - Real Power vs Reactive Power Capability

Key Takeaway: The following information needs to be fleshed out before stakeholders can fully understand the impact of the proposals

Key Issues for PJM Clean Energy Caucus

- Adjustments to the rate design
- Robust testing means
- Adjustment for response time capability
- Implementation
- Lost Opportunity Cost

Premise for PJM Rate Reform

- PJM proposes to base compensation on the actual tested MVAR values measured at the high side of the GSU rather than nameplate MVAR capability.
- PJM proposes this on the premise that some resources have not been able to deliver the MVARs listed in eDART when called upon.
- CEC has asked for information to validate PJM's premise.
- Does PJM have information/data that identifies how many units or MW (compared to all units and MW) failed to provide the MVARs PJM requested at the eDART listed levels? Is this available for recent years, such as 2020 and 2021? Were there legitimate reasons for not providing the requested MVARs?
- The information is critical because it explains whether or not there is a systemic problem that requires an overhaul as PJM is proposing. Perhaps PJM only needs a non-performance provision similar to MISO's "Three Strike Rule."

Key Takeaway: PJM has not demonstrated that persistent underperformance is an issue that needs to be addressed.

Using Tested Values To Confirm Nameplate Capability

- **Initial Data**. PJM currently allows new generation to list nameplate values in eDART until such time as validation testing is done. The testing must be done within 60 months. Will this continue?
- **When testing occurs, system limitations prevent accurate testing of capabilities.**
    - This needs to be addressed or it will create new administrative burdens and persistent disputes about capability and therefore compensation.
- **Possible Solutions:**

    1) PJM to establish telemetry to the low side or per feeder for wind and solar resources to allow for more granular testing and demonstration of unit VAR capability;

    2) PJM to continue to allow new resources to dedicate certain units to absorb VARs while others provide VARs so the full range of capability is captured without impacting system voltage constraints; and

    3) PJM to direct redispatch of local generation, caps, reactors, etc., for VARs during testing.

Performance

- On line 11 of the matrix, PJM provides “no compensation if AVR out of service for the month.”
- What does this mean? Is the rate suspended during any forced or scheduled outage, or just an outage that is AVR-related?
- How much of a month is required for the rate to be suspended?
- Will this apply to existing and new resources or will existing resources not be subject to the same performance requirements and penalties? If the latter, what is the justification?

Need To Account for Response Time

- Response time is very important to grid reliability. PJM's proposal indicates that only fast-acting capacitor banks should be included.
- There are significant time differences in the ability for various generation to respond to VAR needs when a facility is offline and/or at a certain capacity factors and dispatch profiles, e.g., coal, CT, or CCGT with or without blackstart, hydro, wind with or without wind free or caps, and solar with or without Q at night and/or caps.
- If the focus is on delivered VARs, there should be some enhancement to the rate calculation that accounts for units with "fast" acting ability and a reduction to the rate to account for "slower" acting or infrequently dispatched generation.
- There should be some rate enhancement for higher capacity factor (baseload, solar) or higher availability factor (partial output wind, "windfree", solar with Q-at-Night, hydro, EFORd) units, and a rate reduction for lower capacity factor (potentially wind, hydro, CTs) and lower availability factor unit (EFORd).
- Cases need to be built when generators are offline to be counted against units for an availability adjustment because these units are not helping the transmission grid.
- This would mean PJM will be constantly updating resource information.

Administration

- PJM's proposal will result in continued testing that requires staff time and resources
- PJM states it will take 18-25 months to develop this tool.
- New tools can take longer than expected to build and implement,
  - e.g., SPP's Attachment Z2 credits took 8 years.
- Telemetry changes may be required because many existing synchronous units are only metered at the low-side of the GSU.

Rate Calculation & Application

- PJM proposes to calculate compensation using the average of leading and lagging VARs at max p (max MW output under the ISA) and min p (minimum dispatchable MW) using eDART data.
- PJM needs to confirm that it will place min p at zero in the calculation of leading or lagging VARs for resources that are able to provide VARs at zero MW.
- If not, certain resources with very low or 0 min p values will be inappropriately reduced.
- It is contrary to system needs.
    - It is vastly preferable under low load periods when voltage is very low or high (i.e., April/September at night) to utilize a resource that can absorb VARs at 0 mw (or even one that can absorb MW and MVars such as Storage).
    - This compares to units that require a 20% or 40% min MW output level to absorb VARs or may require a significant time delay prior to being able to provide reactive support (i.e., offline coal or nuclear unit).
- The rate should be applied to generator VARs and capacitor banks and reactors.

The Denominator in PJM's Calculation is Inflated

- PJM proposes to calculate the per MVAR rate by dividing total compensation of $377,522,624.82 by the system MVAR capability, which is estimated based on the nominal plant MW ratings of all units in eDART and a .95 power factor.

- This denominator must be adjusted:
    - Units that are directed to operate per a power factor schedule do not provide dynamic reactive response, so under PJM's logic should be removed from the denominator.

    - Units that have no eDART reactive capability curve, eDART reactive curves with 0 MVARs at max or min p, or that do not have a voltage schedule on file in eDART should be removed from the denominator, and/or

    - Alternatively, the rate could be calculated using actual eDART data for all units collecting under Schedule 2 and the corresponding total revenue requirement.

- Need to understand how all the adjustments apply and compare to the calculation Mr. Cao prepared.

Considerations for Implementation

- Implementation Period
    - Need to understand how implementation will directly impact mature project economics.
    - Criteria Need to be defined for grandfathering existing resources.
- 5-year Transition Period
    - Need to understand the justification for a transition.
    - Will the transition apply to all resources, existing and new?
    - How will the implementation impact planned project economics?

Lost Opportunity Cost

- The Issue Charge cites the need to establish means to compensate inverter-based resources lost opportunity costs for providing reactive power, as exists now for synchronous generation
- To date, the PJM proposal has not addressed this component of the Issue Charge
- The issue of lost opportunity cost must be included in order to understand the full impact of the PJ proposal.

IMM Proposal: Synchronization of Revenue to Capability

- IMM proposes to include reactive compensation in the capacity market by eliminating the Ancillary Services offset from the calculation of capacity pricing.
- This fails to tie compensation to when or how much service is capable of being provided, and/or the response time of such resources.
- Compare combustion turbine capacity injection rights and reactive power deliverability to those of wind facilities, solar facilities, wind facilities with WindFree or solar with reactive power at night capability.
    - Combustion turbines may be limited to no more that 5 to 10% capacity factors based on air permits, fuel supply agreements, and other physical and contractual limitations.
    - Wind and solar resources tend to have equal or expanded reactive capability across all levels of real power output.
    - Compare wind facility PJM capacity factors (11-17% default) to wind turbine operation or availability rates (often 70%+).
- The Capacity Market paradigm has been the subject of constant controversy and evolution and PJM continues to consider future large-scale changes in the RASTF. Does it make sense to tie reactive compensation to such an unstable paradigm?

Example: How the CEC Package Would Apply to Solar PV

Proxy Solar PV Unit

Under *AEP*, the fixed charge rate typically includes:

- 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

PV Solar's Reactive Capital Investment

- Inverter
- AEE: DC & AC collection system
- AEE: LV portion of Substation
- Capacitor and/or reactor banks
- GSU

AEP Stated Rate Approach

1. Establish Proxy Capital Costs for Plant Components to Determine Fixed Capability Component
2. Apply Proxy Reactive Allocator to Fixed Capability Component
3. Determine Proxy Balance of Plant Amount
4. Apply Proxy Balance of Plant Allocator to Balance of Plant Amount
5. Apply Proxy Fixed Charge Rate
6. Results in AEP-Based Stated Rate

Proxy Reactive Capital Investment

- 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

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

Sponsor Companies

- Pine Gate Renewables, LLC
- Solar Energy Industries Association
- Leeward Renewable Energy, LLC
- Savion, LLC, a Shell portfolio company
- GlidePath Power Operations LLC
- NextEra Energy Resources, LLC
- Clearway Energy
- Open Road Renewables
- Lightsource BP
- Invenergy
- Jupiter Power
- TransAlta
- Geenex Solar
- Cypress Creek Renewables

Thank You

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