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FERC Technical Conference on Hybrid Resources – Panel III

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PJM appreciates the opportunity to testify at this conference focused on market design and operations issues related to hybrid resources. I am Andrew Levitt and serve as (describe your position and your special role in the stakeholder process).

Through these comments, PJM wished to provide some written responses to the questions raised by the Commission in its Supplemental Notice of July 13, 2020. At the outset, PJM notes that it presently has over 13 GW of hybrid resources in the PJM interconnection queue, almost entirely in the form of solar-storage combination resources. There are also several hybrids currently in operation in PJM, including wind-storage and solar-storage.

Hybrids offer many potential benefits particularly when, for example, batteries are paired with renewable resources. For one, hybrid resources can mitigate some of the local operational issues associated with fluctuating output of variable energy resources. Second, adding storage to variable energy resources enables the flexibility to respond to energy price signals and to provide more reserves. Third, hybridization of variable energy resources gives owners the option to maintain or increase their resource adequacy value as the resource mix changes. Although not the subject of this panel, PJM is actively working with stakeholders to implement an effective load carrying capability (ELCC) methodology for determining the capacity value of variable energy resources, storage and hybrids. Hybrid resources provide a ready avenue for renewable resources and storage resources to boost their capacity value under an ELCC methodology.

Before responding to the specific questions, PJM wishes to make the following general observations on the issues the Commission has raised for this panel:

- In operations, market scheduling, and planning, there are complementary, albeit sometimes complex, interactions between the generation component and the storage component:
  - Solar PV and batteries use complementary inverter technology.
  - For hybrids that are using energy storage to firm the variable generation output – in which the storage is filling in when the variable generation is absent or lower, rather than adding to output during times of already-high variable generation production – the overall hybrid facility is expected to have a power rating comparable to the variable generation component, rather than being sized to the sum of the variable generation plus the storage component. For example, a hybrid with 100 MW solar and 50 MW storage would be expected to have a grid interconnection capacity of 100 MW (or even less than 100 MW). This is consistent with what we see in the queue. With this approach, the storage cannot produce its full output if the variable generator is itself producing close to its full output – by design, the two components have to share a constrained grid connection point. This presents a significant interaction between the two components.

- For closed loop hybrids in which the storage cannot charge from the grid, the storage can only charge during times that the co-located generation is producing[1]. This is a significant interaction between the two components.
- There is a similar interaction related to reactive power capabilities, which can impact operational modeling and in some cases has market impacts as well.

- These significant interactions are best managed by the operator of the hybrid resource.
  - The interactions reflect characteristics of the hybrid plant itself and are often under the control of the plant operator (for example, actual and anticipated output of the variable component and of the storage component). Therefore, the hybrid plant operator is in a good position to manage them.
- Modeling hybrids with significant interactions as a single, integrated unit from a market perspective allows their operators to manage most of the storage/renewable resource interactions highlighted above.
  - If the components of a hybrid were modeled as separate market units, the interactions between them may need to be modeled by the RTO in order to avoid infeasible scheduling and/or dispatch or otherwise disadvantaging the operator of the hybrid unit.
  - This same principle also applies to operational modeling.

With these general observations in mind, PJM provides the following responses to the Commission's questions:

1. Are hybrid resources able to participate in the energy, capacity and ancillary services markets operated by RTOs/ISOs using existing frameworks or market rules? If so, how do they participate? Are market rule changes needed to enable the participation of hybrid resources? Are RTOs/ISOs exploring market rule changes, and if so, what changes are they pursuing?

Yes. Today, hybrids in PJM are largely configured to operate in a mutually independent fashion, include the capability to charge from the grid, and participate in markets as separate units (e.g., the AES/Fluence facility at Laurel Mountain[2]). Both open loop and closed loop hybrids could participate in markets today as a single unit without rule changes.

PJM is working with stakeholders in order to clarify the status quo for hybrid market participation and operational requirements, as well as to consider certain enhancements to further opportunities for hybrid resources to participate in markets.

[1] The term "closed loop hybrid" is sometimes used to refer to a hybrid resource that is configured such that the storage component never charges from the grid. The term "open loop hybrid" is sometimes used to refer to one which can charge from the grid.

[2] https://blog.fluenceenergy.com/aes-marks-energy-storage-milestone-with-400000-mw-h-of-pjm-service-from-laurel-mountain

The PJM stakeholders have approved an issue charge to clarify how existing rules for renewables and energy storage apply to hybrid resources, as well as any rule enhancements that may be needed specific to hybrid resources, such as new metering or var testing requirements, for example. That stakeholder process will start in August of this year in a new subcommittee called the DER and Inverter-Based Resources Subcommittee (DIRS). Among the many issues being considered, the DIRS will also discuss modeling of hybrids.

Moreover, capability rules for hybrids in the capacity market are also currently being pursued as part of the ELCC discussions held at the Capacity Capability Senior Task Force. These would enhance the status quo rules.

2. Hybrid resources consisting of more than one technology type could potentially participate in the market as the separate component parts, or as a single, integrated hybrid resource. Should hybrid resources have a choice of whether to participate in the energy, capacity and ancillary services markets operated by RTOs/ISOs as each of the resource types or as a single resource type? If so, why is this flexibility important?

This is an important question to be addressed in the DIRS stakeholder process. PJM has practical concerns related to separate modeling of hybrids that are configured with significant interactions between the components. As a matter of process, the hybrid issue charge approved by stakeholders will address modeling of hybrids as a single resource and considerations tied to that approach first, and then will turn to separately modeled resources in a later phase of work (approximately towards the end of 2020 or the beginning of 2021).

3. Does operating a hybrid resource as separate components (i.e., co-located) rather than as a single, integrated resource create challenges for RTOs/ISOs in accurately modeling whether hybrid resources will provide operating reserves? If so, is this problem addressed if the resource operates as a single, integrated hybrid resource?

This is potentially one of the concerns around modeling the components of a hybrid separately without also accounting for any significant interactions. For example, if the variable generation component were producing output at the maximum capacity of the grid connection point, the storage component would not be physically capable of producing any power without violating the shared maximum facility output of the two components, and therefore the storage would not be available to provide reserves. By contrast, if the same hybrid were modeled as a single resource, it would be evident that the output is at the maximum level, and there is no headroom available to provide reserves. PJM has a similar operational concern related to modeling the reactive capability of hybrids in the Energy Management System.

4. What is the current ability of RTOs/ISOs to model hybrid resources? Is there a preferred approach?

Today, PJM can model hybrid resources as separate resources (which is practical when there are no significant interactions between the components) or as a single resource. In general, at this time PJM's preference would be to model hybrids with significant interactions between the components as a single unit, both in the market model and the operations model. This approach enables market participants to schedule and operate their hybrid plants as a single, integrated machine, which reflects the reality of hybrids that have significant physical interactions between the components. It also avoids the feature of a separate modeling approach that would require either market participants or the RTO to attempt to reflect significant interactions between the components in their offers, schedules and/or dispatch for energy and reserves.

5. Hybrid resources with certain characteristics may be able to provide essential reliability services. For example, when configured with advanced controls, these resources may be able to provide fast-frequency response and dynamic voltage regulation. What considerations (e.g., models, tools, training) are needed to improve planning and operations models and utility practices to account for the various controlled operating modes of hybrid and co-located resources?

Hybrid resources signing an Interconnection Service Agreement are required to have the capability to provide frequency response, voltage regulation, and ride through. PJM currently depends on these capabilities to reliably operate and plan the system. PJM has had exploratory discussions with transmission owners and resource owners to explore opportunities for better coordination around provision of reactive services from variable resources and hybrids during times without variable generation availability.

6. In some cases, RTOs/ISOs require variable energy resources to provide data and forecasts of resource production based on weather and other factors. Would the same requirements apply to hybrid resources with a variable energy resource component, or how may these requirements differ?

Solar-storage hybrids are currently required to provide the necessary data for PJM to produce a solar forecast. While the hourly output of a hybrid is not expected to match the forecast, the output over longer time scales (such as days and weeks) is, and therefore this forecast is of interest to operational planners in order to best take advantage of the reliability benefits of hybrids.

7. Are existing dispatch systems in the RTOs/ISOs capable of dispatching hybrid resources as a single resource?

Yes.

What are the challenges and/or limitations of such dispatch?

PJM has no concerns with such dispatch, provided the resource owner updates the economic limits to match their actual capability in light of state of charge and other considerations (similar to a standalone storage resource).

8. What are the technical considerations regarding state of charge of the electric storage component of hybrid resources? Are there different factors pertaining to state of charge that are dependent on whether the resource is co-located or operates as a single integrated hybrid resource?

PJM views any such technical considerations as the responsibility of the resource owner and not the grid operator. As with fuel inventory considerations for any other technology type, PJM believes the resource owner is in a far better position to manage their asset.

9. Do existing RTO/ISO market power mitigation rules appropriately recognize the particular operating characteristics of hybrid resources?

Market power mitigation rules are something that will be considered and discussed with stakeholders in the DIRS.

10. Are there established best practices for metering a hybrid resource for participation in wholesale markets? For example, with one meter, or with multiple meters that provide visibility into individual subcomponents or inverters, or some other configuration?

For solar-battery hybrids, PJM currently requires a submeter on the solar component in order to support the development of a unit-specific solar forecast. The current draft PJM proposal for ELCC for hybrids of variable energy resources and energy storage would require a submeter on the variable energy resource component in order to adjust a portion of the accredited MW value in proportion to performance. For DC-coupled solar-battery hybrids (or any hybrid technology that shares inverters between batteries and generators), PJM expects that larger plants may need to deploy many submeters on the DC bus in order to separate out the generation component from the storage component. There may be an opportunity to discuss the status quo and possible enhancements regarding the accuracy and other technical requirements for such DC-side meters that are not used directly in energy settlements, but instead used for other analytical purposes.

11. What are any other potential implications, advantages and concerns for RTOs/ISOs regarding hybrid resources?

As noted above, hybrids offer many potential benefits, of which PJM highlights three. First, they mitigate some of the local operational issues associated with fluctuating output of variable energy resources. Second, hybrids offer the option to owners of variable energy resources to maintain or increase their resource adequacy value as the resource mix changes and their capacity value is impacted. Third, they offer resource owners the flexibility to produce more power during times of higher economic and reliability value (that is, during times of higher LMP), and also the flexibility to produce more reserves.