HYBRID RESOURCES
Avoiding the Transmission Interconnection Logjam

FACT SHEET

One of the primary benefits of hybrid resources—defined as a combination of generation, storage, and/or flexible load that share a common point of interconnection and are operated as a single integrated resource—is their ability to reduce the transmission network upgrades required to interconnect new generating resources to the grid. In most areas with high-quality renewable resources, low-cost and easy points of interconnection have already been used. Renewable projects must therefore pay for expensive network upgrades to the bulk power system when interconnection studies indicate they will overload existing equipment or could cause instability on the transmission system. This cost is most often paid by the project developer rather than the system operator or load-serving entity (often a utility). Compounding this problem is the logjam of renewables projects waiting in interconnection queues, with studies often taking years to complete and projects experiencing many delays. The PJM system, for example, recently announced a pause on all new interconnection requests in order to revamp the interconnection process. These challenges in transmission interconnection for renewable generators is a significant barrier for their further development.

Hybrid resources reduce the need for transmission upgrades by sharing and more fully using limited points of interconnection. Hybrids often include storage technologies, which provide a destination for excess renewable energy while managing the hybrid's instantaneous power injection in order to comply with the interconnection limits and avoid expensive network upgrades. Hybrids composed of wind and solar can also reduce the need for transmission upgrades, as wind and solar output tends to complement one another, both day to day and seasonally. Often, when one is high, the other is low. Figure 1 shows a hypothetical example of a wind + solar + battery hybrid in which battery storage absorbs

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wind and solar output above the interconnection limit and releases it to the grid after renewable output has dropped to lower levels.

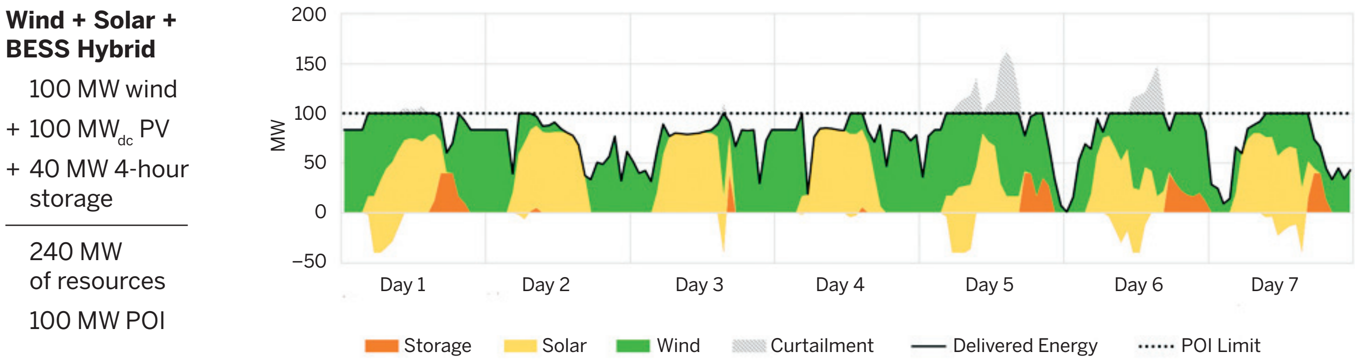
New Considerations for Models Used in Interconnection Studies

While hybrid resources can alleviate the interconnection challenges described above, they also introduce new factors into interconnection studies that need to be considered. The assumptions used in interconnection studies have a major impact on the interconnection costs incurred by renewable projects, and thus the projects' economics and the competitiveness of hybrid resources. Such studies typically only evaluate a few snapshots in time, such as system peak demand or light load conditions, because of the computational intensity of the power flow and stability analyses used. However, to accurately value resources that include battery storage requires a more holistic approach to transmission planning. Transmission upgrade needs should be studied across more periods in the year, given that projects involving renewable

This fact sheet is adapted from ESIG's report Unlocking the Flexibility of Hybrid Resources.

FIGURE 1

Example of a Wind + Solar + Battery Hybrid Absorbing Excess Renewable Output to Keep Instantaneous Injection of Power Below the Transmission Limit



A week-long example of a solar-storage hybrid resource's storage charge/discharge behind a single 100 MW injection limit (shown with the dotted line).

Note: POI = point of interconnection; BESS = battery energy storage system; PV = photovoltaics.

Source: Energy Systems Integration Group. Data from the National Renewable Energy Laboratory's National Solar Radiation Database and WindToolkit.

resources and/or storage generally shift both the timing of transmission congestion and the timing of peak net load. Continual increases in computational power will eventually make these studies possible.

In recent years, the U.S. Federal Energy Regulatory Commission (FERC) has been actively engaged in generator interconnection issues through Order 845, "Reform of Generator Interconnection Procedures and Agreements." While Order 845 does not directly address hybrid resources, many of its provisions directly affect hybrid resources, allowing an interconnection customer to:

- Request a level of interconnection service that is lower than the generating capability of the facility
- Use surplus interconnection service at existing points of interconnection
- Change technology during the interconnection study process without affecting its queue position

Another emerging factor for interconnection studies is the role of the plant controller. Although hybrid resources share many similarities with individual solar, wind, and battery resources, hybrids require additional coordination and modeling of their component resources and plant-level controls, as these help to ensure stable operation and to maximize the net grid-supporting capabilities they can provide to the system.

Designing Hybrids to Avoid Electrical Interactions Among the Component Technologies

The potential for a resource (whether conventional power plants or renewable resources) to interact with others nearby has long been understood, and the industry has developed various means of mitigating these interactions. In the case of hybrid resources, where the close electrical interconnection of multiple resources is by design and the potential for their interaction is known, the approach to coordinating the resources to avoid adverse interactions should be established early in the project's design. Several approaches can be used, most of which involve special configuration and tuning of the plant controller(s). Mitigating this challenge is a shared responsibility among the system operator, the hybrid resource owner, and the equipment manufacturer(s). The hybrid resource's controller(s) should be designed to achieve a single, coordinated response of the entire plant to disturbances on the grid, where all of the hybrid's component resources are pulling in the same direction, thereby maximizing the grid-supporting capabilities from the collective resources.

Defining the Modifications to a Resource That Do and Do Not Require a New Interconnection Study

When material modifications are made to a resource in an interconnection queue, the resource owner must submit a new interconnection application, adding expense and additional delays to the project. There has been considerable debate over what constitutes such a "material modification." Should projects in the queue be permitted to incorporate additional resources behind the point of interconnection? Should existing plants be able to add resources behind a point of interconnection without entering the interconnection queue?

Today, modifying an existing or planned resource often means adding storage, so another question becomes, should the addition of storage prompt a new interconnection study? Since storage can be highly flexible in response to locational marginal price signals or direct utility dispatch signals, it is unlikely to exacerbate, and should reduce, the transmission congestion and overloads that are a primary focus of interconnection studies.

Hybrid resources can significantly reduce interconnection challenges, and it is highly unlikely that adding storage to a planned or operating resource would exacerbate transmission congestion. As a result, future action by system or transmission operators and by FERC could further unlock opportunities for hybrid resources through simplifying the interconnection requirements for both existing and future projects that implement hybridization strategies. System operators should update interconnection study assumptions that determine the conditions against which a plant interconnection is evaluated. This can account for how the evolving resource mix is shifting the timing of peak net load and transmission congestion, and increasing the value of adding storage resources to serve peak load as well as reduce congestion.

While hybrid resources will yield significant benefits for the bulk power system, it is equally important to recognize the value that hybridization brings to individual project interconnection. The long delays in plant interconnection and the increasing costs for transmission upgrades create a unique opportunity for hybrid resources.

Adapted from *Unlocking the Flexibility of Hybrid Resources,* a report by the Energy Systems Integration Group's Hybrid Resources Task Force. Four fact sheets and the full report are available at https://www.esig.energy/unlocking-the-flexibility-of-hybrid-resources.

To learn more about the recommendations described here, please send an email to info@esig.energy.

The Energy Systems Integration Group is a nonprofit organization that marshals the expertise of the electricity industry's technical community to support grid transformation and energy systems integration and operation. Additional information is available at https://www.esig.energy and info@esig.energy.