Duke Energy Business Practice: Studying Storage Interconnection Requests in DEC and DEP

This business practice describes how DEC and DEP study interconnection requests of storage resources, including both charging and discharging. Tables 1 and 2 summarize the discharging and charging scenarios, respectively.

1 Storage Configurations

1.1 Stand-Alone Storage

Stand-alone storage is defined as storage that charges from the electric grid and discharges to the grid. It is either not co-located with other types of resources or, if co-located, can be charged and discharged from the grid independently of the output of co-located resources.

Examples include stand-alone battery storage and hydroelectric pumped storage.

1.2 Storage in Hybrid Plants (e.g. Solar plus Storage)

The most common hybrid plants requesting interconnection in DEC and DEP have been solar plus battery storage. In the most common applications, the output of the plant is limited by control action to the maximum solar-only capacity. The battery is discharged only when available solar power is lower than maximum approved plant output.

In the solar plus battery example, the battery is charged when solar generation exceeds the power injected to the grid. Net plant output may be limited by the IA MW capacity or plant output may be intentionally reduced to charge the batteries for discharge at a later time.

For the purposes of interconnection studies, if the storage and solar at a hybrid plant are intended to inject power at their individual maximum capabilities simultaneously, the storage will be treated like stand-alone storage during study of its discharging impact on the grid. In this situation, the interconnection request would need to specifically request this type of simultaneous operation.

For the purposes of interconnection studies, if the storage at a hybrid plant is to be charged from the grid, the storage will be treated like stand-alone storage during study of its charging impact on the grid.

2 Impact Studies of Storage - **Discharging (Generating)**

2.1 Stand-Alone Storage

Discharging of stand-alone storage is treated similarly to other types of generation in system impact studies. Discharging is studied in peak or near-peak scenarios considering both economic dispatch of system generation as well as alternative dispatches such as maximum generation ("Max Gen") in the area. Storage discharging is studied in both summer and winter seasons.

2.2 Storage in Hybrid Plants (e.g. Solar plus Storage)

In summer peak and near peak cases, solar plus storage plants whose output is limited to the maximum solar output will be studied at maximum solar output. In winter peak and near peak cases, these plants will be studied at maximum storage output only. Economic dispatch of system generation as well as alternative dispatches such as Max Gen are considered.

3 Impact Studies of Storage - **Charging (Load)**

Storage will be studied in charging mode at the most likely times for charging. Based on production cost simulations, two broad categories of charge times are likely:

3.1 Nighttime Charging

At night, solar generators are not producing, so any charging would be supplied by whatever fossil generation is on the margin at low load, such as combined cycle gas generation.

3.2 Midday Charging

In winter, system load dips in midday due to solar heating of the air and buildings, while solar generation may be at its maximum capability. Storage may be charged to get ready for the winter evening peak. In summer, solar generation output rises quicker in the morning than system load. Excess solar generation may be used to charge storage to prepare for the late afternoon summer peak load.

3.3 Stand-Alone Storage

In both nighttime and midday scenarios, stand-alone storage will be studied at 100% of maximum charging capability.

3.4 Storage in Hybrid Plants (e.g. Solar plus Storage)

Solar plus battery hybrid plants will be modeled off (0 MW) in nighttime charging scenarios. In the winter midday charging scenario, solar plus battery plants will be modeled as generating full solar output. *(Alternative: model them at solar max gen minus storage capacity. In other words, full sun, sending as much into charging the batteries as possible, and sending the rest into the grid.)*

Table 1: Discharging Scenarios Studied for Interconnection of Storage

Starting Case	Load	Queue Status	Solar	Solar + Storage	Battery Storage	Pumped Storage	Nuclear	Coal	Gas	Generation Sensitivities	Comments
Summer	90-100%	Study	100%	100% generating	Discharge (100%)	Generating	100%	N/A	100%	Local Max Gen; Gen Down	Peak / Near-Peak
		Base	80-100%	80-100% generating				Economic	Economic		
Winter	90-100%	Study	0%	Solar 0%; Storage (Discharge @ 100%)	Discharge (100%)	Generating	100%	N/A	100%	Local Max Gen; Gen Down	Peak / Near-Peak
		Base						Economic	Economic		

Table 2: Charging Scenarios Studied for Interconnection of Storage

Starting Case	Load	Queue Status	Solar	Solar + Storage	Battery Storage	Pumped Storage	Nuclear	Coal	Gas	Generation Sensitivities	Comments
Summer	80-90%	Study	100%	100% generating	Charge (100%)	Pumping	100%	N/A	100%	Gen Down	Summer Midday (lower load; high solar)
		Base						Economic	Economic		
Summer	60-70%	Study	0%	Grid-Charging Storage (Charge @100%) No Grid-Charging: 0%	Charge (100%)	Pumping	100%	N/A	100%	Gen Down	Summer Nighttime (HE 1-5am)
		Base						Economic	Economic		
Winter	80-90%	Study	100%	100% generating	Charge (100%)	Pumping	100%	N/A	100%	Gen Down	Winter Midday (lower load, high solar) (HE 12-3pm)
		Base						Economic	Economic		

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