ASSESSING THE ROLE OF ENERGY STORAGE AS A PEAKING CAPACITY RESOURCE IN THE UNITED STATES

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Section 1: Overview

The rapid decline of battery storage capital costs has led to an increased interest in using battery storage as a grid resource [1]. Along with these cost declines, around 150GW of peaking capacity could be retiring from the US grid in the next twenty years, which suggests there could be potential for batteries to play a substantial role as a peaking capacity resource in the coming decades [2]. Of course, the ability of energy storage to serve peak load is limited by its energy capacity. This, in conjunction with cost declines and regulatory measures, will determine the speed and extend of battery storage deployment on the US grid to serve this peaking capacity market.

In their recently established order 841, FERC required all ISOs/RTOs to modify their market structures to allow storage resources to participate in all electricity markets within their respective jurisdictions. The order included a request for each ISO to establish a minimum duration requirement for storage generators to participate in capacity markets. Storage resources with a duration less than the requirement are to be paid for the fraction of their capacity that they would be able to provide for the full required duration, also known as firm capacity. This enables all storage resources to participate in all capacity markets while acknowledging the limitation of energy storage to provide peaking capacity.

Section 2: Methodology

We use the latest version of the Regional Energy Development System (ReEDS-2.0) capacity expansion model to analyze the effects of storage duration requirements on the deployment of battery storage in the United States electricity grid. We also include hourly production cost modelling results for the resulting 2050 system in each scenario to assess their performance and resource adequacy. ReEDS-2.0 is a sequential linear optimization model that determines capacity expansion in the US electricity sector from present day through 2050. The recent release of ReEDS-2.0 has many model improvements including a new module that handles the treatment of firm capacity of storage resources as well as required duration for storage investments. The 2019 model version of ReEDS-2.0 includes only 4-hour batteries, so for this work we have added 2-, 6-, 8-, and 10-hour batteries as technology options. We extrapolated capital cost projections for these alternative durations from NREL’s 2019 Annual Technology Baseline. There are five scenarios included in this work: one with batteries excluded from the model and four with various duration requirements for storage. Three of these scenarios have a static storage duration requirement for all regions for the entirety of the model. The other uses the default module in ReEDS-2.0 that determines the firm capacity and required duration of storage endogenously.

Section 3: Results

We find that there is significant potential for energy storage as a peaking capacity resource in the United States. In the dynamic storage capacity credit scenario, there are about 70GW of batteries in 2040 and nearly 200GW of batteries in 2050. Much of this capacity is short (2-hour) duration batteries, with some longer durations built near the end of the model horizon. Initially energy storage with duration as short as two hours is sufficient for providing peaking capacity in most regions in the United States. However, required duration for energy storage to receive full capacity credit quickly lengthens. Peaking capacity potential for storage varies widely by region. Regions in the Midwest with lots of wind penetration and in the northeast with very wide load peaks tend to have lower penetrations and longer duration requirements, while regions with relatively narrow load peaks and/ or high PV penetrations tend to have higher storage penetrations with shorter durations.
We also find that RTO/ISO duration requirements can have a significant impact on both battery storage deployment and system reliability. The scenario with a 10-hour requirement for full capacity credit had far less battery deployment (~25 GW in 2040 and ~50GW in 2050) than the rest of the scenarios. The scenario with a 2-hour requirement had the most (~75GW in 2040 and ~250GW in 2050) while the scenario with a 4-hour requirement had ~25GW in 2040 and ~175GW in 2050). In the scenarios with 2- and 4-hour requirements for capacity credit, the system was unable to reliably serve load when processed through the PLEXOS production cost model at hourly resolution. Even though the 4-hour scenario had less battery capacity than the dynamic scenario, the region-specific limitations were not accounted for.

**Section 4: Conclusions**

Current conditions in the US power system are favorable to adoption of some battery storage as peaking capacity. In some regions, the duration required can be as short as two hours. However, the potential for short duration resources to serve peak load doesn’t last long with increased penetration.

RTO/ISO duration requirements for storage to participate in capacity markets has a significant impact on the economic competitiveness of battery storage in the United States. In scenarios where short-duration storage is allowed to receive full capacity credit, battery storage sets the capacity price from the early 2030s onward. In the dynamic scenario, this price drop is short lived, as longer durations are soon necessary, and capacity prices climb steadily throughout the 2040s until they are nearly the same as that of the scenario without batteries in 2050.

**References**
