END OF THE ROAD FOR PEAKERS? THE FUTURE ECONOMICS OF ELECTRICITY STORAGE AT PEAK MOMENTS IN NATIONAL ELECTRICTY SYSTEMS.

Lennert Thomas, Ghent University, +32 472497095, lennert.thomas@ugent.be
Sam Hamels, Ghent University, +32 499336946, sam.hamels@ugent.be
Johan Albrecht, Ghent University, +32 476511543, johan.albrecht@ugent.be

Overview

Energy storage technologies can provide the necessary flexibility for electricity systems with ever-increasing shares of variable renewable energy (VRE). In principle storage is well suited to deal with potential overproduction from VRE and the strong ramping requirements for thermal generation assets used to meet residual load (Fraunhofer IWES, 2015) [1]. Especially at times of high demand, storage technologies can compete with very flexible generation technologies such as OCGTs or jet turbines. In this paper, we present the economics of storage technologies in the electricity landscape of the next two decades and assess its implications on the market opportunities for conventional generation assets, especially peakers. Our research question is motivated by the rapid decrease of battery costs (UBS, 2015). Future cost reductions of storage technologies impact the cost-competitiveness of conventional peaker plants. Furthermore, some electricity utilities are already anticipating and investing heavily in storage facilities (OECD/IEA, 2014; IRENA, 2015). In our assessment, we compare storage technologies not only to peakers but also to other sources of flexibility like demand side management and increased interconnectivity with neighboring countries.

Today pumped hydro storage is still the most widely-used form of energy storage. Many researchers and analysts expect battery storage technologies - especially lithium ion batteries - to play an important role as prices are projected to drastically decline due to economies of scale. (UBS, 2015). In theory, different types of battery storage technologies can provide flexibility and other electricity system services. The most obvious options are large-scale centralized and smaller-scale decentralized forms of stationary battery assets. Ultimately, the storage capacity of batteries in electric vehicles could also be exploited in the long run. Battery storage technologies could help avoid VRE-curtailment and enable an even higher VRE penetration in the next decades (IRENA, 2015). Moreover, the ability to release electricity stored in batteries at times of peak demand could potentially mitigate the current reliance on conventional peaker plants with a high marginal cost of production (IRENA, 2015). Investing in storage technologies with a rather high load or capital utilization factor can avoid future investments in peakers with very limited running hours.

Energy storage is the only source of flexibility that can effectively shift energy production over a period of time, but it also has a few drawbacks. The supply of electricity from a particular storage capacity is by definition limited in time. The quantity of available storage capacity is therefore a crucial variable. As storage capacity is increased, larger chunks of excess renewable power can be stored, and even charging the batteries with conventional sources of electricity becomes an interesting proposition. This way, additional opportunities for price arbitrage are enabled, and the capacity factor of the battery system is increased substantially. In practice this means that batteries will not only be charged with excess renewable electricity, but also with nuclear or even gas-generated electricity from CCGTs. As long as there is a substantial difference between the price of the charged and discharged electricity, there is a potential business case to analyze.

[1] The expected increase of large fluctuations of residual load is shown in academic literature (Schill, 2014). An example of this is the so called *duck-curve*, which visualizes the effect of sharply decreasing solar production and sharply increasing demand happening simultaneously on ramping requirements for conventional generators (NREL, 2015).

Methods

In this paper, we assess the economics of storage technologies based on a very detailed model of the electricity landscape in Belgium. The Belgian case is of high relevenace because the country faces several challenges and opportunities. Today Belgium has a high share of 'must run' generation capacity (i.e. nuclear, CHP and biomass) but nuclear capacity will be phased-out. Because of low wholesale prices in Central-Western Europe, no new investments in conventional generation are expected for the coming years which leads to security of supply concerns. Our model has been developed to assess future states of national electricity systems, with a focus on LOLE[2] estimates and the need for additional capacity. The model includes the possibility of ambitious market response mechanisms. Moreover, interconnectivity is taken into account as Belgium is a highly interconnected country.

In a first step the model indicates when surplus generation is identified in every 15-minute interval by comparing load and minimal production (i.e. renewable and must-run production). Subsequently, the potential for batteries to charge at very low electricity prices can be quantified. Afterwards, the model allows for the identification of scarcity situations in which the discharging of the batteries can be deemed most interesting (due to high market prices). This way we can quantify not only the degree to which a particular battery capacity can help cope with system-wide imbalances, but we can also determine ways in which batteries can be utilized most effectively (e.g. by charging additionally with other generation assets than variable renewables). In our model, we simulate the strategic behavior of market participants anticipating on changing electricity prices. This means that the owner of a battery system will charge his batteries whenever the current electricity price is substantially lower than the expected future price (i.e. when scarcity due to high demand is anticipated). Consequently, the capacity factor of battery-based storage systems can be substantially increased, as well as the load factor of other (conventional) generation assets.

Results

Batteries allow surplusses of renewable generation to be stored for use at a later time, when a shortage might have otherwise occured. Although the total volume of generation surpluses is generally to small to cover all shortages in this way, the use of batteries still lowers the number shortages substantially. When batteries are additionally charged with electricity produced by CCGTs, arbitrage opportunities to displace OCGTs become even greater. The model shows that a significant amount of additional electricity production by CCGTs stems from this arbitrage. The model also indicates the required amount of battery capacity needed on a system level in order to displace OCGTs in this way, as well as the capacity utilization factor of this capacity. A decreasing residual need for OCGTs therefore becomes apparent.

Conclusions

One of the final goals of this paper is to determine the extent in which conventional peaking capacity can be displaced by battery storage by 2030. The results highlight that energy storage technologies may be poised to displace a significant portion of future conventional peaking capacity. The use of CCGT production to increase the utilization of battery assets and exploit arbitrage strategies can improve the current poor financial situation of CCGTs in Europe. We expect that investments in new capacity for meeting peak demand will start favoring batteries instead of conventional peakers starting around 2025 as batteries become cheaper and OCGTs will be increasingly seen as an old and polluting technology whose time has passed.

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[2] Loss Of Load Expectation