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Policy and market barriers to energy storage providing multiple services

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ABSTRACT

Policy and market conditions remain the primary barriers to stacking energy storage services, reducing its cost-competitiveness with traditional technologies. This article explores two cases that show how treating energy storage as a traditional asset class providing either market-remunerated or regulated services limits its profitability, and how changing market rules creates regulatory risk that could be mitigated through stacking services.

1. Introduction

Energy storage is effective in providing services to each segment of the power system, from demand charge reduction to frequency regulation. A recent GTM Research study predicts that annual deployment of energy storage may increase 12-fold from 221 MW in 2016 to 2.6 GW in 2022 due to favorable policies and falling costs (GTM Research/ESA, 2017). Increased adoption of energy storage has led the industry to seek mechanisms to better quantify its value and seek proper compensation for storage's various services. Nevertheless, policy and market barriers that have stifled adoption in past years continue to do so.

If only considered for a single service, energy storage often costs more when compared to traditional infrastructure such as thermoelectric generators (Diaz de la Rubia et al., 2017). However, studies have shown that using a single energy storage asset for more than one function, sometimes across multiple markets, amplifies grid benefits, increases storage profitability, and mitigates regulatory risk as rules and policies shift. For example, Diaz de la Rubia et al. compare pumped hydro storage (PHS) to combustion turbines for the purpose of variable renewable energy integration. The study concludes that, absent significant technology cost reduction, PHS would only prove cost-effective if it were able to recover part of the costs through “stacking services,” i.e., providing multiple grid services with one asset (Diaz de la Rubia et al., 2017).

Many of the previous studies that have examined the value of grid-connected energy storage have fallen into three general categories: those that identify general policy and market barriers faced by energy storage technologies (though not specific to stacked services) (Bhatnagar et al., 2013; Eyer and Corey 2010; Sioshansi et al., 2012; Wilson and Hughes 2014; Wasowicz et al., 2012); situations in which stacking storage services would be feasible (Braun and Stetz 2008; Fitzgerald et al., 2015); and methods to enable service stacking (Cheng and Powell 2016; Donadee, 2013; Evangelopoulos et al., 2016; Kargarian et al., 2016; Mégel et al., 2015a, 2015b; Wen et al., 2016; Xi et al., 2014). In this paper, we explore the barriers to stacking storage services. The reduced cost of energy storage, combined with the development of new optimization-based methods to stack services (Cheng and Powell, 2016; Donadee, 2013; Evangelopoulos et al., 2016; Kargarian et al., 2016; Mégel et al., 2015a, 2015b; Wen et al., 2016; Xi et al., 2014), have lowered the technological barriers leaving policy and market conditions as the primary obstacles. We investigate these barriers via two case studies: the proposed Lake Elsinore Advanced Pumped Storage (LEAPS) facility and batteries providing frequency regulation to the PJM Interconnection. The former demonstrates the existing regulatory barriers (and potential opportunities) for stacking services. The latter demonstrates how stacked services could mitigate the regulatory risk associated with changes in service compensation in these quickly evolving markets. We conclude by describing different initiatives on a national and regional scale that begin to alleviate some of these obstacles.

2. Energy storage services and value

Energy storage can improve power system economics and reliability by providing various market-remunerated and regulated services including, but not limited to, those listed in Table 1. It is important to note that storage can also provide consumer-related services (e.g., demand charge reduction), but these are not discussed in this article. The value of energy storage is a function of technology type, technology parameters (capacity, output power, efficiency, etc.), location on the grid, utilization rate, and duration of service (Fitzgerald et al., 2015; Lazard, 2016).

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Table 1
Energy storage services.

Service	Description
Market-Remunerated Services	
Ancillary Services	FERC defines ancillary services as "those services necessary to support the transmission of electric power from seller to purchaser to maintain reliable operations of the interconnected transmission system" (FERC, 2017). Ancillary services can be divided into balancing and contingency services: *Balancing Services:* These include services such as frequency regulation and load following are necessary to balance small imbalances between supply and demand. These services are important for effective grid operation, and will become more necessary with increasing penetration of variable renewable energy. Energy storage is able to react to signals both more quickly and more accurately than traditional thermoelectric generators, but it is important to note here that energy storage, unlike traditional generators, is energy-constrained (FERC, 2011). While it can provide both "up" and "down" services, it can only do so in one direction for a finite amount of time. *Contingency Services:* These step in when the grid experiences unexpected failures or outages, and can include spinning and non-spinning reserves. To provide contingency services, energy storage must be able to discharge with sufficient speed and duration.
Energy Services	Energy storage can participate in energy markets by arbitraging energy prices. This is achieved by charging during lower-cost, off-peak hours and discharging during higher-cost, on-peak hours. For such arbitrage to be attractive, the difference between the energy costs during charging and discharging must be sufficiently large, more than overcoming the impacts of round trip cycle loses and operations & maintenance expenses.
Capacity Services	Where capacity markets exist, storage can provide capacity similar to traditional generators, reducing the need for new generation investment. A study by Sioshansi et al. demonstrated that the capacity value of an energy storage device with eight hours of storage would nearly be equal to its rated capacity. Shorter discharge durations would result in lower, but still meaningful, capacity contributions (Sioshansi et al., 2014).
Regulated Services	
Grid Infrastructure Investment Deferral	Energy storage can support transmission and distribution (T&D) systems by mitigating congestion and improving power quality. This can reduce costs for utilities by deferring investment in new T&D equipment (ESA, 2017). Strategically located energy storage systems can be operated to more fully utilize existing transmission lines and reduce renewable energy curtailment that is caused by insufficient transmission or distribution capacity.

Regulated services are compensated through a charge across utility customer bills with regulatory approval (i.e., rate-basing), while market-remunerated services are compensated through revenues from competitive markets. For many investors, cost recovery via rate-basing is attractive due to its stable cash flows. However, cost recovery from the competitive market can prove to be more lucrative and flexible, allowing storage owners to take advantage of momentary, daily, seasonal, annual, and multi-year fluctuations in the value of services and electricity. Therefore, it would be attractive for a storage owner to increase utilization and revenue through stacked services across both market-remunerated and regulated functions.

3. Policy and market barriers to stacking energy storage services

3.1. Classification of energy storage

In restructured power systems, assets are classified as either generation, transmission, or distribution. Cost recovery is a function of this classification. For instance, generation services (e.g., energy, ancillary, and capacity services, where they exist) are traded in markets whereas transmission and distribution investments are rate-based. Energy storage resources are capable of acting as a transmission, distribution, or generating asset, or as a dynamic load. Therefore, storage assets are usually classified as a function of the service they provide. For storage assets providing multiple services, classification is difficult. Though the Federal Energy Regulatory Commission (FERC) has taken steps to review proposals for energy storage assets to obtain revenue through multiple services on a case-to-case basis, current regulations allow owners of energy storage facilities to draw revenue from only a single asset classification. This leaves most storage assets both undervalued and underutilized (Bhatnagar et al., 2013).

3.2. Inconsistent and changing rules across regional markets

Each electricity market has its own set of stakeholders, system characteristics, rules, and regulations. There are differences (such as compensation mechanisms, capacity requirements, and participant restrictions) in the treatment of energy storage across each independent system/regional transmission operator (ISO/RTO) region that make it difficult for developers to operate in multiple markets (Bhatnagar et al., 2013). Moreover, rules and regulations affecting energy storage generally, and stacked services specifically, continue to change as ISO/RTOs learn how to best utilize and compensate storage services providing one or more functions.

4. Lake Elsinore case: Pumped storage providing transmission and generating services

4.1. Background

On Dec. 1, 2005, Nevada Hydro Company (NHC) announced its proposal to pursue the development, ownership, and financing of LEAPS, a 500 MW pumped storage facility above Lake Elsinore as well as an accompanying transmission corridor between the Southern California Edison (SCE) and San Diego Gas and Electric (SDG&E) service territories. The pumped storage facility would be the "non-wires" portion of the project while the transmission corridor (TE/VS) would be the "wires" portion. The LEAPS facility would act as a generation asset by providing ancillary services and also act as a transmission asset by increasing the transfer capacity between SCE and SDG&E, reducing transmission congestion. LEAPS and TE/VS would have added an additional 1000 MW of transmission capacity for the highly constrained SDG&E service territory which, at the time of the LEAPS proposal, only contained 2500 MW of generation with a peak demand of 4500 MW (FERC, 2008).

NHC requested that FERC treat the entire project (both the wires and non-wires portions) as a transmission asset under the California Independent System Operator's (CAISO)'s control with recovery through ratepayers' Transmission Access Charge (TAC) on their monthly bills (FERC, 2008). Even though it was unusual to rate-base pumped hydro storage at the time, NHC defended the use of ratepayer funds by citing the Energy Policy Act of 2005, which encourages deployment of "advanced transmission technologies" that would increase the "capacity, efficiency, or reliability of an existing, or new, transmission facility" (FERC, 2008). NHC claimed that LEAPS served these functions and that, while LEAPS would primarily serve as a