EXHIBIT
#6
DE 17-189

STATE OF NEW HAMPSHIRE
BEFORE THE
PUBLIC UTILITIES COMMISSION

Docket No. DE 17-189

Alectra Energy Solutions, Inc.
Overview of Residential Storage Benefits for Electric Distribution Companies

DIRECT TESTIMONY

OF

VIKRAM SINGH

February 9, 2018

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I. INTRODUCTION AND QUALIFICATIONS

Q. Please state your full name, business address, and position.

A. My name is Vikram Singh and my business address is 161 Cityview Blvd, Vaughan, Ontario, Canada. I am a Manager on the Advanced Planning team at Alectra Utilities ("Alectra"), which is a municipally owned distribution utility servicing over 1 million customers in Ontario. In this capacity I am responsible for providing services to the company related to identifying new technologies and business models that could be leveraged by the utility to foster growth and adapt to changing market conditions.

Q. Please describe your educational background and training.

A. I graduated from Concordia University in 2002 with a Bachelor of Engineering degree. I received a Master's of Business Administration from Institut Europèen d'Administration des Affairs (INSEAD) in Paris, France in 2009.

Q. Please describe your professional background.

A. I joined Alectra in April of 2015. Prior to my employment at Alectra, I was employed as a Director of Business Development at Advanced Green Innovations (AGI) – a technology fund focused on renewable energy technologies. Prior to AGI I was a Business Development Manager at Stirling Energy Solutions, a manufacturer of utility scale concentrated solar power (CSP) modules based on concentrator dish and stirling cycle engine technology.

Q. Have you previously testified before the New Hampshire Public Utilities Commission ("the Commission")?

A. No, I have not.

II. PURPOSE OF TESTIMONY

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to share Alectra's views and experiences in evaluating customer sited residential storage as a utility asset. I will be commenting on the benefits and challenges of using such a technology for both customers and grid operators alike.

III. RESIDENTIAL STORAGE BENEFITS

Q. Please describe any recent experience you may have with projects related to residential energy storage being leveraged as a utility asset.

A. In 2015, Alectra launched a pilot program called "Power.House". The POWER.HOUSE pilot represented Alectra's first demonstration of the value of a Virtual Power Plant – an aggregate fleet of 20 distributed energy resources (DERs) located at customer homes that could be autonomously controlled through intelligent software to simulate a single, larger generating facility.

The technology being used was a combination of rooftop solar PV (between 5kW per site) and a lithium-ion battery installed "behind the meter" at the home of each participating customer. Customers benefit through load displacement, leading to bill reduction and reduced exposure to costly peak rates. They also receive clean, renewable energy that is not subject to the classic intermittency issues that typically limit the value of solar power. In addition, customers are not only be able to use their systems while grid connected, they are also able to leverage the system in the case of an outage, benefitting from increased reliability at all times of the day using a combination of stored and generated solar energy.

From a utility perspective, leveraging carbon-free generating resources and fast-responding storage assets can play a pivotal role in several grid supporting functions. These resources can be used to reduce peak system loads, regulate frequency, and even defer capital costs associated with substation construction that would result from load growth or capacity constraints.

Q. What are the types of grid services that storage can provide? What, specifically, makes storage an ideal choice for these services?

A. Alectra has performed an analysis of the potential grid services that storage can deliver, and mapped these services to DER grid service categories that Lawrence Berkley National Labs and EPRI have jointly identified in a recent study. A table summarizing these use cases is provided below. In addition, the specific technical capability that energy storage systems are equipped with to fulfill each use case is also provided.

Grid Service Use case	EPRI/Berkeley Category	EPRI Function	ESS Technical Capability
Regulation	Safety, Reliability, System Stability	Real Power Smoothing	Push or pull power immediately
Voltage Support	Safety, Reliability, System Stability	Volt-VAR, Volt-Watt	Push or pull power according to configured thresholds
Operating Reserve	Safety, Reliability, System Stability	Price Driven Actions	Push or pull power at a scheduled time; Push or pull power upon receiving a trigger signal
Peak Load Reduction	Safety, Reliability, System Stability; Quality	Peak Power Limiting, Price Driven Actions	Push or pull power at a scheduled time
PV Smoothing and Renewable Integration	Safety, Reliability, System Stability; System and Equipment Constraints; Quality	Real Power Smoothing; Maximum generation limit; Peak power limiting function	Push or pull power according to configured thresholds; Push or pull power upon receiving a trigger signal
Demand Response	Safety, Reliability, System Stability	Price Driven Actions	Push or pull power at a scheduled time; Push or pull power upon receiving a trigger signal
Consumer Use Cases - Bill Savings	Economics & Value	Price Driven Actions; Coordinated charge/discharge management; Direct battery charge / discharge function	Push or pull power at a scheduled time (rate management)
Backup Power	Safety, Reliability, System Stability; System and Equipment Constraints	Connect/ disconnect function	Automatically disconnect from grid and supply power to critical/UPS loads
Maximize PV Self-Consumption	Safety, Reliability, System Stability; System and Equipment Constraints; Quality	Maximum generation limit; Peak power limiting; price driven actions	Predict PV and load profiles to automatically push/pull power to achieve goals
Demand Charge Reduction	Economics & Value	Peak power limiting; price driven actions	Automatically push/pull power to achieve demand reduction goals
Ramping (esp. end of day ramp)	Safety, Reliability, System Stability	Real power smoothing function	Push or pull power at a scheduled time; Push or pull power upon receiving a trigger signal

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Q. What technical advantages does residential storage provide over other technologies that may be used for the same purpose?

A. Residential storage has a number of unique capabilities. Namely:

- **Performance:** Battery chemistry found in today's energy storage devices are extremely fast responding and have a high level of operational flexibility. In addition, batteries require very little ramp-up time, unlike fossil generators or turbines. As a result, they can be used either for grid services that require very quick response times, such as frequency regulation, or for standard grid support functions like capacity relief. They also can be leveraged as loads or generators. This allows them to either source or sink power depending on the needs of the grid. These high performance characteristics of batteries make them extremely flexible to operate and amenable to any number of grid services, as opposed to building purpose-built solutions that risk becoming stranded assets should the needs of the grid change.

- **Scalability**: Utilizing smaller, distributed resources allows a central operator to scale installed capacity according to market dynamics. This allows generation to grow in proportion to load requirements, and allows network planners to adjust capacity according to variances in actual load growth. This helps to provide more measured investments in capacity that are tied to actual market conditions.

- **Locational Benefit:** Once again, due to their distributed nature, residential storage can be collocated at specific nodes or along specific feeders in the network to deliver value where it is needed the most. This allows utilities to avoid oversizing centralized equipment in order to solve issues that present themselves at the "edge" of the grid (i.e. closer to loads).

Q. What specific benefit streams do you see residential storage delivering to grid operators?

A. There are a number of immediate and future values streams that storage can potentially deliver for utility benefit. They are:

- **Capital Deferral:** The ability to defer capital investments in distribution infrastructure to meet load growth requirements provides utilities with the financial returns associated with the time value of money. The longer the deferral period that embedded storage can provide the larger the capital deferral value. In order to capture this benefit, system-wide load forecasting has to be a key function of the distribution system operator – as it will be imperative in determining when to dispatch the assets.

- **Customer Engagement:** Residential storage allows for a much greater level of interaction and engagement with the customer. It provides unique features (such as site level resiliency), as well as added engagement features such as real-time visibility into household loads and local generation. These features have been extremely attractive to Power.House customers.

- **Demand Charge Reduction:** Coordinating dispatch of an aggregate fleet of storage assets allows operators to reduce demand charges assessed by the transmission system operator. This results in system wide savings that get socialized among the entire rate base.

- **Planning Flexibility:** Given the flexible and scalable nature of storage, it also provides an effective hedge against potential variances in actual load growth patterns. Operators are able to deploy localized generation that could act as an insurance policy should, for example, system demand decrease unexpectedly. This would prevent the need to build large centralized assets that may become underutilized.

Q. What are some of the challenges of deploying such a technology?

A. The notion of deploying a Virtual Power Plant (VPP) of residential storage for grid balancing is new and unproven. While battery technology is fairly mature and has proven to be quite reliable, many risks remain involving the uncertainty around their integration into standard grid operating and planning processes. Some specific examples of such challenges are described below:

- **Colocation Risk:** As many of the features of residential storage are dependent on providing locational value, there is always a risk of being unable to enroll enough customers within a required service area to deliver adequate capacity for a specific locational need.

- **IT/OT Integration:** Developing an understanding of how to dispatch storage assets and what type of additional services they can provide is essential for system operators if they are to take full advantage of the technology's potential. As such, understanding how to incorporate the control functions of a VPP into the utility's existing control architecture is a challenge utilities must be prepared to overcome.

- **Technology Risk:** Once again, using an unproven technology comes with certain risks. Especially considering that residential storage typically relies on customer internet for its communications architecture, there are a number of technical challenges that must be quantified before a large scale rollout of these assets can be deemed reliable enough to replace traditional utility assets.

Each of the above risks represents a compelling reason why utilities should pursue pilot projects in order to better understand what role energy storage could play in their future operational portfolio. Controlling a federated group of assets versus a centralized generating resource is a distinct departure from typical utility operations; however with an increase in DER penetration being fueled by lower storage pricing it is a change that we feel utilities must embrace if they are to be prepared to adapt to new market realities.

Q. What is the advantage of utility ownership vs. a third party aggregator or customer-owned model?

A. Distribution System Operators have direct responsibility for the planning, operation, maintenance, billing, and customer service functions required to manage an electric grid. This provides them with an inherent level of technical competency and internal infrastructure that is ideally suited to managing a VPP. It also provides them with extremely detailed visibility into the locational benefit that storage can provide to both participants and non-participants alike. Allowing utilities the flexibility to integrate these assets into the grid where they can provide the most benefit is both economically and operationally efficient, and provides customers with access to more lucrative revenue streams than simply energy savings or time-of-use arbitrage. Utilities can also leverage value streams by coordinating benefits for the transmission network, and by participating in wholesale market activity. Incorporating this functionality into the utility's existing planning and operations activities is a natural fit, and allows for energy storage assets to be fairly valued according the aggregate benefit they deliver to the entire grid.

IV. CONCLUSION

Q. Does this conclude your testimony?

A. Yes it does.