

Benefits of Energy Storage

Unlike other forms of energy, electricity cannot be easily stored in large quantities. As a result, the electricity system has historically operated on a "just-in-time" basis – with decisions about electricity production based on real-time demand and the availability of transmission to deliver it.

With the emergence of new energy storage technologies, however, greater amounts of electricity can be captured and dispatched to the grid whenever required. Storage can also benefit the system in the following ways, fulfilling many of these roles at the same time:

- Easing points of congestion in transmission and distribution networks by temporarily absorbing surges and excess power flow, allowing utilities to defer, or even avoid, expensive system upgrades
- Smoothing out fluctuations of solar and wind resources, bringing added stability to the electricity system
- Providing critical reliability services that support voltage and frequency on the system
- Absorbing surplus baseload generation from renewable and other energy sources during off-peak hours and injecting it back into the system when demand is higher.

Energy Storage in Ontario

For almost six decades, Ontario Power Generation's Beck Pumping Station in Niagara has provided approximately 170 MW of storage capacity to the provincial grid, pumping water to a reservoir during off-peak hours, and providing energy during peak hours.

In 2012, the IESO procured six megawatts of capacity from two storage facilities to provide regulation service. The flywheel facility, operated by NRStor, was commissioned in July and provides 2 MW of regulation service. The remaining 4 MW are being procured through an energy storage system developed by Renewable Energy Systems Canada (RES) and will be coming into service this year.

There are also a number of storage facilities connected to local distribution networks in the province.

New Storage Projects

This March, the IESO issued a request for proposals for up to 35 MW of storage capabilities to provide:

- regulation service which acts on a second-to-second basis to match generation to demand and helps correct variations in power system frequency; and/or
- reactive support and voltage control which are needed to maintain voltages and support the flow of electricity along power lines.

These projects were evaluated on numerous criteria including cost, diversity of technology options, and geographic location. While most of projects will be connected to the high-voltage transmission grid, the selection criteria also included a requirement for some projects to be connected to local distribution networks.

The cost of these contracts is expected to be approximately \$14 million per year for three years and is very competitive relative to comparable storage projects.

The IESO plans to finalize contracts with the following organizations by the end of the summer:

Proponent	Technology	MW
Canadian Solar Solutions Inc.	Battery	4
Convergent Energy and Power LLC	Battery Flywheel	12
Dimplex North America LTD	Thermal	0.74
Hecate Energy	Battery	14.8
Hydrogenics Corp.	Hydrogen	2

The Ontario Power Authority has plans to procure the remainder of the 50 MW target for energy storage services. <http://www.powerauthority.on.ca/generation-procurement/energy-storage>

A Primer on Storage Technologies

Storage technologies take many forms and often perform different functions. The electricity that travels through the grid can only be stored if it is converted into another form of energy like chemical, thermal or kinetic energy. Here is a brief overview of the technologies selected as part of this procurement.

Batteries

There are two types of batteries when it comes to energy storage – flow batteries and solid state batteries – the main difference is in their chemical make-up. Both are capable of changing their output in less than one second, some types of batteries are now being used by grid operators to quickly balance variations in load to regulate frequency.

Flow batteries:

While a conventional battery houses energy in one cell or package, a flow battery stores its energy in chemically reactive liquids, held in two tanks separate from the actual battery cell. The system pumps the two liquids from the tanks into a cell where a chemical reaction releases electrons that supply power onto the grid. To recharge the battery, the flow is reversed: electricity produced on the grid is channeled into the cell, breaks the chemical bond and pumps the liquids back to their respective tanks. This technology is scalable as larger tanks can store and provide more energy.

Solid state:

Solid state (lithium ion, nickel-cadmium, sodium sulfur) batteries are typically used today to charge laptops, cell phones and other devices. Unlike flow batteries, solid state batteries are divided into two sides by a perforated layer called an electrolyte. As the battery charges, chemical ions move through the electrolyte from the positive to the negative and from the negative to the positive electrode as the battery discharges.

Thermal

An in-house water heater is the most basic and common example of thermal energy storage. Thermal energy storage technologies reserve energy in the form of heat or cold. In this way, thermal storage can take excess generation and immediately put it to use, reducing the need to draw electricity at a later time.

Hydrogen (Power to Gas)

Power-to-Gas is a hybrid solution which converts electricity to hydrogen through an electrolyser and injects the hydrogen into a storage tank. A hydrogen fuel cell power module can then be used to create electricity.

Flywheel

Like a wind-up toy, the concept associated with this type of energy storage is not that dissimilar to that of the flywheel. Flywheels can both store and quickly release energy as needed. Flywheels use a rotor placed within in a vacuum to store and then discharge kinetic energy.