temporal

high-performance energy storage

ENERGY STORAGE DEPLOYMENTS IN ONTARIO

APPRO – NOVEMBER 18, 2014 – TORONTO

Cam Carver

CEO, Temporal Power Ltd.

Corporate Overview

- Temporal Power, a Ontario based company, is a global leader in the development of high-performance energy storage.

- The flywheel technology is sized for utility scale, multi-megawatt projects. Product used for precise balancing of power systems to:
  - Integrate Renewable Power
  - Manage Grid Frequency
  - Support Isolated Grids

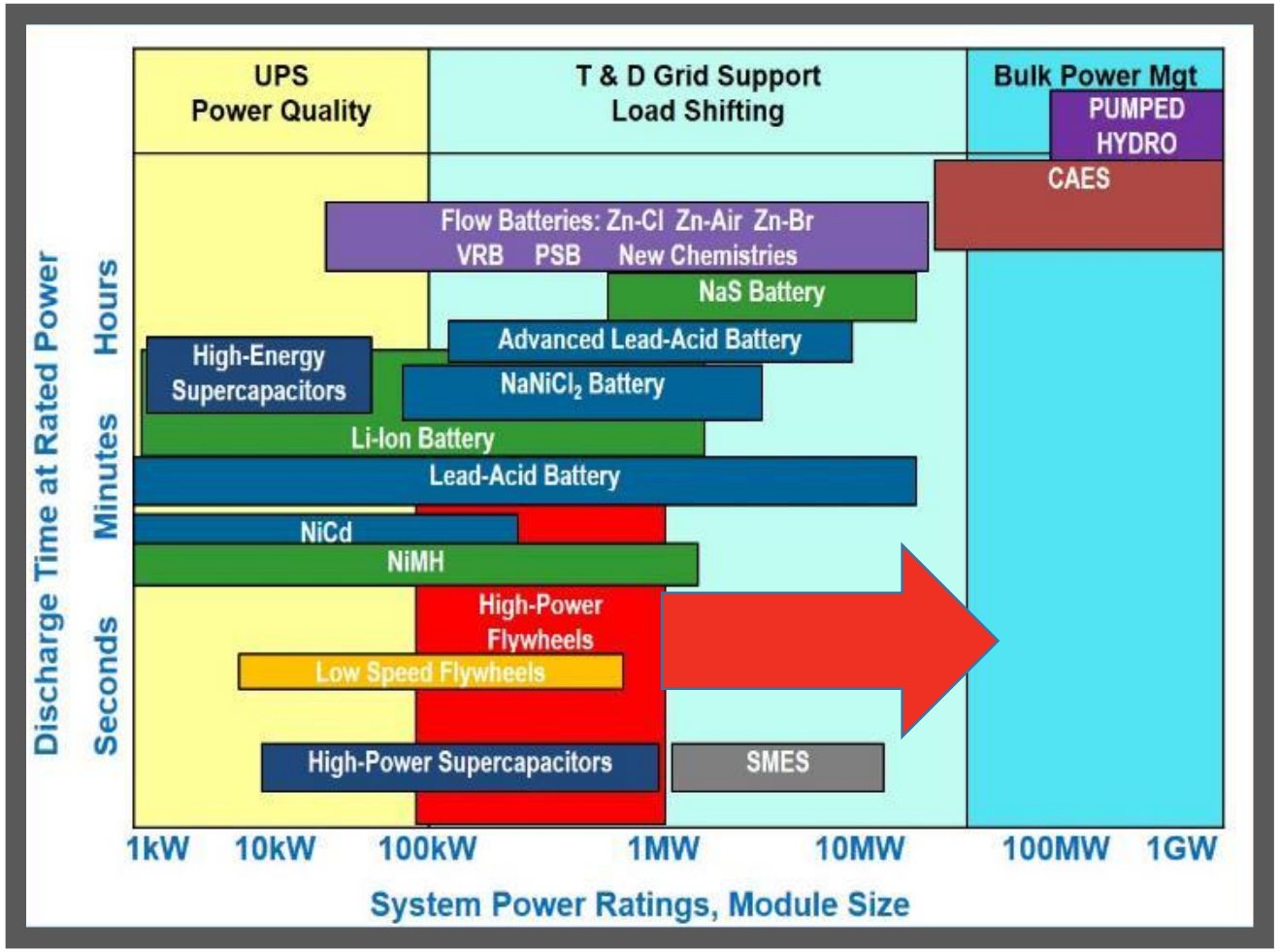
- 7 MW of storage plants commissioned or under construction in Ontario and international projects planned
  - 5 MW Clear Creak Project with Hydro One
  - 2 MW Minto Project with NRStor servicing the IESO

Partners & Investors

Project Partners	Strategic Investors	Key Contractors
• Largest electricity transmitter in Ontario • 2013 revenues of $6.1 billion • Partner in renewables integration commercial demonstration	• Enbridge is a North American leader in delivering energy and has expanding interests in renewable and alternative energy generation • 2013 revenues of $32.9 billion • Investor in Series B round	• Major US aeronautics and engineering firm • 2013 revenues of US$45.4 billion • Engineering partner (safety and control systems) • Ongoing strategic relationship
• Privately held Canadian energy storage project developer • Partner in grid balancing commercial demonstration	• Manager of Northwater Intellectual Property Funds focusing on investments in intellectual property and intellectual property rich companies • Over $800 million in assets under management • Early stage (Series A) investor and investor in Series B round	• Global technology and engineering company • 2013 revenues of $24.7 billion • Electronics supplier • Ongoing strategic relationship

Plus: Ontario Centres of Excellence (**OCE**), Ontario Power Authority (**OPA**), **MaRS**, Sustainable Development Technology Canada (**SDTC**), and the Ontario Department of Research and Innovation (**IDF**)

Energy Storage Applications and Technologies are Vast….

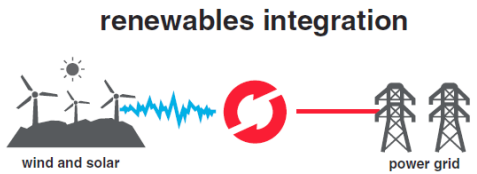


High Performance Energy Storage Applications

Renewable Integration

Market Need

- Intermittent output from wind and solar power generation makes it difficult for grid operators to maintain the required voltage on long distribution lines



Grid Balancing

Market Need

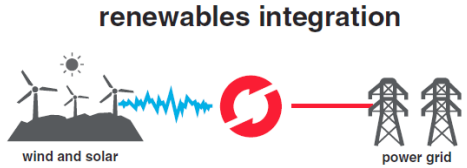
- Requirement of system operators to balance supply and demand in real-time

Isolated Grids

Market Need

- Isolated grid such as remote communities,
  mining sites and islands are often powered by diesel generators which are expensive, inefficient, and increasingly inadequate with the introduction of variable renewable generation

Temporal Power Clear Creek Project



Partner: Hydro One Networks Inc.

Challenge/Requirement
20MW of wind power connected to 40 km feeder line in Southwestern Ontario, Canada. It is causing significant **voltage** swings and power quality problems due to intermittent ramping of wind turbines.

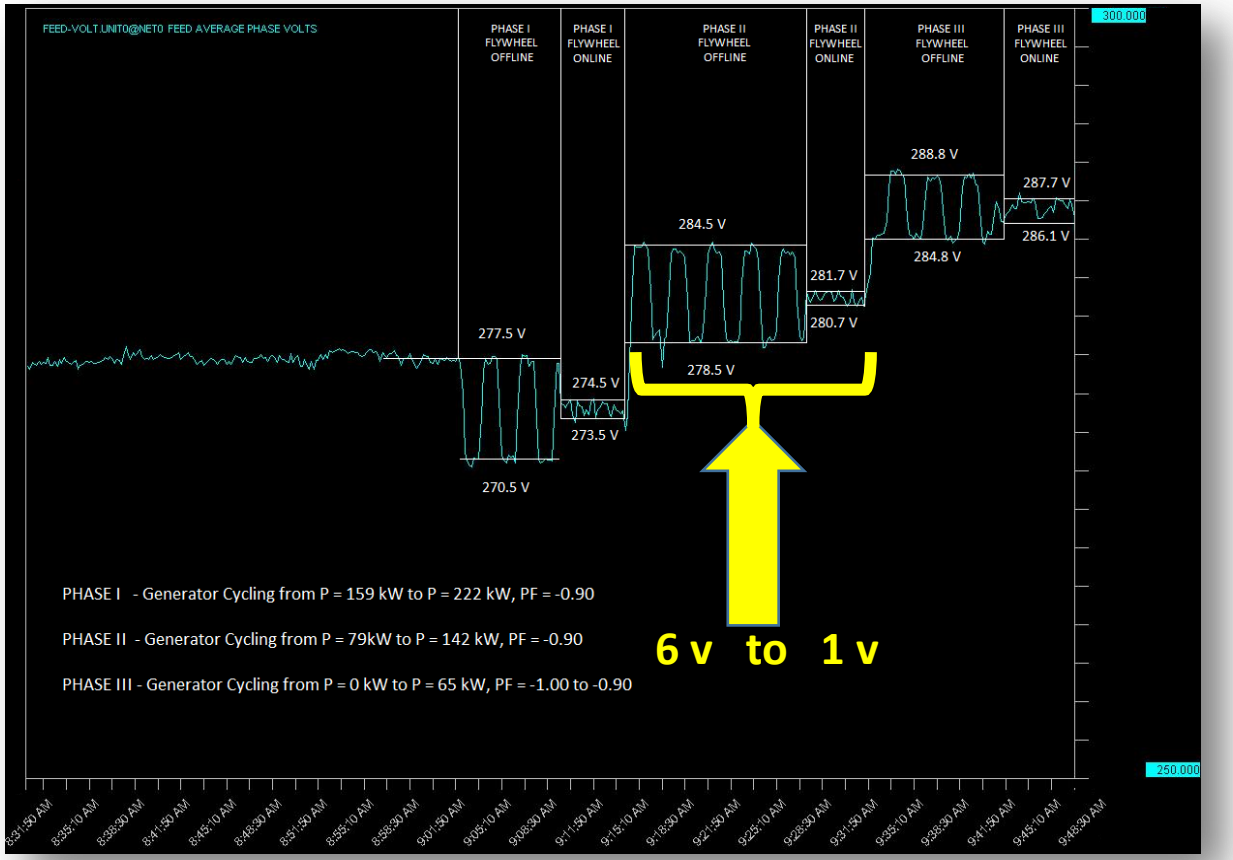
Temporal Power Solution
5MW flywheel facility will provide power quality and voltage support

Initial Testing Results

Phase 1 of the 5MW Hydro One project involved simulating the voltage fluctuations caused by a wind farm in a test setting using “dueling” flywheels

Resulted in Hydro One’s signoff to proceed with the installation of the 5MW system

The testing used Temporal Power’s autonomous control system to determine the real and reactive power required from the flywheel



Temporal Power Minto Project

Partner: NRStor Inc.

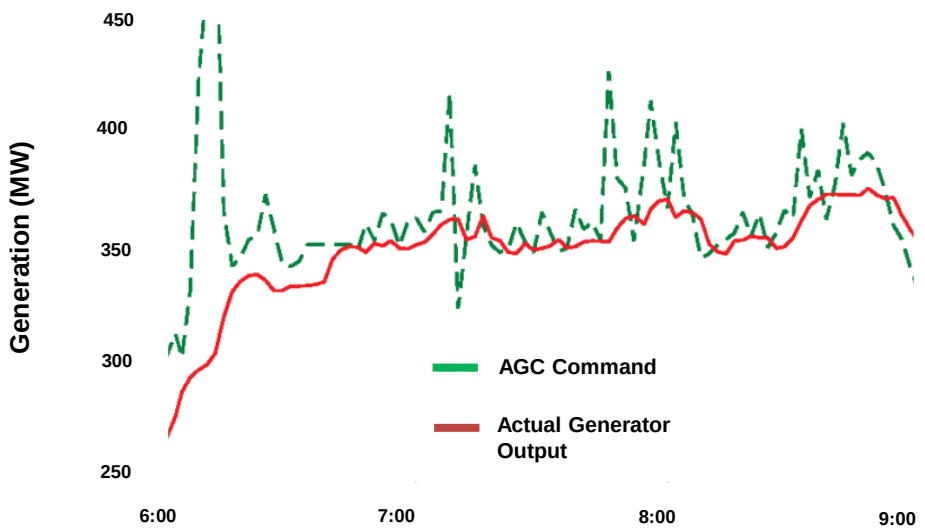
NRSTOR INC
AN ENERGY STORAGE COMPANY

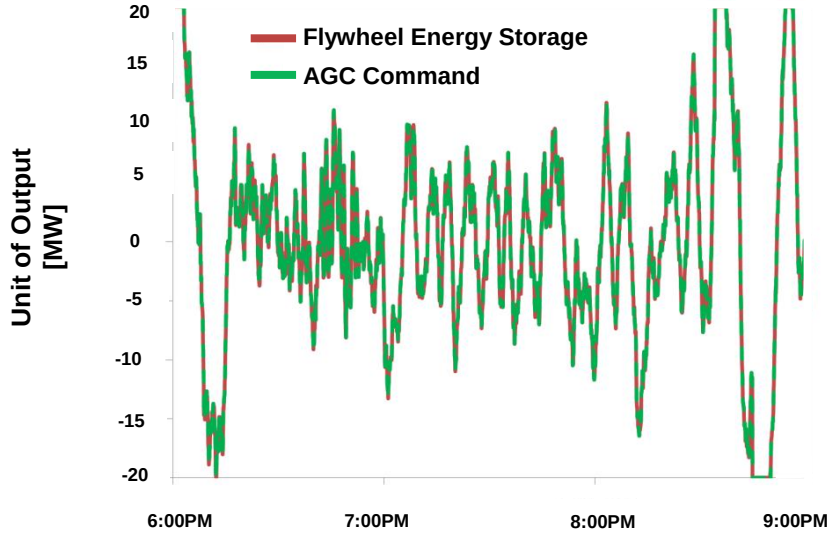
Challenge/Requirement
The IESO wants to demonstrate the effectiveness of using high performance energy storage to replace conventional generation for frequency regulation ancillary services.

Temporal Power Solution
IESO has contracted with NRStor for 2MW of regulation services. The facility will illustrate the potential of fast frequency regulation and inform regulatory and operational changes

High Performance Storage vs. Traditional Generation

- For Grid Regulation: ***Speed Matters!***





Slow-ramping Generator

Traditional resources are slow and respond imperfectly to the fast-changing grid requirements, requiring excessive capacity and higher costs

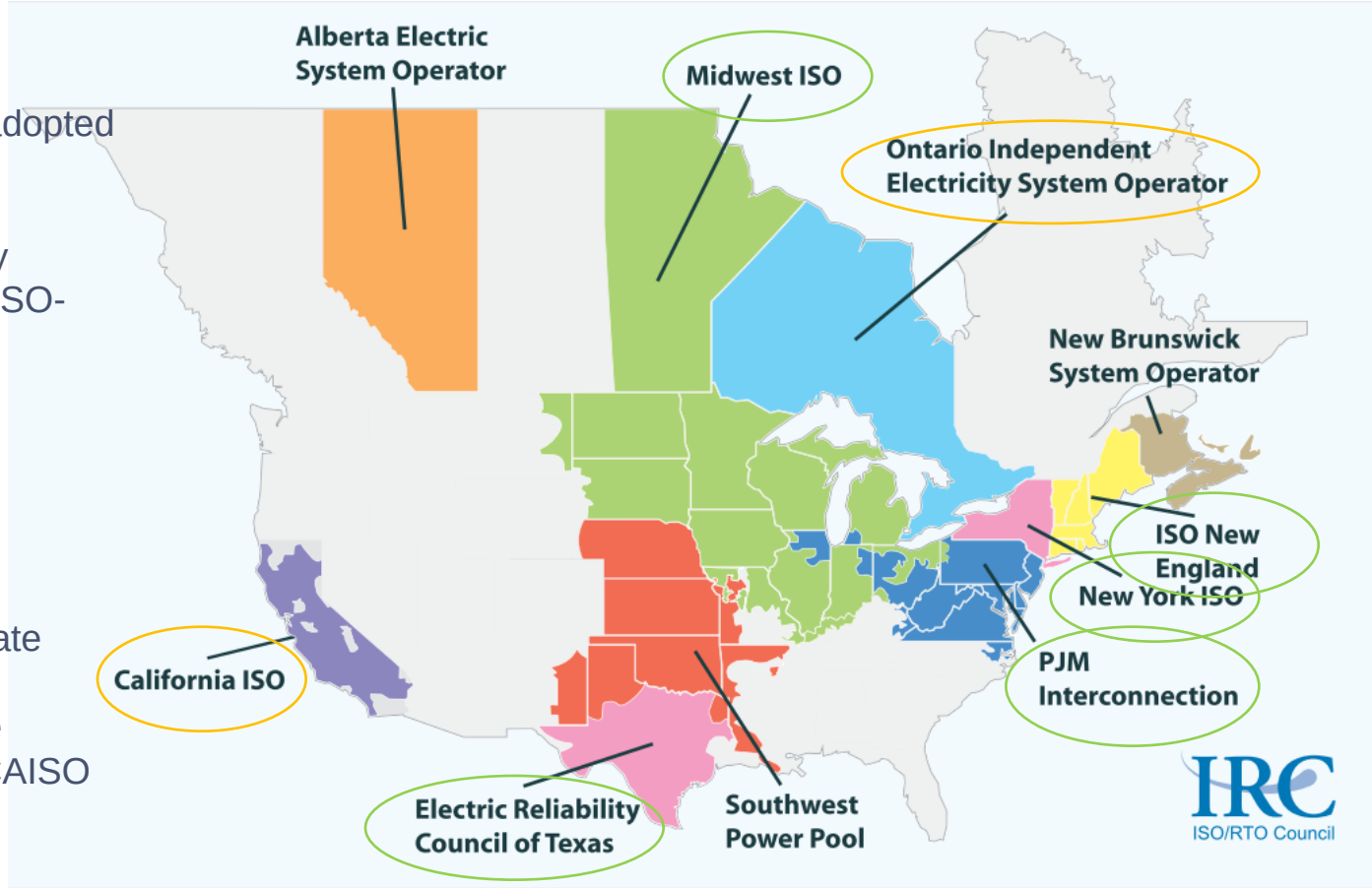
Fast-ramping Storage

Faster resources provide more effective regulation to the grid with fewer MW and lower costs

ISOs incorporating energy storage into planning and operations

ISOs which have already adopted new market regulations to accommodate storage technologies for Frequency Regulation: NYISO, PJM, ISO-NE,
MISO, ERCOT

ISOs where new market regulations to accommodate storage technologies for Frequency Regulation are expected shortly: IESO, CAISO



Source: ISO/RTO Council Website, Jan 2011 – Updated May, 2014

The Minto Project was commissioned in July 2014:

The Ontario Long Term Energy Plan

*"**Energy Storage***

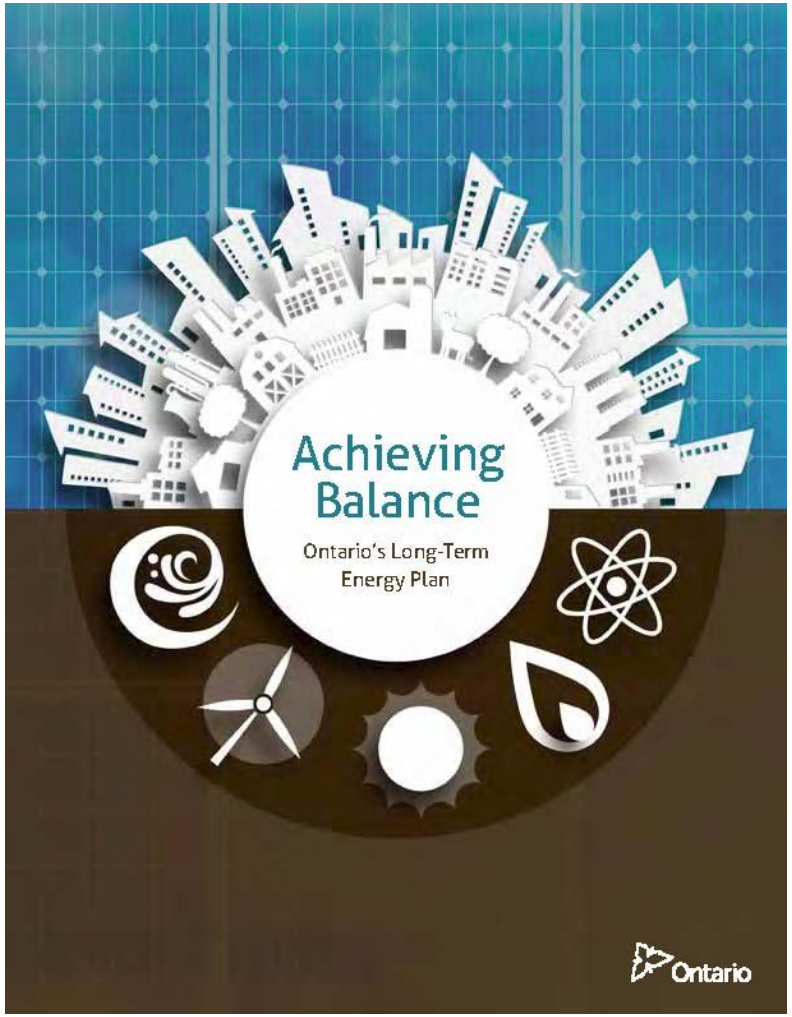
Energy Storage technologies have the potential to revolutionize the electricity system, increasing efficiency, lowering costs and increasing reliability for the consumer….

Storage technology offers the potential to increase the usable energy from renewable energy sources.

….Ontario is the home to a number of innovative companies that are at the forefront of the energy storage sector.

*By the end of 2014, the government will include storage technologies in our procurement process starting with **50 MW** and assessing additional engagement on an ongoing basis….*

The government also intends to initiate work, on a priority basis, to address regulatory barriers that may limit the ability of stored energy resources to compete in Ontario's electricity market…."



Real World Challenges

Technical and System Aspects of Integration and Commissioning

- Communication links
  - Multi-party co-operation
- Connection costs

Technology Specific Operating Models

- Unique and challenging control scheme
- Low voltage ride through

Synergy between Energy Storage technologies and existing generation assets

- Ramp and voltage control
  - Improve local power quality
  - Reduced line losses
  - Enable more renewable energy capacity on specific feeder lines and grid wide

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THANK YOU…

- 2:00 - 3:30 pm **Lessons learned from early Energy Storage deployments: The technology providers experience**
- *Understanding what is success for the technology providers and the sector as a whole. Technology providers will provide insight into what they have learned in the areas of:*
- Technical and systems aspects of integration and commissioning
- Technology-specific operating models
- Synergy between Energy Storage technologies and existing generation assets (or other energy services) that may facilitate new business partnerships
- Successful value propositions for deployments of storage technology
- Remaining challenges for technology providers in Ontario
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- Moderator: Robert Stasko, Energy Storage Ontario
- Cam Carver, CEO, Temporal Power
- Rob Harvey, Director of Energy Storage, Hydrogenics Corporation
- Curtis VanWalleghem, CEO, Hydrostor
- Jason Rioux, Vice President, NRStor
- Hari Subramaniam, CEO, eCamion
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