

# **Grid-scale Storage Technologies**

## **Regulatory barriers and policy instruments**

**Hydrogen Energy Storage for Grid and Transportation Services**

**May 15<sup>th</sup>, 2014**

**Sacramento, CA**





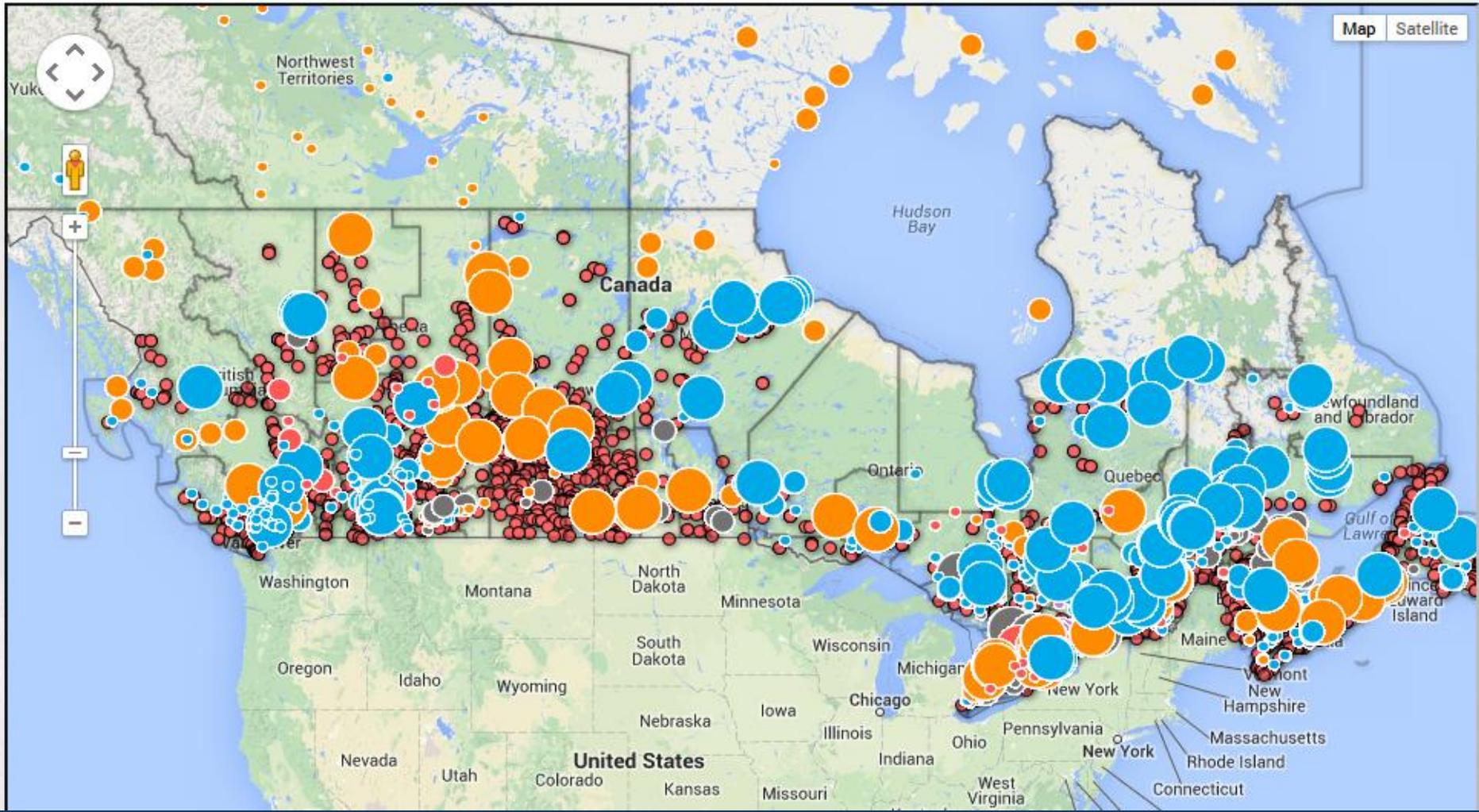
1%      PHS  
99%

CAES > NaS >> LiB > LA > NiCd > Flywheel > RFB

# Electricity Map

Demand 599 TWh

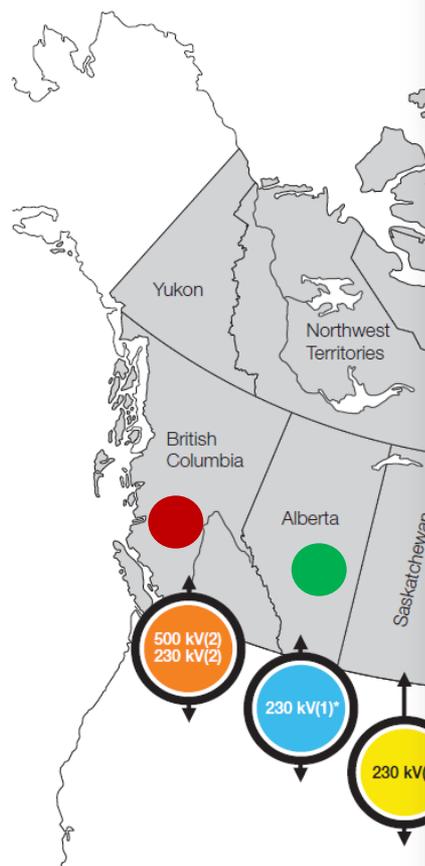
Generation 595 TWh



# Market Structure

## ALBERTA

- Competitive
- Energy-only wholesale electricity market
- All energy transacted through the power pool.



## Techno-economics of Energy Storage

Comparison of battery, compressed air and power to gas energy storage technologies in the Alberta context

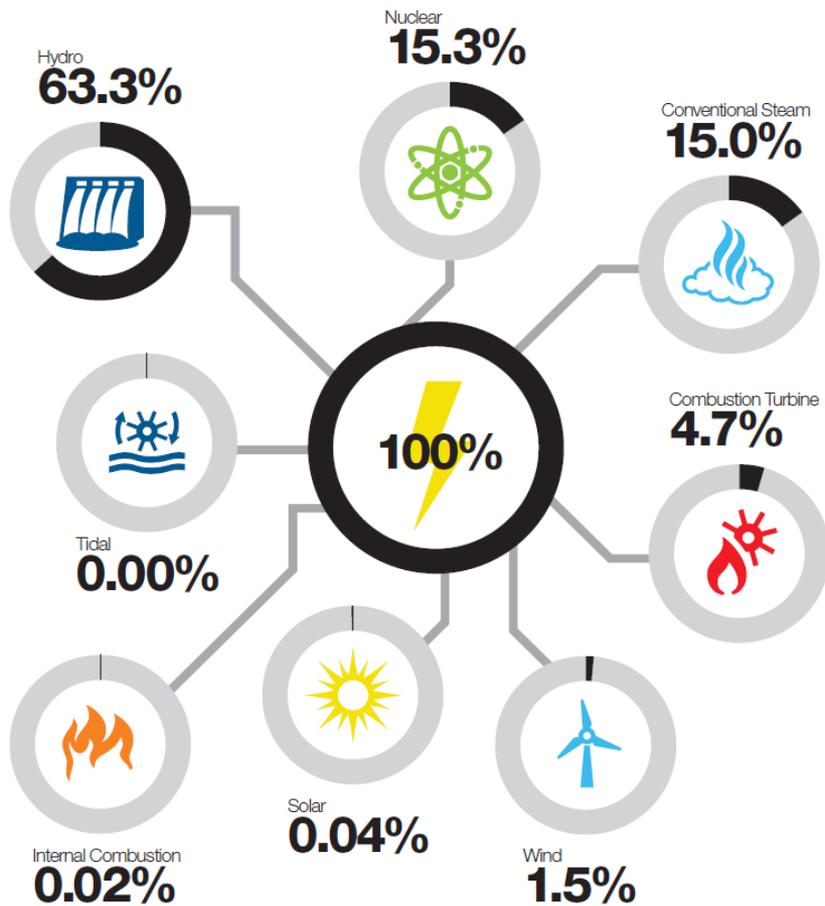
Puneet Mannan<sup>a</sup>, Greg Baden<sup>b</sup>, Leonard Olein<sup>b</sup>, Caitlin Brandon<sup>a</sup>, Brent Scorfield<sup>a</sup>, Nahid Naini<sup>b</sup>, Jake Cheng<sup>b</sup>

<sup>a</sup> Alberta Innovates – Technology Futures, <sup>b</sup> BECL and Associates Ltd

Contact:  
Puneet Mannan  
Alberta Innovates – Technology Futures  
Phone: (780) 450-5380  
Email: [Puneet.Mannan@albertainnovates.ca](mailto:Puneet.Mannan@albertainnovates.ca)  
November 19, 2013, revised March 24, 2014

# Electricity Generation in Canada

already clean ...



## Grid modernization



CEA, 2013

# Energy Storage for Grid Security and Modernization

## *Program Overview*



# Program Scope

## Strategic Support and Analysis

- Techno-Economic Assessments
- Technical Support of Codes & Standards
- Technology Roadmaps

## Demonstration & Validation

- Technical Support of Demo Projects
- System Integration
- Component Validation

## Client Driven R&D

- Manufacturability
- Material Improvement
- Accelerated Testing

✓ **Cost**

✓ **Durability**

✓ **Market Acceptance**



Defer infrastructure investment



Peak shaving & arbitrage



Integrate renewables

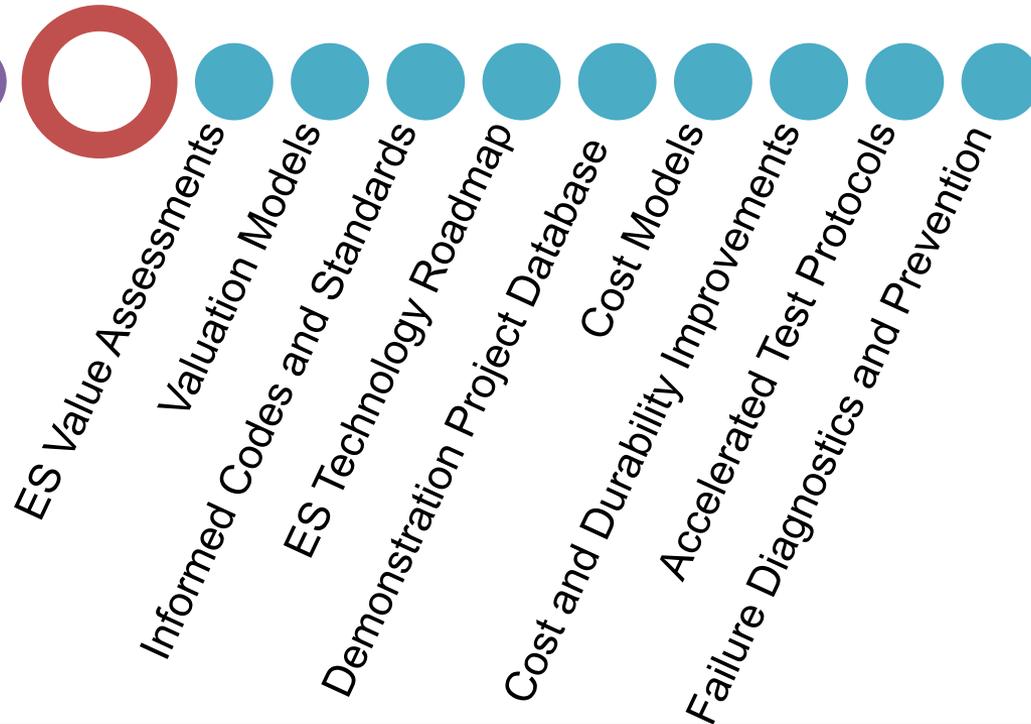
# Program Value Proposition

*To support utilities & industry in modernizing the electricity grid by strengthening the Canadian energy storage technology value chain & reducing risks for utilities to adopt energy storage technologies.*

## Activities



## Outputs

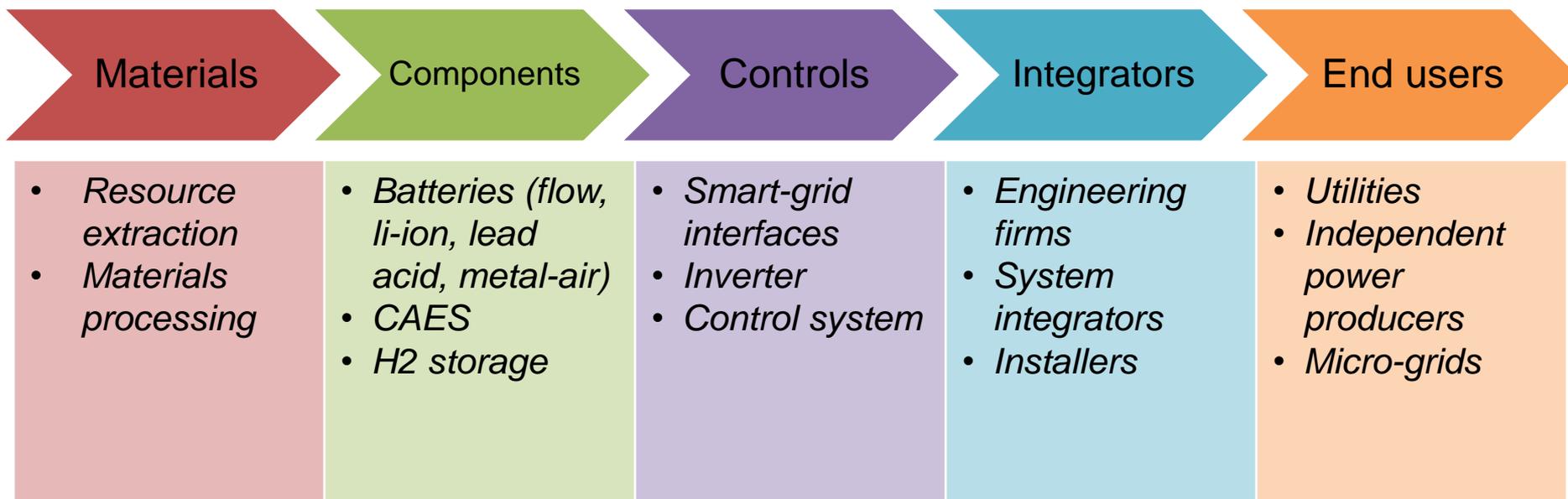


## Outcomes



# Program Goals

To demonstrate at TRL7, an installed **cost reduction** from the current ~\$1000/kWh to under \$500/kWh and from the current ~\$2500/kW to less than \$1250/kW, while increasing the **operating lifetime** to >15 years from today's 5-7 years and strengthening the Canadian Energy Storage supply chain.



ENABLERS: capital, business / technology experts, incubators, regulators, gov't

# Application / Technology Alignment

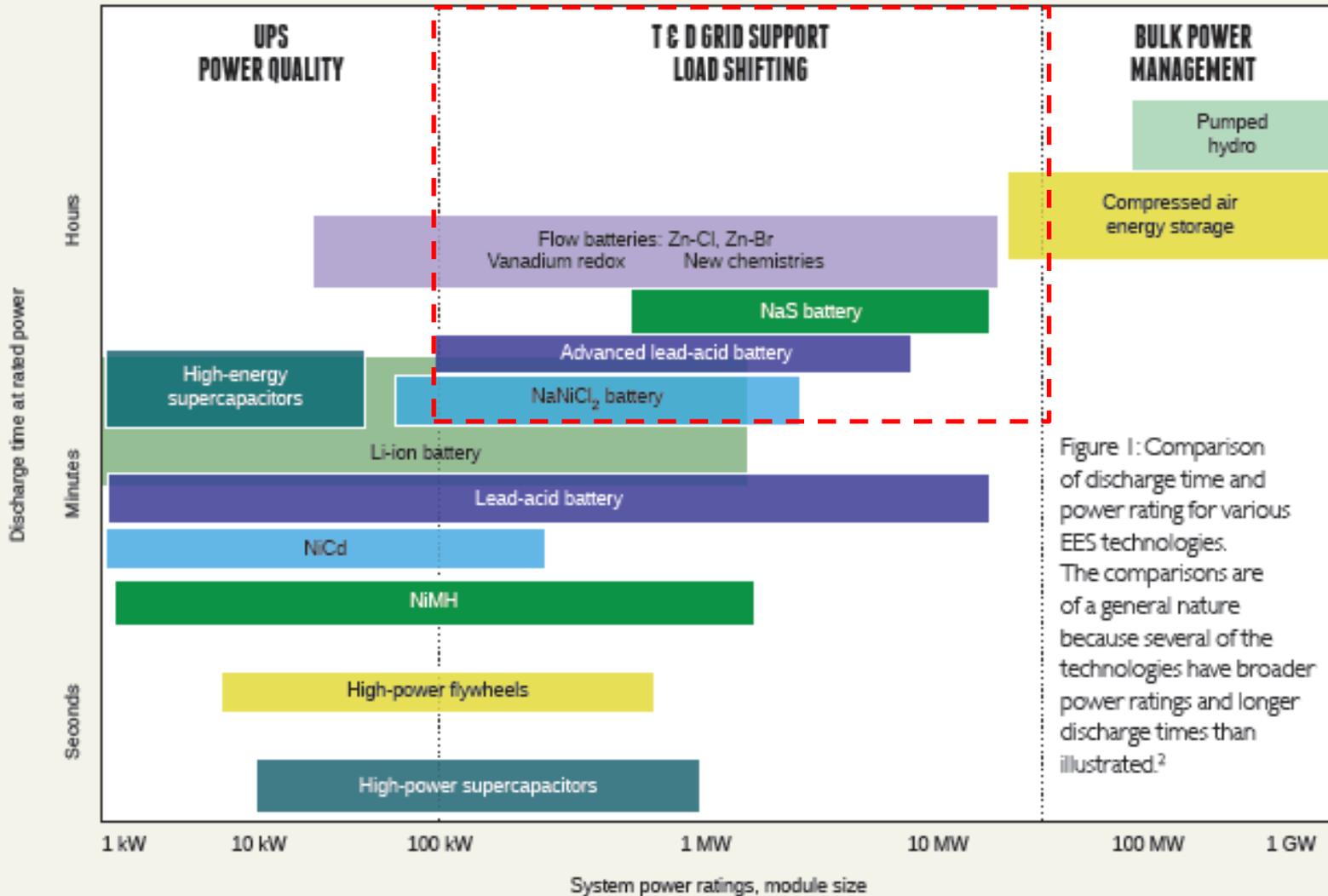
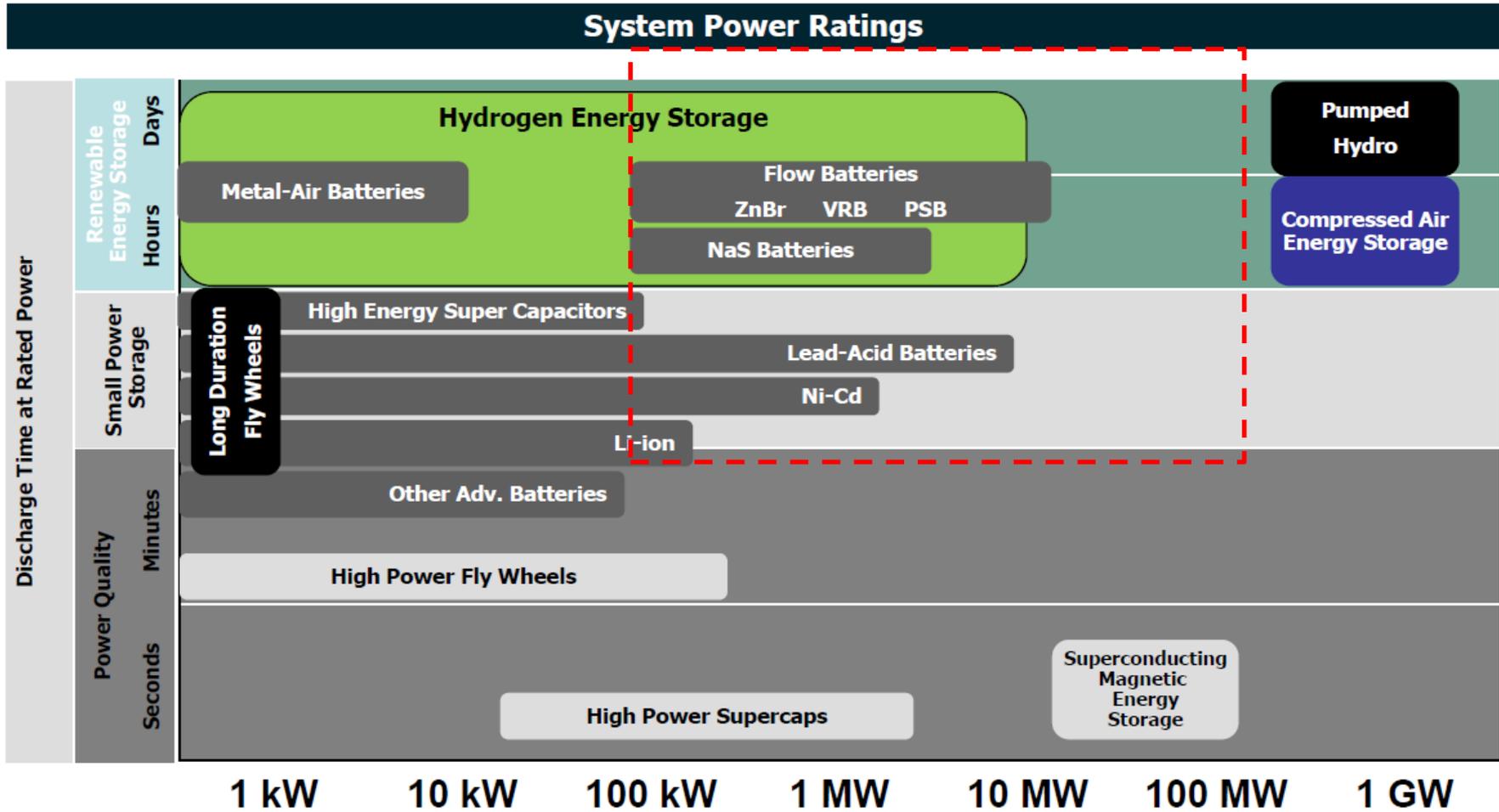


Figure 1: Comparison of discharge time and power rating for various EES technologies. The comparisons are of a general nature because several of the technologies have broader power ratings and longer discharge times than illustrated.<sup>2</sup>

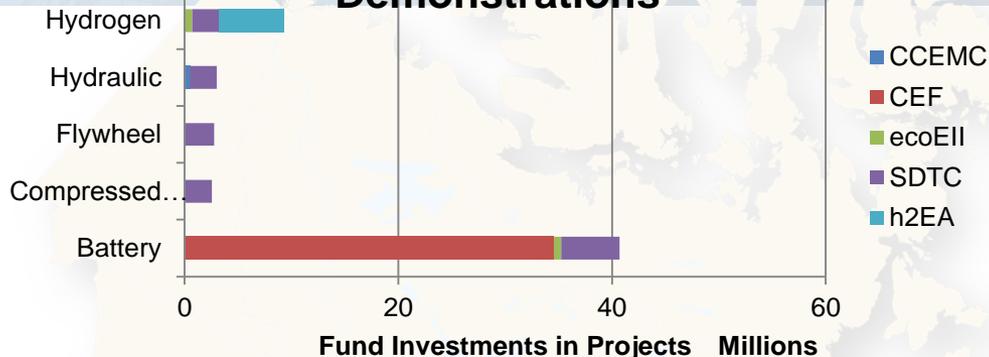
# Application / Technology Alignment



Source: Electricity Storage Association

# Publicly Funded Storage Demonstrations & Pilots in Canada

## Publicly Funded Grid Storage Demonstrations



## Smart Grid in Canada

2012-2013:

[www.nrcan.gc.ca/smart-grid-in-canada-201213](http://www.nrcan.gc.ca/smart-grid-in-canada-201213)

> 17 projects

> \$70 M invested, > \$179 M in project value

(Includes projects announced 2004-2013, does not include utility-funded or privately-funded projects)

# Development of failure diagnostic tools and testing protocols

## Testing protocols

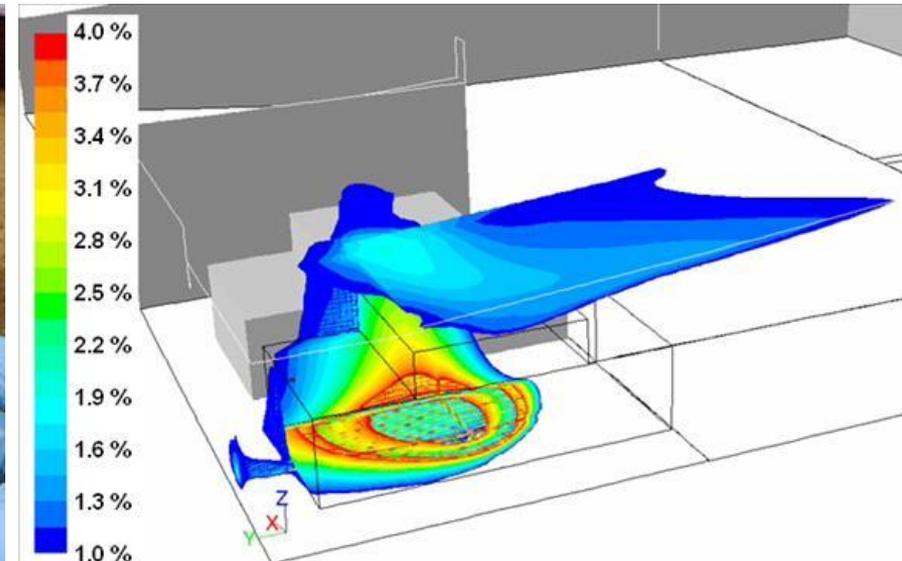
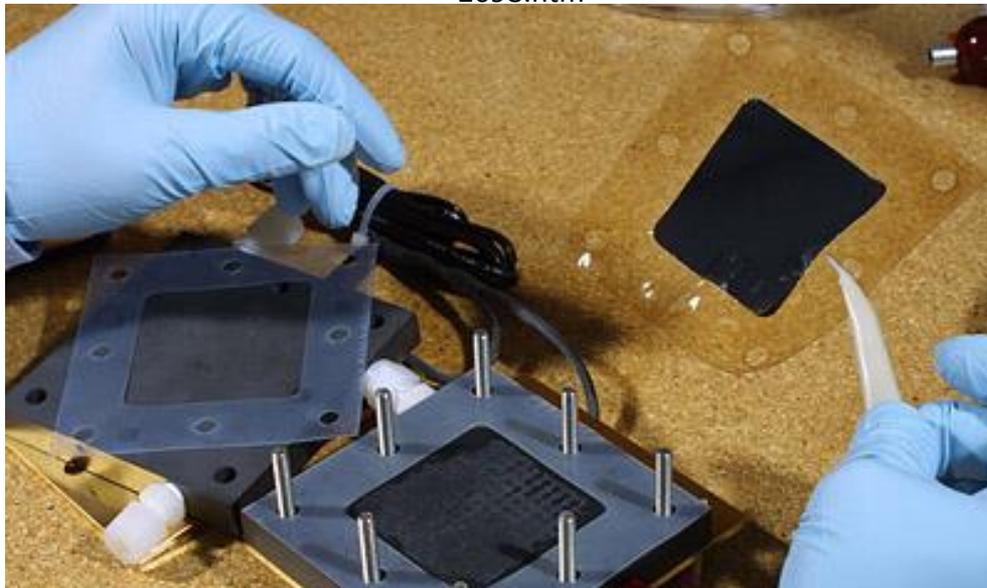
- Failure diagnostics tools
- Dynamic testing protocols for PEM electrolyzers

## Codes & standards

- Hydrogen Release in an Underground Parking Facility
- Gap Analysis on the Codes and Standards Related to the Storage of Hydrogen-Fuelled Vehicles

<http://www.tc.gc.ca/eng/programs/environment-etv-menu-eng-2698.htm>

CAN/BNQ1784000  
(Hydrogen installation)



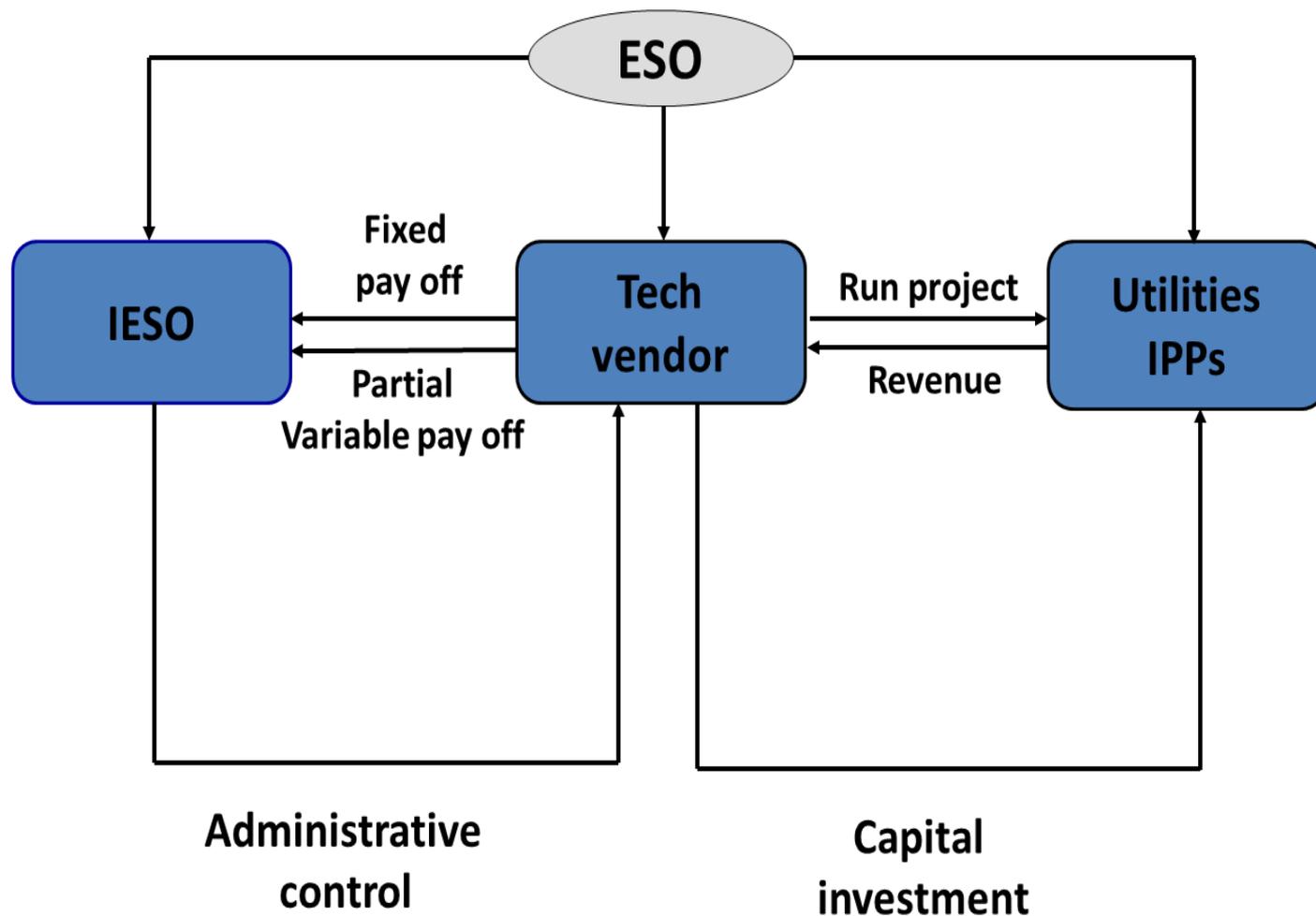
# Policy Instruments

- Feed-In Tariff (FIT) is “technology specific”
- FIT advocates for various types of available technology options on the market.  
FIT may kill competition among energy storage technology developers
- FIT is “dis-incentivizing deployment of energy storage technologies in the grid”.

## Ontario

- Ontario’s current FIT scheme prevents a multi-level scheme for FIT implementation
- Storage technologies added in energy procurement process ( 50 MW).
- Former feed-in-tariff procurement process for renewable generation projects (>500 kW) will be replaced with a competitive procurement model.
- Time of use pricing
- Enabling value stacking
- Ownership structure and eligibility

# I. Business Model



# H2-Storage

## II. Transportation vs. Grid Services



# Questions?

**Kourosh Malek**

Program Technical Lead, Energy Storage for Grid Security and Modernization

Tel: 604-221-3000

[Kourosh.Malek@nrc-cnrc.gc.ca](mailto:Kourosh.Malek@nrc-cnrc.gc.ca)

[http://www.nrc-cnrc.gc.ca/eng/solutions/collaborative/es\\_index.html](http://www.nrc-cnrc.gc.ca/eng/solutions/collaborative/es_index.html)

