Grid-scale Storage Technologies
Regulatory Barriers and Policy Instruments

Hydrogen Energy Storage for Grid and Transportation Services
May 15th, 2014

Sacramento, CA
Demand 599 TWh
Generation 595 TWh
Electricity Generation in Canada

already clean ...

- Hydro: 63.3%
- Nuclear: 15.3%
- Conventional Steam: 15.0%
- Combustion Turbine: 4.7%
- Tidal: 0.00%
- Solar: 0.04%
- Wind: 1.5%

CEA, 2013

Grid modernization
Energy Storage for Grid Security and Modernization

Program Overview
About NRC

• 2012-13 budget: $774M
• Over 4,000 employees
• World-class technical expertise and facilities
MANDATE
Economic development by providing industrial technology development programs and national laboratories to facilitate industrial R&D

OLD APPROACH
☒ Geographically-based institutes
☒ Discrete strategies and business practices
☒ Specialized local facilities and expertise
☒ Individual project activities

NEW APPROACH
✔ Focused: industry-driven, needs-based
✔ Collaborative: internally and externally
✔ Multi-disciplinary: build national capabilities
✔ Strategic: alignment of project outputs
NRC Transformation: Strategic Program Approach

• Focused in areas where we *should* rather than *could*
• Building strategic core-competencies that are managed nationally
• Leads to better, more focused investment decisions in projects and infrastructure
• Enables more deliberate positioning vis-à-vis other innovation players in the Canadian innovation system

GREATER IMPACT

Strategic R&D  Technical Services  Industrial Research Assistance Program  Science Infrastructure
Organizational Structure

DIVISIONS

Emerging Technologies
- Information and Communications Technologies
- Measurement Science and Standards
- National Science Infrastructure
- Security and Disruptive Technologies

Engineering
- Aerospace
- Automotive and Surface Transportation
- Construction
- Energy, Mining and Environment
- Ocean, Coastal and River Engineering

Life Sciences
- Aquatic and Crop Resource Development
- Human Health Therapeutics
- Medical Devices

Industrial Research Assistance Program
- Pacific Region
- West Region
- Ontario Region
- Quebec Region
- Atlantic & Nunavut
- National Office

Common Services to support portfolios and IRAP
## Portfolio Overview

### Market alignment:
- Mining
- Oil & Gas
- Utilities and Independent Power Producers

### Impacts:
- Stronger supply chains
- Increased profitability
- Increased productivity
- Reduced environmental risks

### Target research areas:
- Energy Storage for Grid Security and Modernization
- Bioenergy
- High Efficiency Mining
- Sustainable Water in Mining
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.
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
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.

**Program Goals**

**Materials**
- Resource extraction
- Materials processing
- Batteries (flow, li-ion, lead acid, metal-air)
- CAES
- H2 storage

**Components**
- Smart-grid interfaces
- Inverter
- Control system

**Controls**
- Engineering firms
- System integrators
- Installers

**Integrators**
- Utilities
- Independent power producers
- Micro-grids

**End users**
- **ENABLERS:** capital, business / technology experts, incubators, regulators, gov’t
Sample Projects and Results
Publicly Funded Storage Demonstrations & Pilots in Canada

- > 17 projects
- > $70 M invested, > $179 M in project value

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

Smart Grid in Canada 2012-2013:
SELECTED PROJECTS

- ES performance evaluation in ramping reserve applications
- ES Technology Roadmap (Li-ion)
- **Integrating P2G Module To Existing Storage Valuation Tools**
- Code and safety standards for LiB shipping & delivery
- Framework for data collection and analysis in ES demonstration projects
- Customization of valuation tools to include Canadian jurisdictional data
- Integration of dynamic ES models in power planning & analysis tools
- Evaluation of the secondary usage of vehicle battery packs
Electrochemical Energy Storage for the Integration of Renewables

• **Timeline:** Apr 1st, 2012 to Mar 31, 2015

• **Scope:** Assist NRCan in the evaluation of CEF funded ES demonstration projects by:
  • Gathering real-time operational data
  • Proposing operational scenarios
  • TEA to assess ES projects under specific operating conditions
  • Estimating the cost and reliability of the demonstrated ES technologies

• **Status:** NRC/NRCan Joint Demonstration Project Workshop May 13-14th, 2014, Vancouver BC
  • Feasibility ranking and valuation
  • Standardizing ES Performance / Application Matrices
Development of failure diagnostic tools and testing protocols

Testing protocols
- Failure diagnostics tools
- Dynamic testing protocols for PEM electorlyzers

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

CAN/BNQ1784000
(Hydrogen installation)

DND Power Sources for the Canadian Forces

- **Timeline:** Apr 1, 2011 to Mar 31, 2014
- **Scope:** Support the Canadian Forces in the deployment of energy storage devices by carrying out evaluation studies on the latest battery and fuel cell developments from industry. The primary focus is to identify new battery of performance, safety, reliability and state-of-health. Secondary focuses are the development of new operating procedures and performing expert evaluation of field deployment issues.
- **Status:** Completed
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
Strategic collaboration and co-investment opportunities

ES Market Opportunity

NRC Investment

Value Chain Co-investment

- Reduce Cost & Improve Durability
- 0% to 100% Market Penetration
- $500 to $2500 Price Point ($/kW)

Access a $24-233B global storage market / 10 yrs.¹

$85M-$633M Canadian Economic Benefit / 10 yrs.²
Questions?

Kourosh Malek

Program Technical Lead, Energy Storage for Grid Security and Modernization
T: 604-221-3000
Kourosh.Malek@nrc-cnrc.gc.ca