Future Innovation in Energy Planning

A Special Session to Advise on Ontario's Long-term Energy Future

Emerging Generation Technologies: A 20-Year Prognosis

Alexander McIsaac
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NRStor Company Background

Our mission is to accelerate the commercialization of energy storage technologies

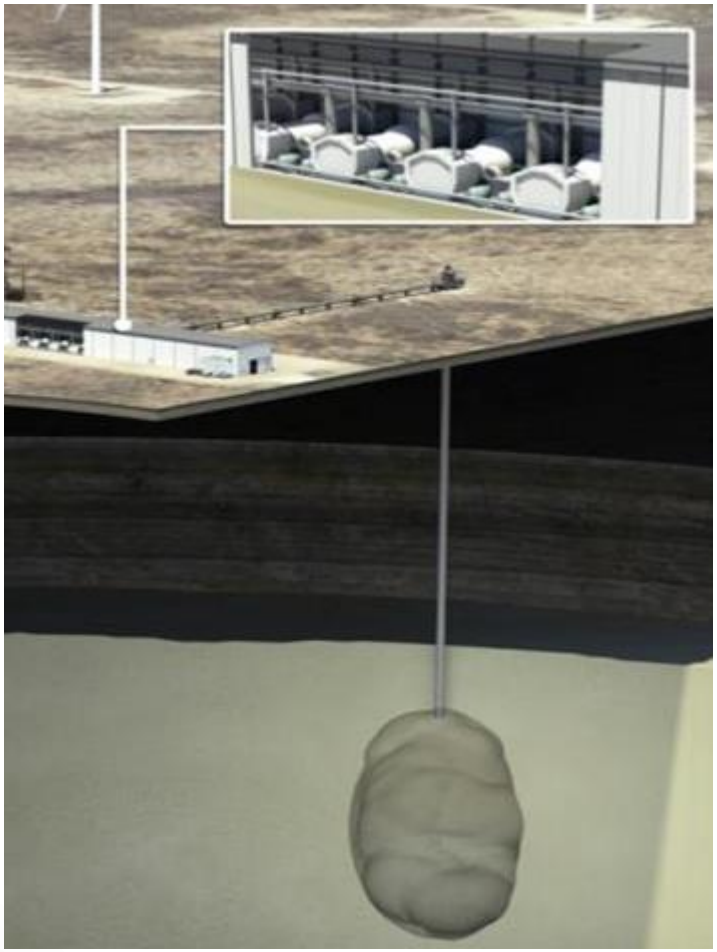
Company Information	• Founded in 2012; Headquartered in Toronto
Operations	• Educating stakeholders; Modeling • Project development; Financing
Business Lines	• Opportunity Assessment • Financing options
Technology Suppliers	• Flywheels; CAES; Batteries
Projects	• 2MW IESO Contract; Assessing future opportunities

What is Energy Storage?

Charge

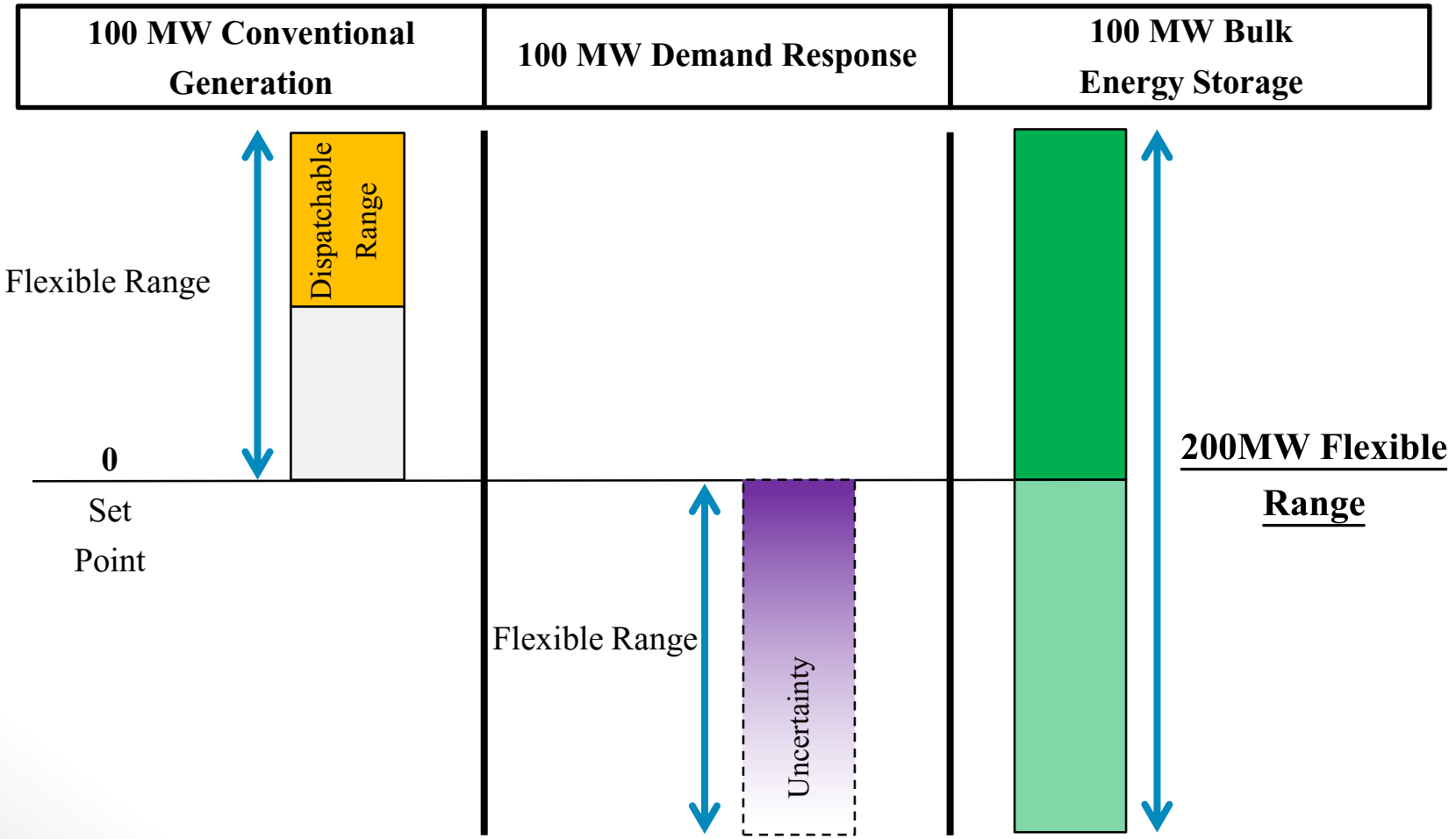
Discharge

Load

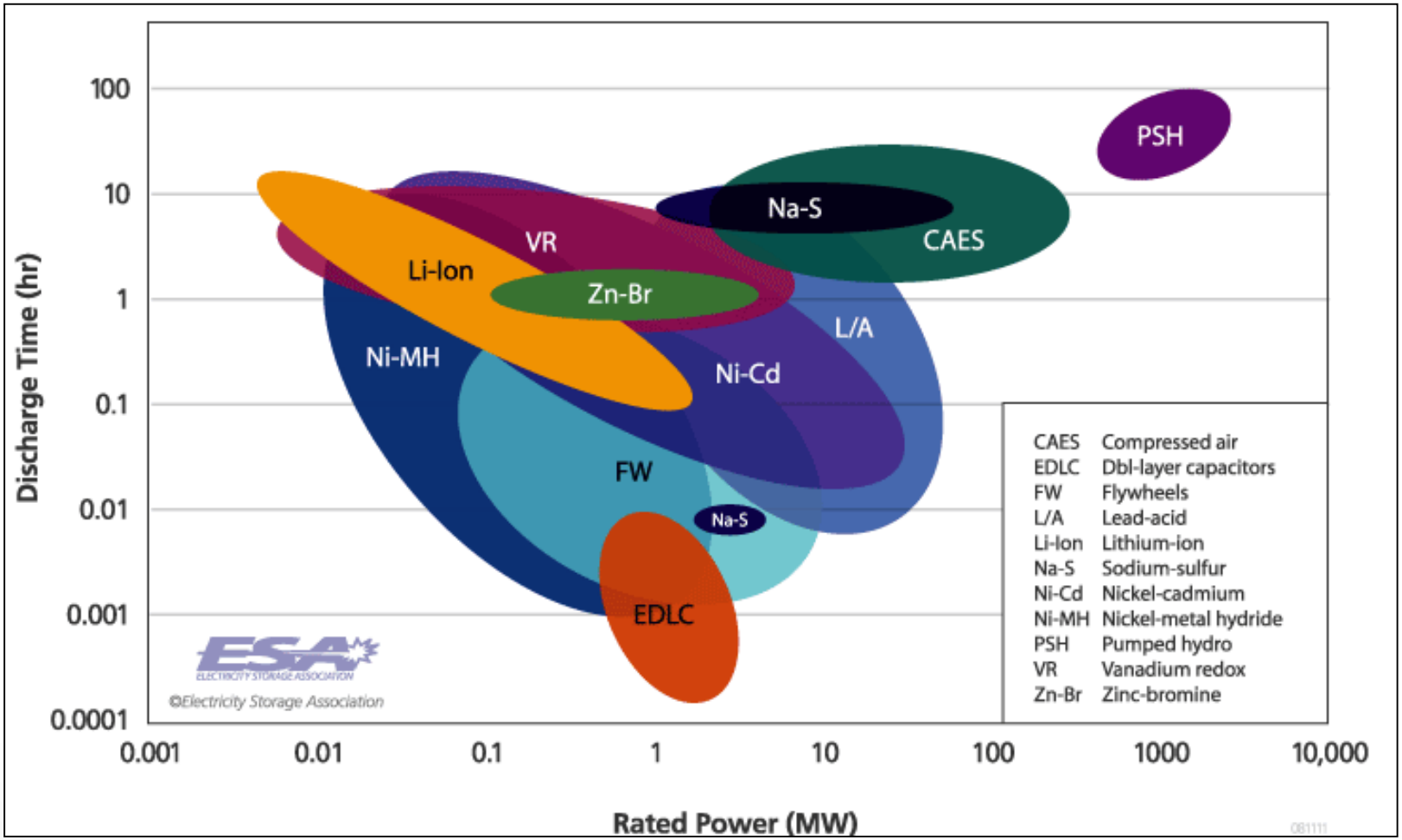


Generation

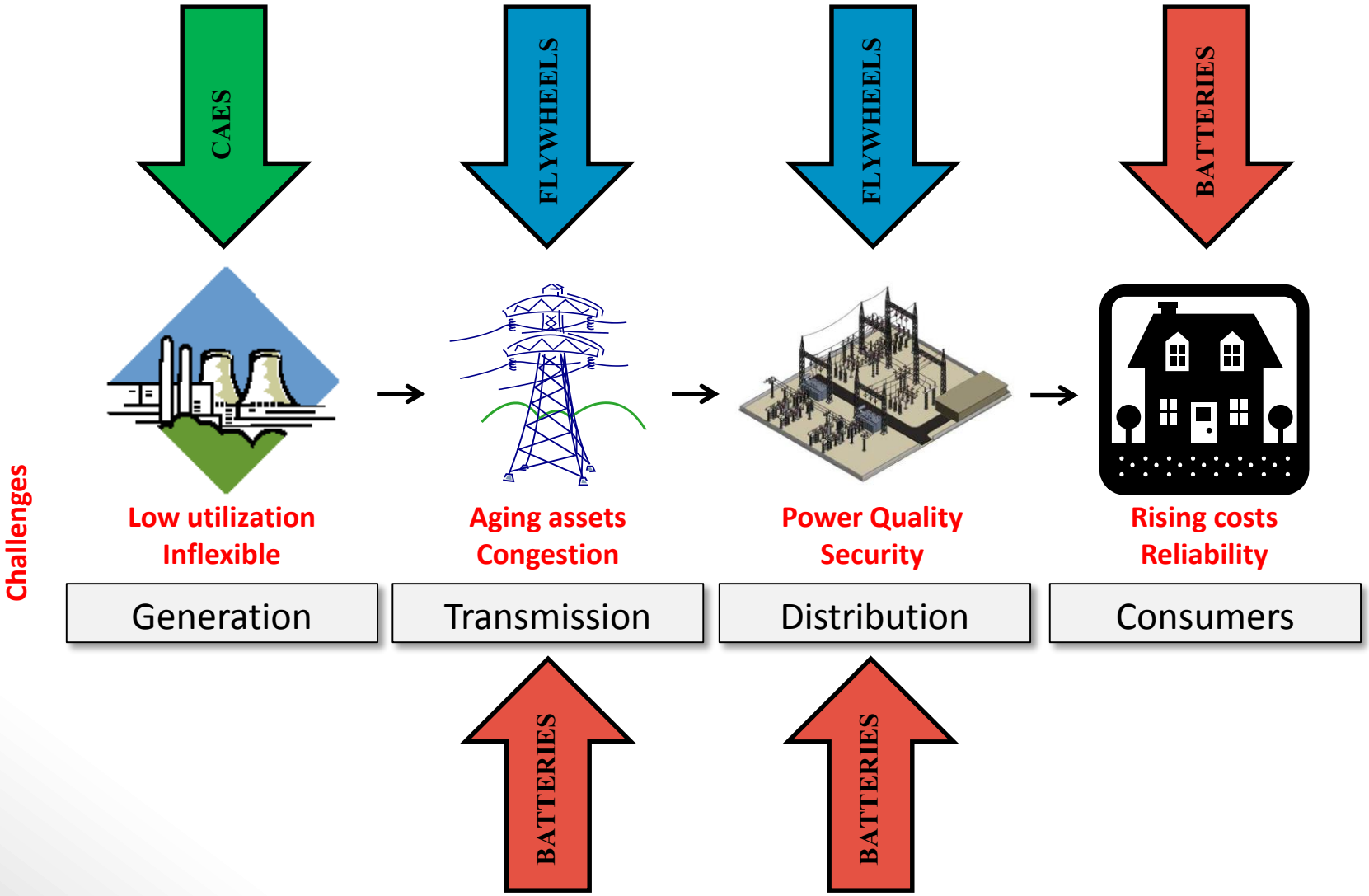
2X the Resource on 1X the Interconnection



Technologies Available Today



Technologies Have Many Applications on the Grid



Different Generation Profiles For Different Services

Optimizing Ontario's Assets:

Technology:

CAES

Flywheels

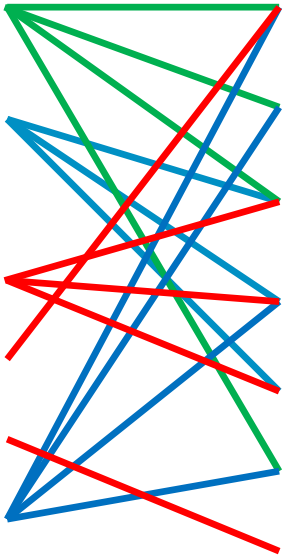
Batteries:

Lithium-ion

Sodium-Sulfur

Lead-Acid

Pumped Hydro



Service:

Fast peaking generation

Storing surplus energy

Wind integration

Frequency regulation

Voltage support

Efficient gas generation

UPS

Hurdles Facing Energy Storage in Ontario

- Developing the business case
  i. Diffused benefits across multiple stakeholders
  ii. Quantifying benefits and avoided costs
- Educating stakeholders
  i. Current state of the energy storage readiness
  ii. Understanding the business case
- Regulatory and procurement environment
  i. No set targets for storage capacity
  ii. Not currently included in the DSC, TSC and related licenses
  iii. Not treated as a wholesale load

Policy Change Happening Internationally

1. United States
   - FERC Orders 755 & 784
   - California
     i. Proposed procurement targets
     ii. Proposed procurement structure (reverse auction mechanism)
     iii. Mandated market growth
   - Texas
     i. Wholesale Storage Load (WSL) treatment
2. Germany
   - World-leader in renewable generation
   - Energy storage subsidy

Energy Storage Business Cases for Ontario

Business Case	Technology	Where is the value?
LDC Smart Grid	Flywheel/Battery	T&D asset deferral; Improved power quality/reliability; Enable higher penetration of green energy and EVs
Regulation services	Flywheel	Faster response frequency regulation; Let traditional gens operate more efficiently
Centralized bulk storage	CAES; Pumped Hydro	New combustion turbine deferral; optimizes grid assets (ie. wind integration)
Industrial & Commercial Customer	Battery	Avoid business interruption (equipment damage, product loss; productivity)
Island & Remote Microgrids	Flywheel/Battery	Reduced diesel fuel & maintenance costs; T&D asset deferral; Renewable integration

Field Battery Energy Storage Project

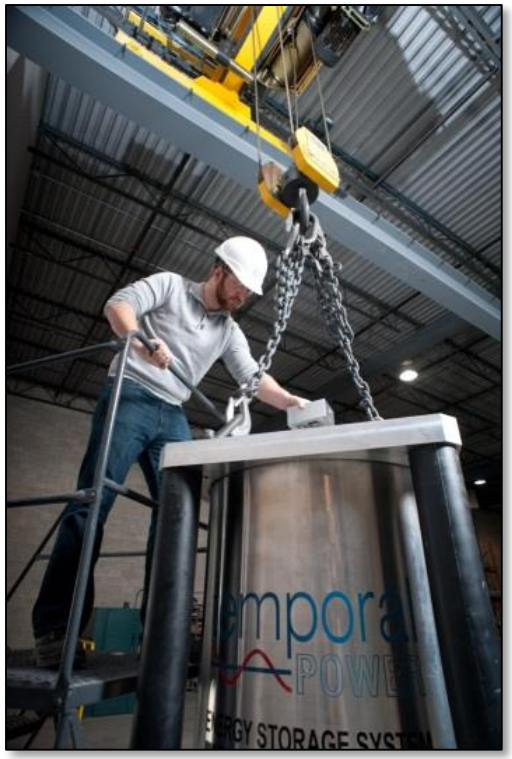
Business Case	Where is the value?
LDC Smart Grid	T&D asset deferral; Improved power quality/reliability; Enable higher penetration of green energy and EVs

Project Specifications	
Technology	Battery
Size	2 MW; 12MWh
Operational Date	2013
Function(s)	Backup Power
Location	Field, British Columbia
Owner	BC Hydro

NRStor Inc. 2MW Flywheel Project

Business Case	Where is the value?
Ancillary services	Faster response frequency regulation; Let traditional gens operate more efficiently

Project Specifications	
Technology	Flywheel
Size	2MW; 500kWh
Operational Date	2014
Function(s)	Frequency Regulation
Location	Minto, Ontario
Owner	NRStor Inc.



General Compression GCAES™ Demonstration

Business Case	Where is the value?
Centralized bulk storage	New combustion turbine deferral; optimizes grid assets (ie. wind integration)

Project Specifications	
Technology	General Compression Advanced Energy Storage (GCAES™)
Size	2MW; 500MWh
Operational Date	2012
Function(s)	Wind Integration (Advanced Prototype)
Location	Gaines, Texas
Owner	General Compression

Bath County Pumped Storage Station

Business Case	Where is the value?
Centralized bulk storage	New combustion turbine deferral; optimizes grid assets (ie. wind integration)

Project Specifications	
Technology	Pumped Hydro Storage
Size	3GW; 30 GWh
Operational Date	1985
Function(s)	Long duration storage
Location	Bath County, Virginia
Owner	Dominion Virginia Power & Allegeny Power

UPS for Industrial Customers

Business Case	Where is the value?
Industrial & Commercial Customer	Avoid business interruption (equipment damage, product loss; productivity)

Project Specifications	
Technology	Battery
Size	4MW (60 sec. duration)
Operational Date	2010
Function(s)	UPS
Location	Phoenix, Arizona
Owner	Phoenix NAP Data Center

Maldives Off-grid Microgrid

Business Case	Technology	Where is the value?
Island & Remote Microgrids	Flywheel/Battery	Reduced diesel fuel & maintenance costs; T&D asset deferral; Renewable integration

Project Specifications	
Technology	Battery
Size	1MW; 1.2MWh
Operational Date	2013
Function(s)	RE Integration
Location	Gasfinolhu Island Resort, Maldives
Owner	T&D Water Technologies and Development

What Can Government, Business and Academia do?

1. Define targets
2. Procurement programs
3. Regulatory policy inclusion:
    1. LTEP and regional planning
    2. Appropriate storage rate class
    3. OEB's renewed regulatory framework for electricity proceedings
4. Continuous improvement of research and modeling

Thank You

Alexander McIsaac

Associate

Tel: (416) 360 2089

E-mail: amcisaac@nrstor.com