Natural Resources Canada | Ressources naturelles Canada

NRCan Smart Grid Symposium

April 9-10, 2024 Ottawa, ON

Canada

Smart Grid Program 1.0 - Portfolio Review

Leaps, bounds and new boundaries

What we'll be speaking about

- Program objective and outcomes
- Types of smart grid solutions tested
- Key achievements from the demonstrations
- Achievements by solution type
- Recipes for success for innovation projects
- Next innovations to tackle
- Topics we'll be exploring over the Symposium

Smart Grid Program 1.0: Objective & Outcomes

"Accelerate the development of smart grids to reduce GHG emissions and generate economic and social benefits."

Innovation Outcomes

- **New knowledge to inform improved regulations, codes, standards**
- **Increased involvement and collaboration of research community and key stakeholders**
- **Increased competitiveness of Canada's cleantech industry and utility operations**
- **Potential for large scale development**

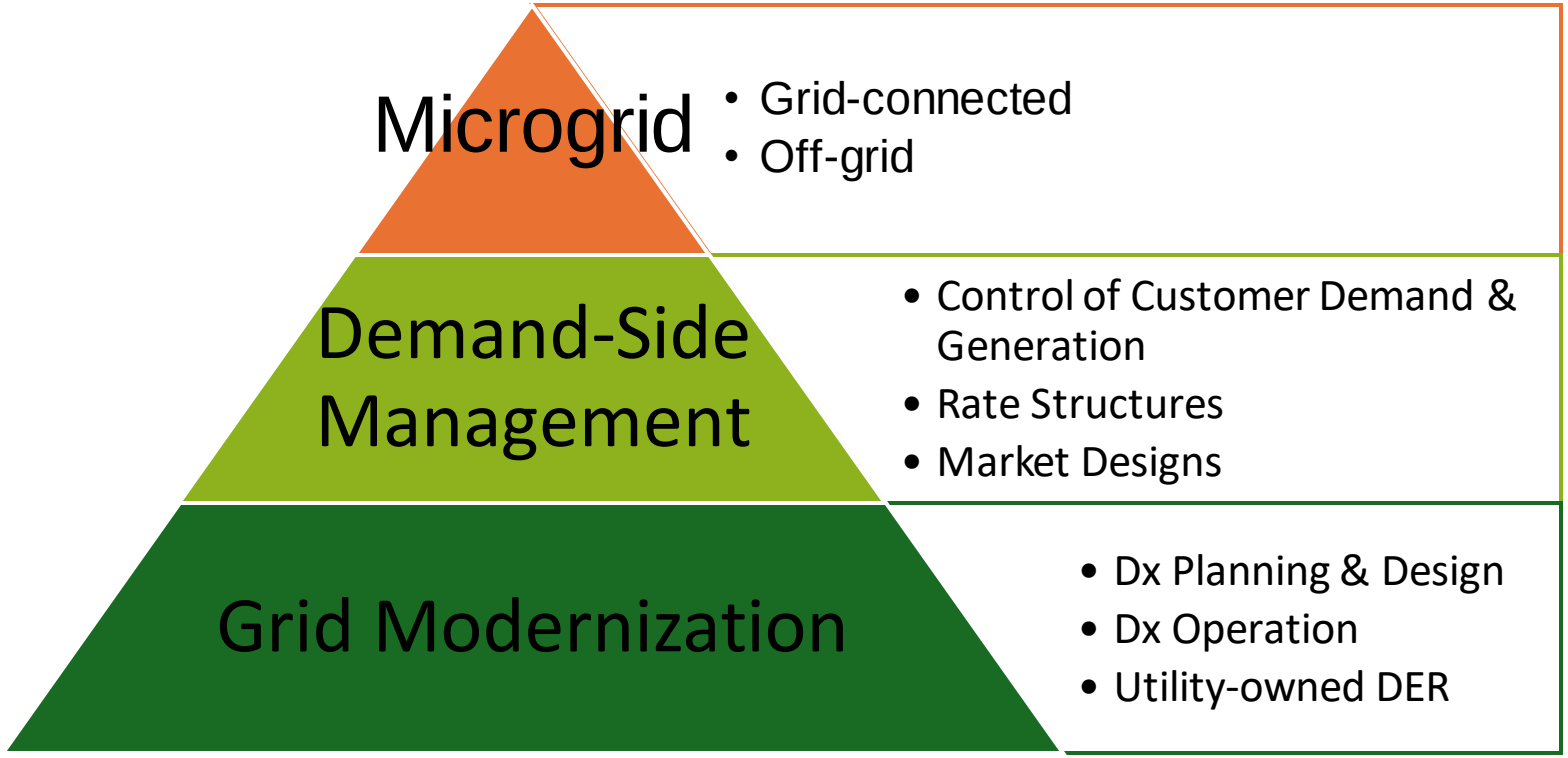
Societal Outcomes

- **GHG emission** reductions
- **Economic and social benefits**

System Outcomes

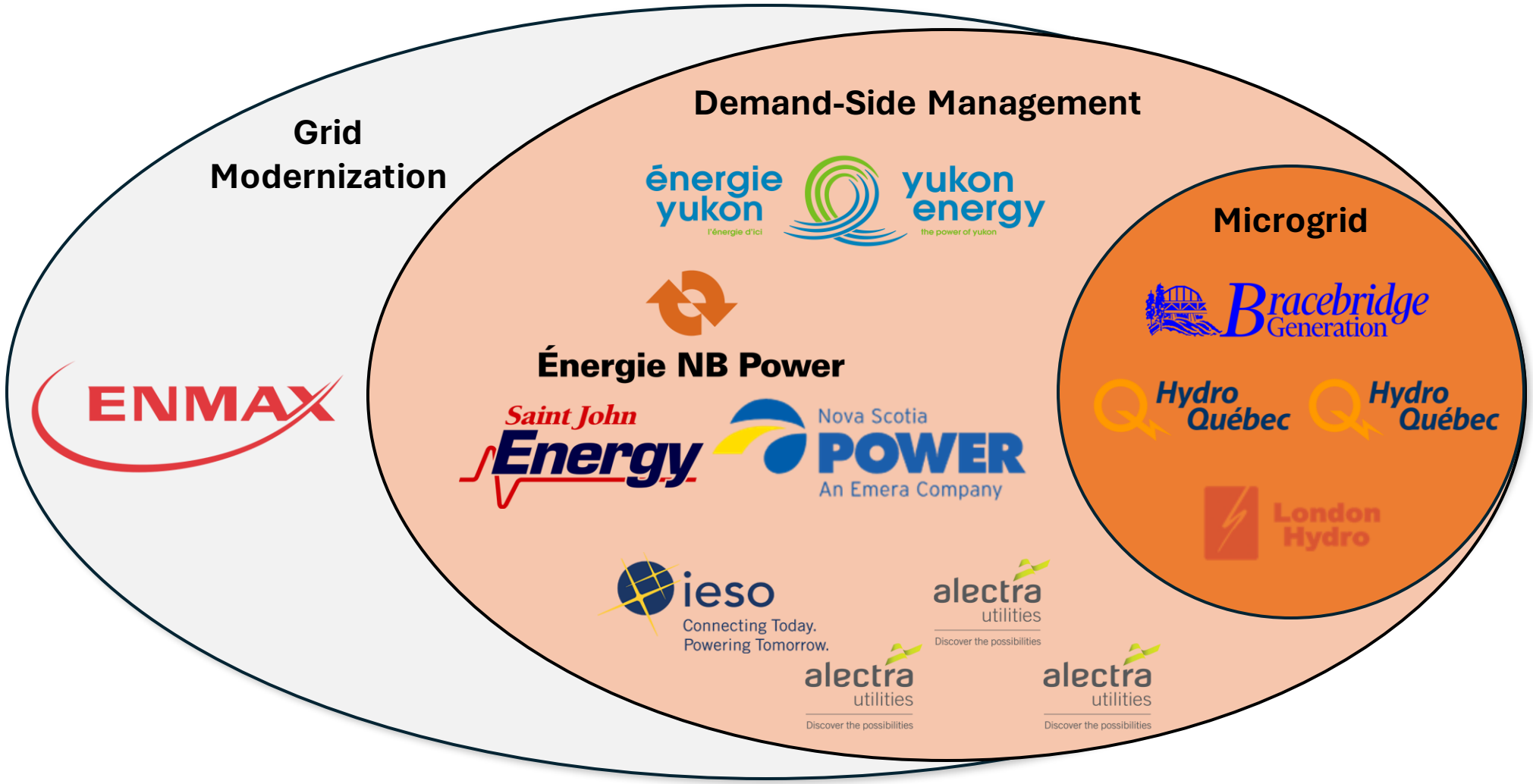
- Optimize **use of the existing** electricity system assets
- Increased system **reliability, resiliency, and flexibility**
- Increased penetration of **renewable generation**
- Improved **cybersecurity**

SGP demo projects fall into 3 broad buckets



Adapted from: US DOE "Modern Distribution Grid – Volume IV - Strategy and Implementation Planning Guidebook", (2020), Figure 6, page 19. URL. Accessed April 2024.

Where each of the 12 projects fall



Key Achievements from demonstration projects of SGP 1.0

Technology

- Bulk System Operator-Distribution Utility-Customer coordination of DERs
- Seamless islanding of microgrids

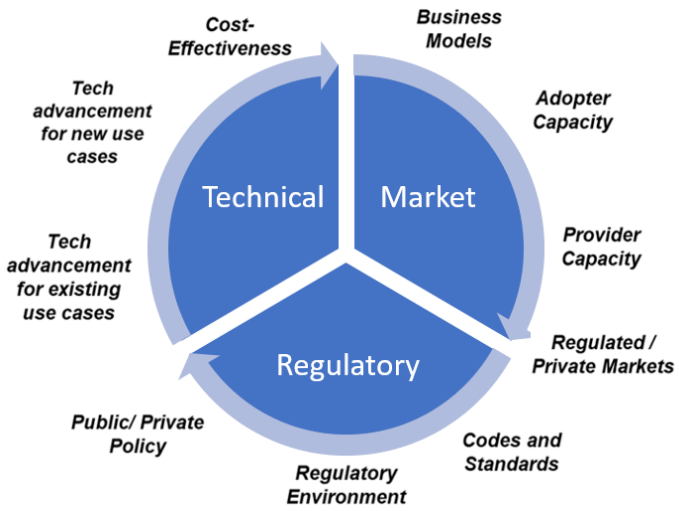
Market

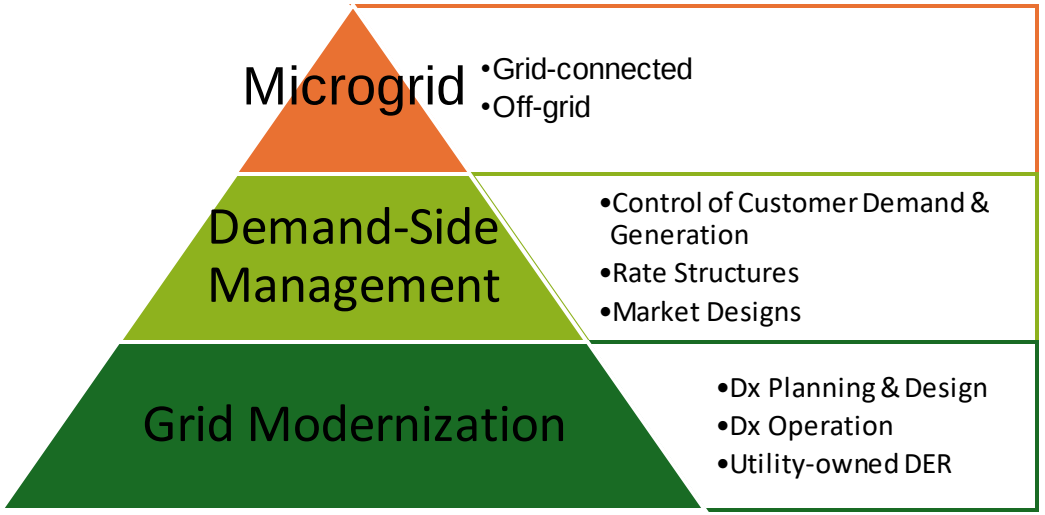
- Business models to enable DER participation from new actors
- Dependable customer performance and high customer satisfaction scores

Regulatory

- Economic use case of non-wires solutions to address grid constraints

Portfolio Analysis Framework





	Technical	Market	Regulatory
Grid Modernization			
Demand-Side Management			
Microgrids			

Achievements: Grid Modernization

- Definition: Distribution system planning, design, and operation (front of the meter)
- Use cases: Improving reliability, resiliency, operational efficiency and asset utilization

Technical	Market	Regulatory
• Novel protection and control schemes • Distributed Energy Resource Management Systems (DERMS) and integration into utility control rooms • Machine learning tools	• Assessing time-value of DERs to the system • Creation of new processes, new departments and job roles within utilities	• Creation of 18+ new utility standards • First application of Innovation Justification Criteria for regulatory approval • T-D coordination model

Achievements: Demand-Side Management

- Definition: Demand response and enabling customer generation (behind the meter)
- Use cases: Peak demand curtailment and grid balancing services

Technical	Market	Regulatory
• DER communication systems and control • Electric-gas hybrid heating control systems • Peak shifting controls (pre-heating or pre-cooling buildings)	• Enhanced customer engagement and compensation platforms • Real-time dynamic pricing signals between utility and customer • High customer dependability and satisfaction	• Recovery of DSM program costs in rates • Testing new customer participation and remuneration models

A wide variety of DERs tested

Front of the Meter


Load Tap Changers


Solar PV


Battery Storage


EV Chargers

Next step: Optimizing dispatch based on value to the grid – and the customer


Solar PV


Electric Battery Storage


EV Chargers


Electric Baseboard Heaters


Electric Air Source Heat Pumps


Electric Hot Water Tanks


Stand-by Diesel Generators


Natural Gas Tankless Water Heaters and microCHP

Behind the Meter

Image reference: [Saint John Energy Smart Energy Project Final Public Report to NRCan]

Achievements: Microgrids

- Use cases: Peak demand curtailment, voltage support/power factor correction, renewables/DER integration

Technical	Market	Regulatory
• Fault management • Microgrid Energy Management System (MEMS) and coordination with DERMS • Seamless planned islanding, blackstart with grid forming capabilities using 100% renewables	• Reduced emissions, deferred infrastructure investment, improved reliability • Strong Indigenous and community consultation, engagement, and partnerships • Replicability to remote communities and urban centers	• Development of practice & interpretation of new standards related to microgrids

Recipes for Successful Innovation Projects: Ingredients from the Proponents

Project Management

Always takes more time & effort

Community & Customer Engagement

Organizational Support

Know the Specs

Technology Selection

Data Strategy

Test early, Fail fast

Where do we go next with innovation?

	Technical	Market	Regulatory

Grid Modernization
Demand-Side Management
Microgrids
	• **Puzzle #1: Fully leveraging DERs**
	  ○ Impacts on power quality
	  ○ Ride-through and grid-forming capabilities for IBR
	• **Puzzle #2: Scaling up DER penetration**
	  ○ Streamlined DER integration and coordination
	  ○ Device connectivity, interoperability, functional equivalence
	• ***Need***: Enhanced distribution planning and operation tools
	• ***Want***: Whole system optimization and improved reliability at the distribution level		

Where do we go next with innovation?

	Technical	Market	Regulatory

Grid Modernization
Demand-Side Management
Microgrids
		• **Puzzle #1: Redefining electricity system actors and their roles**
		  ○ Ownership and compensation models
		  ○ Business transformation
		• **Puzzle #2: Valuing smart grid and non-wires solutions**
		  ○ New services for the grid
		  ○ Customer preferences
		• ***Need***: Cost-benefit tools and new business models
		• ***Want***: Sustainable business models to support grid flexibility, customer choice and affordability	

Where do we go next with innovation?

	Technical	Market	Regulatory

Grid Modernization			• **Puzzle #1**: **Financing** for innovation solutions
			  ○ Rate recovery models
			  ○ Regulations around business models
			• **Puzzle #2: Common technical specifications**
			  ○ Lack of specific codes and standards for new applications
			  ○ Cybersecurity and data governance standards
			• ***Need:*** Experimentation to bring forward evidence needed for pathway development
			• ***Want:*** Accelerating institutional learning to realize the full market potential for innovative solutions

Demand-Side Management			
Microgrids			

Where do we go next with innovation?

	Technical	Market	Regulatory

Grid Modernization
 	
Demand-Side Management
 	
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Symposium: Exploring Deeper Questions

Tuesday – What We Learned

- Complementary role of **regulatory innovation** on technical and market solutions
- How far can we go with **demand side management for reliability, resiliency, and resource adequacy**?
- **Data**: Opportunities and risks
- Journeys to **grid modernization**
- **Microgrids** – pathways for net zero communities?

Wednesday – What's Next?

- **Future of smart grid**: Research efforts
- **Valuing** smart grid and non-wires solutions
- Who pays who, for what, and how much? **Business models** for an active and decentralized grid
- **Bottlenecks** to innovation and scale up
- The **role of the distribution system** in getting to net zero