Microgrid R&D Program at the U.S. DOE

Presenter: Murali Baggu
Program Manager: Dan Ton
2019 Symposium on Microgrids
Fort Collins, August 2019

The Need for Microgrids

The current grid needs more redundancy to protect critical infrastructure and open new value streams.

Critical infrastructure is vulnerable to major disruptions.

Grid infrastructure should be neutral to generation sources while maintaining transmission reliability.

Intentional physical attacks could cause major damage.

Customers are seeking new opportunities to provide grid services to operators and tenants.

Microgrid Program Areas

Remote, Off-grid Microgrids	Grid-connected Microgrids	Networked Microgrids
Resiliency Tools	Standards and Testing	International

Remote, Off-grid Microgrids

Meet community-specific goals. In Alaska, the goal is to achieve a reduction in total imported fuel usage by 50%, while lowering system life-cycle cost and improving reliability and resiliency.

Energy Resilience Challenges Facing Two Alaskan Communities:

- Both villages are rural microgrids supplied by diesel gensets
- Diesel fuel shipped up Yukon River, impassable August-April
- Life threatening issues if diesel runs out during winter
- High energy cost, >25% of average household income

Grid-connected Microgrids

Develop commercial scale (< 10 MW) microgrid systems capable of meeting the 2020 targets:

- **Reduce outage time of critical loads by > 98% at a cost comparable to non-integrated baseline solutions (uninterruptible power supply + diesel generator)**
- **Reduce emissions by > 20%**
- **Improve system energy efficiencies by > 20%**
- **Meet individual community-defined objectives for electricity system resiliency**

2011 Workshop

Defined DOE 2020 targets

Recommended integration of component and system level R&D

2012 Workshop

Prioritized R&D topics - planning/design

Prioritized R&D topics – operations/control

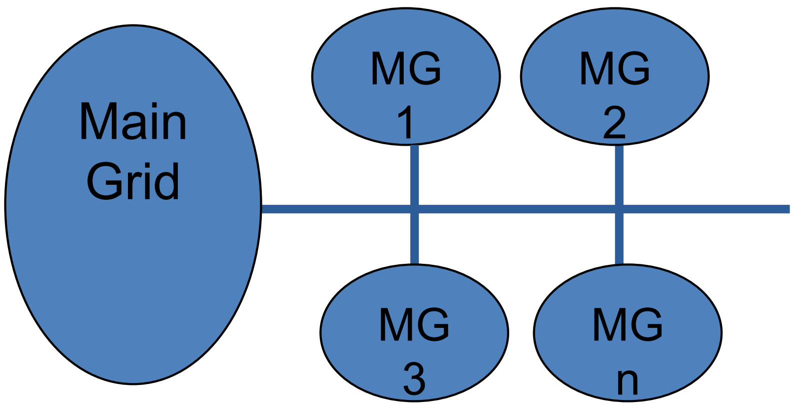
Advanced Grid Research
OFFICE OF ELECTRICITY
US DEPARTMENT OF ENERGY

U.S. DEPARTMENT OF ENERGY

Networked Microgrids

Achieve the following, as compared to a baseline of individually designed and operated microgrids:

- **During extreme event outages, improve customer-level reliability and resilience by:**
  - ✓ **Extending duration of electrical service to critical loads by at least 25%;**
  - ✓ **Maintaining electrical service for all critical loads during a single generator contingency in any microgrid; and**
  - ✓ **Lowering capital expense by at least 15%.**
- **During normal distribution grid operations:**
  - ✓ **Reduce the utility cost of serving the microgrids by at least 10%.**



Multiple microgrids in a mutually reinforcing, power-sharing network with the main grid

Resiliency Tools

Accomplish 20% reduction in systemic impact (calculated from outage duration and frequency and avoided lost load value) under extreme weather scenarios

Microgrid Standards

IEEE 2030.7: Specification of Microgrid Controllers

IEEE 2030.8: Testing of Microgrid Controllers

IEEE working group, "Guide for the Design of Microgrid Protection Systems," approved for development of the next microgrid standard in the P2030 series

International Collaboration

Under U.S.-India Joint Clean Energy Research and Development Center (JCERDC), the collaborative project with 10 academic and 18 private partners from India and U.S. is to develop and demonstrate DSO functions for optimal utilization and management of DER by interfacing DER control and microgrid control system as well as analysis of prototype feeders with high penetration of energy storage.

Smart Grid Component

- Fill the gaps for the integration of DMS and DER controls
- Identify interactive functions in DMS and DER controls that support DSO concepts for grid operations
- Characterize integrated systems through modeling at the field level

Grid Storage Component

- Establish a set of “prototypic” models for electrical system topologies and configurations including loads, generation, storage, etc. for India
- Identify classes of systems for independent and grid integrated microgrids and resilient system architectures

Where We Are – Where We Are Going

PAST

- Campuses and Military Bases
- Single Owners
- Microgrid Design Tools

PRESENT

- Commercial Applications
- Grid-connected and Off-grid Applications
- Local, State, Multi-state and Regional Partnerships

FUTURE

- Networked Microgrids
- Multiple Value Streams
- New Ownership Models

Thank You

Questions?

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Natural Resources Canada | Ressources naturelles Canada

Status of Microgrids in Canada 2019

Dave Turcotte

Fort Collins 2019 Symposium on Microgrids

CanmetENERGY

Leadership in ecoInnovation



Canada

Smart Grid Deployment

SOLAR PV

2.10 GW_{AC} distributed out of

2.48 GW_{AC} installed grid-connected capacity

Data as of December 31, 2017

EV

93.0 k BEWVs and PHEVs on road

> 7.1 k Level 2 charging outlets

> 840 Level 3 charging outlets

Data as of February 7, 2019

SMART METER

>82 % of meters are smart

Data as of December 12, 2018

WIND

0.96 GW_{AC} distributed* out of

12.70 GW_{AC} installed capacity

Data as of December 1, 2018

Federal Funding Programs

Department	Program	Period	Funds
NRCan (Natural Resources Canada)	Energy Innovation Program	ONGOING	$52.9M / year
	Program of Energy Research and Development	ONGOING	$35M / year
	Clean Growth Program	2017 - 2021	$155M
	Green Infrastructure II		
	• Smart Grids	2018 - 2022	$100M
	• Electric Vehicle Infrastructure Demonstrations	2018 - 2022	$30M
	• Electric Vehicle and Alternative Fuel Infrastructure Deployment Initiative	2018 - 2022	$80M
	• Emerging Renewable Power Program	2018 - 2023	$200M
	• Energy Efficient Buildings RD&D	2018 - 2026	$182M
	• Clean Energy for Rural and Remote Communities	2018 - 2024	$220M
NSERC (Natural Sciences and Engineering Research Council Canada)	NSERC Energy Storage Technology Network	2015 - 2020	$5.2M
SDTC (Sustainable Development Technology Canada)	Sustainable Development Tech Fund	ONGOING	$400M
ISED (Innovation, Science and Economic Development Canada)	Strategic Innovation Fund	2017-2022	$1,260M

Public Sector Investments

SMART GRID

$1206 M
TOTAL PROJECT VALUE

$312 M
PUBLICLY INVESTED

150
PROJECTS

MICROGRID

$448 M
TOTAL PROJECT VALUE

$55 M
PUBLICLY INVESTED

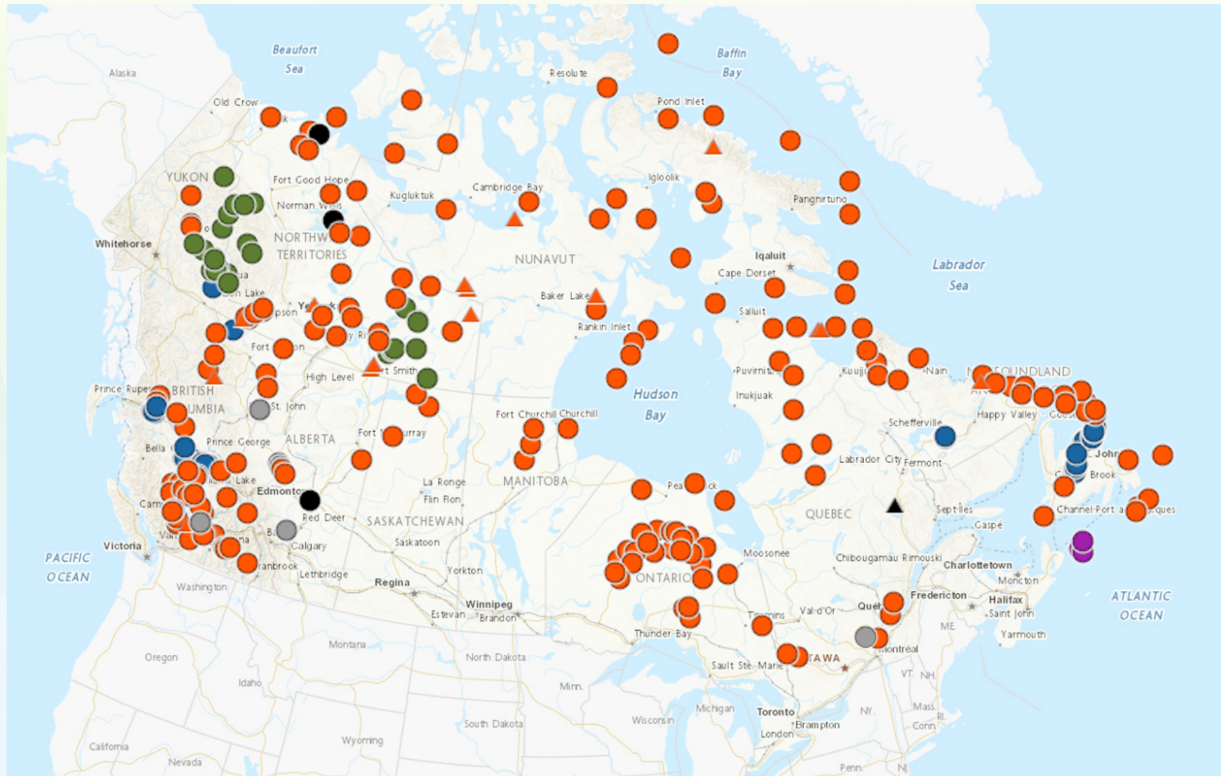
24
PROJECTS

1. Infographic does not include academic funded networks
2. The Ministry of Ontario Energy, Northern Development and Mines Smart Grid Fund is not included due to commercial sensitivity

Remote Communities

Main power source

- Diesel
- Heavy fuel oil
- Hydro
- Natural gas
- Regional grid
- Unknown
- Diesel – commercial
- Natural gas – commercial



Advanced Inverter Functions (AIF)

- AIF are seen as key enablers to operation of remote and other microgrids
- Canada supports AIF development and deployment through
  - Active involvement in the SIRFN and Sunspec Validation Platorm (paper)
  - R&D in AIF applications and impact on renewable hosting capacity
  - Standardization efforts

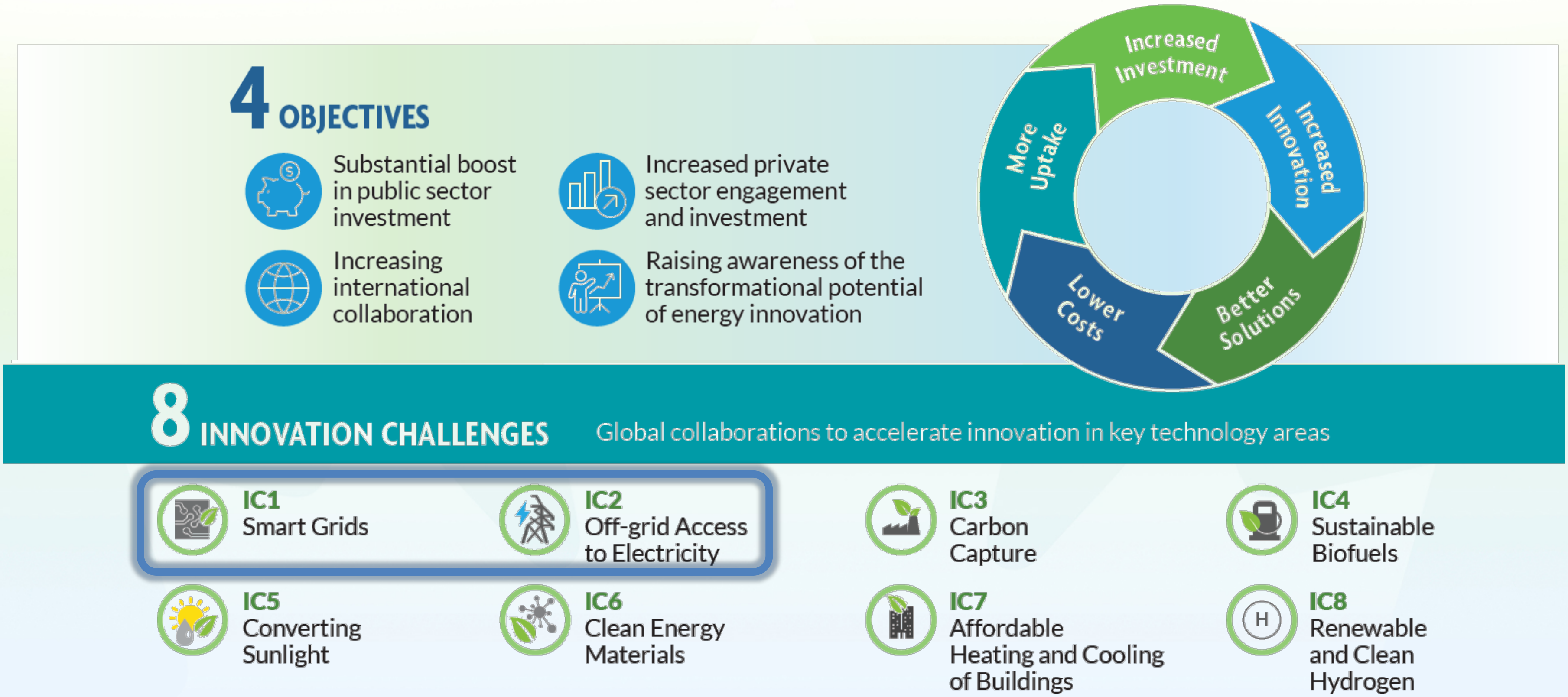
Active Microgrid Projects

- Smart, Proactive, Enabled, Energy Distribution; Intelligent, Efficiently, Responsive (SPEEDIER), Bracebridge Generation,
- Grid Connected Solar plus Energy Storage system with Microgrid capability, Arda Power
- Transactive Energy Network for Clean Generation, Storage, EV Charging Microgrid, Opus One
- Power.House Hybrid: Minimizing GHGs and Maximizing Grid Benefits, Alectra Utilities Corporation
- MiGen Transactive Grid, Hydro Ottawa
- Secondary School Carbon Free Embedded MicroGrid Energy System Demonstration, Ameresco Canada Inc.
- Colville Lake Solar PV + Battery + Diesel, NTPC
- Renewable Energy Microgrid Testing Centre, Canadian Solar
- Microgrid Research and Innovation Park – UOIT, Panasonic Eco Solutions Canada
- Solantro's Autonomous Intelligent Nanogrid Solution, Solantro Semiconductor
- Burlington DC Microgrid, ARDA Power
- Veridian Community Microgrid and Feeder Automation on Distribution Energy Service Platform, Opus One
- Lac-Megantic Microgrid with Solar PV + Battery + EV Charging, Hydro-Québec
- West 5 Net Zero Community, s2e / Sifton
- Advanced Distributed Commercial Microgrid, Green Power Labs
- Community Renewable Energy Microgrid Demonstration Project, Medecine Hat College
- North Bay Community Energy Park, North Bay Hydro Services
- Deployable Microgrid, Nova Scotia Community College

+ 4

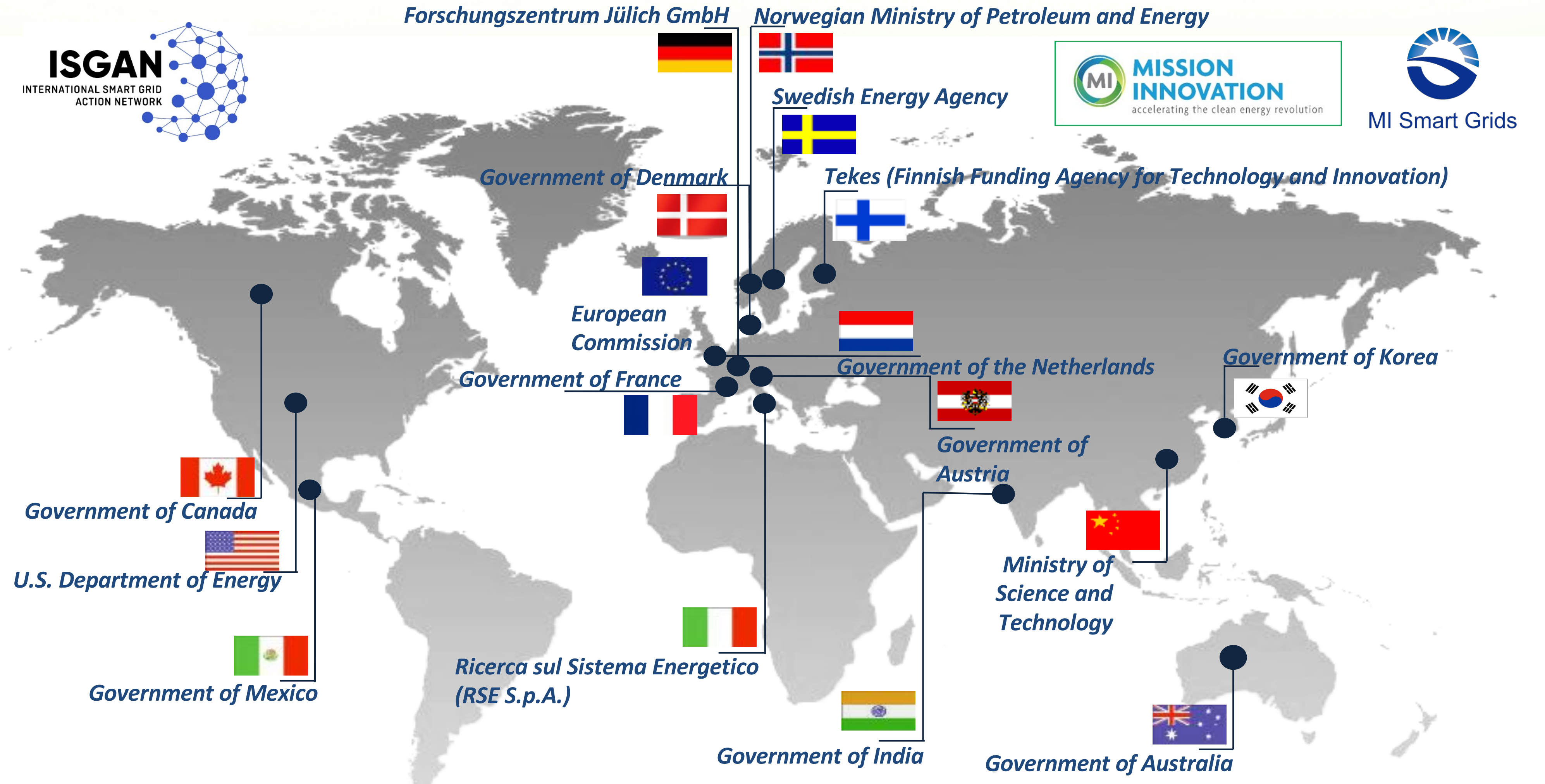
new microgrid projects to be announced shortly

Mission Innovation



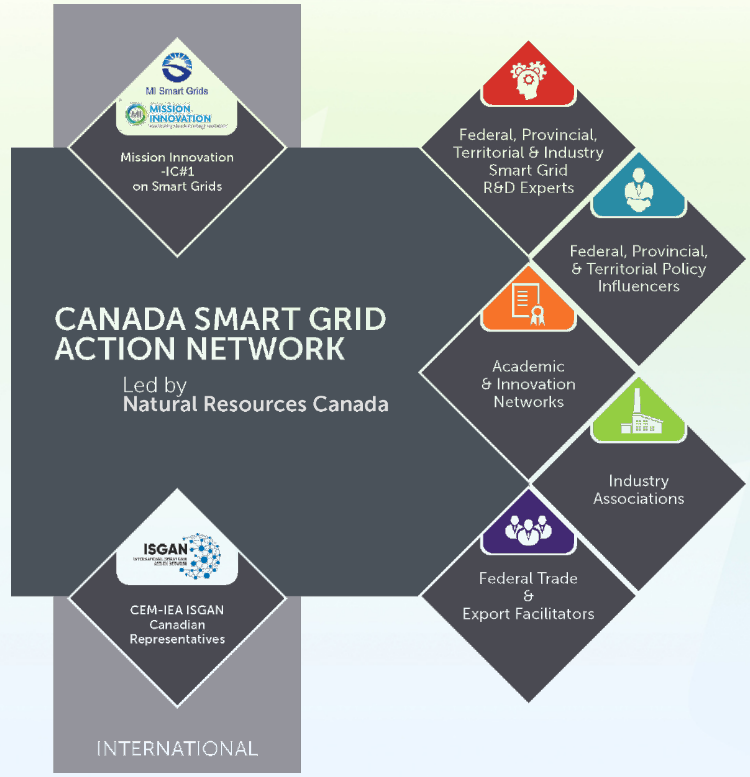
Source: http://mission-innovation.net/about-mi/overview/

ISGAN and MI IC#1 members



Canada Smart Grid Action Network (CSGAN)

- Content to produce Smart Grid in Canada Report gathered through CSGAN from discussions on regional activities, research interests, smart grid metrics, shared knowledge and experiences, and track standard development.



For more information…

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Fort Collins 2019
Micro-Grid Symposium

Guillermo Jiménez; Felipe Valencia, Rodrigo Palma

02/09/2018 – 06/09/2018

Overview of micro-grids in Latinamerica

CENTRO DE ENERGÍA
UNIVERSIDAD DE CHILE

Universidad de los Andes

fcfm
FACULTAD DE CIENCIAS FÍSICAS Y MATEMÁTICAS
UNIVERSIDAD DE CHILE

Summary of projects

Holbox Island,
Design
Yucatan, Mexico

Puertecitos,
Operative
Baja Califonia, Mexico

Puerto Alcatraz, San Juanico
Operative
Baja Califonia, Mexico

Nariño
Design
Nariño, Colombia

Esmeraldas
Operative
Esmeraldas, Ecuador

Ayllu μgrids
Design
Arica, Chile

Huatacondo
Operative
Tarapacá, Chile

PSDA
Design
Antofagasta, Chile

Ollagüe
Operative
Antofagasta, Chile

El Toqui
Operative
Aysén, Chile

TEC,
Operative
Costa Rica

Guajira,
Implementation
Guajira, Colombia

Micro-red UPB
Implementation
Medellín, Colombia

Celsia,
Development
Yumbo, Colombia

Fernando Noronhna
Operative
Pernambuco, Brasil

Lencóis island
Operative
Maranhao, Brasil

Cemig μGrid
Pilot application
Belo Horizonte, Brasil

Trinidad island
Feasibility
Rio State, Brasil

Islas Desertores
Operative
Chiloé, Chile

Overview of micro-grid projects in Latinamerica

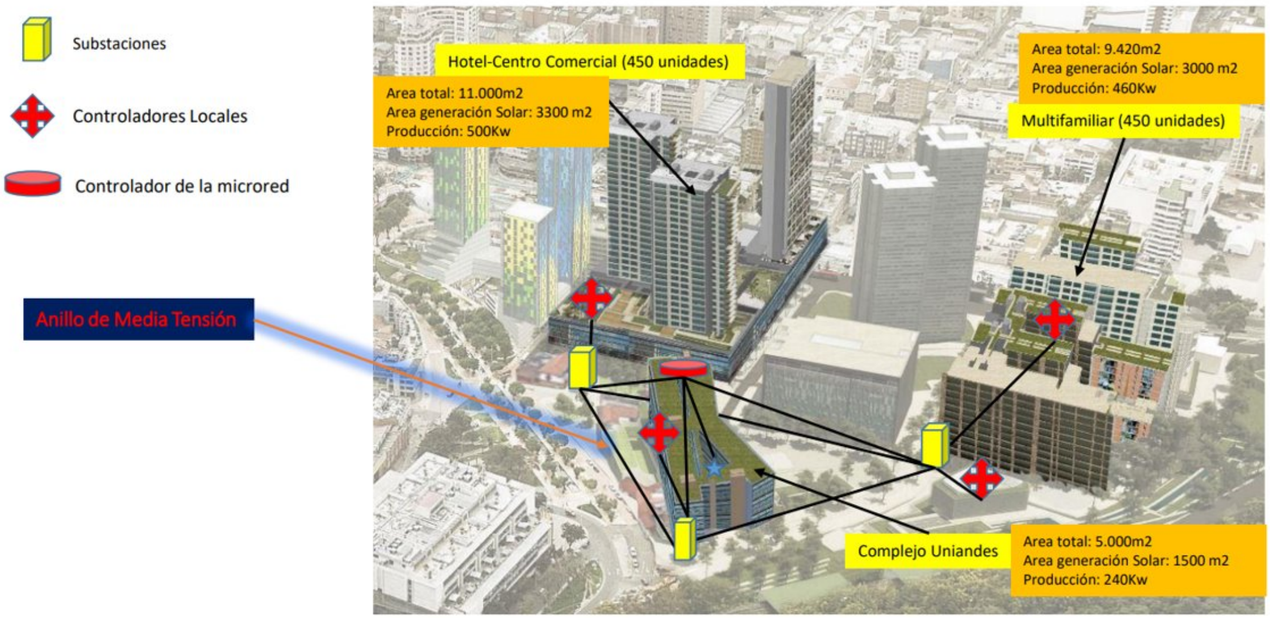
Some new projects in the region

1/ Progresa Fenicia Microgrid project

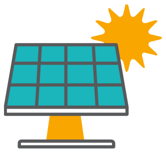
Pilot project to be developed in Bogota's Downtown

Microgrid Progresa Fenicia

Generación Solar pico de 1.2 MWH
Consumo de 900 unidades 1.8 MWH

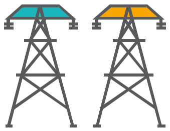


PSDA



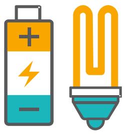
A. Energy sources

- Rooftop PV
- Battery energy storage system (lead-acid technology).
- Natural Gas fired engines



B. Grid connection

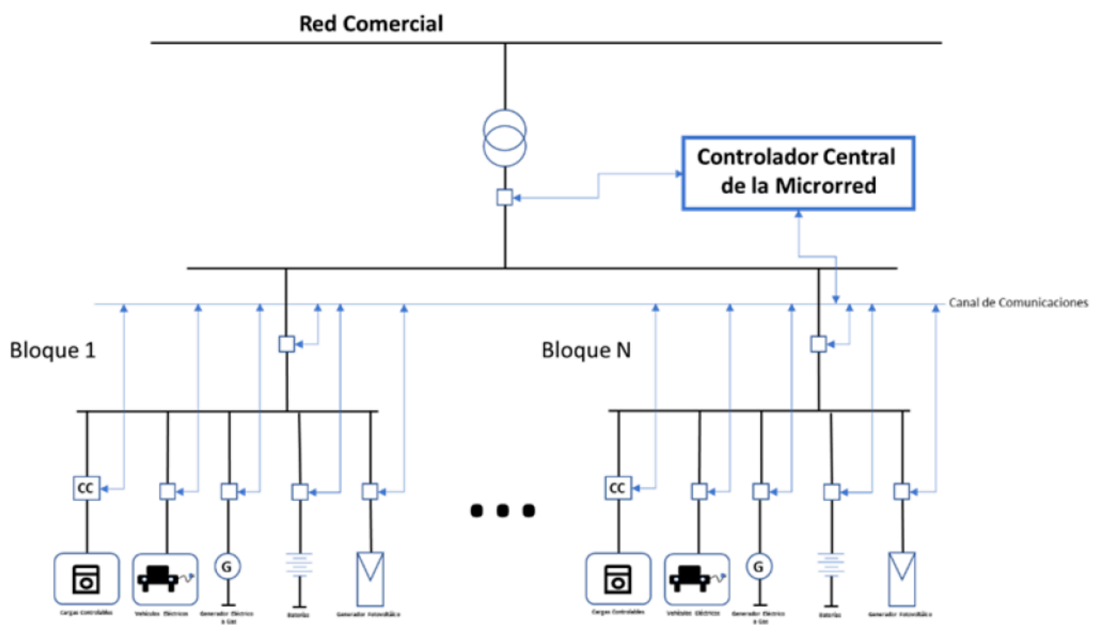
- Grid-connected 3-phase micro-grid.
- 210V/60 Hz Grid Connection
- Three main microgrids coordinated.



C. Application range

- Programmable loads.
- Community participation.
- Research facility

FENICIA (1st Stage)

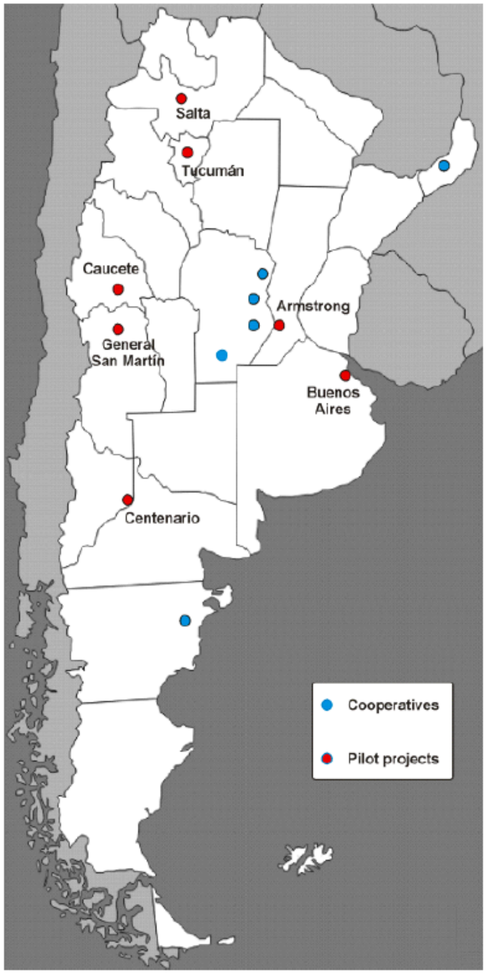


CC: Controlador de Carga

Overview of micro-grid projects in Latinamerica

Some new projects in the region

2/ Argentina's developments



City	Quantity of smart meters	Type of users	Main characteristics of the project
Armstrong	1000	Urban, semiurban	Smart metering, use of renewable energies (500 kW), SCADA in medium voltage, use of cell networks and PLC
Salta	1800	Urban	Communications based on cell networks and PLC
Centenario	5240	Urban	Includes a project of distributed generation based on photovoltaic in the downtown
General San Martín	5000	Urban and rural, including irrigation and lighting	Bidirectional meters, use of RF mesh technologies for communications
Buenos Aires	5000	Urban	First step in the future implementation of a 2.5 million smart meter network
Tucumán	aprox. 500	Urban	Monitor and control in some of the poorest neighbourhoods of the city
Caucete	220	Urban	Includes some photovoltaic distributed generation units.

Rural electrification initiative

ACCIONES

- Proyectos cobertura por Fondos (FAZNI, FAER)
- PERS / PIEC / PECOR
- Plan Todos Somos PAZcifico
- PNER
- Fondo ZNI (SAI) – GD CONPES 3855/16
- Área de Servicio Exclusivo (Res. CREG 076/16)
- Tarifas ZNI (Res. CREG 091/07+&)

UPME: Esquemas de modelos sostenibles en las ZNI (BID)

Reuniones sectoriales (nov, dic) para el análisis y discusión de microrredes sostenibles

El futuro es de todos – Minenergía: Diseño, implementación y evaluación del plan de comunicación, promoción y posicionamiento del programa de gestión eficiente de la demanda de energía en ZNI (SAI)

DNP Departamento Nacional de Planeación / IPSE Instituto de Planificación y Promoción de Soluciones Energéticas para las Zonas No Interconectadas: Ampliación de la cobertura de telemetría y monitoreo de variables energéticas en la ZNI

Superservicios Superintendencia de Servicios Públicos Domiciliarios:

Soluciones tecnológicas en ZNI

Diseñar un esquema de vigilancia diferencial para los prestadores de ZNI

Diseñar un modelo espacial y la geodatabase para la localización y georreferenciación de las ZNI

CREG Comisión de Regulación de Energía y Gas: Doc. 002/14 Marco regulatorio prestación servicio de energía eléctrica en ZNI

DNP Departamento Nacional de Planeación: Evaluar y establecer los procedimientos para considerar el mecanismo APP como alternativa para la ampliación de cobertura del servicio de energía eléctrica en las ZNI (BID)

… | 2017 | 2018 | 2019

WORLD ECONOMIC FORUM

1. Fortalecer el marco normativo y la coordinación inter-institucional
2. Promover los encadenamientos productivos e iniciativas empresariales
3. Empoderamiento y desarrollo de habilidades y capacidades tecnológicas
4. Promover e incentivar el uso integral y eficiente de tecnologías

Res.CREG 012 Solar Pto. Inírida / 038 AG

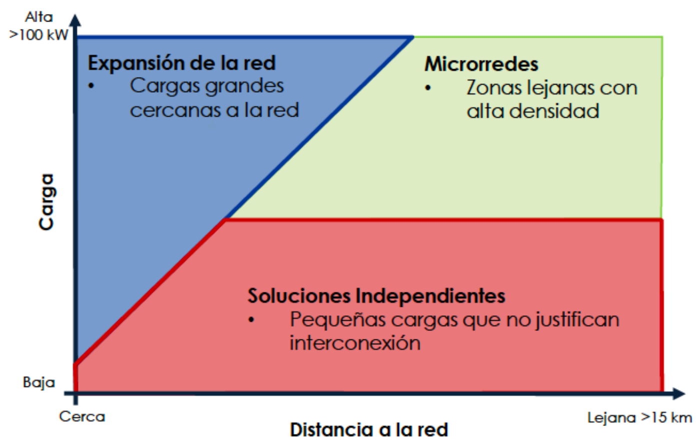
CREG Comisión de Regulación de Energía y Gas: Propuestas (7) *Comisión asesora*

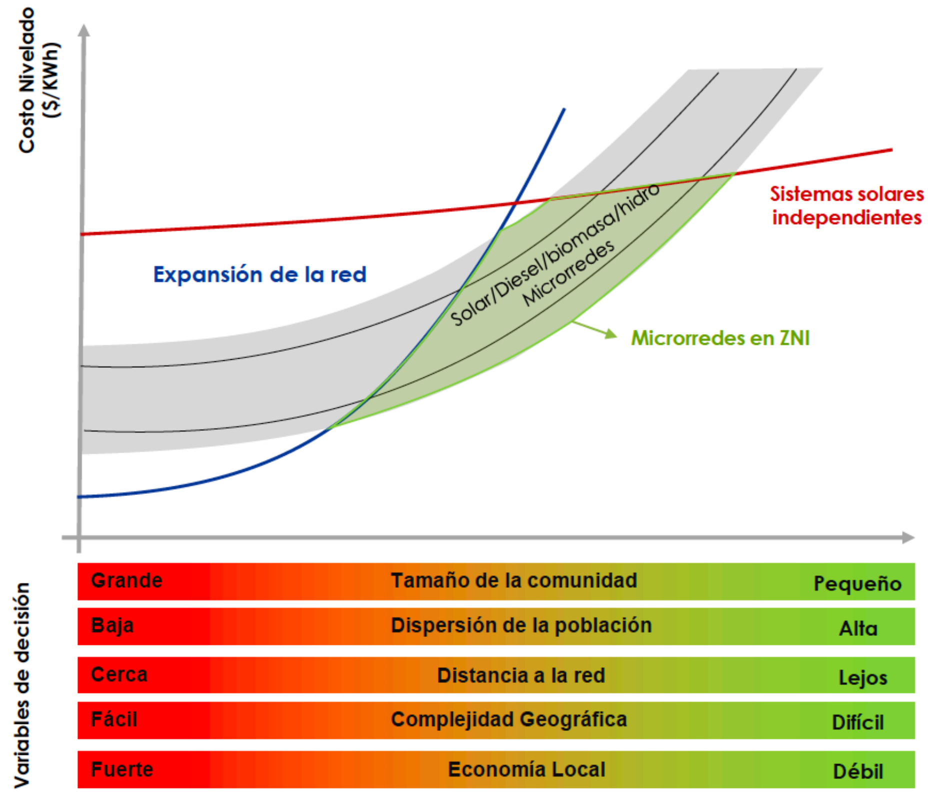
Colombia inteligente – UPME

Universidad de los Andes – CENTRO DE ENERGÍA UNIVERSIDAD DE CHILE

Alternativas de Expansión

- Expansión de la red
- **Microrredes**
- Sistemas Independientes





Conferences & Workshops

SiMIIER 2019
3er SIMPOSIO IBERAMERICANO en
Microrredes Inteligentes con Integración de Energías Renovables
http://simiier.meihaper.org/

Parque Tecnológico Itaipú,

Foz do Iguazú, Brasil

01 al 03 de Octubre 2019



El **SiMIIER 2019** tendrá lugar del 01 al 03 de octubre de 2019 en el Auditorio Milton Santos del Parque Tecnológico Itaipú (Foz do Iguazú, Paraná - Brasil), organizado por la **Red MEIHAPER CYTED**, con el patrocinio del **Programa Iberoamericano de Ciencia y Tecnología para el Desarrollo (CYTED)**.

Fechas Importantes

25/07/2019 - Llamada a propuestas (resumen)
25/08/2019 - Cierre llamada
07/09/2019 - Información de resultados
25/09/2019 - Envío de trabajos completos
01-03/10/2019 - 3er SiMIIER

La Red **MEIHAPER CYTED** (Microrredes Eléctricas Híbridas con Alta Penetración de Energías Renovables) está integrada por más de 30 grupos de investigación y empresas de 10 diferentes países (Argentina, Brasil, Chile, Colombia, Ecuador, España, México, Perú, Portugal y Venezuela).

Se aceptan propuestas de contribuciones en las siguientes categorías:
Mini cursos, conferencias, ponencias de trabajos completos (entre 6 y 12 páginas) y posters.

Temas de Interés Relacionados con Microrredes Inteligentes:
Los temas de Interés del SiMIIER 2019 incluyen, entre otros, políticas de promoción; energía distribuida; redes inteligentes; convertidores electrónicos de potencia; integración de vehículos eléctricos; sistemas de supervisión y control; gestión de energía (generación y demanda); almacenamiento de energía; integración de energías renovables; medidores inteligentes; optimización; modelado y simulación; sistemas híbridos; educación y divulgación; métodos y herramientas de diseño; uso racional y eficiente de la energía; detección, diagnóstico y tolerancia a fallas.

Formato:
Las propuestas de trabajos podrán estar escritas en español, portugués o inglés, en el formato exigido por la Revista IEEE América Latina (**http://www.ewh.ieee.org/reg/9/etrans/esp/info_autores.htm**).

Envío de Trabajos:
Las propuestas deben ser enviadas a **simiier@meihaper.org** y en el asunto debe decir: **"SiMIIER 2019 <Nombre del Autor>"**.

COSTOS

Inscripción al Simposio: **SIN COSTO**
Derecho a Publicación: **SIN COSTO**
Becas: se otorgarán **BECAS DE TRASLADO Y ALOJAMIENTO** a los autores de las mejores propuestas, las que serán seleccionadas por el Comité SiMIIER 2019.

SiMIIER 2019
3er SIMPOSIO IBERAMERICANO en
Microrredes Inteligentes con Integración de Energías Renovables
http://simiier.meihaper.org/

El SiMIIER es un lugar de encuentro que tiene los siguientes objetivos:

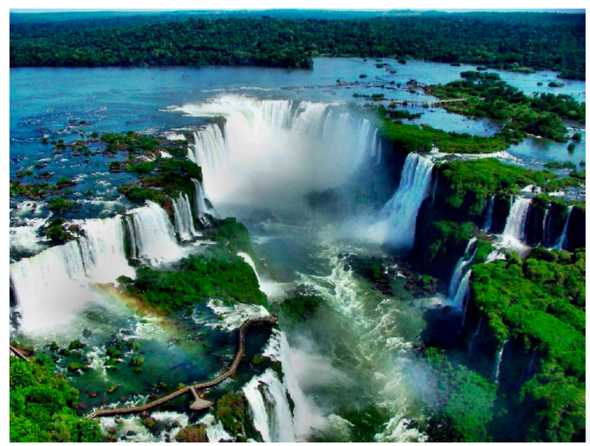
- ✓ Fomentar la integración de la Comunidad Científica y Tecnológica Iberoamericana, promoviendo una agenda de prioridades compartidas para la región.
- ✓ Fortalecer la capacidad de desarrollo tecnológico de Iberoamérica mediante la promoción de la investigación científica conjunta, la transferencia de conocimientos y técnicas, y el intercambio de científicos y tecnólogos entre grupos de I+D+i de los países miembros.
- ✓ Promover la participación de sectores empresariales de los países miembros interesados en los procesos de innovación, en concordancia con las investigaciones y desarrollos tecnológicos de la Comunidad Científica y Tecnológica Iberoamericana.
- ✓ Promover la participación de los investigadores de la Región en otros programas multilaterales de investigación a través de acuerdos específicos.

Lugares para Visitar

Para todos los asistentes al SiMIIER 2019 que lo deseen, está incluida una visita al Parque Tecnológico Itaipú, a la Represa Hidroeléctrica Itaipú (la mayor del mundo, 14 GW de potencia instalada con 20 generadores de 700MW) y a la Estación de Transmisión de Furnas (3 líneas de 765kV en CA y 2 líneas de HVDC de ±600kV CC y 6.300 GW nominales).

Itaipú se encuentra a pocos kilómetros de la ciudad de Foz de Iguazú, la mayor ciudad de la llamada "Triple Frontera" (Argentina, Brasil y Paraguay), distante 15 Km de la ciudad de Puerto Iguazú en Argentina y 12 Km de la Ciudad del Este, Paraguay, conectadas por los puentes internacionales Tancredo Neves y de la Amistad, respectivamente.

La mayor atracción turística de la región es el internacionalmente conocido "Parque Iguazú", donde se encuentran las Cataratas del Iguazú, una de las "siete maravillas naturales del mundo" (https://es.wikipedia.org/wiki/Cataratas_del_Iguaz%C3%BA).



CENTRO DE ENERGÍA UNIVERSIDAD DE CHILE

PROGRAMA IBEROAMERICANO CYTED CIENCIA Y TECNOLOGÍA PARA EL DESARROLLO