Natural Resources Canada | Ressources naturelles Canada

Status of Microgrid RD&D in Canada 2018

Farid Katiraei

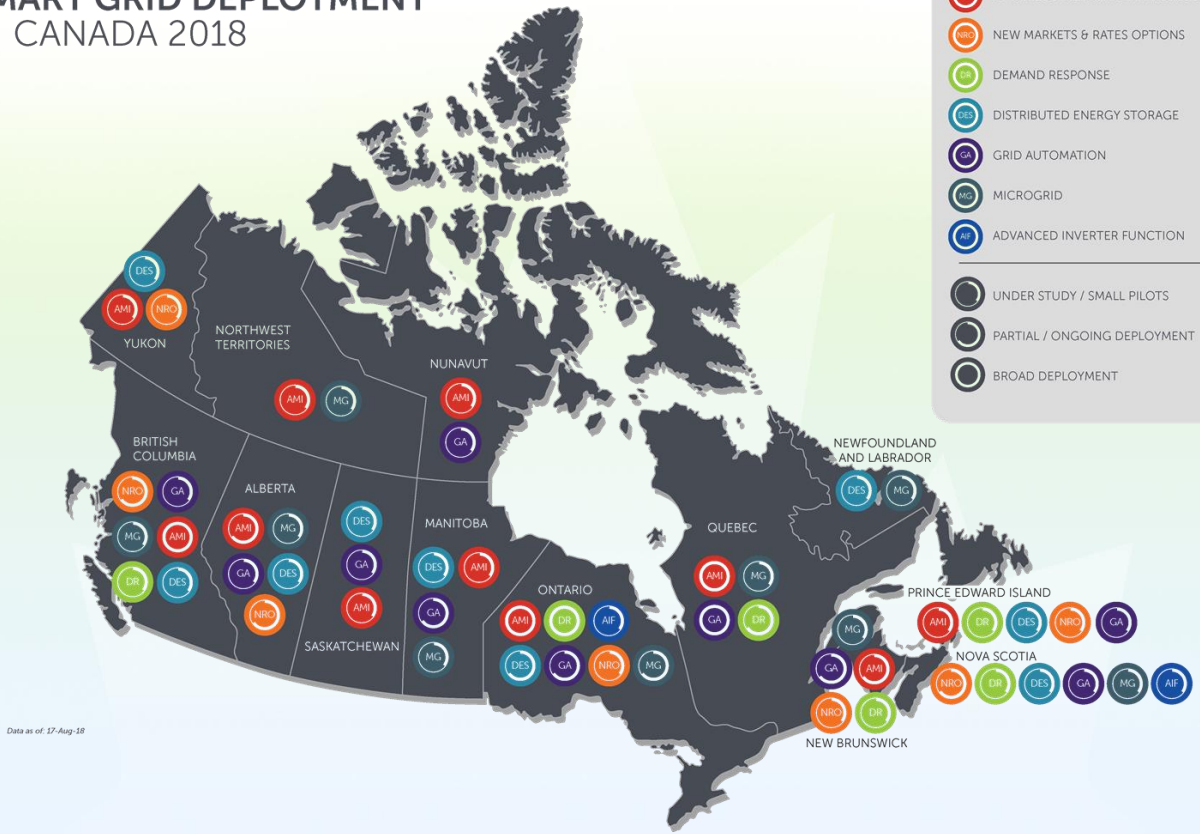
Bucharest 2018 Symposium on Microgrids

CanmetENERGY

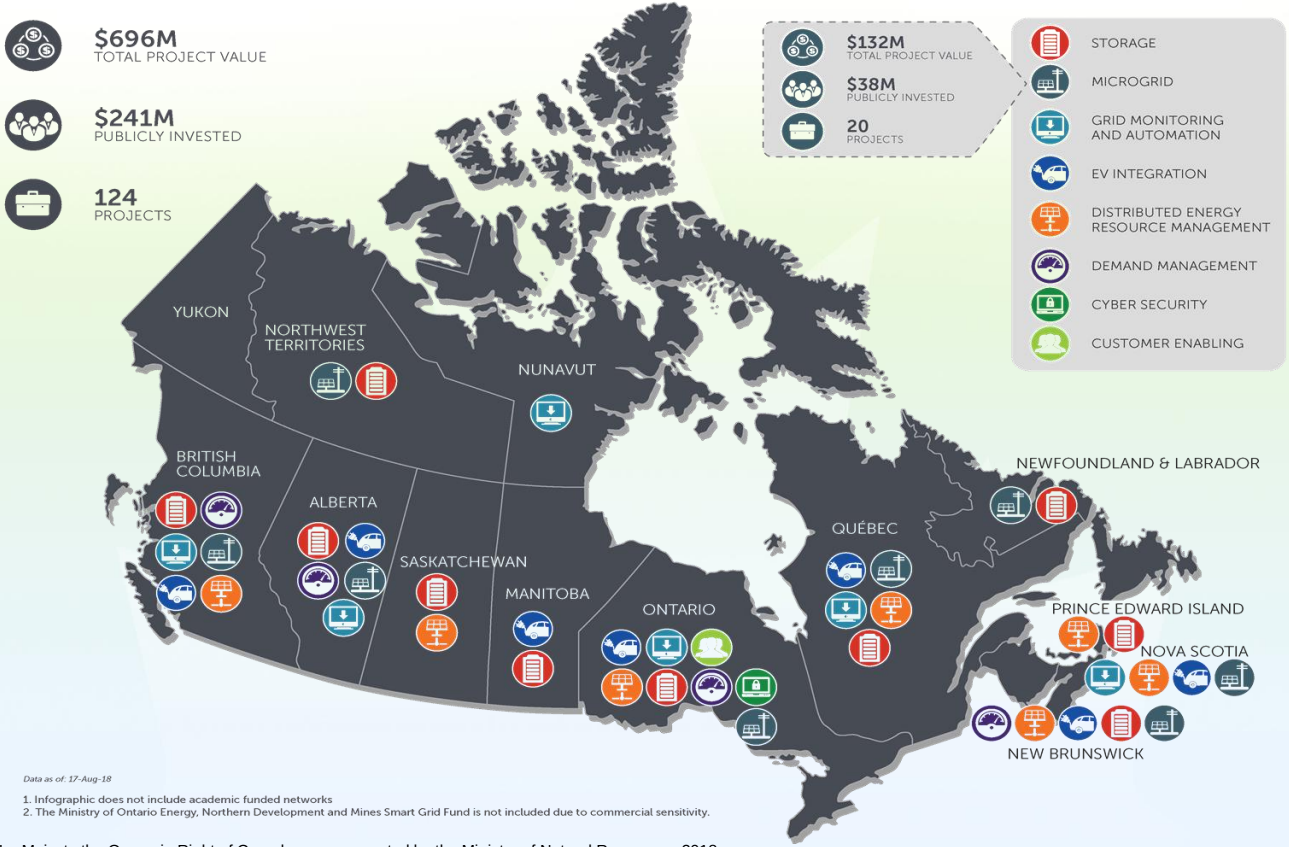
Leadership in ecoInnovation

Canada

SMART GRID DEPLOYMENT
IN CANADA 2018



CUMULATIVE PUBLICLY FUNDED SMART GRID DEMONSTRATIONS AND PILOTS IN CANADA SINCE 2003



Data as of: 17-Aug-18

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.

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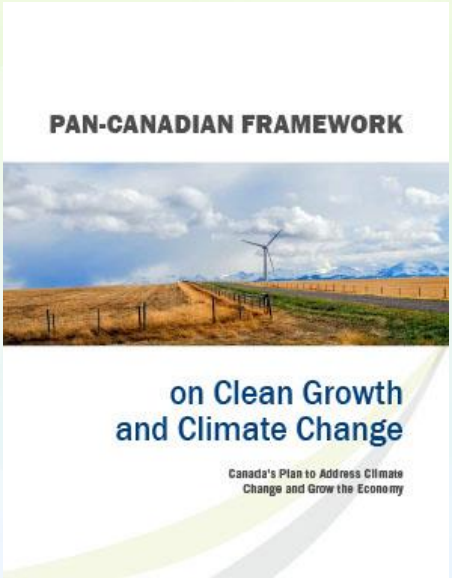
Canada

Public Funding from 2018-2024 under Pan-Canadian Framework

- Green Infrastructure Phase 2
- Energy Innovation Program
- Program of Energy Research & Development
- Clean Growth Program
- Strategic Innovation Fund

Total Funding ≈ $ 2.4 B CDN



Recent Publicly Announced Microgrid Projects

- Transactive Energy Network for Clean Generation, Storage, EV Charging Microgrid
- Grid Connected Solar PV + Energy Storage Microgrid
- 100% Renewable (Solar PV + Wind + Storage) Microgrid Study
- North Bay Community Energy (Solar PV + Battery + Co-generator + EV Charging) Microgrid
- Mobile Microgrid Container Capable of Generating and Storing Renewable Energy
- Building-Scale Microgrid Integrated with Solar PV + Storage with Smart Controls
- Community Renewable Energy Microgrid
- Grid-Tied Microgrid UOIT Campus
- Burlington DC Microgrid
- Modular Nanogrid with Solar PV + Battery with Load Control
- Community Microgrid and Feeder Automation on Distribution Energy Service Platform
- Gull Microgrid with Solar PV + Battery
- Lac-Megantic Microgrid with Solar PV + Battery + EV Charging
- Colville Lake Solar PV + Battery + Diesel
- Aklavik Variable Speed Generator Integrating Solar PV

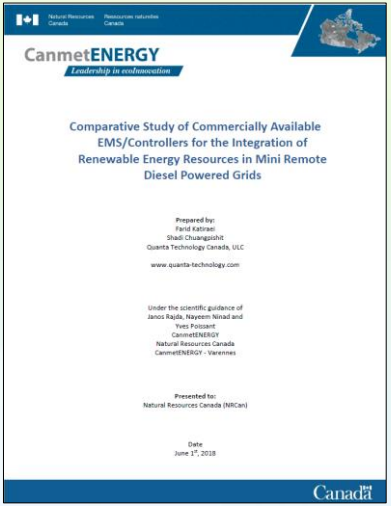
**hyperlinks included for each project*

2017 Renewable Energy in Remote Communities Conference

- Engaging community, utility and renewable experts to decrease the use of diesel for electricity production in northern and remote communities

Technology Assessment for Mini Remote Grids

- Comparative study of commercially available EMS/controllers for the integration of renewable energy resources in small and mini remote diesel powered grids – An Industry Survey:
  - What are basic and advanced features of an EMS for mini-grid
  - Who are the players / solution providers?
  - What is the EMS cost?
  - Potential R&D areas?

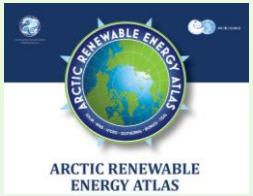


**will be publicly available on NRCan website soon*

Arctic Renewable Energy Atlas & Microgrid Research

- The Arctic Renewable Energy Atlas (AREA) is a comprehensive online tool which will include maps of renewable energy resources, data sets and case studies of renewable energy projects (endorsed by Arctic Council's Sustainable Development Working Group).

- Renewable Energy Microgrid Research in collaboration with the Canadian High Arctic Research Station (Cambridge Bay, Nunavut) and industrial research partners. Improved performance assessment tool for remote electrical microgrids (PATREM).



Source: AREA, https://oaarchive.arctic-council.org/bitstream/handle/11374/1943/AREA-brochure-April-2017.pdf?sequence=1&isAllowed=y; Nunatsiaq Online, http://www.nunatsiaqonline.ca/stories/article/65674nunavuts_canadian_high_arctic_research_station_readies_for_july_1_2017/

Mission Innovation Challenges

- Innovation Challenges:
  - Global calls to action aimed at accelerating RD&D in technology areas where MI members believe increased international attention would make a significant impact in our shared fight against climate change
  - cover the entire spectrum of RD&D; from early stage research needs assessments to technology demonstration projects

1. **Smart Grid Innovation Challenge -** *to enable future grids that are powered by affordable, reliable, decentralised for everyone renewable electricity systems.*
2. **Off-Grid Access to electricity Innovation Challenge -** to develop systems that enable off-grid households and communities to access affordable and reliable renewable electricity.
3. **Carbon Capture Innovation Challenge -** to enable near-zero CO_2 emissions from power plants and carbon intensive industries.
4. **Sustainable Biofuels Innovation Challenge** - to develop ways to produce, at scale, widely affordable, advanced biofuels for transportation and industrial applications.
5. **Converting Sunlight Innovation Challenge** - to discover affordable ways to convert sunlight into storable solar fuels.
6. **Clean Energy Materials Innovation Challenge** - to accelerate the exploration, discovery, and use of new high-performance, low-cost clean energy materials.
7. **Affordable Heating and Cooling of Buildings Innovation Challenge** - to make low-carbon heating and cooling affordable.

Mission Innovation Challenges

Innovation Challenge #1: Smart Grids

- 4 R&D priority areas identified by challenge members as:
  - Regional Grid Innovation
  - Distribution Grid Innovation
  - **Microgrid Innovation**
  - Cross Innovation
- Developed 6 main tasks with work programmes involving sub-tasks looking into microgrid-related activities

Innovation Challenge #2: Off-Grid Access to Electricity

- R&D focused on systems enabling off-grid communities to access affordable and reliable renewable electricity

For More Information

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MICROGRIDS:
US DOE Overview

G. Cardoso

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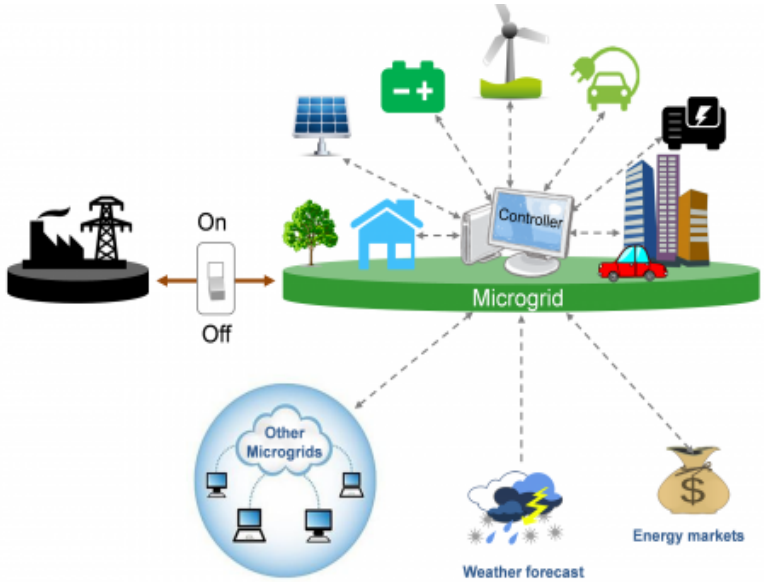
U.S. DEPARTMENT OF ENERGY

Microgrids for Enhanced Resilience, Reliability, Economics, and Efficiency

Resiliency: crucial recovery centers during major disruption events
Reliability: mitigate utility service interruptions
Economics: arbitrage, demand management, controllable loads
Efficiency: renewables integration, combined heat and power

Path forward: seamless grid communication to enable grid services and provide low-cost solutions for grid management and damage mitigation



U.S. DOE - Microgrid Program Areas

CORE

CROSSCUT

Program Areas	Objectives	Goals
Remote, Off-grid Microgrids	• Active control of electrical and thermal energy • Standardized methods for system designs and performance monitoring • Integration of local energy sources	Reduce fuel usage by 50%, while lowering system life-cycle cost and improving reliability & resiliency
Grid-connected Microgrids	• Planning/design tools • Operations/control tools • Integration w. distribution systems • Standardized cost/performance data	Achieve the DOE program goals on reliability, efficiency, and costs, and meet community resiliency objectives
Networked Microgrids	• Tools for planning and evaluation w. new modeling/simulation/optimization capabilities • Enabling implementation in cities and regionally	Meet the defined reliability, resilience, and efficiency targets, during normal and extreme event conditions
Resiliency Tools	• Pre-event preparation • During-event detection and mitigation • Post-event response, recovery, and remediation	Advance the capabilities of distribution system tools for resiliency
Standards and Testing	• New and revised microgrid standards • Standardized test methods & testing	Coordinate development of standards for microgrid controllers and systems; validate the standards via testing

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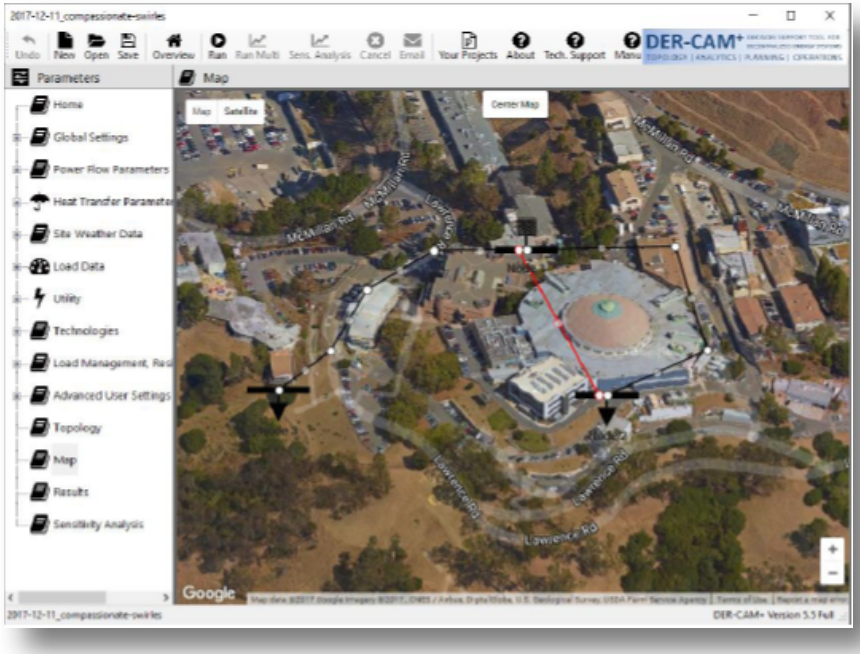
ROMDST:
Remote Off-grid Microgrids Design Support Tool

Adapt DER-CAM to develop an optimization-based design support tool considering power flow for optimum mix of DERs.

Features

- Remote community microgrids
- Network constraints (AC OPF)
- N-1 security constraints
- Component part load efficiencies
- Interactive data visualization capabilities
- AC or DC architectures
- Multiple objectives
- Constraints on fuel availability
- Component library
- Network design
- Demonstration and Validation with Alaska communities



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RADIANCE – Resilient Alaskan Distribution system Improvements using Automation, Network analysis, Control, and Energy storage

Field validation of resilience-based design and operation leveraging resources from multiple networked microgrids.

Scope

- Develop and demonstrate practical use of resilience metrics for coordinated operation; design to minimize outage and financial losses
- Leverage rotational and virtual inertia of microgrid assets including hydro, diesel, energy storage, and µPMU-based sensing to enhance resilience of the overall distribution network
- Rapidly prototype controllers as HIL and conduct cyber-vulnerability testing in a real-time cyber-secure environment
- Field validate increasing resiliency of the distribution system by leveraging resources from multiple networked microgrids

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Microgrid Energy Management System Integration with DMS

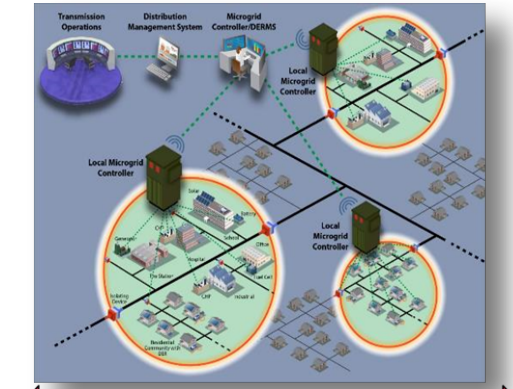
An integrated system consisting of DMS,OMS, DERMS and µEMS controllers for efficient management of DERs.

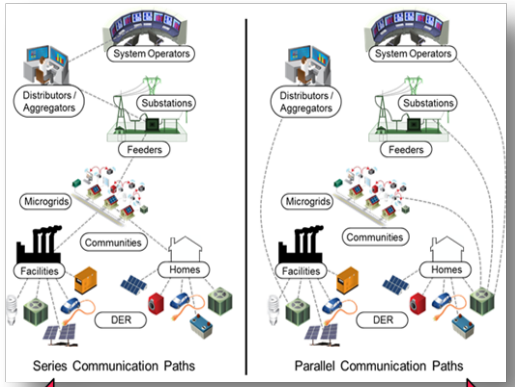
Phase 1

- Developing **an architecture of integrated** system (functions, communication, control, interoperability, security)
- Developing **use cases** for new DMS functions
- Identifying the **gaps in integration** of DMS, OMS, µEMS, and DERMS
- Establishing the **relationship between different components**
- Developing test plan

Phase 2

- Lab demonstration
- Field implementation





Phase 1

Stakeholder Advisory Group → Solution Design → Test Approach

- Gap analysis
- State-of-art in DMS technology
- Control architecture
- Functional requirements

- Structure test approach and plan
- Performance metrics
- Design test setup
- Engage with vendors and utilities

Phase 2

HIL Performance Verification Testing → Site Demo

System Design and Simulation

Performance Assessment & Impact Analysis

Develop, test, and demonstrate integrated control and management systems for distribution systems

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Networked Microgrids
Optimal Design and Operations (OD&O) Tools

Improve distribution system (in this order)

- **Resilience**—(to extreme events)
- **Reliability**—(normal/single failures, e.g., N-1)
- **Economics**—(combined investment and operations)
- **Efficiency**—(not too sure how this will really be incorporated)

Approach

- Leverage development of past and ongoing projects (ROMDST, RDDT, Microgrid protection, GridLAB-D development, etc.)
- New developments in
  - Microgrid and distribution network protection modeling
  - Network, microgrid, device dynamics
  - Understanding/characterization of regulatory and business environments
  - Operations-based design and investment planning
- Create an offline OD&O tool for networked microgrids
- Perform software testing of OD&O
- Create several design test cases using OD&O
- Validate performance using numerical simulations and CIL/PHIL testing

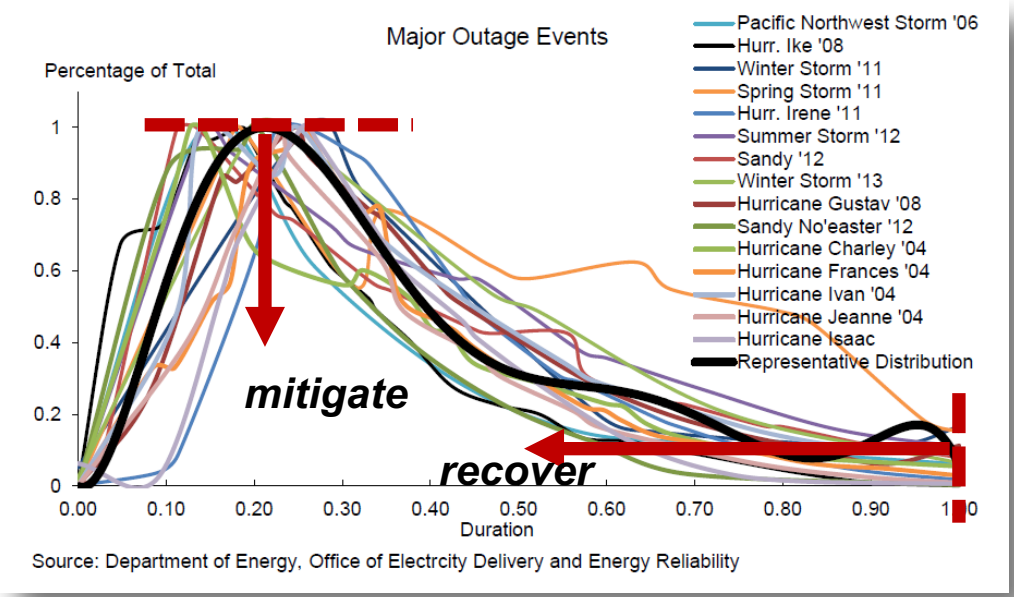
Resiliency Tools

Resilient Distribution Grid Design Tool

Develop an open-source software, **LPNORM**, to enable distribution utilities to assess current resilience postures and determine resilient design upgrades.

Distribution System Restoration Tool

Develop an integrated system restoration tool to minimize outage sizes/durations, as well as associated economic and societal losses, caused by extreme weather events.



Source: Department of Energy, Office of Electrcity Delivery and Energy Reliability

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IEEE Standards for Microgrid Controllers

Goals of IEEE 2030.7 & P2030.8

- Establish specifications and core function testing for microgrid controllers to enable interoperability of different controllers and components needed to operate controllers through cohesive, platform-independent interfaces.
- Allow for flexibility/customization of components and control algorithms while ensuring minimum requirements can be met.
- Focus on functional requirements and interoperability with various DER interfaces.
- Strive to establish comparative performance indices.
- Consider all electrical system interfaces.
- Facilitate wide adoption of standard microgrid controller functional and performance requirements.

Summary Status

- The 2030.7 and P2030.8 are poised to enable deployment of microgrids.
  - ➢ Can be used for RFPs, stakeholder understanding, etc.
- IEEE 2030.7 is now an approved standard.
- Balloting closed for IEEE P2030.8 (Jan 2018).
- The core functions for specification and testing are quantifiable dispatch and transitions.

Regional microgrid initiatives

New York

- ***NY Prize*** competition administered by New York State Energy Research and Development Authority (NYSERDA)
- Promote community microgrids to modernize NY's grid
- 3 phase program:
  - 83 feasibility studies, $100k
  - 11 engineering design, $1M
  - build-out and monitoring, 2018/2019

New Jersey

- Town Center Microgrids program, administered by the Board of Public Utilities
- Promote community microgrids
- 2 phase program:
  - 13 feasibility studies, $200k
  - Engineering design

Multiple other northeastern states have developed microgrid programs

Regional microgrid initiatives

California

- CA leads some efforts: energy efficiency, EV sales
- Large ***EPIC*** grants to fund Microgrid research and demonstrations by California Energy Commission:
  - Demonstrate Business Case for Advanced Microgrids in Support of California's Energy and GHG Policies ($50M)
  - Distribution System Modeling Tools to Evaluate Distributed Energy Resources ($9M)
- CA Storage Mandate; Microgrid Roadmap

Puerto Rico

- Effort to integrate DER and microgrids supported by ARPA-E (DOE)
  - Determine policy and technology options
  - Build new tool to assess grid-integration of DER

THE END

Contact Information

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http://building-microgrid.lbl.gov/

Bucharest 2018
Micro-Grid Symposium

Guillermo Jiménez; Felipe Valencia, Rodrigo Palma

02/09/2018 – 06/09/2018

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UNIVERSIDAD DE CHILE

FACULTAD DE CIENCIAS FÍSICAS Y MATEMÁTICAS
UNIVERSIDAD DE CHILE

Overview of micro-grids in Latinamerica

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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

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Overview of micro-grid projects in Latinamerica

Some new projects in the region

1/ Solar platform of the Atacama Desert (PSDA)

Conceived as a laboratory for testing and developing solar technologies in the conditions of the Atacama desert, that is, high levels of solar radiation, and changing environmental and weather conditions (e.g., temperature oscillations, dust, and soiling formation)

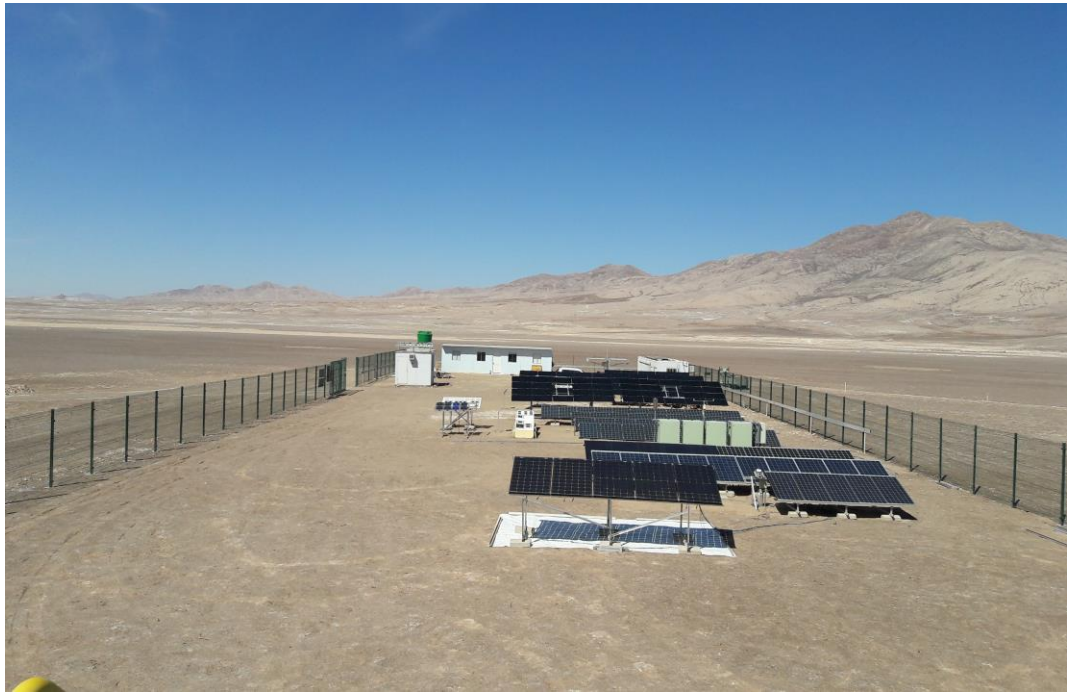
PSDA

General description

1. Location and owner the platform is located 60km from Antofagasta; its owner is the CDEA (energy centre of the Antofagasta university); and has a staff of 2 people on site and 10+ associated researchers.

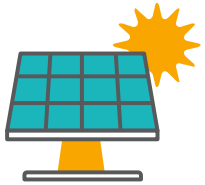
2. Related projects the platform currently is being considered as a laboratory of the following research/development projects: SERC-Chile (Conicyt Chile), Ayllu Solar (BHP Billiton Fundation), and AtaMoS-TeC (CORFO-Chile).

3. Equipment the platform already has several PV technologies under testing, a weather station, and a micro-grid testtbed (battery energy storage system, programmable loads, energy management system).



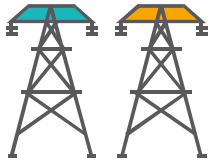
Front View of PSDA

PSDA



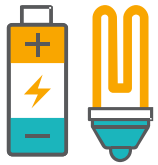
A. Energy sources

- Diesel genset with controllers.
- Battery energy storage system (lead-acid technology).
- PV systems (m-Si, this film, bifacial).



B. Grid connection

- Grid-connected 3-phase micro-grid.
- 380V/50Hz 3-pase ring with several taps.
- 75 kVA-capable grid connection.



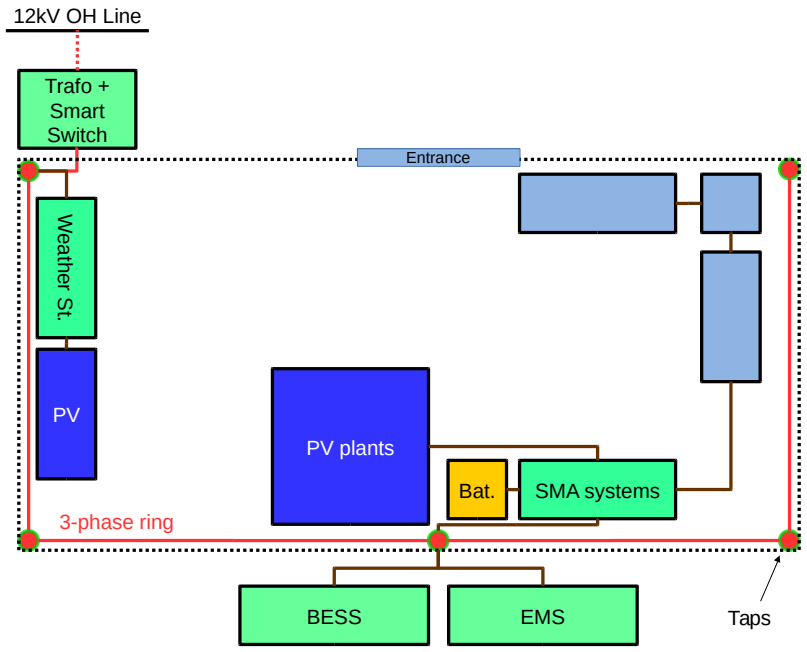
C. Application range

- AC-3 single-phase programmable loads.
- 10kVA-capable loading on micro-grid.
- 20kW, 60kWh battery/inverter system.

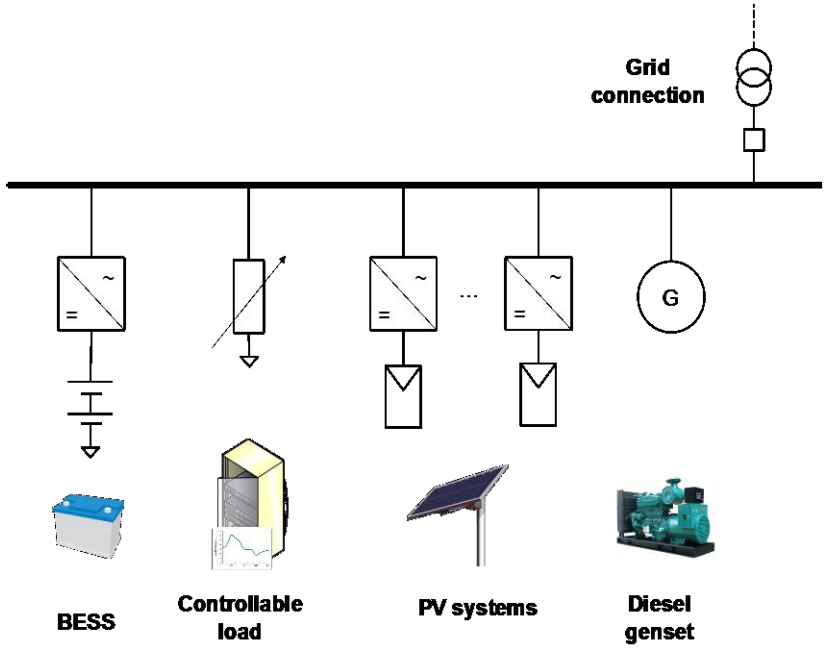
In the platform it is expected to test: new/other solar technologies and new/other materials in extreme desert environmental conditions.

PSDA

Layout and PV technologies and matherials currently under testing



PSDA site layout



Single line diagram of PSDA

PV modules, cells, and materials testing.

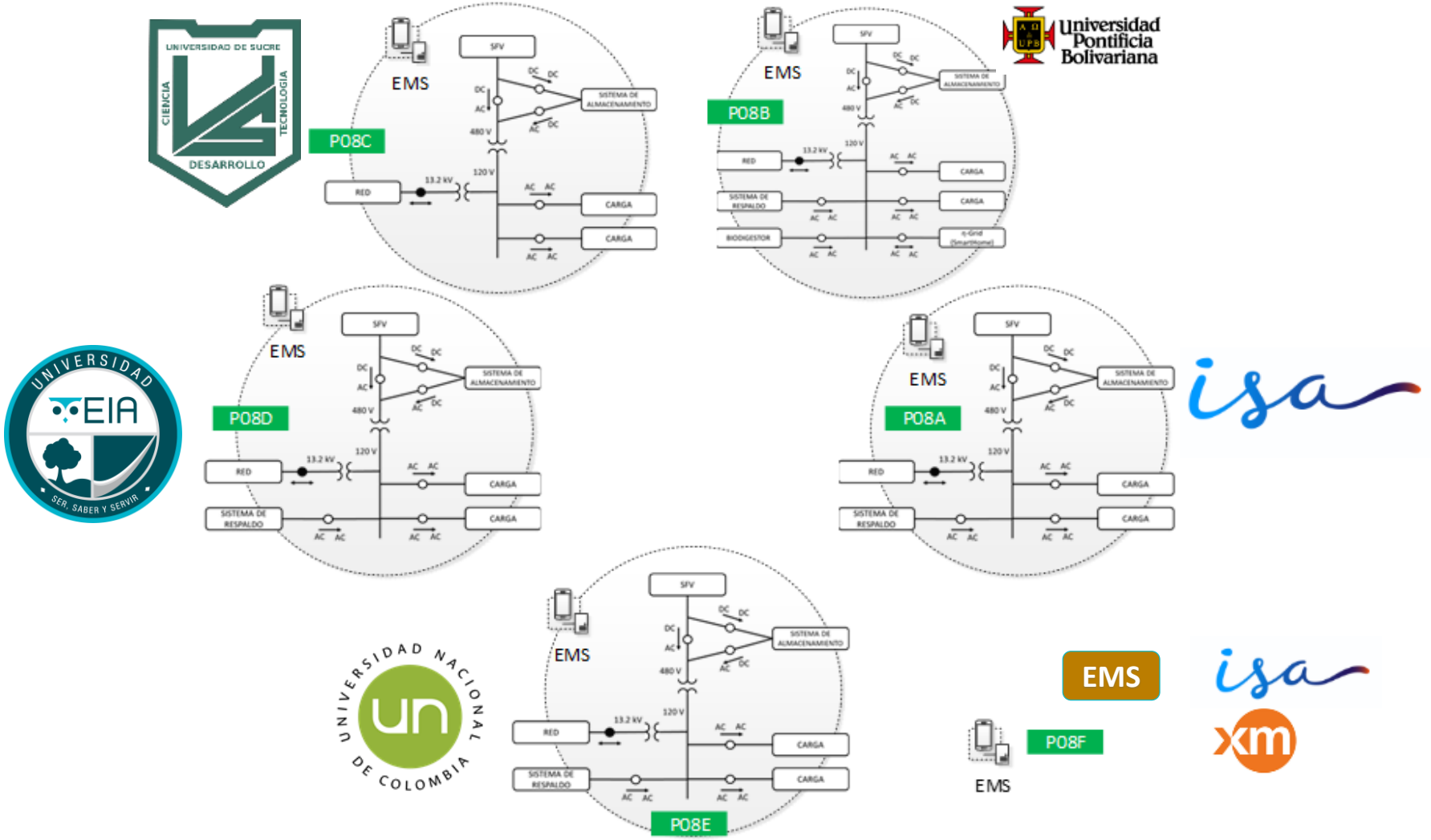
Overview of micro-grid projects in Latinamerica

Some new projects in the region

1/ Electric Interconnection (ISA) micro-grid ecosystem

Combining public and private investment, ISA is currently developing a micro-grid ecosystem in South America that includes facilities in universities and isolated settlements, currently in Colombia and Peru, as part of the project: Scientific Ecosystem Project COLCIENCIAS-Colombia 2030.

University facilities



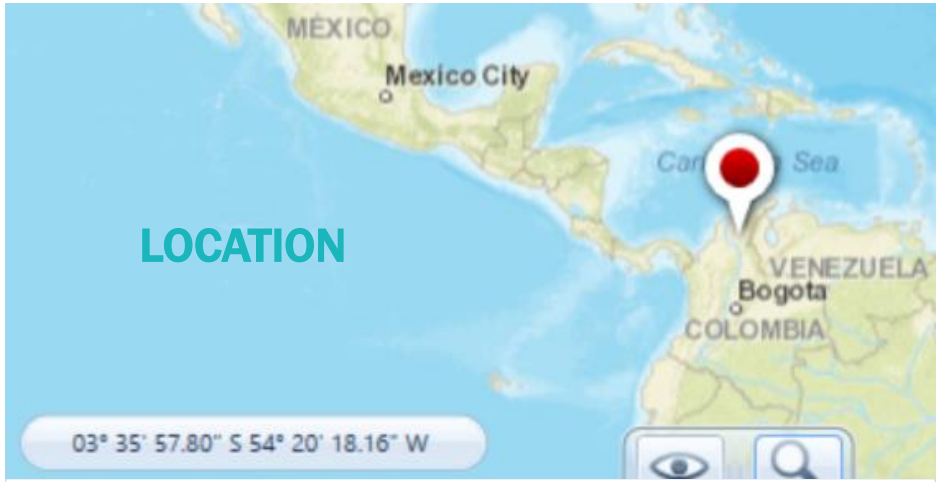
La Victoria - Colombia

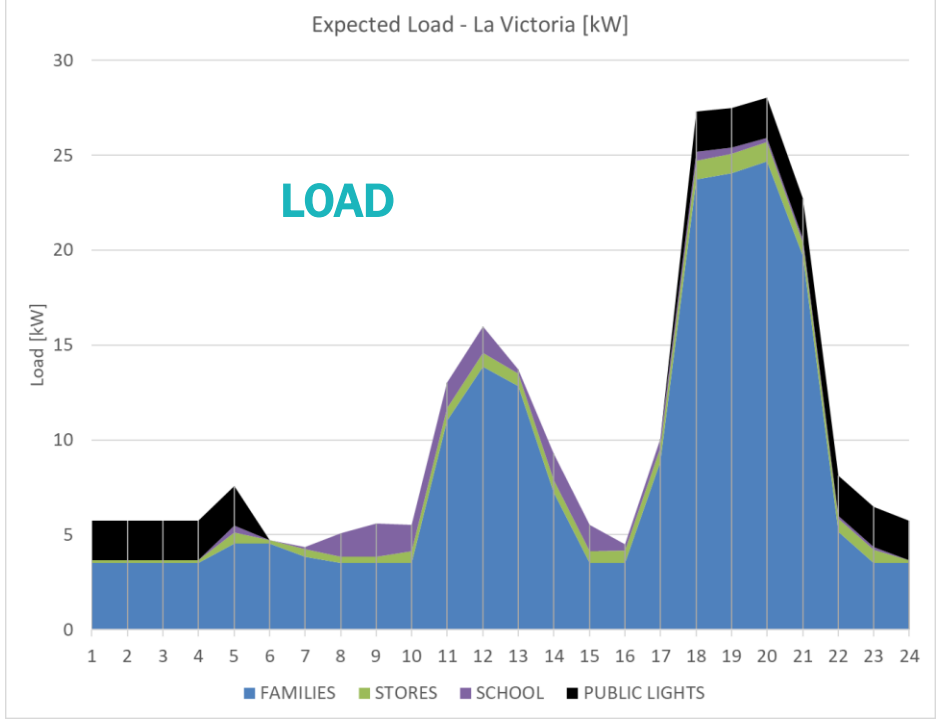
General description

1. **Architecture** the micro-grid combines a diesel genset with a battery energy storage system (Li-ion technology), and a PV power plant to supply a demand of 260,000kWh/d (41.73kW peak).

2. **Energy sources** the micro-grid has a 10kW diesel genset, two PV power plants with a total capacity of 125kWp, a 400kWh Li-ion battery storage system, and a 50kW inverter.

3. **Energy management** the micro-grid is conceived to operate with an EMS that minimise the use of the diesel genset while satisfies the energy demand. The EMS is currently under design.





El Ciruelo - Peru

General description

1. **Architecture** the micro-grid combines a diesel genset with a battery energy storage system (Li-ion technology), and a PV power plant to supply a demand of 260,000kWh/d (51.00kW peak).

2. **Energy sources** the micro-grid has a 20kW diesel genset, a PV power plant with a total capacity of 100kWp, a 600kWh Li-ion battery storage system, and a 60kW inverter.

3. **Energy management** the micro-grid is conceived to operate with an EMS that minimise the use of the diesel genset while satisfies the energy demand. The EMS is currently under design.