MITSUBISHI ELECTRIC

smarter grid solutions

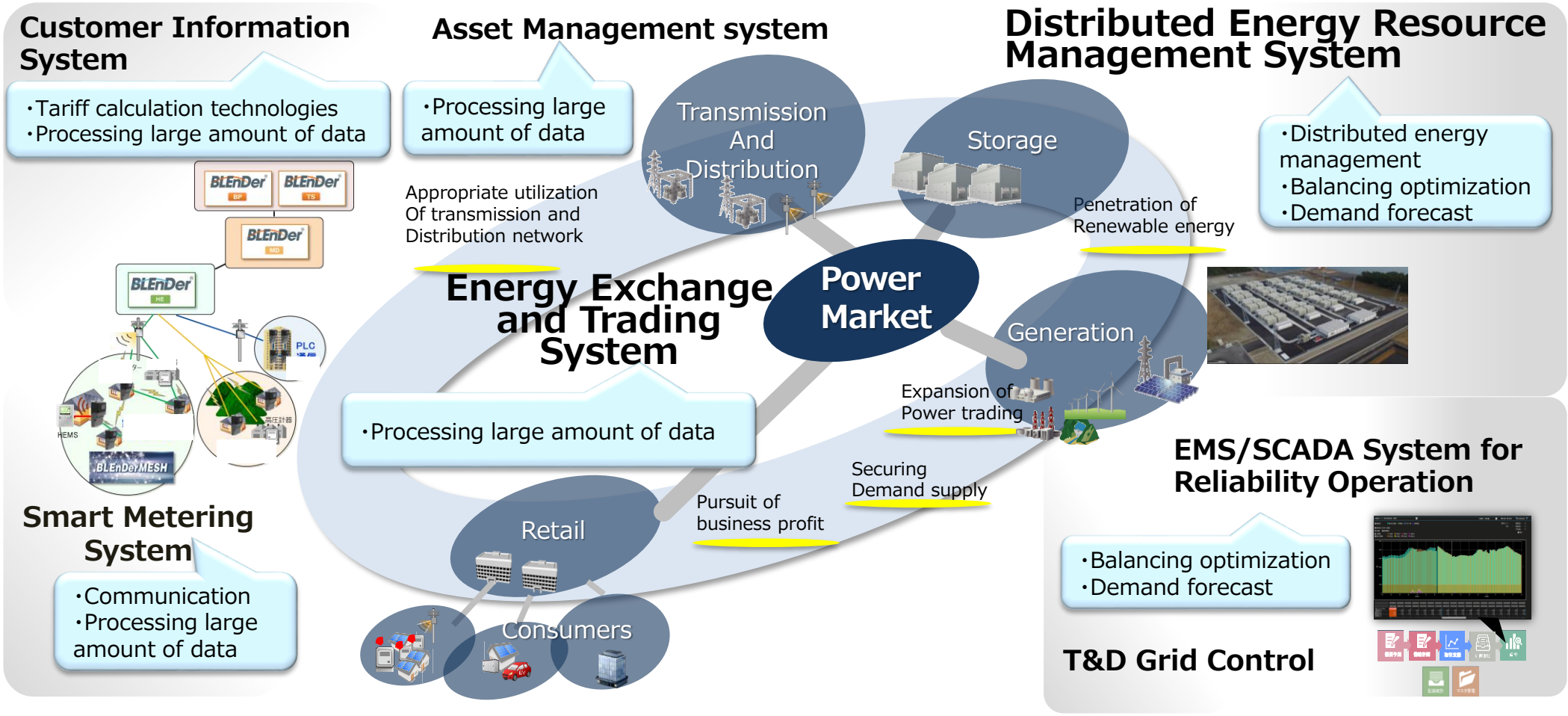
BLEnDer®

STRATA RESILIENCE

Introduction for Several Types of Microgrid System and Digital Energy Platform

MELCO Provides the Digital Solution for Energy System

- Distributed Energy Resources (DER) are expected to play the most important role for electricity supply system towards the carbon neutrality around the world.
- Mitsubishi Electric Corp.(MELCO) has the long history to provide the Digital Solution for Electric Power Industry, in which “BLEnDer®” is a given name for the Solution



Smarter Grid Solutions products deliver for Renewable Environment

ACHIEVEMENTS & RESULTS

- 500 MW Clean Energy Asset Capacity managed
- > £300m Grid Upgrade Investments Avoided
- > 1 TWh Annual Energy Produced by managed DER
- 30 Operational DERMS systems (UK/US/Other)
- 300 ktCO2e Annual Emissions Avoided by managed DER

PRODUCTS

STRATA GRID

Grid DERMS for Distribution Utilities to manage technical issues created by DER and avoid expensive, slow and environmentally impactful grid upgrades

Cirrus FLEX

VPP DERMS for DER Fleet Owners, Battery OEMs, local authorities and C&I customers to monetize flexibility from their assets in energy markets.

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Microgrid DERMS for Distribution Utilities, developers, communities and local authorities to provide energy and power security.

ELEMENT GRID **ELEMENT FLEX**

Edge DERMS for local connectivity and to provide grid edge optimization and control capability linked to Fleet / Utility / Microgrid DERMS

REFERENCE PROJECTS

STRATA GRID

UK Power Networks – Delivering your electricity

- Multi-use case DERMS platform for DSO business model implementation.
- “among the most advanced in the world” (Wood MacKenzie).

AVANGRID

- Flexible Interconnection for inverter-tied grid edge resources creating additional grid hosting capacity.
- Additional use cases including Non-Wires Alternatives, Voltage Management and Power Quality.

Cirrus FLEX

Australian Battery Developer

- Battery energy storage wholesale, ancillary and balancing market dispatch and trading.
- Battery vendor, optimizer agnostic multi-site, large scale solution.

conEdison **endurant**

- Multiple utility scale batteries for peak load management (non-wires alternative) with residual capacity traded in the NYISO.
- Cyber secure control room interface from the cloud.

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Hydro Québec

- Renewable-resource powered microgrid for an entire township - integrated with utility system and operations.
- Wide applicability of controls, energy management and supporting DER analytics.

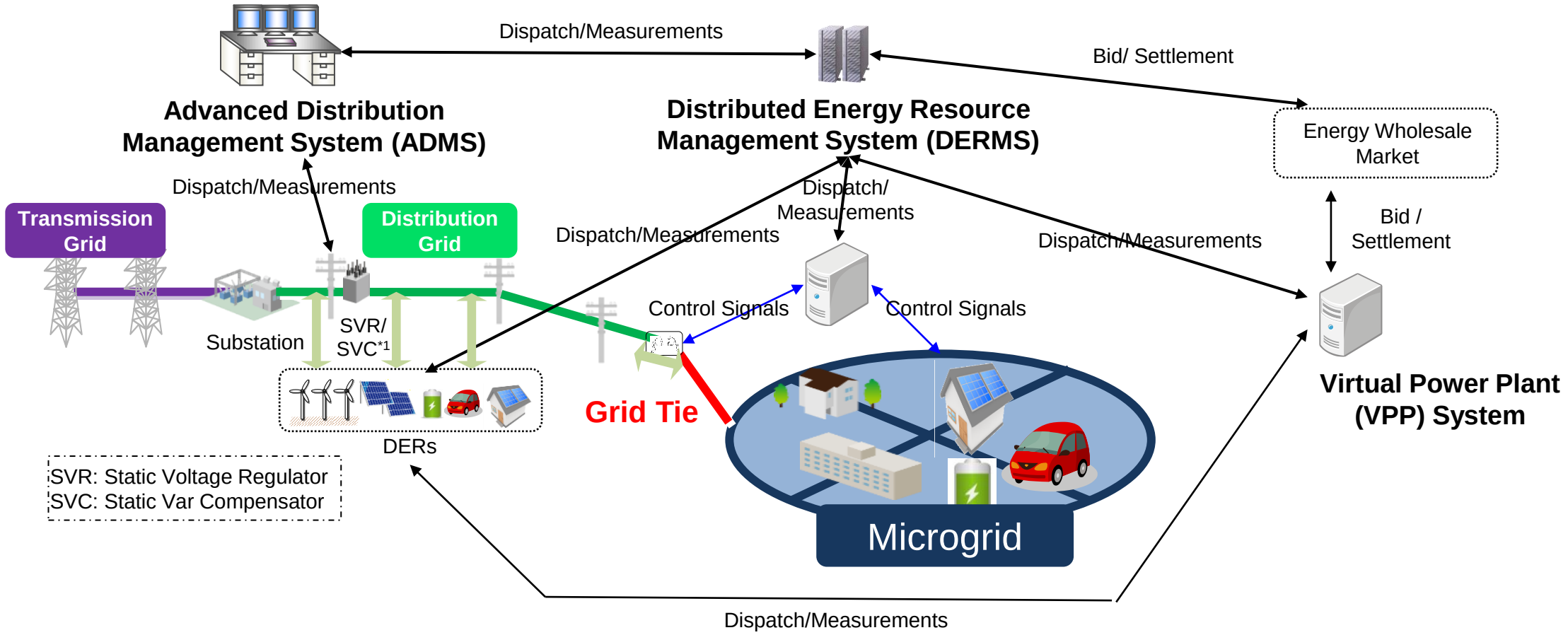
NORTHERN POWERGRID

- Local resilient zones for remote, poorly-served communities.
- Control of back-to-back power electronics bridge with battery storage and ‘socket’ for other DER.

Microgrid Positioning and the Role

According to DoE

"**A group of interconnected loads and distributed energy resources (DERs)** within clearly defined electrical boundaries that **acts as a single controllable entity with respect to the grid** "



What is Objectives and Requirements of a “Microgrid”

According to one of the conferences, the objectives of a “Microgrid” are

(1) **Resiliency, Reliability** : maintain grid in case of an outage events in the grid

(2) **De-carbonization** : reduce the emission of CO2 with the introduction of DERs as main energy sources

(3) **Economics** : not only cost reduction such as decreasing peak demand or energy efficiency but also earning proactively such as demand response or providing grid services

“Employing Data to Achieve Microgrid Goals”, PowerSecure, Microgrid Knowledge Conference, 2023
https://www.microgridknowledge.com/microgrid-operations-and-optimization/article/33004570/want-to-learn-about-microgrids-check-out-the-presentations-from-microgrid-2023

According to DoE, the system requirements of a “Microgrid” are

(1) **Modularity** : standardize the components will simplify the design process, reduce special operation, etc

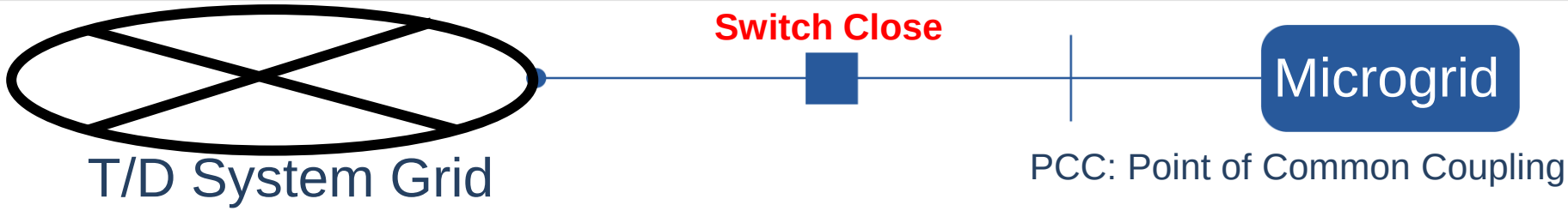
(2) **Flexibility** : control renewables at the microgrid level will reduce uncurtains which leads to stability of the grid behavior.

(3) **Resilience** : minimizing the loss of load during critical infrastructure failure which are vital for the life and safety of a communities.

(4) **Transactive Energy Management** : optimize the allocation of resources by coordinating a multi-power system while considering prioritization, interests, and autonomy

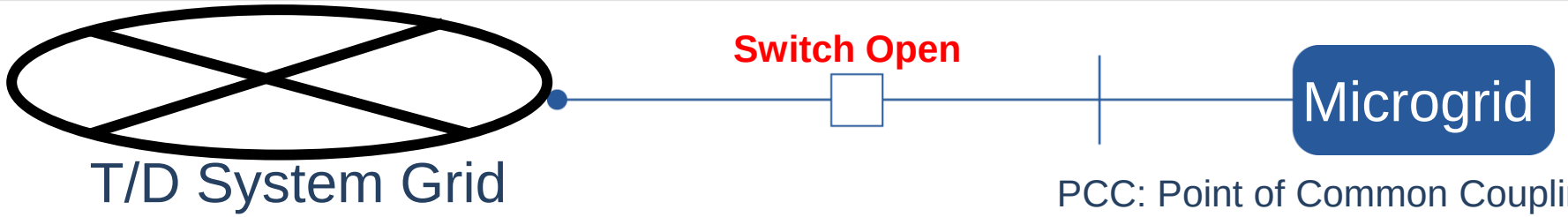
Topic 3: Building Blocks for Microgrids
https://www.energy.gov/sites/default/files/2022-09/3-Building%20Blocks%20for%20Microgrids.pdf

Microgrid - Usecase : Grid Connected



Mode	Goals	Actions
Peak Shaving	Reduce cost of energy drawn from grid	• All BESS charge & discharge • BMS non-invasive curtailment
Grid Events	Reduce energy consumption during system-wide peaks	• All BESS charge & discharge • BMS moderate curtailment
	Manage voltage in case of renewable penetration with low consumption	
	Manage frequency in case of rapid changes in the weather	

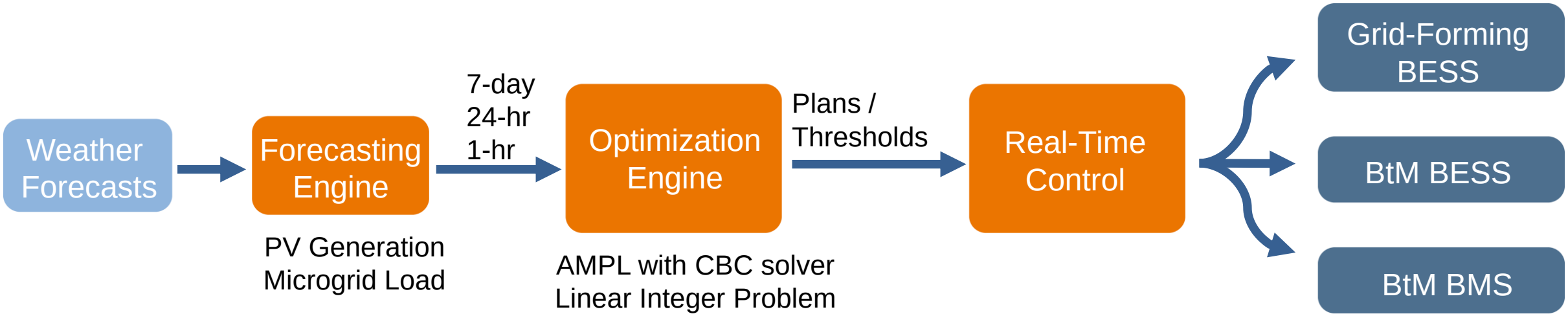
Microgrid - Usecase : Islanding / Islanded



Mode	Goals	Actions
Planned / Unplanned Islanding	Coordinated transition	1. Initiate Island / Loss of Supply 2. Manage flows at PCC / Initiate black start* 3. Islanding sequence / Black start sequence
Islanded	Maximize uptime Minimize cost of diesel generation (if relevant)	• FtM BESS form grid • BtM BESS reduce demand, store excess PV • BMS moderate / aggressive

Microgrid - Core Function

- Uses available resources to reduce local microgrid peak load
  - Objective: Reduce peak daily microgrid load to reduce energy costs
  - DER Types: Grid-forming BESS, BtM BESS, BtM Building Management Systems



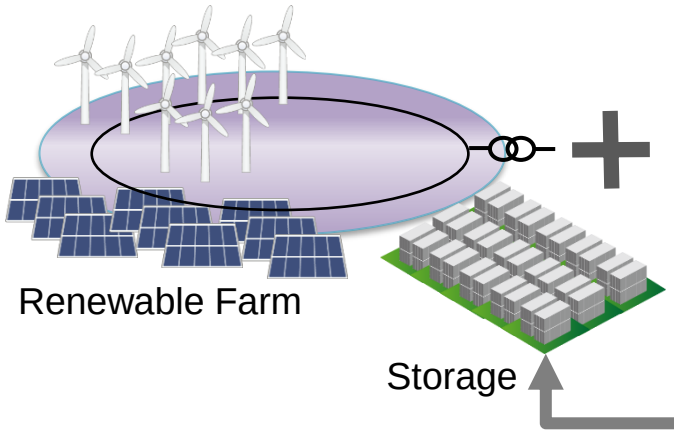
AMPL: A Modeling Language for Mathematical Programming
CBC:Coin Branch and Cut Solver

DER optimization benefits both from the input of **forecasts** as well as from **real-time conditions**, such that controls can be issued with **full situational awareness**.

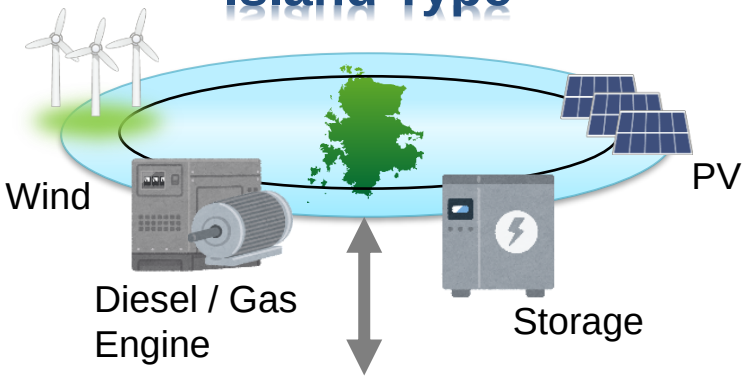
Energy Management Solutions for Microgrid

- MELCO and SGS has developed an Energy Management Solution for the local requirements, respectively.
- Each has the capabilities to control and manages storage system and conventional generators to reinforce the grid with flexibility using PV and wind generation.

Battery for Grid



Microgrid Island Type

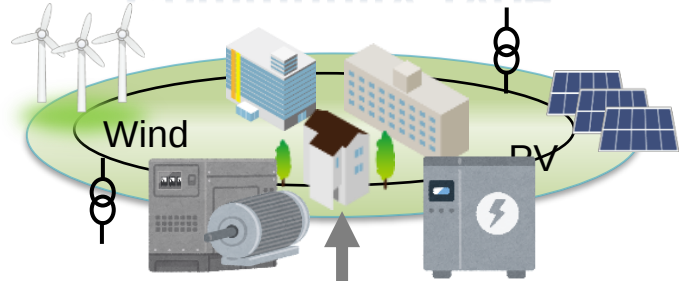


BLEnDer® RE

Grid Stabilization

- Stabilization Control
- Voltage Control
- SoC Management

Microgrid Community Type



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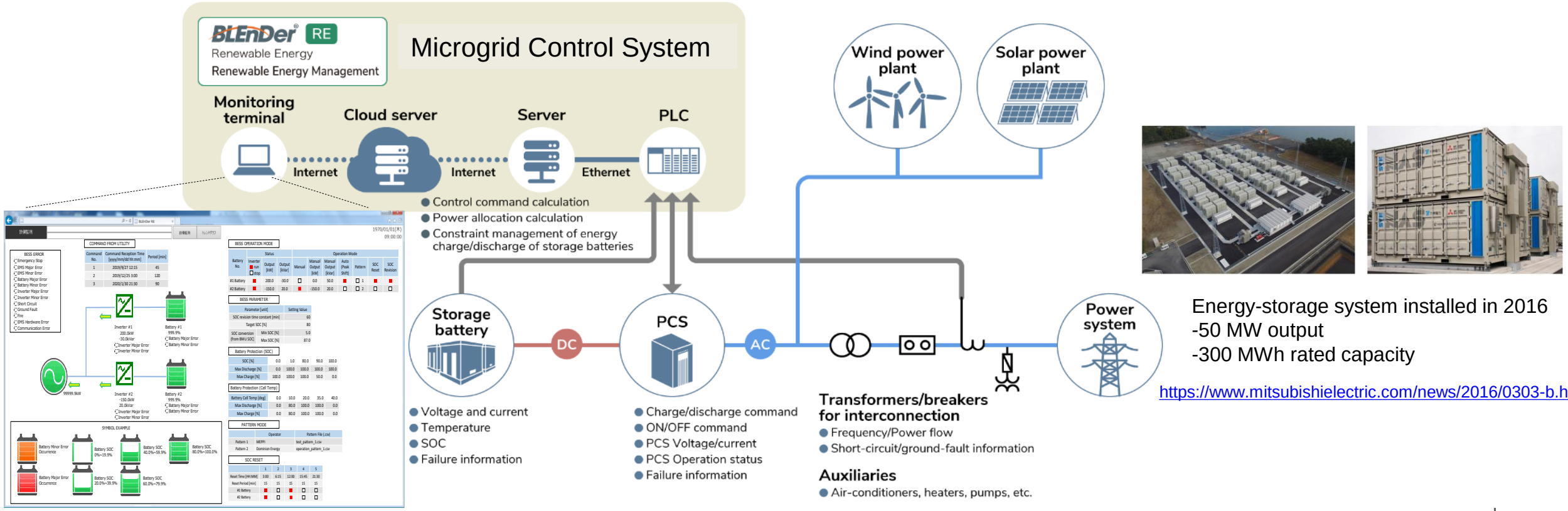
Supply-Demand

- Demand Forecast
- Weather Forecast
- Scheduled Dispatch

BLEnDer®RE ~ Solution for microgrid ~

- Installation of Distributed Energy Resource (DERs) are in progress for the low-carbon and sustainable society.
- However, large-scale introduction of DERs involves various challenges such as its unstable and intermittent output due to weather conditions.
- To these challenges, MELCO has provided the solutions as BLEnDer® RE, which monitors and controls DERs and storage batteries. We offer BLEnDer® RE with the best combination of battery and PCS.
- BLEnDer® RE can support to operate microgrid by controlling batteries, DERs, or internal combustion generators.



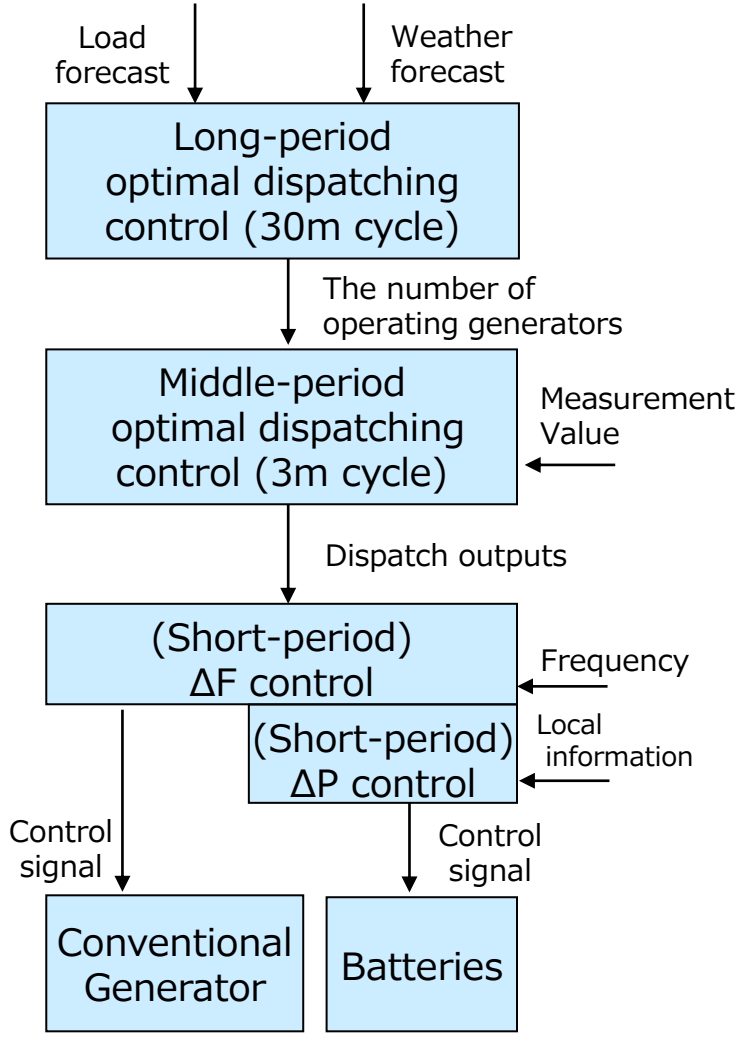
Energy-storage system installed in 2016
-50 MW output
-300 MWh rated capacity

https://www.mitsubishielectric.com/news/2016/0303-b.html

Cascade Control

BLEnDer® RE can configure “Optimal dispatching control ” and “ΔF control / ΔP control” as cascade control considering each equipment characteristics to realize both of economic efficiency and power quality.

Purpose	Control	Contents	Calculation Cycle	Calculation target time
Economic efficiency	Long-period optimal dispatching control	To schedule **start-stop and output of generators** and **charging and discharging of batteries** based on daily demand and renewable energy forecast w/ limiting condition of securing adjustment capacity.	30min.	1day (30min. steps)
	Middle-period optimal dispatching control	To **reallocate and control outputs of generators and batteries based on the error** between actual and planned/forecast value to outputs of each equipment within limits to be most economic.	3min.	2hours (3min. steps)
Power Quality	(Short-period) ΔF control)	To switch the output from batteries to generators **for frequency stabilization.**	1sec.	-
	(Short-Period) ΔP control	To keep the frequency constant **by battery high-speed control** based on local information.	0.1sec.	-



BLEnDer RE

Hybrid Battery System Project in OKI island

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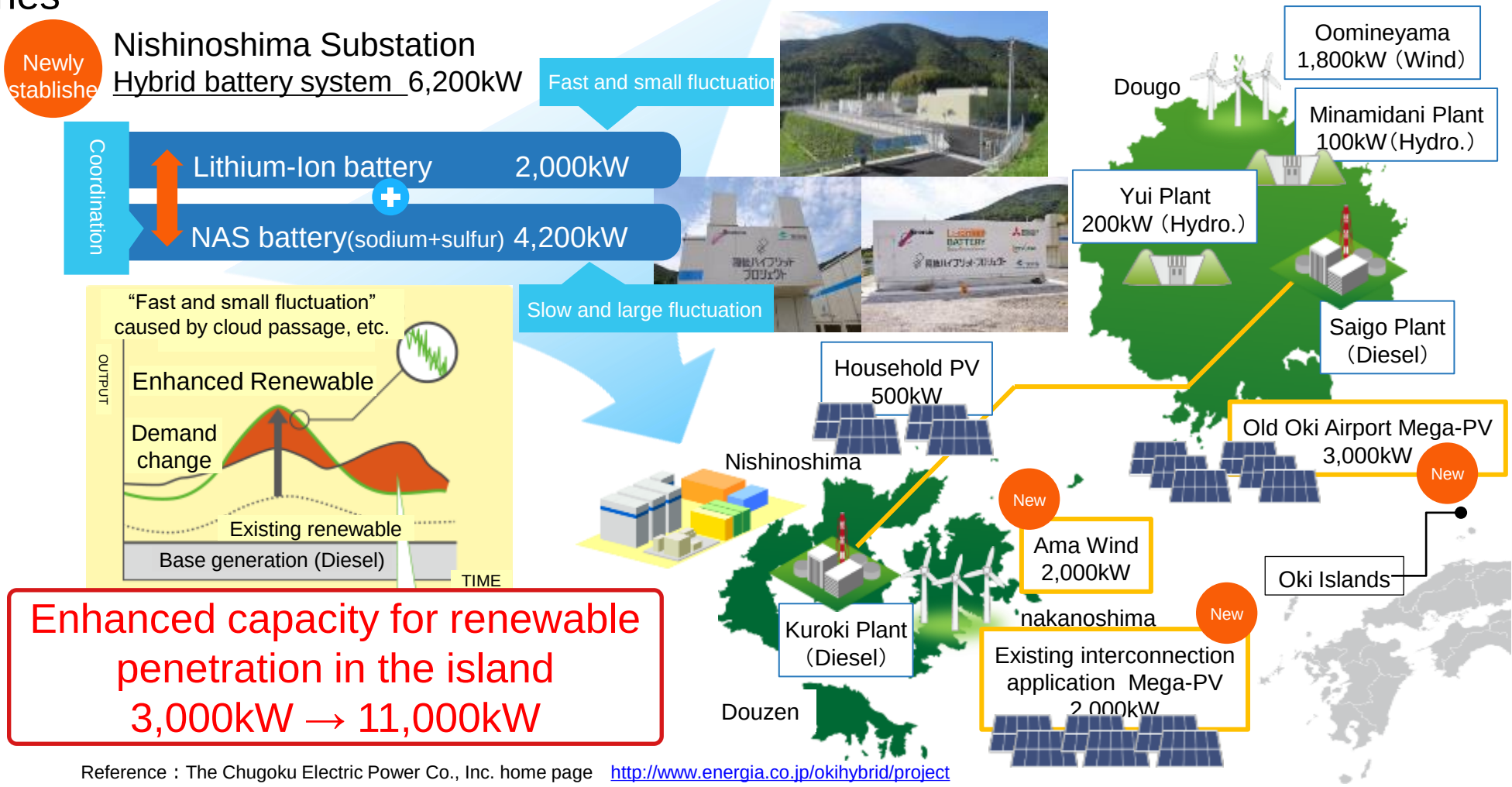
Achievement

- Realized a high-output and high-capacity hybrid battery storage system by controlling different types of batteries



Enhanced capacity for renewable penetration in the island
3,000kW → 11,000kW

Reference：The Chugoku Electric Power Co., Inc. home page http://www.energia.co.jp/okihybrid/project

DERMS 'ecosystem': integration and interoperation of systems and functions

DERMS are an integrated suite of sub-systems and components.

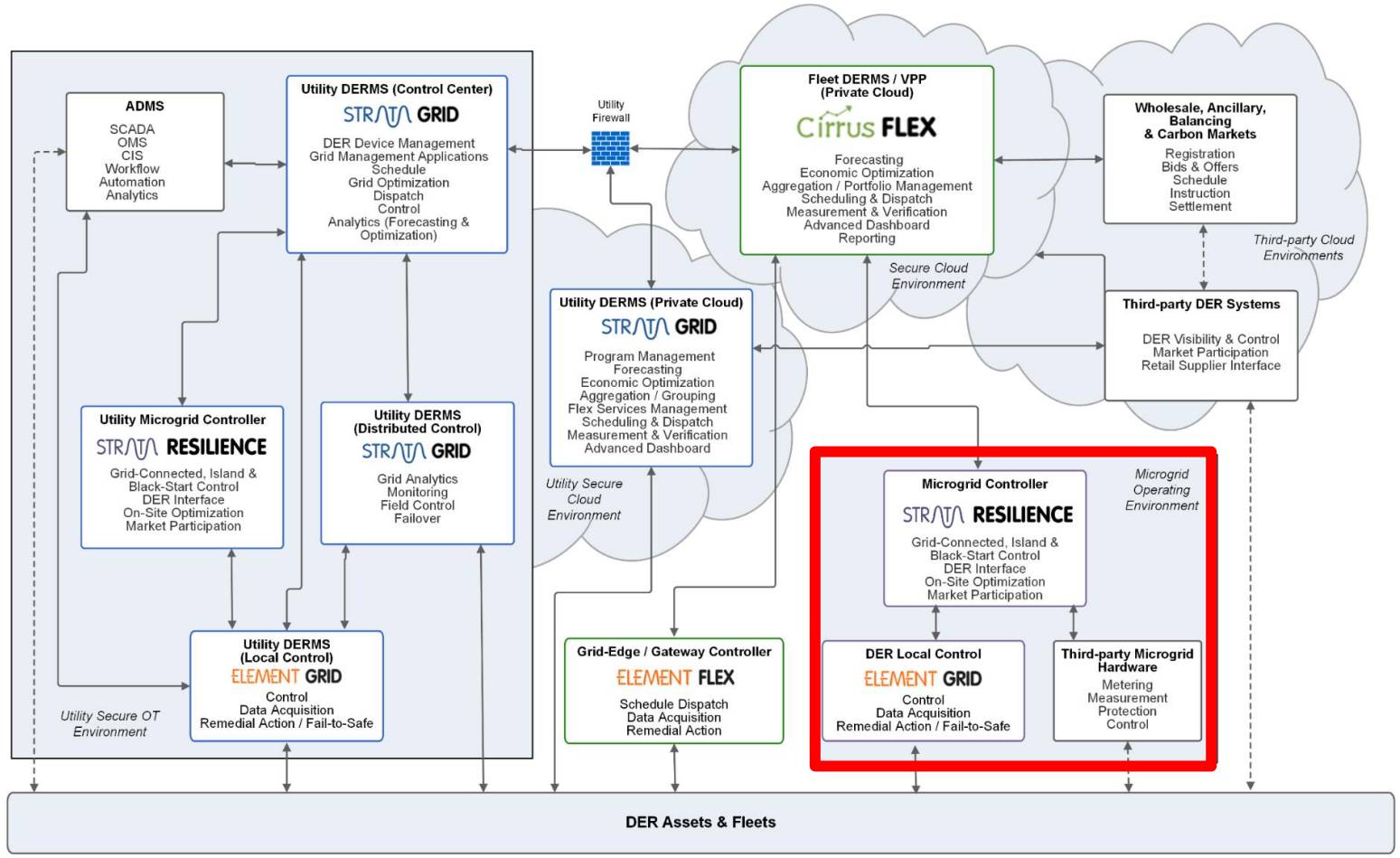
Grid DERMS: On premise Utility DERMS integrated with ADMS focused on grid management use cases and resolving issues with model only control.

Aggregator DERMS: Private cloud features to manage fleets of assets directly (own assets) or via aggregators (BYOD). Secure bridge from Utility to external third parties

VPP DERMS: Private or Multi-Tenant Public Cloud implementation for owners, operators and aggregators offering 'flexibility' to utilities and markets

Microgrid: Substation local controller as part of federated Utility DERMS. Dedicated site / customer microgrid accessing markets via aggregator / VPP.

Grid Edge: Fail safe functions and standardising connectivity (MicroRTU or IoT gateway).



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Lac-Mégantic & Hydro Québec Microgrid - Satellite Overview

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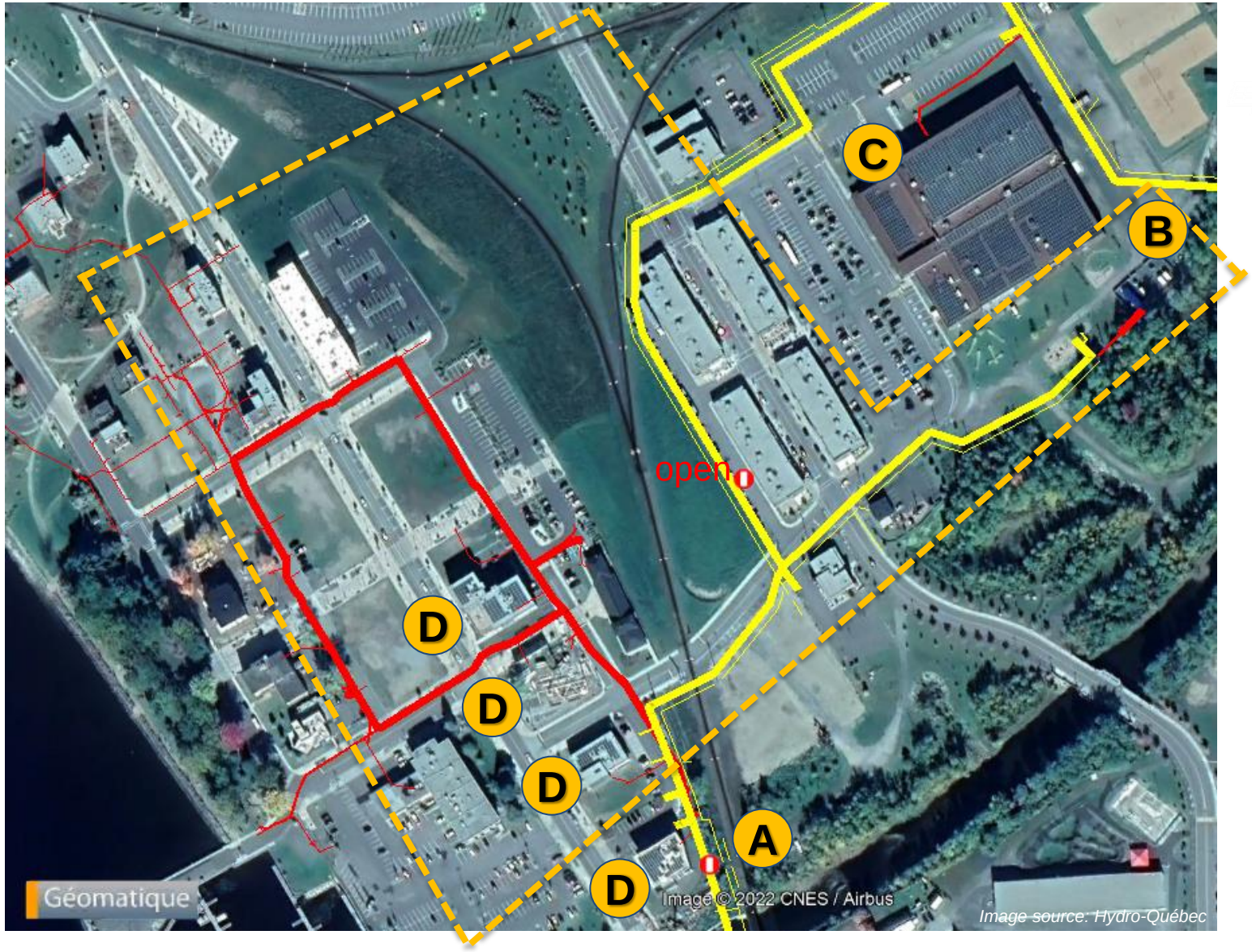
Microgrid perimeter
30 buildings

- A *Microgrid PoC*
- B *Microgrid Substation*
- C *Rooftop PV*
- D *BTM Buildings*
- *25 kV Overhead*
- *25 kV Underground*



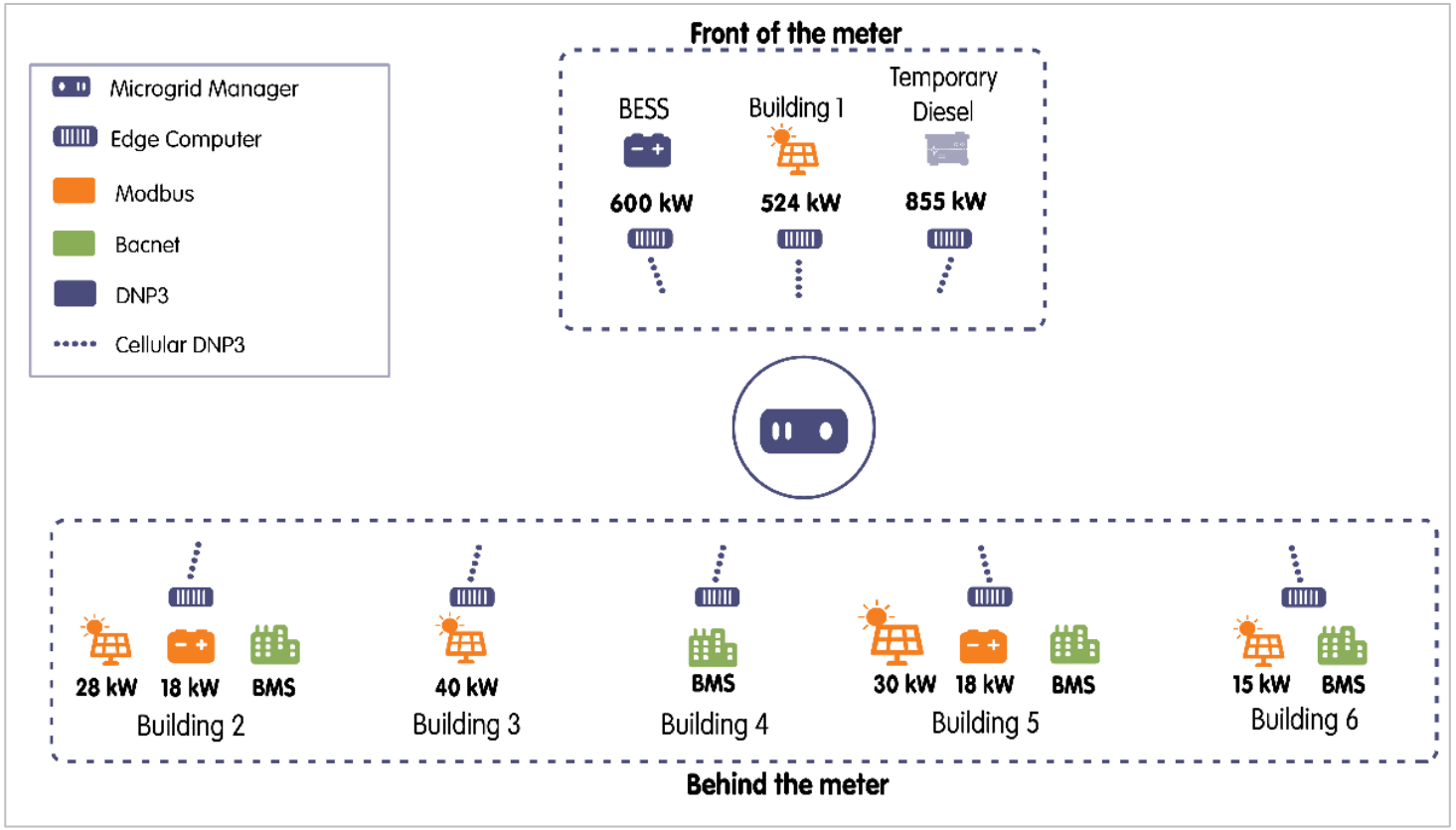
Lac-Mégantic & Hydro-Québec Microgrid Simplified Microgrid Architecture

Microgrid Manager/Controller:

- Delivered via *Strata Resilience* solution
- Coordinating authority between grid measurements and DER control commands

Edge Computers:

- Delivered via *Element Grid* solution
- Unifying control interface between Microgrid Controller and diverse DER types with layer of localized control capabilities



Lac-Mégantic & Hydro-Québec Microgrid DER functionality

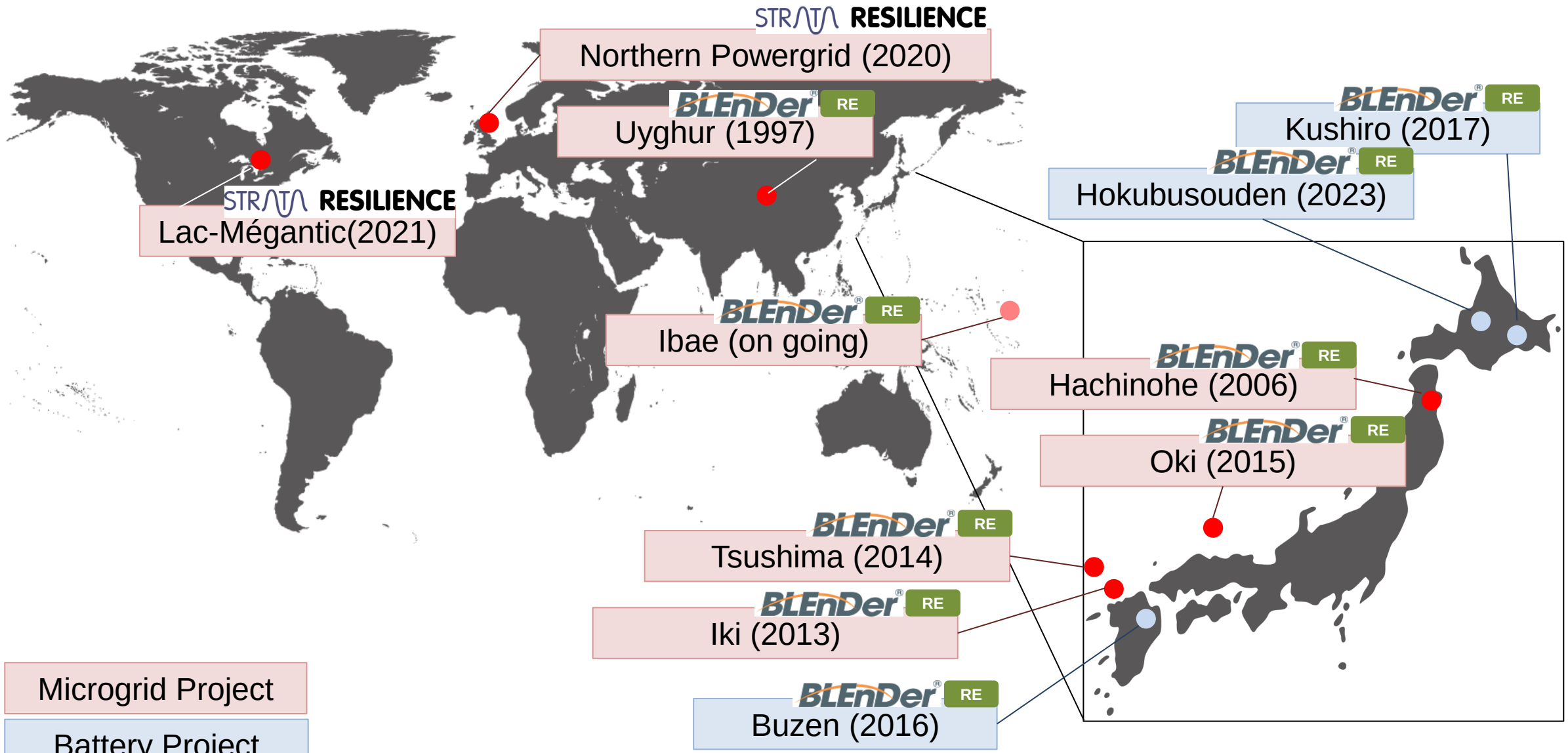
DER	Grid Connected	Islanded
FtM BESS	Direct P/Q	Grid forming
All PV	Un-curtailed Power Factor*	Direct P (if necessary) Power Factor*
BtM BESS	Direct P	Direct P
BtM Buildings	Curtailment levels (non-invasive)	Curtailment levels (invasive)

1. *DER capabilities change when islanded*
2. *DER capabilities are key inputs into control & optimization strategies*

Lac-Mégantic & Hydro-Québec Microgrid Operational Outcomes

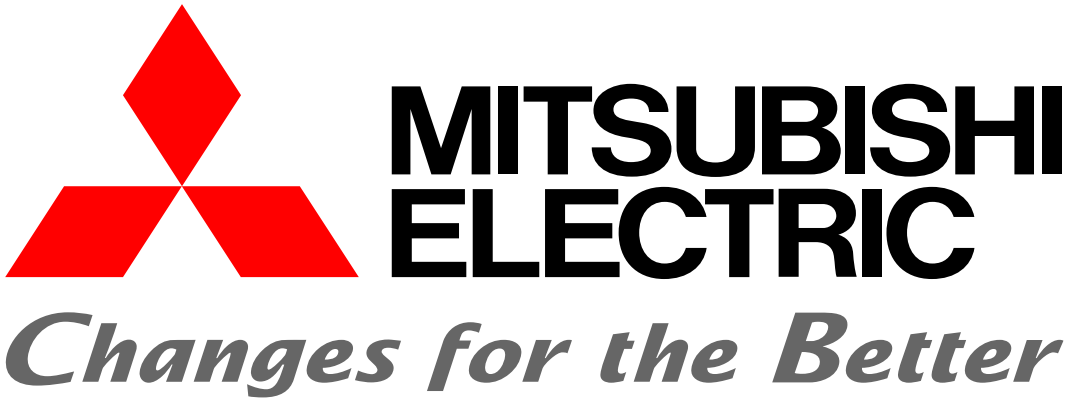
- Island management modes enabled since Autumn/Fall 2021
  - 8 successful islanding and re-synchronization sequences
  - Islanded delivery of power to loads of up to 600 kW
- Hydro-Quebec has responded to more than 25 demand response (GDP) events since 2021
- Optimization modes enabled since Autumn/Fall 2022

Reference Projects



Takeaways

- Microgrids can provide localized low carbon energy with resilience while also providing energy and price security
- Mitsubishi Electric Corp.(MELCO) and Smarter Grid Solutions(SGS) offer major challenges seen in the microgrid to meet its local requirement.
- Island Type Microgrid
  - ➢ Controlling conventional generators by operating in rated outputs which are the most efficient and economical.
  - ➢ Hybrid storage systems contribute with flexible grid operation.
- Community Type Microgrid
  - ➢ Managing island transitions must incorporate local network operational realities and new ways of working.
  - ➢ Community engagement is critical for overall success.



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