

Redox Flow Battery

Smart Energy Innovator
Sumitomo Electric

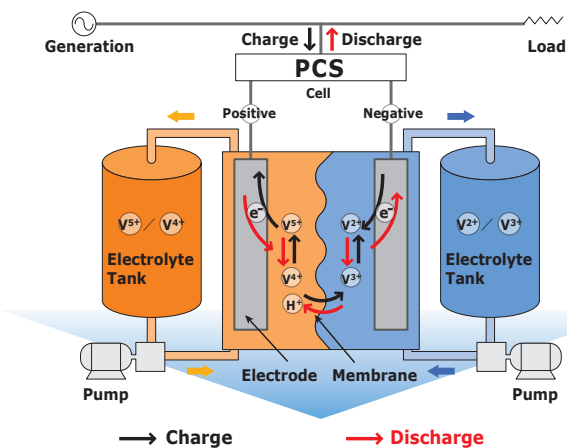
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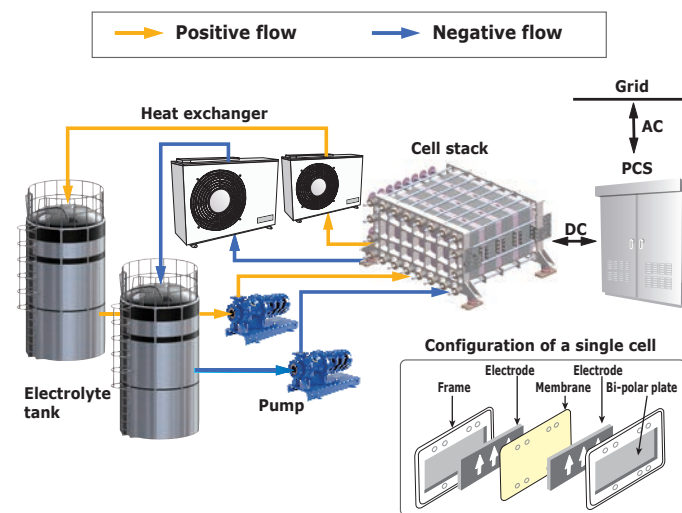
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Principle of Redox Flow Battery (RFB) System - Key Features -

Concept

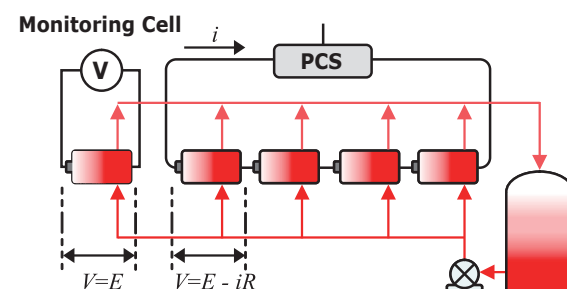


System Configuration



Feature 1: Accurate Monitoring of SOC

- » The state of charge (SOC) can be monitored on a real time basis. It is directly measured during operation by electromotive force (voltage) at the monitoring cell.



Feature 2: Fire Safety

- » Our redox flow battery consists of non-flammable materials and electrolyte.

- » Electrolyte: Vanadium sulphate aqueous solution
 - Non-flammable liquid
 - The mixing of positive and negative electrolyte does not result in ignition.
- » Cell stacks and pipes: Polyvinyl chloride (PVC)
 - Non-explosive (Ignition point: 455°C)
 - High self-extinguishing capability

Extremely low possibility of fire resulting from the flow battery materials and electrolyte

Feature 3: Long-life operation

- » No significant deposition of solution through chemical reactions in the Vanadium redox flow battery



Long design lifetime of 20 years & Semi-permanent use of electrolyte

Feature 4: No operational constraint on cycle life

- » No constraint of system operation on depth of discharge (DoD) and number of cycles

- Depth of Discharge: 100%
- Unlimited number of cycles over lifetime

Highly capable of longlife multiple-cycle operations

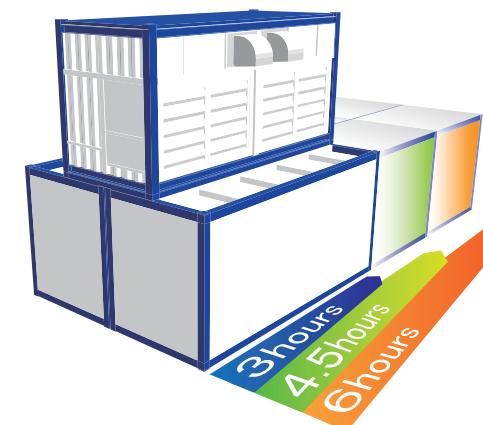
Product Lineup & Layout

Container Type of Redox Flow Battery

- » **Cost Reduction**
The containerization of the flow battery reduces the cost of transportation and local commissioning.
- » **Lifetime & Cycle-basis Economic Values**
Benefits stacking from multiple battery services by unlimited number of cycles over its long lifetime
- » **Flexible Combination of Output & Capacity**
Power intensive mode: Up to 200%
Design flexibility: Easy expansion of capacity
- » **Reduction in Installation Area**
The two-storey design and increase in battery output reduce the installation area of our flow battery system.



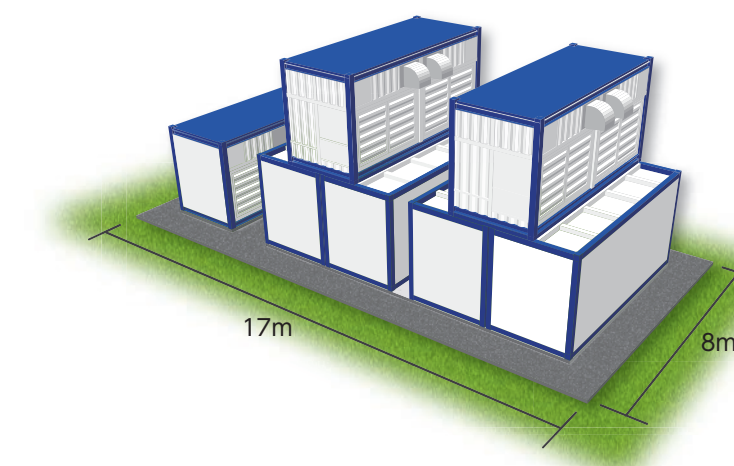
Product Lineup



Basic Specification per Module	Output	Capacity	Dimensions
3 hours model	AC250kW	AC750kWh	6.1m×4.9m×6m
4.5 hours model	AC250kW	AC1,125kWh	9.1m×4.9m×6m
6 hours model	AC250kW	AC1,500kWh	12.2m×4.9m×6m

Example of System Layout

Example: 500 kW × 3h (1,500 kWh) Model



System Size & Installation Area

Output	Capacity	Installation Area
1MW	3MWh	15m×17m
1MW	4.5MWh	21m×17m
1MW	6MWh	27m×17m
10MW	30MWh	85m×27m
10MW	45MWh	103m×27m
10MW	60MWh	131m×27m

Installed case of Redox Flow Battery (RFB) System ①

World largest operational flow battery system in Hokkaido, Japan

- » **Partner**
Hokkaido Electric Power Co., Inc.
- » **System Output and Capacity**
15 MW × 4 h (60 MWh)
- » **Applications**
 - (1) Short term frequency fluctuation controls
 - Free-governor control mode
 - Load frequency control
 - Renewable generation smoothing
 - (2) Long term frequency fluctuation control
 - (3) Excess renewable power management
- » **Project term**
2013~2018
- » **Location**
Minamihayakita Substation, Hokkaido (Japan)



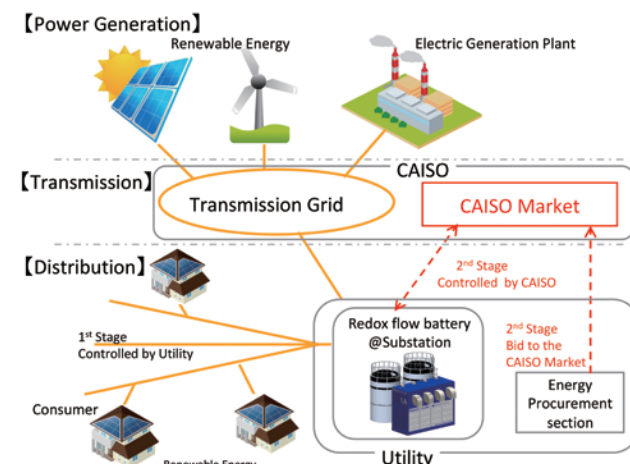
Tanks, Pumps, PCS (1st Floor)



Cell stacks, Heat exchangers (2nd Floor)

RFB System Integration in Transmission and Distribution Networks in California, USA

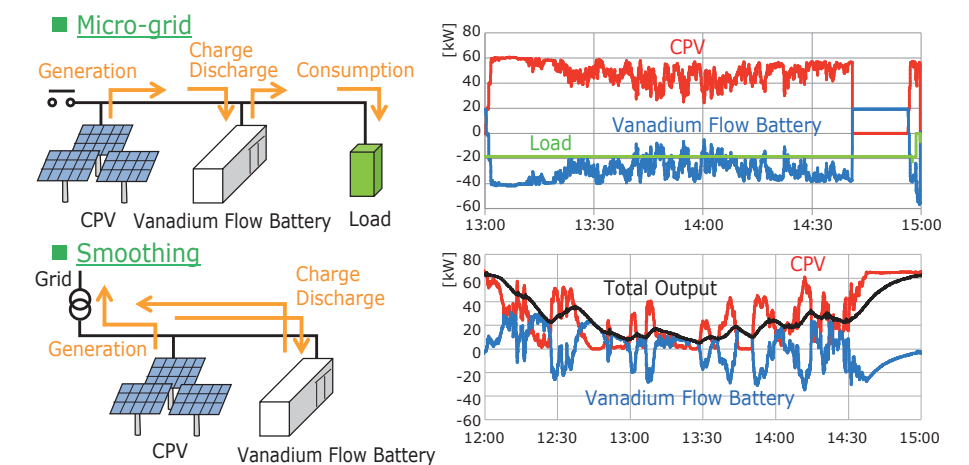
- » **Partner**
Utility in California
- » **System Output and Capacity**
2 MW × 4 h (8 MWh)
- » **Applications**
 - Frequency control
 - Voltage control
 - Excess renewable power management
 - Ancillary services
 - Microgrid
- » **Project term**
2015~2020
- » **Location**
San Diego, California (USA)
- » **UL Safety Certification**
- » **Participate in CAISO**
Energy and Ancillary Service



Installed case of Redox Flow Battery (RFB) System ②

UNIDO Morocco Project

- » **Partner**
UNIDO/MASEN
- » **System Output and Capacity**
Output: 125kW
Capacity: 500kWh
- » **Application**
Micro grid Demonstration
Renewable generation smoothing
- » **Start of Operation**
July, 2019
- » **Location**
Ouarzazate, Morocco



John Cockerill (JC) Project

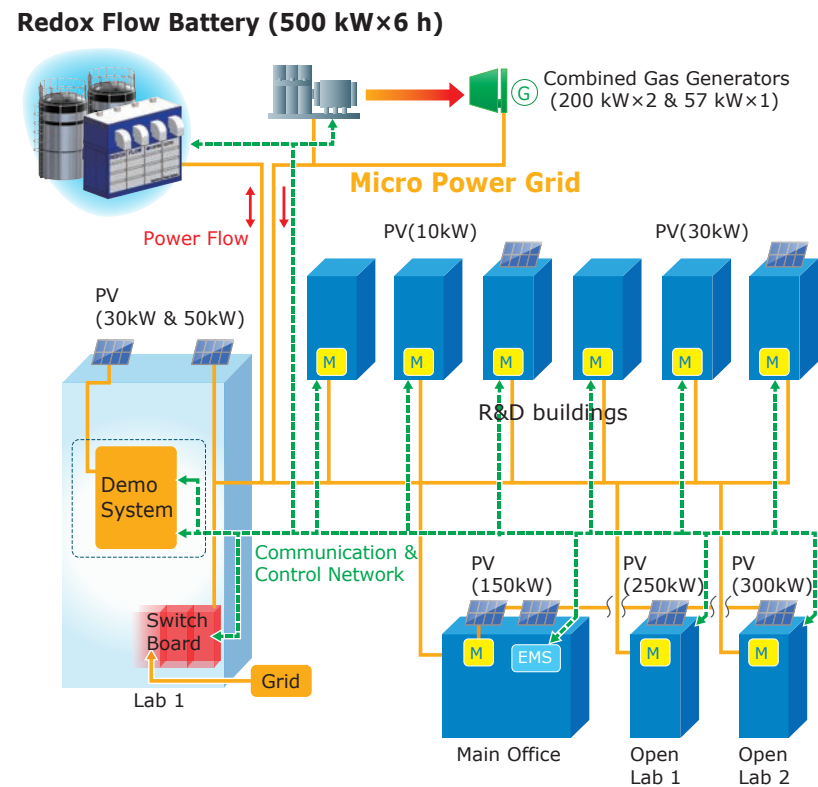
- » **Partner**
John Cockerill (JC)
- » **System Output and Capacity**
Output: 500kW
Capacity: 1700kWh
- » **Application**
Micro Grid/Smoothing/Peak cut/Demand Response
- » **Start of Operation**
September, 2019
- » **Location**
Seraing, Belgium



Installed case of Redox Flow Battery (RFB) System ③

Project with Obayashi Corporation

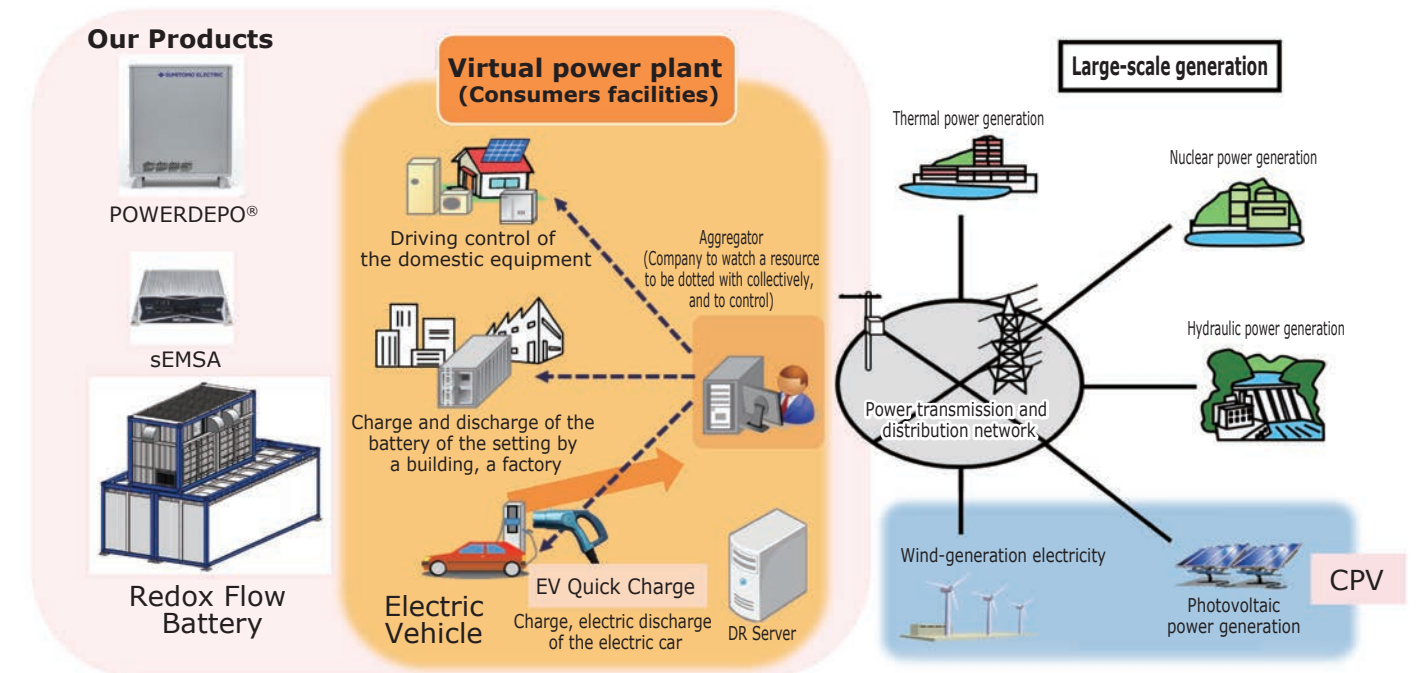
- » **Partner**
Obayashi Corporation
- » **System Output and Capacity**
500 kW×6 h (3 MWh)
- » **Applications**
 - (1) **Grid-connected Mode**
 - Peak reduction
 - Excess renewable power management
 - (2) **Island Mode**
 - Primary voltage source (Black start)
- » **Start of Operation**
January, 2015
- » **Project Location**
Tokyo, Japan



Virtual power plant (VPP)

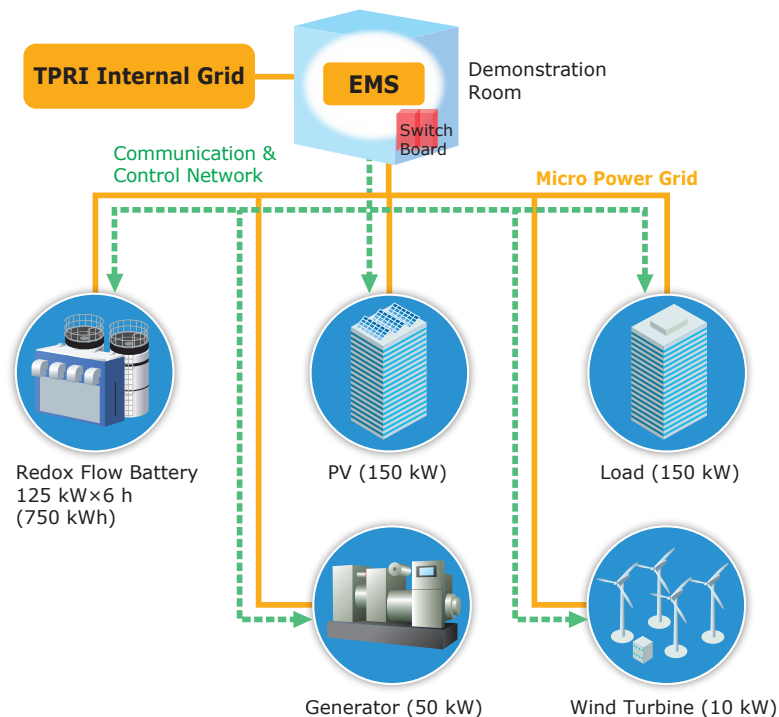
Virtual power plant System

- » A virtual Power Plant, operated by an aggregator which directly controls group of energy resources of consumers for effective demand control to adjust the power system, is expected to be an alternation of conventional power plants.



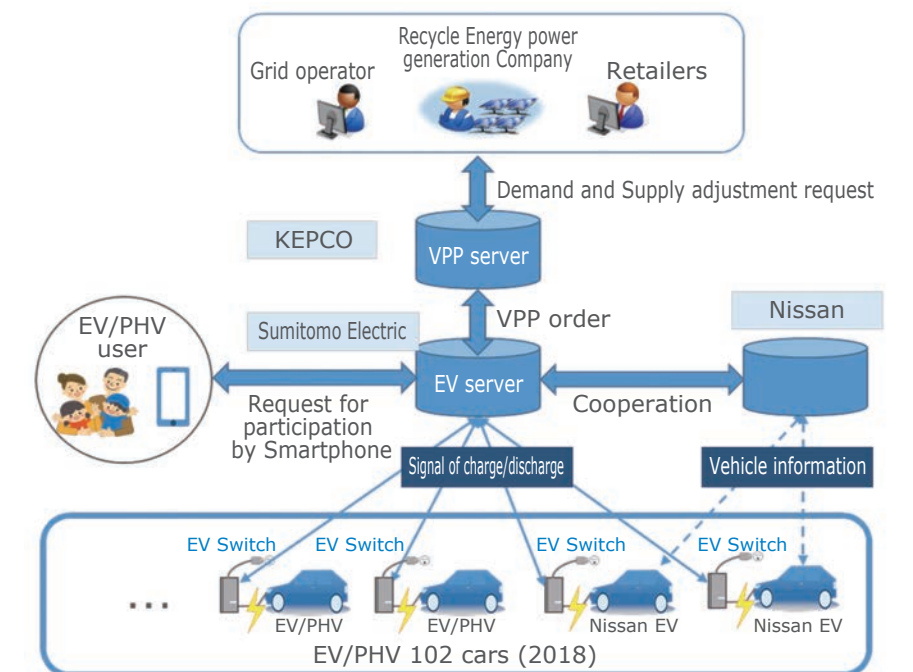
Project with Taiwan Power Research Institute

- » **Partner**
Taiwan Power Research Institute
- » **System Output and Capacity**
125 kW×6 h (750 kWh)
- » **Applications**
 - Microgrid Demonstration
- » **Start of Operation**
February, 2017
- » **Project Location**
Taipei, Taiwan



Utilization of EV/PHV as Adjustment of Power Supply and Demand Balance (VPP)

- » It is expected that incentives will be obtained by using the charging of the EV/PHV as the adjustment of the electricity supply and demand balance.
- » By linking with the telematics server to check the SoC of EV/PHV, it is possible to select the best car for charging.
- » It remotely controls charging based on the driving plan entered at the smartphone, so there is no worry about insufficient of charge on driving.



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