SUMITOMO ELECTRIC
Connect with Innovation

Redox Flow Battery

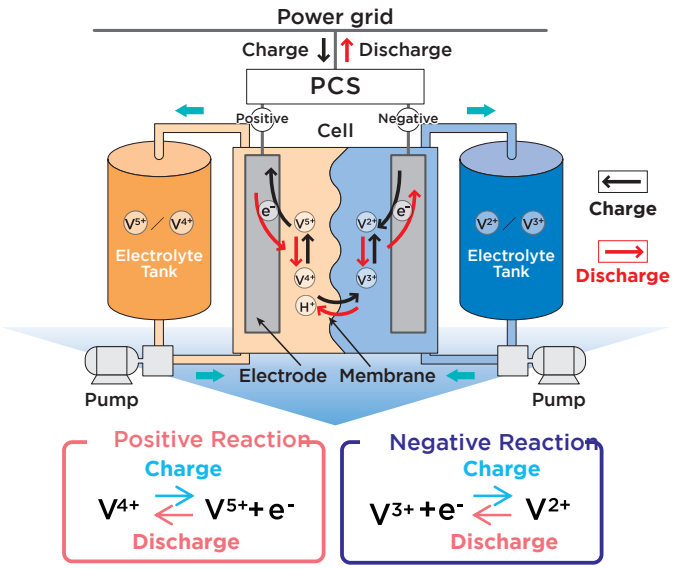
— Long Duration Energy Storage (LDES) —

SUMITOMO ELECTRIC GROUP

Technology Fundamentals and Key Features

Principle

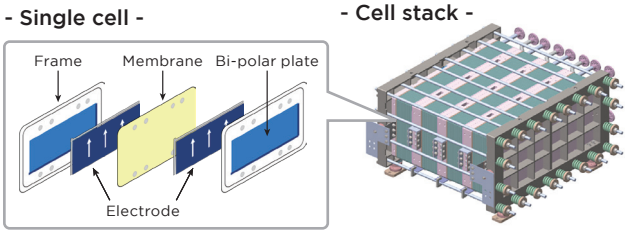
Redox: Reduction/Oxidation of active materials
Flow: Flowing active materials with pumps from tanks



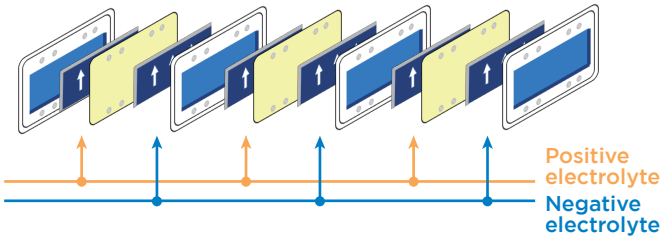
- The reactions are associated with only the changes in valences of the vanadium ions.
- Because the valence changes do not deteriorate the electrolyte, electrolyte can be used semi-permanently.

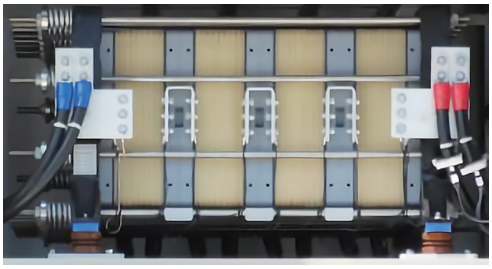
Configuration

Single cell & Cell stack



Cell stacking





cell stack

Features

Long Lifetime

- >20-year design life
- Unlimited charging / discharging cycle
- Significantly low degradation of capacity
- Reusable electrolyte after decommissioning

Fire Safety

- Non-flammable electrolyte
- No thermal runaway
- Since no hazardous materials are used, administrative permission at the time of installation is easy
- Operable under tough environmental conditions

Easy Operation / Operability

- Available State of Charge (SoC): 0 – 100%
- No unbalanced capacity across the cell stacks
- Accurate & real-time SoC monitoring

Type of Redox Flow Battery(RFB)

Container Type Redox Flow Battery

Low Life-Cycle Cost

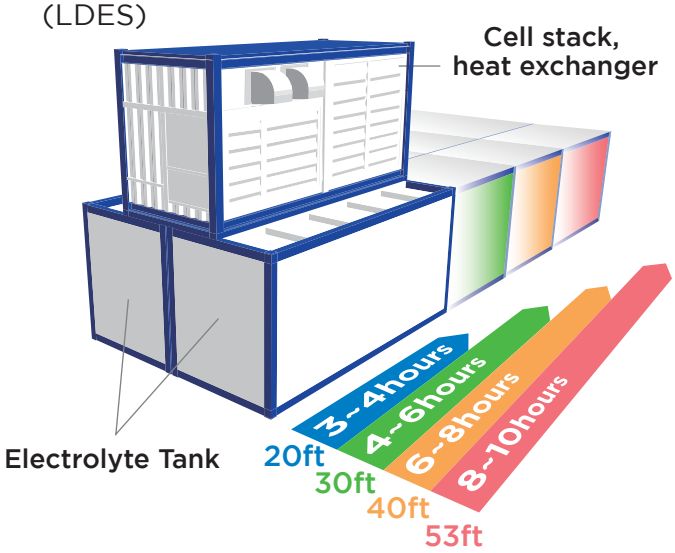
- Low CAPEX per kWh: Lower unit cost ($/kWh) for longer duration systems
- Low OPEX: No need for replacement of cell stacks or electrolyte
- Significant salvage value: Reusable electrolyte of long duration systems

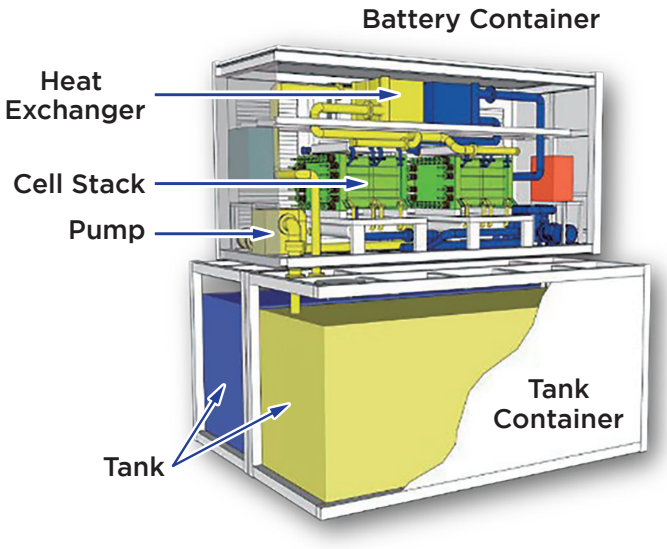
Footprint Reduction

- Minimized installation with the two-storey model: the top is battery container and the bottom two are electrolyte tank containers.

Design Flexibility

- Separation of power (MW) and energy (MWh)
- Easy to build long duration energy storage (LDES)

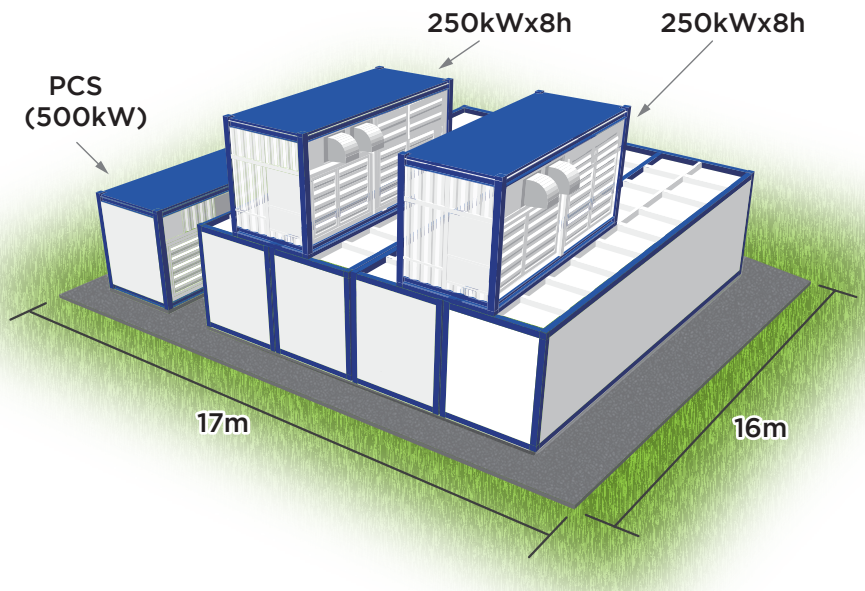




Type (hours)	Output	Capacity
20ft (3~4h)	250kW	750kWh~1,000kWh
30ft (4~6h)	250kW	1,000kWh~1,500kWh
40ft (6~8h)	250kW	1,500kWh~2,000kWh
53ft (8~10h)	250kW	2,000kWh~2,500kWh

Capacity (duration) is expandable for more than 10h.

Example of layout for 500kWx8h (4,000kWh) system



Sample footprint

Output	Capacity	LxW
1MW	4MWh	15m×17m
1MW	6MWh	21m×17m
1MW	8MWh	27m×17m
10MW	40MWh	85m×27m
10MW	60MWh	103m×27m
10MW	80MWh	131m×27m

Grid-scale Project for Utility in Japan

Hokkaido Electric Power Network Project

- Customer: Hokkaido Electric Power Network, Inc.
- Location: Minami-Hayakita Substation
  Hokkaido, Japan
- Power and Energy: 17MWx3h (51MWh)
- Application: Enhancing grid control for new 162MW wind turbines
  (e.g. Frequency regulation, Renewable generation smoothing)
- Operation term: 21 years
- Commencement of Operation: Apr. 2022

Large Scale Flow Battery Demonstration for Grid Control with Hokkaido Electric Power Network

- Customer: Hokkaido Electric Power Network, Inc.
- Location: Minami-Hayakita Substation
  Hokkaido, Japan
- Power and Energy: 15MWx4h (60MWh)
- Objective: Urgent demonstration project of a large scale power storage system, subsidized by METI (Ministry of Economy, Trade and Industry).
- Application: Frequency regulation, Renewable generation smoothing
- Demonstration Term: 2013 to 2018
- Commencement of Operation: Dec. 2015
  (Commercially operational since 2019)

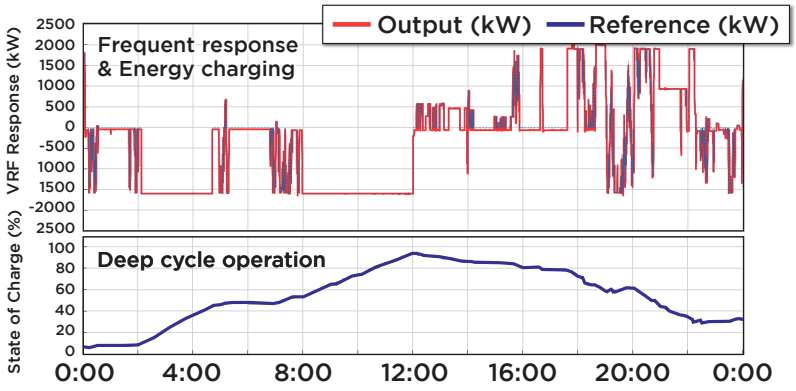
Floor 1: Tank, Pump and PCS

Floor 2: Cell stack and heat exchanger

Grid-scale Project for Utility in US

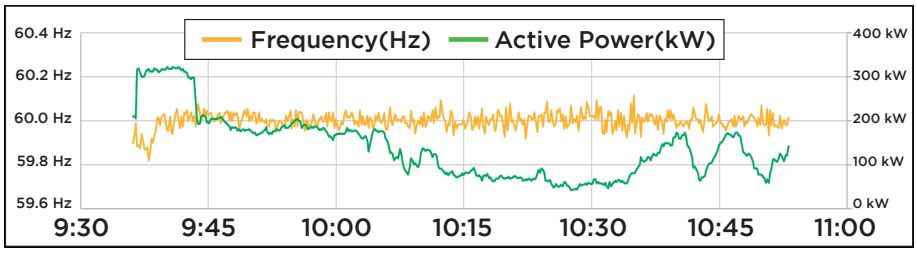
Flow Battery Pilot Project for Grid Applications in California (NEDO project)

- Customer: San Diego Gas & Electric (SDG&E)
- Location: San Diego, California, US
- Power and Energy: 2MWx4h (8MWh)
- Application: Multiple uses of electricity market (CAISO) operation, Microgrid, Peak shaving, Renewable firming
- Demonstration Term: 2015 to 2021
- Commencement of Operation: Mar. 2017 (Commercially operational since 2022)
- First Flow Battery in the US with UL certified Cell Stack (UL1973) in 2017
- First Flow Battery operational in the California Independent System Operator (CAISO) markets since 2018
  - Market participation in both Energy and Ancillary Services (AS)
  - Operation with features of 0-100% Usable SoC, Unlimited Cycle Life



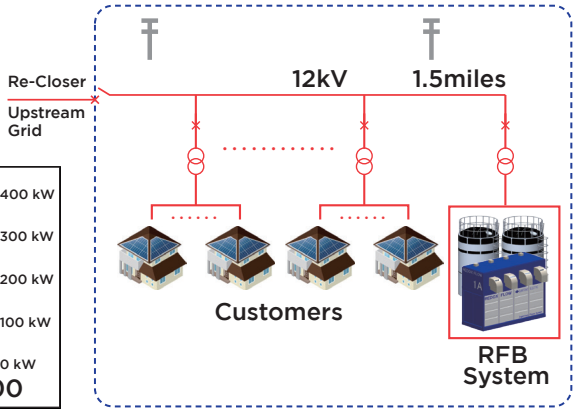
CAISO Operations

- First Flow Battery engaged in a microgrid operation on actual power distribution line independent of external grids in 2021



Microgrid Operation

Microgrid Area



Project in Africa & Europe & Asia

UNIDO Morocco Project

- Customer: UNIDO / MASEN
- Location: Ouarzazate, Morocco
- Power and Energy: 125kWx4h (500kWh)
- Application: Microgrid, Renewable generation smoothing
- Operation under tough environmental conditions
- Commencement of Operation: Jul. 2019

John Cockerill Project

- Customer: John Cockerill
- Location: Seraing, Belgium
- Power and Energy: 500kWx3.4h (1,700kWh)
- Application: Microgrid, Peak shaving, Peak cut operation, Demand response
- Commencement of Operation: Oct. 2018

Taiwan Power Research Institute Project

- Customer: Taiwan Power Research Institute
- Location: Taipei, Taiwan
- Power and Energy: 125kWx6h (750kWh)
- Application: Microgrid, Peak cut operation
- Commencement of Operation: Feb. 2017

Project in Japan

NIPPON P.S Project

- Customer: NIPPON P.S CO.,LTD.
- Location: Tsuruga, Fukui, Japan
- Power and Energy: 250kWx3h (750kWh)
- Application: Carbon emissions reduction by effective renewable energy utilization
- Commencement of Operation: Jan. 2023

Obayashi Corporation Project

- Customer: Obayashi Corporation
- Location: Tokyo, Japan
- Power and Energy: 500kWx6h (3,000kWh)
- Application: Peak reduction, Excess renewable power management
- Commencement of Operation: Jan. 2015

Yokohama Works Megawatt-class Energy Storage Project

- Yokohama Works, Sumitomo Electric Industries, Ltd.
- Location: Yokohama, Japan
- Power and Energy: 500kWx5h, 250kWx5h, 250kWx5h (5,000kWh)
- Application: Peak cut operation, Factory energy management
- Commencement of Operation: Jun. 2012

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Redox Flow Battery System Division

https://sumitomoelectric.com/products/redox

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