



redflow



Redflow Storage for Military Microgrids

Long Duration and Hibernation for Resiliency

DPEC 2024-06-06 – Paul Kelleher, VP

Stewart Air National Guard Base

- + **Contracting Agency:** US DoD Defense Innovation Unit – DIU’s 2023 LDES RFP
- + **Project Location:** Stewart Air National Guard Base, Newburgh, NY
- + **Project Objective:** Multi-building, long duration, microgrid with solar/storage/diesel backup
- + **System Size:** 250 kW / 1.4 MWh BESS paired with existing PV and diesel backup genset
- + **Storage Use Cases:**
 - Classic 4 to 6 hr – daily time shifting PV energy into higher value periods
 - Resiliency during grid outages – multiday on battery and PV alone
 - Offsets diesel genset – during weather extremes fast diesel battery recharge at optimum loading
 - Integration of EV L3 fast charging – tap microgrid 1000Vdc backbone without AC distribution upgrades
- + **Reason for Redflow Selection:**
 - Unique Hibernation Mode
 - Fire-Safe and Mature Technology
- + **Project COD:** Q1 2025

Sigonella Naval Air Station

- + **Project Location:** Sigonella Naval Air Station, Sicily, Italy
- + **Project Objective:** Building-level microgrid providing up to 14-day resiliency w/o grid power
- + **System Size:** 100 kW / 400 kWh BESS paired with existing PV and diesel backup genset
- + **Project Use Cases:**
 - Classic 4 to 6 hr – daily time shifting PV energy into higher value periods
 - Resiliency during grid outages – LDES/hibernation offsets diesel genset
- + **Reason for Selection:**
 - Unique Hibernation Mode
 - Fire-Safe and Mature Technology
- + **Project COD:** Q4 2024

Outstanding Bids: US DOD Facilities

- + **US Army Camp Parks, Dublin, CA**
 - **Project Size:** 1 MW / 4 MWh
 - **Purpose:** Nodal microgrid managed by Lawrence Berkeley National Lab
- + **Sigonella Naval Air Station, Sicily, Italy**
 - **Indicative Phase #2 (Clone of Phase #1)**
 - **Project Size:** 100 kW / 400 kWh
- + **Stewart Air National Guard Base, Newburgh, NY**
 - Dept. of Air Force – Quotes for additional microgrid nodes for EV fast charging locations
 - L3 fast charging otherwise impossible without costly electric infrastructure upgrades at the base



Additional Government/Defense

- + **Stewart Air National Guard Base – US Air Force**
 - Whole base microgrid expansion – conceptual study funded under Phase #1 DIU microgrid project
 - 20+ MWh Potential added LDES
- + **US Embassy Compound (African Continent)**
 - Daily outages on weak local electric grid, heavy diesel standby ops with diesel supply chain issues
 - Quote for 2.4 MWh of LDES with new PV to ride through daily outages without diesel standby operation
- + **Israeli Defense Contractor**
 - Advanced discussions to provide Redflow LDES/hibernation to harden power for remote comms sites

Redflow's Key Resiliency Features

Advanced Long Duration Energy Storage

Hibernation feature extends duration horizon

Redflow LDES – Daily Cycling

- + High efficiency over 4 to 12 hours discharge
- + Proven at hundreds of sites
- + Battery purpose built for LDES in harsh service



Redflow offsets diesel use at dozens of remote Telco and Weather Sites

- + Reduces generator run time
- + Increases generator efficiency
- + Reduces diesel use, GHG, and saves \$

Redflow Hibernation Mode

- + Suspend fully charged battery – discharge in future – no-self discharge or aux power drain
- + Unique Redflow Capability for Resiliency
- + Vast potential for DoD and other applications



Redflow Background

Phased Product Development

2008 to 2020 Commercially Proven Abroad

- + 270+ projects around the world
- + Proven Alternative to Lead-Acid & Li-Ion:
 - Residential on-grid and off-grid
 - Telco tower sites with wildfire or weak grid issues – critical infrastructure
 - Small to medium commercial sites



2021 to date Growing in North America

- + Same field proven battery building block
- + Focus on industrial, large commercial, and utility applications to build volumes and drive manufacturing costs down
- + 2023 achieved exponential sales growth
- + Roadmap to scale, TAA, and US manufacturing



Iterate tech on small scale deployments

2008

Redflow formed
Gen1 developed



2014

Gen2.5 launched



2018

Redflow Thailand
Established



2021

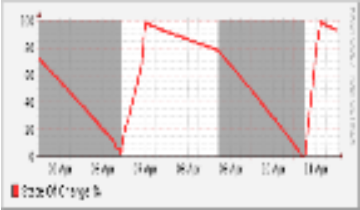
Hibernation
Mode Launched



Initial prototyping
2005



Gen2 battery
2010



Launch Battery
Management System
2017



Gen3
First customer trial
2020

Focus on larger systems

2021

Energy Pod launch for larger systems



2022

2 MWh system Launch in US



2023

Award of 20 MWh system for Paskenta Band of Nomlaki Indians



2023

1.2-1.4 MWh LDES system for US Department of Defense



2023

6.6 MWh system for Barona Band of Mission Indians



US team established

2022



Gen3 launch (July)

2022



4 MWh system for Energy Queensland

2023

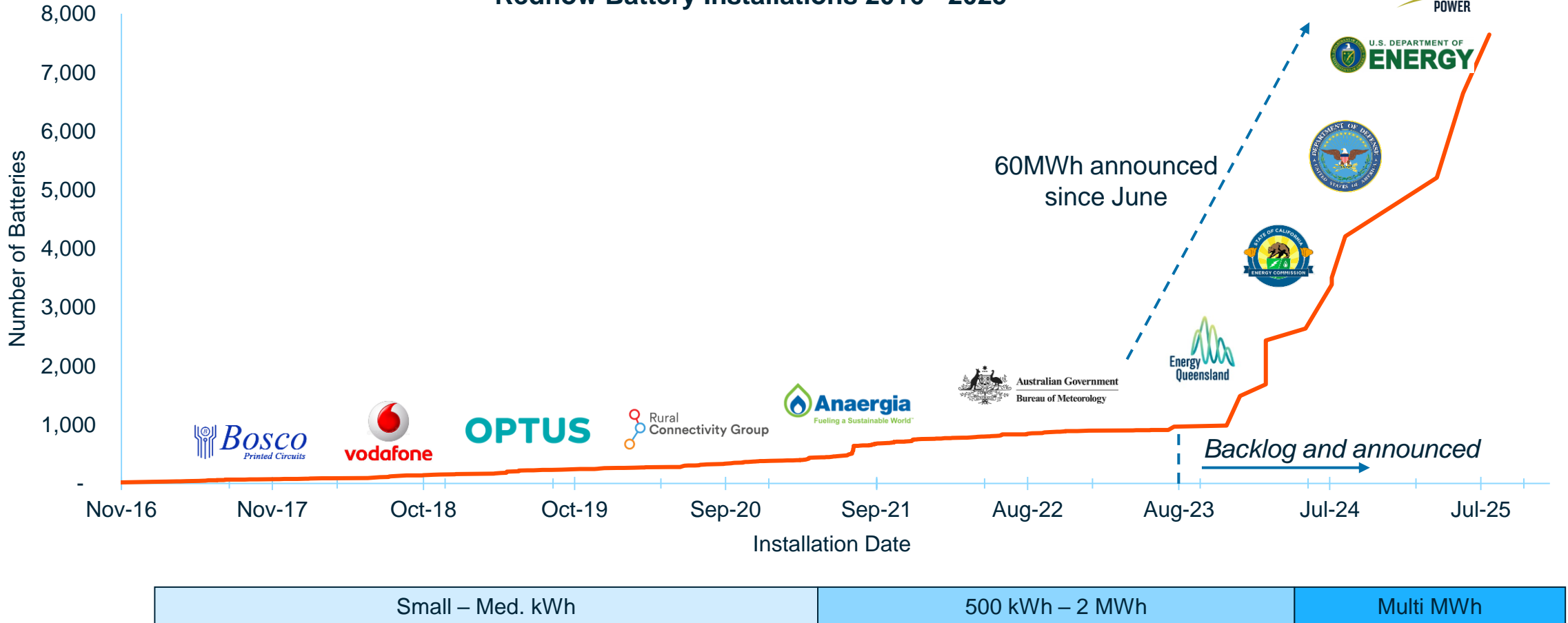


Award of 34.4 MWh system for Valley Children's Hospital

2023

US Market Fuels Sales Growth

Redflow Battery Installations 2016 - 2025*

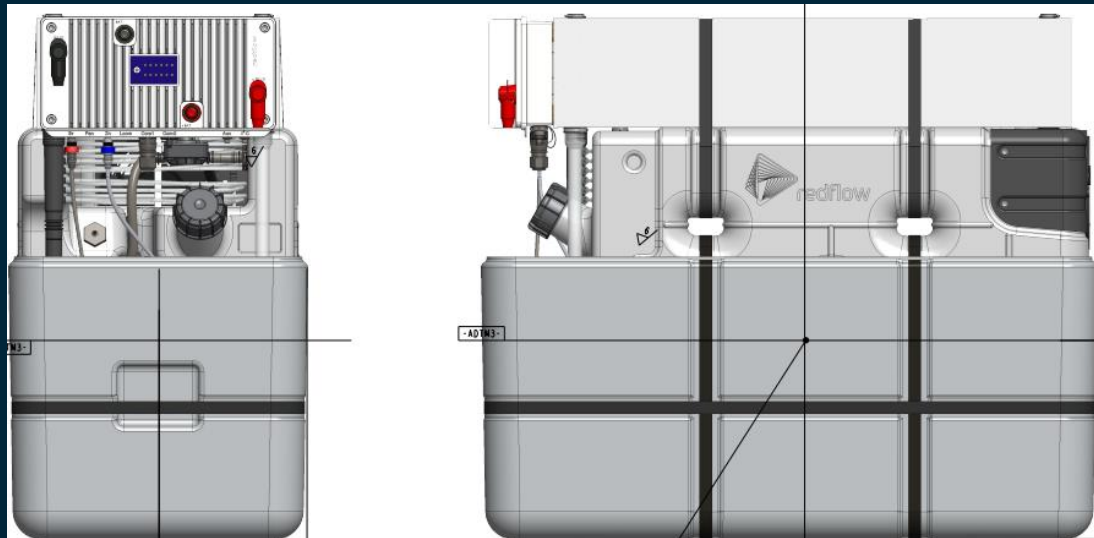


Sources: Company information. * Installations based on deployed systems to 30th August 2023 currently active and currently expected deployment schedule of recently announced CEC, EQ, DOD and DOE projects. Note the specific delivery timetable of the CEC and EQ projects is subject to final contracting and implementation timetable and therefore may be subject to change

Redflow Product

Core Product – ZBM module

- + Modular zinc bromine flow battery cell
- + ZBM3 - 10kWh, 200Ah, 48V 3kW continuous / 5kW peak
ZBM4 - 11kWh, 220Ah, 48V 3kW continuous / 5kW peak
- + C/4 to C/10 discharge at nameplate RTE
- minor RTE reduction to boost to C/3 or extend to C/12
- + 400mm wide x 861mm long x 747mm high
- + Weight 240kg



MWh Scale Multi-Battery Enclosures

Proven building block for scale up to multi-MWh systems



- + 20 ZBM4 modules in isolated, cabinet style battery compartment – 50 kW, 220 kWh total
- + Separate control and DC/DC cabinet
- + Fully integrated, multi-layer Redflow BMS
- + First delivered at our 2 MWh Anaergia installation in Rialto, California
- + Pre-tested and shipped as complete system – no on-site fill or plumbing. TAA option available. IRA bonus ITC compliant option under development.

Redflow Deployments

California, United States



2 MWh California deployment

- + 2 MWh at Anaergia Rialto Bioenergy Facility in SoCal.
- + Reduces peak energy use and optimizes on-site self gen
- + Anchors critical loads in microgrid with on-site self gen
- + Operating for 2.5 years

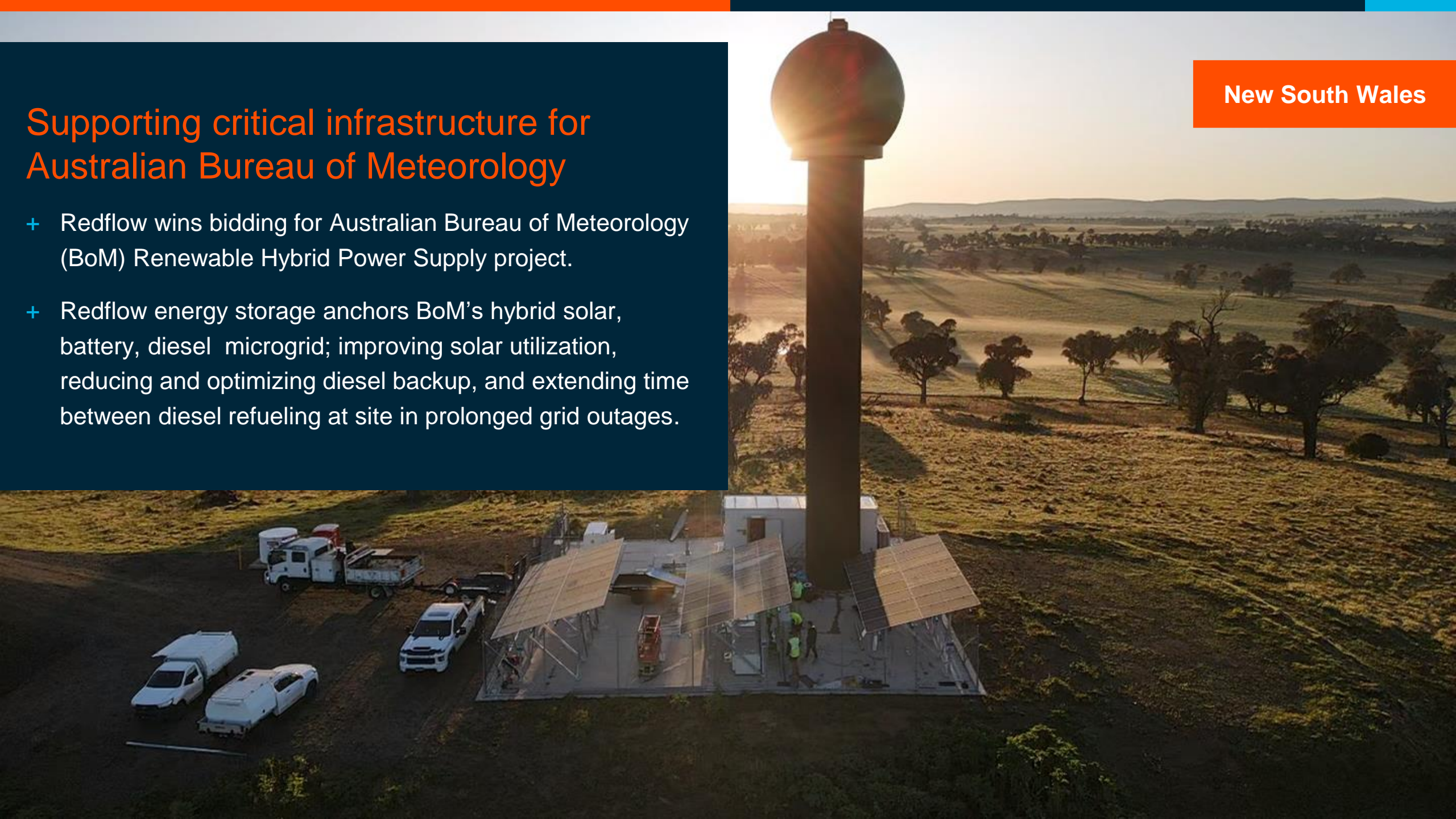
Redflow 60 kWh system offsets diesel genset at a remote Optus teleco site – installed 2019

- + 65% reduction in generator operation run time
- + 17% Increase in generator efficiency
- + ~6000 L of diesel fuel saved every year
- + 16 tonnes of CO₂ abated per annum
- + Est. savings of >US\$7,000 every month

Source: Redflow Analysis

Supporting critical infrastructure for Australian Bureau of Meteorology

- + Redflow wins bidding for Australian Bureau of Meteorology (BoM) Renewable Hybrid Power Supply project.
- + Redflow energy storage anchors BoM's hybrid solar, battery, diesel microgrid; improving solar utilization, reducing and optimizing diesel backup, and extending time between diesel refueling at site in prolonged grid outages.





Solar and Redflow batteries serves for Knox City Council Child Care Center

- + Redflow provides battery storage which meets crucial fire safety requirements for childcare centers in Melbourne.
- + Part of an award-winning green building development featuring energy efficiency and renewable energy with battery storage.

Melbourne, Victoria

Resilience for Optus telco towers

- + Redflow has deployed systems to Optus tower sites around Australia to provide back up power as part of a resilience program.
- + Features Redflow's unique hibernation mode where the batteries sit in a fully charged state for long periods without self discharge. During grid outages the hibernated modules are sequenced after discharge of daily cycling batteries to reduce diesel genset runtime.





Kangaroo Island, South Australia

Australian Island Resort Hotel: 0.56 MWh

- + First large-scale commercial sale of Gen3 batteries.
- + 56 Gen3 zinc bromine flow batteries at Southern Ocean Lodge, as part of its new hybrid renewable energy system.

The image shows a server room with several rows of server racks. The racks are dark green and have white doors with circular ventilation fans. To the right, there are blue power units or UPS systems mounted on a wall. The room is dimly lit, with light coming from the server racks themselves.

South Africa

Bosco commercial deployment

- + Power backup and peak charge avoidance at South Africa largest PCB Manufacturer, Bosco Printed Circuits.
- + 140kWh of ZBM storage.
- + Provides security against power outages and avoidance of peak power prices.
- + Keeps the PCB manufacturing line operating during grid outages, avoiding heavy wastage.

Our largest project to date...



20 MWh
10x larger than
largest prior project

"This project is an important step in California's clean energy transition. It reflects the CEC's goal to commercialise proven long-duration energy storage"

Jonah Steinbuck, Director of the Energy Research and Development Division at the California Energy Commission, 31 May 2023¹

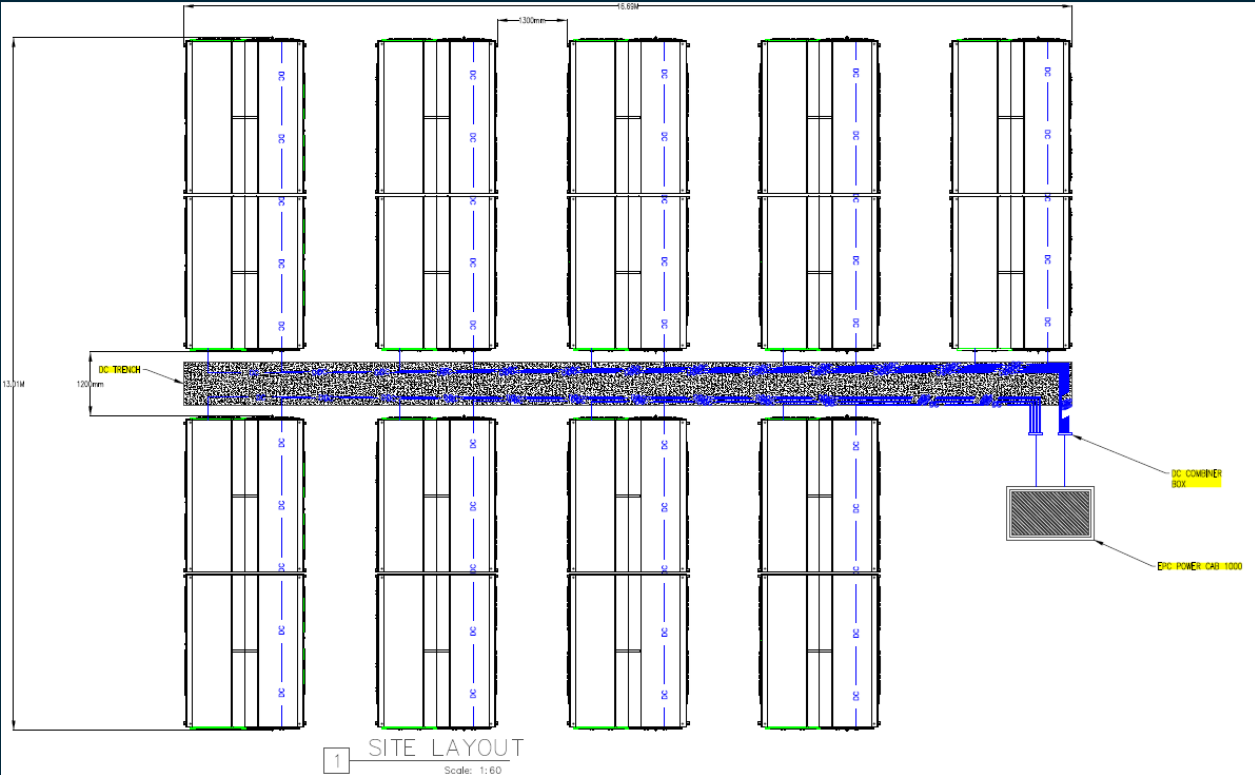


California, United States

Artist's impression of the 20 MWh Paskenta Microgrid Project.
1. Redflow ASX Release, *Redflow to supply 20 MWh battery system in California*, 01 June 2023

Energy Queensland, Australia

- + 1MW / 4MWh for deployment mid 2024
- + Energy Pod 220 configuration – site 17m x 13m
- + Front of Meter – Utility Grid Support



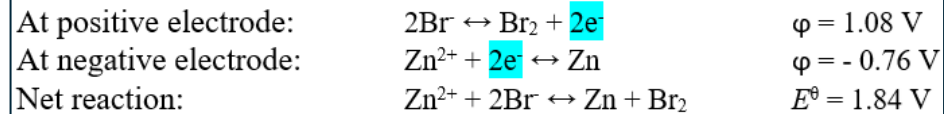
Redflow Chemistry

Zinc-bromine flow battery chemistry



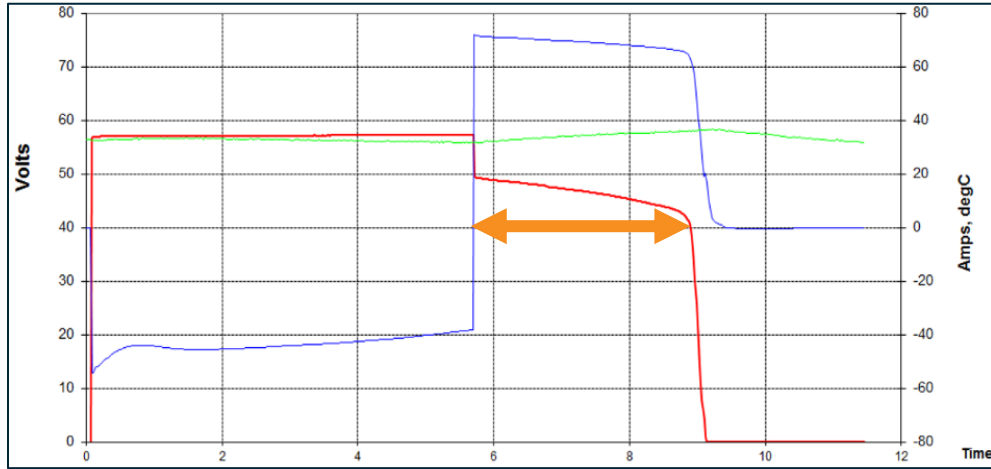
- + Zn-Br redox reaction for energy storage was patented over 100 years ago.¹
- + Yields 2 electrons per half-reaction. Improving energy density
- + Abundant electrolyte component materials:
 - zinc the 4th most abundant metal
 - bromine common in salt deposits and desalination byproduct
- + Organic complexing agent (BCA) is added to industrial oil/gas-well finishing fluids.
- + BCA captures the bromine (Br₂) as it develops at the positive electrode (during charging), while metallic zinc is plated onto the negative electrode.

In ZBFB, the electrode reaction is as follows.

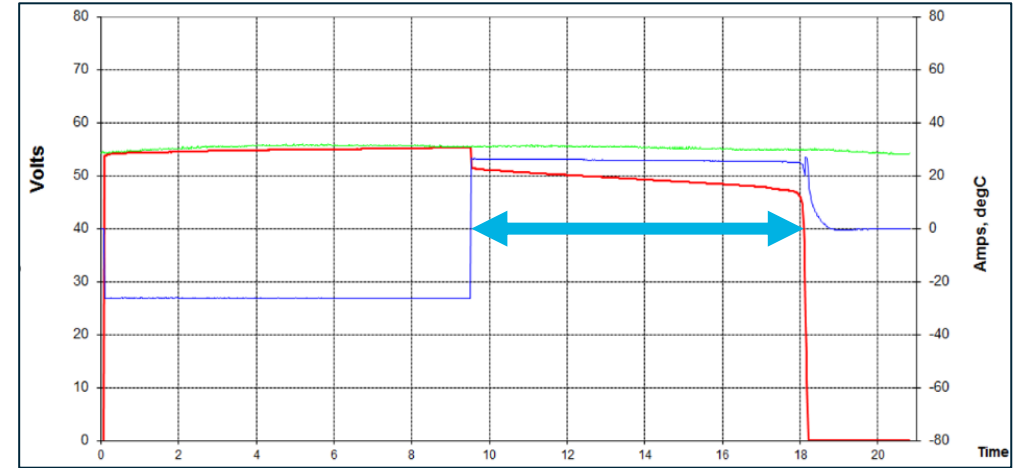


Zinc-bromine redox reaction and resulting electron-volt potentials.²

Zinc-bromine flow battery charge/discharge characteristics

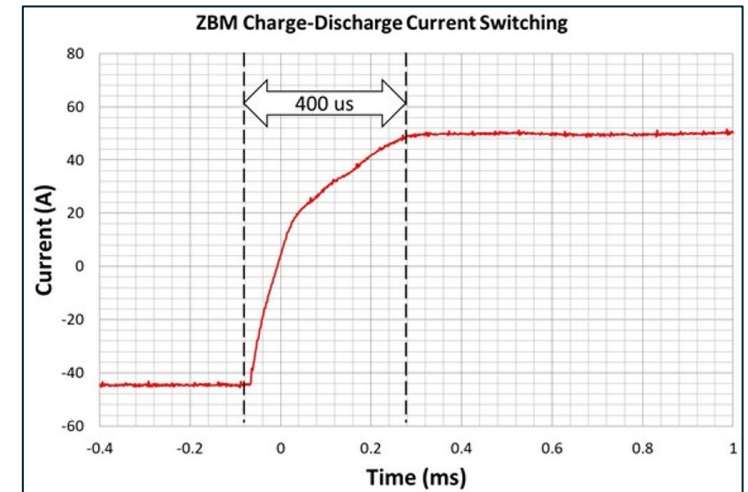
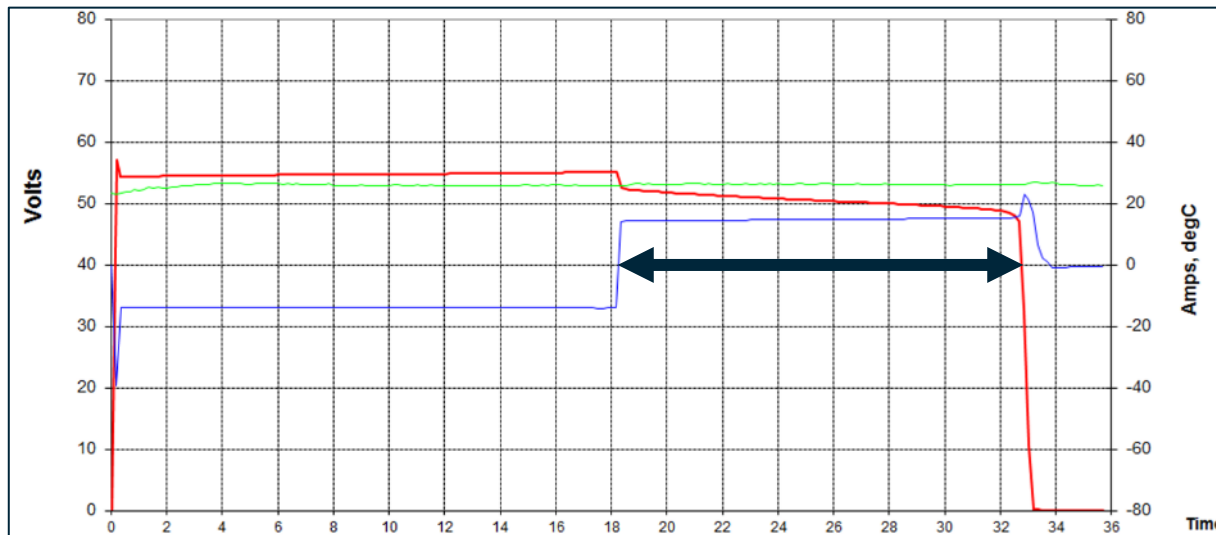


3.1 kW (45.5 Vdc & 68 A) for 3:18 hrs

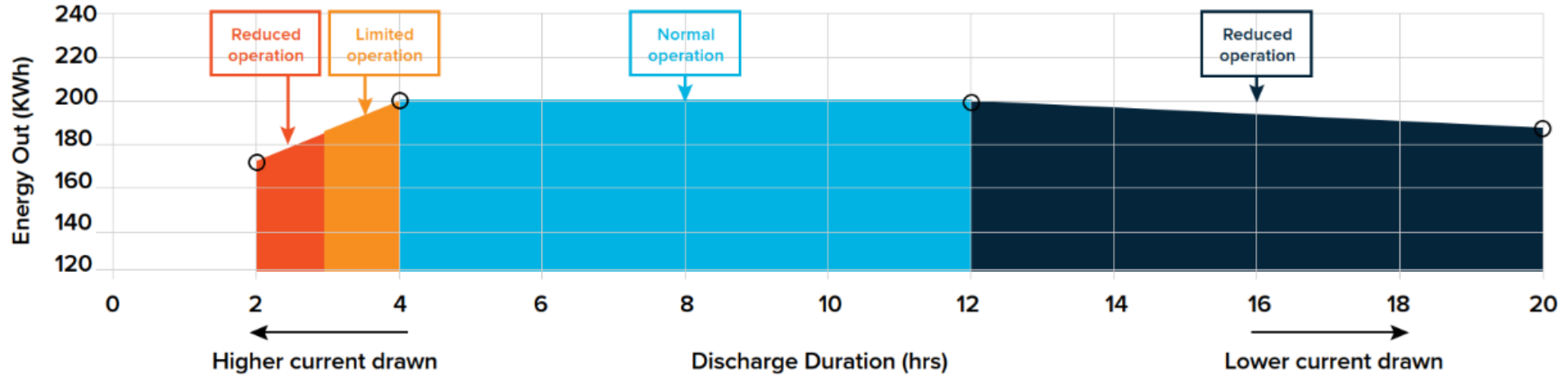


1.25 kW (49 Vdc & 25.8 A) for 8:42 hrs

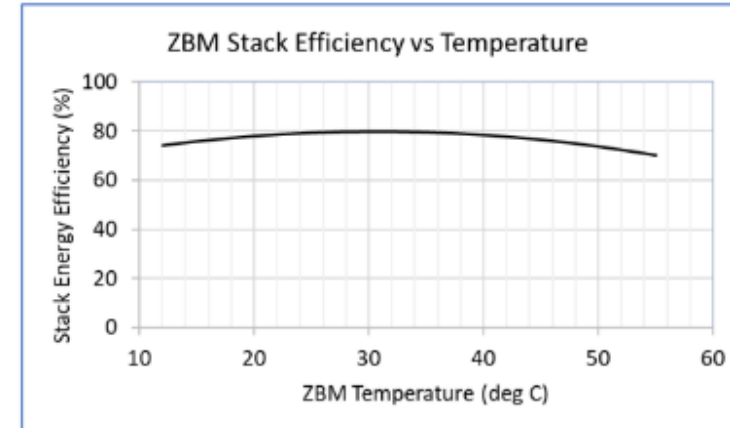
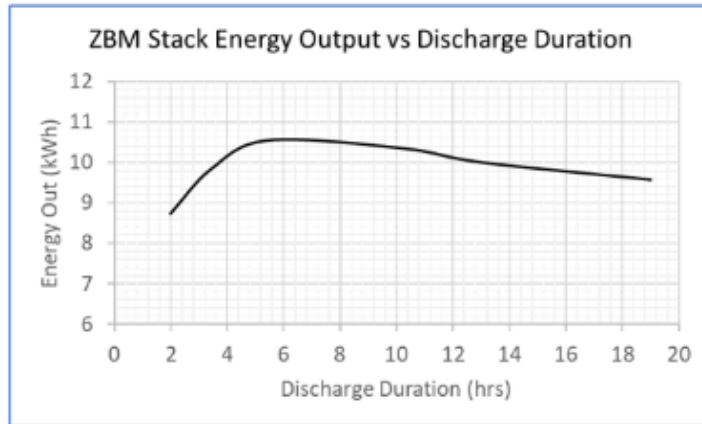
750 W (49.8 Vdc & 15 A) for 14:48 hrs



Redflow's short and long-duration capabilities



High power incurs IsquareR losses.
Long duration has more time for self-discharge loss.



Optimum temperature is ~ 30 deg C.
Efficiency falls at temperature extremes.

Q&A