



redflow



Introduction to Redflow Long Duration Energy Storage

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About Redflow

Redflow at a glance



270+
active deployments



3.2 GWh
total energy delivered to date



Over 6 GWh
qualified sales pipeline



Over \$30m
revenue
for announced projects over next 12- 18 months



500+ MWh
in 2025 ambition
manufacturing scale with capital efficiency



2,080
estimated tonnes of CO₂ offset



34 MWh
largest project announced



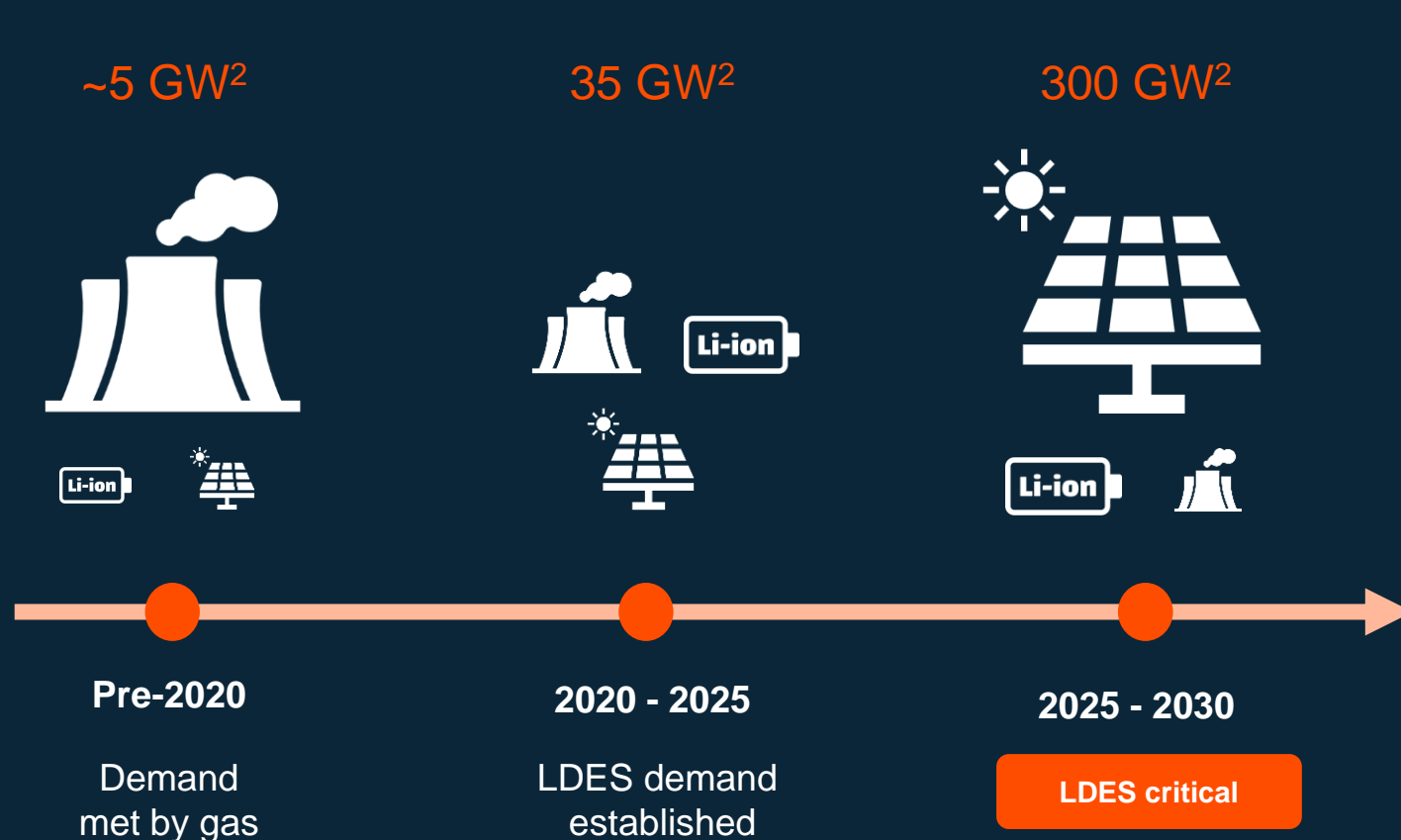
3x density
energy density vs other commercial flow batteries¹



24 million
cumulative hours of field operations since 2018

LDES: why now?

Global need of 2TW+ by 2040¹



LDES penetration has been low in the past

- + High proportion of baseload from coal and gas
- + Renewables supplemented the core grid

Fossil fuels declining as source of baseload

- + Grids increasingly powered by renewables
- + Coal and gas generation prevent climate goals
- + Phasing out of coal and gas peakers
- + Lithium for short term energy storage needs

Renewables powered grids needs LDES

- + Renewables require LDES to shift power to match demand (intra-day, multi-day)
- + Growing demand for 24/7 renewable PPAs
- + Total electricity demand increasing 2x³

Market looking beyond lithium

- + Need for 4-12hr discharge capability
- + Lithium supply constraints and EV demand
- + LDES already viable for long-duration applications

A leader in Long Duration Energy Storage

Core competitive advantages of Redflow's technology



Highest energy density across all commercial flow battery chemistries

- + Zinc-Bromine is up to 3x higher energy and power density than Iron-Flow, Vanadium and other Zinc-based chemistries¹



Active operational experience

- + More than 700 active deployments and millions of cumulative hours of field operations since 2018²



Widely available, low-cost raw materials

- + Zinc is the world's 4th most abundant metal – cost and availability advantages.
- + Zinc-Bromide cited as one of the lowest estimated cost of raw materials across different battery chemistries on \$/kWh basis³.



Flexibility and agility in deployment and performance

- + Modular approach and hibernation mode maximises design capacity flexibility and aligns energy delivery to need.



1. Redflow internal analysis based on core chemistry characteristics and publicly available information
2. Redflow internal operational data as of 7th June 2023
3. See Rocky Mountain Institute, *Breakthrough Batteries*, 2019, Exhibit 20. Important Note – the information in the report is indicative of the estimated relative chemical cost of storage for zinc bromide chemistries. It is not a statement of Redflow's chemical cost of storage, which may differ from their information

Technology leadership developed over many years

Small modular approach allows for **rapid development and iteration**

Strong patent portfolio across multiple jurisdictions plus core IP

Over **18 design and material iterations** of activated carbon surface

Focused R&D roadmap for performance, scale and cost impact + tax benefit

2005

Initial prototyping



2008

Redflow formed
Gen 1.0



2014

Launch Gen2.5



2018

Launch Redflow
Thailand



2021

Energy Pod launch
for larger systems



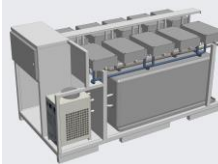
2023

Large scale C+I
systems



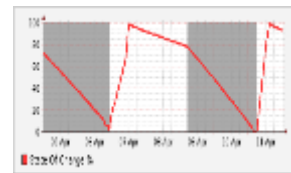
2024/5

Larger Scale
Formats



Gen2.0 battery
1st large scale system
ASX Listing

2010



Launch Battery
Management System

2017



Hibernation
Mode launch

2020



ZBM3 Launch

2022

Redflow North American Roll Out Begins 2021

Commercially proven abroad

- + 2008 to 2021
- + 270+ projects around the world
 - on 5 Continents and in dozens of countries
- + Typically small scale 48 Vdc applications; often remote and off-grid
- + Proven alternative to lead-acid & Li-Ion:
 - Long (24 hrs and beyond) Duration from 1st Installs
 - Residential on-grid
 - Residential off-grid
 - Telco tower sites with fire or weak grid issues
 - Small to medium commercial sites
 - 3 generations of product development, many steps in between
 - Popular residential hybrid inverters from Victron, Sol-Ark, CE+T, etc (48 Vdc)

Scaling for North America

- + 2021 and forward
- + North America – vast market characterized by a race to manufacturing scale and low \$/kWh cost
- + Multi-battery enclosures (Pod-200)
- + Redflow pairs with industrial (1000 Vdc) and utility scale (1500 Vdc) inverters via integrated DC PCS including DC/DC converters.
- + Cost effective bidirectional DC/DC converters (Trumpf, Alencon, Epic Power etc) now widely available and decreasing in cost.
- + Focus on industrial, large commercial, and utility applications to build volumes and drive manufacturing costs down
- + Over 50 MWh orders announced in 2023

Our technology

How does a zinc-bromine flow battery work?



ZBM3: Our third-generation battery

Redflow energy storage module consists of 3 main sub-assemblies.

Stack pack assembly

Most highly complex and high cost, including required machinery.



Control box

(or Mk- Box)
Controls and monitor battery performance.
Consists of electronic & Electrical components
Firmware to control battery.

Tank assembly

ZBM battery module technical specifications



| ZBM3 Technical Specifications | |
|---|---|
| Voltage | 48 Volt DC nominal batteries (typical operating range 40-60V). <i>Higher voltage systems with multiple ZBM batteries available (see Anaergia)</i> |
| Capacity | Maximum 10kWh energy output per daily cycle No reserved battery capacity requirement – full 10kWh cycle depth available |
| Dimensions | 845 L x 823 H x 400 W (mm) 33 L x 32 H x 16 W (in) |
| Weight | 240 kg (530 lb.) with electrolyte 90 kg (198 lb.) without electrolyte |
| Electrolyte volume | 100 L (26Gal) |
| Energy efficiency | 80% DC-DC / 68% AC-AC |
| Internal (electrolyte) operating temperature | Operating electrolyte temperature range of 15°C to 50°C (59°F to 122°F), ZBM2 can typically operate at ambient temperatures outside this range for extended periods. Additional heating kit available.* |
| Communication | MODBUS RS485 |
| Safety data sheet | DG Class 8 for electrolyte |
| Power rating | 3kW (5kW peak) 3kW continuous: current up to 75A (40V disconnection point) *1 5kW duration depending on the State of Charge (SOC): current up to 125A (40V disconnection point) *1, 2 |
| Regulatory compliance marks | CE and RCM |
| Performance | No cycle depth limitations – battery performance and lifetime is not sensitive to cycle depth |

* 1 Values reported for ZBM at 100% state of health (SOH) and room temperature

* 2 Redflow internal testing shows a 5kW supply for approximately 45 minutes before disconnection, for a ZBM starting at 100% state of charge (SOC)

Source: <https://redflow.com/products/redflow-zbm2/>

MWh deployments with Energy Pod





The Redflow Pod200 is the modular building block for large commercial and industrial applications through to 'Community Battery'-scale requirements, with the capability to store up to 200 kWh each.

20 ZBM3 hybrid flow batteries are housed in a custom enclosure which provides electrical protection and various power conditioning configurations, enabling it to deliver energy safely and reliably in a range of applications.



| Technical Specifications | |
|---|---|
| INTEGRATED POWER CONVERSION EQUIPMENT (PCE) | |
| Equipped with optional and scaleable DC-DC converters to achieve higher range output voltages or Selected hybrid inverters for direct AC output. | |
| TECHNOLOGY | |
| + Battery type: | Zinc-bromine hybrid flow battery (ZBM3). |
| + Architecture: | 20 parallel connected ZBM3, 10 kWh batteries. |
| + Battery management: | Incorporated Battery Management System (BMS). |
| ELECTRICAL RATINGS | |
| + Base unit: | 200 kWh/60 kW @ 48 Vdc (nominal) |
| + HiDC unit | 850 Vdc \pm 10% (balanced to Earth) |
| + Integrated unit: | 200 kWh/48 kW 50 Hz, 3-phase, 230/400 Vac or 200 kWh/36 kW 60 Hz, split-phase 120/240 Vac or 3-phase 208 Vac (US only) |
| PERFORMANCE | |
| + Rated discharge power: | Up to 60 kW (continuous) or 100 kW (peak) @ 48 Vdc (Nominally 2.5 kW per ZBM3) or 30 - 60 kW (continuous) or 100 kW (peak) dependent on PCE selection. |
| + Rated discharge energy: | 200 kWh |
| + Duration: | 4 - 12 HOURS (Longer deferred or scheduled discharge via hibernation capability) |
| + Depth of discharge: | 100% |
| + Maximum charge rate: | 50 kW (2.5 kW per ZBM3) |
| BUILDING BLOCKS | |
| + Compatible with external industrial sized storage inverters or larger central storage inverters at high DC voltages (if DC-DC converters are integrated). | |
| + Hybrid inverter integrated units can be coupled to existing PV systems (AC-coupled) or support multiple directly connected solar PV strings via MPPT inputs (DC-coupled). | |
| ON-GRID CONNECTION | |
| + Suitable AC connection required from site main switchboard. | |
| + Grid-export capable. (Selected hybrid inverters comply to regulatory approval in AU/NZ, US and ZA.) | |
| + Blackstart capable. (Additional equipment needed depending on inverter requirements.) | |

Customer drivers and our battery solution

| | Scenario | Lithium-ion battery | Redflow zinc-bromine battery |
|---|--|---|---|
|  Improved battery performance | Fully battery discharge discharge to zero volts | Damages battery | Benefits battery |
| | Deep daily discharge | Shortens battery life | No impact on battery life |
|  Manage high cost of power | Energy output from a full charge/discharge cycle | Declines with cycle count | Sustained |
| | Extended time in standby | Loses stored energy over time | Retains all stored energy while in standby mode |
|  Safety & Durability | High ambient temperature | May need active cooling to avoid life reduction | Ambient/free air cooling sufficient unless sustained ambient temperature is greater than 50C / 122F |
| | Risk of thermal runaway | Potential | Minimal. Electrolyte is non-flammable and bromine acts as a fire retardant. |
|  Enable shift to green energy | Environmental impact | Challenging to recycle | Easy to recycle |

Our North American story



The beginning of Redflow's US journey

2 MWh CEC-funded BESS at Anaergia's Rialto Bioenergy Facility in California

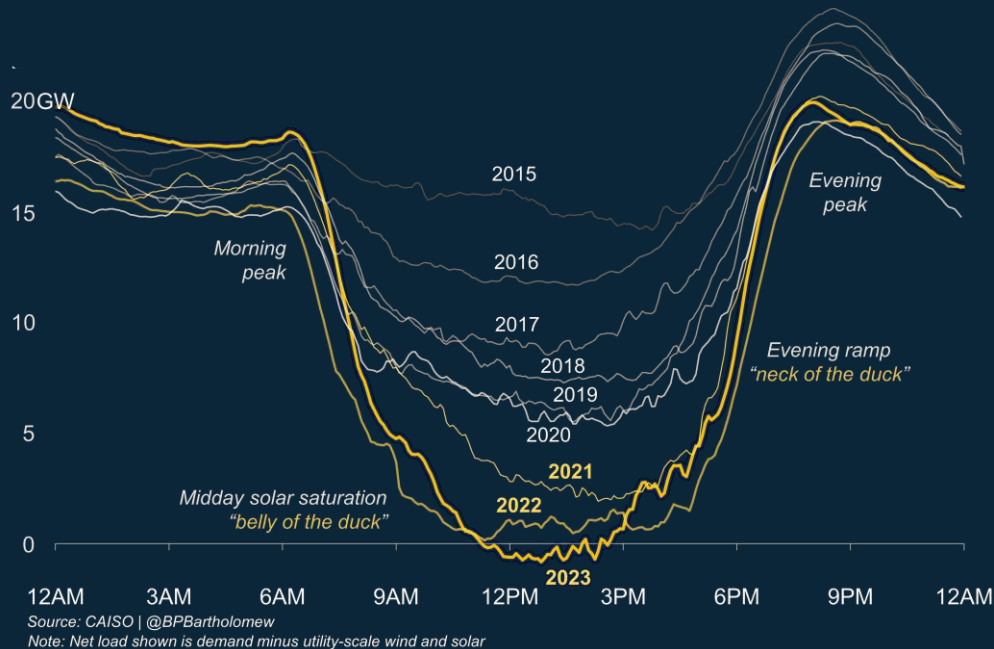
- + 10 months from initial contract to commissioning, completed entirely during COVID despite supply chain and marine freight disruptions
- + Developed entirely new "Energy Pods" form factor for the project, which now serves as the platform for Redflow's large scale deployments
- + The energy storage system contains 192 zinc-bromine flow batteries, designed to reduce the microgrid's peak energy use
- + Project completed on-time, on-budget, and has shown an excellent operational track record since commissioning



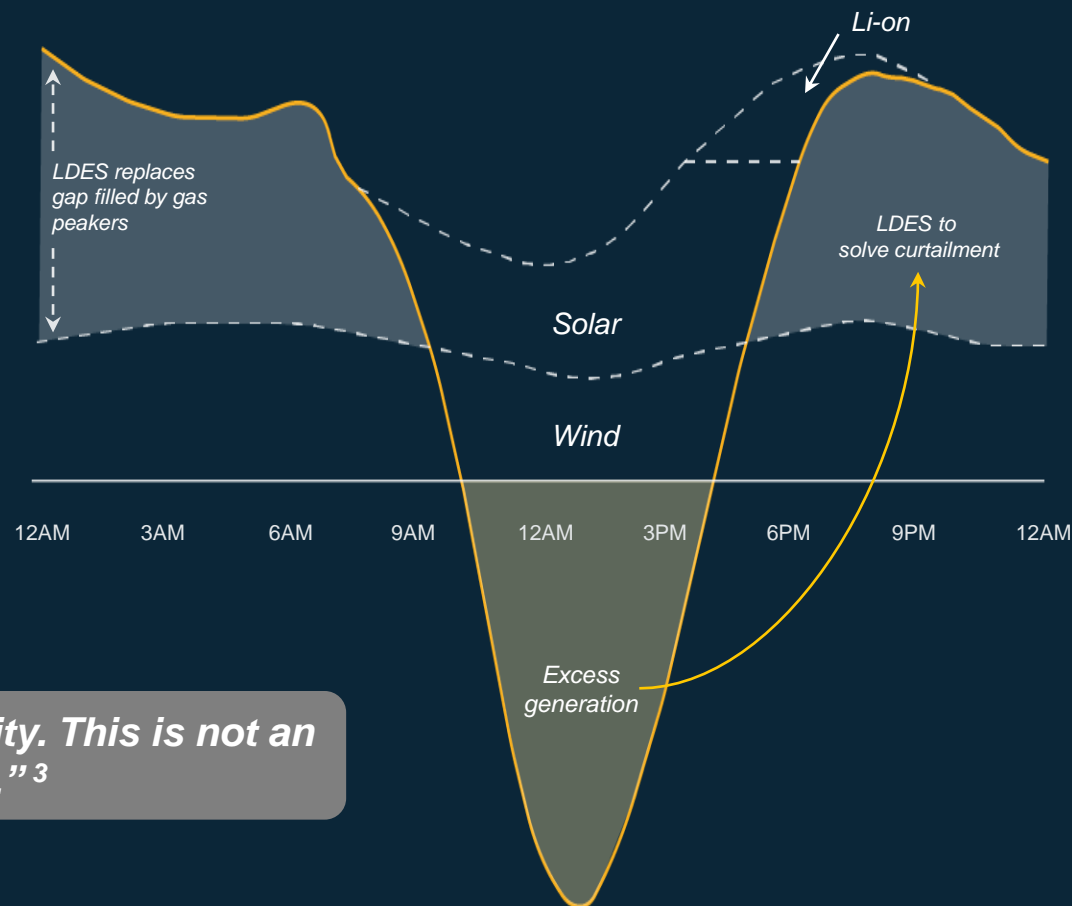
LDES increasingly seen as crucial to the energy transition

Renewables acceleration generates new challenges that LDES is best equipped to solve

California duck curve 2023¹



California 2030: increased scale and duration²



“Long-duration energy storage is not a luxury, but a necessity. This is not an economic paradigm, it’s a reliability paradigm.”³

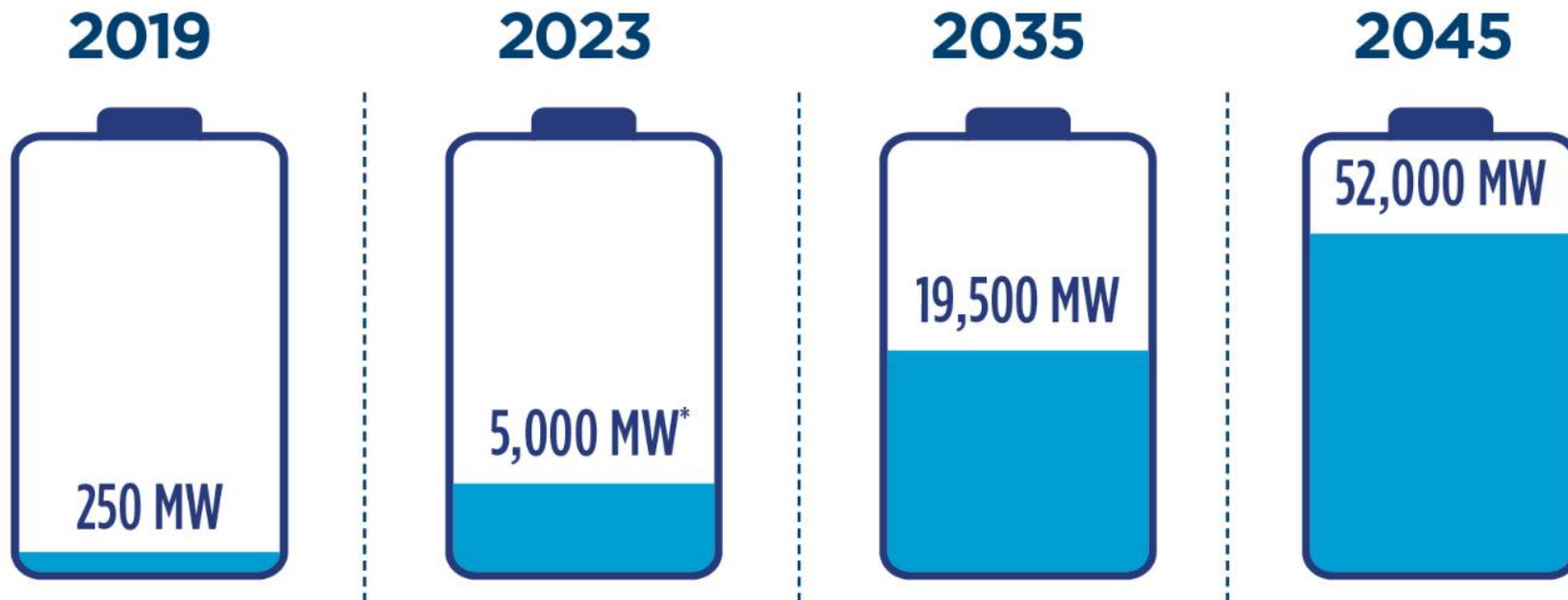


1. CAISO
2. Source: PTK analysis. Illustrative only
3. PNNL.gov, Long-Duration Energy Storage: The Time Is Now, May 2023, Citing PNNL study in Journal of Energy Storage, Defining long duration energy storage, April 2023

Scale-up of LDES key to California's \$330 million strategy to de-risk BESS procurement

California's growing battery storage capacity

captures the state's abundant renewable resources



*Projected as of June 1, 2023 based on California ISO interconnection queue.

Source: June 16, 2023 CEC Business Meeting LDES Program Presentation

Success at Anaergia led to new CEC Award: Redflow's largest project to date



20 MWh

10x larger than Redflow's largest prior project

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

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



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

Two new major projects announced in last 2 weeks

Reflects growing focus on LDES and Redflow's industry leadership position



US Department of Defense

- + US\$2.83 million contract with the United States Department of Defense's (DoD) Defense Innovation Unit (DIU) to deliver a prototype microgrid using a 1.2 to 1.4 MWh Redflow non-lithium long duration energy storage (LDES) system
- + Project will repower a solar plus short duration storage microgrid currently located at the Stewart Air National Guard Base in New York state.
- + Objective is to demonstrate long duration advantages versus current non-operative 1 hr li-ion batteries.
- + Unique hibernation feature of key interest to DoD

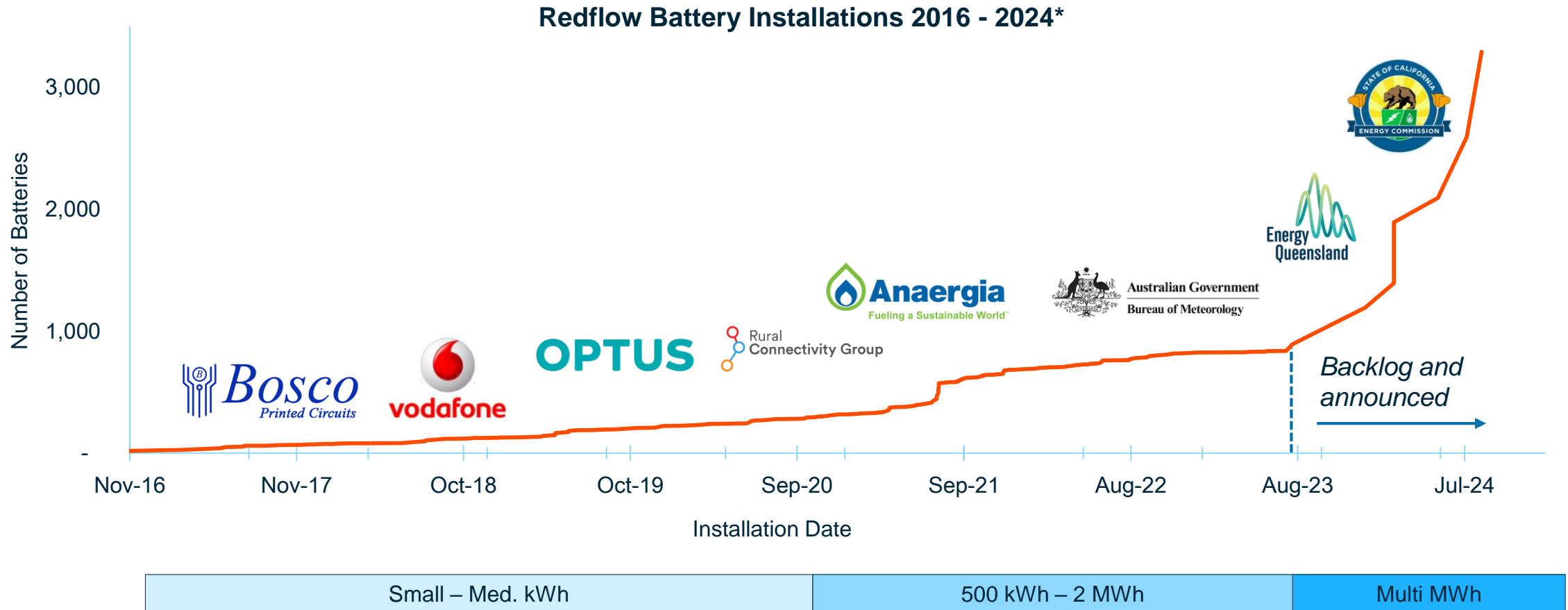


US Department of Energy

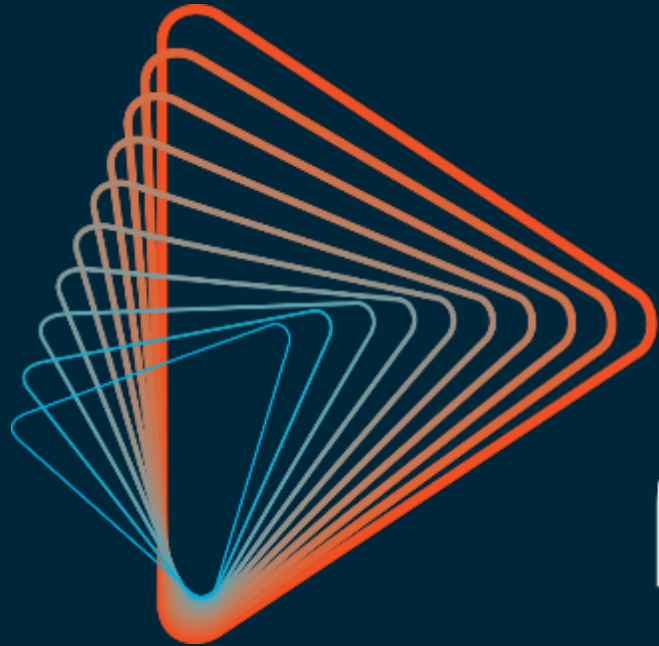
- + Department of Energy (DOE) has approved funding for a 34.4 MWh long-duration energy storage (LDES) microgrid project in which Redflow has been named as the battery provider.
- + The project will form part of the DOE's US\$325 million LDES program
- + The project will enable the Valley Children's Hospital in Madera, California to lower daily energy costs and offset and eventually replace diesel generators with carbon free standby energy
- + The project is being sponsored, and expected to be co-funded by, the [California Energy Commission \(CEC\)](#).

Redflow has reached a critical inflection point

Focus on MWh-scale projects led to step-change in industry profile, scale and pipeline impact



Sources: Company information. * Installations based on deployed systems to 30th August 2023 currently active and currently expected deployment schedule of recently announced CEC and EQ 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



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