



# UPower

Vanadium Flow Battery

Catalogue

2025



**RKP**

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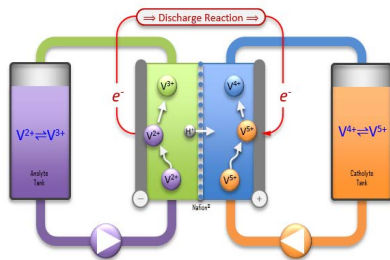


Fig.1.1.1 The VFB schematic diagram

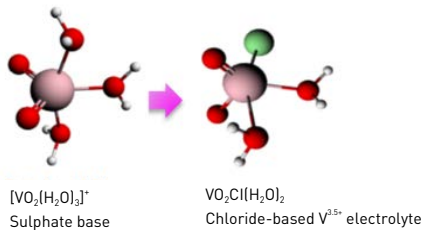


Fig.1.1.2 The molecular formular of VFB

### 1.1 VFB fundamentals

#### A regenerative fuel cell

VFB is a rechargeable electrochemical device that stores and releases electrical energy, via reversible redox (reduction-oxidation) reactions of  $V^{n+}$  ( $n=2, 3, 4, 5$ ) that are dissolved in aqueous electrolytes or fuels. As such it has the following unique advantages for electrical grid and utility applications:

- Store energy in liquid electrolytes, allowing separate design of power (kW) and Energy (kWh);
- Capable of a long duration up to 24 hours or even longer;
- Use “Inert” electrodes that are not subject to structural fatigue during operation, potentially allowing for unlimited cycle life without degradation;
- Use aqueous electrolytes and non-flammable components, so inherently safe.

Traditionally, VFB uses sulfate electrolytes that are of limited vanadium solubilities in a narrow temperature range. That leads to a limited energy density of the battery that is bulky and takes a large footprint.

#### The new generation VFB

A new generation VFB has been proved of substantially improved properties over the traditional sulphate chemistry:

##### More stable electrolyte chemistry

- 2x energy density, allowing compact design, 3~5x reduction footprints;
- Up to 55°C, enabling operation under broad conditions with improved efficiency.

##### Optimized electrochemistry

- Inhibiting oxygen activity, mitigating electrode degradation on the cathode side and ensuring a long cycle life without performance degradation;
- Easing electrochemical balancing, allowing embedded auto-balancing.

##### Higher chemical activity

- Less sensitive to impurities, improving reliability and allowing use of low-grade, cost-effective vanadium resources;
- High chloride activity, more corrosive, requiring use of compatible materials.

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Fig.2.1.1 UPower Module

### 2.1 UPower Module, a commercial product after repeat field-validation and engineering

UPower Module is a journey of a decade engineering that successfully advanced the lab discovery to a reliable commercial product in the fields.

#### Core IP for the mature UPower Module design and its integration

- Electrolyte chemistry;
- Battery with the chemistry;
- UPower Module in design;
- Stacking up with seamless pass and construction of system;
- Prefabrication and delivery of storage stations.

#### One of the first UL and CE certified VFB product worldwide

- One of first VFB product certified to both American ("UL") and European ("CE") standards as well as by the U.S. Department of Transportation(DOT);
- Validated to safety and environmental standards by third parties.



#### Delivers maximum operational flexibility

- Separate design in power and energy, precisely matching customer needs;
- Flexible in stacking with seamless bypass to meet voltage, power and energy requirements;
- Capable of long discharge durations up to 24 hours and even days;
- Allowing stacking up of benefits to maximize value to customers.

#### 2x energy density over traditional VFB for 80% footprint reduction

- UPower Module, the most compact design among VFB competitors;

#### Already offering competitive leveled costs over a long life

- Practically +20,000 cycles at 100% DOD;
- Without degradation -100% access to rated capacity over a long life;
- One UPower Module capable of delivering up to several hundred 100kWh life cycle capacity;
- Minimal maintenance;
- Vanadium electrolytes can be fully recycled or used, and its value remains;
- Scaling up production to further reduce Capex, making LCOE more competitive.

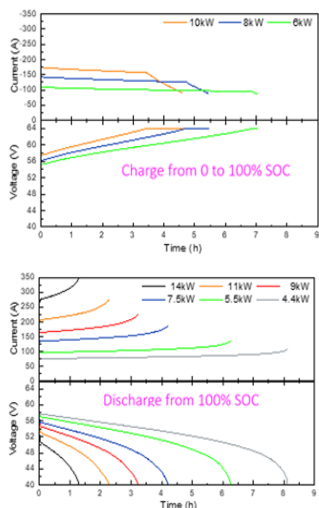


Fig.2.1.2 Charge and discharge from 0% to 100% SOC

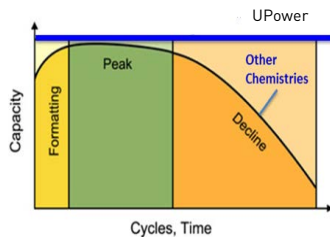


Fig.2.1.3 Cycle times

**+20,000 cycles and no capacity loss**

- Excellent reversibility ensuring unlimited cycles up to 100% SOC and DOD over 25 years;
- +20,000 cycles and allowing 100% access to rated energy over the long life.

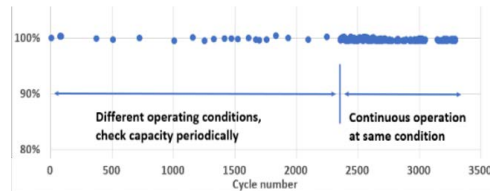


Fig.2.1.4 UPower exhibits 0% fade

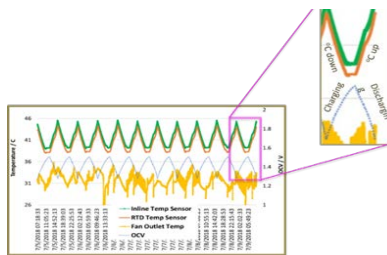


Fig.2.1.5 Temperature change during charging and discharging

**Unique heat properties, simplified heat management**

The fig. 2.1.5 shows that self-cools 8°C when charging, ideal for PV and storage application; up to 1.5kW cooling from a 100W fan cooling adequate for up to 60°C.

**Inherent safe, non-explosive and non-flammable**

- Use of aqueous electrolytes, fire retardant and a large heat sink;
- Non-flammable;
- No thermal runaway;
- About 9°C rise during short circuit.

The fig. 2.1.6 shows that short-circuiting a fully charged stack with the pumps off only increases temperature about 9°C rise during short circuit. Even this increase is eliminated when the pumps are turned on.

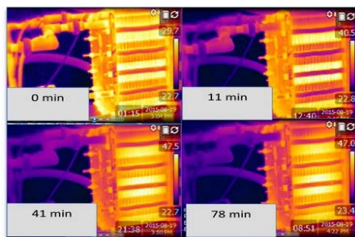


Fig.2.1.6 Short-circuit testing

**Easy deployment, operation, maintenance and expansion**

- Prefabricated and factory sealed, shipped ready to run;
- IP20 for indoor(40i), IP54 for outdoor(40o) application;
- Higher environment tolerance (e.g. less A/C);
- Plug and play connection on site, deployment by local technicians;
- Seamless bypass technology;
- Built in auto-balancing, proprietary control, 98% capacity alignment, achieved long term stability;
- Deployable on crushed gravel (no concrete foundations needed);
- Reconfigurable for future needs;
- Stack up to MWs.

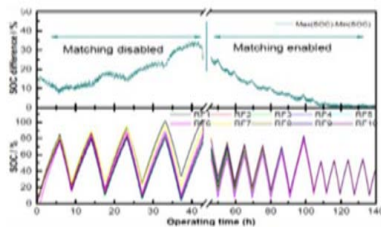
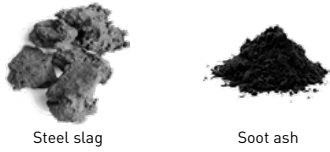


Fig.2.1.7 Operating and fault records

**Highly modularized and robust design**

- 10kW/40kWh per module;
- Housed in a 5mm steel shell;
- Includes rugged secondary containment which renders the unit virtually bullet proof and flood-proof to 1.4m;
- DOT test on transportation.



Steel slag

Soot ash



Electrolyte (Chloride-based V<sup>5+</sup> electrolyte)

Fig.2.1.9 The origin of VFB

Sustainable

- Made from sustainable materials;
- Electrolytes primarily made from industrial waste such as soot ashes, slag;
- Electrolytes 100% reusable or recyclable into high purity chemicals;
- Permanently retaining vanadium value, facilitating leasing;
- Vanadium not resource-limited, with 200 years of identified deposits;
- Leading to 44kg CO<sub>2</sub> emission saving per MWh over Li-ion batteries.

2.2 Operating conditions

UPower Module has been designed for the widest possible range of operating conditions and operational procedures. Unlike other batteries, UPower Module is able to endure lower states of charge, also for extended periods as well as being used for multiple cycles per day without impacting on the capacity of the battery. UPower Module has an ambient temperature operating range of 0-50°C(40i-Indoor) /-25-50°C(40o-Outdoor).

Within this temperature range, UPower Module offers unlimited cycling without degradation. UPower Module is not sensitive to humid, or dusty conditions. Also, UPower Module is cooling down during charge and heating up during discharge. This is a particularly useful characteristic that is substantially different from most other batteries. It reduces the thermal management burden during the day when being charged by solar power. This helps improve overall system energy efficiency. This unique thermal characteristic allows UPower Module to be built with simple air-cooling rather than air conditioning which is expensive, failure-prone and reduce system efficiency by approximately 20-25%. Cells are having very low tolerances in their parameters, reducing the need for balancing individual cells further. These factors reduce the risk of overloading individual cells during charging to almost zero, a risk that leads to critical failures (i.e. explosion/fire) in BESS solutions available today.



Fig.2.2.1 Thermal chamber at 60°C validating desat conditions

## 2.3 Specification and performance

### Technical data

Items	Unit	Parameters
Rated power	kW	10
DC voltage	V	36-57.6
Max. DC current	A	390(MAX)
Dimensions W*D*H	mm	40i(Indoor): 875*1775*2060; 40o(Outdoor): 915*1775*2110
Ambient temperature	°C	0-50(40i-Indoor) /-25-50(40o-Outdoor)
Storage temperature	°C	-15-50 (SOC=50%)
Weight	kg	2800(40i-Indoor/40o-Outdoor)
Lifetime	Cycles/years	+20,000/+25
Short circuit current	A	1300
Communication interface		Modbus TCP
Series	Module	Max. 25
Enclosure		IP20(40i-Indoor) / IP54(40o-Outdoor)
Certifications		IEC 62932
Auxiliary power	Vac	100-240
	Hz	50/60
	W	Off: 20 Typical: 600 Max.: 800

### Discharge performance

Duration	Power	Energy	Efficiency
Hour	kW	kWh	%
2	14	28	76
3	12	36	78
4	10	40	80*
6	7.2	43	82
8	5.6	45	84

Note: \* Round trip DC efficiency, at 10kW discharge after charged to 100% SOC.

The charge and discharge characteristic curve of the battery is shown in the figure below:

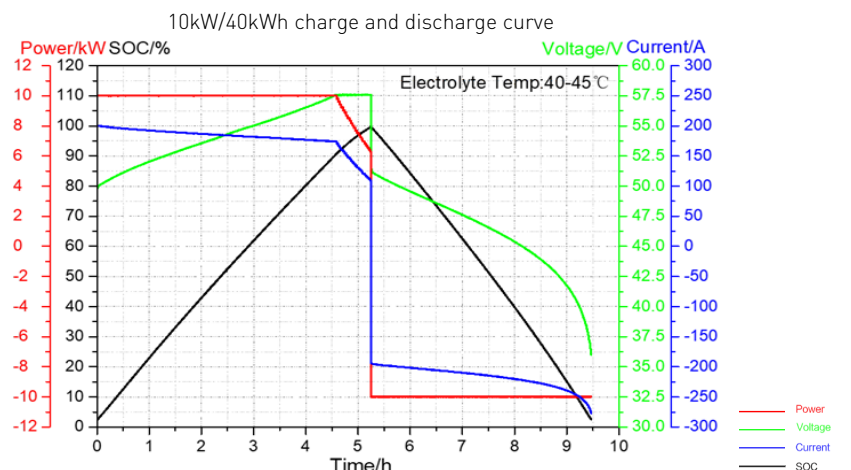


Fig.2.3.1 The charge and discharge curve

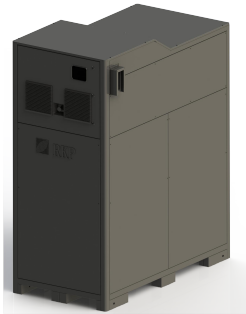


Fig.2.4.1 UPower in factory

## 2.4 Design concept

UPower Modules have a modular design to best meet customer power and energy requirements in the most flexible manner.

- UPower Module is specifically designed for valuable long duration & heavy cycling applications;
- UPower Module is a high-volume commodity product tailored to ensure modularity, flexibility and durability to support a wide variety of use cases from kWh to MWh and even several hundred kWh;
- Storage applications range from grid stability and optimization to commercial, industrial & home storage with substantial cost savings and operational benefits;
- UPower Module supports corporate HSE policies through safety, nonflammability, sustainable sourcing, and positive recycling value;
- There is no "greener" BESS than UPower Module.



Outdoor

2.5 UPower Module Structure and function

Simple assembly of common industrial components that can be standardized and manufactured globally near customers.

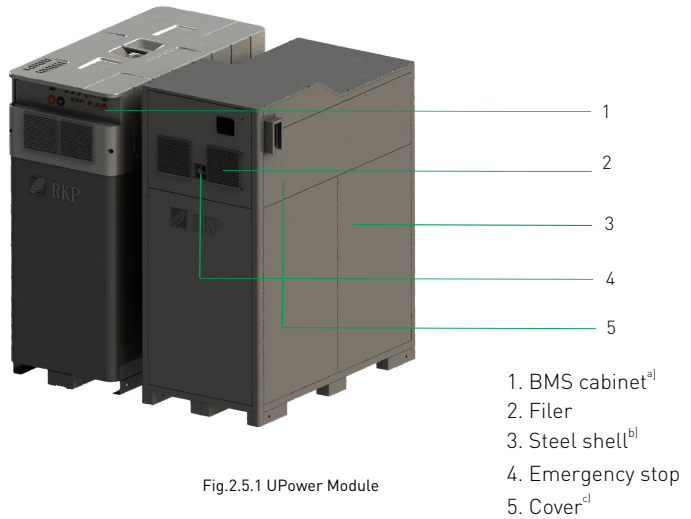


Fig.2.5.1 UPower Module

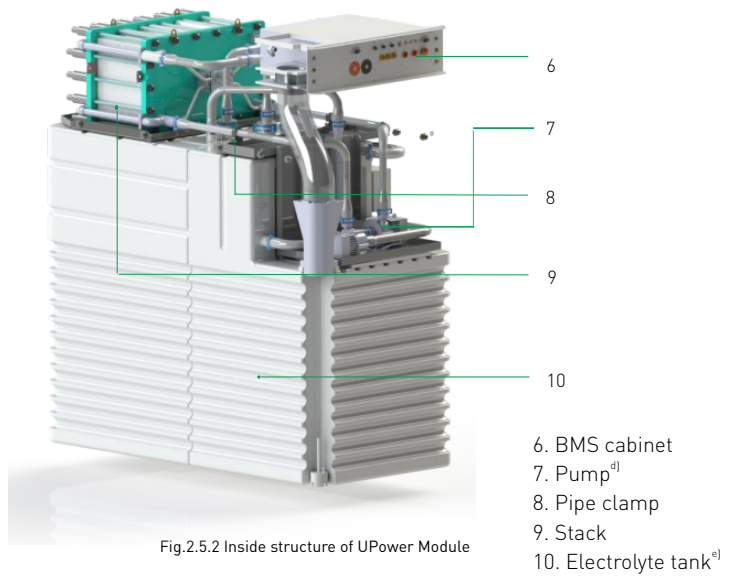


Fig.2.5.2 Inside structure of UPower Module

Note:

- a) &d): Pump & BMS cabinet: Highly modular with few moving parts - only two pumps and one fan that can be quickly replaced, embedded BMS;
- b) Steel shell: System protection flood-proof to 1.4m secondary; containment;
- c) Cover: Field-rugged IP54 protection from rain, dust and insects;
- e) Electrolyte tank: Seamless leak proof design with high surface area for simple total system cooling.



Fig.2.5.3 Stack

Stack

Mid-sized stack optimized over 25 years eliminates leaks and is sized for maximum resilience and automated mass volume production.

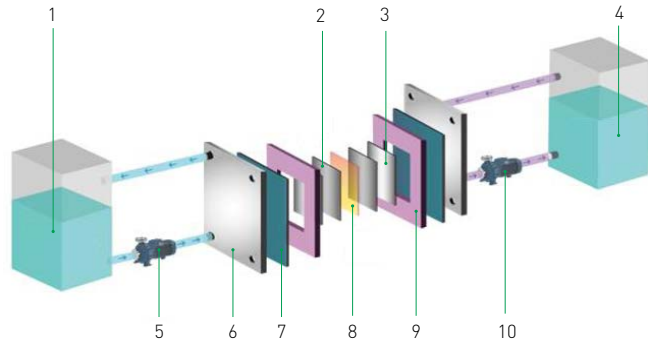


Fig.2.5.4 Structure of stack

- |                         |                      |
|-------------------------|----------------------|
| 1. Positive electrolyte | 6. End plate         |
| 2. Electrode            | 7. Current collector |
| 3. Bipolar plate        | 8. Membrane          |
| 4. Negative electrolyte | 9. Flow frame        |
| 5. Pump                 | 10. Pump             |



Fig.2.5.5 Electrolyte extraction

Electrolyte

The high energy VFB Electrolyte with its third generation chemistry is produced from sustainable resources (waste and by-products) and is fully recyclable.



Fig.2.5.6 The developing path of electrolyte

- Electrolyte is 100% reusable or recycled in to high purity chemicals;
- Saving 44kg CO<sub>2</sub> emission per MWh manufactured storage capacity compared to Li-ion batteries;
- Permanently retaining vanadium value, facilitating leasing;
- Electrolytes primarily made from industrial waste such as slag;
- Vanadium not resource-limited, with 200 years of identified deposits.

It is one of the most sustainable and environmental friendly energy storage solution in the market.

BMS cabinet

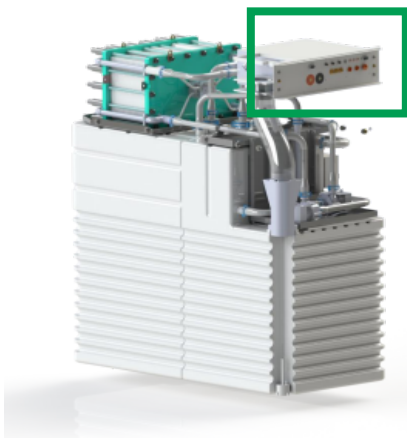
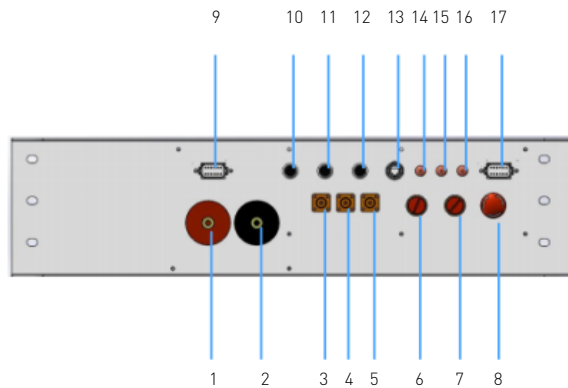


Fig.2.5.7 Position of BMS cabinet



- |                   |                   |
|-------------------|-------------------|
| 1. DC+            | 9. EX1            |
| 2. DC-            | 10. Fuse 1        |
| 3. L P1-1         | 11. Fuse 2        |
| 4. N P1-2         | 12. Fuse 3        |
| 5. PE P1-3        | 13. Ethernet E1   |
| 6. Start/Stop     | 14. Power light   |
| 7. Reset          | 15. Running light |
| 8. Emergency Stop | 16. Fault light   |
|                   | 17. EX2           |

Fig.2.5.8 Interface of BMS cabinet

**Emergency Stop**

When an emergency occurs, people can take protective measures by quickly pressing this button. And it will make the contact earthed and stop all pumps (all aux. voltage)

## 2.6 UPower Module control system

### Battery management system (BMS)

Each UPower Module BMS (Battery management system) governs pump and contactor machinery, along with balancing at the module level. Additionally, within each UPower System of batteries, one module adopts the role of the string controller, performing as the point of contact with the EMS.

The modules communicate with the string controller to provide a centralized point of control, operations monitoring, and alert reporting.

The UPower Module is capable of performing SOC balancing and module bypass while maintaining continued string uptime.

A secondary read-only Modbus port is provided for process monitoring. Data is acquired from the string controller, or the modules individually, or any combination thereof. The Modbus TCP interface is provided.

BMS cabinet supports the Modbus TCP protocol.

The main functions are as below:

- Data acquisition, safety management of battery unit and information transmission with other equipment;
- Test the data related to the thermoelectric fluid of the battery unit, including the voltage and current of the stack or module, as well as the temperature, pressure, flow and liquid level of the electrolyte;
- The state of charge (SOC) of the battery unit is managed through measured OCV in real time;
- Diagnose the battery unit and start the corresponding process.

### UPower Module monitoring system

The main functions are as below:

- Battery system data collection and graphic display;
- Historical operation data saving;
- Setting of limiting parameters for system operation;
- Operation and maintenance of battery system;
- Communicate with background monitoring system.

### Control board

The control and monitoring system can be integrated into a control board, the main function:

- Summarize the MODBUS of UPower Module, integrate a set of BMS, convert the battery information into Ethernet protocol and send it to the monitoring system of the upstream energy storage station through the battery monitoring system, and can independently carry out remote monitoring of the battery system;
- Provide communication interface between total BMS and PCS;
- Provide power supply and working status indicators of the system and each UPower Module.



Fig.2.6.1 BMS

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An example of UPower System configuration	19
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## 3.1 General

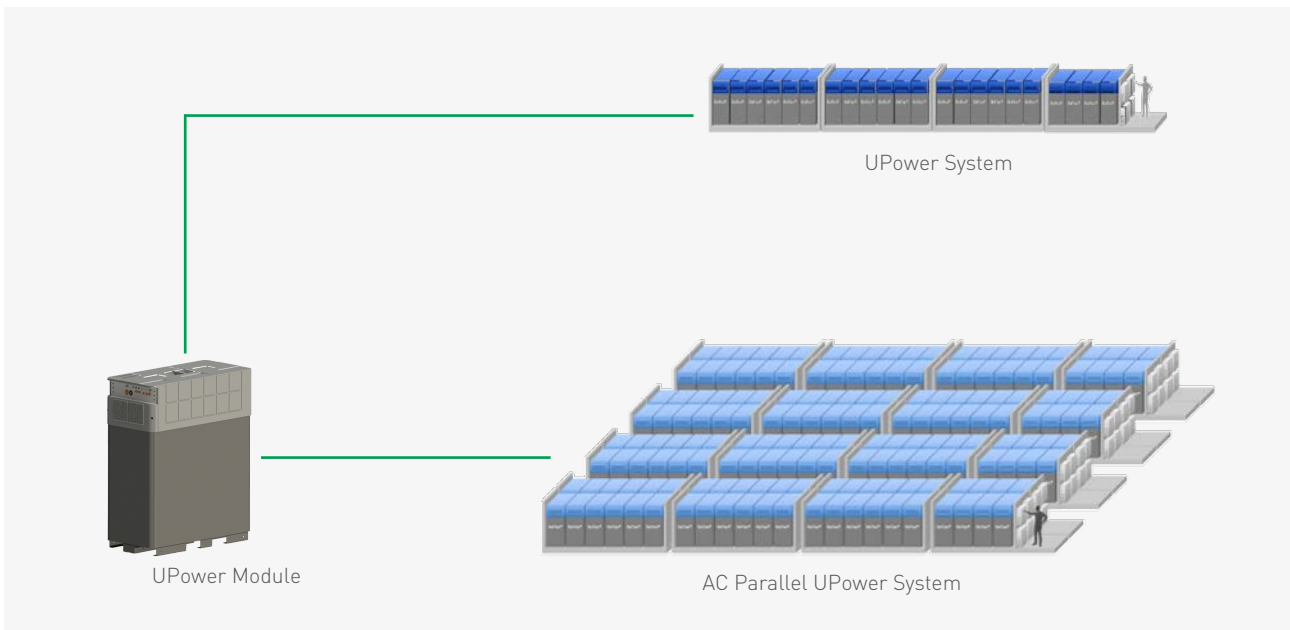
### Prefabrication

Prefabricated UPower System for quick & reliable large-scale deployments. 6 UPower Module will be pre-wired and factory tested on each standard flat racks to slide into 20' shipping containers for deployment on site, it possesses features:

- Factory assembled including full quality assurance and quality control;
- Plug-and-play by local technicians;
- Minimal field set up time;
- UL, CE, IP20 indoor & IP54 outdoor certified;
- Redundant array architecture;
- Rapid AC outdoor deployment for temperatures from -25°C to +50°C.

### Scalability

The modular architecture of the UPower Module delivers groundbreaking grid storage flexibility to enable broad application of a mass-produced product.



UPower Module, designed for peak performance, top quality and reliability, enables the customers' asset highly reliable, upgradable and expandable.

From kW to several hundred 100kW



Items	UPower Module/System	several hundred 100kW UPower Module Plant
Capacity	200 kW / 800 kWh	250 MW / several hundred 100kW
Lifetime	+25 years	+25 years
Dimensions W*D*H	22.8m * 2m * 2.4m	20,000m <sup>2</sup>
Weight	64t	228 UPower System per floor
Certifications	IEC 62932	IEC 62932
Temperature	0-50°C (32-113°F)	-25-50°C (-13-122°F)
Enclosure	IP54	Ventilate with no air conditioning

Advantage of UPower System

- Either UPower modules or UPower System can be seamlessly bypassed for high reliability;
- UPower System can be deployed on crushed gravel (no concrete foundations needed);
- Several hundred 100kWh electricity warehouse requires a ventilated building;
- The enormous thermal mass of a GWh deployment makes the battery virtually impervious to the most extreme weather;
- UPower System modularity supports phased commissioning during construction and capacity upgrades as loads develop;
- Redundant array architecture for utility-grade reliability.

## 3.2 An example of UPower System configuration

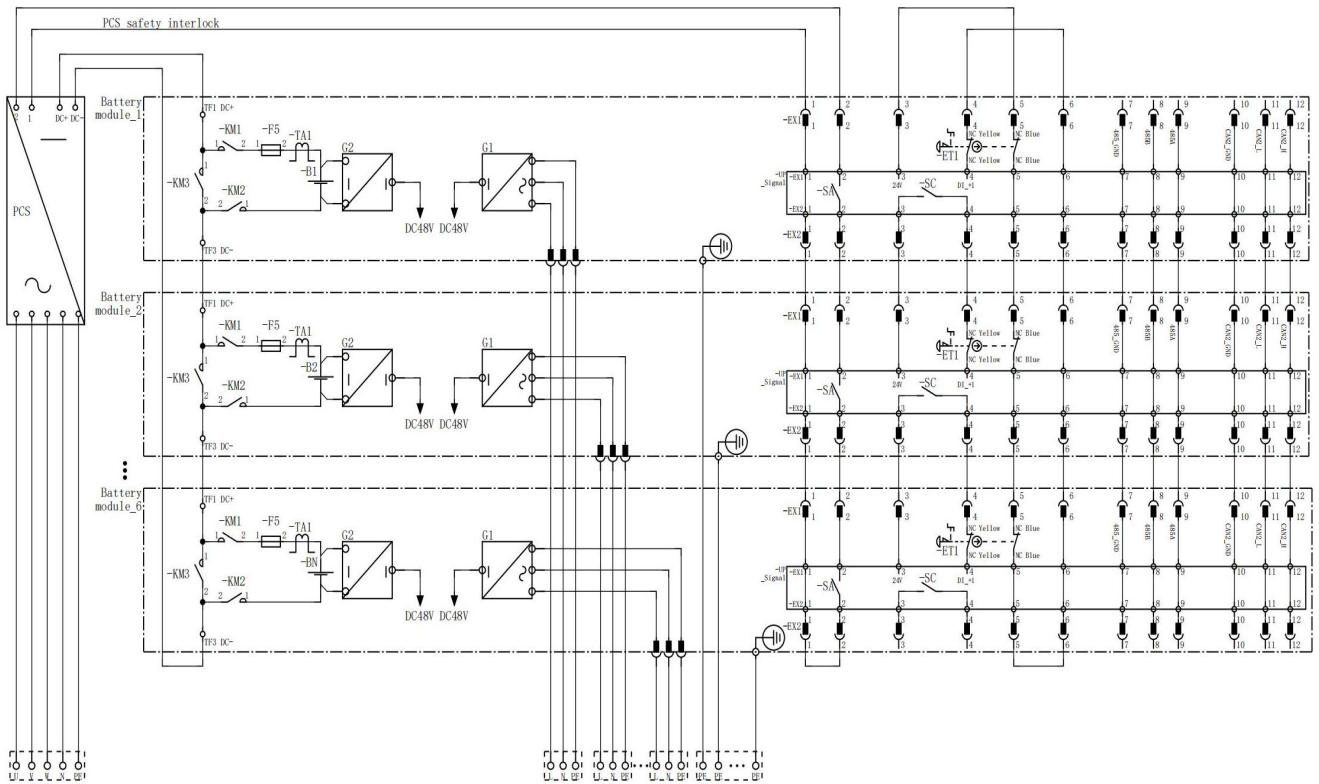


Fig.3.4.2 Diagram of 6 UPower Module in string

**Note:**

1. UPower Module 1-6: 6\* (10 kW), 6\* (36~57.6 Vdc), 278A
2. Power conversion system (PCS), DC voltage: 806~1500V;
3. Distribution box AC supply: for ESS auxiliary power management  
String Controller:
  - Power supply: 400Vac
  - Communication protocol: MODBUS/TCP
  - Function: system control for both battery and PCS, power output control;
4. Grounding protection for ESS.

**Schematic symbols:**

	PCS		Ground Terminal
	Contactor		Emergency Stop
	Fuse		AC Power
	Current Transformer		DC Power
	Connector		Knob
	Signal Processing Board		

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Single line electric diagram 21

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Management, communication and control 23

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Primary equipment 25

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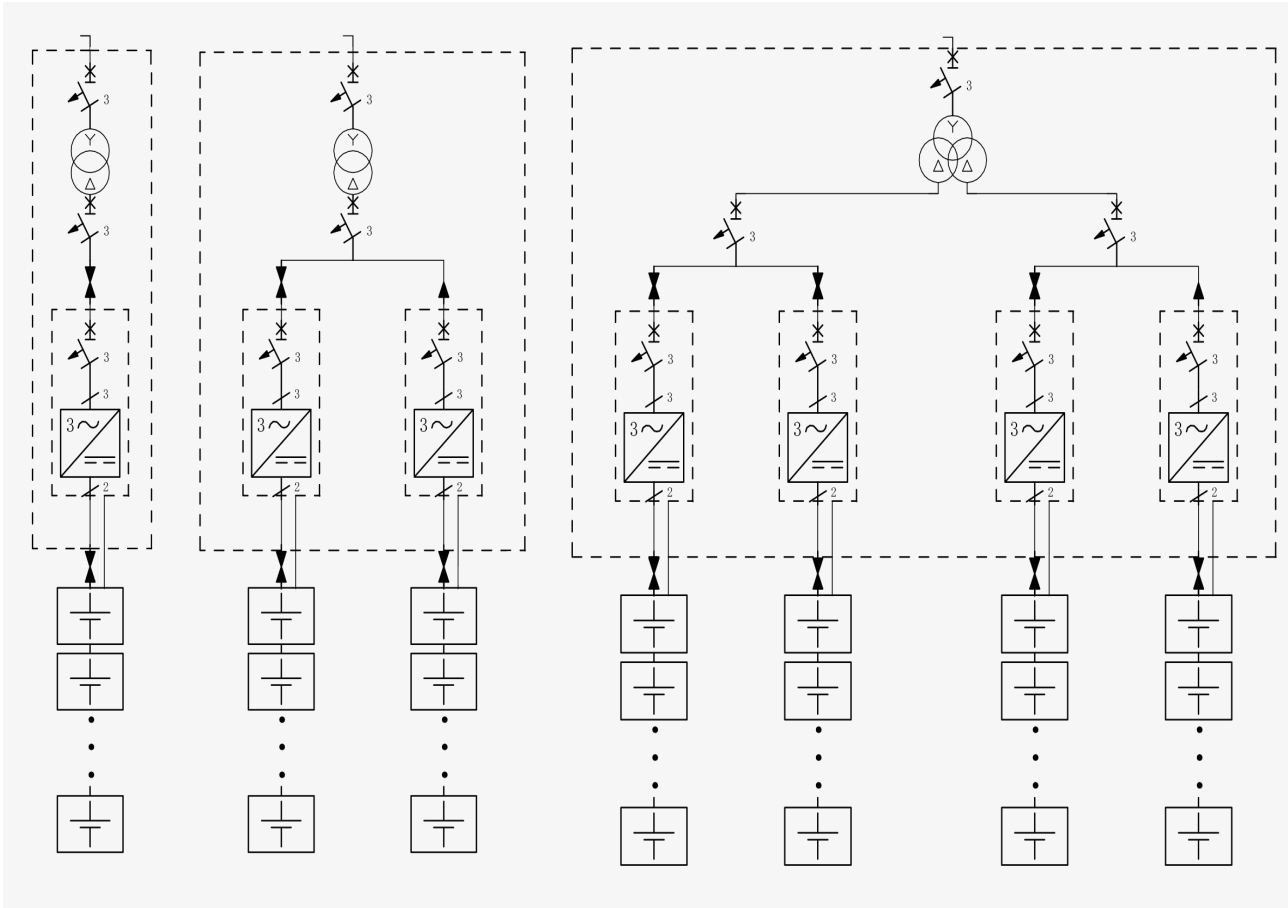
## 4.1 Single line electric diagram

Please find the three options of UPower System as below:

Option 1

Option 2

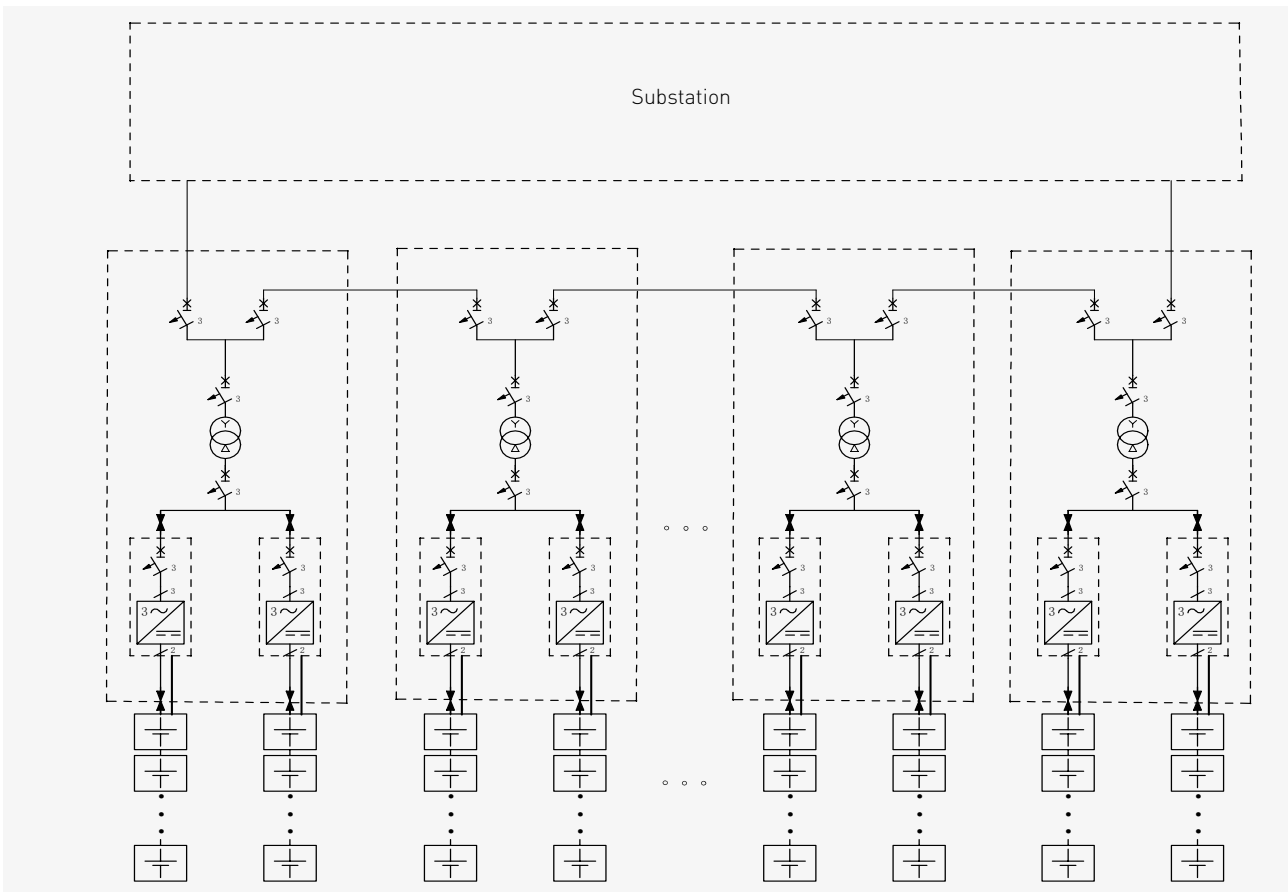
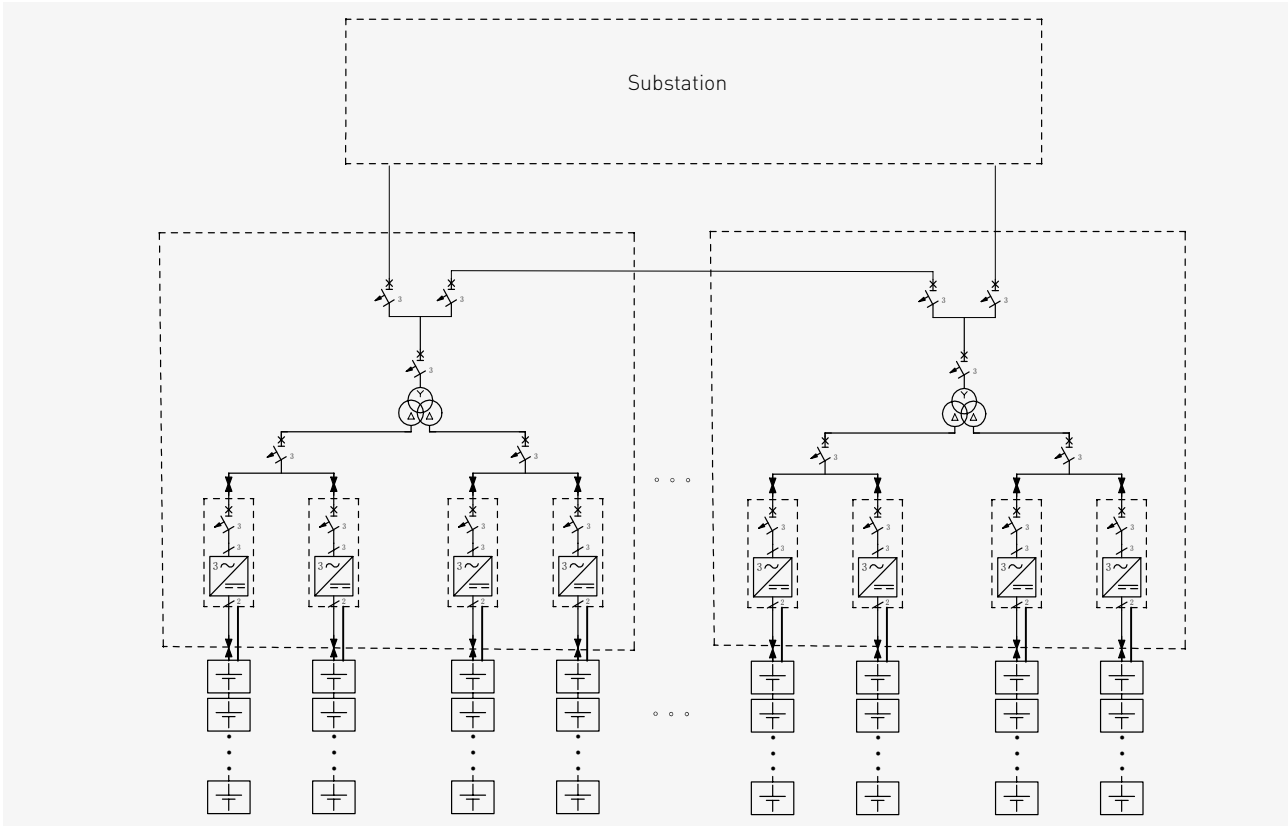
Option 3



Items	Unit	Option 1		Option 2		Option 3	
The quantity of UPower		14	25	14	25	14	25
Transformer	kVA	SCB11-160	SCB11-315	SCB11-315	SCB11-630	SCB11-630	SCB11-1250
	kW	140	250	140	250	140	250
PCS	V	327.6	585	327.6	585	327.6	585
	A	247	247	247	247	247	247
Battery module	kW	140	250	140	250	140	250
	V	504-806.4	900-1440	504-806.4	900-1440	504-806.4	900-1440
	A	278	278	278	278	278	278

More options are available according to real situation of the project.

Single line electric diagram of complete station:





## 4.2 Management, communication and control

### Energy management system (EMS)

The energy management platform is an operation and maintenance management platform developed to meet the monitoring needs of energy storage equipment in the new energy field PCS, electric energy meter and other equipment can also monitor the environmental quantity.

EMS system has good openness and supports Modbus protocol access based on RS485 (RTU) and RJ45 (TCP) interfaces.

The system has the following operation modes:

- On grid mode
  - Charging
  - Discharging
- Off grid mode (island mode)

The energy management system can be provided by RKP or by customer, including hardware and software.

### Communication system

BMS communicates with EMS through Ethernet. BMS and PCS communicates indirectly through EMS; transformer communicates with and is controlled by EMS; Digital watt-hour meters are connected to EMS through RS485 bus, smoke sensor signal is connected to the DI input port of EMS; The information collected by EMS communicates and interacts with industrial computer and upper layer through network port.

The video monitoring information and the detailed battery information collected by BMS are then uploaded to the SCADA system and video monitoring platform in the distribution room through Ethernet along with relevant information of local equipment such as air conditioning and firefighting.

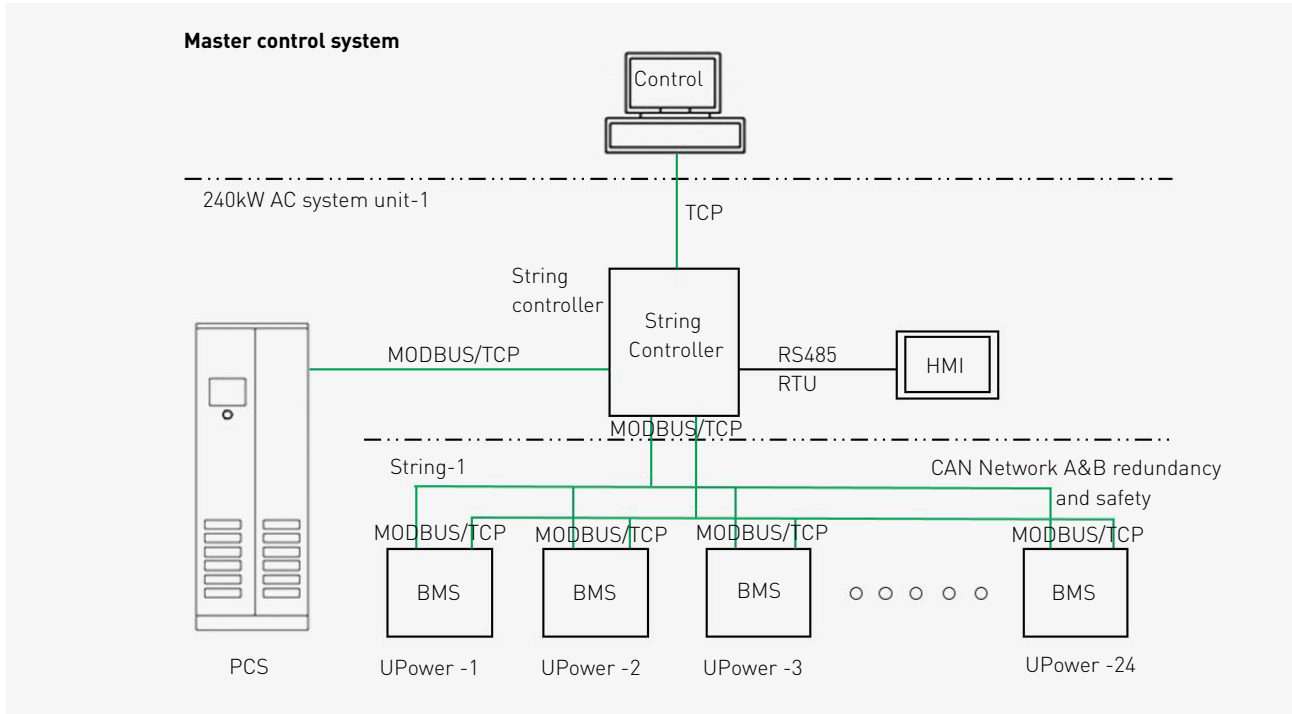
### System control network

There are different levels of control existing generally for battery storage system, the typical control network is designed according to the configuration of UPower Module and its UPower System:

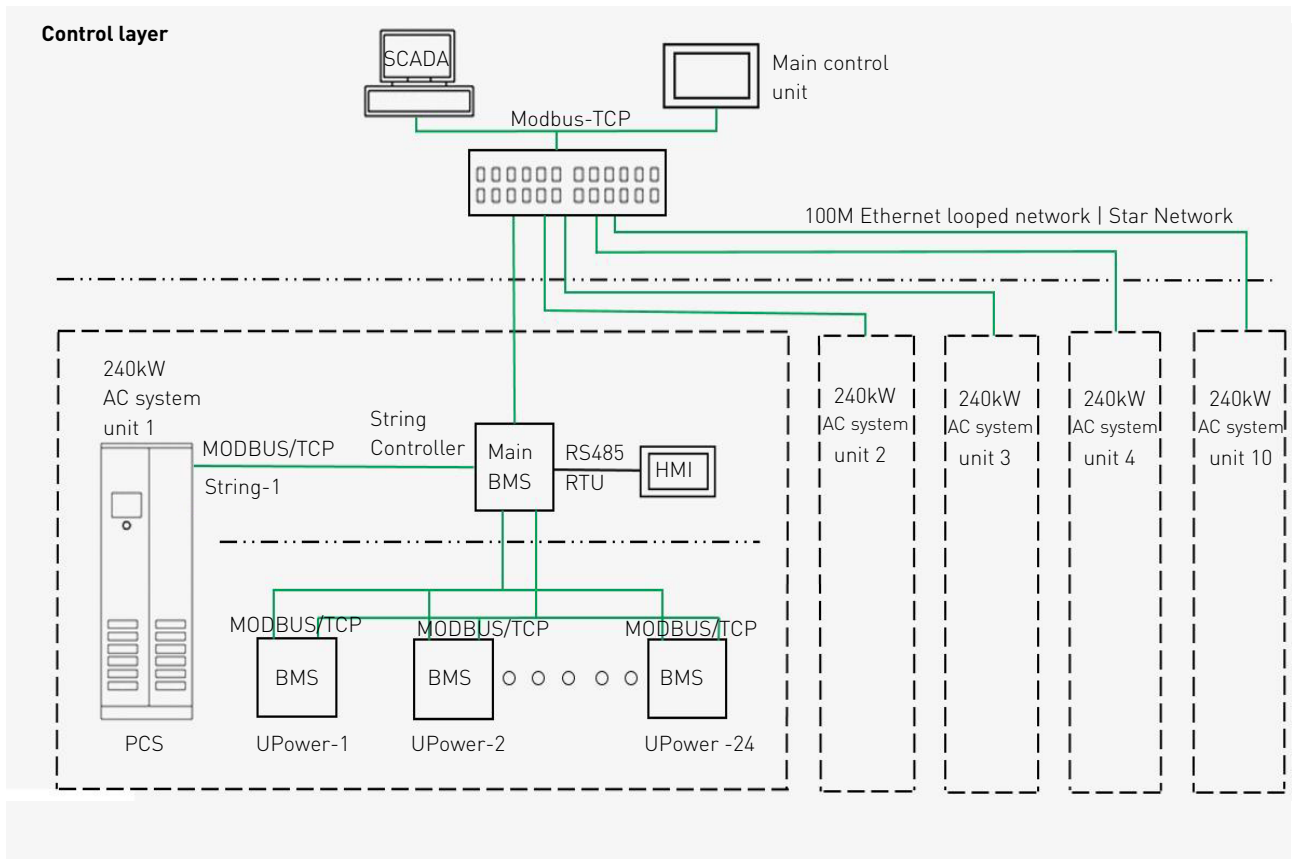
- UPower Module
- Series modules: UPower System
- Parallel string

**A UPower System control network topology**

A typical UPower System consists number of UPower modules in series, the control network taking 24-UPower Modules UPower System as an example:



Parallel UPower System control network, taking 10-UPower modules UPower System as an example:



**4.3 Primary equipment**

**PCS**

UPower modules in the UPower System configuration can be integrated with various PCS. Depending on the project specific requirements (frequency, voltage range, delivery time, warranty), an optimal choice will be made on a case-by-case basis. The PCS partner provides the necessary quality, certification, and global supply chain to support this deployment. The PCS matches the UPower Module voltage profile and can be both DC and AC paralleled to achieve the required voltage, current and frequency ratings.

**Transformers**

The power distribution transformers manufactured by RKP are optional to increase the low voltage to medium voltage. The selection of the step up power distribution transformer can be:

- Dry or oil immersed type
- Indoor or outdoor application
- Cooper or aluminum material
- Two or three windings
- Loose or integrated with PCS and switchgear

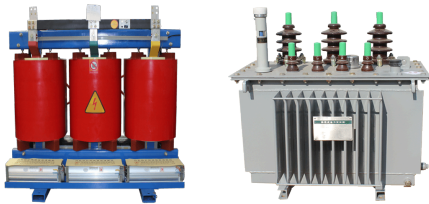


Fig.4.3.1 Transformers

Items	Unit	Value
Rated medium voltage	kV	11, 24, 40.5
Rated low voltage	A	630
Capacity	kVA	160-2500

**Switchgear (RMU)**

The gas insulated switchgear will be applied to collect the feeders of power at medium voltage level if required, all live parts are insulated in the sealed gas tank which enhances the operator’s safety and reliability of asset, the major function includes:

- Cable connection
- Transformer protection
- Measurement



Fig.4.3.2 Switchgears

Items	Unit	Value
Rated medium voltage	kV	12, 24, 40.5
Rated low voltage	A	630
Capacity	kA	20
IAC		AFLR-20kA-1s

**Prefabricated integrated substation**

As leading prefabricated substation provider, RKP can integrate power distribution switchgear, transformer and PCS into the pre-manufactured, pre-tested substation to reduce site construction time and workload, achieve fast delivery and cost efficiency. The prefabricated substation can be containerized or customized design.



Fig.4.3.3 Prefabricated substation

The unique prefabrication and packaging competence that enables standardized transport worldwide.

More details of primary equipment please consult RKP office near you.



Fig.4.3.4 Standardized transport

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Transportation 27

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Installation 27

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Maintenance 27

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Commissioning 27

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Training and warranty 28

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Decommissioning and recycling 28

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Fig.5.1.1 Standard flat rack

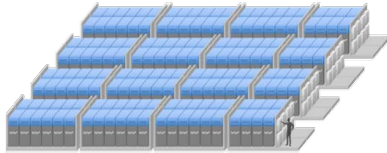


Fig.5.2.1 UPower System



Fig.5.2.2 Cable connection

## 5.1 Transportation

6 UPower Modules will be pre-wired and factory tested on each standard flat rack to slide into 20' shipping containers for deployment on site.

## 5.2 Installation

UPower Module is a tough battery that can operate in a wide range of ambient conditions including extreme temperatures and humidity. Therefore, depending on the environment and application requirements, UPower Module can be placed outdoors such as on compacted gravel. Site options:

- Solar canopy (increase eff. +3%)
- Cold weather package (-25°C to 50 °C)
- Vault/theft protection package
- Extreme heat requires site-specific solutions

UPower Module and UPower System can be deployed in a simple shed to shield the battery plant and maintenance personnel from direct sun, wind, and rain. If a shed is required, design criteria include:

- Ventilation should be designed for five air exchanges per hour;
- The load bearing of the ground no less than 2.8 t/m<sup>2</sup>. (A single UPower Module weighs ca. 2,800 kg);
- 150mm reinforced concrete flooring with epoxy coating / or container floor;
- The ground surface must be flat and free from ponding. The ground for access to the batteries needs to be hard for a 3t forklift to operate.

They also can be installed in the buildings according to design, data center, shopping mall and bulk storage building for instance.

## 5.3 Maintenance

With almost a decade of field experience, maintenance has been virtually designed out of the UPower Module. Not only have maintenance-prone mechanical components such as valves, unions and internal filters been eliminated, but the patented breakthrough chemistry no longer requires electrolyte rebalancing every 20-40 cycles and eliminates potential damage to electrodes from high temperature operation. Due to the electrolyte formulation with the Chloride-based V<sup>25</sup> electrolyte, the electrodes never become salt-coated, there is no electrolyte mixing required and 80% individual part reduction has been achieved.

## 5.4 Commissioning

UPower Modules are shipped integrated into 6-pack flat racks. They are filled with electrolyte, factorysealed, and at 50% state of charge. After AC factory acceptance testing, each flat rack is shipped inside a 20' shipping container. This allows for an efficient assembly and commissioning of the battery on site at minimal man-hours or special equipment or local supplies. Due to the travel restrictions, RKP has the two different commissioning experience as below:

- On site commissioning by our team commissioning on site can be executed by our technical team (with support from the contract partner). The team will assist CE with the installation and commissioning, including the requested SAT (FAT will have been executed at the factory prior to shipping). Travel and lodging/food will be reimbursed at costs. Labor rate for technical staff will be charged per day.
- Remote commissioning, supported by our team via virtual tools of deployment and commissioning, local electricians and engineers will be supported remotely by RKP technical staff. This is possible due to the full factory integration and testing of the UPower Module. Detailed technical training tutorials are available. This approach supports development of local

Experienced personnel required to perform ongoing service and maintenance.

## 5.5 Training and warranty

### Training

UPower Module has been designed for ultra-low maintenance, both in terms of effort and costs.

To manage operation and maintenance costs and minimize MTTR (mean time to repair), we support training local service personnel to perform most of these tasks rather than employing additional operation and maintenance services. These services can be well supported through virtual instruction.

### Warranty and service Contract

The UPower Module is designed to self-protect against most operating conditions and operational procedures. Warranty is extended to unlimited cycling, operating temperature range between 0-50°C, and lower states of charge, also for extended periods. Warranty excludes physical damage (e.g. collisions with fork-lift/truck, resulting from war, earthquakes, floods, or any damages resulting from force-majeure e.g. pandemic) and gross negligence. This standard warranty includes the warranty on usable capacity. Warranty for subsequent years, including the warranty on usable capacity, can be acquired by mutual agreement through a yearly service contract of the UPower Module.

## 5.6 Decommissioning and recycling

RKP offers decommissioning services at the end of the project's economic life cycle. These services include:

- Upon decommissioning of the BESS, the battery and PCS can be shipped to our factory at cost, no charges applied for the recycling process;
- The batteries will be decommissioned and shipped back to the factory whilst filled with electrolyte, eliminating any risk of spills whilst emptying the batteries;
- The electrolyte and all battery components can be recycled after useful life.
- Please note that UPower Module makes use of vanadium that is sourced from industrial waste, hence it is a net-positive recycling product.





Field of application 30



Illustrative examples 31



Typical project details 32



6.1 Field of application

The market demand is shifting towards longer duration, such as renewable integration that require heavy cycling.

- Increasing global renewable energy penetration requires buffer capacity of 4h and longer;
- The electrification of the transport sector and societal digitalization are demanding high-quality of sustainable power in the context of aging grids;
- Over 700 million people in developing countries need access to clean, affordable and reliable electricity;
- The one of prevailing battery technologies for years to come is VFB;
- VFB is expected to take the larger market share as markets are shifting to heavy cycling 24/7 use cases;
- RKP will make use of both technologies to create an even more flexible, hybrid solution.

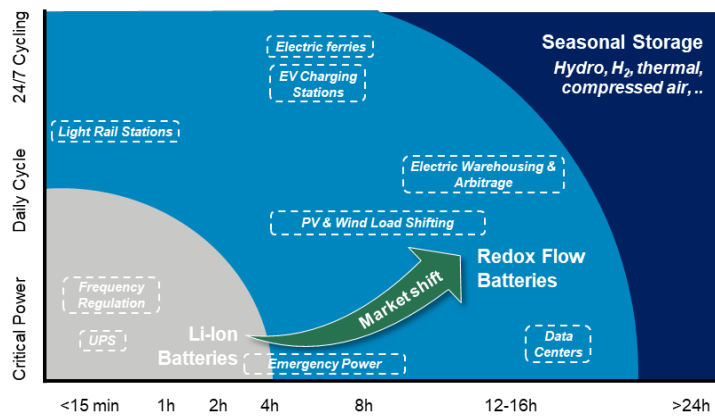


Fig.6.1.1 Battery discharge duration

RKP addresses the entire storage space except seasonal storage, the typical application ranges from home storage to bulk storage.

## 6.2 Illustrative examples

UPower Module is a high-volume commodity product tailored to ensure modularity, flexibility and durability to support a wide variety of use cases from kWh to GWh. Storage applications range from grid stability and optimization to commercial, industrial & home storage with substantial cost savings and operational benefits.



### Bulk storage

- Peak shaving
- Power resiliency
- Control regulations and ancillary services
- T&D deferral



### Microgrids

- On-grid or off-grid
- Reliability and sustainable
- Maximize PV and wind utilization
- Diesel replacement and fuel savings



### Commercial and industrial

- Demand charge reduction
- Time of use savings
- Flexible capacity/ramping
- Load shifting and electricity warehousing



### Home storage

- Stable power supply
- Decrease the dependency on grid
- Integrate roof solar
- Facilitate EV charging posts
- Reduce electrical bills



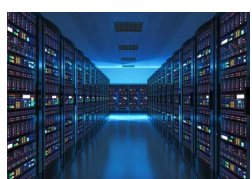
### Renewable integration

- Time shift
- Smoothing
- Firming



### EV charging

- 24/7 storage from limited grid feeds
- On-demand high power EV charging
- Reduce local congestion



### Back-up power

- Critical facilities such as hospitals and data centers must have resilient and redundant power feeds
- A reliable alternative for diesel generators

6.3 Typical project details

Heron island research station



Items	Details
Customer	University of Queensland, Brisbane
Location	Heron Island, Great Barrier Reef, Australia
Date of execution	Completion: September 2019
Products / Technical details	<ul style="list-style-type: none"> <li>• Stable power supply</li> <li>• Energy management system</li> <li>• Replace diesels</li> </ul>
Contract structure	<ul style="list-style-type: none"> <li>• Subcontractor to one of the world's leading companies in the area of renewable energy</li> <li>• UPower Module delivery &amp; integration within two weeks</li> </ul>
Initial investment profile & yearly maintenance needs	Annual maintenance by JUWI according to UPower Module standard operational procedures

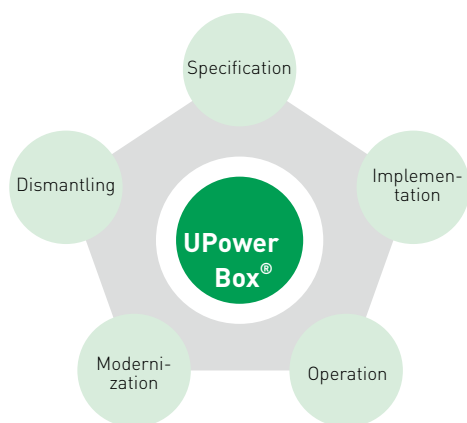


RKP services 34



Example of services provided 34





## 7.1 RKP Services, by your side throughout the life of your installation

### Specifying

We help you to define your solutions: selection guide, technical assistance, and advice...

### Implementing

We oversee the completion and commissioning of your installation: design, cost optimization, guaranteed performances and dependability, with final commissioning tests.

### Operating

We help run your daily operations in real time: maintenance contract, technical assistance, supply of replacement parts, corrective and preventive maintenance, operation and maintenance training.

### Modernizing

We can bring the performance of your installation up to date: installation audit, UPower Module diagnosis, adaptation, modification and end of life recycling.

### Dismantling

We can dismantle your complete UPower Module at the end of its service life: disassembly with environmentally-compatible recycling.

## 7.2 Examples of services provided

### Warranty extension

A warranty extension is proposed if your installation is checked by ourselves before being commissioned.

### UPower Module diagnosis

Throughout the life of the equipment, it is possible to carry out routine measurement of its characteristics in order to optimize maintenance. This service may be part of a global installation maintenance contract.

### End-of-life recycling

RKP service has an operational subsidiary supporting you to recycle your UPower Module if required.

Quality assurance	36
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Quality assurance  
Certified quality: ISO 9001

A major asset

RKP integrates a functional organization whose main role is to check quality and monitor compliance with standards. This procedure is:

- uniform throughout all departments ;
- recognized by many customers and approved organizations. But above all, it is its strict application that has allowed us to obtain the recognition of an independent organization.

The International Accreditation Forum (IAF). The quality system for the design and manufacture is certified to be in conformity with the requirements of ISO 9001: 2015 quality assurance standard.

Strict and systematic checks

During manufacturing, each product and solution is subject to systematic routine testing with the aim of checking the quality and conformity.

The results obtained are recorded and approved by the quality control department on each device's test certificate. This therefore guarantees product traceability.

Environment protection

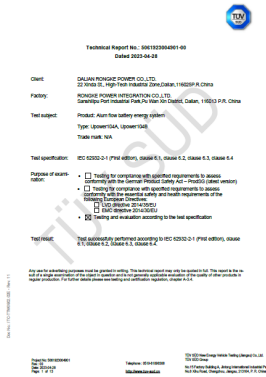
As part of the group's environmental policy, RKP offers to recover your product system and thus eliminate any discharge to the atmosphere. In order to help you protect the environment and to relieve you of any concerns in terms of stock or dismantling, RKP service offers to take back your equipment at the end of its life. Production sites are certified to ISO 14001.

Occupational health and safety

Occupational Health and Safety (OH&S) bears the highest importance at RKP. RKP demonstrates its commitment towards control of the risks and improvement in performance of OH&S by complying to OHSAS 18001:2007 certified by China National Accreditation Service (CNAS). RKP management believes in process approach and its policy is based on PDCA methodology that focuses on elimination or minimizing risks to personnel and other interested parties who could be exposed to OH&S hazards associated with its activities. Strong mechanisms are in place to assure that RKP performance on OH&S not only meets, but will continue to meet, its legal and policy requirements.

Carbon footprint reduction

UPower Module offers a sustainable energy storage solution: a recent study executed by VANITEC1 shows that a VFB battery avoids 44 kg CO2 emissions per MWh stored, in comparison to a Li-ion battery. Additionally, the vanadium used in our electrolyte is sourced from industrial waste (soot ash). This makes UPower Module a net-positive recycling product that meets the most stringent regional requirement.





Order form	38
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**Order Form****Project information**

Project name

Location

Segment

- Home       Commercial building     Data center       Island  
 EV charging    Utility                       Renewables

Project stage

**Working condition**

Installation

- Indoor       Outdoor

Ambient temperature

Daily charge/discharge time

Corrosively

Others

**Battery selection**Discharge performance  
(Duration / Power / Energy / Efficiency)

- 2h / 14kW / 28kWh / 76%  
 3h / 12kW / 36kWh / 78%  
 4h / 10kW / 40kWh / 80%  
 6h / 7.2kW / 43kWh / 82%  
 8h / 5.6kW / 45kWh / 84%

Total capacity (kW / kWh)

**Integration**

PCS provided by VT

- Yes       No

Transformer (voltage of both sides)

EMS provided by VT

- Yes       No

Switchgear to connect network

- Yes       No

**Service required**

Design

- Yes       No

Supply

- Yes       No

Construction

- Yes       No

Transportation

- Yes       No

Installation

- Yes       No

Commissioning

- Yes       No

Operation

- Yes       No

Maintenance

- Yes       No

Spare parts

- Yes       No

Warranty

- Standard 1 year  
 Extension to \_\_\_ years

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