



Enhancing availability and
reliability of the electrical network

Battery energy storage system PQplusS

Modular and flexible storage solution

To meet ever growing energy challenges

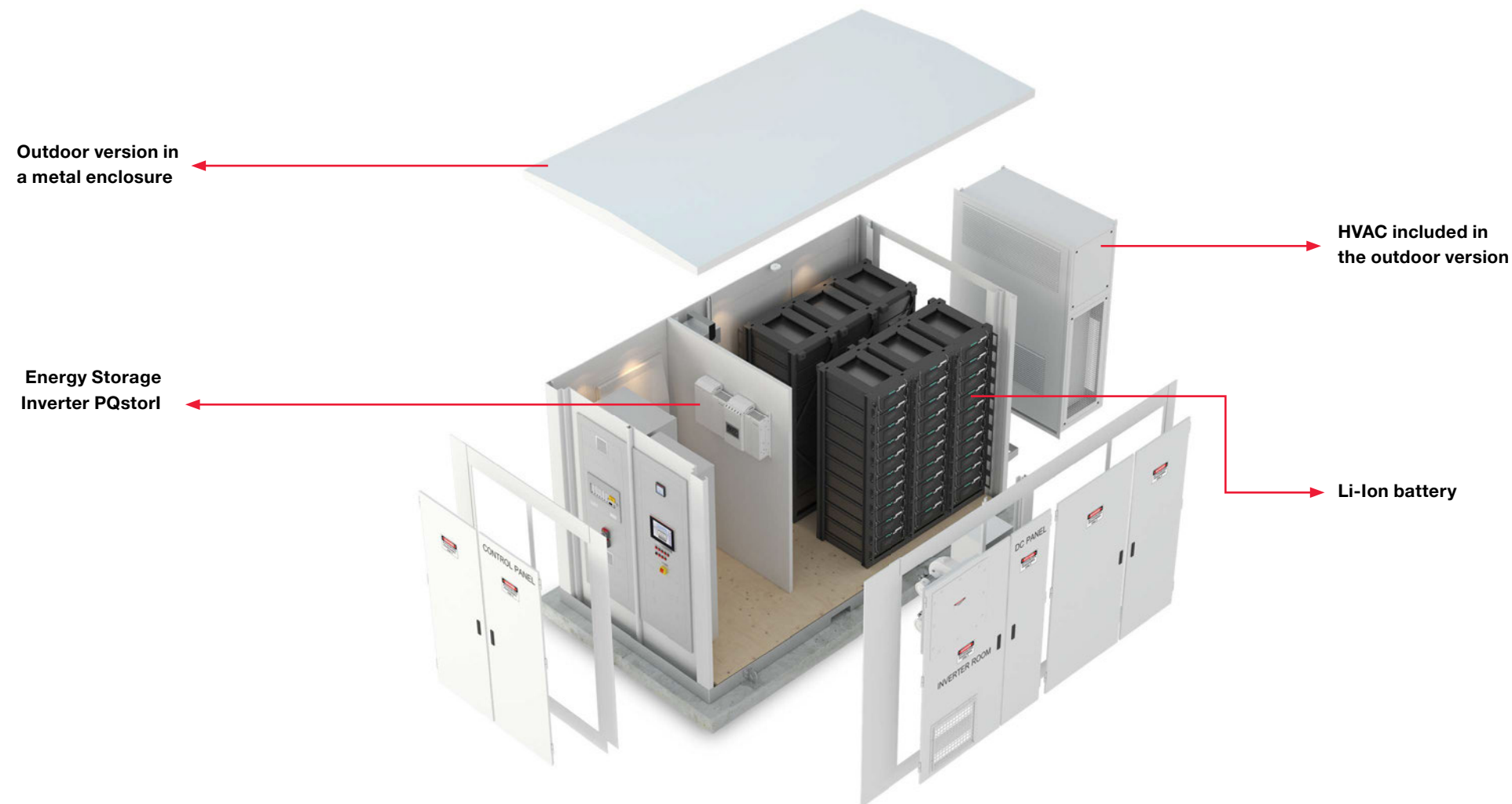
this solution is a global technology leader that is advancing a sustainable energy future for all. We serve customers in the utility, industry and infrastructure sectors with innovative solutions and services across the value chain. Together with customers and partners, we pioneer technologies and enable the digital transformation required to accelerate the energy transition towards a carbon-neutral future. We are advancing the world's energy system to become more sustainable, flexible and secure whilst balancing social, environmental and economic value.

The battery energy storage system (BESS), PQplus is an easy-to-use, plug-and-play solution, that enables in enhancing the performance of the electrical network.



Battery energy storage system PQplusS

Plug-and-play solution for enhancing performance



Modular and compact

- Suitable for indoor as well as outdoor installation
- Different section of Inverters, batteries and control parts
- Firefighting system based on Condensed Aerosol Fire Extinguishing Agent (StatX or similar) offered as an option
- Separate LV compartment for housing the user interface, protection etc.

Complete range

- Small to large: covers a wide range of power (kW) and storage capacity (kWh)
- Mix and match to get desired rating (kW/ kWh)
- Modules for inverters, batteries or a combination of the two are available
- Power rating up to 1.6 MW

Control system with functionalities for:

- Peak shaving
- Load shifting
- Backup power
- Power Quality (reactive power and harmonic compensation ability)
- Capability to operate in islanding mode with blackstart feature (optional)

Battery energy storage system PQplusS

Ideal for behind the meter applications performance



Our grid is transforming. A commercial and industrial (C&I) customer can also be an electricity producer as well as a consumer (i.e. a prosumer). A battery energy storage system is therefore becoming an integral part of the changing relationship between the utilities and their customers. PQplusS enables its users to reduce energy cost and makes the network more resilient while improving the overall efficiency, reliability and availability of the power system. It helps the electricity consumer by actively managing the timing and profile of their energy usage through the following functions:

Peak shaving

The energy consumption pattern in the C&I segment follows a cycle of peak and low load conditions. Peak load periods coinciding for several consumers can lead to a shortage of power supply. To avoid such situation, utilities often charge premium price for energy consumed during peak hours, resulting in high energy cost to the consumer. PQplusS is used for peak demand shaving, resulting in a uniform load distribution around the complete load cycle and saves penalties for the consumer.

Power quality

Developed voltage source converters (VSC), which form the core of the PQplusS, and are capable of offering power quality functionalities without reducing the battery life. Harmonic filtering, reactive power compensation and load balancing improves the power quality at the consumer end. This improves the efficiency of operation of the overall electrical network.

Back-up power

PQplusS provides back-up power to sensitive loads due to its capability to operate in islanding mode with black start features. The automatic transition from current control mode to voltage control mode is smooth and takes place within a few seconds following a power outage. It reduces the need of a traditional back-up power source such as diesel generator thereby reducing CO₂ emissions. Additionally, as it is a power electronics based device, it is less noisy compared to a conventional diesel generator, and can be used in a populated area such as office buildings, hospitals and similar infrastructure to avoid noise pollution.

Wide energy and power range

Right choice for integrators providing utility scale solutions

PQplusS is available in a wide range of power and energy ratings, making it the right choice for system integrators, aggregators and end users building their own system where energy storage is needed for utility scale applications. All users who can provide the right control system for utility scale applications can use the PQplusS. It can also be used where multiple energy sources such as wind, solar, and diesel generators operate in parallel and where the integrator's system controller coordinates the overall operation.

In addition to the functions of peak shaving, power quality and back-up power support, the PQplusS can be controlled by a 3rd party controller to perform:

Load leveling

Load leveling involves storing power during periods of light loading on the system and delivering it during periods of high demand. During these periods of high peak demand, the PQplusS supplies power, reducing the load on distribution grid and less economical peak-generating facilities. Generation load is shifted from high peak demand to off-peak period. This helps in postponement of investments in grid upgrades or in new generating capacity and reduces congestion in the power distribution network.

Frequency regulation

The PQplusS is charged (or discharged) in response to an increase (or decrease) in grid frequency. This approach to frequency regulation is a particularly attractive option because of its rapid response time and emission-free operation. Frequency response increases reliable operation of the grid and reduces the need for additional generation facilities which are expensive to operate and maintain.

Integration of renewable energy

Unpredictability is one of the key drawbacks associated with the green energy sources such as wind and solar plants. A large renewable energy source imposes additional burden on the network operators due to its unpredictable behavior.



The PQplusS can minimize the impact of renewables on the network by offering a “buffer” which can absorb excess power and release the same when the output from these sources fall short.

Capacity firming

The variable, intermittent power output from a renewable power plant, such as wind or solar, can be maintained at a committed level for a period of time. PQplusS smoothens the output and controls the ramp rate (MW/min or kW/min) to eliminate rapid voltage and power swings on the electrical grid. This helps in maintaining the grid codes, improves reliability of the grid and efficiency of the renewable source.

Spinning reserve

PQplusS can respond in less than half a second, which is much faster compared to the response time of standard generators whose response time may range to several seconds. This helps maintain network continuity while the back-up generator is started and brought online. Generators are able to work at optimum power output, without the need to keep idle capacity for spinning reserves. To provide effective spinning reserve, the storage system is maintained at a level of charge ready to respond to a power outage. This minimizes the impacts from power outages on the grid and lowers the cost of operation and maintenance for the generators as well as CO₂ emissions.

One stop solution for your energy storage needs and power quality problems



PQpluS is available in outdoor as well as indoor version. It uses PQstorl range of inverters and AC500 range of PLC (or similar) as the energy management system (EMS) for standard applications.

The batteries used are sourced from our trusted partners to provide the right match for our energy storage product.

PQpluS for outdoor installation

For outdoor applications two executions exist. In the first execution, the inverter and batteries together with the EMS and peripherals are housed in one enclosure. In this execution, maximum twelve inverters and six battery racks can be combined. Several combination modules are available from a minimum of 30 kW power and 68.5 kWh energy to a maximum of 360 kW and 411 kWh rated system.

Examples of such combinations are:

- 2 x PQstorl (30kW each) inverter and 1 x battery rack: 60 kW (max) and 68.5 kWh (max)
- 9 x PQstorl (30kW each) inverter and 4 x battery racks: 270 kW (max) and 274 kWh (max)

The second execution type has independent modules of inverters and battery racks. This execution is used where power/ energy requirement is above 360 kW/ 411 kWh. Modules of inverters and batteries of different rating can be combined to achieve the desired power and energy level for the PQpluS.

Examples of independent inverter and battery modules:

- Up to 32 x PQstorl inverters: max power 960 kW
- Up to 14 x battery racks: max energy 960 kWh

Multiple modules of inverters/ batteries can operate in parallel to build storage capacity up to 1.6 MW/ 2.2 MWh. For example, a 960 kW/ 1100 kWh rated PQpluS require the following modules:

- Inverter modules: 32 modules of 30 kWh PQstorl
- Battery modules: 2 off 8 x battery racks

PQpluS for indoor installation

For indoor installation, the inverters and battery racks are installed side by side together with a control cubicle which houses the EMS and other peripherals. The PQstorl inverter can also be mounted on a wall.

Example of indoor installation:

- 1 x PQstorl inverter (30 kW) with control and protection mounted inside a common cubicle with one battery rack (68.5 kWh)

The indoor installations are configured depending on availability of space etc. and can reach up to 1.6 MW/ 2.2 MWh ratings.

PQpluS is one stop solution for your energy storage needs and power quality problems.

Features and benefits

PQpluS offers great value to a customer requiring energy storage – large or small. Packed with powerful features to enhance power quality by harmonic mitigation, load balancing and reactive power compensation, the PQpluS doubles up as a power quality improvement device in the electrical network.



Footprint

For applications in commercial buildings and industries where real estate comes at a premium, the compact design of PQpluS consumes minimum space for installation.

Modularity

A wide range of standard modules reduces the time for engineering and offers the user a choice of different rating of power/ energy to suit any specific application.

In-built controller

While the PQpluS can be used with any third party controller for a wide range of applications, the built-in controller for applications such as peak shaving, load shifting, back-up power and power quality makes it an ideal choice for standard applications for a commercial and industrial customer.

Installation

PQpluS comes in both indoor as well as outdoor variants. The outdoor version is available in a metal enclosure, making it easy to install and connect to the existing power and control system. This provides flexibility to a user to place the storage device as per their convenience.

Power Quality

Most of the loads in the present power system are non-linear in nature. They impose problems on the network such as high harmonic pollution, low power factor and unbalance of loads. All these lead to additional system losses and lower the operational efficiency. The built-in power quality features of the PQpluS give an added advantage by filtering the harmonics, performing load balancing and providing reactive power compensation, without stressing the battery lifetime.

User interface

With its touchscreen user interface, it allows the operator full access to the PQpluS parameters. It can be used to consult data and set parameters and can communicate with customer controller systems through Modbus RTU as well as Modbus TCP/ IP protocol.

PQpluS

Technical specifications

General		
Configuration		Modular
Location		Indoor or Outdoor
Max ambient temperature		50°C (104°F)
Min ambient temperature		-10°C (23°F) non condensing
Max average temperature over 24 h		35°C (95°F)
Altitude		<1000 m above sea level ⁽¹⁾
Relative humidity		Maximum 90% RH non condensing
Interlocking (optional)		Mechanical or Solenoid
Standards		IEC60529, IEC61439
		Optional Cyclonic Condition
		IEEE 693-2005 High seismic level

Electrical		
Grid connection voltage (+/- 10 %)		380 VAC - 415 VAC
Rated output: (+/- 10 %)		30 kW up to 1.6 MW
Frequency		50 or 60 Hz
Insulation level		up to 3 kV BIL
Arc fault mitigation (optional)		REA101 Arc fault detection relay (for outdoor version only)
Short circuit current		up to 50 kA for 1 second (for outdoor version)

Enclosure (Outdoor)		
Material		Mild steel (optional stainless steel SS304)
Base frame		Hot dipped galvanized steel
Protection		IP55 inverter section/ IP65 (battery section) - IK08 impact level
Door locking		Front: lockable handle bolted type
Installation		Base fixing, on concrete footing or raised platform
Handling		Fork and crane lifting via base
Cable entry		Bottom only

Enclosure (Indoor)		
Material		Mild steel
Protection		IP21 (IP30 for PQstorl wall mounted version)
Door locking		Optional
Installation		Free floor standing
Cable entry		Bottom

Inverters			
Type	PQstorl - M (Module)	PQstorl - WM (Wall-mounted)	PQstorl - C (Standalone cabinet)
Rated power (at 400 V)		30 kW, 80 kW and 100 kW	
Network frequency (+/- 5 %)		50/ 60 Hz	
Equipment losses		<= 2 % of the equipment power typically	
Connection method		3-wire/ 4-wire	
DC voltage (min)		590 V for 3 W application; 650 V for 4 W application	
DC voltage (max)		830 V (890 V with reduced power)	
Overload capacity		150 % for 10 s once per 15 min (load history has a bearing on overload capacity)	
Redundancy ⁽²⁾		Master/ master or master/slave arrangement	

Power quality characteristics		
Reactive power compensation: target cos Φ		Programmable from 0.6 (inductive) to 0.6 (capacitive) ⁽³⁾
Harmonic mitigation ⁽⁴⁾		
Harmonic range		Up to 2 nd to 13 th harmonic
Harmonics selectable		3-wire/ 4-wire: 5 harmonics
Filtering target		Programmable for each harmonic in absolute Ampere value
Harmonic attenuation factor		Better than 97% at rated load
Response time		P:20 ms
		Q: 20 ms
		Harmonics: 2 networks cycles typically (10-90% filtering)
Load balancing characteristics		Balance the currents between phases and/ or between phases and neutral (4-Wire application)

Customer interface		
Interface point of communication		PLC based energy management system (EMS)
Communication protocol		Modbus TCP/ IP, Modbus RTU (optional), OPC UA (optional)
HMI		Touch screen for setting parameter, consulting status, functions etc.
Connection for communication		Ethernet based (RJ45)
Additional communication with inverter		Wi-Fi, HMI touchscreen

Batteries		
Type	Energy (1C)	Power (2C)
Model ⁽⁵⁾	Samsung 198S M2	Samsung 198S P3
Energy [kWh]	68.5 kWh	56.5 kWh
Capacity [Ah]	94 Ah	78 Ah
Nominal Voltage [v]	725 V	725 V
Voltage Range [v]	635 V - 821 V	614 V - 811 V
Weight [kg]	562 kg	562 kg

- Higher ratings available on request
- For full redundancy combine only master units. If limited redundancy is acceptable, master and slave units can be combined. The desired redundancy level can be obtained by selecting more or less master units
- If cos Φ of the installation is higher than the target cos Φ, the filter will not downgrade the existing cos Φ. The inverters can operate in 4-quadrant (100% real power to 100% reactive power)
- CT's to be provided at the main incomer (source-side)
- Reserve the right to provide batteries of different make/ model.

Application example

In a world where climate change has become one of the biggest concerns, the Danish capital, Copenhagen, has set itself an ambitious goal - to be the world's first carbon neutral city by 2025. In order to achieve this, breakthrough innovations are being implemented into its energy system.

One of these innovations is the Energy Lab Nordhavn project that has transformed a part of the new residential area Nordhavn, into a "full scale living lab". The project, funded by The Danish Energy Technology Development and Demonstration Program, aims to develop and demonstrate the energy solutions of the future – integrating electricity and heating, energy-efficient buildings and electric-powered transport into an intelligent, flexible and optimized energy system.

A significant part of the project is the battery energy storage system supplied to Radius, Denmark's largest power distribution company by us. Installed in an urban environment, it is able to supply power to approximately 200 apartments at the time of the day where the demand for power is at its highest. This technology is the first of its kind in Denmark.

In Energy Lab Nordhavn, solar and wind energy power produce the majority of the electricity. Together with these two renewable energy sources, a modular battery energy storage system is installed, which comprises Li-ion batteries and intelligent energy storage inverter.

The storage system is a key element of the energy supply, as it improves the power quality of the electrical network by performing the functions of peak load shaving and frequency response. These two functions can be extremely helpful in certain markets: peak shaving can reduce penalties paid by customers for excess of consumption by reducing their peak load demand and, at the same time, can release network stress by providing a more uniform load distribution through the day; frequency response, a mechanism used by National Grid, can help manage grid stability, leading to an improvement of productivity for connected loads and grid reliability.

“ By integrating battery storage in Nordhavn we have the opportunity to learn more about how new technological solutions and market mechanisms interact with the grid. I expect, that battery technology, on the longer horizon, holds the potential to reduce the load on the grid and make it run more cost-efficiently.

Knud Pedersen

Chairman of the Board, Radius Elnet,
Orsted's electrical grid division

