

X O L T A



## **BAT-79 USER MANUAL**

XOLTA OUTDOOR BATTERY ENERGY STORAGE SYSTEM

**Advanced energy storage system for  
renewable energy and grid support applications**

## TABLE OF CONTENTS

### 1. Safety information and legal terms

1.1	Document purpose and structure .....	3
1.2	Important safety Instructions .....	3
1.3	Actions in case of emergency situations .....	4
1.4	XOLTA certified installers .....	6
1.5	Safe disposal of lithium-ion batteries .....	6
1.6	Disclaimer .....	6
1.7	Legal .....	6
1.8	Copyright .....	6
1.9	Void of warranty .....	7
1.10	Abbreviations .....	7

### XOLTA Battery Energy Storage System Overview

2.1	Introduction .....	8
2.2	Hardware description .....	9
2.3	System safety .....	10
2.3.1	Safety measures .....	10
2.3.2	Internal electrical scheme of the XOLTA outdoor BESS .....	11
2.4	Key specifications .....	12

### 3. XOLTA Battery Energy Storage System

3.1	Delivery inspection .....	12
3.2	Location requirements .....	13
3.3	Installation procedure .....	13
3.3.1	Electrical requirements .....	13
3.3.2	Installation overview .....	14
3.4	System operation .....	18
3.5	Maintenance requirements .....	18

### 4. XOLTA Battery System functionality

4.1	Operating modes .....	19
4.1.1	Maximizing solar self-consumption .....	19
4.1.2	External control .....	20
4.1.3	Grid voltage support .....	20
4.1.4	Load following .....	21
4.2	Site controller state machine .....	21
4.2.1	SC States .....	21
4.2.2	Transitional Sequences .....	23
4.3	XOLTA outdoor BESS monitoring .....	23

### 5. Web API

5.1	Web API .....	24
-----	---------------	----

# 1 SAFETY INFORMATION AND LEGAL TERMS:

## 1.1 Document purpose and structure

The purpose of this manual is to provide the user of the XOLTA Outdoor Battery Energy Storage System (BESS) with an overview of system installation, functionality and operation.

The document is organized as follows:

<b>Chapter 1</b>	sets out important safety information, what to do in emergency situations and a list of abbreviations.
<b>Chapter 2</b>	gives a brief introduction to the XOLTA outdoor BESS system and describes its main features and key specification parameters. Safety measures and protection schemes used in the XOLTA outdoor BESS are also described.
<b>Chapter 3</b>	deals with system installation, maintenance and location requirements. Liability limitations are also mentioned.
<b>Chapter 4</b>	describes currently available XOLTA outdoor BESS operating modes and operating states.
<b>Chapter 5</b>	provides a list of telemetry signals accessible via the Web API.

## 1.2 Important safety instructions

The XOLTA outdoor BESS installation and servicing should only be performed by XOLTA certified installers. In consequence, XOLTA provides no liability for property damage or injury caused by system modification or repairs performed by unqualified personnel or failure to follow the following important safety instructions.

The safety instructions have been divided into:



**WARNING** - indicates a dangerous situation which, if not avoided, could result in death or injury.



**CAUTION** - indicates a situation where damage to the equipment or injury may occur.

### IMPORTANT SAFETY INSTRUCTIONS

Read the entire document carefully before installing or using XOLTA outdoor BESS.



#### **RISK OF EXPLOSION:**

Do not apply any external force to the XOLTA outdoor BESS.

Avoid physical damage to the battery. Keep the XOLTA outdoor BESS away from where it may accidentally be physically damaged.

Do not dispose of the XOLTA outdoor BESS in fire.



#### **RISK OF FIRE:**

Keep system away from flammable objects and heat sources.

Do not expose the battery system to temperatures in excess of 50°C.



#### **RISK OF ELECTRICAL SHOCK:**

There are high voltages present on AC and DC cables. There is a risk of death or serious injury due to electric shock. Report any external cable/wire damage to XOLTA or local XOLTA system installer. Do not touch uninsulated wires.

Never use a system if it is defective, damaged or broken.

Never attempt to disassemble, repair, modify the product or use it in any way other than as described in this manual. Repairs or replacement of components must only be performed by a XOLTA certified technician.

Never immerse the XOLTA outdoor BESS in water or other fluids.



**RISK OF DAMAGE:**

Do not expose the battery system to temperatures below -25°C or in excess of 50°C

Do not place any objects on top of the XOLTA BESS. It might lead to improper product operation or problems with thermal management.

**OTHER PRECAUTIONS:**



The product should not be used for any purpose other than described in this manual.

Unpleasant smell might indicate electrolyte leakage from battery cell(s). In this case, switch the system off and contact your XOLTA system supplier immediately. Ventilate the room if possible and avoid inhaling the odor.

The XOLTA outdoor BESS is heavy. Suitable lifting equipment is necessary.

Do not paint any part of the product.

For long term storage (longer than 1 month), the product should be charged to 40% SoC and then disconnected from the grid. Observe warranty conditions.

The product must be disposed of according to local regulations.

**1.3 ACTIONS in case of emergency situations**

The XOLTA outdoor BESS is designed to be very safe. It monitors essential parameters of the battery system and protects the battery from damage. The main battery safety measures are presented in Table 1.1 below.

**Table 1.1:**  
List of main safety measures in XOLTA outdoor BESS

✓	State of the art battery cells with excellent safety performance
✓	State of the art battery management system (BMS) assuring over/under voltage and over/under temperature monitoring for each individual battery cell
✓	Redundant battery cut-off relay controlled by BMS
✓	Temperature sensors monitoring battery system temperature
✓	Active battery current control depending on battery cells temperature, voltage and state of charge (SoC)
✓	System diagnostics, error handling and automatic grid connection/disconnection controlled by the site controller
✓	Battery air humidity monitoring and condensation prevention system
✓	AC and DC protective fuses

Despite all these built-in safety measures, emergency situations can still occur. In such emergencies, the actions to take are as follows:



#### LEAKAGE

The battery pack might leak toxic electrolyte. Electrolyte is corrosive and odorous.



#### ACTION

- Avoid any contact with the leaking liquid or gas.
  - In case of electrolyte **inhalation** - contact medical help.
  - In case of electrolyte **contact with skin** - wash thoroughly with water and soap and contact medical help.
  - In case of electrolyte **contact with eyes** - rinse eyes with water for 15 minutes and contact medical help.
  - In case of electrolyte **ingestion** - force vomiting and contact medical help.
- Do not enter the room, if installed inside.
- Ventilate the room if possible.
- Contact your XOLTA system supplier.



#### FIRE

Fire may occur due to mechanical damage or external sources of heat and fire. Hazardous fumes such as carbon dioxide, carbon monoxide and hydrocarbons are emitted during battery fires.



#### ACTION

- Disconnect the power from the battery system (if possible without getting too close to the battery and without inhaling fumes).
- Never try to extinguish a battery fire yourself. If battery cells catch fire, then only qualified firefighting personnel with appropriate protective equipment should attempt to extinguish the fire. Keep away from battery fire and contact firefighters.
- If components other than battery cells catch fire, then ABC or carbon dioxide extinguisher can be used to extinguish the fire.
- Keep away from the battery and contact emergency firefighters.



#### IMMERSION IN WATER

Immersing the XOLTA outdoor BESS in water risks causing a short-circuit and damage to the battery system.



#### ACTION

- Do not try to access the XOLTA outdoor BESS.
- Disconnect the power (if possible without getting too close to the battery).
- Never use a flooded battery system again.
- Keep away from the battery and contact your XOLTA system supplier.



## DAMAGED BATTERY

Any sign of mechanical damage or abnormal behavior of the battery system or its peripheral components should be treated with extreme caution.



## ACTION

- Never use a damaged battery system again.
- Disconnect the power.
- Keep away from the battery and contact your XOLTA system supplier.

### 1.4 XOLTA certified installers

XOLTA provides appropriate training to installation technicians for XOLTA systems.

The XOLTA outdoor BESS must only be installed and commissioned by XOLTA certified installers. Contact XOLTA for a list of available XOLTA certified installers.



### 1.5 Safe disposal of Lithium-ion batteries

Lithium-ion batteries must be treated as hazardous waste and not be disposed of with regular waste.

A XOLTA battery which has reached the end of its functional life can be returned to the seller that originally sold the battery or to the dealer of a new industrial battery.

### 1.6 Disclaimer

We have taken every precaution to ensure that all information provided in this manual is correct and up to date. However, we assume no responsibility for damage to persons and property arising as a result of following recommendations and/or procedures described in this manual. Furthermore, we assume no responsibility for any infringements of rights of third parties which may result from the use of this manual.

### 1.7 Legal

The system was designed to assure that an installed XOLTA outdoor BESS and all its associated functionalities behave safely under the predefined operating conditions. However, please, read all sections describing safety issues and precautions carefully before installation, operation, or performing service work on a XOLTA outdoor BESS. Failure to do so could result in reduced system performance, damage to the system, personal injury or even death.

### 1.8 Copyright

This document and all information contained in the XOLTA User Manual are copyright 2021 by Lithium Balance A/S. All rights reserved. Lithium Balance reserves the right to make changes to the products described in this manual at any time without notice. This manual may be photocopied or otherwise distributed only to the extent that is necessary for the correct operation and installation of XOLTA outdoor BESS.

## 1.9 Void of warranty

XOLTA does not assume any direct or indirect liability for any damage or loss caused if:

- The product covered is not continuously connected to the internet via LAN cable, meaning that XOLTA cannot monitor the performance of said product;
- The product covered has not been stored, transported, set up or installed in an appropriate and professional manner in accordance with technical standards and regulations, in accordance with the relevant installation manual of the product or the instructions of XOLTA;
- The product covered has been operated contrary to its intended use or contrary to the instructions in the relevant installation manual;
- The product covered was out of service for a continuous period of more than six months after the initial installation due to the fault of the Purchaser;
- The product covered has not been serviced properly and professionally according to technical standards or XOLTA's maintenance instructions;
- The product covered has been exposed, even temporarily, to vibrations that even insignificantly exceed the usual extent of vibrations caused by transport and installation;
- The product covered has been improperly altered or otherwise tampered with by the Purchaser or any third party;
- An overvoltage has occurred in the power grid to which the product covered is connected;
- The product covered has been exposed to force majeure (in particular lightning, fire, earthquake or natural disaster) or harmful environmental conditions such as air pollution, salt water or sulphur corrosion;

**NOTE!**

Always refer to the Terms and Conditions document delivered by XOLTA for warranty conditions.

## 1.10 Abbreviations

**Table 1.2:**  
List of abbreviations used in this XOLTA User Manual

BESS	Battery Energy Storage System
BMS	Battery Management System
BoL	Beginning of Life
BPU	Battery Protection Unit - a unit containing switches and fuses for battery protection
CAN	Controller Area Network - Serial communication protocol developed by Bosch
CMU	Cell Monitoring Unit of nBMS
DoD	Depth of Discharge
EoL	End of Life
ESS	Energy Storage System
GUI	Graphical User Interface
MCU	Main Control Unit of nBMS
MODBUS	Serial communication protocol developed by Modicon
n-BMS	Battery Management System from Lithium Balance A/S
NTC	Negative Temperature Coefficient thermistor
PCS	Power Conditioning System
POR	Power on Reset
PV	Photovoltaic
SC	Site Controller
SoC	State-of-Charge
TCO	Total Cost of Ownership
TMS	Thermal Management System

## 2 XOLTA BATTERY ENERGY STORAGE SYSTEM OVERVIEW:

### 2.1 Introduction

The XOLTA outdoor BESS is a modular, cloud-connected multipurpose stationary energy storage system. The BESS was designed for a wide range of ambient temperature conditions which makes it suitable for outdoor installation without any additional enclosure. The system is designed for various operation modes (applications) which will be further described in Chapter 4.

The main features of the XOLTA outdoor BESS are:

- **PLUG AND PLAY:** Simple installation and commissioning. The system requires grid connection, internet and electric meter connections.
- **ALL IN ONE:** All components of the system are integrated into a single cabinet. This includes the battery cells, the power conditioning system (PCS), the thermal management system (TMS), the battery management system (BMS), the multi battery rack control system and the energy management system.
- **OUTDOOR OPERATION CAPABILITY:** The mechanical casing of the system was designed to be effective up to enclosure rating IP55 (dust and water jet ingress).
- **MODULARITY:** The storage system power and energy can be expanded and tailored to specific needs. In total, up to 32 XOLTA battery racks can be connected and operated in parallel providing up to 1MW and 2.5MWh.
- **MULTIPURPOSE:** The system is designed for various applications, from the integration of renewable energy (e.g. increasing renewable self-consumption) up to various grid support applications (e.g. frequency and voltage support).
- **XOLTA CLOUD CONNECTION:** The system is integrated with the XOLTA Cloud. It allows for system monitoring, advanced control, data acquisition, and data storage.
- **SAFETY:** The system is designed to offer exceptionally high operational safety. For example, the system is fitted with state-of-the-art battery systems, multi-layer and redundant protection systems, Lithium Balance's battery management system (BMS) which assure maximal system safety under various operating conditions.
- **LOW TOTAL COST OF OWNERSHIP:** This is achieved by very high system round-trip efficiency, low standby losses, minimal operational and maintenance (O&M) cost and intelligent energy management.
- **SITE CONTROLLER:** This works as a multi battery rack control system and an energy management system (EMS) which manages the entire XOLTA outdoor BESS. It provides charge/discharge power management, monitoring to assure safe system operation, communication with all system peripherals (e.g. the battery converter), data acquisition, communication with the XOLTA Cloud, system diagnostics and error handling.
- **THERMAL MANAGEMENT SYSTEM:** Simple and efficient parallel cooling system.
- **PERIPHERALS:** Possibility of integrating external energy meters and other.

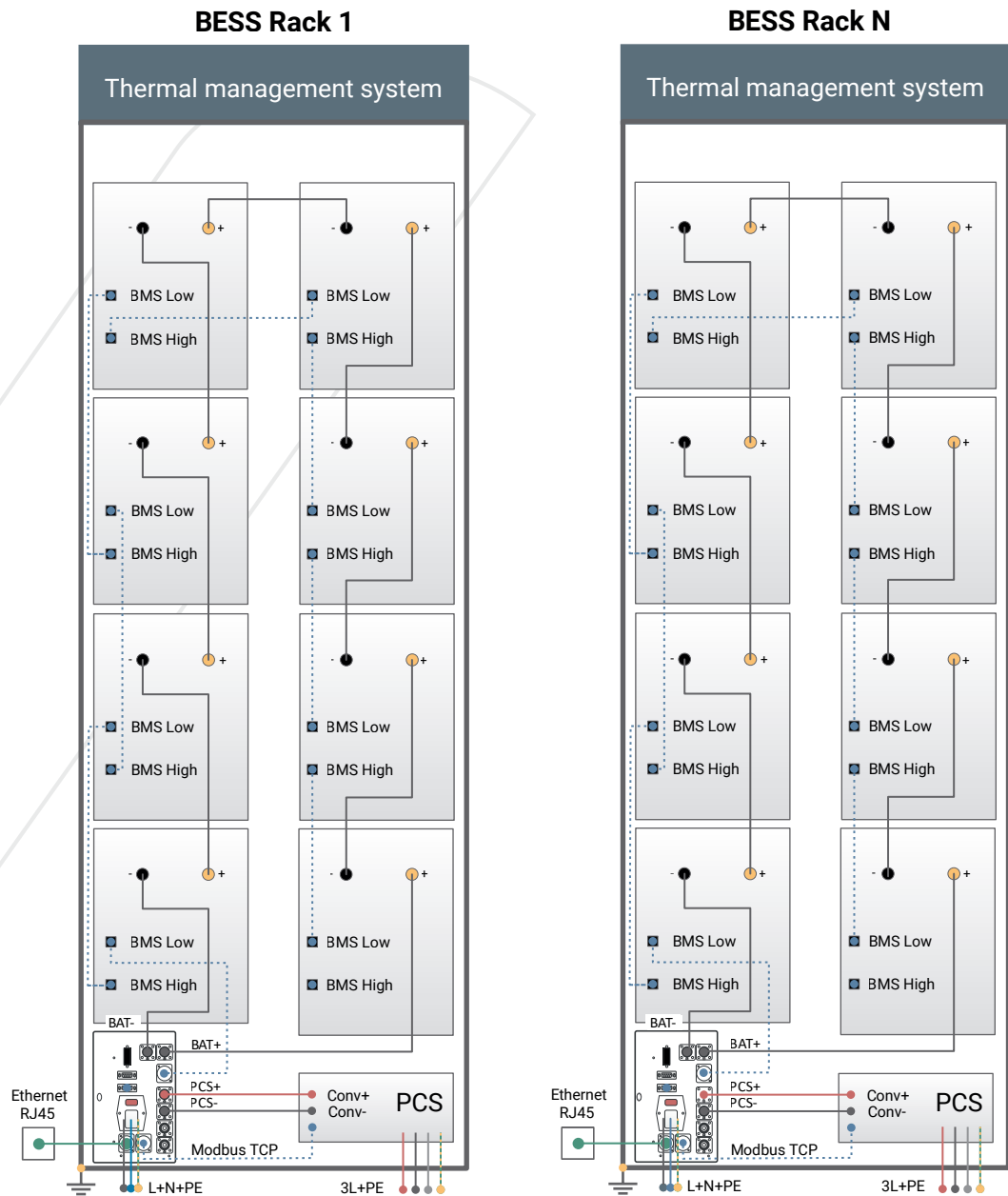


## 2.2 Hardware description

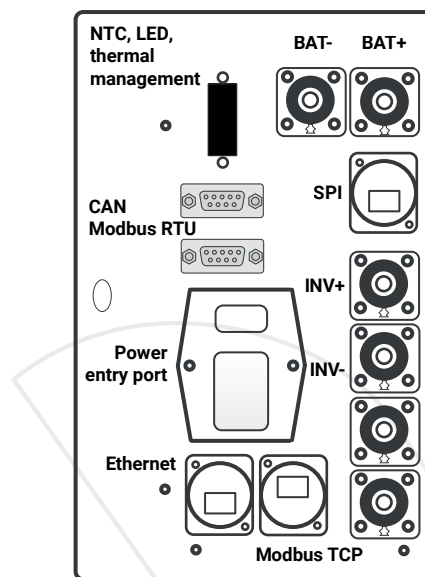
In this section, different hardware components of the XOLTA outdoor BESS are described. Figure 2.1 presents the schematic drawing of the XOLTA outdoor BESS.

Each rack (battery cabinet) of the XOLTA outdoor BESS consists of eight serially connected battery packs (as seen in Figure 2.1. All battery cells are protected by Lithium Balance's n-BMS.

**Figure 2.1:**  
Illustration of the XOLTA outdoor BESS hardware components



**Figure 2.2:**  
Illustration of the  
XOLTA outdoor BESS  
BPU front view



Each XOLTA outdoor BESS has a battery protection unit (BPU). Figure 2.2 is an illustration of the BPU consisting of a communication section and a power section.

The site controller is installed in the BPU and is connected to the XOLTA Cloud using the Ethernet port shown in Figure 2.2. The Ethernet port ensures communication between neighboring racks if operating in unison. The site controller communicates with Lithium Balance's n-BMSs via the CAN bus.

The DB9 Modbus port is used for communication with peripherals (e.g. energy meters).

The RJ45 port marked SPI is used for communication between the n-BMS MCU and the n-BMS CMUs (which are located in battery packs). An additional DB15 plug is used for activation of the thermal management system, sensing outdoor air temperature, LED diodes control and communication with the humidity sensor-

The Modbus TCP port is used for communication with the power conditioning unit (PCS) and communication with neighboring racks if operating in unison.

The BPU is powered by single phase 230V AC and is protected by a 1.5A fuse located in the power entry connector.

## 2.3 System safety

### 2.3.1 Safety measures

The XOLTA outdoor BESS is protected by Lithium Balance's state of the art n-BMS. The system monitors essential parameters of the battery system (cell voltage, current, temperature) to ensure safe operation. The n-BMS also monitors the battery main parameters, e.g. State of Charge (SoC) and performs battery cell balancing to ensure maximal energy utilization and performance.

The XOLTA outdoor BESS is equipped with a battery protection unit (BPU) which protects the battery and the inverter from conditions which can be detrimental to the BESS. It includes redundant relays controlled by the n-BMS and redundant fast battery fuses.

In addition, in order to assure system longevity and safe operation (maintaining correct operating temperatures), each of the XOLTA outdoor BESS battery packs is equipped with 12 temperature sensors (two sensors per battery module). These give a total of 96 temperature sensors per battery rack. This number of temperature sensors allows for quick detection of local temperature gradients and thus ensures system safety and equal cell performance during the system lifetime. Furthermore, temperature sensors are located on all battery safety-related PCBs

The thermal performance of the XOLTA outdoor BESS is also monitored by the site controller and allows for power/current derating whenever the cell temperature or the ambient temperature is outside a strictly determined range. The site controller also allows for converter error handling and automatic connection/disconnection of battery racks.

The XOLTA outdoor BESS is also built with a special closed metal housing designed to prevent fire propagation between battery modules in the extremely unlikely event of battery thermal runaway. The cabinet is made of vandal resistant steel.

Finally, every Outdoor BESS can be equipped with an external emergency stop button which disconnects the battery racks from the grid. The emergency stop button should be installed by an electrician when connecting the BESS to the grid.

### 2.3.2 Internal electrical protection schematics of the XOLTA outdoor BESS

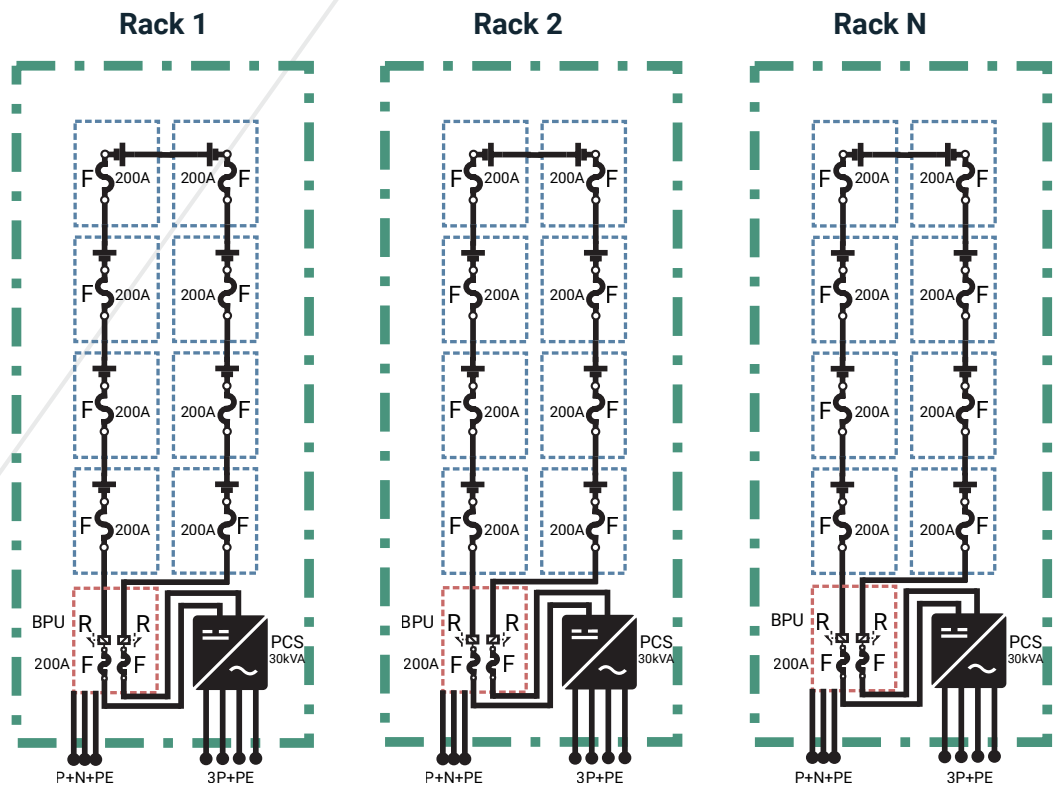
Figure 2.3 illustrates the protection scheme used inside the XOLTA outdoor BESS. The protection schematics includes the following main components:

- one fast DC fuse located in each battery pack;
- two fast DC fuses located in the BPU;
- two DC relays controlled by the n-BMS (2 relays per BPU);
- one 1.5A AC relay for protection of the BPU power supply;

All metallic parts of the battery rack, battery packs and BPU are grounded.

In addition, all battery converters (PCS) provided as a part of the XOLTA outdoor BESS are grounded and protected with AC fuses and DC and AC relays to ensure safe operation of the PCS.

**Figure 2.3:**  
Illustration of electrical protection schematics used for the XOLTA outdoor BESS



## 2.4 Key specifications

Key specification parameters of the XOLTA outdoor BESS are shown in the following table.

**Table 2.1:**  
Key specifications  
for BAT-79

TECHNICAL PROPERTIES	
Power (charge/discharge)	30 kW standard, up to 80 kW
Nominal energy	79 kWh
Battery chemistry	Li-ion NMC
Nominal battery voltage	700V DC
Battery voltage range	614-797 V DC
Grid connection voltage*	3 x 400V AC
Battery system efficiency**	96,6%
Cooling standard	Forced air cooling via heat exchanger (ambient temperature -25°C to 35°C)
Cooling active - optional	Cooled by air conditioner (ambient temperature -25°C to 45°C)
Parallel coupling	Ability to couple multiple racks in parallel
Cabinet	Coated, vandal resilient steel enclosure
Dimensions	D723mm x W846mm x H2180mm
Weight	1,083 kg. per rack
Standards	CE: Safety, health and environment
	UN38.3 classification for safe transportation
	EN 61010-1: 2010 + A1: 2016 – safety req. battery systems
	EN 62477-1 (2012) safety req. for converters
	EN 61439-1 (2011) inverter general construction and safety
	EN/IEC 61000-6-2, industrial level – inverter EMC immunity
	EN/ IEC 61000-6-4, class A – inverter EMC emission
Protection rating	IP55
Expected life time	15 years
Performance warranty	10 years / 70%

\*Higher voltage levels feasible with transformer, \*\*100% DoD, 15kW round-trip efficiency at 25°C

## 3 XOLTA BATTERY ENERGY STORAGE SYSTEM:

This part of the manual describes the installation and electrical connection of the XOLTA outdoor BESS

### 3.1 Delivery inspection

Each XOLTA outdoor BESS is delivered as a fully assembled cabinet on a single pallet. It has been carefully checked and tested prior to shipping. However, upon delivery, you should verify visually the state of packaging to make sure that it is in good condition. In case of any visual damage to the packaging, report it to XOLTA support.

### 3.2 Location requirements

- The XOLTA outdoor BESS is intended for outdoor use and is protected up to IP55;
- The ambient temperature in the installation place should be in the range of from -25 to maximum +35°C. The temperature range can be expanded with active cooling. Please observe data sheet specifications.
- The system should not be immersed in water or exposed to high temperatures, flames or physical force;
- No object should be placed on the top of the cabinet or within 0.5m of the top of cabinet;
- The battery cabinets should be permanently fixed to the ground. Moving the assembled battery racks is strictly prohibited as this can damage the rack structure or the battery packs;
- All XOLTA outdoor BESS racks should be placed vertically and safely secured to the rack base and the underlying foundation.

**Figure 3.1:**  
Illustration of the  
XOLTA outdoor BESS  
battery racks



**WARNING:**

The XOLTA outdoor BESS should not be installed at the following locations:

- Areas prone to earthquakes
- Altitudes above 2000 meters above sea level; up to 4000 meters might be permissible but will require converter's maximum power derating
- Areas prone to flooding, open flames, explosion and extreme changes of ambient temperature

### 3.3 Installation procedure

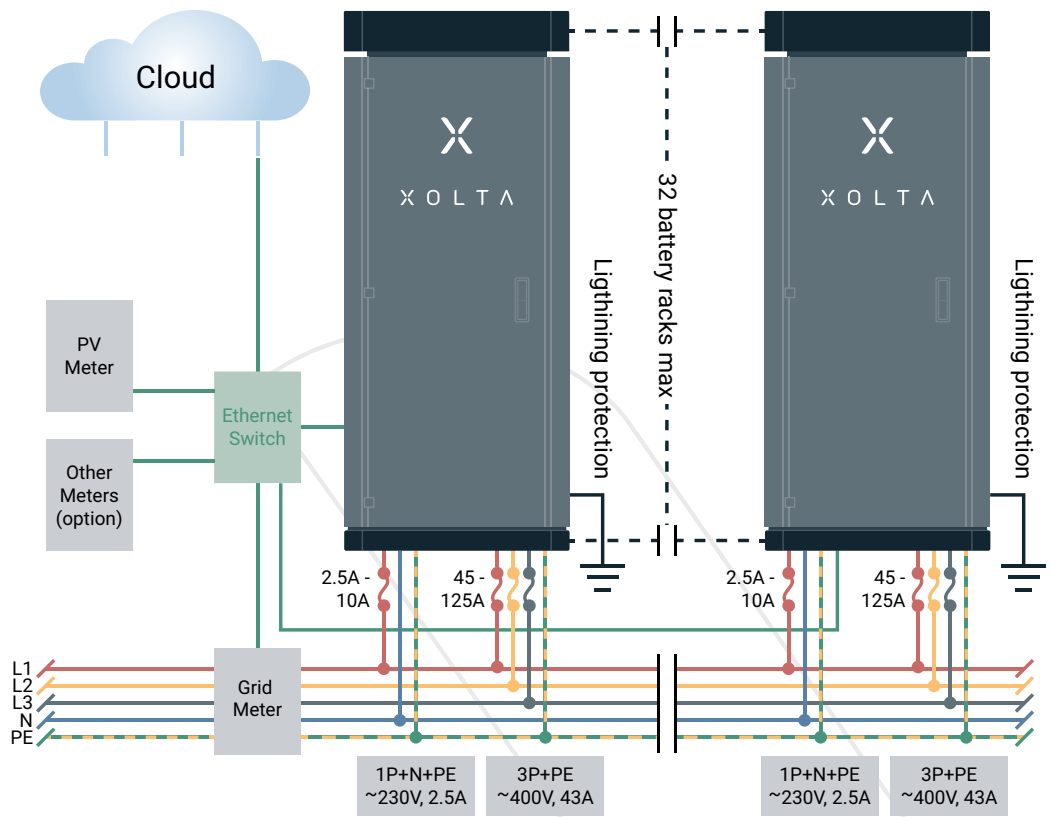
#### **3.3.1 Electrical requirements**

The XOLTA outdoor BESS has been designed for connection to low voltage three phase 400V AC 50Hz electrical grids. However, the system can also be connected to grids with other voltage levels (e.g. medium voltage level) if appropriate power/voltage conditioning units such as power transformers are in place. Each XOLTA outdoor BESS cabinet (rack) has the following electrical requirements:

- 3 P+PE 400V AC 50Hz connection point;
- 1 P+N+PE 230V AC 50Hz connection.

Electrical installations and protection circuits must only be undertaken by an authorized electrician. Figure 3.2 shows the installation and protection schematics for the 30kVA battery rack.

**Figure 3.2:**  
Illustration of the XOLTA outdoor BESS electrical connection and protection for 30kVA battery rack



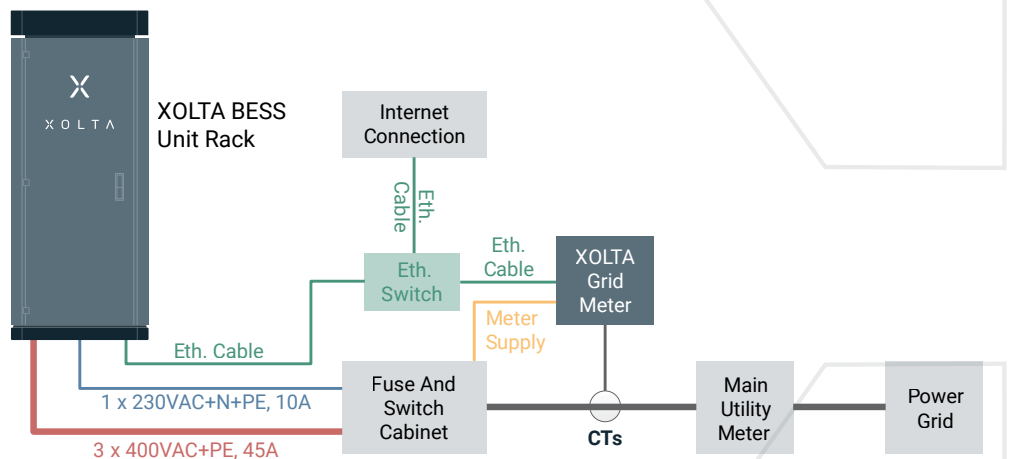
The XOLTA outdoor BESS must be installed and commissioned by a XOLTA-trained technician. Any subsequent changes or modifications performed by unauthorized personnel are strictly prohibited and could compromise safety.

### 3.3.2 Installation overview

#### 3.3.2.1 Typical installation without solar panels

The block schematics in Fig 3.3 depict a typical installation of the XOLTA outdoor BESS unit rack without solar panels.

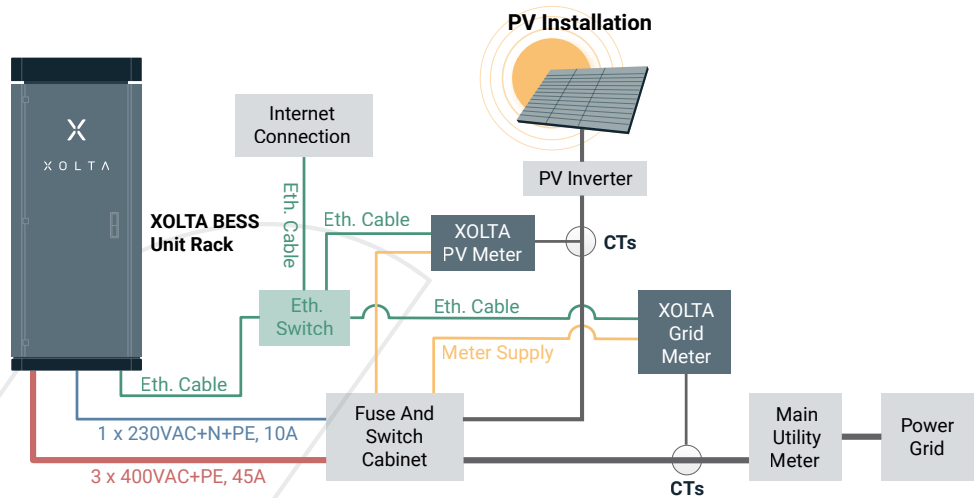
**Figure 3.3:**  
Typical XOLTA outdoor BESS installation without solar panels



### 3.3.2.2 Typical installation with solar panels

The block schematics in Fig. 3.4 depict a typical installation of the XOLTA outdoor BESS unit rack with solar panels.

**Figure 3.4:**  
Typical XOLTA outdoor BESS installation with solar panels



### 3.3.2.3 Grid feeding monitoring relay (optional)

In certain grids, there is a need to install a grid feeding monitoring relay between the battery system and the public grid. The relay collects all relevant data regarding unusual status of the public grid and automatically disconnects or reconnects the battery inverter. The grid feeding monitoring relay must be set up according to specific local grid requirements.

If the specific grid parameter measured by the grid feeding monitoring relay is non-compliant, a 24V signal is no longer provided to the inverter.

The grid feeding monitoring relay connects to the three phases (L1->L3) for voltage measurement and utilizes three current transformers for measuring the current flow in the grid. Current transformers should be mounted on the three grid phases entering from the main grid meter.

**IMPORTANT!**

The grid feeding monitoring relay must be installed to take measurements before any consumption, i.e. right after the main utility meter.

A diagram of the grid feeding monitoring relay installation is shown in Fig. 3.5.

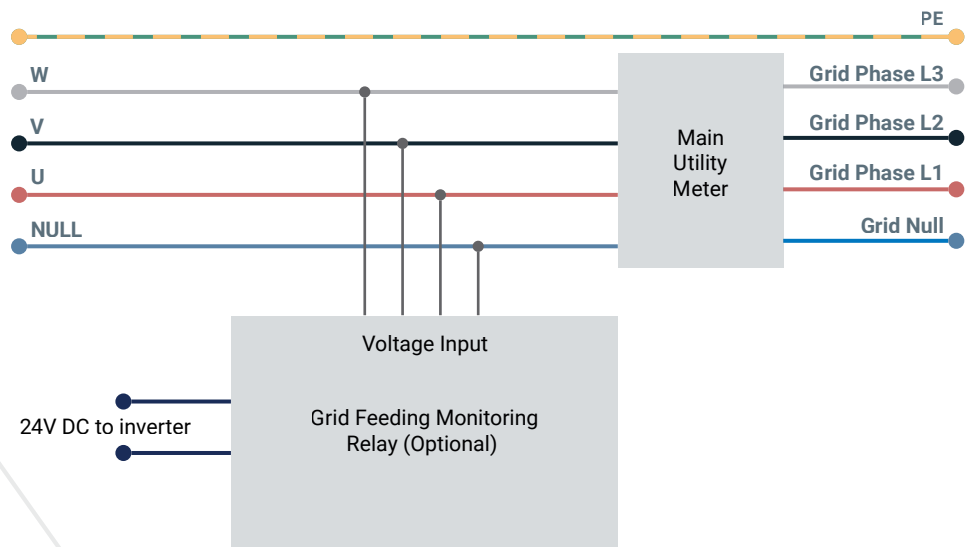
Depending on the manufacturer, the grid feeding monitoring relays may have different outputs for driving the enable/disable signal for the inverter. Some of them may require an intermediate small signal relay to handle the drive signal requirement.

The diagram of this only shows the principal connection diagram.

**NOTE!**

If grid feeding monitoring relay is not needed in the specific location, then 24 V DC from power supply should be permanently connected to the inverter terminal 13 (Fig. 3.6).

**Figure 3.5:**  
Diagram of grid feeding monitoring relay installation



The XOLTA BESS unit terminal connections (Fig. 3.6 and Fig. 3.7) are located at the bottom of the rack. Remove all five screws holding the lower front plate to access the unit terminal connections Fig. 3.7.

**Figure 3.6:**  
Illustration of the five screws holding the lower front plate



**Figure 3.7:**  
Illustration of the terminal functional layout





The detailed specification of the unit terminal functional layout is provided in Table 3.1.

**Table 3.1:**  
Terminal functional layout

TERMINAL	TERMINAL1	TERMINAL2	TERMINAL3
Function	Controller PE	Controller Null	Controller power
Voltage specification	PE	N: AC NULL	L: 240 VAC
Prefuse rating	-----	-----	Prefuse: Min: 2.5 A
Conductor cross section	1.5mm <sup>2</sup>	1.5mm <sup>2</sup>	1.5mm <sup>2</sup>

TERMINAL4	TERMINAL5	TERMINAL6	TERMINAL7
Inverter PE	Inverter power L1	Inverter power L2	Inverter power L3
PE	L1: 400 VAC	L2: 400 VAC	L3: 400 VAC
-----	Prefuse: Min: 45 A	Prefuse: Min: 45 A	Prefuse: Min: 45 A
16mm <sup>2</sup>	16mm <sup>2</sup>	16mm <sup>2</sup>	16mm <sup>2</sup>

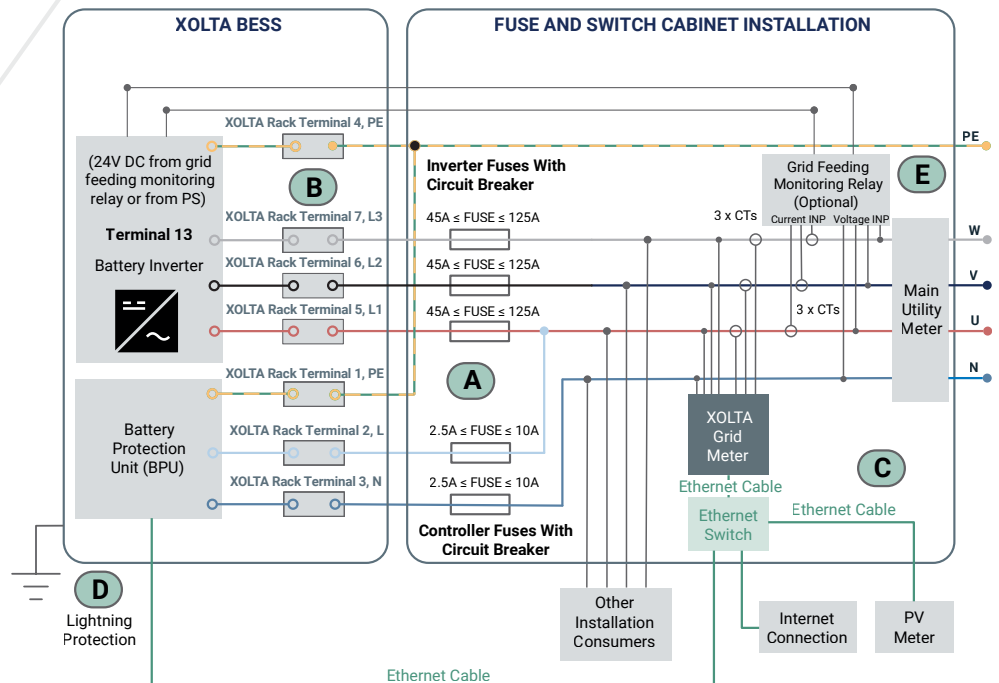
### 3.3.2.5 Fuse and switch cabinet installation diagram

The XOLTA outdoor BESS rack installation procedure can be divided into the following steps:

- A) Installation of the appropriate fuses with circuit breakers in the fuse and switch electrical cabinet;
- B) Connection of the cables to the unit terminal;
- C) Installation of the required power meters (e.g. grid meter, PV meter, etc.);
- D) Earthing of the battery rack (installation of the lightning protection);
- E) Installation of the grid feeding monitoring relay (optional and dependent on the local grid requirements);

All installation steps are visualized in Fig. 3.8.

**Figure 3.8:**  
Diagram of the fuse and switch cabinet installation



### 3.3.2.6 Power components minimum rating

**Table 3.2:**  
Power components minimum rating

COMPONENT	VOLTAGE RATING	POWER/CURRENT RATING
Protection contractor	3 X 400 VAC	>45 A
Protection contractor coil	1 x 240 VAC	<20 W
Protection contractor SW*	240 VAC	>2.5 A
Controller fuse*	240 VAC	>2.5 A
Inverter main SW*	3 X 400 VAC	>45A
Inverter fuses*	3 X 400 VAC	>45A

\*Alternatively, a combined Switch/Automatic fuse with corresponding rating can be used

### 3.3.2.7 Recommended cable cross sections

The cables connecting the switch and fuse cabinet to the XOLTA outdoor BESS unit rack must comply with the specifications in Table 3.3.

**Table 3.3:**  
Recommended cable cross sections

CABLE	USE	CABLE CROSS SECTION	VOLTAGE RATING
Controller power	L, N, PE to controller	3x1.5mm <sup>2</sup>	750 V
Inverter power	L1, L2, L3, PE to inverter	4x16mm <sup>2</sup>	750 V
Rack earthing	(lightning protection)	1x16mm <sup>2</sup>	Follow local regulations

### 3.3.2.8 Lightning protection

The XOLTA outdoor BESS is equipped with protective earthing (SAG 16mm<sup>2</sup> DIN Terminal where the earth wire must be connected). The XOLTA rack is internally grounded with 10mm<sup>2</sup> wire. The grounding resistance should follow local regulations.

## 3.4 System operation

The XOLTA outdoor BESS is intended to be operated from the XOLTA Cloud or via the Web API. System operation is described in Chapter 5. Different operation modes and operation states of the XOLTA system are described in Chapter 4.

Additionally, the operational state can be monitored by means of multicolored LED indicators that are located at the top. The color codes of the LED indicators provide information about current operational state of the XOLTA outdoor BESS. Details are provided in Table 3.4.

## 3.5 Maintenance requirements

### WARNING:

Even a de-energized XOLTA outdoor BESS can cause injury or even death if operated by unauthorized persons.

All maintenance must therefore be undertaken only by authorized personnel.

The XOLTA outdoor BESS was designed to require very little maintenance. Nevertheless, the following maintenance is required to ensure smooth operation and longevity:

- The BESS converter must be maintained by checking for dust and cleaning when needed;
- For the XOLTA outdoor BESS, it is recommended that the following be undertaken every two years:
  - check whether all fans are functioning correctly;
  - visually inspect the condition of the power and communication cables, e.g. damage, dirt and dust, loose connections, missing labels;
  - visually check for the presence of any kind of leakage from the system;
  - measure the system grounding resistance;
  - check the tightness of the electrical and mechanical connections.

All system maintenance must be undertaken only by an authorized XOLTA technician.

Any abnormalities during system operation should be reported to XOLTA support. Spare parts should be ordered from XOLTA support.

**Table 3.4:**  
Explanation of the LED indicator color codes

LED COLOR CODE	OPERATION STATE	PCS STATE	BPU DC RELAYS STATE
No color	System is powered OFF	OFF	OFF
Blinking orange	System in INITIALISATION or START-UP or SHUTDOWN sequence	ON/OFF	ON/OFF
Solid orange	System is in SLEEP state	OFF	ON
Blinking green	System is in transitioning from SLEEP to RUN state	ON	ON
Solid green	System is in RUN state	ON	ON
Blinking blue	System is in RUN state and is discharging	ON	ON
Blinking purple	System is in RUN state and CHARGING	ON	ON
Solid red	System is in ERROR state	OFF	OFF

## 4 XOLTA BATTERY SYSTEM FUNCTIONALITY:

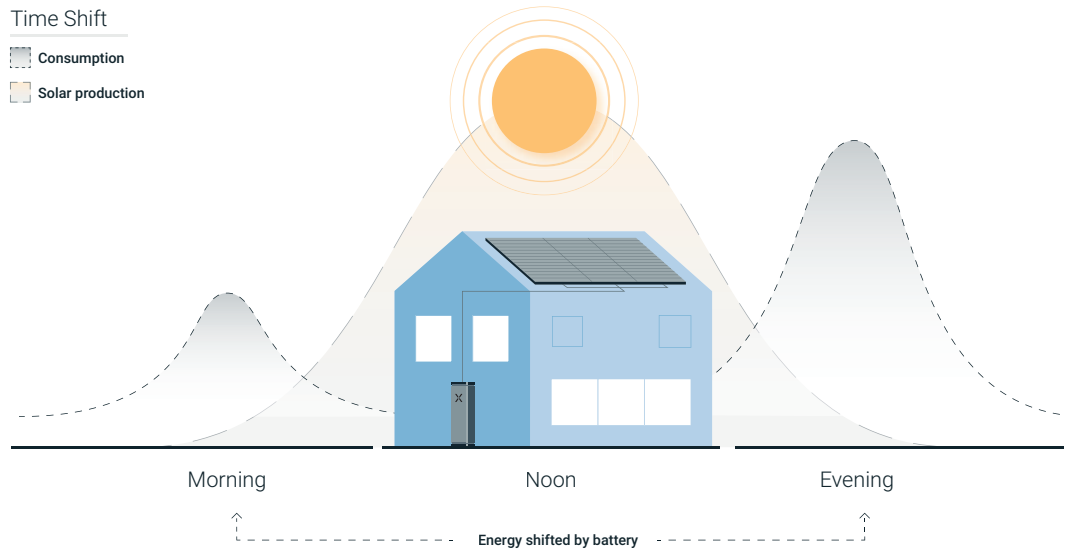
### 4.1 Operating modes

The XOLTA outdoor BESS currently offers the following operating modes in order to fit different users' needs.

#### 4.1.1 Maximizing solar self-consumption

Maximizing self-consumption mode is the default operational mode of the XOLTA outdoor BESS. It is designed to maximize the use of renewable energy, such as solar energy. As the generation of power from solar energy often occurs at times of the day when residential households have low consumption needs, the XOLTA outdoor BESS will store the excess solar energy during the day and release it when user consumption exceeds the production of renewable energy production, as shown in Figure 4.1. In the maximizing self-consumption mode, the battery will charge when there is excess solar energy (solar production is higher than the demand) and discharge when the demand is higher than the solar production

**Figure 4.1:**  
Illustration of maximizing self-consumption mode functionality in the most optimal situation



#### 4.1.2 External control

The XOLTA outdoor BESS is able to react to power setpoints received from external systems. An interface (web API) is provided which allows the user to decide the active power (P) and reactive power (Q) controlling the battery system charge or discharge accordingly. This mode is ideal for users who would like to develop their own control algorithm. It is also used for an installation functional check when a XOLTA technician is doing on-site commissioning. There are two different formats of external control:

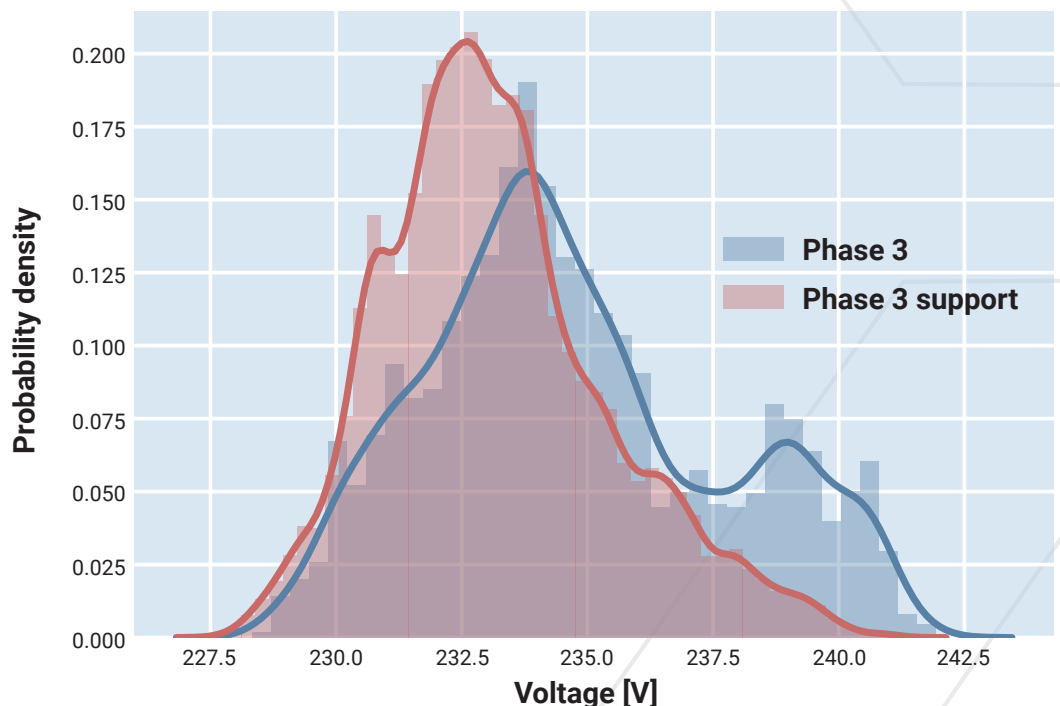
- Single setpoint: System will work upon the single setpoint. The input can only be one value at a time.
- Schedule: System will work on a time schedule. It can be one value or a list of values.

The limitation of P-setpoints is constrained by the maximum apparent input/output power of the inverter and the local grid capacity. Q-setpoints are limited by the power factor and the P measurement. Positive P and Q-setpoint stand for charging and negative for discharging. A detailed XOLTA cloud API instruction can be provided on request.

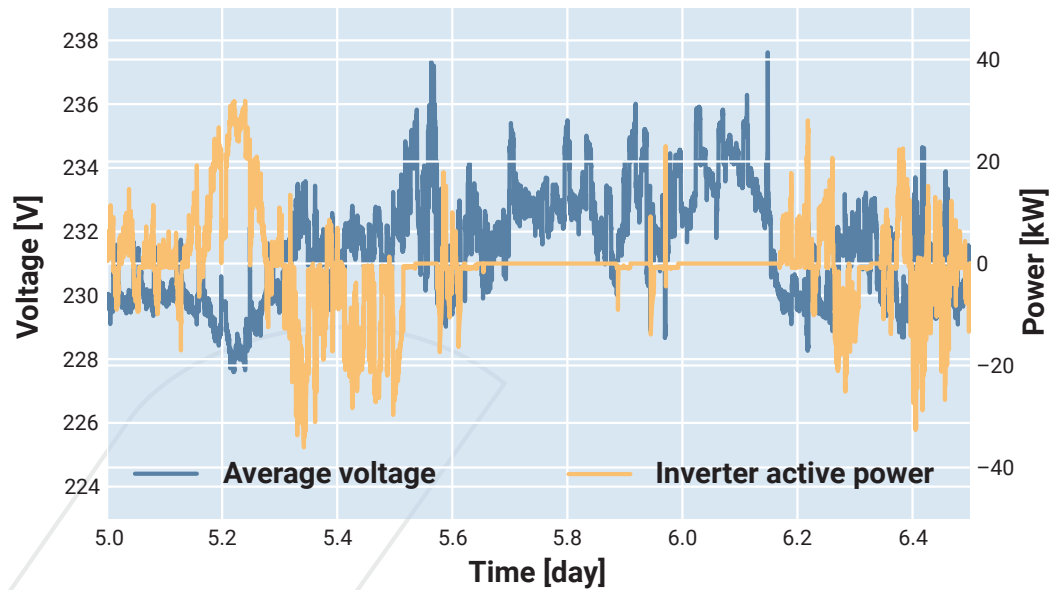
#### 4.1.3 Grid voltage support

Grid voltage support is an operational mode intended to align with the distribution system operator's (DSO's) requirements. Depending on the grid situation, the XOLTA System can offer different control mechanisms to minimize the local grid voltage variations and meet the DSO requirements, as shown in Figure 4.2 and 4.3.

**Figure 4.2:**  
Exemplification of the grid voltage distribution with and without grid voltage support mode



**Figure 4.3:**  
Grid voltage variations and XOLTA outdoor BESS active power output operating in the grid voltage support mode



#### 4.1.4 Load following

Load following is an operational mode used to support a microgrid. The XOLTA system tracks the microgrid consumption in real time and provides power when needed.

## 4.2 Site controller state machine

The XOLTA Energy Storage System (ESS) Site Controller (SC) is a finite-state machine with three distinct states;

- SLEEP (idle)
- RUN (active)
- ERROR

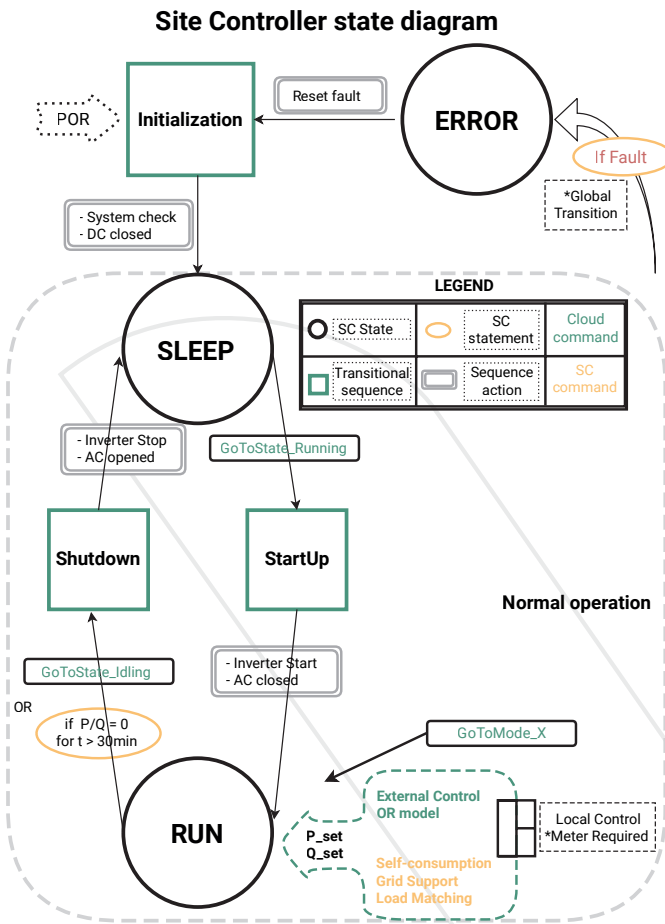
Transitions from one state to the other occur through intermediate sequential procedures. The SC state diagram can be found in Figure 4.5 and a short description of the states and transitional procedures is provided in sections 4.2.1 and 4.2.2.

### 4.2.1 SC States

#### 4.2.1.1 Sleep state

The system is idling; it is only monitoring and transmitting battery vitals and waiting for a request to activate. In this state the DC contactor of the battery is open. The inverter is inactive (IGBTs off) with both the AC and DC contactors open. For a period of system inactivity of more than 30 mins, the BMS is disabled and turned off in order to further reduce energy losses. Upon a state change request, the system is able to be active and ready to receive and inject power within a few seconds. The detailed state diagram of the XOLTA outdoor BESS is presented in Figure 4.5.

**Figure 4.4:**  
XOLTA system  
state diagram



#### 4.2.1.2 Run state

The run state is the operational state of the XOLTA outdoor BESS. In this state, it is able to receive and inject power from and to the batteries according to the associated algorithms defined by the user's chosen mode (Section 4.1). If there is no charge/discharge request, the inverter will immediately switch to standby. When standby is enabled, the IGBTs stop switching while both the AC and DC contactors remain closed (inverter remains connected to the network and inverter voltage level is the same as DC voltage).

If the system is left inactive (inverter P,Q = 0) for a longer period (30 min), then it will automatically transition to the sleep state.

#### 4.2.1.3 Error state

If a fault is detected, the system will immediately switch to the error state. A series of actions will then occur:

- Immediate shutdown of inverter, DC and AC contactors open
- BMS is disabled, DC relay open
- Report error to the XOLTA cloud

If the fault can be resolved internally, then the system will return to the state it was in when the error was diagnosed and carry on the task it was previously executing.

## 4.2.2 Transitional Sequences

### 4.2.2.1 Initialization

Accessible from POR (Power-on Reset) or from the error state in the event of a fault reset as shown in Figure 4.8. During this sequence the following occurs:

- Check of all communication lines of ESS, internal (serial busses) and external (cloud)
- Status check of all devices
- In case of error, reset the device showing the error
- Activate BMS

Once the sequence is complete, the system automatically transitions to the Sleep state.

### 4.2.2.2 Startup

Accessible from sleep state and transitions the system to the run state. During this sequence, the following occurs:

- Inverter is activated
- BESS DC contactors close
- AC and DC contactors of inverter close

### 4.2.2.3 Shutdown

Accessible from the run state and transitions the system to the sleep state. During this sequence the following occurs:

- Inverter is de-activated
- AC and DC contactors of inverter opened

## 4.3 XOLTA outdoor BESS monitoring

To monitor your battery, you need to register for the XOLTA Web App and register your battery. Go to [app.xolta.com](https://app.xolta.com). For the best experience we recommend using the Google Chrome browser.

For larger installations, an API is available. See the next chapter for details.

## 5 WEB API:

### 5.1 Web API

It is possible to receive BESS telemetry data and control a device directly by using the XOLTA cloud API. Please contact [support@xolta.com](mailto:support@xolta.com) for further information and to get API access.

The API gives the possibility to send commands to the device and acquires real-time and historical telemetry data of the site. The telemetry data is currently available in four different granularities: every 10 seconds, every minute, every 10 minutes and every 60 minutes. The 10-second option gives real-time data, however it will be sent as 1-minute packages each with 6 values inside. The other options give average values which aggregate all the data points of the 10 second data.

The table below provides a list of telemetry signals that are available to query over the API.

**Table 5.1:**  
List of tele-  
metry signals

NAME	UNIT	DESCRIPTION
Bms Cell Temperature	oC	Cell temperature across all racks
Bms Cell Voltage	V	Cell voltage in the racks
State of charge	%	State of charge of the device trimmed between 0 and 100
Bms Air Inlet Temperature	oC	Temperature of the cooling inlet air across all racks
Bms Shunt Temperature	oC	Temperature of the shunt sensor inside the BPU across all racks
Inverter Active Power	kW	Active power of the inverter
Inverter Reactive Power	kW	Reactive power of the inverter
Meter Consumption*	kW	Active power consumed by load and auxiliaries on the site (e.g. cooling, BPU, etc.) and measured by a meter
Meter Grid*	kW	Active power injected into/taken from the grid at PCC and measured by a meter. It includes net power (injected into/ taken from the grid)
Meter Pv*	kW	Active power produced by the PV system and measured by a meter

\*Metered values are only provided if the meter is operated by XOLTA

