

# Substation BESS Bonaduz

## Technical Specification

### MV/LV prefabricated Substation (MEHO)

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# 1 Introduction

This specification defines the minimum requirements for the design, manufacture, testing, delivery and commissioning of a MV/LV prefabricated Substation containing MV and LV Switchgear, Auxiliary Transformers, Control and Protection cabinets (incl. SCADA or RTU) for the UW BESS Bonaduz project.

The MEHO eHouse use materials and surface protection for the construction and systems which withstand the detrimental effects of the environment, without degradation or unintended change of visual appearance, for at least the specified lifetime of the construction and system.

## 1.1 Copyright

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## 1.2 Acronyms

Term	Definition
AC (ac)	Alternating Current
CB	Circuit Breaker
DC (dc)	Direct Current
DCS	Distributed Control System
EN	European Normalized Standard
GA	General Arrangement (drawing)
IEC	International Electrotechnical Commission
ISO	International Standards Organization
ITP	Inspection and Test Plan
LED	Light Emitting Diode
MV	Medium Voltage (1kV to 36kV)
RAL	Germany based color standard
RTU	Remote Terminal Unit
SLD	Single Line Diagram
TBA	To be Announced
TBC	To be Confirmed

## 2 Scope

### 2.1 Scope of supply

The scope of supply includes the design, manufacture, testing at factory\* (covers only general inspection of MEHO building, not the electrical equipment which will be done at site), delivery to site, assembly and installation, and commissioning of all internal wiring and equipment.

(\*) The cost of possible visitors is excluded.

The scope of supply also includes:

- The Substation enclosure
- Enclosure auxiliaries (Ventilation, Heating, Lighting, Sub-distribution, Fire detection/Fire alarm, etc.)
- MV Switchgear (33 kV)
- MV/LV Auxiliary Transformers (1x1600kVA, 33/0.4 kV)
- LV Switchgear (AC and DC Distribution Panels)
- Control and Protection cabinets (covering the HV, MV and LV protection zones)
- SCADA-HMI / RTU for signal exchange, monitoring and control purposes
- All devices that are needed for the pre-assembly, erection, operation, maintenance and repair of the delivered system, such as:
  - Standard accessories
  - Auxiliary equipment
  - Special tools (including the calibration of measuring devices)
  - Equipment needed for safety
- All above mentioned components are to be installed onto a unique foundation or support frame and assembled in compact execution
- All the parts to be installed in concrete foundation (anchor bolts, etc.) shall be specified in a timely manner and shall be supplied according to the agreed time schedule

The MV/LV prefabricated Substation have been offered for two possible configurations:

#### 2.1.1 Configuration (prefabricated Substation for 1x HV incomer)

The prefabricated MV/LV Substation will be placed and connected between Power Transformer 1x 60MVA, 54.5/33 kV and the customer's BESS (Battery Energy Storage System).

### 2.2 Scope of Services

- Engineering (Base and Detail design engineering)
- Procurement of long lead items (upon approval of base design)
- Manufacturing (upon approval of detail design)
- Mounting, fixing, and installation of equipment into/onto building structures. This includes the supply and installation of all fixing materials
- Quality Control and Quality Assurance

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- Factory Acceptance Test at the factory
- Packing, Transport and Unloading (Delivery to Site)
- Site Installation
- Site Commissioning

## 2.3 Exclusions

- Civil works
- Steel structure
- External cabling supply, installation and termination.
- Supply and installation of cable terminations incl. cable glands inside of enclosure
- Fire sealing of cable opening at the bottom of the eHouse

# 3 Applicable standards

Ensure compliance of the specified equipment and works with the latest revisions of the below listed codes, standards and regulations and any referenced sources therein:

## 3.1.1 EU Directives

This specification shall be applied in accordance with the EU Directives listed in the table below:

*Table 1: Applicable EU Directives*

Directive No.	Directive Title
2014/35/EU	Low Voltage Directive
2014/30/EU	Electromagnetic Compatibility Directive
2006/42/EC	Machinery Directive
2002/95/EC	RoHS Directive
2002/96/EC	WEEE Directive

All equipment and installations are required to comply with the latest editions of the relevant Statutory Instruments. All equipment shall also comply with the provisions of all relevant directives of the European Union (EU). In order to confirm compliance, all equipment shall carry the “CE mark” in accordance with directive 93/465/EEC, where required by the applicable EU directive(s).

## 3.1.2 Codes and Standards

This specification shall be applied in accordance with the internationally recognized codes and standards listed in the table below.

MEHO e-house building is designed according to Finnish Decree of the Ministry of the Environment on the Energy.

*Table 2: Applicable Codes and Standards*

Standard No.	Standard Title
IEC 60364	Electrical Installations for Buildings

IEC 61936-1	Power installations exceeding 1 kV AC and 1.5 kV DC – Part 1: AC
IEC 61000-6-2	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments
IEC 61000-6-3	Electromagnetic compatibility (EMC). Part 6-3: Generic standards – Emission standards for residential, commercial and light-industrial environments
EN 62271-1	High-voltage switchgear and controlgear - Part 1: Common provisions
EN 62271-102	High-voltage switchgear and controlgear – Part 102: AC disconnectors and earthing switches
EN 62271-103	High-voltage switchgear and controlgear - Part 103: Switches for rated voltages above 1 kV up to and including 52 kV
EN 62271-105	High-voltage switchgear and controlgear - Part 105: AC switch-fuse combinations for rated voltages above 1 kV up to and including 52 kV
EN 62271-200	High-voltage switchgear and controlgear - Part 200: Metal-enclosed AC switchgear for rated voltages above 1 kV up to and including 52 kV
EN 62271-213	High-voltage switchgear and controlgear - Part 213: Voltage detecting and indicating systems
EN 60282-1	High-voltage fuses - Part 1: Current-limiting fuses
EN 60255-26	Measuring relays and protective devices - Part 26: Requirements for electromagnetic compatibility
EN 60255-27	Measuring relays and protective devices - Part 27: Product safety requirements
EN 61869	Instrument Transformer
EN 50522	Earthing of power installations exceeding 1 kV AC
EN 50110-1	Operation of electrical installations Part 1 and Part 2
EN 60076-1	Power transformers - Part 1: General
EN 60076-2	Power transformers - Part 2: Overtemperatures for liquid-filled transformers
EN 60076-3	Power transformers - Part 3: Insulation levels, voltage tests and external clearances in air
EN 60076-4	Power transformers - Part 4: Guide to lightning and switching impulse voltage testing of power transformers and reactors
EN 60076-5	Power transformers. Part 5: Short-circuit strength
EN 60076-10	Power transformers - Part 10: Determination of noise levels
EN 50588-1	Medium power transformers 50 Hz, with a maximum voltage for equipment not exceeding 36 kV - Part 1: General requirements
EN 61439	Low Voltage Switchgear assembly
EN 505261	Effects on structures
EN 50522	Earthing of high-voltage systems with nominal alternating voltages above 1 kV
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 61666	Identification of terminals within a system

IEC 60445	Basic and safety principles for man-machine interface, marking and identification – Identification of conductors by colors or numerals
EN 13501-1	Fire classification of construction products and building elements
Building Codes	<ul style="list-style-type: none"> <li>➤ Euro Codes</li> <li>➤ Finish National Annexes</li> <li>➤ SFS-EN 1990</li> <li>➤ SFS-EN 1991</li> <li>➤ SFS-EN 1993</li> </ul>

### 3.1.3 Building protective actions

- Building fulfills consequences classes CC2, medium consequences due to loss of human life or considerable economic, social or environmental consequences.
- Exterior environmental withstand cl. C3 ISO 12944-2 / 5
- Interior environmental withstand cl. C2 ISO 12944-2 / 5
- Fire resistance: EI 90 (I <-->0), A2-s1, d0, EN 13501-1/-2
- Loads and load combinations are according to SFS-EN 1991-1-1, SFS-EN 1991-1-3 and SFS-EN 1991-1-4. The structure can withstand the equipment weight included in the offer and a live load of 2,5 kN/m<sup>2</sup> on the floor. If client is placing equipment into the building, the capacity of the structure has to be verified by Hitachi Energy.

### 3.1.4 Precedence of Directives, Codes, Standards and Specifications

In the event of deviations or conflicts arising between specifications, directives, codes and standards, and where there is no firm definition by this Specification, then the most stringent formulation of the above shall be applied.

## 4 Technical requirements

### 4.1 Project specific setup

The customer's BESS (Battery Energy Storage System) will be connected to the existing 60kV Network of the Swiss utility via a MV/LV prefabricated Substation, a Power Transformer and PASS (HV Hybrid Switchgear).

The prefabricated Substation will also supply with AC and DC power to the Substation auxiliaries. Hitachi Energy reserve it's right to revise the offer upon availability of BESS information which may affect either partially or substantially the offered design basis in this specification.

#### 4.1.1 Technical Information

The MV/LV prefabricated Substation shall be designed to function correctly in the electrical system shown in the document "Single Line Diagram".

The prefabricated Substation is a factory built MEHO ehous-solution for MV switchgear and control equipment. The MEHO ehous can be built as single lift unit or from modules that are completely furnished in a controlled factory environment. This shortens the project delivery time, and the control building is easily installed on site, which saves time and costs while also reducing installation faults.

The control panels, MV switchgear, DC system and AC-distribution panels are pretested at the factory and installed in the ehous. Main part of process cabling can also be completed at the factory and tested.

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#### 4.1.2 Ambient conditions

Unless otherwise specified in the “Technical Schedule”, the electrical cabinets and enclosures shall withstand all foreseeable environmental conditions.

- Maximum ambient temperature: +40°C
- Maximum daily average ambient temperature: +30°C
- Annual average ambient temperature: +20°C
- Minimum ambient temperature: -25°C
- Maximum relative humidity 95%
- Altitude 1000 meters above sea level

#### 4.1.3 Environmental Loads

Unless, otherwise specified in the “Technical Schedule”, the design shall consider:

- Fundamental value of the basic wind velocity  $v_{b,0}$  to be 21 m/s.
- Terrain category of 1 and height of building ~5,0m.
- Wind load of 0,7 kN/m<sup>2</sup>.
- Snow load to be 3,5 kN/m<sup>2</sup> on ground (2,8 kN/m<sup>2</sup> on roof)

#### 4.1.4 Design life and availability

The Design working life is 50 years.

The structures, used materials, corrosion classes and colors are shown in the provided supportive documents attached to the Hitachi Energy Firm Offer.

#### 4.1.5 Delivery

The prefabricated Substation shall be fully assembled before delivery.

## 5 Design requirements

### 5.1 General Design

The MV/LV prefabricated Substation:

- Must be designed for continuous operation, designed to ensure satisfactory operation under all climatic and atmospheric conditions prevailing at site
- Must be fabricated such that the framework is sufficiently rigid and stable to withstand all normal operating, handling and shipping forces without deformation, misalignment or damage
- Shall be a self-supporting construction
- Shall have watertight protection
- Shall be made of sandwich panels type mineral wool insulation
- Shall have internal cable routing, pulling and termination from the top of the panels
- Must be weatherproof housing ready for placing into position upon a concrete base

- Must ensure that in no part of the equipment, including busbars, connection, isolators, fuses, contacts, cable boxes and trunkings and connections must the temperature rise exceed the values specified in the relevant IEC/EN norms and standard.

## 5.2 Painting

Outside colour shall be single-colour RAL, MEHO standard.

Inside colour for compartments shall be RAL9010 (White)

## 5.3 Noise and vibration

Acoustic noise insulation, see the section "Walls, doors, roof and floor construction".

No Vibration requirements.

## 5.4 Corrosion protection

Minimum corrosion protection:

- Corrosion protection of all steel components must be in accordance with ISO 12944, Part 1-8.
- Sandwich panel (roof and walls) corrosion class C3 (outside) / C2 (Inside).
- Structural steel framework C3-M.

# 6 Construction requirements

## 6.1 General description

The e-house (MEHO) is a factory built and pretested substation e-house building for MV switchgear and control equipment. The building is the whole building module or of modular construction by using standard modules. A suitable size of the building can be achieved by putting the modules together.

Assembling of the building on site is simple; the modules will be bolted together and building electricity cabling are made by plug connector from module to module. The control panels, MV switchgear, DC-system and AC-distribution panels are pretested at the factory and installed in the building. Main part of process cabling can also be completed at the factory and tested.

- The prefabricated Substation must be built for heavy duty industrial environment, and the structure must be suitable for outdoor use
- The prefabricated Substation shall be self-supporting and suitable for mounting on concrete pillars or on the steel support structure or concrete slab.
- The compartments and doors must provide space and clearances specified by applicable regulations (e.g. clearance required for the HV-incomer, MV equipment)
- The doors shall be arranged in a way that personnel have a means of egress regardless of equipment fault or fire location
- Provide front accessible equipment and make sure all maintenance work can be carried out from the front
- All equipment shall be installed and removed from the e-house doors and openings foreseen
- All power-, signal-, control- and communication cables from external parties must enter/leave the e-house through the bottom or through the wall.

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## 6.2 Dimensions

The Substation and equipment dimensions are specified in the “Technical schedule”, which is part of this specification. Dimensions also in e-house drawing and equipment layout drawings.

## 6.3 Frame construction

The frame is made by welded tubular profile beams with optimal dimensions for each single part of the construction. The transport modules can be lifted to foundation by using lifting beam.

## 6.4 Lifting lugs

The e-house transport modules are lifted onto the foundation using a crane truck. The building is attached at and lifted in four or six points. The number and location of the lifting lugs can be found in the project specific lifting drawing. Detailed instructions for lifting will be found in the project specific lifting plan part of the site construction documentation package.

## 6.5 Base frame

The base frame is made by welded tubular profile beams with optimal dimensions for each single part of the construction.

## 6.6 Internal Cable raceway

For all cabling, appropriate cable ducts, ladders or wire mesh cable trays must be installed.

All cables must be regularly fixed with appropriate cables ties or cable cleats designed to withstand the expected short circuit conditions.

Comply with the relevant and applicable norms and standards related to cable separation, EMC, earthing, etc.

## 6.7 Walls, doors and floor construction

### 6.7.1 Walls

Sandwich panels type mineral wool core.

The wall module type is 150 mm thick wall sandwich panel with mineral core and covered from both sides with zinc coated 0,5 mm profiled steel sheets. Panel protective coating is Polyester gloss, 25µm).

Insulating power  $U=0,26W/m^2K$ . Outside color standard RAL 7035 (light grey). Inside color standard RAL 9010 (white). Surface class: both sides A2-s1,d0. Corrosion class C3/C2.

The wall and ceiling points shall be sealed with sealing compound.

The wall module type is 150 mm thick wall sandwich panel with mineral core and covered from both sides with zinc coated 0,5 mm/0,4mm profiled steel sheets.

### 6.7.2 Floors

Floor material is 15 mm high quality plastic coated flooring plywood panel, color standard RAL 7010 (gray). The floors are insulated with 150 mm thick mineral wool placed on plywood boards (12mm) fixed to the lower frame beams of the building. Insulating power  $U=0,24W/m^2K$ . Surface class D-s2, d1.

Floor material is 15 mm high quality plastic coated flooring plywood panel. The floors are insulated with 150 mm thick mineral wool placed on plywood boards (12mm) fixed to the lower frame beams of the building.

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Penetrations through the e-house roof are not allowed.

The structure must withstand the planned equipment weights. At least a tension of 2.5 kN/m<sup>2</sup> applied to the floor.

The space between the cross beams shall be insulated by rock wool. Underneath the cross beams there shall be a layer of fibre cement plates if required to achieve the fire rating.

Fire resistance rating	REI30
Insulating power	Roof U=0,2
U [W/m <sup>2</sup> K]	Wall U=0,26 Floor U=0,24 (not for trafo room)
Sound reduction index for door	Rw 20

## 6.8 Doors

### 6.8.1 General

The building has usually one or two doors. Each door is equipped with door closer and emergency crossbar. The doors are made for outdoor use made from painted steel profiles. Door plate 1mm steel, powder coating 100µm, inside rock wool. Outside color standard RAL 7035 (light grey). The dimensions of the door are 1000x2100mm or 1200x2500mm. Sound reduction index Rw 20. Insulating power U=1.4W/m<sup>2</sup>K.

- The door shall be manufactured with the same (or higher) specification as the walls and ceiling with the exception that the steel material shall be a minimum of 1mm thick
- The door frame shall be recessed with a rubber seal in the recess
- Stable welded door hinges, surrounding seal and rebate
- Doors must open to the outside
- Doorstop to keep the door in open position

### 6.8.2 Standard compartment doors

Requirements for standard compartment doors:

- Two egress doors opposite located, if the e-house length is according to IEC >20m.
- Door close type ABLOY LE184 or equal
- Individually lockable
- Door lock fitted with an anti-panic bar

### 6.8.3 Transformer compartment doors

The transformer compartment must have an external access double-wing door (standard key access)

The removable wood plank (with yellow/black stripes) allow visual inspections during operation (without opening the MV and/or LV breakers).

### 6.8.4 Door sizes

Doors must be sized for replacement of interior installed equipment (e.g. individual largest switchgear cubicle) without removal of wall or roof.

Suggested door sizes (subject to the detail design):

Dimensions (opening)		
Standard compartment door (for switchgear, MCC, etc.)	Height	2500mm
	Width	1200mm
Double wing door for big transformer	Height	2500 mm
	Width	1200+600mm

## 6.9 Roof

The roof module type is 200 mm thick wall sandwich panel with mineral core and covered from both sides with zinc coated 0,5 mm profiled steel sheets. Panel protective coating is Polyester gloss, 25µm).

Insulating power  $U=0,20W/m^2K$ . Outside color standard RAL 7016, (Anthracite gray). Inside color standard RAL 9010 (white). Surface class: external Broof / internal A2-s1,d0 . Corrosion class C3/C2.

The roof with a smooth slope is designed for a distributed load of 2.8 kN/m<sup>2</sup>.

The roof module type is 200 mm thick wall sandwich panel with mineral core and covered from both sides with zinc coated 0,5 mm profiled steel sheets.

At least Four (4) pieces lifting lugs are foreseen on top of the e-house for crane attachment. Centre of gravity and rope lengths shall be documented in the installation and operation manual.

## 6.10 Cable entry

The prefabricated Substation shall be designed for bottom cable entry or wall entry if needed.

The cable entry points shall be specified during detail engineering. After cabling all cable entries must be done according to fire rated.

## 6.11 Medium Voltage compartment

The Medium Voltage Switchgear room should be separated and depend on Switchgear model the arc duct design shall be included.

## 6.12 Transformer compartment

The transformer compartment must be separated from the switchgear compartment by wall.

Separate extraction rails shall be provided for the support and installation/removal of the transformer completely outside the container. The guide rails shall be designed and approved in collaboration and accountability of the transformer supplier.

The transformer compartment must be designed to provide the transformer with sufficient airflow volume through adequately sized ventilation openings.

The air inlets shall be equipped with mechanically adjustable louvers with weather protection grills.

## 6.13 Fire

The Prefabricated e-house shall be designed to prevent the propagation of fire from either external sources (e.g. outdoor power transformers) or from internal equipment faults and shall and the Prefabricated e-house envelope shall have a minimum of a 30 minute fire rating.

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All construction materials including insulation shall be non-combustible and according to standards and regulations at the installation place. Side walls, doors, roof and bottom floor shall be thermally insulated and fire protected.

Fire class is P3, Fire hazard class 1, Security level class 1 according to Finnish Decree of the Ministry of the Environment on the Energy.

The building is considered as one fire space/zone including a cable space under the floor. There is no fire separation between different parts of the building or outwards or inwards of the building. Fire with-standing class is 0 minutes.

Separated transformer room is made of non-combustible materials. Transformer must be fire behavior class F1.

The building is considered as semi warm according to the Finnish Ministry of the Environment on the Energy.

Design and manufacture of steel structure CE-approved.

MEHO e-house building electrical installations for building installation are made by based of IEC 60364

Electrical Installations for Buildings and Finnish national annexes SFS 6000.

High voltage installation is made by based of IEC 61936-1 Power installations exceeding 1 kV AC and 1,5 kV DC - Part 1: AC and EN 50522 - Earthing of power installations exceeding 1 kV a.c. High voltage

installation and earthing is also Finnish national annexes SFS 6001.

Operation of electrical installations EN 50110-1 Part 1 and Part 2. Finnish national annexes SFS 6002.

## 6.14 Rainwater system

Rainwater gutters and downpipe are made of steel sheets coating Pural RWS. Color standard RAL 7024/ RR23 (graphite gray). Corrosion class C3.

Guttering and down pipes shall be fitted external to the prefabricated building. No internal downpipes are permitted.

## 6.15 Cooling and heating

AC air source heat pumps units provide the air condition in the room. The AC is mounted inside the room; for E-house which has big heat losses. Cooling is implemented by cooling of Hitachi Energy equipment if otherwise defined.

The ambient temperature in the MEHO building electrical equipment room is kept between +10...25°C (24h average max. +27°C) and relative humidity below 50%. The main heating is implemented with air source heat pumps and back up by electrical radiant heaters.

Transformer room has not separated cooling system.

## 6.16 ACB distribution board

Distribution board for MEHO-building electricity will be engineered standard MEHO- ACB1 board and its part of substation AC board.

## 6.17 Fixings

All metal handles, hinges, screws and nuts must be of manufacturer's standard finish and suitably protected against corrosion. Externally fitted fixings must be hot dipped galvanized.

Cadmium plated fixings must not be used.

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## 6.18 Stairs

Exterior walkway, stairs with handrail and landing shall be provided for access to the e-house and associated cable basements.

## 6.19 Fittings and accessories

### 6.19.1 Rating plates

Each prefabricated substation must be fitted with e.g. a stainless steel/ factory standard rating plate with all information of the MV switchgear, transformers and LV switchgear as detailed in their respective specifications engraved/etched onto the rating plate.

The rating plate must be placed in a position that it is clearly visible from the front of the prefabricated substation.

### 6.19.2 Name plates

Each prefabricated substation must be fitted with label plates engraved plastic with all the information engraved/etched. Printed name plates will not be acceptable.

# 7 Electrical requirements

## 7.1 General

The main electrical equipment of the MV/LV prefabricated Substation is shown in the document “[Single Line Diagram](#)” and “[Protection Single Line Diagram](#)”. More detailed information shall be provided as part of the detail design engineering during Project execution.

General rules to be complied:

- DC shall not be used to supply power outlet sockets, lighting, fans, etc.
- All DC power fuse (MCBs, etc.) must transmit an alarm to the DCS

## 7.2 Earthing and Lightning protection

Internal earthing system and earthing of the equipment inside the e-house, is part of the delivery scope. All conductive components (i.e. metallic parts) within the e-house shall be connected to the equipotential bonding bar such as frames, support structures, all pipes and ducts, installed equipment, etc. in accordance with the relevant IEC/EN norms and standards.

Earthing / equipotential bonding interface:

- EB10 –earthing bar for all internal e-house connections
- MEB –bar for external connection e.g. MV cabling and main earthing grid

## 7.3 Sub-Distribution Panel

The e-house, must be provided with a power sub-distribution panel to supply all auxiliaries such as fans, sockets outlets, lighting, fire detection, fire alarm, etc.

The sub-distribution panel may have control equipment, e.g. required for ventilation, etc.

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## 7.4 Lighting

The prefabricated Substation shall be supplied with energy efficiency lighting devices (LED-lamps). The on/off switches are located alongside of the doors. The illuminance is at the range of 300-500 lux.

Power supply for the lighting is 230 VAC, 50 Hz. The on/off switches are located alongside of the doors. The illuminance is at least 300 lux as general lighting. In office table area illuminance is level at 500 lux. As EXIT light is used LED-lamps located every main door. The emergency light (LED-lamps) will be switched on automatically after AC voltage disappears.

Emergency light will be switched on automatically in case absence of AC voltage supply.

An on/off switch for all lights inside the e-house compartment shall be placed at each door on the latch side of the doorway.

### 7.4.1 Exit- and emergency lighting

There must be separated exit- and emergency lighting system. At least one (1) light in each compartment must have emergency backup batteries, close to the exit doors. The batteries must provide power for a minimum of 3h autonomy. For emergency lighting system 1h autonomy. System design by Standard: EN 1838 , EN 50171

### 7.4.2 Outside container

The light above each door outside the e-house, light shall have motion detector-, lux level- and time adjustment.

### 7.4.3 Socket outlets

At least two (2) power sockets (1PNE), type and voltage according to local standards, for >6A shall be installed below of each compartment-light switch.

## 7.5 Auxiliaries

### 7.5.1 Ventilation

The prefabricated Substation shall be provided with ventilation, as required to maintain internal operational temperatures (to be provided and confirmed by means of calculations).

Ventilation system is design to make regular air ventilation for MEHO e-house. This ventilation system is not for cooling purpose. The ventilation is implemented using a two-speed exhaust ventilation fan, if needed with thermostat to rise speed/ air condition double volume. Ventilation duct, fitting and air valves are ready installed and tested. Fresh air is let in through filtered ventilation openings on the wall.

Transformer room has natural ventilation and temperature controlled forced exhaust fan.

The design of the ventilation system shall consider limitations, and space constrains caused for instance by the structural design and the heat generated by the equipment housed inside the e-house. Ventilation ducts, fitting and air valves shall be ready installed and tested.

Responsible for design and supply a system taken into account the environmental conditions of the place of installation in order to maintain the required temperature range.

### 7.5.2 Limiting of arc faults

For buildings equipped with MV switchgear an arc pressure is vented directly out through the channels and opening arc vents at the walls of the switchgear room. The arc vents are directed upward. The dimensions of the vents are according to MV switchgear manufacture.

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### 7.5.3 Heating

Small wall mounted, electric heaters, should be supplied for simple low temperature protection. These heaters shall be controlled by a thermostat.

### 7.5.4 Temperature measurement

The air inside temperature of each compartment must be measured by a sensor providing 4...20 mA signal in loop, which must be used locally for control purposes and transmitted to the DCS.

### 7.5.5 Fire detection and alarm

The prefabricated Substation shall be equipped with fire detection system.

Fire detectors are used for fire detection. Detectors has AC-powered and backup long life battery. Detector system can connect to the alarm system or I/O Scada system.

The detection (optical) and alarm system shall be designed in a way the units can be tested regularly to demonstrate correct operation.

### 7.5.6 Security System

The e-house, burglar alarm monitoring shall be implemented with the outer door limit switch.

Door open information is cabled and can connect to the I/O Scada system. Signals cabling to the DCS.

### 7.5.7 Interface with RTU or SCADA

For the remote operating/monitoring from the substation control system, a communication interface for remote control and signal exchange purposes is foreseen.

## 7.6 Interlocks

All interlocks shall be fail-safe and hardwired. Interlocks shall be enforced in all modes of operation: local at the equipment, remote operation from the bay control panel and remote operation from the Substation control system.

Interlocks shall inhibit the "ready to close" or "ready to open" signal for remotely controlled switching which is to be sent to the control system. Interlocks signals shall be implemented as both a hardwired signal within the switchgear close permissive circuit and as a binary output input into the bay controller.

Interlocks shall be provided to prevent:

- Live circuits being connected to circuits which have been earthed and vice versa
- Equipment opening or closing under loads which exceed the rating e.g. disconnectors opening under load
- Incorrect switching sequence
- Any situation which might endanger personnel or damage equipment

## 7.7 Wiring

The internal wiring shall conform to IEC 60227. The units shall be delivered with all items of equipment fully wired. All wiring shall be methodically arranged and shall follow an orderly and tidy pattern, grouped in a logical manner according to circuits involved, and shall be adequately supported and protected from mechanical damage. Wiring shall be arranged so that access to terminals or other apparatus is not impeded.

All connections to equipment and to terminals shall be tight and shall be made off with suitable crimp type connections. Wire looms shall be neat and shall not impede access to terminals of equipment. Connections to devices must not be under strain. Where wiring is connected to moveable equipment, such as equipment on hinged panels or doors, the

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conductor shall be multi-strand flexible. Wiring runs shall be so arranged as to minimize pick-up of interference or spurious transients. Not more than two wires shall be connected to any one side of a screw terminal.

Internal wiring shall be connected to the equipment side of the terminal blocks except where looping is required on the external cable connection side of the terminal block to provide short-circuiting facilities for current transformer secondary circuits.

Internal wiring shall be identified with ferrule numbering.

## 7.8 Identification and Labelling

All electrical equipment forming part of the prefabricated substation must be readily identified by a label in accordance with the relevant standard and this specification.

All labels must be engraved/etched plastic.

All equipment labels must be mounted on a fixed portion of the enclosure directly adjacent to the device.

## 7.9 Safety

Design considerations:

- Escape routes and clearances within the e-house, in accordance IEC standards.

Equipment considerations:

- No flammable equipment may be installed and no flammable liquid inside the container
- Automatic fire alarm system
- Doors with panic locks to open from indoor
- Warning plates shall be placed
- Pressure discharge duct shall be provided for the MV switchgear.

# 8 Equipment requirements

The below refer to the minimum requirements of equipment housed inside the prefabricated Substation e-house.

## 8.1 MV Switchgear

The Medium Voltage Switchgear installed into the prefabricated Substation shall comply with the requirements of the technical schedule.

## 8.2 MV-LV Auxiliary Transformer

Auxiliary Transformer installed into the prefabricated Substation must be dry-type and shall comply with the requirements of the technical schedule.

## 8.3 LV Switchgear

The Low Voltage Switchgear installed into the prefabricated Substation shall comply with the requirements of the technical schedule.

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## 8.4 Control and Protection Panels

To ensure the reliable operation of the BESS, effective protection and control of the grid connection will be essential.

### 8.4.1 Protection principle (Preliminary)

The configuration and coordination of the protection scheme will be based by protection zones, in which the division of the protection zone is closely related to the configuration of the protection relay.

The types of electrical equipment in the protection zone are different, and the characteristics of electrical and non-electrical quantities after a fault are different; on the other hand, the coordination of adjacent protection zones varies with protection.

The below described Protection zones are preliminary and indicative only, and subject to adjustment upon availability of the Power System studies and Protection coordination results.

### 8.4.2 HV Incomer-Transformer protection zone

One (1) panel will be required, and the panel will be used for one Incomer + one Transformer, equipped with:

- 1x IED for the incomer feeder control & protection with below functions:
  - I/C Differential protection or Distance protection + Backup Protection
  - Measurements, Control and monitoring of HV equipment (CB, DS, ES, ... etc.).
- 1x IED for the Transformer feeder control and protection with below functions:
  - Transformer Diff. Prot. + Backup Protection + AVR.
  - Measurements, Control and monitoring of HV equipment (CB, DS, ES, ... etc.).

## 8.5 Interconnections

The prefabricated Substation must be fitted with interconnections (power and control) between MV Switchgear and Transformers, Transformers and LV Switchgear.

The power connections must be either cabling or busbar and must be sufficiently rated to the connected equipment's maximum current and fault rating.

All interconnections must be fully supported. Equipment terminals must not be used to support the interconnection cables or busbar.

## 8.6 MV and LV terminations

The base frame or support structure of the prefabricated substation must not interfere or impede the installation of the MV and LV cables.

The prefabricated substation must be installed with suitable cable clamps and adjustable frames to suit the MV and LV cables to be connected to the MV and LV switchgear.

# 9 Operational requirements

## 9.1 Operation Mode

The MV/LV prefabricated Substation shall be designed for full load operation, 24 hours a day, and be capable of bi-directional power flow and optimized for the direction of power flow in export mode operation as this will be the normal mode of operation of the BESS Bonaduz.

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Below data has been provided from the customer side during Tendering stage:

- Loading BESS = 7 x 8 MW + 1.6MVA (Aux. Power)
- Unloading BESS = 50 MVA (max. 2 hours)

## 9.2 Import Mode

Power to supply the equipment auxiliaries is imported from the High Voltage distribution network through the connecting transformer(s).

## 9.3 Export Mode

When the BESS (Battery Energy Storage System) is operational, the power is exported through the transformer connected to the HV distribution network.

# 10 Quality requirements

## 10.1 Quality Assurance and Factory Testing

### 10.1.1 Construction Quality Assurance

A quality system that complies with the requirements of ISO 9001 for all work on the prefabricated substation shall be implemented.

Two project-specific Inspection and Test Plans (ITPs) for the prefabricated substation will be submitted for review:

#### 10.1.1.1 Factory ITP

This document covers all activities i.e. engineering, design, supply, manufacture, factory assembly, factory testing, type testing, resolution of factory defects/punch lists, release for delivery, preparation for transport, etc. for the prefabricated substation and all associated equipment installed in the substation.

#### 10.1.2 Site ITP

This document covers all on-site activities i.e. delivery to site, unloading, installation, assembly, site testing, resolution of site defects/punch list, handover, etc.

#### 10.1.3 Factory Acceptance Testing

The factory acceptance testing shall be completed with the prefabricated Substation fully assembled, according to the in-service arrangement.

Detailed test procedure covering all the Factory Acceptance Tests along with connection diagrams, acceptance norms, reference standards and details of test instruments shall be submitted well in advance for approval by the purchaser.

The Factory Acceptance Test shall perform but not limited to the following tests:

- All tests applicable to the MV Switchgear as per the relevant IEC/EN norms and standards
- All tests applicable to the Auxiliary Transformer as per the relevant IEC/EN norms and standards
- All tests applicable to the LV Switchgear as per the relevant IEC/EN norms and standards
- All tests applicable to the Control and Protection cabinets as per the relevant IEC/EN norms and standards
- Detailed mechanical inspection

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- Detailed electrical inspection
- Review of routine test certificates for protection devices
- Review of manufacturing inspection and test documentation and records
- Review of manufacturing defect list / punch items

#### 10.1.3.1 Routine Tests

Routine tests must be performed at the manufacturers factory prior to shipment to site, including:

- a) Verification of correct wiring
- b) Dielectric test on the MV interconnection
- c) Test on auxiliary and control circuits
- d) Function tests

## 11 Site requirements

Site-ITP (Inspection Test Plan) covering installation, pre-commissioning checks and commissioning will be provided.

### 11.1 Transport

The prefabricated Substation shall be delivered with the packing applicable to the utilized shipment mode, and security elements. The impact recorders installed for transport shall remain fixed to the switchgear until the equipment is located in its final position.

### 11.2 Installation at Site

The requirements for the installation helpers (under Hitachi Energy Switzerland Ltd.) shall be specified as part of the offer, including the number of people needed, required qualifications and standard tools.

Sequence of installation as per:

- Unloading and unpacking (Customer to ensure soil bearing capacity)
- Mechanical alignment
- Anchoring and fixation

### 11.3 Commissioning at Site

#### 11.3.1 Cold Commissioning (before energization)

Equipment shall be energized according to manufacturer's recommendations, including but not limited to:

- Check all interface:
  - Check earthing connections
  - Check power supply connections
- Check if all terminals tight and all cable plugged-in correctly
- Check air inlet and outlet are not blocked

#### 11.3.2 Hot Commissioning (post energization)

The work must be according to manufacturer's commissioning manual, each system (e.g. thermostat setting, temperature measurement, etc.) must be checked.

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11.3.3 Site Acceptance Test (SAT)

The following tests shall be performed (no exhaustive) during the SAT:

- Mechanical operation test on Circuit Breaker
- Mechanical operation test on disconnectors and earthing switches
- Operating times and current absorption measurement on coils and motors
- Interlock functionality check
- Signals and alarm check
- Dielectric test of auxiliary circuit
- Main circuit electric resistance measurement

12 Service requirements

12.1 Maintainability

All components requiring regular maintenance, testing or inspection, shall be accessible.

In order to improve the maintainability, and availability of the power supply system, the design of the power supply shall be such that:

- Preventive maintenance of any equipment shall be undertaken without any impact on the availability of the installation
- The LCC is to be installed at an appropriate height and be accessible to maintenance personnel. All wiring and connections within the control cabinet are readable accessible for maintenance.

12.2 Lifetime

The switchgear and all associated equipment shall be designed for a minimum of 40 years operation.

12.3 Spare parts

12.3.1 Consumable spare parts

All consumable spare parts required for the transformers up to the end of the defect's liability period.

12.3.2 Routine maintenance spare parts

All consumables and spare parts for routine and scheduled maintenance up to end of the defect's liability period.

12.3.3 Long-term maintenance

A priced list of optional recommended spare parts for long-term maintenance activities and strategic planning, as well as any special tools required to perform long-term maintenance activities.

13 Revisions

Rev.	Page (P) Chapt. (C)	Description	Date Dept./Init.
A	-	First Issue	18.12.2024 / HJ
B		Second Issue	20.01.2025 / HJ

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Rev.	Page (P) Chapt. (C)	Description	Date Dept./Init.

14 Technical Schedules

14.1 Schedule A: System Parameters

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Item	Parameter	Network	Unit
1	Nominal voltage	50	kV
2	Highest network voltage	58.8	kV
3	Lowest network voltage	51.3	kV
4	Number of phases	3	-
5	Frequency	50	Hz
6	Neutral Treatment	Directly earthed at selected points	-
7	3-Phase short circuit (rms)	31.5	kA
8	Duration of short circuit	1	sec
9	3-Phase short circuit current (peak)	TBC	kA
10	HV Insulation levels:		
	• Lightning impulse (peak)	325	kV
	• Power frequency 1 min (rms)	145	kV
	MV Insulation levels:		
11	• Lightning impulse (peak)	140	kV
	• Power frequency 1 min (rms)	70	kV
	Fault levels (at Grid connection point):		
	• Ip (peak short circuit current)	-	-
	3-phase	TBD	kA
	1-phase	TBD	kA
	• I''k (initial symmetrical short circuit current)	-	-
	3-phase	TBD	kA
	1-phase	TBD	kA
	• X/R Ratio	-	-
	3-phase	TBD	kA
	1-phase	TBD	kA

## 14.2 Schedule B: E-house Technical Details

Item	Description	Unit	MEHO Design
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1	<b><u>Dimensions</u></b>		
	Length	-	TBA
	Width	-	TBA
	Height	-	TBA
2	<b><u>General</u></b>		
	Input AC MV cable entry	-	MV incomer cables from bottom of e-house
	Output AC & DC cable entry	-	Outgoing cables to consumers from bottom of e-house
	Auxiliary cable entry	-	Outgoing cables to consumers from bottom of e-house
3	<b><u>Environmental</u></b>		
	Application	-	Outdoor
	Ambient temperature range	°C	-30°C to +40°C
	Transformer room MV room		+10°C to +27°C (nominal +21°C)
4	Altitude	m	1000
5	Wind speed	m/s	21 m/s
6	Humidity	%	<90% (non-condensing)
7	Solar radiation	W/m2	1000

### 14.3 Schedule C: MV Switchgear Technical Details

#### Incomer PASS M00

Switchgear type:	SF6 – Wall mounting
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Version:	Fully equipped
Number of cubicles:	4
Rated voltage:	36 kV
Service voltage:	33 kV
Rated frequency:	50 Hz
Power frequency withstand voltage:	70 kV
Impulse withstand voltage (BIL)	170 kV
Condition of partial discharge test:	1.1Un/1.1Un/V3 = 100/10pC
Rated BB current:	2000 A
Rated short circuit current:	20 kA
Rated short circuit current duration:	..3s
Peak current:	50 kA
Internal arc classification (IAC):	20 kA 1s AFL
Electrical arc sensor:	No
Pressure relief:	Left side via pressure relief duct to the outside
Partition class:	PM
Loss of service continuity:	LSC2
Degree of protection for gas filled compartments:	IP65
Degree of protection – LV compartments:	IP3X
Operating pressure:	150 kPa
Insulation warning level:	140 kPa
Minimum functional level for insulation:	140 kPa
Tightness leakage rate:	< 0.1% p.a.
Sealed pressure system:	> 40 years
Seismic qualification:	Not applicable
Phase sequence:	L1, L2, L3 (Front to back, Left to right)
Ambient temperature:	.-5...40°C
Altitude:	<=1000 m
Installation conditions:	Indoor, clean and dry
Method of neutral point connection:	Solidly earthed neutral
Remote communication protocol:	IEC61850
Communication media:	Electrical

#### 14.4 Schedule D: Auxiliary Transformer Technical Details

Pos	Item	Qty
01	Transformer characteristics / electrical data and accessories	1 pcs

	<p>Hitachi Energy Dry – Standard RESIBLOC®</p> <p><b>Active part</b></p> <p>Rated Power [kVA] 1600</p> <p>Primary voltage [V] 33000</p> <p>Primary tapplings at no load +/-2 x 2,50%</p> <p>Secondary Voltage at no load [V] 400</p> <p>Primary insulation level [kV] Um 36 / AC 70 / Li 170</p> <p>Secondary insulation level [kV] Um 1.1 / AC 3 / Li 0</p> <p>Frequency [Hz] 50</p> <p>Number Of Phases 3</p> <p>Vector Group Dyn5</p> <p>Ambient temperature max./monthly/annual average [°C] 40 / 30 / 20</p> <p>Max. average temperature rise (HV/LV) [K/K] 100 / 100</p> <p>Environmental, climatic, fire E2, C2, F1</p> <p>Temperature class (HV/LV) F / F</p> <p><b>Winding material</b></p> <p>Conductor material HV AL</p> <p>Conductor material LV AL</p> <p><b>Performance values (based on pure sinusoidal load under rated performance conditions)</b></p> <p>Standard IEC60076-11:2018</p> <p>Eco Efficiency Requirement According to TIER 2 of</p> <p>EN50708-1:2020</p> <p>Impedance (HV-LV) [%] 6,00 (+/- 10%)</p> <p>No load losses [W] 2277 (+ 0%)</p> <p>Load losses at 120°C [W] 14300 (+ 0%)</p> <p>Total losses [W] 16577 (+ 0%)</p> <p><b>Sound level</b></p> <p>Sound power level Lwa (under no load condition) [dB(A)] 67</p> <p><b>Harmonics</b></p> <p>Earthing screen HV/LV</p> <p><b>Tappings</b></p>	
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	<p>Off-load tapplings reconnectable by bolted links</p> <p><b>Environment information</b></p> <p>Altitude (a.s.l.) [m] &lt;1000</p> <p>Location Indoor</p> <p><b>Cooling</b></p> <p>Cooling class AN</p> <p><b>Protection class</b></p> <p>Protection class IP00</p> <p><b>Preliminary dimensions and weight</b></p> <p>Length [mm] 2000</p> <p>Width [mm] 1500</p> <p>Height [mm] 2500</p> <p>Weight [kg] 5800</p> <p><b>Customer connections</b></p> <p>HV-Terminals placed on the surface of the windings</p> <p>LV- Terminals placed above the windings</p> <p><b>Steel parts</b></p> <p>Core clamps with lifting possibilities</p> <p>- Painting System: C2</p> <p>- Painting color: acc. To manufacturer standard</p> <p><b>Transformer base</b></p> <p>Bi-directional rollers</p> <p>Pulling lugs</p> <p><b>Monitoring</b></p> <p>PT 100 temperature 3-wire sensor (1 pc(s). per limb)</p> <p>- wired to terminal strip</p> <p>TR 250 temperature monitoring device (1 pc(s).)</p>	
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	<div>- mounted</div> <div><b>Marking</b></div> <div>Rating Plate with technical data acc. To applicable standard (1 pc(s).)</div> <div>- Language: English</div> <div>- Material: Adhesive</div> <div><b>Documentation</b></div> <div>Documentation acc. To manufacturer standard</div> <div>- Language: English</div> <div><b>Comments and Exceptions</b></div> <div>TVP Option included</div>	
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14.5 Schedule E: LV Switchgear Technical Details

Item	Description	Unit	MEHO Design
1	<u>Manufacturer</u>		

	Name	-	TBA
	Equipment Designation	-	TBA
	Place of manufacturer	-	TBA
2	<b><u>General</u></b>		
	Switchgear Type	-	Standardized with doors and side walls
	Construction Type	-	metal cells with doors
	Number of cabinets (Option 1)	-	see SLD
	Number of cabinets (Option 2)	-	See SLD
3	<b><u>Power System Information</u></b>		
	Nominal voltage	V	400VAC
	Rated current busbar	-	2500A
	short-circuit current rating	-	I1s=50kA
4	<b><u>MV-Cells features</u></b>		
	Transformer (Incomer)	-	TBA
	AC Distribution (feeders)	-	TBA
	DC Distribution (feeders)	-	TBA
13	<b><u>Dimensions (assembled)</u></b>	-	
	H x W x D	mm	2113 x 3712 x 899
	Weight	T	1500 kg

## 14.6 Schedule F: DC System Technical Details

DC system 110 VDC			
Pos	Code	Description	Qty

01	V001339X	<p>EDC-F 110V/22,5A/155Ah 2,00 pcs 8 065,00 16 130,00</p> <p>Modular DC system with output distribution and battery</p> <p>Charger/rectifier and DC distribution cabinet</p> <ul style="list-style-type: none"><li>- Input voltage: 3x400/230 VAC, 50/60Hz</li><li>- Output voltage nominal: 110 VDC</li><li>- Output current: 22,5 A</li><li>- Output power: 3 x 800W (3 pcs of PVF800 rectifier modules)</li></ul> <p>Control unit:</p> <ul style="list-style-type: none"><li>- VELA</li><li>- Alarms on potential free contacts</li></ul> <p>DC output distribution</p> <ul style="list-style-type: none"><li>- 12 pcs of 2-pole diazed fuses gGxx/25A with control relays</li></ul> <p>Battery:</p> <ul style="list-style-type: none"><li>- 110Vdc/155Ah: 9 x Exide Marathon M12V155FT</li></ul> <p>Other:</p> <p>Connection for parallel connection with fuses and switch.</p> <p>Connection for test load with switch.</p> <p>Cabinet: 2100x800x600 mm (H x W x D), RAL 7016, IP21, cable input form top</p> <p>(bottom to be agreed)</p>	2 pcs
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14.7 Schedule G: RTU Technical Details

Item	Description	Manufacturer	Qty
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1.1	<p>Cabinet</p> <ul style="list-style-type: none"> <li>- 2200x800x600...1000</li> <li>- Glass/metal door</li> <li>- 19" rack rails</li> <li>- Terminals and MCBs</li> <li>- Light</li> </ul>	Rittal	1
1.2	<p>NTP Time Server in 19" Slimline Housing</p> <p>GPS satellite receiver</p> <p>incl. GPS antenna and 20m antenna cable RG58</p> <p>Power Supply: 100-240 V AC / 100-200 V DC</p> <p>Signal Outputs:</p> <p>1 x LAN interface 10/100 MBit, RJ45 connector</p> <p>new CPU with better performance - 25.000 requests/second</p> <p>20-60 V DC</p> <p>Signal Outputs:</p> <p>1 x LAN interface 10/100 MBit, RJ45 connector</p>	Meinberg	1
1.3	<p>Fast/Gigabit Ethernet Switch</p> <ul style="list-style-type: none"> <li>- 24 ports: RJ45 (+4 SFP gigabit ports)</li> <li>- Power supply 110/250 VDC, 110/230 VAC (x2)</li> <li>- 0 °C ... 60 °C</li> <li>- Fanless design</li> <li>- Mounting 19" cabinet</li> <li>- Protection class IP30</li> </ul>	Belden	1
1.4	<p>SFP Fiberoptic Gigabit Ethernet Transceiver SM</p> <ul style="list-style-type: none"> <li>- 1 x 1000 Mbit/s with LC connector</li> </ul>	Hitachi Energy	2
1.5	<p>19" swing frame rack for optional redundant power supply</p> <p>With flexible configuration for I/O, CMU and power supply</p>	Hitachi Energy	1
1.6	<p>Power supply unit for RTU560 racks</p> <ul style="list-style-type: none"> <li>- Input voltage: 110-220 VDC</li> <li>- Output voltage: 5 and 24 VDC</li> <li>- Suitable for redundant power supply in 560MPR03/560SFR02</li> </ul>	Hitachi Energy	2



1.7	<p>Central module of the RTU560 with 32 bit CPU</p> <ul style="list-style-type: none"> <li>- 2x serial communication interface (RS-232 or RS-485) for remote communication</li> <li>- 2x Ethernet interface (10/100BaseT)</li> <li>- 1x USB port</li> <li>- 1x serial peripheral bus</li> <li>- crypto chip</li> <li>- battery buffered real time clock</li> </ul> <p>Licenses for protocol, functions and SD-card are not included</p>	Hitachi Energy	1
1.8	<p>Bus connection unit for 560SFR02 (Basic)</p> <ul style="list-style-type: none"> <li>- Alarm and warning contacts</li> <li>- Minute pulse in- and output</li> <li>- Supervision of redundant power supply</li> <li>- For 2 units 560CMR0x (one basic unit, one extension unit)</li> </ul>	Hitachi Energy	1
1.9	<p>HMI License, SD-card (560CMR01, 560CMR02, 540CMD01, 540CID01)</p> <p>open DP</p> <p>incl. Basic and PLC/Archives license</p>	Hitachi Energy	1
1.10	<p>Binary input, 16 channels, LED's</p> <ul style="list-style-type: none"> <li>- single indications, double indications, digital measurands and pulse counters</li> <li>- Resolution: 1 ms</li> <li>- Process voltage: 110 -125 VDC</li> <li>- LED signal for each input</li> </ul>	Hitachi Energy	1
1.11	<p>Analog input module (mA, V), 8 channels</p> <ul style="list-style-type: none"> <li>- Resolution 12 bit + sign</li> <li>- measuring ranges: +/- 2 mA; +/- 5 mA; +/- 10 mA; +/- 20 mA; +/- 40 mA; +/- 2 VDC; 0 ... 20 VDC</li> </ul>	Hitachi Energy	1
1.12	<p>Panel PC</p> <ul style="list-style-type: none"> <li>- 4GB RAM*</li> <li>- 500GB SSD*</li> <li>- CPU: Intel series*</li> <li>- Windows OS</li> </ul> <p>*PC parameters in the project design may differ from the listed in the scope of supply document</p>	Advantech / Eqt	1
1.13	<p>Touch monitor</p> <ul style="list-style-type: none"> <li>- 21.5" Active matrix TFT LCD 16:9</li> <li>- Panel / wall mount installation</li> <li>- Touchscreen</li> <li>- Supports industrial 12VDC power input</li> </ul>	Elo/ Eqt	1

1.14	Drawer for keyboard and mouse - Aluminium front panel - 3.5 U	Rittal	1
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