Introduction to Battery Energy Storage System (BESS)

A Battery Energy Storage System (BESS) is a technology that stores electrical energy in the form of chemical energy within batteries. The stored energy can be later converted back to electricity when needed. BESS plays a crucial role in modern power systems by helping to balance the supply and demand of electricity, improving grid stability, and integrating renewable energy sources.

How a BESS Typically Works?

Charging: During periods of low electricity demand or when excess renewable energy is available, the BESS charges its batteries by converting electrical energy into chemical energy through electrochemical reactions. This is typically done using a rectifier or other charging mechanism.

Energy Storage: The charged energy is stored in the batteries until it is needed. Battery modules or cells are connected in series and parallel to achieve the desired voltage and capacity.

Inverter Conversion: When electricity is required, the inverter converts the direct current (DC) stored in the batteries into alternating current (AC), which can be used to power electrical devices or fed into the grid.

Output Control: The control system monitors the state of charge, system performance, and grid conditions. It determines when to discharge energy from the batteries based on the grid's needs or the user's requirements.

Grid Interaction: BESS can interact with the grid in various ways, depending on its configuration and purpose. It can provide ancillary services such as frequency regulation, voltage support, and grid stabilization. It can also be used for peak shaving, load shifting, or providing backup power during outages.

Operational Information

The below site layout of the 103 Cabbage Tree Road, Williamtown project shows the key equipment and site arrangement indicative of all sites in the Hive Battery Developments Pty Ltd portfolio. The following table describes the intended functionality of key assets during operation.

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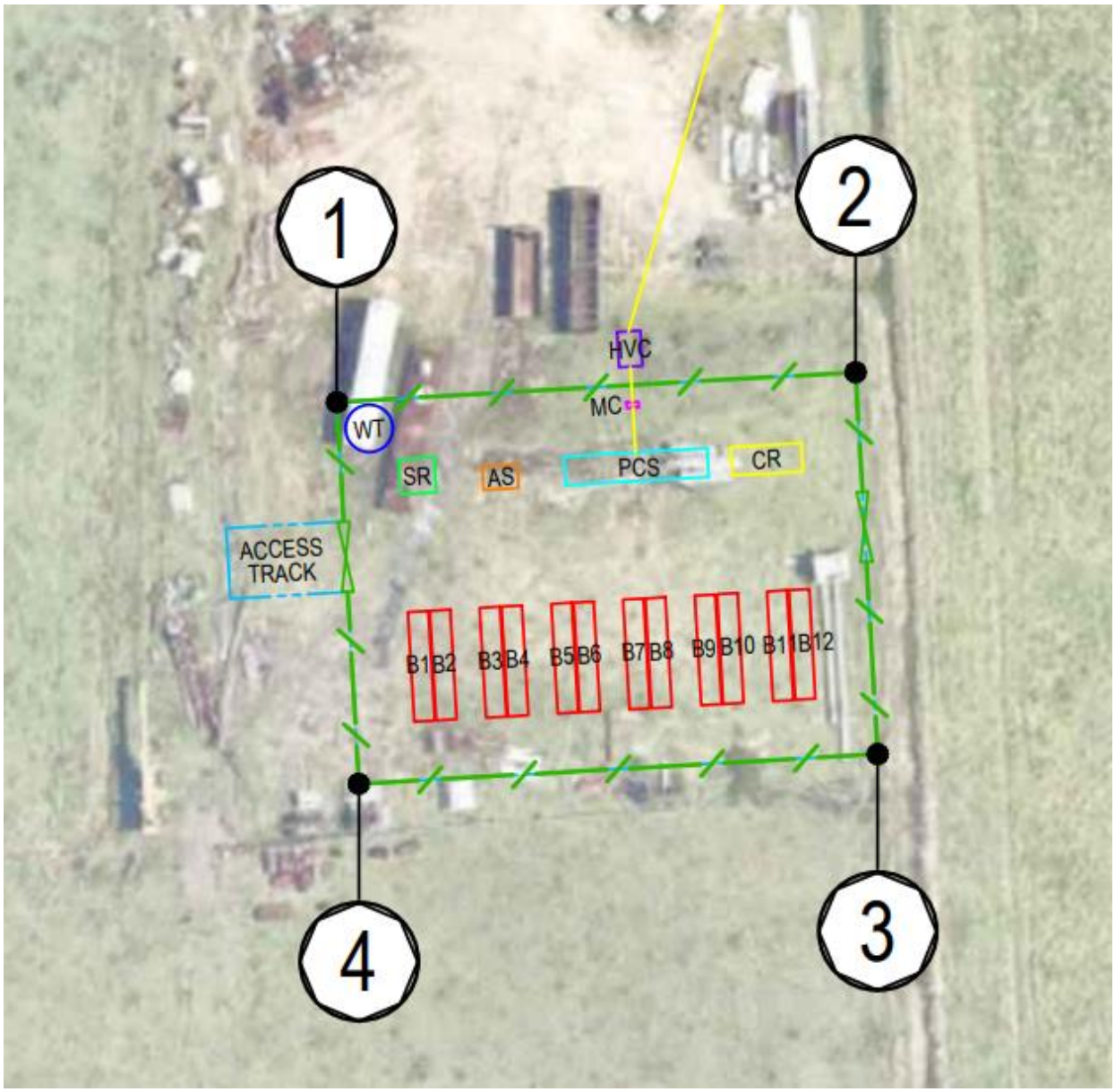
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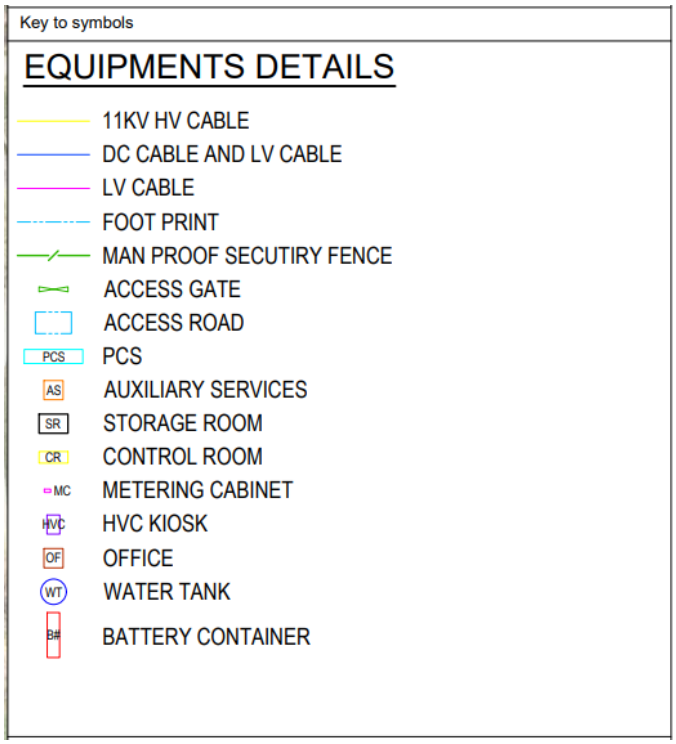
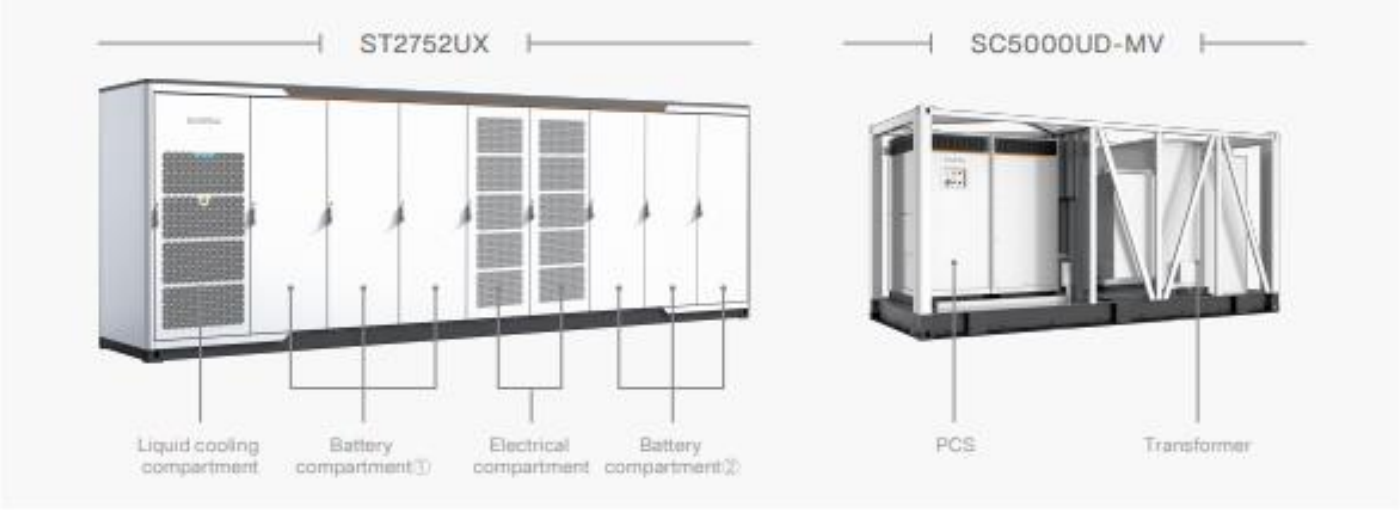


Equipment	Description
Power Conversion System (PCS)	• Use: control the bidirectional flow of power (when the battery is charging and discharging) and to convert DC power from the battery to AC power at the appropriate voltage level required by the network. • Contains: power transformer, DC to AC inverter, AC to DC rectifier, switchboard
Auxiliary Services	• Use: supply power for auxiliary equipment (e.g. lighting, BESS cooling, control room). • Contains: power transformer, switchgear
Storage Room	• Use: storage of spare parts required for operations and maintenance activities • Contains: spare parts
Control Room	• Use: collect and transmit BESS operational data and monitoring/control equipment • Contains: SCADA systems, databases, software
Metering Cabinet	• Use: collect and transmit power import/export data to Ausgrid • Contains: Ausgrid meter
High Voltage Customer (HVC) Kiosk	• Use: isolate the system from the network for maintenance works or in the event of a fault • Contains: switchgear (owned by Ausgrid)
Battery Container	• Use: house the batteries, there individual control systems and fire suppression systems • Contains: battery cells, battery controls, cooling system and fire suppression systems

How does a BESS Work?

Based on over 25 years of power electronic conversion technology, SUNGROW has innovatively integrated electrochemistry, power electronics, and power grid support technologies, and developed a new generation of liquid-cooled energy storage systems featuring professional integrations. Through the integrated design of one set of products, one data system, one control system, and one link logic, the system works holistically. It can shorten the distance between electrochemistry and the power grid, and effectively links the units in the system, thereby supporting the three key requirements of safety, efficiency, and grid-connection. Through the patented flow channel design scheme, it can provide a balanced temperature in the system battery packs and battery cells. In addition, through the holistic design which utilizes the EMS, PCS, DC-DC controller, and BMS, it improves system compatibility and adaptability. Further, as a result of the modular component design and integrated pre-installation structure, it also facilitates a seamless transportation and installation.



Key features:

Balanced Heat Dissipation

The system uses a patented liquid cooled heat dissipation scheme, with a ≤2.5°C temperature difference in the battery cells, delivering a balanced system temperature, which alleviates large battery temperature differences caused by traditional heat dissipation methods.

Modular Installation

The modular design of the main components such as the DC-DC controller and the battery pack and the pre-installed internal wiring of the energy storage system greatly save the construction time and costs, and facilitate the operation, maintenance, and replacement.

Professional Integration

The DC-DC controller integrates BMS functions, reducing system control levels and providing rack-level battery management. The integrated design of PCS and DC-DC controller provide higher system compatibility and adaptability, which greatly reduces the difficulty of system commissioning and adaptation.

Refined Management

The system adjusts the charge-discharge ratio through the DC-DC controller, thereby providing full charge and discharge and solving the parallel barrel effect between racks. It also reduces the battery SOC (state of charge) error through SOC automatic calibration, eliminating downtime and manual on-site operation and maintenance.

System Safety

Early detections of unhealthy batteries are possible as a result of battery health AI monitoring. It also comes with four-level overcurrent protection and battery rack AI arcing detection to ensure the power safety, and various anti-leakage designs, power battery compartment design, and meets NFPA 855/69/68/15 and IEC63933-5-2 safety requirements.

Overview of Liquid Cooling System

The battery part of the BESS adopts liquid cooling technology to dissipate heat. Compared with air cooling, liquid cooling technology brings less loss and better temperature uniformity. Liquid cooling system mainly comprises of liquid cooling unit, pipes, liquid cooling battery pack, coolant and other component such as connectors and valves.

The coolant of the system is mixed solution of ethylene glycol and water. The coolant flows from the water outlet main pipe of liquid cooling unit to the 6 longitudinal branch pipes. Each branch is divided into 8 finer branches and flows to the liquid cooling battery pack to cool or heat the battery cell. After flowing out of the pack, it is summarized to the return main pipe through the branch pipe and returned to the liquid cooling unit. The coolant flow direction is shown below:

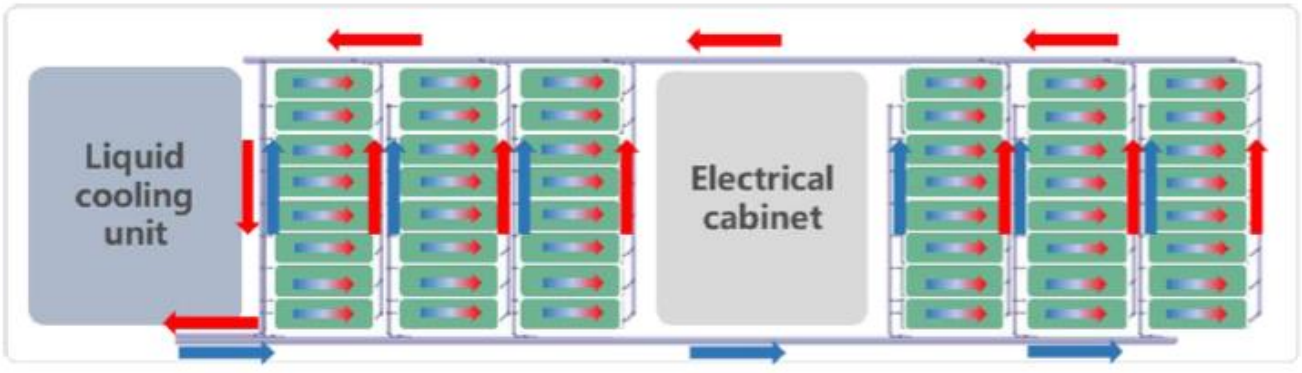


Fig. 1 Coolant Flow Direction

ST2752UX

Liquid Cooling Energy Storage System

Preliminary

LOW COSTS

- Highly integrated ESS for easy transportation and O&M
- All pre-assembled, no battery module handling on site
- 8 hour installation to commission, drop on a pad and make electrical connections

SAFE AND RELIABLE

- Integrated DC/DC converters actively limit fault current
- DC electric circuit safety management includes fast breaking and anti-arc protection
- Multi level battery protection layers formed by discreet standalone systems offer impeccable safety

EFFICIENT AND FLEXIBLE

- Intelligent liquid cooling ensures higher efficiency and longer battery cycle life
- Modular design supports parallel connection and easy system expansion
- IP54 outdoor cabinet and optional C5 anti-corrosion

SMART AND ROBUST

- Fast state monitoring and faults record enables pre-alarm and faults location
- Integrated battery performance monitoring and logging

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Type designation	ST2752UX
Battery Data	
Cell type	LFP
Battery capacity (BOL)	2752 kWh
System output voltage range	1160 ~ 1500 V
General Data	
Dimensions of battery unit (W * H * D)	9340*2600*1730mm
Weight of battery unit	26,400kg
Degree of protection	IP54
Operating temperature range	-30 to 50 ℃ (> 45 ℃ derating)
Relative humidity	0 – 95 % (non-condensing)
Max. working altitude	3000 m
Cooling concept of battery chamber	Liquid cooling
Fire safety	Fused sprinkler heads, NFPA 69 explosion prevention and ventillation IDLH gases
Communication interfaces	RS485, Ethernet
Communication protocols	Modbus RTU, Modbus TCP
Compliance	CE, IEC 62477-1, IEC 61000-6-2, IEC 61000-6-4, IEC 62619

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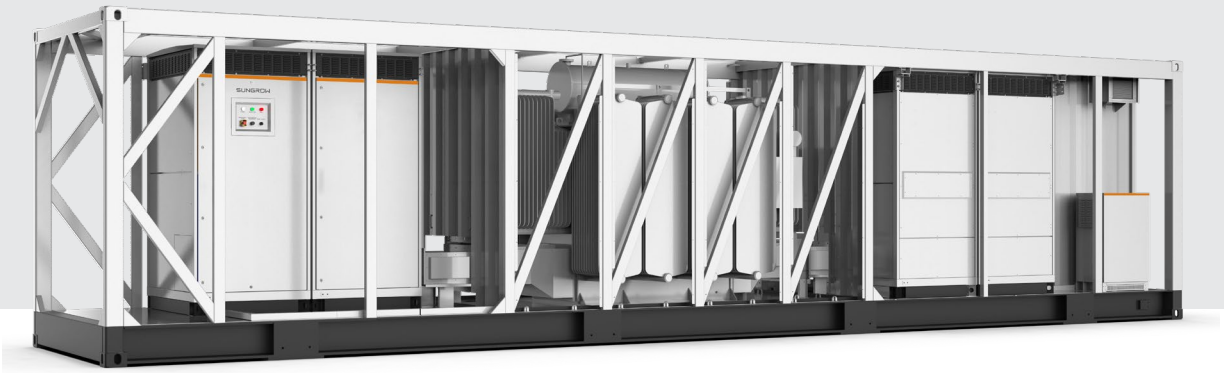
SC4980UD-MV

Preliminary

Power Conversion System



HIGH YIELD

- Advanced three-level technology,max. efficiency 99%
- Effective forced air cooling,no derating up to 45°C
- Wide DC voltage operation window, full power operation at 1500V

SMART O&M

- Modular design,easy for maintenance
- IP65 protection degree, easy for outdoor installation
- C5 anti-corrosion degree, adjust to applications close to the sea

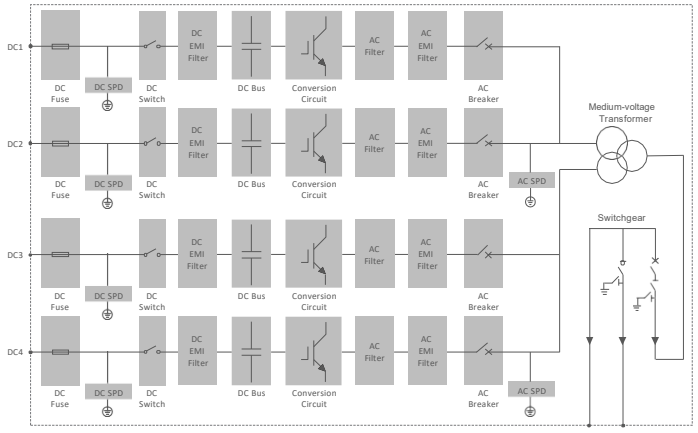
FLEXIBLE APPLICATION

- Bidirectional power conversion system with full four-quadrant operation
- Compatible with high voltage battery system,low system cost
- Battery charge & dis-charge management and black start function integrated

GRID SUPPORT

- Compliant with CE, IEC 62477, IEC 61000 and grid regulations
- Fast active/reactive power response
- L/HVRT,FRT, soft start/stop, specified power factor control and reactive power support

CIRCUIT DIAGRAM



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Type Designation	SC4980UD-MV
DC side	
Max. DC voltage	1500 V
Min. DC voltage	800 V
DC voltage range	800 – 1500 V
Max. DC current	1588 A * 4
No. of DC inputs	4
AC side (Grid)	
AC output power	4980 kVA @ 50 ℃
Converter port max. AC output current	1307 A*4 @50℃
Converter port nominal AC voltage	550 V
Converter port AC voltage range	484 – 605 V
Nominal grid frequency / Grid frequency range	50 Hz / 45 – 55 Hz, 60 Hz / 55 – 65 Hz
Harmonic (THD)	< 3 % (at nominal power)
Power factor at nominal power / Adjustable power factor	>0.99 / 1 leading – 1 lagging
Adjustable reactive power range	-100 % – 100 %
Feed-in phases / AC connection	3 / 3
AC side (Off-Grid)	
Converter port nominal AC voltage	550 V
Converter port AC voltage range	484 – 605 V
AC voltage Distortion	< 3 % (Linear load)
DC voltage component	< 0.5 % Un (Linear balance load)
Unbalance load Capacity	100 %
Nominal frequency / Frequency range	50 Hz / 45 – 55 Hz, 60 Hz / 55 – 65 Hz
Efficiency	
Converter max. efficiency	99%
Transformer	
Transformer rated power	5000 kVA
LV / MV voltage	0.55 kV / 20 – 35 kV
Transformer vector	Dy11y11
Transformer cooling type	ONAN
Oil type	Mineral oil(PCB free) or degradable oil on request
Protection	
DC input protection	Load break switch + fuse
Converter output protection	Circuit breaker
AC output protection	Circuit breaker
Surge protection	DC Type II / AC Type II
Grid monitoring / Ground fault monitoring	Yes / Yes
Insulation monitoring	Yes
Overheat protection	Yes
General Data	
Dimensions (W*H*D)	12192*2896*2438 mm
Weight	28000 kg
Degree of protection	IP54 (Converter: IP65)
Operating ambient temperature range	-35 to 60 ℃ (> 50 ℃ derating)
Allowable relative humidity range	0 – 100 %
Cooling method	Temperature controlled forced air cooling
Max. operating altitude	4000 m (> 2000 m derating)
Display	LED, WEB HMI
Communication	RS485, CAN, Ethernet
Compliance	CE, IEC 62477-1, IEC 61000-6-2, IEC 61000-6-4
Grid support	L/HVRT, FRT, active & reactive power control and power ramp rate control, Volt-var, Volt-watt, Frequency-watt

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Control Room

The Control Room container will be scoped to include:

- ➢ Control room container
- ➢ Electrical and communications ducts and cables to the control room
- ➢ Control room air conditioning
- ➢ Fire alarms
- ➢ Lights
- ➢ Electrical Distribution Board

Quantity	**One (1)**
Item	Design Parameters
Access doors - equipment	1.3 m minimum width, double leaf, lockable with emergency internal escape. Metal frame and metal clad insulated door. Not less than 1 to be provided.

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Dimensions	Fully in accordance with AS/NZS requirements Adequately sized to effectively install, operate inspect and maintain all equipment, hardware, and auxiliary equipment. Space provisions to install future equipment to be provided.
Arrangement	Located above ground on concrete foundations. Control room shall internal arrangements (Racks) to mount and secure network switches and devices related to EMS3000, Element flex as well as PSU, UPS and Electrical distribution boards
Type	Prefabricated modular building suitably sized to house the switchgear, control, protection, communications and AC/DC supply systems and associated SCADA and RTU systems interfaces as appropriate
Materials of construction	Metal frame support structure; external profiled metal wall and roof cladding; internal metal clad wall to ceiling lining; heavy duty fire resistant floor materials with suitable covering; and internal fire resistant insulation infill. No wood to be used in the construction.
Access doors - equipment	1.3 m minimum width, double leaf, lockable with emergency internal escape. Metal frame and metal clad insulated door. Not less than 1 to be provided.
Fire Rating	The level of fire rating (containment of a fire inside the building and penetration of fire from outside to inside) for all wall, roof and floor systems, including penetrations (e.g. doors, vents, etc.) shall be determined by the Contractor's design development and a project HAZOP, and substantiated by the fire risk assessment undertaken by the Contractor.
Ventilation	Positive pressurisation preferred Duty and standby systems with heavy duty, high efficiency filtration.
Air Conditioning	Split system air conditioning units, including one complete standby unit, to be provided. Air conditioning system performance and equipment status to be provided with remote status monitoring communications facilities.
Design Building Internal Air Temperature	23$_o$C ±2$_o$C at the maximum design conditions

Fire detection and alarm	VESDA system or equivalent to be provided, including dual thermal and smoke detection systems. Integral fire indication and alarm panel with remote status monitoring communications facilities, to be provided.
Fire protection system - automatic	Water (TBC by fire risk assessment).

Auxillary Equipment (Services)

Auxiliary Equipment
The Scope of this package is to Supply and Install the Auxiliary system. This package includes:

- **Step down transformer**
- **Switchgear**
- **Lan and communication cables**

LV AC Power Supply System

The Contractor may design and supply a new LV AC power supply to supply the Works. The LV AC supply system shall comprise the following main components:
a) 400V Main Distribution Board (MDB):
The Main Distribution Board is to intended to provide power to the Auxiliary loads (General lighting, Batteries cooling system, control room etc)

i. Form 3B MCCB or ACB (subject to load requirement) on incomers. If ACB is used, the ACB shall be withdrawable;
ii. A generator link box shall be provided in close proximity to the MDB to enable the connection of temporary mobile generator (stand-by) power supply;
iii. MCCBs and MCBs included for outgoing load feeders. No motor starters /drives assumed to be required;

iv. The MDB shall have internal arc fault classification in accordance with IEC 62271.200 for an internal arc of at least 1s at switchboard rated fault current;

v. Main Circuit breaker between the Auxiliary transformer and the Main distribution Board must have a remote tripping functionality.

b) Control Building Distribution Board (CBDB):

i. CBDB is fed from the Main Distribution Board;

ii. Supplies required for normal function of the control building, including but not limited to lighting, 230V general purpose outlets and heating, ventilation and air conditioning will be fed from a CDBD.

Switchgear

The LV switchgears shall be designed for a nominal voltage of 400/230 V (according to IEC 60038) and AS / NZS 61439 and to withstand a short-circuit current of minimum 10% higher than required by calculations for a duration of one (1) second.

Switchgear busbars, circuit breakers, cable compartments and LV compartments shall all be contained in separate compartments and barriers shall be provided between the compartments to prevent the spread of ionised gases.

Busbars shall be copper and shall be capable of carrying full current continuously along the entire length of the busbar without exceeding maximum allowable standard temperatures. Busbars, busbar connections and insulation materials shall be capable of withstanding without damage the thermal and dynamic effects of short-circuit fault current equivalent to the short time rating of the associated switchgear. Facilities shall be provided to accommodate thermal expansion of the busbars and associated components.

All main switchboards, relay panels and control equipment shall be provided with duplicate 110V DC power supplies for control and alarm purposes.
For emergency operation of MV feeders and LV incomers, mechanical off switches shall be provided.

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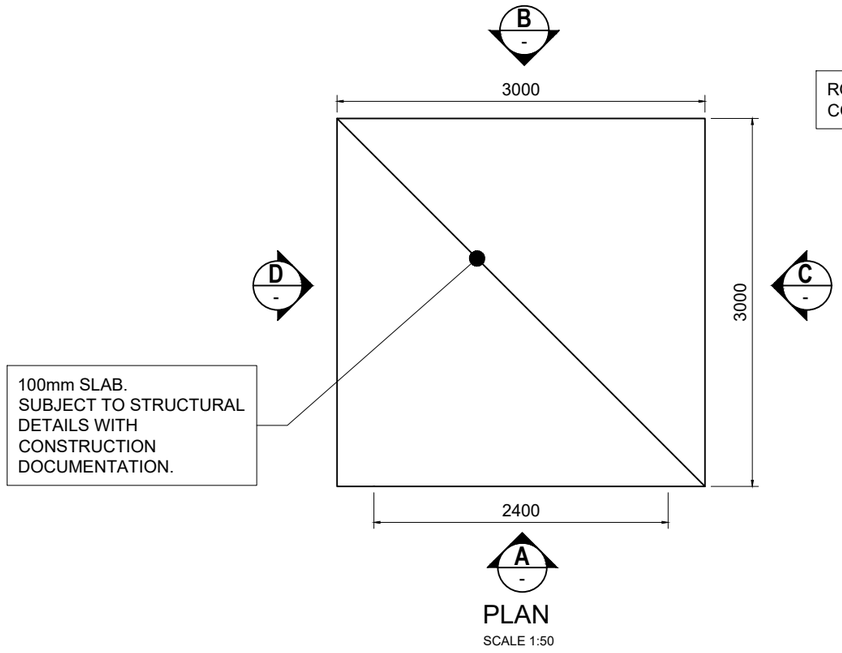

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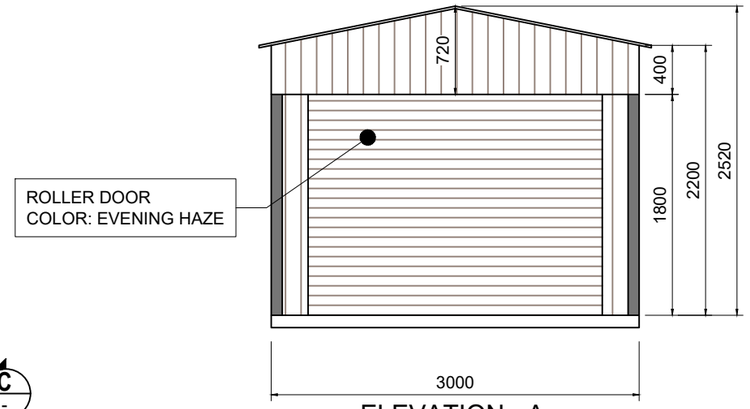

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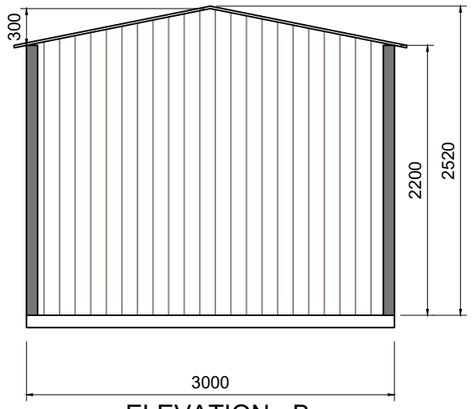

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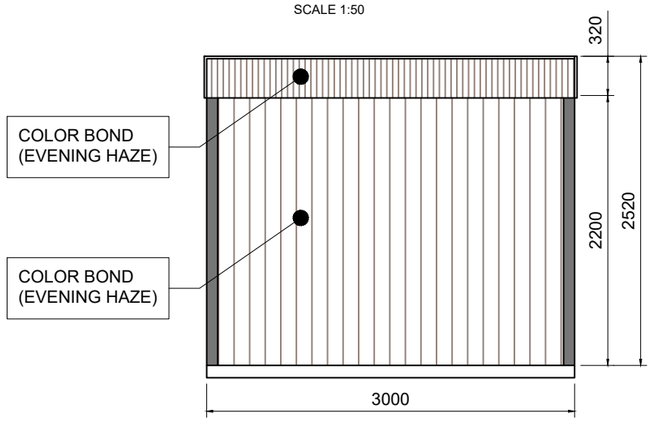

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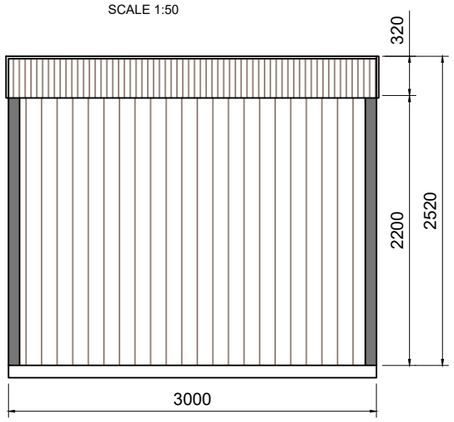

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ORIGIN OF LEVELS :			
CONTOUR INTERVAL:			
DESIGNED: R.F.	DRAWN: S.J.	PLAN: 1:50	LONGITUDINAL SECTION : HORIZ. N/A VERT. N/A
CHECKED: R.F.	APPROVED: R.F.		CROSS SECTION : HORIZ. N/A VERT. N/A

CLIENT
CLEAN ENERGY TRANSFER FUND PTY LTD

PROJECT
PROPOSED BATTERY SHED

DRAWING TITLE

SHEET 1 OF 1 SHEETS

HDB Job No 23056

REVISION A

DWG No 23056(SHED)

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