Energy Local Storage Advanced system

D7.6 Safety, maintenance and training procedures and documents

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Executive Summary

Driven by European energy policy targets on decarbonised energy system and the massive penetration of renewable energy, Electrical energy storage is clearly recognised as one of key technologies to ensure high reliability and increased flexibility of the grid.

Storage is also one of the core elements of the forthcoming energy supply system to enable an increasing local production of renewable energy sources (RES) with fluctuating power output.

Within the European project ELSA, the objective of work package 7 is to disseminate and trigger exploitation of the project results, thus paving the way for new activities and business opportunities of the European industry.

Safety procedures, maintenance processes, and training of professionals involved in the development, the production, the transportation, the installation, the operation and the maintenance, have been elaborated and consolidated as a Customer Manual documents (in Annex), and displayed as followed:

1- Safety documents contains the precautions of use (batteries safety requirements), and an Emergency guide.

2- Maintenance documents describes Power electronic maintenance operations and periodical checks; the Batteries replacement threshold value capacity and Alarms management process.

3- Training guide with a specific focus on requirements of rescus workers and paramedics.

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APPENDIX

List of Acronyms and Abbreviations

ACER	(EU) Agency for the Cooperation of Energy Regulators
AEEGS	(IT) Authority for Electricity, gas and water system
AENOR	(ES) Asociación Espanola de Normalización y Certificación (Spanish Association for Standardization)
AFNOR	(FR) Association Française de Normalisation (French Association for Standardization)
AGU	(IE) Aggregated Generator Units
ASHRAE	American Society of Heating, Refrigerating, and Air-conditioning Engineers
Bacnet	Building Automation Control Network (ISO and ASHRAE Communication standards)
BATSO	Battery Safety Organization
BEES	Battery Electrical Energy Storage
BETTA	(UK) British Electricity Trading and Transmission Arrangements
BM	(UK) Balancing Mechanism
BEPOS	Bâtiment à Énergie Positive
BREEAM	BRE Environmental Assessment Method
BMU	(UK) BM Unit
BoEU	Bock of Energy Unit (Prosumer, Consumer or Producer)
BS	British Standard
BSI	British Standards Institution
CA	Commercial Aggregator
CAN	Controller Area Network
CASCO	ISO Council Committee on Conformity Assessment
CE	(FR) Conformité Européene (European Conformity)
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
CER	(IE) Commission for Energy Regulator
CHP	Combined Heat and Power (Cogeneration)
CNE	(Spanish) National Energy Commission
CNMC	(Spanish) National Commission of Markets and Competition
COPOLCO	ISO Committee on Consumer Policy
DE	Deutschland

DECC	(UK) Department of Energy and Climate Change
DEVCO	ISO Committee on Developing Country Matters
DIN	(DE) Deutsches Institut für Normung (German Institute for Standardization)
DNO	(UK) Distribution Network Operator
DOE	(US) Department of Energy
DS3	(IE) Delivering a Secure Sustainable electricity System
DSM	Demand Side Management
DSU	(IE) Demand Side Unit
DSO	Distribution System Operator
DSU	(IE) Demand-Side Units
DTU	(UK) Demand Turn Up
EC	(EU) European Commission
EDEMS	ELSA District Energy Management System
EEE	(EU) Electrical and Electronic Equipment
EEG	(DE) Renewable Energy Act
EEMS	ELSA Energy Management System
EES	Electrical Energy Storage
EFR	(UK) Enhanced Frequency Response
EGIP	(IE) Embedded Generator Interface Protection
EJP	(FR) Effacement des Jours de Pointe (Peak Days Curtailment)
ELSA	Energy Local Storage Advanced system
EMC	ElectroMagnetic Compatibility
EMR	(UK) Electricity Market Reform
EN	European Standard
ENTSO-E	European Network of Transmission System Operator for Electricity
EnWG	(DE) EnergieWirtschaftsgesetz – Energy Industry Act
EPC	Engineering, Procurement and Construction/Commissioning
EPD	Environmental Product Declaration
ES	(Country code) Spain
ESCO	Energy Service COmpany
ESTI	European Telecommunications Standards Institute

EU	European Union
FCDM	(UK) Frequency Control by Demand Management
FFR	(UK) Firm Frequency Response
FR	(Country code) France
GEMA	(UK) Gas and Electricity Markets Authority
GEN	Global Ecolabelling Network
GRI	Global Reporting Initiative
GTRN	(IT) National Transmission System Operator
HQE	Haute Qualité Environnementale
HVAC	Heating, Ventilation and Air-Conditioning
IEC	International Electrotechnical Commission
ICPE	(FR) Classified facilities for the environment protection
ICT	Information and Communications Technology
IE	(Country code) Ireland
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IS	Irish Standard
IT	(Country code) Italy
ITU	International Telecommunication Union
LCA	Life Cycle Assessment
MIC	(IE) Maximum Import Capacity
NASI	National Standards Authority of Ireland
NETA	(UK) New Electricity Trading Arrangements
NF	Norme Française (French Standard)
OASIS	Organization for the Advancement of Structured Information Standards
Ofgem	(UK) Office of Gas and Electricity Markets
OpenADR	Open Automated Demand Response communication standards
OSGP	Open Smart Grid Protocol
PC	(ISO) Programming Committee
PCI	(EU) Projects of Common Interests
PCR	Product Category Rules

PDC	(ISO) Policy Development Committee
POR	(IE) Primary Operating Reserve
PQQ	Pre-Qualification Questionnaire
PV	Photovoltaic
REE	(ES) Red Electrica d'España
RRD	(IE) Replacement Reserve- Desynchronised
RRS	(IE) Replacement Reserve-Synchronised
RT	(FR) Règlementation Thermique
RTE	(FR) Réseau de Transport d'Electricité
SAE	(US) Society of Automotive Engineers
SASMI	Skills Academy for Manufacturing and Innovation
SC	Subcommittee
SCADA	Supervisory Control and Data Acquisition
SEM	(IE) Single Electricity Market
SEMO	(IE) Single Electricity Market Operator
SOR	(IE) Secondary Operating Reserve
STAR	(IE) Short Term Active Response
STOR	(UK) Short Term Operating Reserve
TA	Technical Aggregator
TAG	ISO Technical Advisory Groups
TC	Technical Committee
TMG	Technical Management Board
TR	Technical Report
TRL	Technology Readiness Level
TSO	Transmission System Operator
UK	(Country code) United-Kingdom
UL	(US) Underwriters Laboratory
UN	United Nations
UNI	Ente Nazionale Italiano di Unificazione (Italian National Standardisations)
UPS	Uninterruptable Power Supply
US	(Country code) United States

VDE	(DE) Verband Der Elektrotechnik Elektronik informationstechnik e.V.
WEEE	(EU) Waste Electrical and Electronic Equipment
WP	Work Package
XP	(FR) Norme Expérimentale (Experimental Standard)

1 Introduction

Taken into account the increasing electricity market share of renewable and distributed generation and the growing limitations of the energy grid, Electrical Energy Storage (EES) is a clear key technology priority for European Union to develop the European power system of 2020 ((EU) The European Commission COM(2012) 271 final. Renewable Energy: a major player in the European energy market, 6.6.2012). Therefore, EES will become an essential contributor to grid modernization that meets the future needs under low carbon emission constraints.

1.1 Project background

The European electricity market over the last twenty years was marked by a deep transformation towards a unique inner market and an openness to competition.

This was instigated by three successive European Directives:

- Directive 96/92/EC in 1996 [2] ((EU) Directive 96/92/EC of the European parliament and of the council of 19 December 1996 concerning common rules for the internal market in electricity.) referred to as “First Energy Package”
- “Second Energy Package” embodied within the Directive 2003/54/EC in 2003 [3] ((EU) Directive 2003/54/EC of the European parliament and of the council of 23 June 2003 concerning common rules for the internal market inelectricity.)
- Directive 2009/72/EC in 2009 named “Third Energy Package” [4]((EU) Directive 2009/72/EC of The European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC.)
- In order to face the coming energy transition to a decarbonized energy production and deliver a new deal for energy consumers [25], the European Union is re- designing its electricity market [5].

In this context, EES, as one of key technologies can play a significant role. As a matter of fact, decentralised small and medium size energy storage systems provide much greater operating flexibility than today large, centralized energy distribution systems. EES is expected to improve the operating capabilities of the grid, to ensure high reliability and flexibility together with a cost reduction for final consumers.

The project ELSA aims to create a new EES solution characterized by a remarkable cost reduction and high level of flexibility, with low-cost second-life electrical vehicle Li-ion batteries. The hope is that this technology could bring low cost energy storage to the grid.

The ELSA solution will provide smart-grid featured services such as demand-response, power quality, ancillary services and PV power smoothing, Peak-shaving and Time-shifting in the application fields such as: Building, Grid, ICT, and Electrical vehicle batteries

1.2 Proposal Scope of this deliverable

As part of the recommendations for the exploitation of project results, B4B system, the scope of this deliverable and the objective is to present safety, maintenance and training procedure.

Codes, rules and procedures will be proposed concerning safety procedures, customer manuals, maintenance processes, and training of professionals involved in the development, the production, the transportation, the installation, the operation, the maintenance, and the repair of local energy storage systems.

A specific focus will be on requirements of rescus workers and paramedics.

Most of the documents and guides elaborated for Elsa B4B exploitation have been included in the Appendix, however due to heavy files some have been reduced but could be handed on request.

2 SAFETY DOCUMENTS

2.1 Precautions of use (Batteries safety requirements)

Safety documents are defined and deal with the safety of humans, either personnel involved in the installation, maintenance, operation of the storage installation or the public (e.g. people living in the neighbourhood) as well as environmental safety.

2.1.1 Overview

B4B is an energy storage system, developed by RENAULT and BOUYGUES ENERGIES & SERVICES since 2012. The first prototype have been developed during ELSA project and install on Plaisir lab test, Aachen test site, Ampère test site and Challenger.

The system is composed from on 1 to 8 batteries. The system is designed from 24kW to 96kW. The power electronics is developed by ABB. It is composed of one or two cabinets depending the power of the system containing:

- 1 DC/DC converter per battery
- 1 AC/DC converter for all batteries.
- A main WAGO controller
- All electrical protection on AC side and on DC side

The electrical characteristics are the following:

- Nominal voltage: 400 V three-phase current, 50 Hz.
- Maximum input power (charge): 12kW per battery.
- Maximum output power (discharge):12 kW per battery.
- Storage capacity: 11 kWh per battery.

Below is an example of the implantation plan of a technical room hosting such energy storage system.

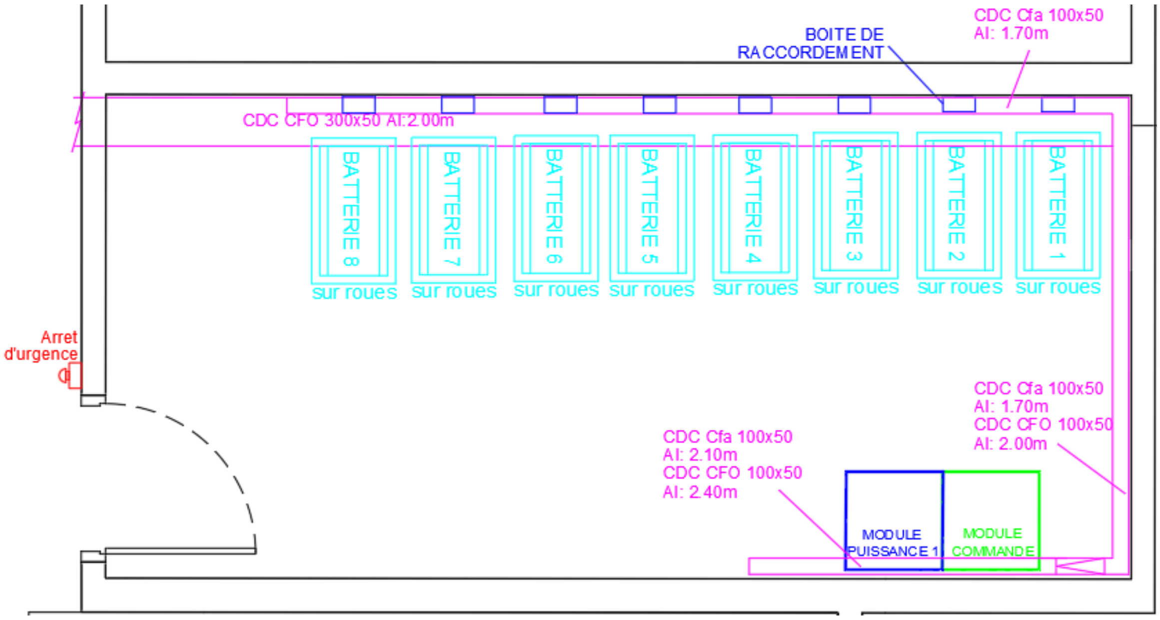


Figure 1: Example of B4B system implementation in a technical room

(A) Battery

(B) Power module

(C) control/command cabinet

2.1.2 Safety issues

2.1.2.1 Internal design

The risks related to storage system use are identified:

- Electric shock.
- Thermal incident.
- Loss of building's power supply.
- Backup power disturbance.
- False alarm concerning the building's safety.
- Negative impact on the economic power supply conditions.

The first five risks may impact people's safety. Thus, a general safety concept has been established. It is based on precautions taken in the system's internal design and on external precautions as well, which this document is the object.

Cf. annexe 1 : Safety Concept 20150116.xlsx

This document and its appendices were presented to a set of experts listed below for information and validation of the general safety concept of this system.

Name	Organism/Company	TITLE
Lieutenant-Colonel Michel GENTILLEAU	SDIS 86 - Service départemental d'incendie et de secours de la Vienne	Chef du Pôle « Compétences et moyens opérationnels »
Lieutenant-Colonel Olivier LABADIE	SDIS 78 - Service départemental d'incendie et de secours des Yvelines	Chef du Groupement « Formation - sports »
Lieutenant-Colonel Christophe BETINELLI	SDIS 78 - Service départemental d'incendie et de secours des Yvelines	Chef du Groupement « Prévention »
Colonel Serge DELAUNAY	SDIS 44 - Service départemental d'incendie et de secours de la Loire-Atlantique	Chef d'Etat Major
M. Sébastien WILLEM	Sécurité Civile	
M. Cédric RIGOLLET	Fédération des Sapeurs Pompiers	
M. Christophe DURINGER	Fédération des Sapeurs Pompiers	
M. Dominique ILSBROCK	Laboratoire Central de la Préfecture de police	Ingénieur
M. Hervé BAZIN	Laboratoire Central de la Préfecture de police	Ingénieur

Mme Pauline BAVOUX	Ministère du Logement, de l'Égalité des territoires et de la Ruralité	Chef de projet « Sécurité et prévention des risques dans les bâtiments d'habitation »

2.1.2.2 Precautions around the system

This document aims to materialize the agreement of various stakeholders (such as, the system supplier, the customer, the operator, the control office, civil safety actors) about the necessary precautions to gather, in order to ensure the security of the installation and operation of the storage system. Its scope goes beyond French regulations, which are at the moment not suitable for storage systems composed of lithium-Ion batteries, in order to cover with robustness the identified specific risks.

2.1.3 General provisions

2.1.3.1 Definitions and fields of application

- **"Accumulator" : Electrochemical device designed to accumulate and store energy with the aim of being able to restore it in electric DC form (of which operation is reversible).**
- "Accumulator battery" : Association of several accumulators with the aim of having greater energy storage and/or higher output DC voltage.
- "Inverter" : electrical device connected to an accumulator battery, allowing to restore its energy to a power grid (alternating current) or device providing an output DC voltage and connected to an accumulator battery.
- Batteries used in this storage system :

Cf. annexe 2 : RETEX feux de VE nov 2014.pdf

For this version of the document, the French regulations were taken into account. An adaptation would be necessary for an installation out of France.

Cf. annexe 3 : Analyse préalable de la règlementation.xlsx

2.1.4 Implantation– Arrangement

This section applies to the local where the system installation is located. The regulatory requirements' state of art was collected and analyzed although it is formulated for storage systems that are likely to generate and accumulate hydrogen (batteries with gas recombination). Since this particular risk is not present for Lithium-Ion batteries considered in our system, this regulatory basis will not be a reference adapted to our system.

Thus, in consultation with specialists in fire safety services, specific risk analysis was conducted.

2.1.4.1 System implantation constraints

The implantation site must have a suitable surface for receiving the storage system. The main door of the technical room and paths leading to it must be wide enough to allow the various elements delivery.

Unlike hydrogen accumulator batteries previously mentioned, this system does not require additional air exchange for operating.

The environment and thermal conditions should be adapted to aging process of the equipment and in particular of the batteries. The system is functional between 0 and 40°C. The conditions of temperature for a nominal use are however located between 5 and 30°C.

Retention tanks are normally required under the batteries, so as to retain fluid in a fire event in the case of liquid or liquefied electrolyte.

In the case considered here, this risk is isolated because of the type of the batteries used.

Implantation outside the building :

The installation must be in conformity with local current regulations regarding minimal safety distances to adopt for its implementation, in relation to property boundaries and the local urban plan. Beyond 8m from the facades, installation into a dedicated-use structure (e.g. in a container) can be made without special requirements concerning firebreak degree.

Implantation inside the building:

Installation must be done in a dedicated technical room, reserved for electricians.

Any room with this installation should be marked as an electrical room and treated as a room with an important particular risk, in accordance with the applicable regulations (ERP, dwellings, residential). Concerning in particular stability and fire resistance degree.

This room must be specified on the plans, if it is required under the applicable regulation (ERP, dwellings, residential), in order to be identified by rescue services as at early stage as possible and as soon as they arrive at the implementation site.

The room will have to be equipped with an outdoor emergency stop key, of which the effect should be to open the circuit breaker coupling the system to the building grid.

The room should resist to fire in case of internal cause as well as in case of an external cause spread. Its resistance will have to be adapted to regulatory requirements according the considered building (Labor code, ERP, IGH).

This applies also to the presence of an autonomous fire detection system.

The presence of a combustion gas evacuation device (in case of fire), must be conditioned to current regulations for building classification (Labor code, ERP, IGH). A system with air evacuation vents, leading directly to the outside, should be arranged.

This room should not be located in the floor. If that was the case, plan a dry standpipe for water supply and if possible do not place the room below sleeping rooms/areas.

2.1.4.2 Integration in the landscape

The operator takes the necessary measures to satisfy esthetics of the site. The entire site must be maintained in a clean condition (painting, planting, turfing …).

To be conformed to local regulations, to the project owner.

2.1.4.3 Accessibility for rescue service

The system should remain readily accessible to emergency services (access path specified for example), so as to limit intervention times and ensure availability of a large water quantity.

If not possible, complimentary equipment is relevant to delay fire spread and thus offset the additional intervention time (sprinkler type or water mist). This equipment necessity is to study case by case by the considered building stakeholders

If the room was located on a circulation area, an access hatch shall be arranged according to the measures about rooms with important risks.

2.1.4.4 Designing

Battery module (cyan): 350 kg

Power module: 200 kg

Command module: 200kg

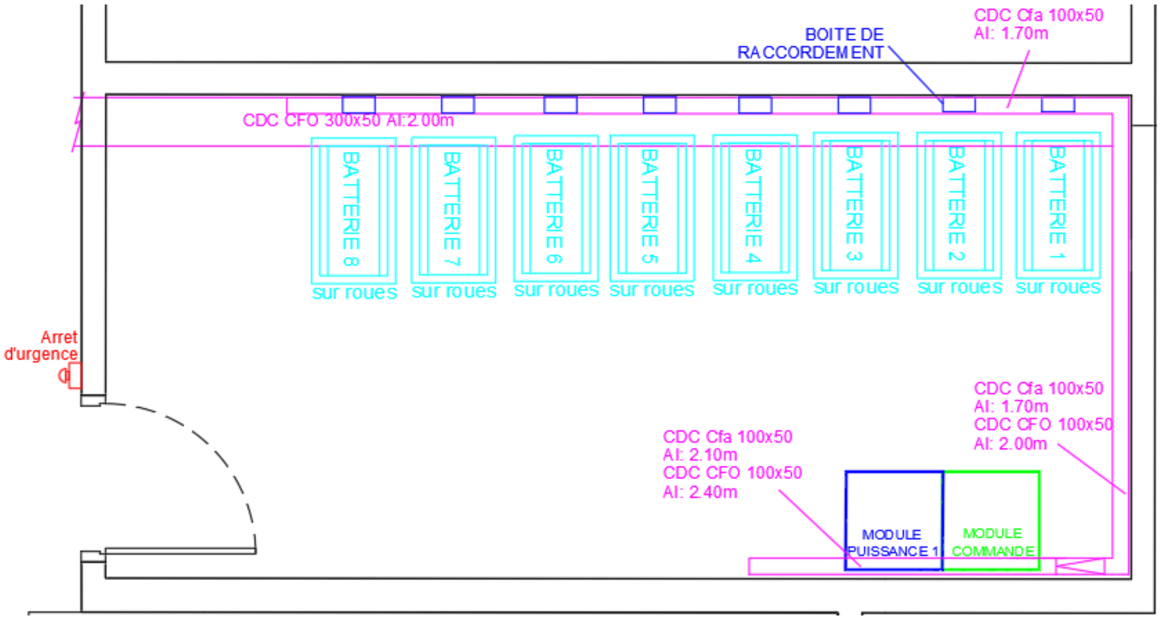


Figure 2: System dimensions for 8 modules

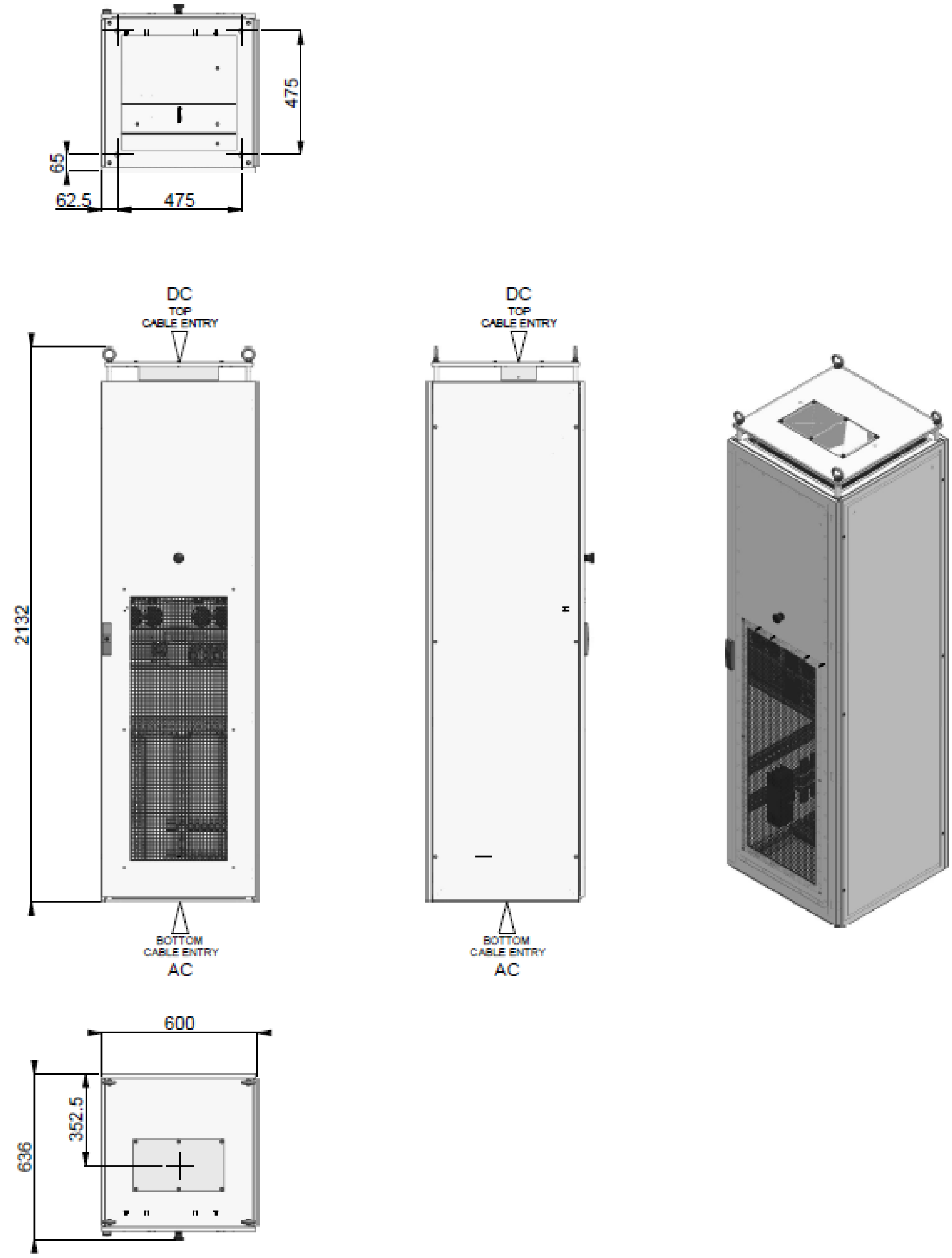


Figure 3: Weight and size of the electronics modules

Sufficient space must be planned regarding safety issues and in order to perform without difficulties the various installation and handling operations.

Furthermore, operations such as changing the battery are planned in the life of the system. The necessary space should be arranged for the associated handling means.

2.1.4.5 Resistance of loads' weight to ground

The room must be able to support the loads corresponding to the stated weights of the system equipment.

2.1.4.6 Execution of the installation

Installation of the system, its execution, and interventions such as batteries replacements, are reserved to the supplier. However, all relevant information related to operation procedures are made available to the operator.

The characteristics of the main switch (circuit breaker), at the top of the system, must be adapted to site characteristics: breaking capacity, protection against indirect contacts (TN/TT), protection of the connection with the main switchboard SGX according to connection length and installation conditions.

The system is equipped with a protection relay accordingly to the local regulation of the country concerned. , the isolation unit required by the UTE C15-400 guide is considered satisfied. However, in order to eliminate any risk of complete power shutdown in the building, the site wishing to be equipped with this system will have to make a subscription allowing a return of power, induced by the system, towards the grid via its point of delivery.

All modifications to the installation, caused by implementing this type of equipment in an existing facility, require initial control report. (R4226 – 14).

2.1.4.7 Internal communication in the building

To enable local system operation by the building, the client (or the operator) will be responsible for establishing secure communication with the system.

2.1.4.8 External communication in the building

To enable remote management, the system requires a robust and secure external communication, of which implementation will be discussed case by case.

2.2 Battery handling precautions

2.2.1 Pack transport terms and conditions

Pack transport conditions are as follows.

- Battery pack must be transported in UN3480 class 9 case.
- Damaged battery pack cases must respect P908 requirements.
- Ideal transport temperature is 25°C or less.
- Temperature up to 45°C are acceptable for short periods.
- For safety reasons, battery pack temperature must never exceed 60°C at any timePack transport conditions are as follows.

2.2.2 **Pack handling conditions**

Battery pack handling conditions are as follows.

- Knocks and falls must be avoided.
- Battery Pack has to be protected against splash water. Short circuit risk during transportation or handling is mainly due to fall risk but also to humidity conditions.

2.2.3 **Pack storage conditions and location requirements**

Battery pack storage conditions and installation location requirements are as follows.

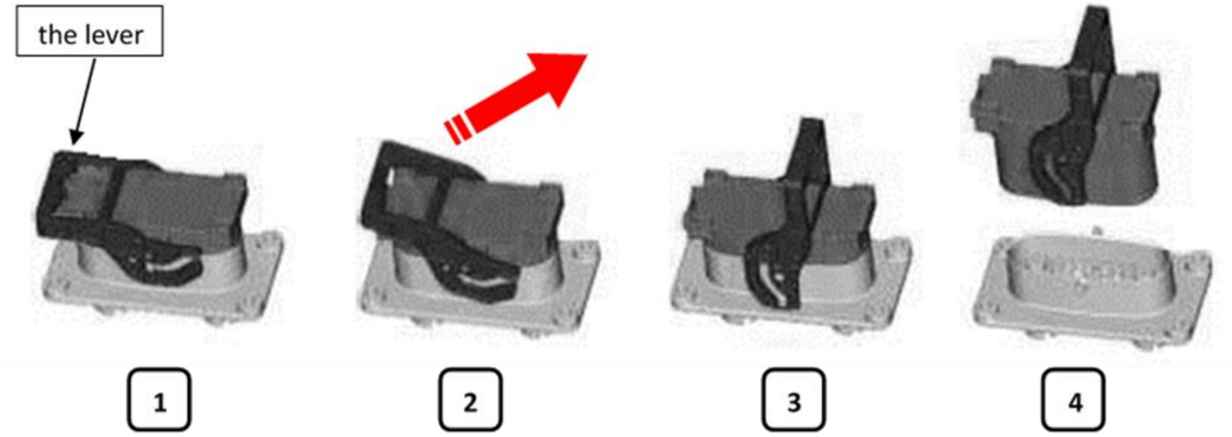
- Storage temperature range must be between -25°C and 25°C. The ideal temperature of the pack environment is 20°C.
- The stationary storage system installation area shall be ventilated and without flood-risk, away from heat sources, sparks and flames.
- Maximal battery pallet stacking is 1/1.
- Once defined, the storage location must be validated by the on-site risk prevention service or by HSE service.
- Battery storage without particular retention.

In case of module deterioration caused by shock, safety risks are many (ex: battery wrapping drilled by Fenwick fork, fall, etc.). Their gravity depend on the nature of the shock: deformation, electrolyte leak or fire caused by short circuit.

- Electrolyte leak of the battery pack is unlikely, especially packed in PVA cartons. Nevertheless, in case of electrolyte leak, wear chemical protection gloves against corrosion and protection glasses.
- Disperse absorbent products then collect them to be treated with classic organic solvents.
- The electrolyte of the lithium-ion battery is a clear liquid with an organic solvent characteristic smell. The electrolyte is a flammable liquid solution.
- If any leaks, ventilate area if necessary.

2.2.4 **Electrical lockout**

To protect against electrical hazards in non-operating conditions, the battery pack must be electrically ‘locked-out’ by completely disconnecting the service plug as shown in Figure xx and by closing the emplacement on the pack with the cover provided in the original packaging.



2.2.5 **Installation method**

The installation requirements are as follows.

- Nothing shall be placed on the packs. Any parts other than the fixed parts shall not be subjected to a load.
- The pack cases shall be grounded (The earth resistance shall be less than 0.05 Ω).
- Select fixed points so that the packs become stable and can keep their posture, though it is not necessary to fix them using all of the fixed parts.
- The battery pack is protected from the water, dust and human access at the degree of IP67B (connection, SD/SW open), IP67D (connection, SD/SW closed), at the vehicle level (battery mounted on the vehicle).
- The weight of the battery pack must be supported by a robust part or by anchor points.

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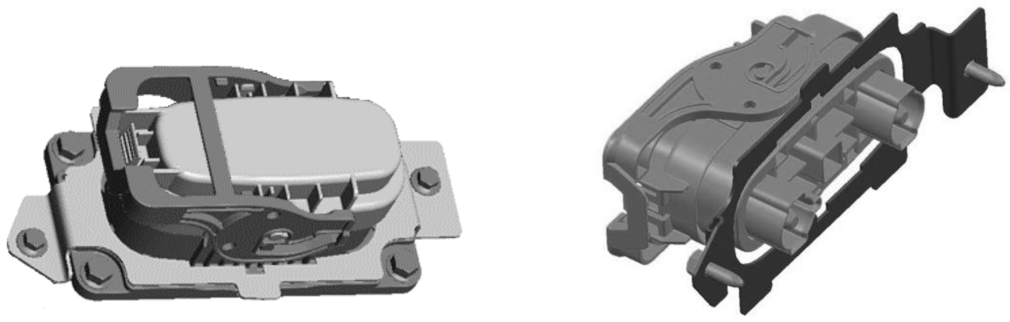
Service Plug basic descriptions



Connection: Insert the plug to the position shown in Figure yy and push the lever until it clicks.

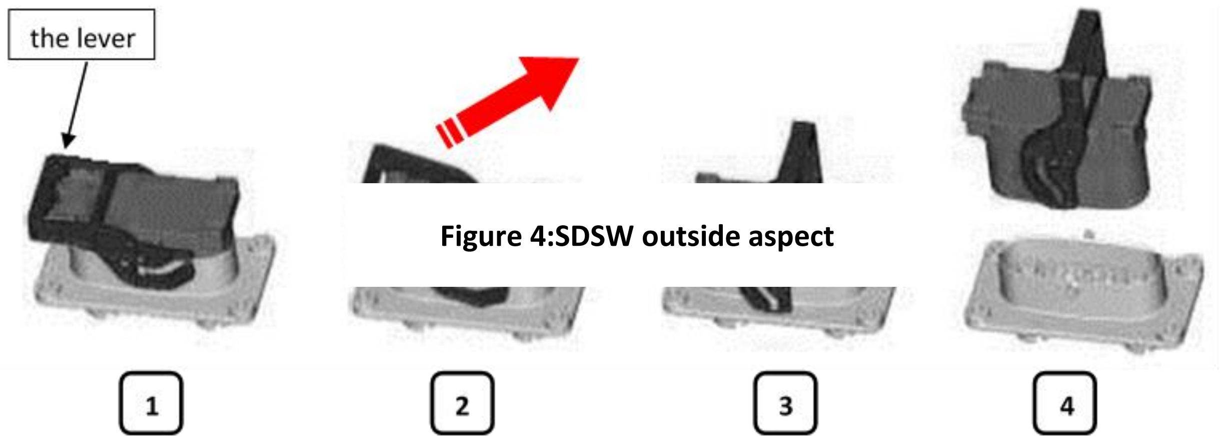


Figure 4:SDSW outside aspect

Figure 5: ***Service plug disconnection method***

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- The weight of the battery pack must be supported by a robust part or by anchor points.

The document “Safety Concept”, gives Provisions and recommendations for the B4B energy storage system installation and operation. The file is shown in Annex 1 and describes the following items:

Safety issues (Internal design, Precautions around the system)

General provisions (Definitions and fields of application)

Implantation- Arrangement (System implantation constraints - Implantation outside the building- Implantation inside the building- Integration in the landscape- Accessibility for rescue service , Designing, Resistance of loads’ weight to ground, Execution of the installation, Internal communication in the building, External communication in the building).

Operation – Maintenance (Monitoring operation- Access control- Emergency stop- Cleanliness- Periodic checking of electrical installations- Battery handling precautions)

Limitations

Validation

2.3 Emergency guide

The following documents make up the ELSA BES training material and respective assessments. The files are shown in Annex 2.

ELSA_D7.6 Unit 1 - Introduction to Energy Storage.pptx

ELSA_D7.6_Unit 2 - ELSA Architecture.pptx

ELSA_D7.6_Unit 2 site - ELSA Architecture SASMI.pptx – (Other sites can be completed during the final stage of the project if necessary)

ELSA_D7.6_Unit 3 - ELSA Hazard Management.pptx

ELSA_D7.6_Unit 4 - ELSA 1st and 2nd Responders.pptx

ELSA_D7.6_Unit 5 - Battery Architecture.pptx

ELSA_D7.6_Unit 6 - Grid Services.pptx - (Support Unit)

ELSA_D7.6_Unit x - Battery Terminology.pptx - (Support Unit)

ELSA Battery Energy Storage Training Assessment Booklet - Questions.doc

ELSA Battery Energy Storage Training Assessment Booklet - Answers.doc

3 MAINTENANCE

3.1 Power electronic- Maintenance operations and periodical checks

This manual is intended for all people that are involved in integrating, installing, operating and/or maintaining the DT5 system solution. People involved in the integration, installation and maintenance of the equipment are expected to know the standard electrical wiring practices, electronic components and electrical schematic symbols. End users should focus on maintenance instructions of this manual.

The following documents make up the ELSA Power electronic maintenance operations and periodical checks. The files are shown in Annex 2 :

Safety Instructions

Upon Reception (Delivery inspection- Unpacking instructions- Lifting and transportation guidelines- Identification tag- Storage)

Maintenance instructions - Maintenance intervals

Standard maintenance procedure

Step 1: Check the ambient temperature conditions

Step 2: Shut the system down

Step 3: Inspect and clean the inverter

Step 4: Check the condition of the unit contactors and fuses

Step 5: Check the tightness of the electrical and mechanical connections

Step 6: Correct any abnormal conditions found

Step 7: Restart the system

Fan replacement

AC/DC or DC/DC module change

Troubleshooting guide (Fault treatment procedure)

Monitoring operation

System operation must be carried under direct or indirect supervision of a person designated by name by the operator and who has the knowledge about system control and the dangers and disadvantages of the used or stored system products.

3.3 Access control

Access to the technical room will be reserved to authorized personnel only. The access control will be done by means of a technical solution (key, badge, other …) defined and implemented by the building operator.

3.4 Emergency stop

The technical room should be equipped with an emergency stop device, located close to the access door outside the room, and which will allow an electrical separation of the system from the building grid.

3.5 Cleanliness

The technical rooms must be regularly cleaned to avoid clusters of dangerous or polluting materials and of dust. The cleaning equipment must be adapted to the risks presented by products and dust.

The local hosting the system should not be used to deposit or store any material or equipment other than those commonly in service in this local.

3.6 Periodic checking of electrical installations

All electrical installations must be maintained in good condition and must be checked after installation or modification by a competent person. The frequency, the purpose, the extent of electrical installation checks as well as the reports content related to the said checks are set by the 20th December 1988 decree concerning labor regulations.

3.2 Batteries- Replacement threshold value capacity

The only maintenance activity on the batteries is the monitoring of their capacity.

A process is implemented in the system for an automatic and regular check of the capacity of each batteries without stopping the system. This choice was made to make this check as transparent as possible for the final user of the system.

The aim is to perform the capacity verification without involving an external system or a battery substitution, with a loss of punctual and limited availability (first discharge, then load).

This process is called the Capacity Check.

The goal is to ensure that the battery does always have a capacity of 11 kWh. If the result of two consecutive capacity check is bellow 11kWh a warning will be raised on the system HMI and the replacement of the battery will be suggested.

The Capacity Check is performed periodically (every 3 months). It can also be launched manually by the user of the system.

Only one capacity check can be performed at a time. It is not possible to have 2 batteries or more in Capacity Check mode at the same time. This is to keep maximum flexibility of the system.

The Capacity check consists first on a charge at 100% of the battery. To complete the charge of the battery to be verified, the system controller takes advantage of phases where the user's need is to store energy. Under these conditions, the battery subjected to the capacity check will take precedence (with regard to the other batteries of the complete system) and will take advantage of the sequence to increase its level of charge. Conversely, during this phase, the battery subjected to the capacity check will be kept at rest in the phases where the user's need is to destock energy (the other batteries of the system will then be used).

The second step of the Capacity Check is a full discharge of the battery. The logic is the same as for the load. Indeed, the controller will take advantage of phases where the need of the user is to destock energy, to request priority the battery subject to capacity verification.

However, to ensure the repeatability and representativeness of the measurement, an additional constraint is added on the discharge power of said battery. The controller will impose the maximum discharge power allowed by the system. Under these conditions, only the needs of the user, greater than this power will continue to discharge the battery.

The automatic capacity check optimizes the operating costs of the energy storage system, especially for equipment, operation and maintenance costs:

- Equipment costs :
    - The integrated automatic capacity check does not depend on additional measuring equipment.
- Costs related to possible breaches of instructions :

    - The integrated automatic verification of storage capacity makes it possible to check regularly (or occasionally in the event of an alert raised by the system itself) the functional status of the energy storage system. This check therefore makes it possible to monitor the functional deterioration of the system and to try to compensate for it as much as possible. In other words, this mechanism makes it possible to ensure the robustness of the services offered over time.
- Maintenance costs :
    - The functional verification of the storage system is an essential step for the proper functioning of the storage system in its environment. Automating this verification by provoking it regularly (or occasionally) makes it possible to limit the need for team interventions for simple verification needs. This therefore limits the operating costs of the system.

This integrated verification also makes it possible to avoid the heavy manual interventions implementing the insulation of the battery with respect to its environment. The battery remains in its operating environment during the entire check. Once again, this eases the maintenance operations and therefore the associated costs.

3.2 Alarm management process

This work is still in progress and we are unable to provide a comprehensive document about alarm management of the system yet.

However, in case of system malfunction, alarms are generated by different components of the system.It all are fed back to the system controller and then to Stanet (cloud based system manager). Depending on the type of alarm, an action will be launched. This categorization of alarms is underway. Some alarms will directly identify the failure and schedule a repair response.

Others will require a further diagnosis the first level can be done remotely thanks to the sending of orders for specific diagnosis and analysis of past events on the system.

4 TRAINING

3.1 WORKERS & PARAMEDICS

The following documents make up the Emergency Response guide for 1st & 2nd Responders based on the content of the training material Unit 4 (see in Annex) :

ELSA_D7.6_Emergency Response Guide.docx

ELSA_D7.6_Emergency Response Guide Appendix A.docx

ELSA_D7.6_Appendix B - Nissan Leaf Battery Specs - 295B0-3NA9B-E.pdf

ELSA_D7.6_Appendix B - Renault Kangoo Material Date Sheet.pdf

ELSA_D7.6_Appendix B Renault Kangoo-X61_Pack_Data sheet.pdf

5 Conclusions

Storage is a key enabler for the energy transition to a low- carbon electricity sector. ELSA, as a new electricity storage system for the final customer, is an essential complement to enrich and energize the electricity storage market by offering to final consumers, new deals of electricity bill reduction services and new revenues from the sale of technical services to electricity network operators.

Moreover, with the use of EV second-life battery, the ELSA solution also will be an excellent alternative in EV battery recycling and in the contribution to the virtuous loop of 100% sustainable.

Most projects are using existing, mature storage technologies. Thus, regulation is ‘aware’ of these technologies and hence integration of these storage systems is not blocked by safety regulations..

Main issues related to safety for demonstration projects but also initial commercial projects include the problem that local authorities and fire brigades have very little experience with the installation of storage systems e.g. at district or residential level. Thus, these projects often spend considerable time and effort to convince these authorities with respect to the safety of the installed system.

Guidelines could complement regulations. A safety guideline for example could be developed on top of the existing regulations (e.g. safety testing for batteries). This guideline should contain practical information (e.g. how to fight a fire) and should relate to known systems (e.g. compare a battery system to a transformer) to overcome the doubts of local authorities. Such guidelines are not an issue at the local level only, also international standardisation organisations would have to contribute.

Coordination and cooperation between system operators should be increased to make use of new services in an efficient way. This coordination and cooperation should be further strengthened in the context of network planning, network operation, emergency situations and restoration.

5 BIBLIOGRAPHY

[1] *(EU) The European Commission COM(2012) 271 final. Renewable Energy: a major player in the uropean energy market,* Brussels, 6.6.2012, p. 14.

[2] *(EU) Directive 96/92/EC of the European parliament and of the council of 19 December 1996 concerning common rules for the internal market in electricity..*

[3] *(EU) Directive 2003/54/EC of the European parliament and of the council of 23 June 2003 concerning common rules for the internal market inelectricity..*

[4] *(EU) Directive 2009/72/EC of The European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC..*

[5] *(EU) The European Commission COM(2015) 340 final. Launching the public consultation process on a new energy market design, Brussels, 15.7.2015, p. 17..*

APPENDIX

B4B – SAFETY CONCEPT

Provisions and recommendations for the B4B energy storage system installation and operation

PROTOTYPE OF THE OPERATIONAL STORAGE SYSTEM

6 modules (including 1 power cabinet + 1 battery)

Author	Organism / Company	Title
Bertrand BOUDAUD	Bouygues E&S	Head of service – Design Manager
Serge LAVERGNE	Bouygues E&S	Electrical testing and commissioning Manager
Patxi ETCHEBARNE	Bouygues E&S	Storage project leader
Yann CHAZAL	Renault	Engineering project manager
Jean-François ROBIN	Renault	Design safety leader
José RUBIO	Socotec	

Content

1) OVERVIEW

B4B is an energy storage system, developed by RENAULT and BOUYGUES ENERGIES & SERVICES since 2012. A prototype is implemented on the site of Challenger, the head office of BOUYGUES CONSTRUCTION.

This first prototype is composed of 6 batteries of “Kangoo ZE”, as well as power electronic components and electronic control systems necessary to the management of the batteries:

- Six independent high current cabinets (modules) including: one battery, one charger, one inverter.
- One main cabinet carrying :
  - The general supply system.
  - A main controller (supervision of the charge and discharge of each battery, overall system management, interface allowing intelligent energy management and ensuring general security).
  - A security controller, allowing redundancy of the security system.

The electrical characteristics are the following:

- Nominal voltage: 400 V three-phase current, 50 Hz.
- Maximum input power (charge): 18 kW (3 kW per charger).
- Maximum output power (discharge): 72 kW (12 kW per battery).
- Storage capacity: 66 kWh.

Below is an example of the implantation plan of a technical room hosting such energy storage system.

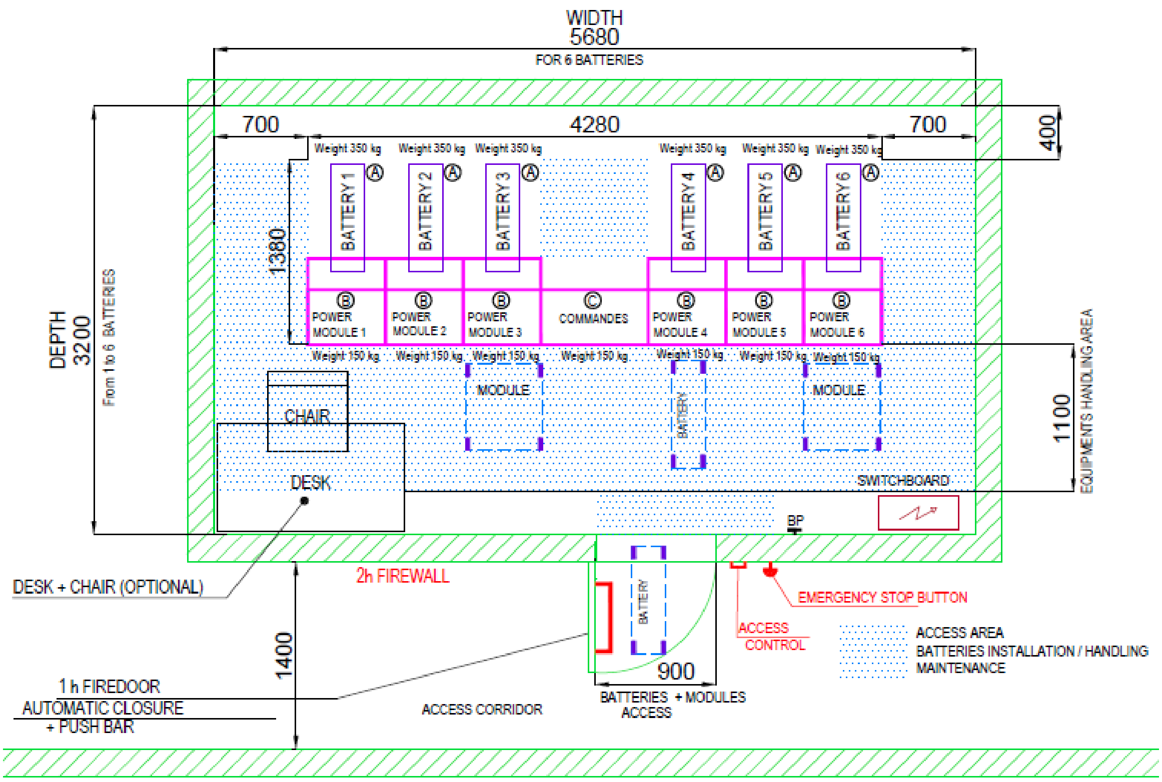

Figure 1 – Example of B4B system implantation in a technical room.

(A) Battery

(B) Power module

(C) control/command cabinet

2) Safety issues

a) Internal design

The risks related to storage system use are identified:

- Electric shock.
- Thermal incident.
- Loss of building's power supply.
- Backup power disturbance.
- False alarm concerning the building's safety.
- Negative impact on the economic power supply conditions.

The first five risks may impact people's safety. Thus, a general safety concept has been established. It is based on precautions taken in the system's internal design and on external precautions as well, which this document is the object.

Cf. annexe 1 : Safety Concept 20150116.xlsx

This document and its appendices were presented to a set of experts listed below for information and validation of the general safety concept of this system.

b) Precautions around the system

This document aims to materialize the agreement of various stakeholders (such as, the system supplier, the

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Lieutenant-Colonel Mi-chel GENTILLEAU	SDIS 86 - Service départemen-tal d'incendie et de secours de la Vienne	Chef du Pôle « Compétences et moyens opérationnels »
Lieutenant-Colonel Oli-vier LABADIE	SDIS 78 - Service départemen-tal d'incendie et de secours des Yvelines	Chef du Groupement « Formation - sports »
Lieutenant-Colonel Christophe BETINELLI	SDIS 78 - Service départemen-tal d'incendie et de secours des Yvelines	Chef du Groupement « Préven-tion »
Colonel Serge DELAUNAY	SDIS 44 - Service départemen-tal d'incendie et de secours de la Loire-Atlantique	Chef d'Etat Major
M. Sébastien WILLEM	Sécurité Civile	
M. Cédric RIGOLLET	Fédération des Sapeurs Pom-piers	
M. Christophe DURINGER	Fédération des Sapeurs Pom-piers	
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M. Hervé BAZIN	Laboratoire Central de la Pré-fecture de police	Ingénieur
Mme Pauline BAVOUX	Ministère du Logement, de l'Égalité des territoires et de la Ruralité	Chef de projet « Sécurité et pré-vention des risques dans les bâti-ments d'habitation »

customer, the operator, the control office, civil safety actors) about the necessary precautions to gather, in order to ensure the security of the installation and operation of the storage system. Its scope goes beyond French regulations, which are at the moment not suitable for storage systems composed of lithium-Ion batter-ies, in order to cover with robustness the identified specific risks.

3) General provisions

a) Definitions and fields of application

i) Definitions

- "Accumulator" : Electrochemical device designed to accumulate and store energy with the aim of being able to restore it in electric DC form (of which operation is reversible).
- "Accumulator battery" : Association of several accumulators with the aim of having greater energy storage and/or higher output DC voltage.
- "Charger" : Electrical device providing an output DC voltage and connected to an accumulator battery.
- "Inverter" : electrical device connected to an accumulator battery, allowing to restore its energy to a power grid (alternating current).
- Batteries used in this storage system :

Cf. annexe 2 : RETEX feux de VE nov 2014.pdf

ii) Application field

For this version of the document, the French regulations were taken into account. An adaptation would be necessary for an installation out of France.

Cf. annexe 3 : Analyse préalable de la règlementation.xlsx

4) Implantation– Arrangement

This section applies to the local where the system installation is located. The regulatory requirements' state of art was collected and analyzed although it is formulated for storage systems that are likely to generate and accumulate hydrogen (batteries with gas recombination). Since this particular risk is not present for Lithium-Ion batteries considered in our system, this regulatory basis will not be a reference adapted to our system.

Thus, in consultation with specialists in fire safety services, specific risk analysis was conducted.

a) System implantation constraints

The implantation site must have a suitable surface for receiving the storage system. The main door of the technical room and paths leading to it must be wide enough to allow the various elements delivery.

Unlike hydrogen accumulator batteries previously mentioned, this system does not require additional air exchange for operating.

The environment and thermal conditions should be adapted to aging process of the equipment and in particular of the batteries. The system is functional between 0 and 40°C. The conditions of temperature for a nominal use are however located between 5 and 30°C.

Retention tanks are normally required under the batteries, so as to retain fluid in a fire event in the case of liquid or liquefied electrolyte.
In the case considered here, this risk is isolated because of the type of the batteries used.

i) Implantation outside the building

The installation must be in conformity with local current regulations regarding minimal safety distances to adopt for its implementation, in relation to property boundaries and the local urban plan. Beyond 8m from the facades, installation into a dedicated-use structure (e.g. in a container) can be made without special requirements concerning firebreak degree.

ii) Implantation inside the building

Installation must be done in a dedicated technical room, reserved for electricians.

Any room with this installation should be marked as an electrical room and treated as a room with an important particular risk, in accordance with the applicable regulations (ERP, dwellings, residential). Concerning in particular stability and fire resistance degree.

This room must be specified on the plans, if it is required under the applicable regulation (ERP, dwellings, residential), in order to be identified by rescue services as at early stage as possible and as soon as they arrive at the implementation site.

The room will have to be equipped with an outdoor emergency stop key, of which the effect should be to open the circuit breaker coupling the system to the building grid.

The room should resist to fire in case of internal cause as well as in case of an external cause spread. Its resistance will have to be adapted to regulatory requirements according the considered building (Labor code, ERP, IGH).
This applies also to the presence of an autonomous fire detection system.

The presence of a combustion gas evacuation device (in case of fire), must be conditioned to current regulations for building classification (Labor code, ERP, IGH). A system with air evacuation vents, leading directly to the outside, should be arranged.

This room should not be located in the floor. If that was the case, plan a dry standpipe for water supply and if possible do not place the room below sleeping rooms/areas.

b) Integration in the landscape

The operator takes the necessary measures to satisfy esthetics of the site. The entire site must be maintained in a clean condition (painting, planting, turfing …).

To be conformed to local regulations, to the project owner.

c) Accessibility for rescue service

The system should remain readily accessible to emergency services (access path specified for example), so as to limit intervention times and ensure availability of a large water quantity.

If not possible, complimentary equipment is relevant to delay fire spread and thus offset the additional intervention time (sprinkler type or water mist). This equipment necessity is to study case by case by the considered building stakeholders

If the room was located on a circulation area, an access hatch shall be arranged according to the measures about rooms with important risks.

d) Designing

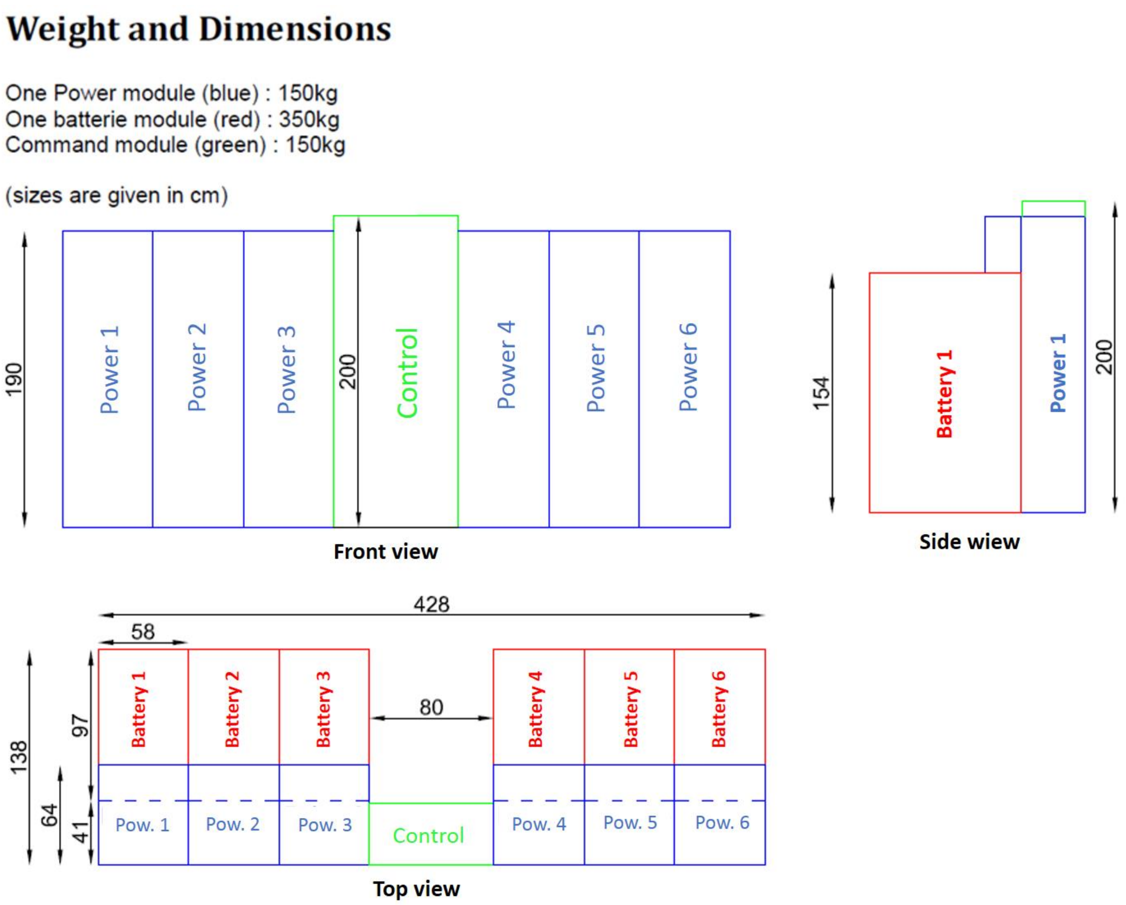

Figure 2 – System dimensions for 6 modules

Sufficient space must be planned regarding safety issues and in order to perform without difficulties the various installation and handling operations.

Furthermore, operations such as changing the battery are planned in the life of the system. The necessary space should be arranged for the associated handling means.

e) Resistance of loads' weight to ground

The room must be able to support the loads corresponding to the stated weights of the system equipment.

f) Execution of the installation

Installation of the system, its execution, and interventions such as batteries replacements, are reserved to the supplier. However, all relevant information related to operation procedures are made available to the operator.

The characteristics of the main switch (circuit breaker), at the top of the system, must be adapted to site characteristics: breaking capacity, protection against indirect contacts (TN/TT), protection of the connection with the main switchboard SGX according to connection length and installation conditions.

The system is equipped with a protection relay accordingly to DIN VDE 0126 standard integrated to the PV inverter, the isolation unit required by the UTE C15-400 guide is considered satisfied. However, in order to eliminate any risk of complete power shutdown in the building, the site wishing to be equipped with this system will have to make a subscription allowing a return of power, induced by the system, towards the grid via its point of delivery.

All modifications to the installation, caused by implementing this type of equipment in an existing facility, require initial control report. (R4226 – 14).

g) Internal communication in the building

To enable local system operation by the building, the client (or the operator) will be responsible for establishing secure communication with the system.

h) External communication in the building

To enable remote management, the system requires a robust and secure external communication, of which implementation will be discussed case by case.

5) Operation – Maintenance

a) Monitoring operation

System operation must be carried under direct or indirect supervision of a person designated by name by the operator and who has the knowledge about system control and the dangers and disadvantages of the used or stored system products.

b) Access control

Access to the technical room will be reserved to authorized personnel only. The access control will be done by means of a technical solution (key, badge, other …) defined and implemented by the building operator.

c) Emergency stop

The technical room should be equipped with an emergency stop device, located close to the access door outside the room, and which will allow an electrical separation of the system from the building grid.

d) Cleanliness

The technical rooms must be regularly cleaned to avoid clusters of dangerous or polluting materials and of dust. The cleaning equipment must be adapted to the risks presented by products and dust.

The local hosting the system should not be used to deposit or store any material or equipment other than those commonly in service in this local.

e) Periodic checking of electrical installations

All electrical installations must be maintained in good condition and must be checked after installation or modification by a competent person. The frequency, the purpose, the extent of electrical installation checks as well as the reports content related to the said checks are set by the 20^{th} December 1988 decree concerning labor regulations.

f) Battery handling precautions

Interventions on batteries should be entrusted to the storage system supplier. It is pointed out however that their handling is subject to the following precautions:

i) Safety requirements

(1) Pack transport terms and conditions

Pack transport conditions are as follows.

Battery pack must be transported in UN3480 class 9 case.
Damaged battery pack cases must respect P908 requirements.
Ideal transport temperature is 25°C or less.
Temperature up to 45°C are acceptable for short periods.
For safety reasons, battery pack temperature must never exceed 60°C at any time

(2) Pack handling conditions

Battery pack handling conditions are as follows.

Knocks and falls must be avoided.
Battery Pack has to be protected against splash water. Short circuit risk during transportation or handling is mainly due to fall risk but also to humidity conditions.

(3) Pack storage conditions and location requirements

Battery pack storage conditions and installation location requirements are as follows.

- Storage temperature range must be between -25°C and 25°C. The ideal temperature of the pack environment is 20°C.
- The stationary storage system installation area shall be ventilated and without flood-risk, away from heat sources, sparks and flames.
- Maximal battery pallet stacking is 1/1.
- Once defined, the storage location must be validated by the on-site risk prevention service or by HSE service.
- Battery storage without particular retention.

In case of module deterioration caused by shock, safety risks are many (ex: battery wrapping drilled by Fenwick fork, fall, etc.). Their gravity depend on the nature of the shock: deformation, electrolyte leak or fire caused by short circuit.

- Electrolyte leak of the battery pack is unlikely, especially packed in PVA cartons. Nevertheless, in case of electrolyte leak, wear chemical protection gloves against corrosion and protection glasses.
- Disperse absorbent products then collect them to be treated with classic organic solvents.
- The electrolyte of the lithium-ion battery is a clear liquid with an organic solvent characteristic smell. The electrolyte is a flammable liquid solution.
- If any leaks, ventilate area if necessary.

(4) Electrical lockout

To protect against electrical hazards in non-operating conditions, the battery pack must be electrically 'locked-out' by **completely** disconnecting the service plug as shown in Figure xx and by closing the emplacement on the pack with the cover provided in the original packaging.

Service Plug basic descriptions

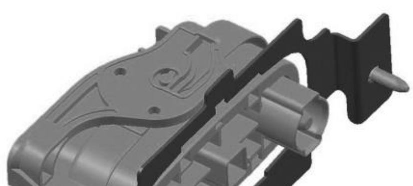

Figure xxx – SDSW outside aspect

Connection: Insert the plug to the position shown in Figure yy and push the lever until it clicks.

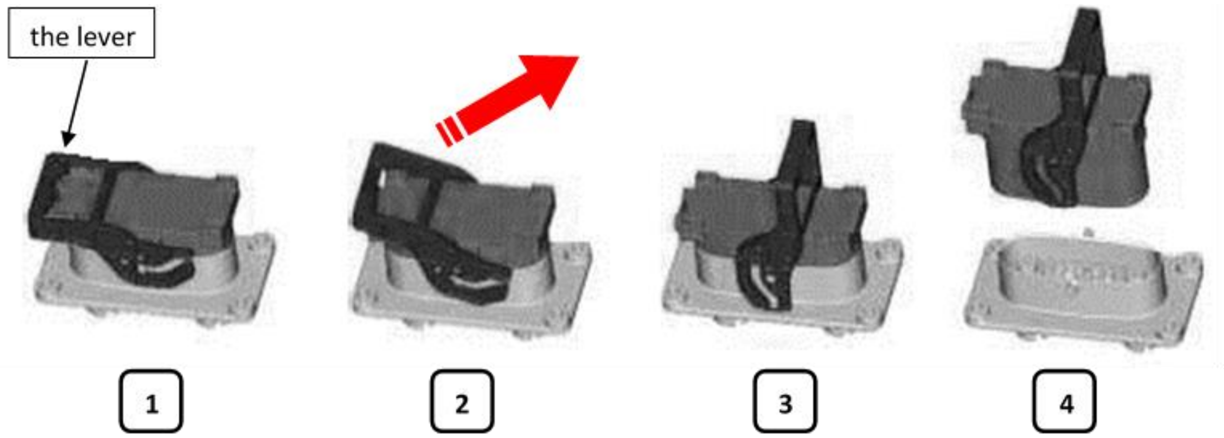

Figure yy – Service plug disconnection method

ii) Installation method

The installation requirements are as follows.

- Nothing shall be placed on the packs. Any parts other than the fixed parts shall not be subjected to a load.
- The pack cases shall be grounded (The earth resistance shall be less than 0.05 Ω).
- Select fixed points so that the packs become stable and can keep their posture, though it is not necessary to fix them using all of the fixed parts.
- The battery pack is protected from the water, dust and human access at the degree of IP67B (connection, SD/SW open), IP67D (connection, SD/SW closed), at the vehicle level (battery mounted on the vehicle).

The weight of the battery pack must be supported by a robust part or by anchor points.

6) Limitations

The system is not designed to be used as a backup power for critical systems. Moreover, except specific study, it should not be installed in a part of a backup power unit. The current system is validated for TN and TT grid infrastructure.

7) Validation

RENAULT

Name :

Title :

Signature :

Bouygues ES

Name :

Title :

Signature :

Socotec

Name :

Title :

Signature :

Annex

DT5 MAINTENANCE

INSTRUCTION MANUAL

ELSA DT5 system

Maintenance instructions

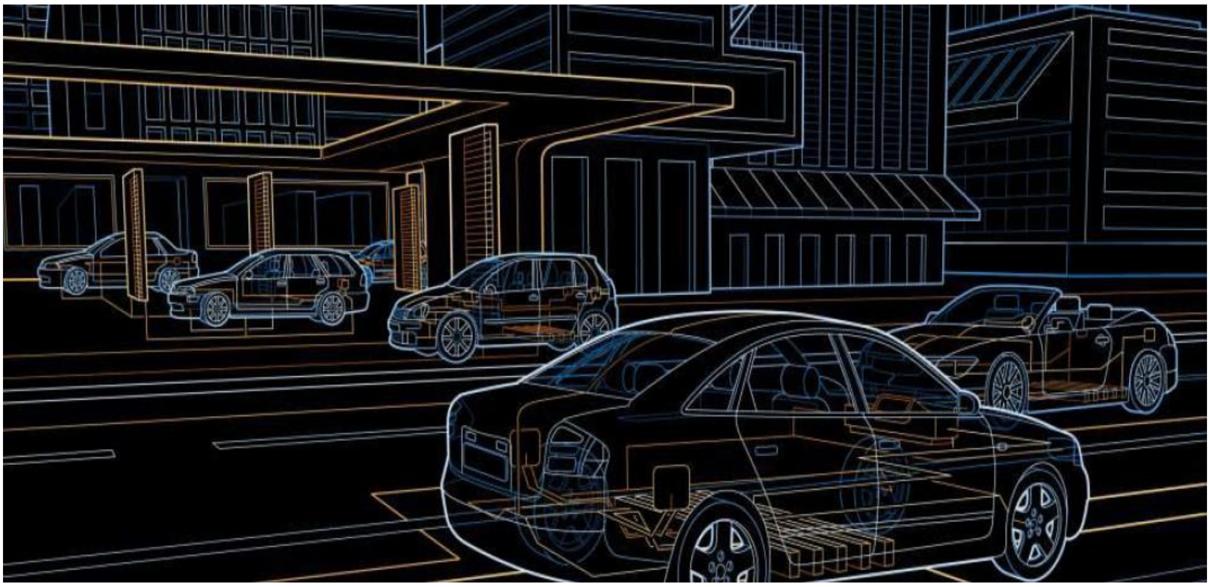

Table of contents

4 Introduction to this manual

4.1 What this chapter contains

This chapter gives basic information on this manual.

4.2 Intended audience

This manual is intended for all people that are involved in integrating, installing, operating and/or maintaining the DT5 system solution. People involved in the integration, installation and maintenance of the equipment are expected to know the standard electrical wiring practices, electronic components and electrical schematic symbols. End users should focus on maintenance instructions of this manual.

5 Safety Instructions

These safety instructions are intended for all work on the DT5 system. Neglecting these instructions can cause physical injury and death. All electrical installation and maintenance work on the system should be carried out by qualified electricians. Do not attempt to work on a powered DT5.

After switching off the supply to the system, always you must always wear isolating gloves and eye-protection when working on electrical installations. Also make sure that all local safety regulations are fulfilled.

DANGER: To ensure safe access, supplies to each individual enclosure must be isolated before opening.

WARNING: This equipment contains capacitors that are connected between phase and earth. A leakage current will flow during normal operation. Therefore, a good earth connection is essential and must be properly connected before applying power to the inverter.

WARNING: If the ground is not done properly, under certain fault conditions in the unit or in the system to which it is connected it can result in full line voltage between chassis and earth ground. Severe injury or death can result if the chassis and earth ground are touched simultaneously.

6 Upon Reception

6.1 What this chapter contains

This chapter gives basic information on how to inspect, transport, identify and store the DT5 solution.

6.2 Delivery inspection

Each DT5 system cubicle is delivered in a box designed to protect adequately the equipment during shipment. Upon reception of the equipment, make sure that the packing is in good condition. Verify the state of the shock and tilting indicators (if mounted on the enclosure or on the panels).

6.3 Unpacking instructions

After removal of the top cover, check visually the exterior and interior of your inverter for transportation damage.

Any loss or damage should be notified immediately to your representative.

6.4 Lifting and transportation guidelines

Please note that inverter equipment weighs approximately 250 kilograms. Care should be taken to ensure that correct handling facilities are used.

To transport the equipment, use a forklift or similar equipment. The enclosures have to be transported vertically.

6.5 Identification tag

Each system is fitted with nameplates for identification purposes.

The inverter nameplate is located at the top left of the master panel door, at the outside.

The nameplate information should always remain readable to ensure proper identification during the life of the inverter. The main inverter nameplate includes the inverter type, the nominal voltage range and frequency as well as a serial number and an ABB internal article code.

6.6 Storage

If your system is not installed once unpacked, it should be stored in a clean indoor, dry, dust free and non-corrosive environment. The storage temperature must be between

-25°C (-13°F) and 70°C (158°F) with a maximum relative humidity of 95%, non-condensing.

Table 1: Maximum allowed ambient conditions for storage

	Storage (in the protected package)
Temperature	-25 to 70°C (-13 to 158°F)
Relative humidity	Max. 85%
Contamination levels (IEC 60721-3-3)	Chemical class 3C3[a] Mechanical class 3S3[b]

Remarks:

[a] Locations with normal levels of contaminants, experienced in urban areas with industrial activities scattered over the whole area, or with heavy traffic.

[b] Locations without special precautions to minimize the presence of sand or dust. Also applies to locations in close proximity to sand or dust sources.

7 Maintenance instructions

7.1 What this chapter contains

This chapter contains the maintenance instructions for the inverter. Although your DT5 system has been designed for minimum maintenance, the following procedure should be carefully followed to ensure the longest possible lifetime of your investment.

WARNING: All maintenance work described in this chapter should only be undertaken by a qualified electrician. The safety instructions presented in this manual must be strictly adhered to.

WARNING: High AC and DC voltages may be present in the inverter panel. Do not touch any inverter parts unless you have ascertained that they do not carry dangerous voltage levels.

WARNING: Under no circumstances close the DC and AC contactor manually. Failure to adhere to this guideline may result in physical injury and/or in inverter damage.

7.2 Maintenance intervals

Table 2 lists the routine maintenance intervals. Depending on the operating and ambient conditions, the intervals of Table 2 may have to be reduced. Announced intervals assume that the equipment is operating under approved operating conditions.

Table 2: DT5 maintenance intervals

Maintenance	Intervals
Standard maintenance procedure	Depending on the dustiness/dirtiness of the environment, every 12 to 24 months.
Cooling fan change	Every 4 years for the (35000 hours)
AC/DC or DC/DC module change	In case of module failure

7.3 Standard maintenance procedure

7.3.1 Step 1: Check the ambient temperature conditions

With the system running, check the ambient temperature conditions and make sure that they are similar to the conditions at the commissioning stage. If higher temperatures are present, this may indicate a problem with the switch room cooling/ventilation system. If the ambient temperature is higher than 40°C/104°F, a derating would be applied.

7.3.2 Step 2: Shut the system down

- Switch the system off and remove the power supply.
- Open the door and make sure that no voltage is present on the AC and DC side.
- Open the auxiliary circuit fuse box.

7.3.3 Step 3: Inspect and clean the inverter

- Inspect the cubicle visually for any condition that could indicate an abnormal stress (e.g. abnormal appearance/color of components and wires)
- Remove all dust deposits in and around the unit. Pay special attention to the fan. Indeed, the dust from the cooling air may run into overtemperature faults if the inlet is not cleaned regularly. Pay special attention to this item if the system has experienced shut downs due to over temperature in the past.
- Ensure that no loose particles are left in the unit that could cause consequential damage.
- If necessary remove dust from it with a soft brush.

7.3.4 Step 4: Check the condition of the unit contactors and fuses

- Ensure that the AC and DC contactor can move freely.
- If bad fuses are found (upstream or in the unit), replace them. If the fuse in one phase is bad, it is good practice to change the fuses of all phases.

7.3.5 Step 5: Check the tightness of the electrical and mechanical connections

- Ensure that all electrical connections are properly fixed and that connectors are properly plugged in. Remove oxidation traces of pin connectors if present. To this effect a small stiff brush can be used.
- Check the mechanical fixation of all components and retighten if necessary.

7.3.6 Step 6: Correct any abnormal conditions found

If required, refer to advice on troubleshooting the unit.

7.3.7 Step 7: Restart the system

- Reclose the auxiliary circuit fuse box.
- Close the door and make sure that the situation return to the normal condition.
- Reapply power to the system upstream.
- Restart the system, verify that the fan starts running

7.4 Fan replacement

There are different types of fans present in your system. The cooling fan lifespan is between 3 and 6 years typically, depending on the usage and ambient temperature.

Fan failure is often preceded by increasing noise from the bearings and rise of the heatsink temperature despite cleaning. It is recommended to replace the fan once these symptoms appear. Contact your service provider for replacement fans for your system.

To exchange the cooling fans, follow the instructions below:

- Ensure that the power to the system is switched off (upstream).
- Open the door and make sure that no voltage is present on the AC and DC connection.
- Remove the screws of the front panels of AC/DC or DC/DC modules
- Remove the screw that fix the fan to the modules
- Remove the fan assembly from the enclosure.
- Refit the assembly in the unit. Ensure proper fixation by the screws.
- Reconnect the fan wires to the terminal block.
- Reclose the cover.

Figure 6: Overview of DC/DC cooling fan in

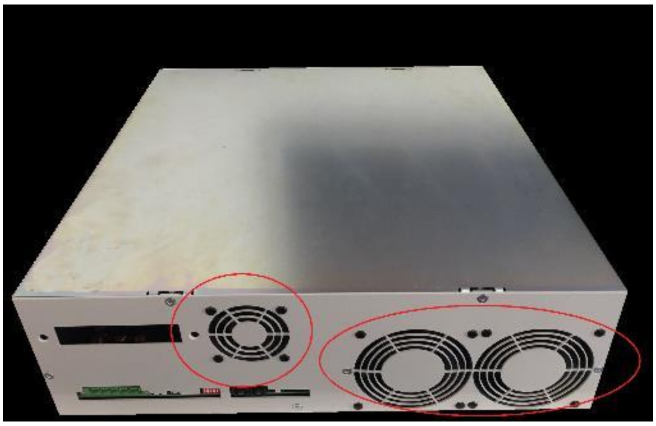

Figure 7: Overview of AC/DC cooling fan in

7.5 AC/DC or DC/DC module change

It is not possible to predict a failure of the AC/DC and DC/DC module. Contact your service provider if capacitor failure is suspected.

Once the faulty module is identified, the replacement consists in extracting that module and installing a new one.

The module that has been extracted shall be sent to the service provider for diagnosis.

8 Troubleshooting guide

8.1 What this chapter contains

This chapter presents the troubleshooting guide for DT5 system. The fault treatment procedure is described. Also, an overview of possible errors is given. Finally, recommendations are made on how problems may be resolved.

WARNING: All troubleshooting and repair work described in this chapter should only be undertaken by a qualified electrician. The safety instructions presented in Chapter 5 of this manual must be strictly adhered to.

WARNING: High AC and DC voltages may be present in the inverter enclosure. Do not open the panel and touch any inverter parts unless you have ascertained that they do not carry dangerous voltage levels.

WARNING: Under no circumstances close the DC and AC contactors manually. Failure to adhere to this guideline may result in physical injury and/or in inverter damage.

WARNING: Some checks may have to be made with the supply on and the inverter protective cover removed. These tests must be carried out only by authorized and qualified personnel, in accordance with the local regulations. Apply the safety guidelines that are presented in Chapter 5. Failure to adhere with the safety guidelines may result in lethal physical injury.

8.2 Fault treatment procedure

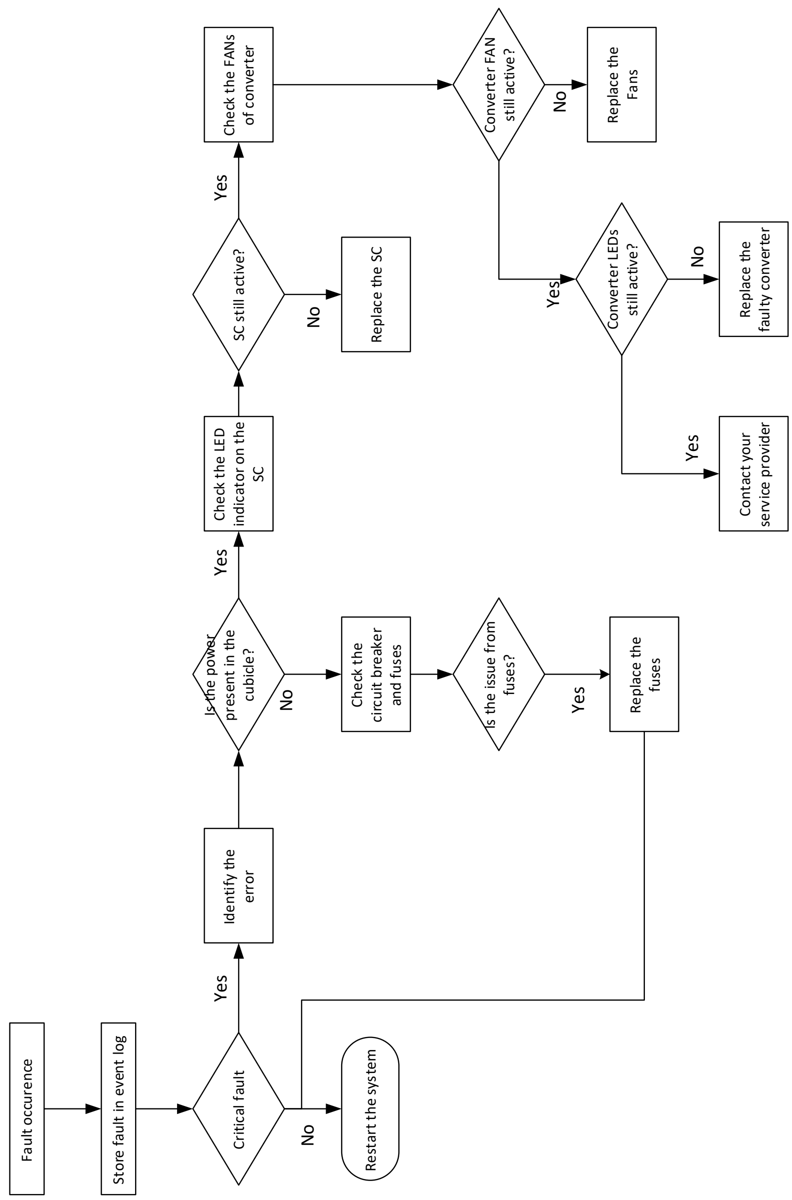

Figure 8: DT5error treatment procedure in flowchart format

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s.a. ABB n.v.

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Service: jumet.services@be.abb.com

http://new.abb.com/high-voltage/capacitors/lv

Additional information

We reserve the right to make technical changes or modify the contents of this document without prior notice. With regard to purchase orders, the agreed particulars shall prevail. ABB does not accept any responsibility whatsoever for potential errors or possible lack of information in this document.

This is an overview of all of the Units under development with a brief description of each slide contained in the unit.

It also includes a section at the far right that looks at the relevance of each slide for a given audience. To be completed.

This is important as it is not possible to have a 'one document suits all' approach to this training.

This document is also being used as a reminder of what aspects need to be completed for GCOLS's input into Deliverable 7.6.

2. ELSA Unit 1 - Introduction to Energy Storage – v1.0

3. ELSA Unit 2 - ELSA Architecture - v1.0

This is a generic module.

a. ELSA Unit 2e - ELSA Architecture SASMI - v1.0

However there are also Units 2a – 2f that are site specific units relating to each of the demo sites.

I believe that Alexandre could help complete these rather than having to request each individual site representatives for this information as I believe most of it already exists within previous reports. – I could come to Paris for a couple of days to complete this if Alexandre is available?

4. ELSA Unit 3 - ELSA Hazard Management - v2.0

5. ELSA Unit 4- ELSA 1st and 2nd Responders - v1.0

This is a short Unit that would lead into other units but specifically for 1st & 2nd Responders only.

This will also form the opening to the 'Emergency Response Guide' for 1st & 2nd Responders which is currently under development.

UNIT 1- INTRODUCTION TO ENERGY STORAGE

Energy Local Storage Advanced system

Energy Storage Systems (ESS)

Energy Local Storage Advanced system

- 1. Introduction to Energy Storage Systems (ESS)

What is energy storage?

Energy storage involves the capture of energy at one time for use at a later time.
Energy can take different forms, for example:
Light, heat, mechanical, gravitational, electrical, sound, chemical, magnetic, kinetic, nuclear or atomic energy and so on.
These forms of energy can be transferred and transformed between one another.

A wind-up clock stores energy as mechanical energy in the spring tension.
A battery stores chemical energy which is then converted to electrical energy.

Energy Local Storage Advanced system

1. Introduction to Energy Storage Systems (ESS)

Benefits of Energy Storage

There are a number of benefits energy storage can offer in various forms and to various stakeholders, these include;

- Energy storage can enable the integration of more renewables (especially solar PV and wind) in the energy mix.
- Storage technologies could decrease the need to invest in new conventional generation capacity, resulting in financial savings and reduced emissions especially from electricity generation.
- They can also provide system stability during electricity outages by supplying energy at these times and reducing the financial costs of power outages.

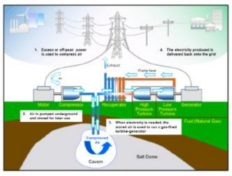
ELSA - SASMI 5

Energy Local Storage Advanced system

- 1. Introduction to Energy Storage Systems (ESS)

Examples of energy storage systems

Compressed Air Energy Storage (CAES)



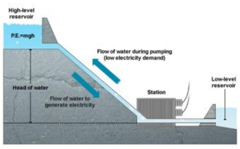
In a CAES plant, ambient air is compressed and stored under pressure in an underground cavern. When electricity is required, the pressurized air is heated and expanded in an expansion turbine driving a generator for power production.

Energy Local Storage Advanced system

- 1. Introduction to Energy Storage Systems (ESS)

Examples of energy storage systems

Pumped Hydroelectric Storage (PHS)



A pumped storage system requires two water reservoirs – an upper and a lower – and water is moved between these two levels. By using surplus (or cheap) electricity to pump water from the lower reservoir to the upper reservoir, energy can be stored in the form of gravitational potential energy, which can then be converted back into electrical energy at a later time by allowing the water to flow back down from the upper to lower reservoir though a turbine and generator – just like conventional hydroelectric technology. In this manner energy is converted from electrical to kinetic to gravitational potential and then back to kinetic and finally back to electrical again.

Energy Local Storage Advanced system

1. Introduction to Energy Storage Systems (ESS)

Benefits of Energy Storage

- Utilisation of storage also means fewer and cheaper electricity transmission and distribution system upgrades are required.
- Energy can be stored when prices are low and used on site when they are high to save consumers and businesses money on their bills. Alternatively the stored energy can be sold.
- Storage technologies can reduce the usage of fossil fuels, enabling a greener energy supply mix.

ELSA - SASMI 6

Energy Local Storage Advanced system

- 1. Introduction to Energy Storage Systems (ESS)

In summary: -

- Comparing one method of energy storage with another is only of use in determining which is the optimal for a specific solution.
- None of them are optimal for all purposes.
- Different storage methods differ in capacity and maximum usable storage time.
- Reliable and affordable energy storage is a prerequisite for using renewable energy.
- Energy storage therefore has a pivotal role in the future.
- Energy storage is the most promising technology currently available to meet the ever increasing demand for energy.
- Energy can be stored, Power cannot.

UNIT 2 ELSA ARCHITECTURE

Energy Local Storage Advanced system

ELSA Architecture

Energy Local Storage Advanced system

3. ELSA Architecture

What does the ELSA Building Energy Storage System (BESS) do?

ELSA addresses existing development needs by combining 2nd life EV batteries with an innovative local ICT-based Energy Management System in order to develop a low-cost, scalable and easy-to-deploy battery energy storage system.

2

Energy Local Storage Advanced system

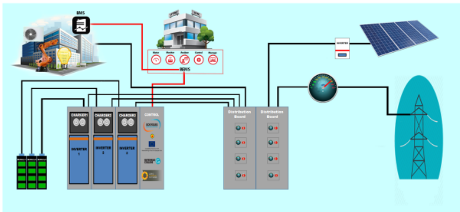
3. ELSA Architecture

What is contained within the Energy Storage System (ESS)?

Energy Local Storage Advanced system

3. ELSA Architecture

An example of an ELSA Energy Storage System



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Energy Local Storage Advanced system

3. ELSA Architecture

The ELSA Energy Storage System

In essence, the components of the B4B storage system are:

- A number of 'Controller Modules' – dependent on the number of batteries being used.
- A number of 'Power modules' each containing an inverter, a charger and security devices – dependent on the number of batteries being used.
- A communication link with an Energy Manager.
- The installation feeds into the Main Building Distribution Board of the building.

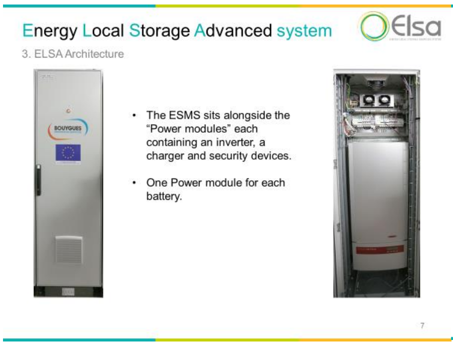
5

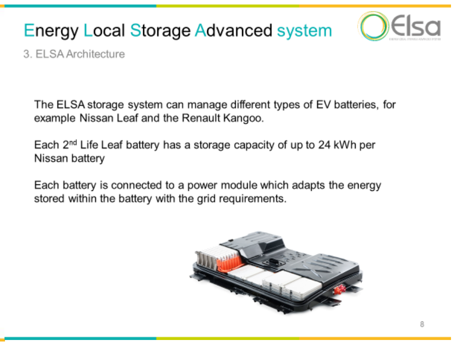
Energy Local Storage Advanced system

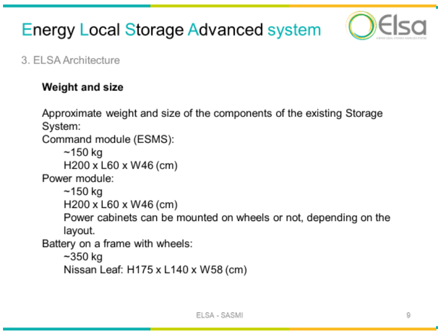
3. ELSA Architecture

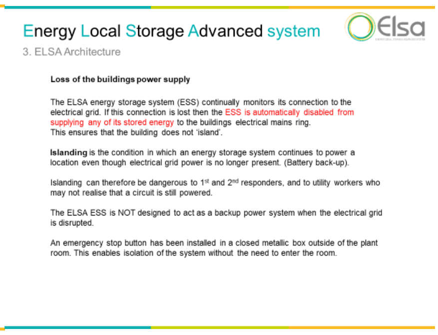
- The 'Control Module' - A single controller (Energy Storage Management System - ESMS), is contained in a separate command module. This module manages the charge and discharge of each EV battery and ensures the security of the whole system.
- A 'Safety PC' is also situated within this module that monitors and manages all safety aspects regarding the safe operation of the equipment.
- A single Control Module can control up to 6 Power Modules

6

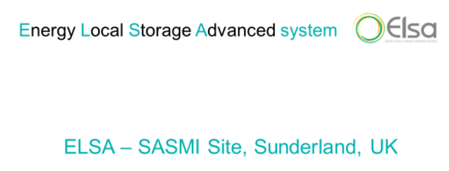


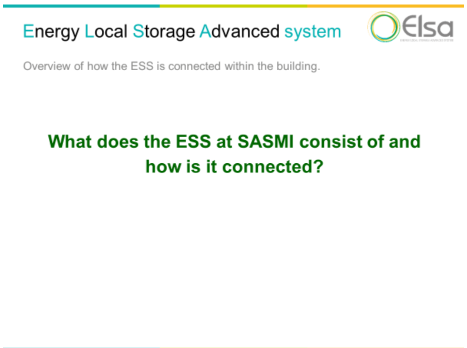


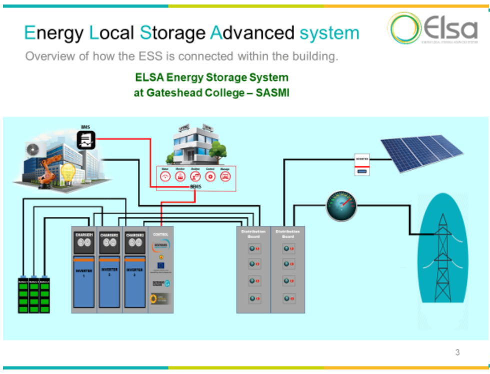


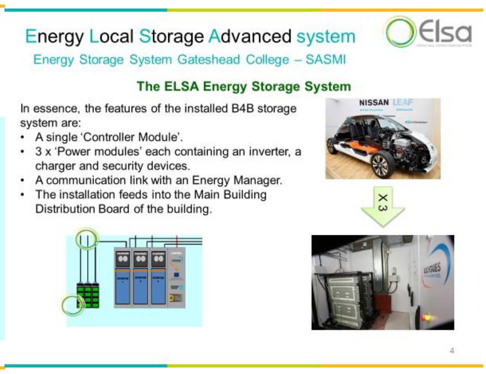


UNIT 2e ELSA ARCHITECTURE SASMI

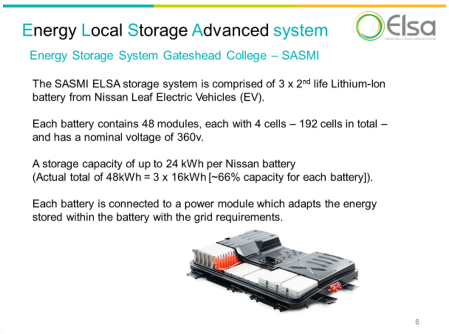


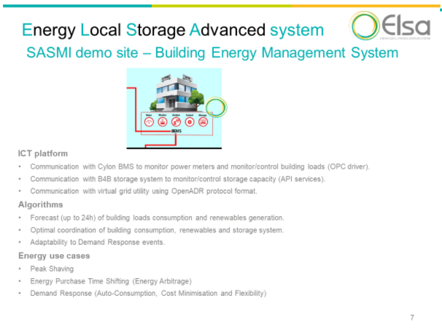


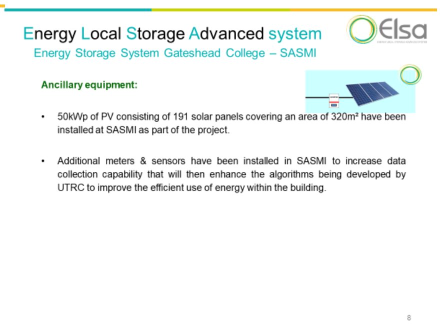

Energy Local Storage Advanced system
Overview of how the ESS is connected within the building.
ELSA Energy Storage System
at Gateshead College – SASMI
3

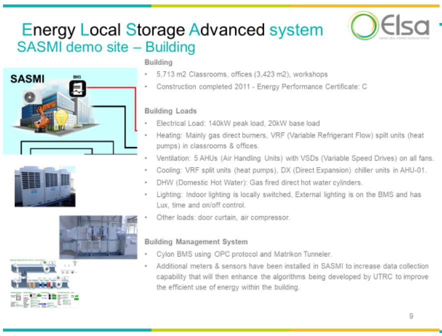

Energy Local Storage Advanced system
Energy Storage System Gateshead College – SASMI
The ELSA Energy Storage System
In essence, the features of the installed B4B storage system are:
• A single 'Controller Module'.
• 3 x 'Power modules' each containing an inverter, a charger and security devices.
• A communication link with an Energy Manager.
• The installation feeds into the Main Building Distribution Board of the building.
NISSAN LEAF
X 3
4

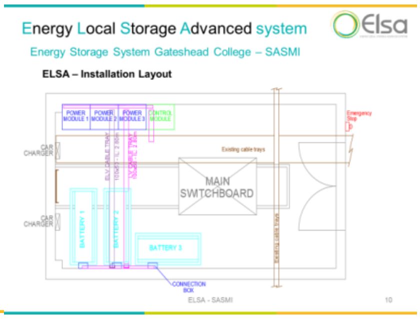

Energy Local Storage Advanced system
Energy Storage System Gateshead College – SASMI
NISSAN LEAF
X 3
Storage system capacity
1st life batteries : 72 kWh
2nd life batteries: ~48 kWh
5

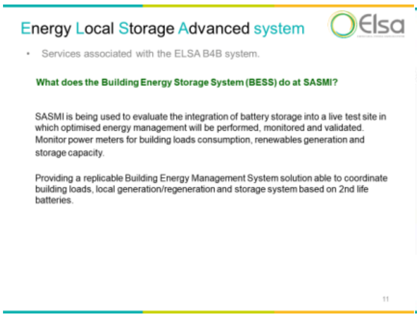

Energy Local Storage Advanced system
Energy Storage System Gateshead College – SASMI
The SASMI ELSA storage system is comprised of 3 x 2nd life Lithium-Ion battery from Nissan Leaf Electric Vehicles (EV).
Each battery contains 48 modules, each with 4 cells – 192 cells in total – and has a nominal voltage of 360v.
A storage capacity of up to 24 kWh per Nissan battery
(Actual total of 48kWh = 3 x 16kWh [~66% capacity for each battery]).
Each battery is connected to a power module which adapts the energy stored within the battery with the grid requirements.
6

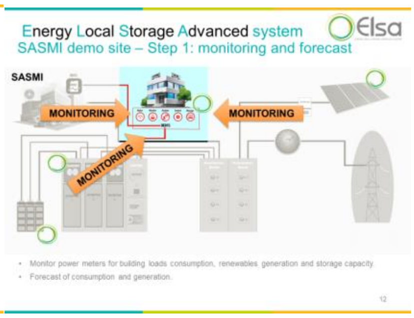

Energy Local Storage Advanced system
SASMI demo site – Building Energy Management System
BEMS
ICT platform
• Communication with Cylon BMS to monitor power meters and monitor/control building loads (OPC driver).
• Communication with B4B storage system to monitor/control storage capacity (API services).
• Communication with virtual grid utility using OpenADR protocol format.
Algorithms
• Forecast (up to 24h) of building loads consumption and renewables generation.
• Optimal coordination of building consumption, renewables and storage system.
• Adaptability to Demand Response events.
Energy use cases
• Peak Shaving
• Energy Purchase Time Shifting (Energy Arbitrage)
• Demand Response (Auto-Consumption, Cost Minimisation and Flexibility)
7


Energy Local Storage Advanced system
Energy Storage System Gateshead College – SASMI
Ancillary equipment:
• 50kWp of PV consisting of 191 solar panels covering an area of 320m² have been installed at SASMI as part of the project.
• Additional meters & sensors have been installed in SASMI to increase data collection capability that will then enhance the algorithms being developed by UTRC to improve the efficient use of energy within the building.
8

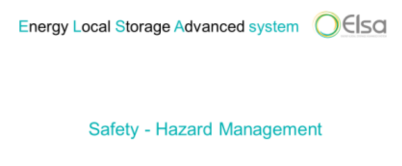


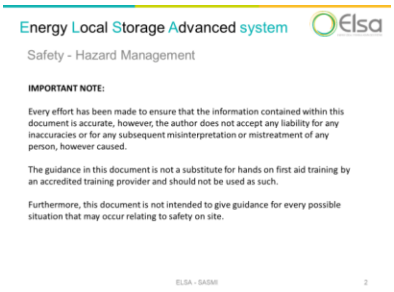


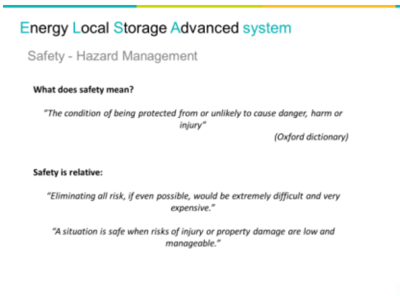




UNIT 3 ELSA HAZARD MANAGEMENT







Energy Local Storage Advanced system

Energy Storage Technology	Potential Hazard	Hazard Protection	Potential Hazard Control
Water storage (hydraulic systems, dams,..)	Rupture, water flows	Avoid corrosion and mechanical rupture	Manage water streams
Liquid fuels (gasoline, diesel, ethanol,…)	Fire, explosion	Avoid sparks, flames	Manage fire and fume emissions
Lead acid and Alkaline Rechargeable batteries	Hydrogen gas release (mainly in overcharge), explosion, Acid and Alkali release.	Avoid battery electrical abuse (e.g. voltage control and protection)	Manage gas flow release, neutralize spillage of acid or alkali,…
Lithium - ion batteries	Combustible gas release, corrosive electrolyte release, fire.	Avoid heat or flames, and battery electrical abuse.	Manage fire and fumes emissions, neutralise spillage of electrolyte.

- As we can see above lithium - ion batteries have different behaviours when compared to other battery technologies, requiring the use of suitable risk and hazard control, specifically relative to the so-called **"thermal run-away"** associated with a fire hazard.

Energy Local Storage Advanced system

Safety - Hazard Management

Electrolyte

- All batteries store chemical energy and contain electrolyte materials, which are usually a fluid or a gel. In the event of an accident which damages the battery casing/pouch, electrolyte leakage can create a hazard. The electrolyte in a battery is corrosive and can burn skin or eyes, eat holes in clothing, or even etch a concrete floor.

Flammable gases

- Some battery chemistries generate hydrogen and oxygen gases during charging, and hence pose a hazard due to the mixture of flammable gases. If it ignites easily it can cause a fire or explosion if allowed to accumulate in a small area.

Energy Local Storage Advanced system

Safety - Hazard Management

Electrical Shock

- The safety risks associated with a battery system are dependent on the voltage of the battery bank and any other voltage applied to the battery bank by an inverter or energy source.

Weight

- Such a hazard arises from the potential of an object falling. This may occur due to inappropriate battery accommodation and arrangement. Batteries like those used in forklifts, are heavy and require proper material handling equipment to lift them safely.

Energy Local Storage Advanced system

Safety - Hazard Management

Li-ion Battery Damage and Fluid Leaks - What are electrolyte risks?

- The risks that electrolyte poses are as follows : -

  1. Flammable
  2. Harmful if swallowed
  3. Causes severe burns
  4. Irritating to eyes, respiratory system and skin
  5. May cause sensitisation by skin contact
  6. Prolonged exposure could cause serious damage to health
  7. Toxic
  8. Possible risk of irreversible effects

- Since the Li-ion battery is made up of many small sealed battery modules, electrolyte solution leakage should be minimal.
- **Wearing the correct PPE is critically important.**

Energy Local Storage Advanced system

Safety - Hazard Management

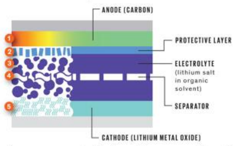
What is electrolyte decontamination?

Energy Local Storage Advanced system

Safety - Hazard Management

Thermal Runaway in a Lithium-Ion Battery

1. Heating starts.
2. Protective layer breaks down.
3. Electrolyte breaks down into flammable gases.
4. Separator melts, possibly causing a short circuit.
5. Cathode breaks down, generating oxygen.



- The severity of a cell thermal runaway event will depend upon a number of factors, including :-
  1. the SOC of a cell (how much electrical energy is stored in the form of chemical potential energy)
  2. the ambient environmental temperature
  3. the electrochemical design of the cell (cell chemistry)
  4. the mechanical design of the cell (cell size, electrolyte volume, etc.)

Energy Local Storage Advanced system

Safety - Hazard Management

Electric Shock

If you suspect someone has received an electric shock you must first ensure that all power sources are isolated BEFORE you can attempt to treat the casualty.

If faced with a casualty who is in the process of receiving an electric shock you should:
- Attempt to turn the power off at the distribution board and mains.
- To remove any cables/power tools etc., still in contact with the casualty, take the following actions:
  Insulate yourself from the ground with books, newspapers, or rubber matting
  Use an object of low conductivity such as a wooden broom to push away the power source.
  Seek medical assistance.

Energy Local Storage Advanced system

Safety - Hazard Management

Emergency Stop Button

Energy Local Storage Advanced system

Safety - Hazard Management

High Voltage Circuit Shut-Off System

The battery high voltage can be shut off by the following method:

Disconnection of the service plug positioned in the centre area of the Li-ion battery, this shuts off output high voltage when manually removed.

Remove the service plug by pressing the locking tab (1) and rotating the handle (2) upward.

Using the handle, pull the service plug completely out of its socket.

Wait at least 5 minutes for complete discharge of the high voltage capacitor after the service plug has been removed.

UNIT 4 ELSA 1ST AND 2ND RESPONDERS

Energy Local Storage Advanced system

Risk Information for 1st & 2nd Responders

Energy Local Storage Advanced system

Risk Information for 1st & 2nd Responders

Site Specific Risk Information / Premise Risk Management (SSRI/PRM)

Intelligence gathering PRIOR to an incident.

Obtaining information about a potential risk, before it becomes a risk is a vital part of fire service operations. Legislation exists in many European countries that enable FRS to enter buildings, familiarise themselves and obtain information prior to any incident.

ELSA - SASMI 2

Energy Local Storage Advanced system

Risk Information for 1st & 2nd Responders

Fire fighters have a requirement to gather the correct and appropriate information regarding possible risks/hazards within a building to help inform risk assessment and tactics.

This is often called Site Specific Risk Information (SSRI).

Information gathering should be carried out by local crews with suitable skills, assisted by technical fire safety officers and building owners/managers possibly as part of regular fire audits.

Most Fire and Rescue Services have a pre-agreed system and structure for this process.

Energy Local Storage Advanced system

Risk Information for 1st & 2nd Responders

Pre-planning is key to enhancing the safety of firefighters and others likely to be affected by Fire and Rescue Service operations.

The following information should be readily available for the local FRS who would deal with an incident relating to the ELSA system at your site:

1. Component parts of the system.
2. Layout of the ELSA system on site.
3. Methods of isolating the B4B system.
4. Method of isolating the battery.
5. Identification of possible hazards associated with the B4B.
6. Battery specifications.
7. Effect on the B4B system when the grid supply to the building is disrupted.
8. How to deal with possible hazards related to the batteries.

All of the above are explained in detail within Units 1, 2 and 3.