LONG LASTING BATTERIES

Bringing Ni-Zn back to accelerate the European Energy Transition

Outlines of the project & objectives

LOLABAT proposition

High Performance → 2000 cycles at 1C rate and 100% DoD / 200000 cycles at 5% DoD

High energy efficiency → 86-88%

High power → P_{max} more than 1000 W/kg

Low cost → 200-260 €/kWh

High energy → 50-90 Wh/kg / 80-200 Wh/l

High stability and calendar life

High sustainability

High safety

High recyclability

LOLABAT ambition

Cycle life increase → up to 4000 cycles at 100% DoD by the end of the project

Developing NiZn for grid applications in LOLABAT & its preparation for a production in Europe

By increasing its TRL via:

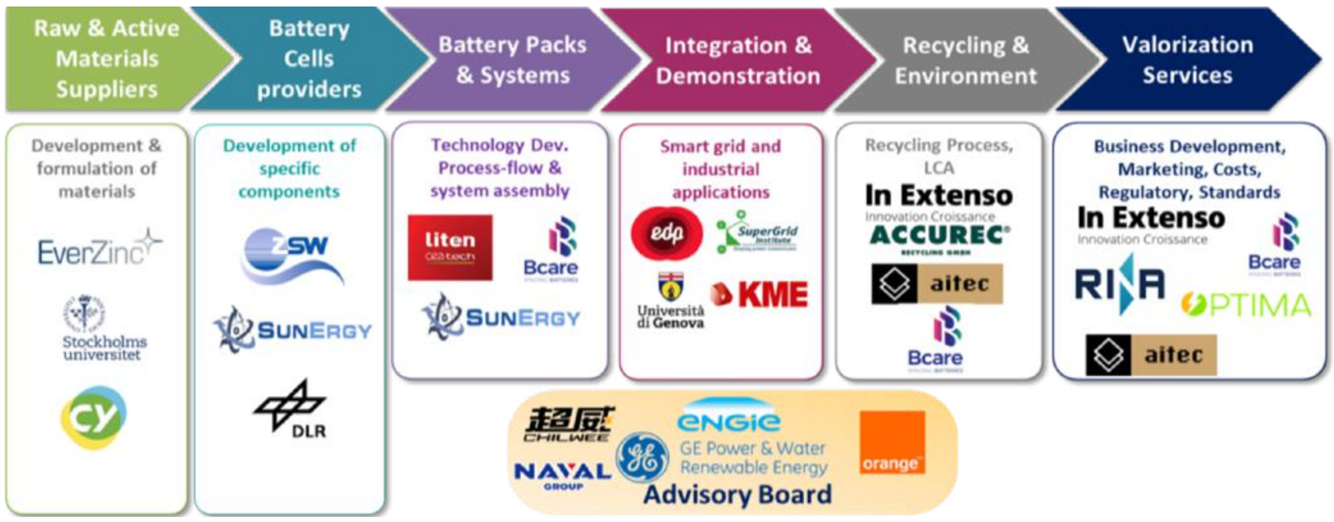
- BMS and sensors improvement;
- Testing and demonstration in stationary energy storage applications (demo sites).

Preparation for a future industrialisation by:

- life cycle and life cycle cost analyses, Recycling studies, assessment of Norms, Standards and grid compliancy, realization of business model and market studies, extensive dissemination and communication of the project results and NiZn technology

LOLABAT objectives

- Improvement of cell performance and cost to sustain the European lead on the RNZB
- Capacity up-scaling and design of battery pack for demonstration of robustness, safe and performance in stationary energy storage applications
- Assessment of costs and ensuring of the environmental and sustainability compliances
- Preparation for a future industrial production of NiZn batteries in Europe



Inside this Issue

Project proposition, ambition, objectives

News & Events

SUPEHR23 LOLABAT Conference

Project Technical Progress

Dissemination activities

Project meeting

H2020 GA n°963576

News Events

LOLABAT Conference organization in synergy with similar projects

***SUstainable PolyEnergy generation and HaRvesting – SUPEHR23*”,**

September, 6-8, 2023 - Savona (Italy) - https://supehr23.unige.it/

Affiliated projects

flexnconfu IANOS SOLSTICE Robinson NEXTMGT

The **Conference SUPEHR23** will provide an opportunity for the academic and industrial communities to meet in a highly interdisciplinary environment, to investigate new ideas, to share innovative solutions, and to discuss future research directions in the area of energy storage, power plants, hybrid systems and polygeneration.

The main topics are:

- 6th September: Electrochemical and alternative energy storage
- 7th September: Sustainable power plants – Thermal and electrical hybrid systems
- 8th September: Energy micropolygeneration and harvesting

The 2023 **Low Emission Advanced Power (LEAP) Workshop** organized by the U.S. Department of Energy, National Energy Technology Laboratory (NETL) will be included within SUPEHR23 conference. LEAP Workshop is focused, since 2010, on the transition to net-zero carbon and the associated technology development.
SUPEHR23 also benefits from the endorsement by the International Gas Turbine Society of Japan.

Some **industrial sponsorships** have been finalized and some more are under discussion with different stakeholders. Among these, it is worth mentioning 3 local companies in Liguria with the headquarter near conference location: Tirreno Power (a gas-fired power plant in the province of Savona, Italy), Ansaldo Energia and Ansaldo Green Tech (the major Italian player in the power production and provider of solutions for the power generation industry) and Fincantieri (world-wide leader in cruise ships and luxury yacht).
SUPEHR23 conference is also supported by the Thermochemical Power Group, TPG, a multidisciplinary research group based at the Polytechnic School of the University of Genoa. TPG includes the Rolls-Royce University Technology Centre on Fuel Cells, since 2004, and the Hydrogen Initiative for Sustainable Energy Applications , Hi-Sea, in collaboration with Fincantieri.

News Events

LOLABAT Conference organization in synergy with similar projects *SUstainable PolyEnergy generation and HaRvesting – SUPEHR23*”, September, 6-8, 2023 - Savona (Italy) - https://supehr23.unige.it/

Preliminary technical program overview (to be confirmed)

Keynote Lectures
Battery Energy Storage Systems (including NiZn batteries by LOLABAT project)
Low Emission Advanced Power systems
Advanced Heat Pump: - industrial prospective
Speakers from EC, US

Plenary session
Vision for Future Green Power Generation and Storage
Which hydrogen technology for sustainable energy
From digital twinning to cyber-physical modeling
Speakers from EC, US, Japan, China

Technical sessions (based on the received abstracts):
Development of storage systems (hardware – modelling – materials)
Integration of storage systems
Cyber-physical energy system models
Electricity Market
Decarbonising heat
Technology for hydrogen (distribution/transportation)
Harvesting & Energy storage
Bladeless turbo expander (Tesla technologies)

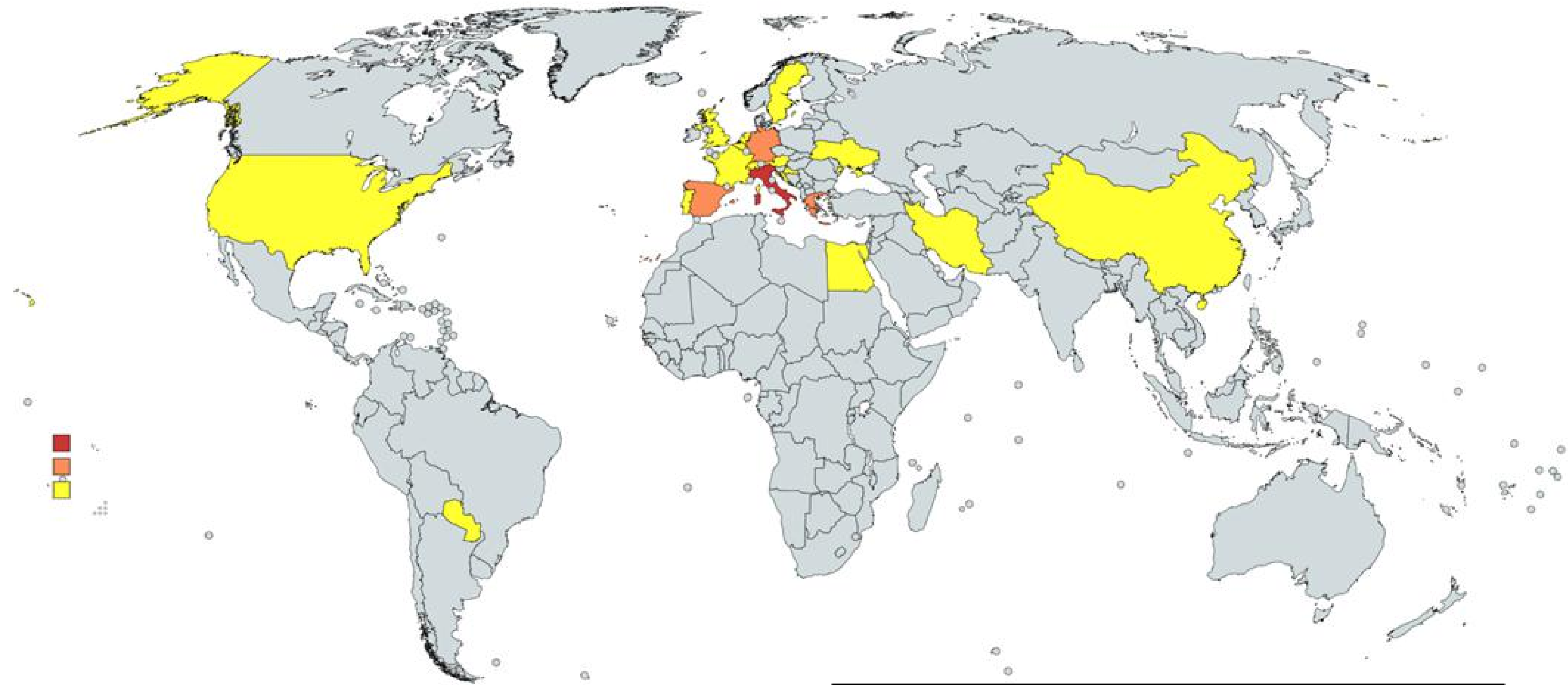
Workshop on European Commission Funding and Project Management
Workshop on Energy Regulators
Technical visit in Tirreno Power Power Plant in Vado Ligure near Savona

...work in progress...

H2020 GA n°963576

News Events

SUPEHR23
SUstainable PolyEnergy generation and HaRvesting
Conference and Exhibition
Savona (Italy), 6th - 8th September 2023



- 63 abstract received
    - 53 technical papers
    - 10 oral presentations
- 19 participating countries

DRAFT SUBMISSION DEADLINE
14TH April 2023

OPEN ACCESS
Proceedings publication

TWO SPECIAL ISSUES:
Applied Thermal Engineering – Elsevier –
Green Energy and Intelligent Transportation – Elsevier

Web of Conferences

SAVONA UNIVERSITY CAMPUS

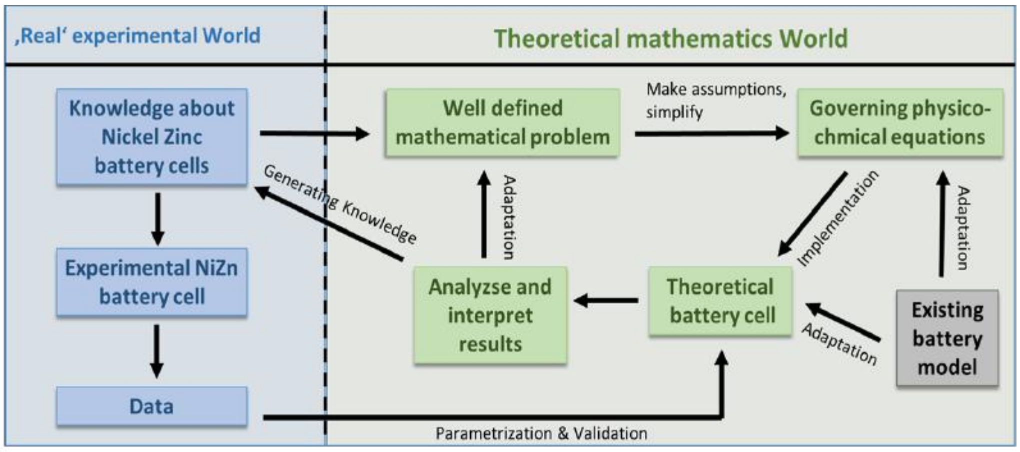
H2020 GA n°963576

Project Technical Progress

WP3: Improvement of NiZn cell components

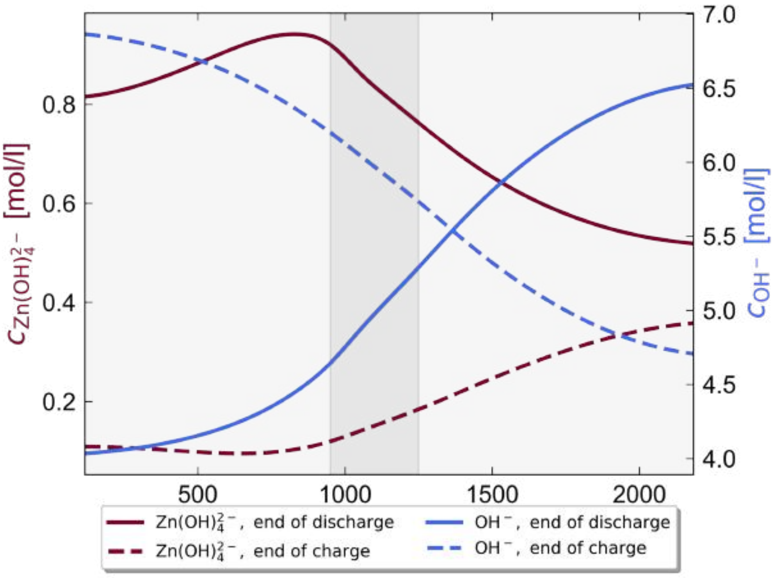
This WP focuses on the development of more performant cell components (electrodes, separator and electrolyte) of the NiZn battery compared to the cell technology available at the beginning of the project (GEN1) in close association with theory-based computational modelling and simulation.

Simulations help to elucidate the complex interaction of all cell components and help to identify limiting processes in the demonstrator. This facilitates the interpretation of cell properties and behaviour leading to an iterative improvement in the overall performance of the cell.



Schematic representation of the development of a theoretical NiZn model in relation to experimental development.

A theory, based on non-equilibrium thermodynamics, was developed for transport and reactions in NiZn cells with alkaline aqueous electrolyte. The basics for this computational modelling of electrochemical cells were written as a contribution of the chapter "Basics of Computational Modelling for Electrochemical Transport, Reactions and Cells" in the course of the LoLaBat project and will be published in "Encyclopaedia of Electrochemical Power Sources", Vol.2, planned publication date 2024.



Volume averaged spatially resolved concentration distribution of zincate (bordeaux) and hydroxides (blue) at the end of discharge (solid line) and at the end of charge (dashed line)

Based on the theory, a 1D+1D volume-averaged continuum model was implemented in Python and MatLab. This "theoretical built battery" allows the prediction of local concentrations, electric potentials and volume fractions by the cell during battery cycling. Such pre-calculations can help to identify limiting processes in the battery cell. For example, whether there is sufficient zincate locally for the reduction reaction at the anode during charging. Based on literature research and exchange with partners from the WP, theories and models for the description of degradation processes in the battery, such as gas evolution during cycling, are developed.

H2020 GA n°963576

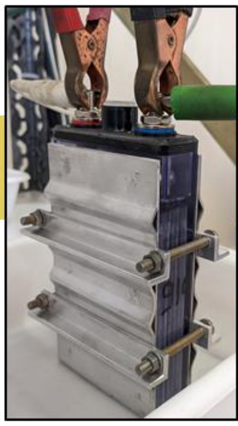
Project Technical Progress

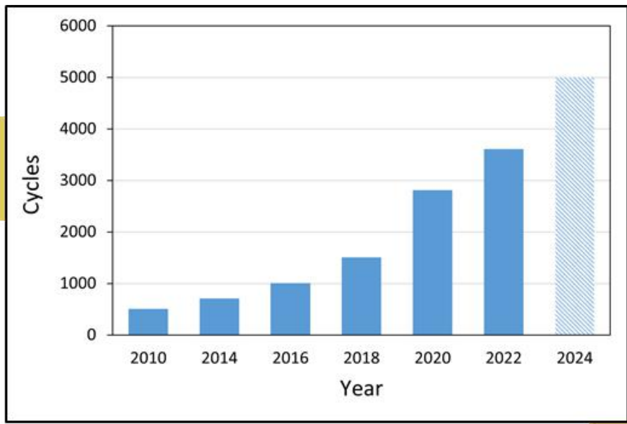
WP4 - Electrical characterisation and battery pack conception & design

LOLABAT's successful story of upscaling NiZn batteries

8Ah cell

The base cell for all the materials developments, with the objectives of improving the cyclability and decrease the costs.



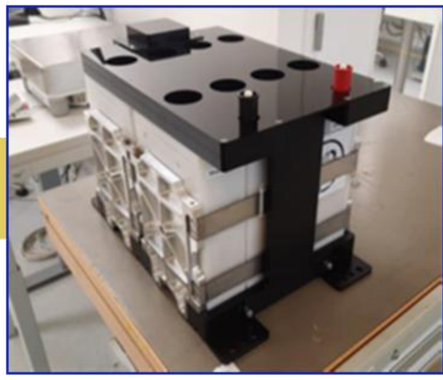


100Ah cell

Upscaling and validation of the developments made with 8Ah cells.

1.25 kWh module

Eight 100Ah cells in series for the development of voltage balancing and thermal management, with integration of sensors and battery management system (BMS).



10 kWh battery pack

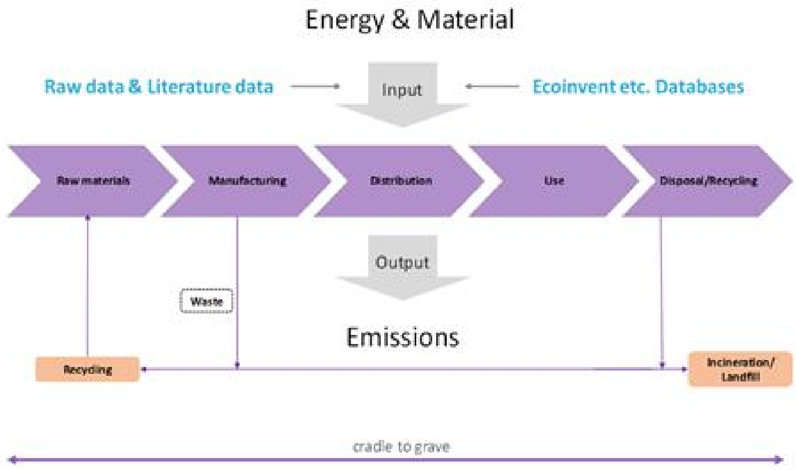
Eight modules in series including a Powerbox with all the BMS and control functions, and with a design adapted to the demo cases users.

Project Technical Progress

WP5: Environmental Impacts and Cost Analysis

In the previous Newsletters: Task 5.1: Environmental framework: state of the art of the environmental performance of current battery technologies (environmental impacts of all the current market batteries has been performed); Task 5.2: Recycling of NiZn battery (design and validate a specific recycling process for NiZn battery).

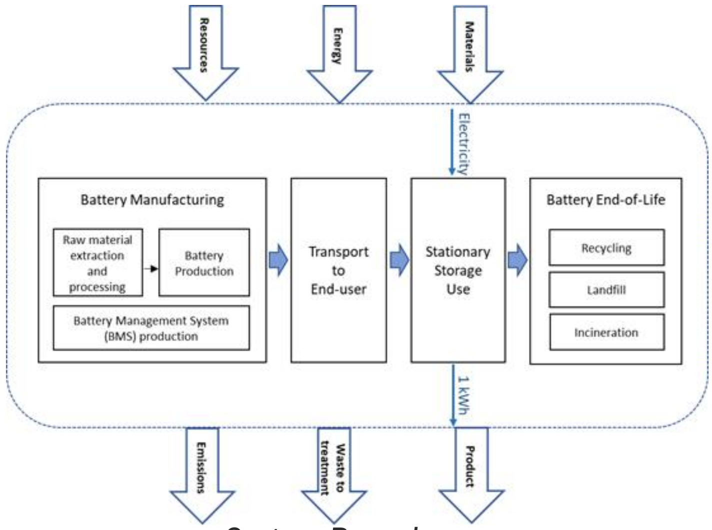
Task 5.3 & Task 5.4 : Traditional Environmental Life Cycle Analysis & Life Cycle Cost Analysis (LCCA) from cradle to grave - The aim of the task is to analyze the potential environmental impacts of NiZn batteries with those electrochemical batteries that are its market competitors in energy storage applications, from cradle to grave, according to ISO 14040:2006 and ISO 14044:2006. In this comparative LCA, the new NiZn battery is compared with other two battery product systems: Lead-acid and lithium-ion batteries.



LCA from cradle to grave

All three battery product systems are compared on the basis of the Functional Unit (FU) "To release 1 kWh of electricity to a storage system" and the functional unit is considered over the entire lifetime of the batteries. The LCA covers all stages of the product life cycle: from raw materials extraction, through manufacturing, transportation, use and end-of-life. In the Life Cycle Inventory, primary data were collected and considered for the assessment of NiZn battery, while data from literature and ecoinvent database were compiled and used for the analyze of Lead-acid and lithium-ion batteries. The recommendation of ILCD (EC-JRC 2011) is applied for the life cycle impact method to include all environmental impacts where the product system has relevant contributions. The impacts modelling at midpoint level (ReCiPe method) is considered by using the software openLCA, version 1.11, where the method is directly available. The deliverable of this LCA includes life cycle inventory results and life cycle impact assessment results

The task 5.4 is being developed by AITEC with support of participant partners BCARE and SUN. The aim of this task is to develop LCCA of NiZn battery and compare with the data obtained from other storage battery technologies under a cradle to grave approach. This LCCA method assess all the costs of acquiring materials, development of new product/manufacturing, storage and disposal of product. The assumption about the material and energy inputs, functional units, system boundary etc. are following the task 5.3 for calculation of life cycle costing.



System Boundary

The initial manufacturing flow chart for battery production and template to define data needs has been prepared. The information about mass breakdown and some cost numbers have been collected for novel NiZn battery. The estimation of costs are based on pre-pandemic material prices, refers that GEN1 NiZn battery of 8Ah cell characterized by 2000 cycles is estimated as 260 €/kWh. By introducing the reduction in the cost of supports, ZnO and the new electrolyte 8.1, the overall cost per kWh is estimated at **183 €/kWh**, i.e. a reduction of 29.6%.

H2020 GA n°963576

Project Technical Progress

WP5: Environmental Impacts and Cost Analysis

Task 5.5: Optimization of LCA and LCCA through Artificial Intelligence - The LCA developed in Task 5.3 and the LCCA developed in Task 5.4 serve as baseline for definition of optimization function and development of artificial intelligent optimization algorithm. The aim is to optimize the variable (in €/kWh/cycle) to compare the result with our desired target of 0.05€/kWh/cycle. The Genetic Algorithm (GA) of AI has been identified to be used for optimization and methodology for GA has been prepared. The objective functions that to be optimized have been identified and list of variables acting as chromosomes and genes are identified. In parallel to it, a MATLAB script of GA algorithm is being prepared and tested for different methods of crossover.

Task 5.6: Macroscopic analysis of technical and business risks affecting the security of supply of new NiZn batteries raw materials - The overall objective of this task is to assess the security of supply of new NiZn battery materials through multiple risks gatherer under two categories, technical and business risks. The materials with high risk could become bottlenecks for future battery production as they impact on key substances in battery design. The objectives are generally attained. The assessment of new NiZn battery raw materials showed that some materials present notable technical risks or notable business risks. Some materials also stand out because of their notable level of risk on both technical and business aspects. A key challenge to ensure stability and continuity of activities in battery manufacturing is to anticipate and manage risks linked to:

- Lack of availability/shortage (temporary or long-lasting) of some important components.
- Price fluctuations for some components.
- Safety (prevention of incidents and accidents) during transport, storage, handling and use.

These risks were grouped into two main categories, technical risks (related to the physical and biological hazards of the material) and business risks (related to the origin of the material (manufacturing, geopolitical context, etc.)). This risk analysis has been carried out in 3 stages:

- Stage 1: Identification of raw materials and data sources.
- Stage 2: Assessment of tech., regulatory and business risks;
- Stage 3: Macroscopic analysis.

Within the context of LOLABAT project, a particular attention should be paid to several materials, as they represent currently (and/or in the future) a potential bottleneck to the commercialisation of NiZn batteries. The main results of the analyses are reported in a hierarchisation matrix, showing in its vertical axis the technical risks, and the business risks in its horizontal axis in Deliverable 5.6.

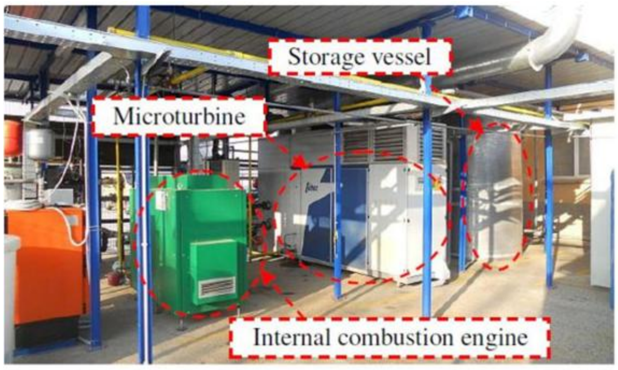
The weighting used in the hierarchisation matrix is as follows:

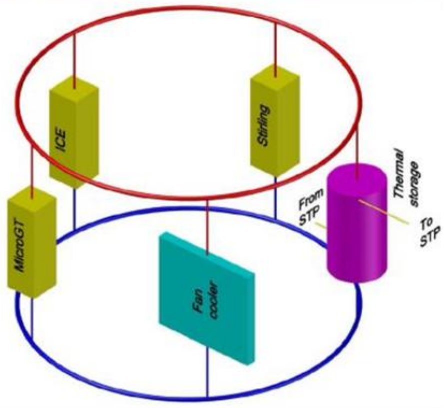
- For business risks: 1 point for availability risks, 2 points for market risks and 1 point for future evolution risks;
- For technical risks: 1 point for physical risks, 2 points for biological risks and 1 point for transport and storage risks.

This weighting is justified by the prevalence of market risks and biological risks among the assessed risks. However, the reading and analysis of the graph (in Deliverable 5.6) is limited because it only assesses substances in two dimensions, whereas the raw material factsheets show that there are multiple parameters to evaluate risks.

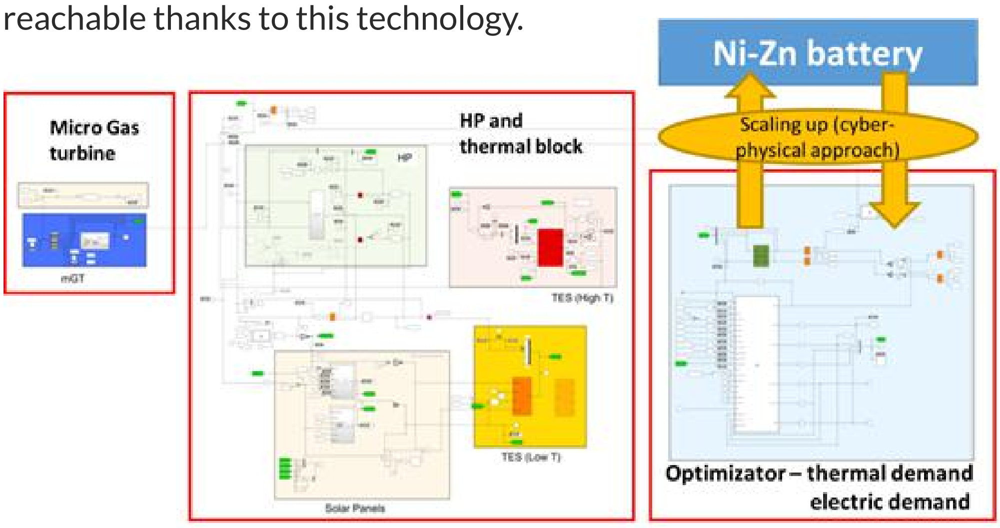
Project Technical Progress

WP6: RNZB performance demonstration for stationary energy storage applications



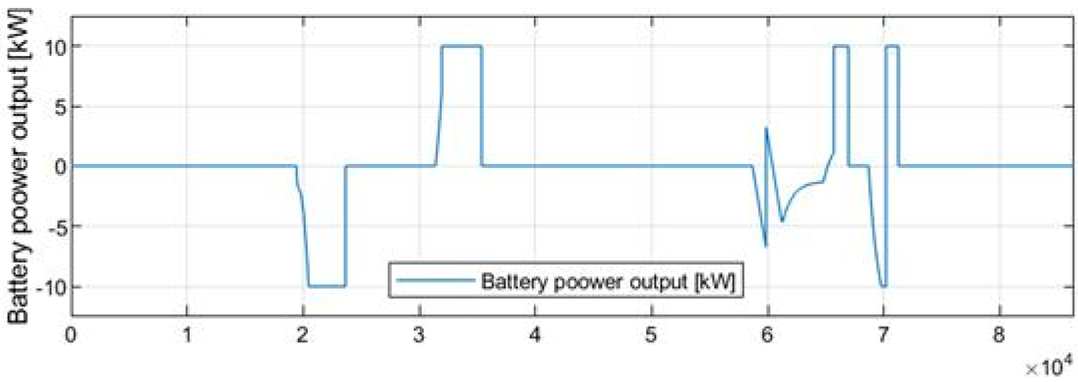


T6.3 BESS Contribution to smart distribution grid management - The demo case hosted by UNIGE focuses on the daily balancing of energy within tertiary buildings, where the aim is to provide electrical and thermal energy to a user, ensuring high efficiencies and low environmental impact. The demo site is in the Innovative Energy Systems (IES) Laboratory of the Savona's Campus of University of Genova, which is connected to the local DHN and share electric power with the Smart Polygeneration Grid. The aim is to evaluate the performance of the NiZn batteries and the synergy with micro gas turbine (mGT), thermal energy storage (TES) and heat pump in a real civil scenario. The BESS is expected to be implemented into the subsystem on May 2023. Meanwhile, UNIGE is currently performing a specific activity to evaluate the thermo-economical impact of this integration, studying dedicated operative strategies to enhance the plant's profitability and increase the savings in terms of emission reachable thanks to this technology.



At the same time, together with the other partners of the Consortium, UNIGE is working on dedicated dynamic models of the BESS, to be implemented into its "Model-In-the-Loop" (MIL) system (see scheme on the left proposed). This activity is essential to evaluate some possible charge and discharge profiles for the BESS.

Based on the previous works done by UNIGE, it is already possible to estimate some load ramps for the BESS, as shown hereafter:



After some operative scenarios will be virtually evaluated (an activity that will include a sensitivity analysis of the size of the battery), all the main equipment models will be replaced with the real ones (including the Ni-Zn-based BESS) and the same operative scenarios will be evaluated running the physical equipment through a "Hardware-In-the-Loop" approach.

In this way a full characterization of the BESS will be performed, both on the BESS itself and, more importantly, its performance will be evaluated when integrated into a real Smart Polygeneration grid.

Dissemination Activities

Participation of the partners to events and conferences to present the project

2022 Batteries Event, October 18th-21st, 2022 in Centre des Congrès – Lyon – France

BATTERIES EVENT 2022 LYON OCT. 18 > OCT. 21 FRANCE

The perfect forum where all the battery industry stakeholders will be able to meet, discuss industry trends and best practices – from the battery production to its recycling.

Workshop: Green energy and materials for a sustainable future, Oct 20th, 2022. 13.00-16.35, Stockholm University

Functional materials for energy generation and storage are keys for current society and our sustainable future. It is time to connect experts and share ideas from academia and industry within this field. Materials, devices, challenges, and opportunity related will be discussed in this workshop.

Stockholm Material Hub

32nd ISE Topical Meeting experimental and modelling tools for electrochemical energy devices -20-22 June 2022

32nd Topical Meeting of the International Society of Electrochemistry

Electrochemical Energy Devices, Experimental tools, Modelling tools

JEPO 2022 2-7 October 2022

The North section of the French Polymer Group (GFP) organized together with the Belgium Polymer Group (BPG) the 49th Study Day on Polymers (JEPO) in Bussang, France, 2-7 October 2022

GFP Section Nord

H2020 GA n°963576

Dissemination Activities

Participation of the partners to events and conferences to present the project

Enlit Europe is a joint platform comprised of European Utility Week and POWERGEN Europe events which are the exhibitions focusing on a future-proof energy production throughout the entire supply chain from the power plant to the end user. The next Enlit Europe will inspire over 18000 visitors with three days of transformative networking on 29 November – 1 December 2022 at Frankfurt Messe.

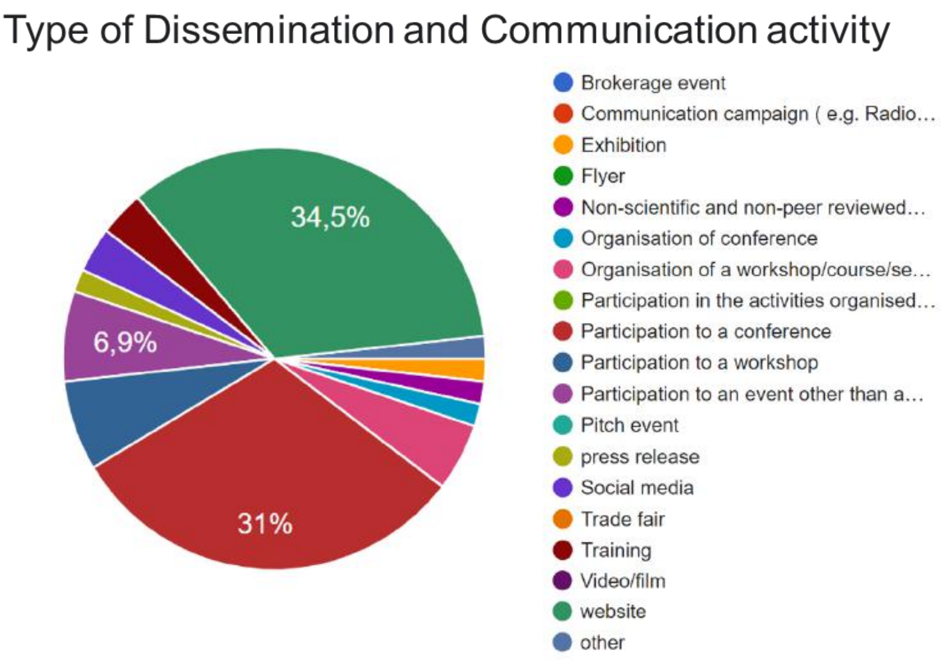
LOLABAT was presented at Enlit at the RINA stand. The scope was to visit the stand and learn more about the concept and the whole project updates. Moreover, was presented the **conference SUPEHR23** which will take place in September 2023.

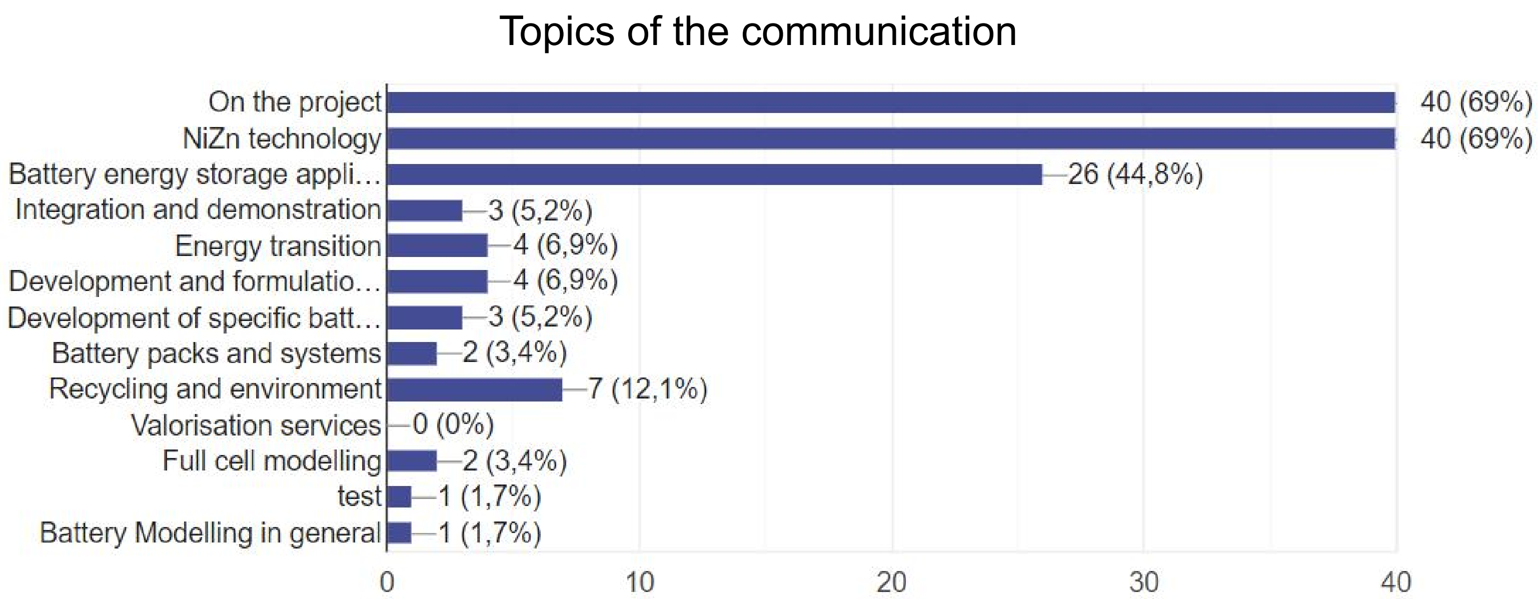
The trade fair Enlit in Europe is planned as a series of events, exhibition and an end-to-end forum designed for collective action toward tackling Europe's energy transition.

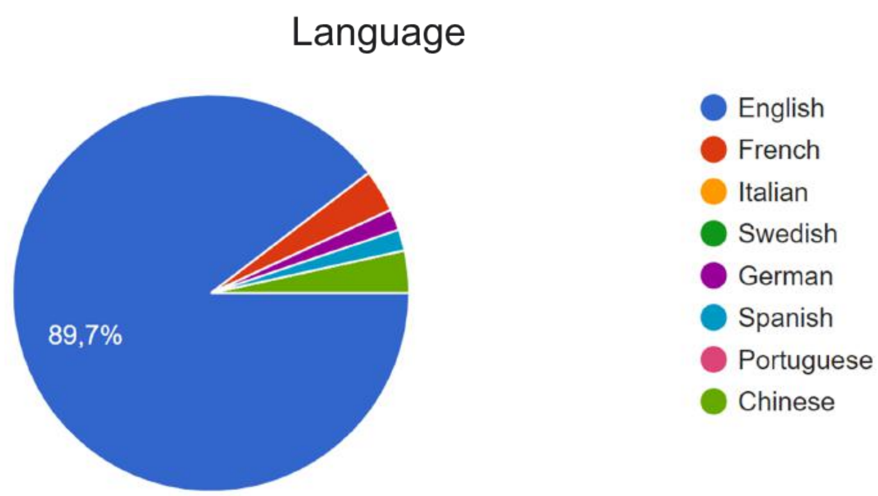
The exhibit features an assortment of products disrupting the current unsustainable energy flows.

AI software, long-duration batteries, renewable power production, decentralised energy generation and services of engagement and raising awareness about the global avenues for energy transition will be on display at Enlit Europe 2022. The floor plan is divided into thematic hubs each with their own programme schedule making it a perfect place for creating parterships between exhibitors and visitors. Some topics featured at the Enlit Europe 2022 hubs are Data hub, New energy landscape hub, Lifecycle management and Empowered consumer hub.

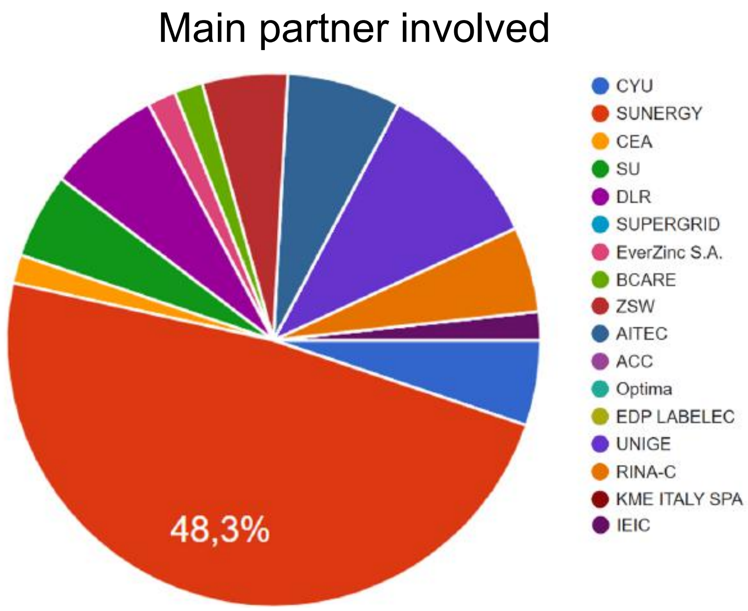
Dissemination Activities

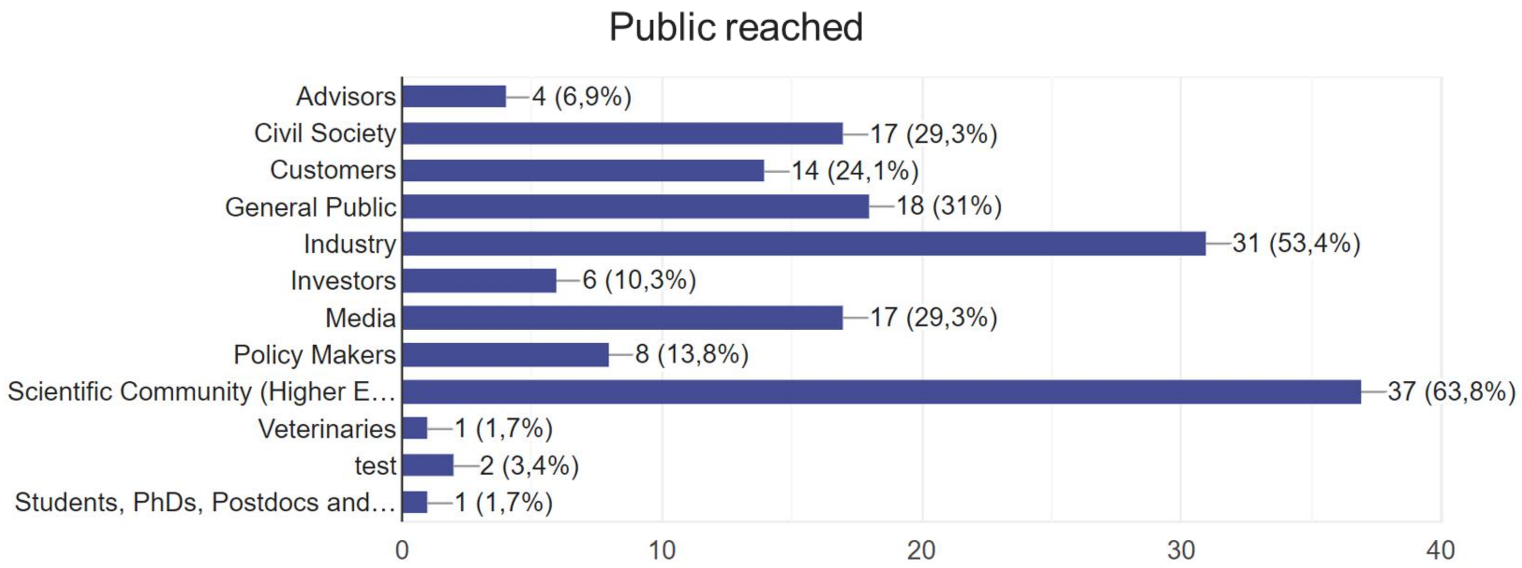


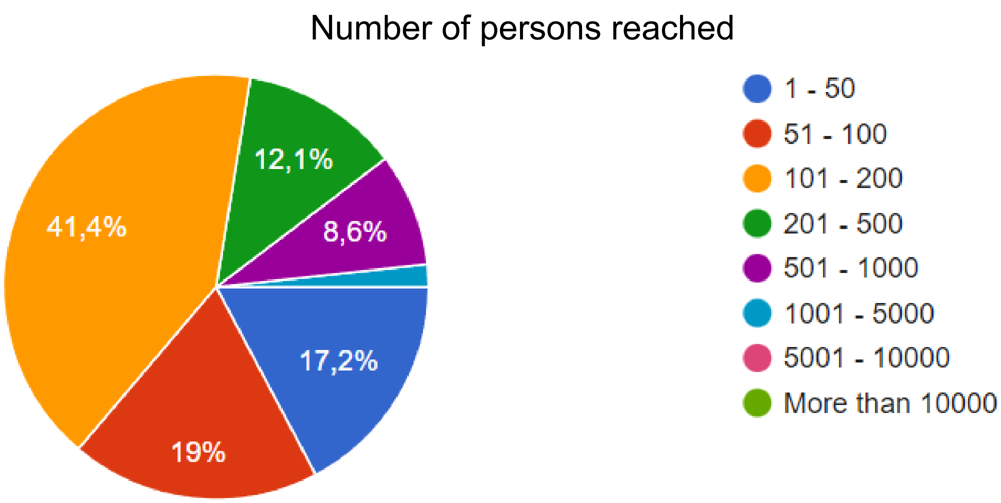




Dissemination Activities







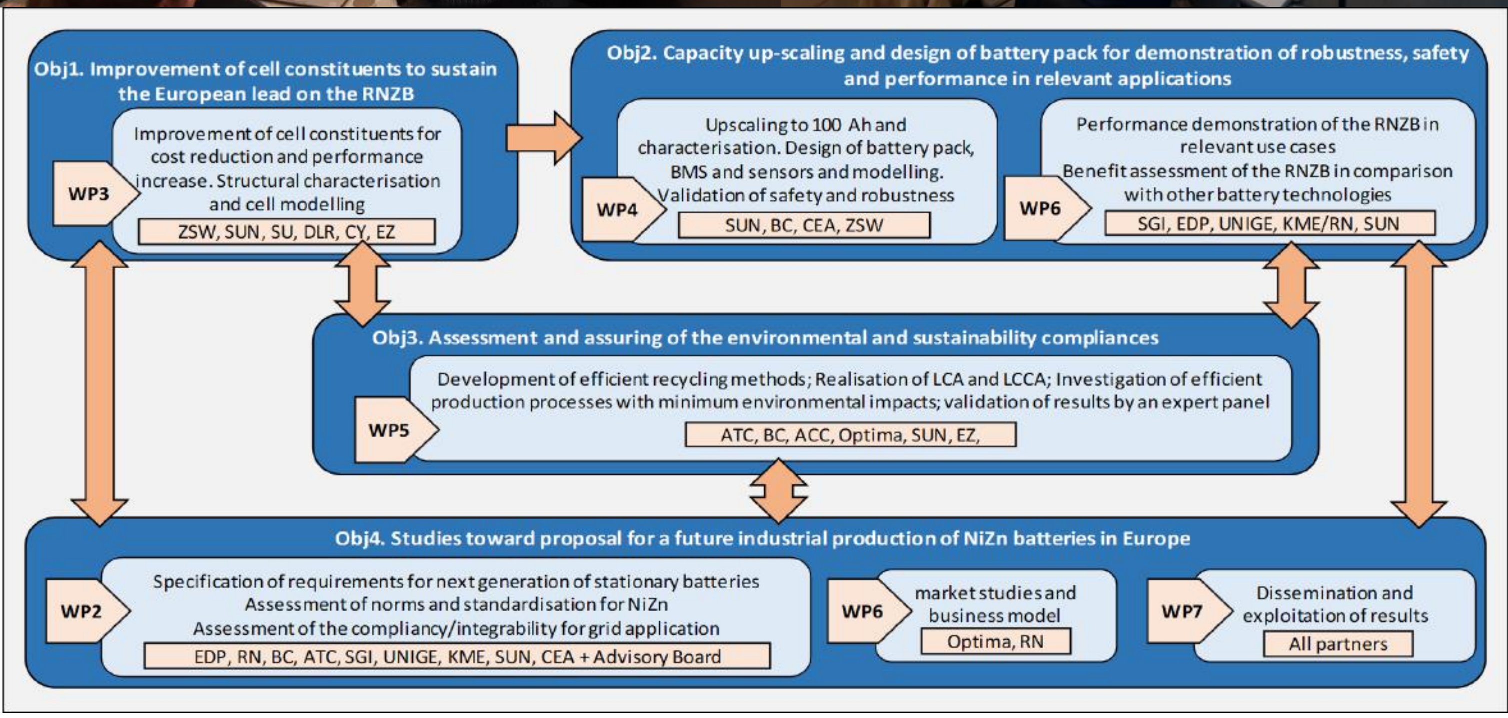
H2020 GA n°963576

Project Meeting

4th Steering committee meeting – 14-15th December 2022

M24 - Outlines of the project & objectives (reporting period: 17/06/2022 -> 15/12/2022)

ZENTRUM FUR SONNENENERGIE- UND WASSERSTOFF-FORSCHUNG BADENWURTTEMBERG - **ZSW** - ULM - Germany



- ☐ Welcome address, brief presentation of the **ZSW**
- ☐ Presentation of the project Outlines of the project & Objectives
- ☐ WP1-7 status
- ☐ Advisory Board members overview (Results feedback, Potential applications feedback, Industrial and market deployment vision)
- ☐ Visit to ZSW facilities