FORGING

INDUSTRY-ACADEMIA FORUM TO UNCOVER THE POTENTIAL OF EMERGING ENABLING TECHNOLOGIES

CO-CREATION WORKSHOP PRELIMINARY RESULTS

Novel Enabling Technologies for a Sustainable Future: Technologies for Energy Efficiency and Trustworthy Autonomy

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Use-case: MIXEES – Mixing Technologies for Efficient Energy Storage

Facilitators: Brigita Jurisic (INL), Marta Martorell Camps (i2CAT)

The group focused on the energy sector as a whole, with an initial discussion revolving around renewable energy sources and the challenges of balancing production and demand when energy comes from renewable sources. One of the group members, who is from an island, shared their expertise on closed energy systems and the conversation shifted to the insights this could offer for energy communities.

The key issue identified is **utility-scale storage in closed energy provision systems**. This issue arises from the difficulties in matching production and demand, as well as from the growing societal electrical needs due to electrification and to the increased use of energy-hungry, AI-powered digital solutions. The difficulty in achieving efficient utility-scale storage results in inefficiencies within the broader energy industry and creates uncertainty about the profitability of storage solutions.

To address these challenges, the group proposed a utility-scale storage system relying on a combination of **flow batteries**, **lithium-ion batteries**, **BESS** (battery energy storage system), **predictive model control** and development of **novel materials**. This solution would enable a better match between production and consumption and ensure grid stability: currently, fossil fuel-based production is needed to complement renewable energy generation in order to ensure grid stability and availability of electricity when renewable energy is not accessible. The implementation of the proposed solution, called MIXEES, has potential to enhance the maximization of clean energy production, availability and use, to facilitate a higher systemic resilience, and to a support better price stability in the long term.

Materials research was identified as a key resource to achieve this value proposition, being a suitable tool towards the choice of widely available, reusable, recyclable and scalable materials for utility-scale storage. The storage should be part of a closed energy system enabling the provision of energy from renewable sources only for all users, at all times (summer, winter, day, night, low tide, high tide, with wind, and without wind). The ideal testbed for this solution would be an island, as island energy systems are necessarily closed, self-sufficient, and unable to feed from the grid. Learnings from this kind of testbed could be then transferred to energy communities on the mainland.

The major social benefits of this solution would be the availability of clean energy for all users and – consequentially – cleaner and healthier environments with improved air quality and reduced human-generated climate impact.

Group 2: Claudia Vivalda, Gonçalo Luís Costa Ramalho, Jorge Salgado Beceiro, Itziar Vidorreta, Niccolò Mazzoleni, Susana Costa

Use-case: SMARTBEM

Facilitators: Livia Di Bernardini (APRE), Ana Martins (INL)

The group decided to develop their use-case in the **building sector**. They began by identifying the main problems related to energy efficiency in this sector. Key issues included lack of access to energy sources, climate change and the need for adaptation, high dependency on energy suppliers, and low citizen awareness regarding energy consumption and optimization. These challenges highlighted the urgent need for innovative energy management solutions that can improve sustainability and operational efficiency in buildings. Next, the group identified several important needs to address. They emphasized the necessity for faster adoption of technology in society to improve system efficiency and higher energy literacy among citizens. Additionally, they highlighted the need to reduce dependence on centralised energy grids and enhance competitiveness in the energy sector. By addressing these needs, the group aimed to create a more resilient and efficient energy system. After a brief discussion, the group decided to focus on **building inhabitants** as their target audience. They identified **low flexibility in energy source management as the primary problem**. This lack of flexibility limits the ability of users to dynamically switch between different energy sources, leading to higher costs, inefficiencies and reduced sustainability.

To enhance flexibility and efficiency in energy source management for both new and existing buildings, the group proposed a solution based on **Model Predictive Control**. This technology used for energy management in buildings is an advanced control strategy that optimizes energy use by predicting future system behaviour over a defined time horizon. The main objectives were to facilitate decision-making processes and optimize energy use. The proposed solution, named SMARTBEM, aimed to reduce CO2 emissions, improve social awareness, empowering citizens to actively engage in energy management, and lower operating costs, making energy solutions more accessible and cost-effective. To develop this solution, the group identified several relevant resources, including system modelling skills to create accurate energy consumption models; AI competencies, and technology selection and optimization tools to integrate the most effective energy solutions. They also highlighted key factors necessary for the development of this solution, such as the required investment, available user data, environmental and energy sector information (including demand, consumption, prices, and forecasts), and the need for user training to ensure efficient adoption and engagement with the system. The group suggested initially applying SMARTBEM to some existing piloting facilities for simulation. This allows for simulated testing and refinement before full-scale deployment.

The group also identified several limitations for this use-case, including potential low interest from investors in this solution, high implementation costs (particularly in retrofitting older buildings),

difficulties in accessing data from building inhabitants, and infrastructure issues that could hinder full implementation, especially in outdated buildings with inefficient energy systems. These challenges could pose significant barriers to the widespread adoption of SMARTBEM. On the other hand, the group noted that SMARTBEM could offer substantial benefits. It has the potential to streamline regulatory and bureaucratic processes in the long term, reduce energy costs for citizens, create a more balanced and resilient energy framework, decreasing reliance on traditional grids, and enhance overall sustainability in society. By addressing these key issues, SMARTBEM has the potential to drive long-term improvements in energy management, reduce carbon footprints, and enhance sustainability in the building sector.

Group 3: Dmitri Petrovykh, Elia Turatti, Halil Lacevic, Helena Mur Perez, Miguel Márquez, Mohamed Wael Ben Khaled, Omid Sharifahmadian

Use-case: RE-VIVE

Facilitators: Francesca Foliti (APRE), Viviana Pérez Clausen (i2CAT)

The group did not focus on a specific sector initially but rather discussed several concrete challenges that humans and buildings face in relation to energy efficiency. These challenges include, for instance, the rise of energy consumption, the increase in energy prices, the looming shortage of energy, bad behavioural issues surrounding individual energy use, climate control issues inside cars, personal comfort within buildings, and the damage caused by harmful UV light from outside windows (such as to pieces of art in museums). Several possible solutions were explored, including the development and implementation of community energy systems, the use of more durable materials capable of blocking UV light, the deployment of better insulation systems, and more.

Eventually, the group chose focus specifically on potential ways to **improve individual comfort with temperature regulation** inside **buildings**. This led them to the ideation of a hybrid and flexible system designed to control energy flows inside and outside urban buildings, with the ultimate goal of enhancing both physical and social well-being for individuals *and* creating more comfortable indoor environments.

The solution they envisioned, titled RE-VIVE, consists of a data-driven control system that combines **predictive modelling** with **digital twin technology** to enable better energy management, to forecast energy consumption more accurately, and to optimize HVAC (Heating, Ventilation, and Air Conditioning) operations and systems. RE-VIVE primarily targets **citizens in urban areas**, and its primary benefits include a decrease in energy consumption, hence in CO_2 emissions, alongside a reduction of the so-called "*urban sprawl*": by making existing urban buildings more energy-efficient, the need for new construction in suburban areas would decrease, thus helping to limit gentrification.

The group agreed that the implementation of RE-VIVE would require an active involvement and commitment from various actors, from technology providers and developers to building owners, from private banks to start-ups, from public institutions to citizens and citizen communities. For RE-VIVE to be successful, significant public and private investments, as well as effective efforts to persuade the public to trust the solution, would be required.

Finally, possible challenges and feasibility limits were mentioned with regards to the development of the envisaged solution, including societal resistance, long payback periods for investors, the difficulties of applying such technologies to older buildings, and the need for critical raw materials.

Group 4: Albert Pujol Márques, Ensieh Iranmehr, Diogo Saraiva, Marco Agostini, Ömer Onur, Sergi Novo Colom, Valia Iliopoulou

Use-case: CONVENSE – Advanced Connected Vehicles to Enhance Safety and Energy

Facilitators: Sofia Gatteri (STAM), Jorge Martins (VTT)

The group activity started with an initial brainstorming on the challenges posed with regards to energy efficiency. The group had a vivid and fruitful exchange on several key issues in this sector, encompassing different application areas and related problems.

Benefitting from the "Problem Tree" exercise, multiple causes were identified and clustered into: energy consumption, flexibility, regulations and/or policies, production costs, labour skills, and data. At this stage, the group identified **data management** as the main problem to be tackled, entailing aspects such as data collection, data sharing and data analysis.

Later on in the discussion, the group further elaborated on the context, and recognized that efficient and sustainable **road transportation** is a critical component of supply chain logistics and mobility solutions. However, there are challenges related to insufficient data management and utilization concerning energy and environmental performance. This deficiency impacts the **optimization of fleet operations**, which must address variables such as road infrastructure, real-time weather conditions, obstacle detection, road works, and charging station availability in the case of electric vehicles.

Traditional fleet management strategies often lack the necessary real-time processing, predictive capabilities, and cooperative strategies that can enhance energy efficiency and reduce operational costs. Titled CONVENSE (Advanced Connected Vehicles to Enhance Safety and Energy), the proposed technological solution addresses these challenges through the integration of **Model Predictive Control** and **Platooning** to enable optimal route planning, load balancing, and coordinated vehicle movement.

While MPC enables predictive, real-time decision-making by continuously adjusting vehicle speeds, energy consumption, and routes based on dynamically changing conditions, platooning enables groups of electric vans to travel together at optimized distances, reducing energy consumption and enhancing safety and obstacle avoidance through shared sensor data.

The proposed integration of MPC and platooning into fleet route optimization services would represent an important step towards energy-efficient and trustworthy autonomous transportation. By leveraging real-time data processing, predictive analytics, and coordinated driving, the solution would enable smarter, more resilient logistics operations that benefit both businesses and the environment.