Bringing research and industry closer: accelerating innovation and uptake of new technologies. Energy storage & Concentrated Solar Thermal Energy

Following a series of introductory webinars and two physical workshops (on Wind Energy and Energy Systems Integration, Delft, Netherlands and on Energy Storage, Fuel Cells and Hydrogen in Padova, Italy), the SUPEERA project travelled to Almería, Spain to discuss research-industry cooperation in the topics of Energy Storage and Concentrated Solar Thermal (Power & Heat) technologies (CSP/CST). The full-day workshop, which took place in hybrid mode, was co-organised with EERA Joint Programmes ES and CSP/CST and it allowed a fruitful knowledge exchange between the panellists and more than 60 participants, the majority of them travelling to PSA facilities (CIEMAT) in Almería. The workshop saw the participation of professionals, experts, and researchers across the EERA community, along with key representatives from the energy industry in Spain. The agenda was divided into four main sections at the end of which, a panel discussion offered the opportunity to boost lively discussions and animate insightful debates.

Opening the workshop

The workshop was opened by **Julian Blanco,** Director of the Plataforma Solar de Almeria (PSA), who presented the institution and briefly described its concentrated solar power research facilities and laboratories.

The introductory session continued with a keynote speech by **Cristina Trueba**, Chair of the Implementation Working Group (IWG) on Concentrated Solar Power and Solar Thermal Electricity (CSP/STE). After an introduction of the European political context in which the SET Plan has emerged, she gave an overview of the Plan, explaining its objectives and structure with particular attention to the CSP IWG. She finally discussed the importance of cross-cutting issues related to CSP, such as the integration of CSP and PV.

Ivan Matejak, SUPEERA coordinator and Operations Director at EERA, presented the objectives of the project and the workshop. In his introductory speech, he also highlighted some of the key factors and trends of the European clean energy transition. For example, he brought the audience's attention to the fact that nearly all new capacity in Europe comes from renewables, but also warned that current energy policies are largely insufficient to keep the global temperature rise below 1.5° by 2050.

Maria Oksa, Senior Scientist and Project Manager at VTT, presented some key findings from the analysis of all 27 National Energy and Climate Plans (NECPs) best practices (e.g., regional cooperation in research, regulation, projected storage capacity, remote areas, and circular economy) and gaps in energy storage among Member States. In addition, she explained how the six common pathways of the SUPEERA project were selected according to different criteria and gave an overview of European policies related to energy storage and solar technologies.

Collaboration between research and industry: best practices, barriers, and replicability potential

Ivan Matejak underlined the dynamism of R&I in the energy transition, remarking how the SET Plan has been influenced by the new energy priorities of the European Commission (e.g., the European Green Deal and Repower EU). Moreover, he presented some takeaways from the EERA's latest publication, such as the need to decarbonize the heating & cooling sector and to reduce energy demand. He concluded that the research community can have a crucial impact on the development of low carbon technologies in both long and short-term, where it can contribute to accelerate existing knowledge implementation to scale up already tested and validated solutions and technologies.

Ricardo Sanchez (CIEMAT), CSP Joint Programme Coordinator, provided information on the joint programme, describing how it is structured, presenting the team, and illustrating the objectives of each sub-programme. Important objectives highlighted by the coordinator were, for example, consolidating and improving the technology of Line-Focusing CSP systems, reducing the capital and operating costs of the CSP plant, and improving the materials used in CSP/CST.

Myriam Gil Bardajì (KIT), Joint Programme Energy Storage (JP ES) Coordinator, presented the mission and vision of the JP giving also an overview of its latest activities and events, such as mobility schemes, PhD days, and workshops. She finally illustrated JP ES flagship project, StoRIES, whose main objectives aim at fostering a European eco-system of industry and research organisations on hybrid energy storage technologies and providing access to world-class research infrastructures related to materials and energy storage.

After the presentation of the joint programmes, the perspective of the industry sector was delivered by representatives of some prominent CSP actors: Protermosolar, Malta inc. and SENER, who brought the audience's attention to the importance of bringing closer R&D and industry and highlighted some crucial challenges that the sector is currently facing.

David Trebolle, Secretary General at Protermosolar, described some of the challenges that need to be tackled to improve the scalability of CSP technologies. For example, he stressed the problems related to the decoupling of the Spanish CSP tenders and grid access, and he questioned whether the levelized cost of electricity (LCOE) is the most accurate indicator to estimate the whole system costs. In addition, he discussed some key aspects relevant to the regulatory framework and the design of the latest CSP tender in Spain. In his closing remark, he underlined the most crucial issues that will help to accelerate innovation and development of the CSP market, such as the establishment of a stable regulatory framework, the optimization of tenders, the minimization of CAPEX costs, and closer cooperation between research and industry.

Escarlata Muñoz, Senior Industrial Engineer at Malta Inc., presented the main activities of the company, highlighting that their services on providing synchronous pumped-heat electricity storage are crucial to enable the transition from fossil fuels to renewables. Moreover, she gave an overview of their work and partners (e.g., Siemens, Google, Proman, etc.) and briefly explained their innovative process to produce heat and electricity. Finally, she pointed out how they collaborate with R&D institutes, highlighted future R&D collaboration opportunities (e.g., development, testing and qualification of innovative

components for Malta's molten salt Pumped Heat Electricity Storage), and pointed out the importance of a specific regulation for storage technologies (which should differ from the one on generation that is currently applied).

The first session was closed by **Sergio Relloso**, from the New Technologies Business Unit at SENER, who illustrated SENER's deep involvement in the CSP sector and described their contribution to R&D activities. He identified that by lowering the price of electricity generation and increasing the reliability of CSP technologies it will be possible to increase their deployment in the future. In that end, R&D plays a crucial role to overcome these challenges. He also stressed that the energy market is currently not perceiving CSP as a reliable technology due to the various incidents that many power plants have experienced (mainly technical issues related to the hot tank).

Q&A

The discussion during the Q&A session focused on several **key areas for improvement** in the CSP and energy storage sectors.

Sergio Relloso, clarified that SENER encountered some problems related to the construction of the hot tank and highlighted the need for a qualitative improvement in the way these are built. **David Trebolle** brought up in the discussion the exceptional reduction of CSP technologies CAPEX price over the last 30 years and pointed out that this has been due to increased R&D efforts. Finally, he noticed that the commodity market is in a difficult situation because of the increasing cost of raw materials and transport. **Myriam Gil Bardajì** focused on the lessons learnt in the implementation of the StoRIES project. She specified that the main difficulty in the first year of the project was to engage all the stakeholders in the ecosystem and highlighted the importance of bringing on board experts from the industry. At the end of the session, **Escarlata Muñoz** remarked that although reducing prices is a fundamental challenge, it is also crucial to address issues related to the electricity grid regulation.

Cross-sectorial dialogue for system solutions towards the CET objectives

Spyridon Pantelis, Project Manager at EERA, introduced the importance of facilitating the dialogue on cross-cutting issues (both technological and non-technological) relevant to the clean energy transition. He stressed that identifying them is a fundamental part of the SUPEERA project as they provide a coordinated input to decision-makers and they improve the conceptual framework of the clean energy transition. He added that the cross-cutting issues provide a context that goes beyond the specific technologies and ensure that the transition is designed adopting a system thinking approach.

The first speaker of the session, **Miguel Frasquet**, CEO of Solatom, stressed the importance of CSP technologies to decarbonise energy-intensive industrial processes, especially regarding industrial heat production. He explained that there is a window opportunity for these technologies that Solatom is currently targeting and he clarified that their strategy is using modular design solutions as it is not possible to standardize CST from an engineering perspective. Finally, he described some of the advantages (e.g., no commercial interest, possibility to keep longer projects) and disadvantages (e.g., lack of commercial experience, different timing) of the collaboration between industry and research institutes.

Eduardo Zarza, technical coordinator at PSA, illustrated the benefits of the integration of thermal storage into STE plants, notably dispatchability, higher yearly efficiency of the plan, and enhanced plant control under solar radiation transients (possibility to control even during cloudy days), providing also data from the system operator depicting the actual use of STE plant to the energy grid. He concluded by remarking that in comparison to photovoltaics, CSP is much more dispatchable than other renewable energy sources.

Rocío Bayón, Senior Scientist at CIEMAT/PSA, provided further technical details about the functioning of CSP plants in Spain. In particular, she focused on the differences between parabolic through collectors, central receiver plants, and linear Fresnel, and the various applications of thermal energy storage. Finally, she explained how electricity is generated at night-time utilising thermal storage technologies and highlighted that one advantage of thermal storage is that can be integrated even to dismantled coal power plants.

Cristobal Villasante, Renewable Energy coordinator at Tekniker, illustrated the importance of digitisation to accelerate the development of CSP technologies, underlining that this is an important topic for CSP. In particular, he highlighted how digitisation can reduce overall costs (both CAPEX and OPEX), as well as increase CSP reliability and facilitate system integration. For example, an important aspect is that the use of wireless technology allows cost reduction for wiring and other expensive materials. Finally, he pointed out that digitalisation enables better control and data analysis and reduces inspection and maintenance needs.

Q&A

The followed discussion provided some deeper insights of the **technical and economic aspects** mentioned in the presentations.

For example, **Miguel Frasquet** stressed that in the CSP sector there are many opportunities for integration with different technologies, notably geothermal systems and heat pumps. He added that CST will play an important role in the energy transition due to the high temperature heat it can provide compared to other renewable energy technologies. **Eduardo Zarza** explained that, in Spain, it is possible to produce electricity up to seven and a half hours after sunset when CSP plant is running at full power, and this allows them to provide a fraction of the generated power to grid operators when it is needed in winter time. Moreover, he clarified some technical differences between power and temperature related to CSP plants and pointed out that in such plants thermal losses are very low. **Rocío Bayón** elaborated on the different role of molten salt and oil to reach high temperatures. Finally, **Cristobal Villasante** reiterated that digitalization can increase the efficiency of a CSP plant and reduce the uncertainty related to manual operations.

The role of energy storage in future power grids

The session was opened by **Javier García-Barberena**, Strategy and Business Development Manager at CENER. At the beginning of his speech, he outlined the context of the energy transition, highlighting that it includes many interrelated challenges, notably technical, economic, environmental, social, and strategical ones. As for the strategical aspects, he stressed the importance of adopting a common European approach to compete with key players at international level, such as the US, China, and Russia. Furthermore, in line with

what previously mentioned by David Trebolle, he agreed that the levelized cost of electricity (LCOE) might not be the most appropriate indicator for conducting cost analysis and base the relevant auctions upon. He finally stressed the necessity to exploit the contributions of different technologies to the energy system and identify the most optimal energy mix. In this sense, he explained how cheap and massive storage systems are needed in the short term to increase the flexibility and dispatchability of the entire electricity system.

Walter Gaggioli, Head of Solar Thermal and Smart Network Division of the department of Energy technologies and renewable energy source at ENEA, argued that thermal energy storage (TES) is one of the enabling technologies for the energy transition. He pointed out that the rising share of variable renewable energy can have a strong impact on the power systems in terms of alterations of the electricity markets, supply, security, stability and reliability of the power networks. Thus, he concluded that storage technologies can provide several benefits, notably time-shifting, extension of the production period, and integration with other renewables.

Salvatore Vasta, research engineer at ENEA, talked about the role of TES in reducing the impact of industrial processes on the grid (especially related to heating and cooling). He highlighted that although solar energy is regarded as one of the most promising substitutes for traditional energy sources in the industrial field, its intermittent and unstable nature leads to mismatch between supply and demand. In this context, solar heat storage can be a suitable solution to alleviate this challenge. Concluding, he presented some insights from an ongoing research, testing the properties and suitability of several materials in the scope of a closed cycle sorption system coupled with solar heat for industrial applications.

Linda Barelli, associate professor at the University of Perugia, illustrated how hybrid storage systems can be integrated into the power grid. At the beginning of her presentation, she gave an overview of the latest challenges and trends in the energy storage and electricity grid sectors. She stressed the need for more flexibility of the electricity grid and presented the benefits of the hybridization of complementary storage technologies.

Manuel Baumann, researcher at KIT, illustrated some of the challenges related to the availability of raw materials for energy storage technologies. In particular, he pointed out that supply chain constraints might slow down the scaling up of these technologies. As the market of critical raw materials is monopolized by individual countries (China being the country with a major concentration of raw materials and related processing), and this imposing an increase in costs of these materials and subsequently to the related components, battery prices could increase significantly in the next few decades. For this reason, sustainability assessment should be carried out in early technological readiness level (TRL) research. Finally, he underlined that although battery recycling can mitigate these risks, such practices should be integrated with other strategies, such as making use of technologies that are based on abundant materials (e.g., Mg, Na) and combining several storage technologies (as well as focusing on other grid flexibility options).

Q&A

The presentations delivered by the speakers stimulated insightful discussion on the critical role of **raw materials** and **seasonal storage** in the context of the clean energy transition.

Manuel Bauman, further elaborated on the topic of the price of raw materials. He brought the audience attention to point that this is not directly related with abundancy of the material, as it also depends on mining and process capacity, and geographical concentration (e.g., China is the monopolist of many rare earth materials). **Walter Gaggioli** and **Javier García-Barberena** agreed that there is not a single energy storage technology that covers all the energy storage needs. For example, for large scale capacity, thermal energy storage is a cheap technology for the primary market and should be used in proximity to the end user. **Salvatore Vasta** tackled the issue of materials and technologies for seasonal thermal energy storage. He remarked that seasonal energy storage solutions already exist and are suitable for domestic and residential applications, but the critical point is to scientifically prove that it is possible to use them with low costs and maintenance needs. **Linda Barelli** commented that seasonal long-term storage is a crucial issue for the energy transition, specifying that the related technologies are not yet completely available to the market. In her opinion, while hydrogen technologies can support long-term storage, these are not able to guarantee seasonal storage to large-scale capacity that will be needed in the future. She instead mentioned the positive role that reactive metals can play in this regard. Finally, she remarked that in the long term the development and market uptake of energy storage technologies has to be reflected in national and EU policies.

Conclusions

Promoting the uptake of new technology in the Energy Storage and Concentrated Solar Power sectors demands a steady collaboration between academia and industry to be able to materialize and concretely implement what has been designed at a more theoretical level. By organizing this kind of events, the SUPEERA Project aims at boosting connections among different areas of the sustainable energy production sector and several categories of actors involved within each area.

The recording of the workshop is available at this link.