

Proceedings

Sun and thermal Energy: Europe's Precious Energy Sources for Efficient Industries and Buildings

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Abstract: In this workshop, we discussed the progress of five Horizon 2020 projects—HYCOOL, SHIP2FAIR, THERMOSS, SUNHORIZON and HYBUILD—all implementing solar thermal and renewable technologies for buildings and for the industrial sector. The discussion offered opportunities to identify and benchmark key challenges being faced by the projects, both technical and non-technical, and allowed to identify cooperation opportunities.

Keywords: solar; thermal; renewables; energy efficient buildings; industry; heat pumps

1. Introduction

In the framework of Sustainable Places, a workshop was organized to present the progress and results of five innovative H2020 projects: SHIP2FAIR [1], SUNHORIZON [2], HYCOOL [3], THERMOSS [4], and HYBUILD [5].

All of these projects are implementing renewable energy technologies such as solar panels and heat pumps for both the residential and the industrial sectors, in order to decrease energy consumption and increase thermal comfort and high performances in industrial processes.

One of the objectives of the workshop was to raise awareness on the barriers that each project is currently facing in terms of policy and market acceptance, how to deal with the digitalisation and monitoring data, and to discuss achieved impacts in terms of cost reductions and other benefits that are demonstrated through the projects' demo sites.

2. Key Innovative Aspects

Below is a short presentation of the key innovative aspects of the five projects involved in the workshop:

- The main goal and innovative aspect of SHIP2FAIR is to foster the integration of solar heat in industrial processes from the agro–food sector.
- SunHorizon aims to develop heat pump solutions that will act properly coupled with advanced solar panels providing heating and cooling both for residential and tertiary buildings.

- THERMOSS ensures an efficient match between supply and demand of energy through real-time management of thermal energy and by retrofitting through advanced heating and cooling technologies, leading to up to 30 % savings in energy consumption.
- HYCOOL’s mission is increasing the use of solar heat in industry processes, by coupling of a new Fresnel CSP Solar thermal collectors (FCSP) with specially build Hybrid Heat Pumps.
- HYBUILD combines a compact sorption storage, a high-density latent storage, and an efficient electric storage in residential buildings.

3. Discussion

The following sub-sections and Tables (see Tables 1–4) provide a summary of the discussion which was conducted during the workshop. The 5 participating projects intend to stay in contact after the workshop to further benchmark their progress and findings around these key horizontal issues

Highest Technological Challenges Faced by the Projects

Table 1. Technological challenges.

Project	Key Technological Challenges Faced in the Project Activities
SHIP2FAIR	Integration engineering of SHIP components with local process from a i) thermal production (how to inject heat produced by the solar field in the line via collectors or direct hot water/steam injection), ii) civil engineering point of view (find suitable roof space or ground space able to host solar field without structural/regulatory problems), iii) control (how to manage solar production combination with local generators production particularly in presence of CHP Units which could lose benefits from cogeneration feed-in etc.) point of view.
SunHorizon	The technology challenges of SunHorizon project could be divided in two main groups: the first is related to the single technologies, to improve its performances reducing the cost. The latter concern that all these already technologies should be properly connected each other to cover at least 80% of H&C demand and provide, at the end of the project, a TP almost ready for the market.
THERMOSS	Reaching a thermal grid flexibility through the development of a two-way substation which would allow the buildings to both sell and buy thermal energy (prosumers) is the highest technological challenges of the project.
HYCOOL	The main challenges faced concern the optimal integration of the solar generation field inside the industrial plants and the flexible operation of the hybrid heat pump in discontinuous industrial processes. Particularly, for what concerns the integration issue, it relates both to the identification of available space for the installation of huge solar collectors’ field as well as how to integrate the heating production inside the existing industrial plant. While, the flexible operation of the heat pump can be improved by properly sized sensible and latent storages, specifically designed for the given industrial process.
HYBUILD	The real-time measurement of the state of charge of the thermal battery system represents a key achievement of the project at this stage. The main remaining technological challenges focus on the integration of the key thermal components for flexible operation, the development of the BEMS system that efficiently manages both thermal and electric energy systems and storage to meet the objectives of users and the successful implementation of this novel technology in three existing demonstration sites.

4. How Digitalization and Monitoring Data Can Facilitate the Promotion of the Technologies of the Projects

Table 2. Digitalisation and monitoring data.

Project	Digitalisation and Monitoring Data
SHIP2FAIR	Guarantee a bulk of monitored data to facilitate replication both at design and management point of view, also considering solar forecast data.
SunHorizon	Schneider Electric is leading activities on creation of a monitoring platform for assessment of energy savings within the demonstrators of SunHorizon project. The solution created allows to monitor energy consumption of different vectors in buildings (heat, electricity, gas, water) and indoor environment values to ensure proper occupants experience. The scope of this solution is critical for the project because to boost replicability is important for the assessment of energy savings after implementing sustainable/renewable solutions and the improvements of indoor air quality. Having reference cases is very important, as facilitate the promotion of new technologies towards clients and general public.
THERMOSS	In a real sensors network, a telecontrol system must periodically (e.g., every few minutes) acquire, store and validate data gathered by sensor measurements in order to achieve accurate monitoring of the whole network in real time. These values need to be validated before further use, in order to assure the reliability of the results obtained when using these data. The digitalization in the building sector (in this case residential), can help with better overview of the energy flows and targeting energy savings, but also for maintenance (predictive maintenance) and faults identification. THERMOSS database store everyday more than 150.000 single data related to the sensors installed in demo sites across Europe. A relative data check tool for the analysis of incoming data and relative notifications have been implemented to improve data reliability and help in data handling.
HYCOOL	The digitalization can help in improving the reliable operation of such innovative technological solutions. For instance, the integration of BIM approaches will help the system planning and maintenance procedures. Furthermore, the accurate data monitoring will help in validating the efficiency of the hybrid solar cooling processes. Finally, the development of user-friendly management and control platforms will reduce the barriers related to the limited awareness of the technicians about innovative heating and cooling technologies.
HYBUILD	The digitalization and monitoring data is critical to the validation of the results in the demonstration sites, enabling the LCA, LCC and Social LCA to be performed. Additionally, digitalization allows for the development of service-centric control systems, which can focus specifically on key comfort thresholds and potentially allow for alternative revenue streams for the system operator (such as participation in flexibility markets).

5. How to Increase Social Acceptance of Projects' Technologies, and Main Non-Technological Barriers

Table 3. social acceptance and non-technological barriers.

Project	Social Acceptance and Non-Technological Barriers
SHIP2FAIR	Industries are often quite reluctant to renovation, even if energy bill is a relevant voice of cost in their process. It's important to increase, also thanks to further demonstration and showcases the acceptability of SHIP2FAIR
SunHorizon	Currently Heat Pumps (HP) and Solar thermal are the most common and socially accepted RES Based H&C solutions. During the project the consortium will aim to

	increase the social acceptance installing a monitoring architecture to interact with local tenants via a smart end user interface via App. In addition, the SunHorizon demopites will living laboratory where to test innovative H&C HW and SW solutions completely open to the citizens during the so called SunHorizon Open Days.
THERMOSS	One of the main non-technological barriers are users (especially in the residential sector) not knowing what technologies are doing and the subsequent skepticism. For installing a newly developed technology it's therefore so important to have a clear understanding of the energy savings. This topic is connected with the monitoring aspect implementation coordinated by Schneider Electric. The philosophy followed in the Thermoss project is to limit the impact on the final client as much as possible, by the usage of technologies only in the boiler rooms and wireless sensors for indoor air quality to limit installation discomfort.
HYCOOL	Usually industries are quite conservative, since their main aim is to guarantee a reliable operation. For this reason they often consider novel technologies based on renewable sources too risky. In order to overcome these barriers, the idea is to setup strong training processes, to increase technical awareness about HYCOOL solution. This also comprises an open tool made available for the pre-feasibility studies of the technology in different industrial processes and climates. Furthermore, activity on standardization is promoted, to make HYCOOL technologies ready for a rapid market uptake.
HYBUILD	The completion of the LCA, LCC and Social LCA within the project will help address concerns relating to lifecycle impacts and assist future building owners with considering the technology. Additionally, the control system for HYBUILD is being designed considering use cases of the end users (who are also project partners) and with the expectation they can manage user profiles to ensure the settings are applicable to them. Lastly, the development of two tailored solutions: one optimized for heating and DHW in the continental climate and one optimized for cooling provision in the Mediterranean climate ensure consumer's specific needs are met directly.

6. Key Measures to Achieve Cost-Reduction of Projects' Technologies

Table 4. Cost reduction of technologies.

Project	Cost Reduction of Technologies
SHIP2FAIR	Optimization of the design of the components (particularly for substructures) as well as of the sizing of thermal energy storage to reduce solar field size and CAPEX.
SunHorizon	The cost of SunHorizon solutions will be reduced thanks to an optimisation design tool and a predictive maintenance solution. In particular the consortium will focus on both CAPEX and OPEX as briefly described here below: CAPEX: optimized tool including robust design (Optimisation Design Under Uncertainty Tool) to sizing the system avoid safety factors; OPEX: Predictive maintenance and faults forecasting via monitoring. (H&C Predictive Controller) and development of a thermal comfort driven smart end user interface
THERMOSS	THERMOSS technologies are mostly at high TRL and in some case, earlier versions have reached the market. THERMOSS therefore has developed a tool, called WARME, which raises awareness on energy, carbon emissions and costs savings, including suitable incentives for reducing the CAPEX.
HYCOOL	The cost reduction will be addressed through careful design processes of each component to be optimized for typical heating and cooling demand of industrial processes. For instance the hybrid adsorption heat pump optimization will comprise a critical analysis of existing and innovative adsorbent materials, with the cost as crucial constraint. Furthermore, Life Cycle Cost analysis will be carried out to

identify the components which mainly affect the overall cost of the HYCOOL system, to properly address the cost-optimization efforts.

HYBUILD While the HYBUILD solution represents an integrated solution at a moderate TRL level, the technological components that make up the solution frequently are expected to have higher TRLs (up to TRL 9), implying that these components could be individually tested and exploited in the market in advance of system integration. Combined with efforts to achieve a compact solution should assist in reducing the CAPEX of the whole solution. Additionally, significant OPEX savings are expected through efficient operation of the BEMS system.

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Conflicts of Interest: The authors declare no conflict of interest.

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