Integrating National Research Agendas on Solar Heat for Industrial Processes

Project Deliverable 1.5: Final report on consortium structure and governance definition beyond INSHIP

D 1.5 – FINAL REPORT ON CONSORTIUM STRUCTURE AND GOVERNANCE DEFINITION BEYOND INSHIP	
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Contents

1. Content of deliverable

This Deliverable Report is summarizing the work and results of "Task 1.3 Follow-up SHIP structure" as part of "WP1 ECRIA Consortium Coordination" of the project "INSHIP – Integrating National Research and Innovation Agendas on Solar Heat for Industrial Processes" (GA 731287), which overall aims at the definition of a European Common Research and Innovation Agenda (ECRIA) on Solar Heat for Industrial Processes (SHIP).

This Task 1.3 addresses the definition of all aspects related to the managerial and administrative aspects linked to the discussion, definition and creation of the needed governance structure to effective future EU SHIP research activities integration, initially within the existing EERA Joint Programme on CSP (JP-CSP), and with the close assistance of the EERA Secretariat office:

- Identify suitable possible governance structure models for INSHIP, analysing similar national, European and international organisations, determining the most adequate and efficient one. To this end, the integration of additional key research organizations (currently not belonging to EERA JP-CSP) as well as relevant industrial stakeholders should be considered.
- Determine the most adequate corporate purpose to be created (subprogramme within existing JP, new JP or other possible suitable alternative), as well as the scope of involvement, role, participation degree and contribution of different partners, also providing a layout for the governance during its implementation phase
- Define the structure and selection procedures to establish the Governance Board as well as their function in INSHIP ECRIA (specification of voting rights, composition of bodies, specification of partner roles in the governance scheme, etc.).
- The possible mechanisms of participation of funding agencies and ministries will be taken into consideration during the definition of the governance structure (see also Task 7.1). The participation of Industry will also be considered through Task 8.4.

In short, this report will summarize the discussions, checked options and eventually established ECRIA/SHIP consortium and governance structure ensuring the operation and decision-making processes along the development of the activities foreseen in the pursuit of the ECRIA objectives beyond the execution of INSHIP.

Please note that some of the information provided in the following was taken from respective websites, which are provided in the respective context, but without further explicit quotation.

2. Results and discussion

2.1. Introduction and General Considerations

To develop activities to pursue the ECRIA objectives in a consortium and governance structure, involved partners and stakeholders must provide the respective resources required for these activities (working time, funds for travel, accommodation and subsistence, administrative framework, …). For most of the involved stakeholders, such resources can only be provided with support from an external funding source. Over the last years, the CSP/CST community could establish and keep up a consortium structure in form of the EERA JP-CSP (see section 2.2.2), initially with the support of the EU funded IRP STAGE-STE and the ECRIA INSHIP projects, which e.g. provided the context and platform for regular physical meetings of the consortia.

The requirement of such external funding thus provides both the background and the main challenge to define a consortium and governance structure beyond the INSHIP project.

Another challenge for the research community on Solar Heat in Industrial Processes (SHIP) is the broadness of technologies and applications, and associated stakeholder groups. These range across all temperature levels and, depending on the particular definition and scope, may even include technologies for thermally driven industrial cooling at application temperature levels well below 0 °C, low temperature solar heat up to approx. 100-150 °C, medium temperature 100/150 °C to 300/400/500 °C and high temperature above 300/400/500°C. As indicated, temperature levels may be defined differently in different context. Within INSHIP, the scope of technical research in WPs 2-4 had been defined to the three ranges of low temperature SHIP (80-150 °C), medium temperature SHIP (150-300°C) and high temperature SHIP (400-1500 °C). To address these temperature levels, different solar thermal technologies are applied. While for low temperature heat, non-concentrating solar technologies (e.g. uncovered flat absorbers, flat plate collectors, evacuated tube collectors) are used, while at medium to high temperature levels, concentrating technologies (e.g. non imaging optical concentrators, parabolic trough collectors, linear Fresnel collectors, heliostat field and central receiver systems (tower technology), parabolic dish or other concentrating technologies) are used. In terms of end users (industries using solar heat in their processes), also a very broad spectrum of sectors and industries is using heat and could apply SHIP.

Historically, different temperature level technologies and/or applications are addressed by different stakeholder or researcher groups, consortia and communities. While, for example, the industrial and research communities addressing Concentrated Solar Power CSP (Concentrated Solar Thermal Electricity STE), the same technologies can be applied to provide medium to high temperature solar heat for industrial processes. In consequence, in

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the corresponding communities the relevance of concentrated solar heat CSH (together with CSP/STE sometimes also referred as concentrated solar thermal CST) is more and more acknowledged and addressed. Similarly, industrial and research communities addressing solar heating and cooling in buildings are also addressing low T SHIP technologies and applications. Due to this broadness in temperatures, technologies and corresponding stakeholder groups, any consortium and governance structure addressing SHIP may include only sub-groups. For example, fore purely practical reasons of having limited and "manageable" consortium sizes, it may even be advisable to restrict the scope and stakeholder group to certain sub-topics of SHIP.

Acknowledging all the above, it must be noted that very broad and strong consortia could be formed with financial support from the European Commission through the IRP STAGE-STE (2014-2018) and the ECRIA INSHIP (2017-2020). While in STAGE-STE, only concentrating technologies had been addressed, in INSHIP also low temperature SHIP is addressed, and consortium structure and partners are accordingly differing. Nevertheless, as mentioned above, these two projects provided the background to successfully establish the EERA JP-CSP, which will be discussed in more detail in following sections.

Within the EERA JP-CSP, all current JP organizations (with just one exception) are partners of ECRIA INSHIP, and are thus involved in discussions and active work of the JP-CSP.

Also within the activities of the IEA Tasks Task 64/IV and Task IV (described in the following sections as well), European experts are well represented and many members of the INSHIP consortium actively contributed to the definition / re-definition / implementation of these Programmes/Tasks, partly supported through INSHIP WP1, Task 1.3.

2.2. Consortium Structures and Governance considered and established

In the following sections, the discussions and options will be briefly summarized. In section 2.2.1., different options are briefly mentioned which had been discussed and considered, but did not succeed to provide a consortium and governance structure for the SHIP ECRIA beyond INSHIP. In sections 2.2.2 and 2.2.3, those structures successfully defined with active contributions from the INSHIP consortium are presented.

2.2.1. Possible funding sources and governance structures discussed

Some of the INSHIP partner institutions concentrate the majority of existing large-scale R&D facilities for CSP in Europe. Most of these facilities are included at the 'Trans-national Access Activity' of the EC-funded Integrating Activity called SFERA-III (Solar Facilities for the European Research Area - Third Phase; see https://sfera3.sollab.eu/). So, it has been considered whether in the context of research facilities a follow-up structure of the INSHIP ECRIA could be established. Even though the SFERA consortium is a rather small group, non-

SFERA partners can be involved by means of so-called infrastructure access mobilities (similar to those implemented in the framework of INSHIP WP6). However, due to

- a lack of a medium term (follow-up) funding perspective, as no further calls and projects similar to SFERA are expected to be launched by the European Commission,
- the fact that the group of research infrastructure/facilities partner is too small a sub-group of the SHIP community
- despite significant overlap, SFERA is addressing CSP rather than CST topics and thus
- does not address low temperature SHIP topics

the option to define a follow-up structure based on large CSP research infrastructures had to be discarded.

Similarly, it was discussed whether the "EU-SOLARIS" ESFRI (European Strategy Forum on Research Infrastructures) initiative (see http://eusolaris.eu/) aiming at the definition and implementation of a European Research Infrastructure Consortium (ERIC) around existing European solar thermal concentrating infrastructures and facilities, could offer a follow-up structure for the INSHIP ECRIA, in a similar way as previously discussed and decided on the follow-up of IRP STAGE-STE initiative (2014-2018). The EU-SOLARIS vision is to further assist the Concentrating Solar Thermal (CST) and Solar Chemistry technologies' deployment by enhancing the research infrastructures development and Research and Technology Development (R&D) coordination. EU-SOLARIS is expected to be the first of its kind, where industrial needs and private funding will play a significant role.
However, for reasons similar to those listed above, this option had to be discarded. In addition, EU-SOLARIS, besides well advanced and successfully achieved the STEP1 of the ERIC creation (in 2019), is not yet formally established.

In terms of potential funding frameworks, the new EC funded framework program "Horizon Europe" was considered. During 2020, Draft versions of related Work Programmes have been prepared. However, there was no reliable and firm information available on calls to be expected, exact timelines and involved budgets. In contrary, from work program draft versions which became known to several partners, it seemed that future funding options and calls for Solar Heat and SHIP was rather minor. During the final INSHIP project meeting in December 2020, the consortium discussed even an initiative to provide further input to the Work Program Definition process through the respective national representatives, to strengthen funding of SHIP research and demonstration by defining/issuing related project calls. With respect to a future follow-up structure of the INSHIP ECRIA, the option to find an appropriate funding option within the Horizon Europe FP project calls had to be discarded. Still, final Horizon Europe Work Programmes will be screened after publication by interested INSHIP consortium members, and within the available calls, collaborative research on SHIP in sub-groups and consortia can be expected. However, a funding framework for a follow-up structure of the INSHIP ECRIA seems quite unlikely to emerge.

Within the INSHIP Task 7.1 "Coordination and alignment of national RTD programmes and objectives in SHIP" and Task 8.4 "Joint framework for active collaboration with industry", possible mechanisms of participation of funding agencies and ministries (Task 7.1) and Industry (Task 8.4) has been taken into consideration with respect to the definition of a potential future governance structure. However, from none of these activities, concrete options other than those described in this report have emerged.
For further details on these activities and results, we refer to the corresponding public INSHIP deliverable reports "D7.3 Common SHIP RTD strategy doc" and "D8.4 Guidelines of relationship between industry and European SHIP research".

2.2.2. EERA JP-CSP, Sub-Programme 6 Solar Heat in Industrial Processes and Applications

As part of the European Energy Research Alliance (EERA), the Joint Programme on Concentrated Solar Power (JP-CSP) is addressing the use of CSP/CST for electricity generation and concentrated solar heat. This framework provides a governance structure under which the involved partners coordinate and support joint research, discuss and update the research priorities and agenda.

At the same time, the EU funded IRP STAGE-STE (2014-2018) and the ECRIA INSHIP (2017-2020) projects provided a funded framework for regular physical meetings of the consortia and CSP/CST research community and JP-CSP, at least for the partners / stakeholders involved in both JP-CSP and in the mentioned projects as partners.

At the beginning of the INSHIP ECRIA, the JP-CSP did not contain a Sub-Programme (SP) on SHIP topics, thus it was an obvious option to discuss the definition of SHIP related activities in the framework of the EERA JP-CSP. Accordingly, in Period 1 of the INSHIP project, discussions were initiated and both contributing partner organisations and a corresponding work programme was defined. During Period 2 of the INSHIP project, the newly defined Sub-Programme 6 "Solar Heat in Industrial Processes and Applications" was established in the JP-CSP as part of the Work Programmme update (2018-2021). It should be noticed that, being part of the JP-CSP, this SP6 was born associated to solar concentrating technologies and, as consequence, addressing industrial processes requiring working temperatures beyond the threshold of 150-180 °C. As the INSHIP ECRIA includes also the lower temperature range of SHIP technologies and applications, the discussion about to finally include (or not) the low temperature range in the final follow up structure was addressed several times in the context of both INSHIP and JP-CSP, with no final outcome and decision until now.

Thus, this SP6 could provide one governance structure to pursue the ECRIA objectives beyond the execution of INSHIP. However, with the end of INSHIP, no external funding will be available to support active contributions. Therefore, discussions within the JP-CSP were initiated to discuss the level of activities (see also section 2.2.2.3. below). A decision was taken to continue activities on a low level and the definition of a respective follow-up work programme 2022-2026 was envisioned. Therefore, the **JP-CSP SP6 will eventually provide one governance structure to pursue the ECRIA objectives beyond the execution of INSHIP**.

In the following, some more detailed information on the JP-CSP and on SP6 are provided.

2.2.2.1. About the EERA JP-CSP (see https://www.eera-csp.eu/)

The EERA JP-CSP address the technologies and applications associated to the use of solar thermal concentration. Heat production using solar energy is based on photo-thermal conversion, which is the most efficient method to convert solar energy into usable energy (efficiency > 60 %). Solar collectors are devices that enable efficient photo-thermal conversion by reducing infrared losses. To increase the solar collector efficiency, concentrating collectors such as compound parabolic collectors (CPC), Linear Fresnel Reflector (LFR), Parabolic Trough Collector (PTC), Solar Tower and Solar dish can be used. The optical concentration is crucial because the heat losses are proportional to the absorber area and not to the solar collector aperture. In Concentrating Solar Thermal (CST) technologies, there is a decrease in the absorber area and an increase in the aperture area, allowing an efficient collection of solar light. The CST technologies can reach a concentration factor from 5 to more than 1000. Changing the concentration factor is possible to realise a solar plant that can work at a temperature from 60°C to more than 1000°C. This technological flexibility allows the adaption of CST technologies to many industrial processes, or the emerging green applications related, as example, to high temperature solar chemistry and material processing.

The use of CST technologies for electricity production, traditionally known with the acronym CSP (Concentrating Solar Power), and more recently with STE (Solar Thermal Electricity) to distinguish between solar concentration for PV plants and solar concentration for solar thermal power plants, have been already tested, providing solutions relatively cheap, reliable and available at high TRL. For these reasons, CSP/CST should be considered among the key sustainable technologies that can reduce the fossil fuel consumption of processes and their corresponding carbon footprint.

As far as CSP or also Solar Thermal Electricity (STE) generation is concerned, the global (worldwide) installed capacity was 6397 MW (December 2020), considering the 115 STE projects currently in operation. The majority of these projects (4967 MW) were related to trough designs, due to being normally considered as most bankable for project financing. Tower projects (1188 MW) allow to higher maximum temperature and hence increased efficiency for power generation and thermal heat storage, reason why it could achieve lower electricity costs in locations of low attenuation of the light between the mirrors and the receiver. Linear Fresnel technology has much lower current commercial deployment (242 MW, also in December 2020).

The European CSP industry is behind the large majority of all these projects (more than 70% of all previously indicated nominal installed power). Therefore, and considering the clear path European society is addressing to the decarbonisation of the energy sector, this technology is called to have a bright future. Certainly, and thanks to the thermal energy storage, CSP/STE can make a significant contribution to the transformation of the European energy system by providing an important share of dispatchable renewable electricity. By providing flexibility for grid services, CSP can facilitate the integration of variable output renewables such as photovoltaic (PV) or wind energy, thereby contributing to the reliability of the transmission grid. The best solar resources for CSP are to be found in Southern Europe, which makes this technology complementary to those renewable energy technologies that find their best resources in other regions of Europe. Besides the generation of electricity, CSP systems can provide high temperature heat for industrial processes or thermochemical processes, thus contributing to the decarbonisation of the industrial and transport sector.

With regard to the technical potential of concentrated solar technologies to electricity generation, according to IEA, commercial STE plants produced 15,6 TWh in 2019 and the organization forecasts a worldwide contribution, in the Sustainable Development Scenario, of 53,8 TWh in 2025 and 183,8 TWh in 2030[1], with around 60 GW of installed power. However, the technical potential of CST is much higher if we also add the capability of providing thermal energy for industrial heat applications. The annual world thermal energy consumption of the industrial sector is higher than 23.600 TWh, and a significant portion of this energy consumption can be delivered with CST technologies[2]. Thanks to the thermal storage capability, the power generated by CST power plants is fully dispatchable and, therefore, these plants can perform the role of baseload and also making possible the penetration of very high rates of renewable electricity in sunny countries (complementing the non-dispatchable technologies like PV and Wind). Another important technical factor that could strongly promote the deployment of CST technology for electricity production in scenarios close to 100% of renewable energy generation, is the necessity of a specific amount of synchronous electricity generation to guarantee system inertia levels above the current critical ones and, as a consequence, sufficient grid stability. Advances in electronics and converters will certainly reduce the current inertia levels limit[3]. The market potential worldwide is, therefore, substantial and this justifies the efforts to maintain the current competitive advantage of the European industry in terms of both installed capacity in Europe and global market share of European companies. Nevertheless, to make all this possible, a strong an intense research effort should be done, being this the main reason behind this JP, as there is still plenty of room for many technical improvements yet, mainly dealing with increasing efficiencies and decreasing costs.

The JP is structured in the following six Sub-programmes:

- Sub-Programme 1: Line-Focusing CSP systems
- Sub-Programme 2: Point-Focusing CSP systems
- Sub-Programme 3: Thermal Energy Storage
- Sub-Programme 4: Materials for CSP

[1] International Energy Agency. "Concentrating Solar Power tracking report" (https://www.iea.org/reports/concentrating-solar-power-csp). June 2020.

[2] Solar Payback project. "Solar heat for industry" (https://www.solar-payback.com/wp-content/uploads/2020/06/Solar-Heat-for-Industry-Solar-Payback-April-2017.pdf).

[3] S.C. Johnson, J.D. Rhodes, M.E. Webber, "Understanding the impact of non-synchronous wind and solar generation on grid stability and identifying mitigation pathways". Applied Energy, 262, 114492, 2020.

- Sub-Programme 5: Solar Driven Thermochemical Processes
- Sub-Programme 6: Solar Heat for Industrial Processes and Applications

Some of the partner institutions concentrate the large majority of existing large-scale R&D facilities for CSP in Europe. Most of these facilities are included at the 'Trans-national Access Activity' of the EC-funded Integrating Activity called SFERA-III (Solar Facilities for the European Research Area - Third Phase). So, this free access mechanism can be used to ease the way for non-SFERA partners to benefit from them, thus giving a higher coherence to the whole JP. It is intended that this very useful cooperation mechanism will be later transferred to EU-SOLARIS activities.

As a summary, this JP currently (2021) involves 14 full participants plus 13 associated participants with a total commitment of 167.1 person-year/year devotion. This JP-CSP JP will continue with the management structure and procedures used during the IRP STAGE-STE and also all current JP organizations (with just one exception) are partners of ECRIA INSHIP, so a smooth management of the JP is expected. Finally, this JP-CSP Description of Work (DoW) is designed as a 4-year long project, covering the current one the period 2018-2021. An assessment of the results and of the partnership evolution will be carried out at the end of such a period in order to decide and define the future subsequent scientific activities and technical content of the JP.

2.2.2.2. About Sub-Programme 6 Solar Heat for Industrial Processes and Applications (Description and Work Programme / DoW 2018-2021)

The general objective of the current Sub-Programme 6 aims at addressing the specificities of the use of Concentrating Solar Thermal (CST) technologies in the Industrial framework. Approximately 75% of the global primary energy demand for industry stands for heat supply. Medium and high temperature Solar Heat for Industrial Processes (SHIP) can therefore significantly contribute to the decarbonisation of the industrial sector. Dwelling on the technological developments sought in SP1 and SP2 at CST technology, SP3 at Thermal Energy Storage and SP4 at Materials levels, the Sub-Programme 6 focus on addressing the main technical and technological challenges faced by CST technologies on SHIP applications, defining the boundary conditions for the development of well suited technologies. Such boundary conditions are also sought when addressing Energy Intensive sectors, thus in close relation with the specific technology developments sought in SP5. As so, the Sub-Programme enforces research activities aligned with the following specific objectives:

- Development of targeted steam integration concepts for medium temperature applications aiming not only the development of optimized supply level integration concepts but also standardized Balance of Plant (BoP) concepts enabling an approach to cost-effective "plug & play" solutions to the integration of solar driven steam in steam distribution networks;
- Specification of boundary conditions for the design of solar concentrating technologies optimizing the use of available rooftop and façade areas in industrial plant buildings;

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- Development of suitable industrial environment specific durability tests for collector components including the specification of materials and the definition of component and material testing suiting the environmental conditions existing in different industrial sectors (e.g. outdoor and indoor corrosivity, dusting/soiling conditions) increasing the reliability of SHIP collectors;
- Development of hybridization concepts for large industry sites and industry parks, including resource efficiency (integration of energy and resource efficiency in waste and water- flows);
- Development of tools for 100% RES concepts combining energy efficiency of processes (changing technology and optimizing heat integration) and heat integration of total sites with an innovative design of various energy supply technologies that interact with each other (in series or parallel).

Additionally, considering the relevance of economic and financial aspects in the market penetration of SHIP, competitiveness related questions such as heat supply costs benchmarking and technology cost reduction are also included among the results sought for SP6.

2.2.2.3. Status and recent activities of the EERA JP-CSP and SP6 in the context of SHIP topics

During 2020, in several meetings of the JP-CSP, the continuation of activities beyond the INSHIP project was discussed. As mentioned above, keeping up of joint activities shows difficult for most of the partners without external funding for the required resources. On the other hand, all JP-CSP members agreed that the consortium structure and related governance is beneficial in many respects for all partners as well as for the general support of RTD on CSP/CSH/SHIP. Therefore, the group opened a discussion on a priorisation of activities with the aim to define a minimum set of activities which should be kept active beyond INSHIP and without external funding. Eventually, a set of minimum activities was defined and will be used as the basis for the definition of the work programme for the next period which is planned in 2021 (see listing at the end of section 2.3). Most of the partners committed to contribute on such a minimum level in order to keep the important consortium and governance structure of the JP-CSP beyond INSHIP. Therefore, it is ensured that **the EERA JP-CSP will provide one future consortium and governance structure for the objectives of the INSHIP ECRIA.**

Besides the continuation of RTD work and minimum coordination as defined in the work programme of JP-CSP and following the discussions described above, two recent activities of the JP-CSP can be mentioned here. The first one is the setup of a new website for the JP (see https://www.eera-csp.eu/) which was implemented in 2020.

The second activity has been the involvement of JP-CSP in discussions and the definition process on a national/EU funding context which will be newly defined and established. In the framework of the so-called "Clean Energy Transition Partnership (CETP)", funding for future transnational RTD shall be provided with a combination of EU and national funding. The CETP is intended to provide a continuation of the previous ERA.net (Solar-ERA.net / CSP-

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ERA.net) funding lines.
As one of the first steps in the definition of this funding mechanism, expert groups were established to define research priorities and research challenges by means of input papers to a Strategic Research and Innovation Agenda (SRIA). This process has been started in Summer 2020 and the resulting SRIA was presented at the SET-plan conference in November 2020. Along the definition of research priorities / SRIA input, countries were asked to express their interest to participate in the funding instrument and respective topics.
Coordinated by JP-CSP, the CSP/CST community ensured that their research priorities were included in the respective topic areas of CETP and the respective SRIA input papers. In particular, the priorities of SHIP research were provided as input to the input paper of the topic Cluster "Heating & Cooling solutions" in general, and particularly to the challenge section on industry, as well as to the input paper of the topic Cluster "Renewable Technologies" in the challenge section on CSP. Further topics related to SHIP (e.g. thermal storage as cross-cutting topic, or high T processes and solar chemistry) have been addressed by respective members of the JP-CSP.

2.2.3. IEA Tasks on Solar Process Heat / SHIP

Beyond the European level, there are governance structures in the framework of the International Energy Agency IEA. These activities are organized within so-called Technology Collaboration Programmes (TCPs). Through Implementing Agreements, states become members in TCPs and support activities to contribute.

The Technology Collaboration Programmes (TCP) function within a framework created by the IEA. The TCP mechanism is a flexible and effective means for IEA member and non-member countries, businesses, industries, international organisations and non-government organisations to research breakthrough technologies, to fill existing research gaps, to build pilot plants, to carry out deployment or demonstration programmes – in short to encourage technology-related activities that support energy security, economic growth and environmental protection.

There are two TCPs which are addressing Solar Process Heat / Solar Heat in Industrial Processes and Applications: the TCP "Solar Power and Chemical Energy Systems (SolarPACES)" and the TCP "Solar Heating and Cooling (SHC)".

Currently (02/2021), SHC has 19 members: Australia, Austria, Belgium, Canada, China, Denmark, France, Germany, Italy, Netherlands, Norway, Portugal, Slovakia, South Africa, Spain, Sweden, Switzerland, Turkey, United Kingdom,
and SolarPACES has 20 members: Australia, Austria, Brazil, Chile, China, European Commission (DG RESEARCH & INNOVATION and DG ENERGY), France, Germany, Greece, Israel, Italy, Mexico, Morocco, Namibia, Republic of Korea, South Africa, Spain, Switzerland, United Arab Emirates and United States of America.

In consequence, for the joint SHC/SolarPACES Task 64/IV which is described below, the involved 30 country members are:
Australia, Austria, Belgium, Brazil, Canada, Chile, China, Denmark, European Commission

(DG RESEARCH & INNOVATION and DG ENERGY), France, Germany, Greece, Israel, Italy, Mexico, Morocco, Namibia, Netherlands, Norway, Portugal, Republic of Korea, Slovakia, South Africa, Spain, Sweden, Switzerland, Turkey, United Arab Emirates, United Kingdom, United States of America.

For more information on IEA, SHC and SolarPACES, see the respective Websites:
https://www.iea.org/areas-of-work/technology-collaboration/renewable-energy
https://www.iea-shc.org
https://www.solarpaces.org

In the past, SHC and SolarPACES had jointly defined and executed the Task 49 (49/IV) "Solar Heat Integration in Industrial Processes" during 02/2012 – 12/2015. For results and more information, see https://task49.iea-shc.org/. In the years 2018-2019, i.e. in INSHIP periods 1 and 2, discussions were initiated on a follow-up Task. This lead to the definition and start of the Joint SHC/SolarPACES Task 64/IV "Solar Process Heat" which will be running over 48 months during 01/2020 – 12/2023. This will be detailed in the following section 2.2.3.1.

In parallel, within SolarPACES, the Task IV "Solar Heat Integration in Industrial Processes" regularly meets/met at the annual SolarPACES conferences. Following the implementation of Task 64/IV, discussions were initiated on remaining tasks to be addressed by SolarPACES Task IV. More detailed information on this ongoing SHIP related Task IV is given in the following subsections 2.2.3.2.

With the implementation of the SHC/SolarPACES Task 64/IV and re-definition of SolarPACES Task IV, these **IEA Tasks will also provide future consortium and governance structure for the objectives of the INSHIP ECRIA.**

2.2.3.1. Information on the IEA SHC/SolarPACES joint Task 64/IV (2020-2023)

Following the previous SHIP related Task 49, this Task 64/IV "Solar Process Heat" has been defined during 2018-2019 and started January 2020 with a duration of 48 months, i.e. will end Dec 2023.

The industrial sector accounts for approximately 30% of the total energy consumption in the OECD countries. The major share of the energy that is needed in industrial companies, services and agriculture is used for heating and cooling of buildings and for production processes at temperatures from ambient up to approx. 400-500°C. This is a temperature range that can be addressed with solar thermal technologies at a high TRL.

To be able to make use of solar heat in industry and to support this market sector for the solar thermal industry, it is necessary to integrate solar thermal systems into the energy supply schemes in a suitable way.

Scope
The scope of the Task is on solar thermal technologies for converting solar radiation into heat and further the intelligent integration of the produced heat into industrial processes (i.e., the

subject that is covered by the Task starts with the solar radiation reaching the collector and ends with the hot air, oil, water or steam being integrated into the application).

Applications, systems and technologies, that are included in the scope of this task, are:

- All processes in industry, commerce and agriculture that are thermally driven and operated in a temperature range from ambient temperature up to approx. 400-500 °C.
- Solar thermal systems using air, water, low pressure steam or oil as a heat carrier, i.e. not limited to a certain heat transfer medium in the solar loop.
- All types of solar thermal collectors are addressed: uncovered collectors, flat-plate collectors, improved flat-plate collectors - for example hermetically sealed collectors with inert gas fillings, evacuated tube collectors with and without reflectors, CPC collectors, MaReCos (Maximum Reflector Collectors), linear Fresnel collectors, parabolic trough collectors.

Objectives

The goal of the proposed Task is to help solar technologies be (and also be recognized as) a reliable part of process heat supply systems. These systems are hybrid supply systems and will have to be integrated in the upcoming developments of the digitalization of industrial production systems and their energy demand. Instead of focusing on component development, we will look at the overall (solar) system at process temperatures from just above ambient temperature up to approx. 400°C-500°C. Open research questions are the standardization of integration schemes on process level and on supply level and the combination with other efficient heat supply technologies. As a very important aspect, the experiences of numerous solar process heat markets throughout the world will be brought together to enable a market-oriented dissemination of existing and new knowledge.

The key objective of this new Task is to identify, verify, and promote the role of solar heating plants in combination with other heat supply technologies for process heat supply, such as fossil and non-fossil (biomass and biogas) fuel boilers, combined heat and power, heat pumps, or power-to-heat.

The Task is organized in five main activities / Subtasks, derived from the described key areas:

- Subtask A: Integrated energy systems
- Subtask B: Modularization
- Subtask C: Simulation and design tools
- Subtask D: Standardization and Certification
- Subtask E: Guideline to market

For more information, see https://task64.iea-shc.org/

Many members of the INSHIP consortium are actively involved in this joint task, in the role of Operating Agent (DLR), Subtask Coordinators (CIEMAT, CRES, AEE INTEC, Fraunhofer ISE) or as contributing experts from many further institutions.

2.2.3.2. Information on the IEA SolarPACES Task IV

While the joint Task 64/IV was defined to address SHIP technologies and applications up to maximum temperatures of approx. 400-500°C, a gap was apparent for Solar heat for industrial processes starting from 400-500 °C.

With newest (concentrating) solar technologies these high temperatures above 400-500°C can be reached. This opens the way for solar high temperature heat applications. SolarPACES task IV "Solar Heat Integration in Industrial Processes" will address this topic in a new working group that established first discussions in autumn 2020. An initial expert meeting to define topics/activities and priorities has been held online on Nov 26, 2020. The work group will intensify information exchange between experts all over the world. The pillars of this activity will be:

- Update on most recent developments in the field by regular tasks meetings
- Supporting the cooperation between experts and inducing joint R&D projects
- Identification of R&D needs for the high temperature applications
- Promoting the application of high temperature heat by sharing information, presentations in the annual SolarPACES conferences

For more information, see https://www.solarpaces.org/csp-research-tasks/task-annexes-iea/task-iv-solar-heat-integration-in-industrial-processes/

As in Task 64/IV, also in the SolarPACES Task IV many members of the INSHIP consortium are actively involved, in the role of Operating Agent (DLR), or as contributing experts from many further institutions.

2.3. Defined Consortium Structure and Governance beyond INSHIP

On European level, the consortium structure and governance chosen and established under the given circumstances and boundary conditions as discussed in the previous sections, is in the framework of the EERA Joint Programme on CSP (JP-CSP). (EERA = European Energy Research Alliance). Here, the "Sub-Programme 6 (SP6) Solar Heat for Industrial Processes and Applications" has been defined during the INSHIP project lifetime.

More details on this Sub-Programme 6 of the EERA JP-CSP are given in section 2.2.2 (2.2.2.2 and 2.2.2.3.), updated information can be retrieved from newly implemented Website of the EERA JP-CSP under https://www.eera-csp.eu/.

On international level beyond the EU, two consortium and governance structures in the framework of IEA TCPs have been defined or are under re-definition:

- IEA joint SHC/SolarPACES Task 64/IV "Solar Process Heat", 2020-2023, with 30 member states actively participating

- IEA SolarPACES Task IV "Solar Heat Integration in Industrial Processes", with 20 member states actively participating.

More details on these Tasks is given in sections 2.2.3.1 and 2.2.3.2 or from the related Websites.

Despite the fact that detailed scope, objectives and implementation plans differ between these three consortia, there is a significant overlap both in scope, topics content and, in particular, in participants from the European SHIP research community, an intensive exchange and alignment of the activities on EU/EERA and on International/Worldwide/IEA level can be expected, that information and results are shared and initiatives and activities are mutually stimulated between these consortia. While the EERA JP-CSP consists of European partners only, also in the IEA Tasks the participation of European experts and institutions is overproportionally strong. It can therefore be expected that, overall, these consortia jointly provide the envisioned follow-up structure for activities towards an INSHIP ECRIA even without providing an explicit ECRIA structure and governance. Such governance principles should eventually meet, among others, the following criteria:

- Proper coordination, by defining and implementing ascendant, descendent and transversal channels of communication and information flowing among the different bodies and members of the organization.
- Proper internal regulated procedures and formalities to daily normal activities of the organization.
- Internal solid structure well and fully endorsed by the participant organizations
- Transparency, both at a technical level and at an economic management level, without prejudice to the due confidentiality that should be maintained.
- Sustainability, always minimizing the internal costs of the organization and structure.
- Proper or sufficient dedication of persons directly involved, to guarantee the correct functioning of the organization.
- Existence of cohesion policies to promote close relations and the cohesion of the members, the industry, the scientific community and, ultimately, the society in general.
- Internal and external control procedures, to be applied when needed
- Flexibility, to be able to provide for, adapt to and respond rapidly to any changes that might occur in its environment, in a continually-evolving framework, both from an economic and social point of view, and from a technological and industrial point of view.
- Distribution of powers, to guarantee a correct, clear and transparent distribution of duties and powers among the different bodies of internal organization structure to be defined.
- Independence, from the potential specific interest of individual partners and/or of organizations belonging to, and not necessarily in line with overall organization interests.

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- Democratic participation, to ensure the presence and democratic participation of all members and that seek consensus and a balance of interests at stake.
- Non-discrimination, due to gender or nationality.
- Policies of conflicts of interest avoidance, to guarantee total independence and the non-existence of partiality or distortion in the decision-making processes.
- Meritocracy, to always select the most adequate person to any defined position.

Nevertheless, as a considered key element in this process maintains the definition or achievement of some financing that could drive, at least, a minimum of “gluing” activities. As this financing is not expected to come, at least in the short or medium time, from the Horizon Europe framework programme or other Pan-European initiatives such as the CETP, it is not easy to foresee how and when a solid and stable SHIP Organization could be created. In the meantime, it is considered that the only “bridge” or temporal solution to maintain some continuation of related activities would be the reinforcement of the existing Sub-Programme 6 of the EERA JP-CSP.

Within this JP-CSP (and thus also for SP6), the following specific actions were agreed (on October 2020) among all participant organizations (all as well partners of the INSHIP project just with one exception) to increase the current level of activity and internal organization and collaboration:

- Management
  - Organization of periodic meetings/telcos with European SHIP research organizations
  - Periodic yearly short report on realized activities by involved stakeholder’s /research partners*
- Definition and continuously update of an European SHIP Research Agenda
  - Follow up the results of key identified SHIP research projects
  - Follow up on key scientific publications directly related to SHIP topics
  - Definition and continuously update of a key list of SHIP research topics
- Promotion of SHIP Project Development
  - Continuously monitoring of suitable SHIP related calls at EU and National levels
  - Trying to always have an active involvement in SHIP proposals definition and participation
- Increase the visibility of SHIP topics
  - Contribution to European Commission and other European and/or national bodies with regard to SHIP related initiatives
  - Periodic organization of industry oriented SHIP workshops
  - Participation and contribution to policy oriented events/documents related with SHIP topics
- Development and maintenance of Internal database of key SHIP info:
  - Development and continuously update of key industrial and governmental stakeholders related to SHIP topics
  - Development and continuously update of a project (national and EU research projects) info compiling the following information:

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- Project name
- Acronym
- Financing source
- Leading organization (coordinator)
- Years of execution
- Total project budget
- Individual budget (of the organization partner providing the information)
- Additional comments/info (if relevant)

With the development of all previously indicated activities, to be implemented from 2021 and beyond, it is expected to maintain a reasonable degree of collaborative activity until a suitable path to the full achievement of objectives indicated within the Section 1 of the present document is found.

2.4. Final Summary of achieved results

Other options for funding of a future consortium structure or other frameworks have been discussed, but none of these other discussions has led to a concretization of a consortium and governance structure for the INSHIP ECRIA.

In summary, during the implementation of INSHIP and through active contributions from INSHIP partners, with the

- EERA JP-CSP Sub-Programme 6 (SP6) Solar Heat for Industrial Processes and Applications"
- SHC/SolarPACES Task 64/IV "Solar Process Heat"
- SolarPACES Task IV "Solar Heat Integration in Industrial Processes"

three ECRIA/SHIP consortium and governance structures could be defined / re-defined and implemented ensuring the operation and decision-making processes along the development of the activities foreseen in the pursuit of the ECRIA objectives beyond the execution of INSHIP.

3. Degree of progress

Work in Task 1.3 is concluded and this Deliverable Report D1.5 is finalized with some delay.

4. Dissemination

There were no dissemination activities related to the content of this deliverable report.