Integrating National Research Agendas on Solar Heat for Industrial Processes

Project Deliverable 6.6:

D 6.6 – Final report on the Infrastructure Access Scheme		
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Contents

1. Content of deliverable

This report includes a description of the publicity done on the new opportunities for access the INSHIP's research infrastructures offered in this Project, and a description of the selection procedure of the proposals received in the different calls scheduled during the lifetime of the INSHIP Project. On the other hand, this report gathers information about the proposals received, approved and rejected in each call, about the projects already implemented as well as the main achievements obtained through the corresponding mobility mission.

Finally, a list with the scientific output of the users at the installations, a list of researchers who have accessed to INSHIP's research infrastructures through Union support and a list of research infrastructures made accessible to all researchers in Europe and beyond through EU support (INSHIP support) and summary of access per installation per reporting period (RP) are included in this report.

2. Description of the publicity concerning the new opportunities for access

The Infrastructure Access Scheme (IAScheme) is a funding option to perform joint R&D activities at an existing and registered Research Infrastructure (RI) working on SHIP related topics. It has been designed with the objectives of: i) providing significant added research activities to the ECRIA, ii) collecting an important amount of further national contributions (from a larger number of organizations), and iii) enlarging the scope and critical mass of the common European research community on SHIP topic (up to the full EERA JP-CSP) to guarantee the best possible ECRIA results.

In the first and second calls, the advertising campaign for access to our research infrastructures was carried out internally, that is, within the consortium. The main idea was to promote INSHIP Infrastructure Access Scheme among the INSHIP consortium partners. The approach was done by e-mail, and also on the private area of the INSHIP project website.

In the third call, in addition to the e-mail sent to each partner of the INSHIP consortium, an official launch of the call was carried out in social networks, i.e., LinkedIn and Twitter, making use of several accounts which aim are to promote the activities of EU-funded CSP projects like INSHIP, namely through the LinkedIn 'H2020 CSP projects' group and the twitter account with the same name. Furthermore, the communication manager of EERA (European Energy Research Alliance) was asked to make this call announced on the EERA website, as she did on 22nd November 2019, and the communication manager of ESTELA (European Solar Thermal Electricity Association) was also asked to submit the call to all its members through the means of communication she usually use.

22 NOV 2019

EU PROJECT INSHIP: CALL FOR PROPOSALS FOR ACCESS TO INFRASTRUCTURES

The EU-funded project INSHIP (Integrating National Research Agendas on Solar Heat for Industrial Processes) has opened a 2nd call for proposals under the recently established Infrastructure Access Scheme. The scheme is part of the INSHIP project and financed by the EU. It allows researchers, but especially industry players to use different facilities and exchange staff. [...]

https://www.eera-set.eu/new-call-for-proposals-to-access-the-ship-infrastructure-iascheme/

Within the framework of the advertising campaign carried out in this third call, an information flayer was prepared and distributed among the partners, and was also upload on the INSHIP website (https://www.inship.eu/research_infrastructures.php) to make it available to the industry, as they are a primary target of this call. The industry is expected to lead the proposals for this call, and that is why ESTELA was contacted to spread the word about the call among its members.

3. Description of the selection procedure

The following details the proposed selection procedure finally used for the selection of proposals under the IAScheme, after the update proposed by the coordinator of the activity, discussed during the 3rd Coordination Meeting in Trento in October 2019, and finally approved by the General Assembly (GA) on 30 October 2019. The changes to this procedure are related to the eligible costs of the core partners and networking partners, see Tables Table 1 and Table 2, to the in-kind contribution required to partners, and to the budget limit than can be requested in each proposal as described in this document in section 3.1.

Table 1. **Eligible cost for the IAScheme approved by the GA members**

	Core Partner (Hosting)	**Core Partner (Visiting)**	**Networking Partner (Hosting)**	**Networking Partner (Visiting)**	**External partners**
Travel and Accommodation	N	Y	N	Y	Y**
Infrastructure consumables or, Infrastructure use costs	Y	Y	Y	Y	N
General Personnel Costs	N*	N*	N	N	N
Personnel costs regarding hosting activities and personnel costs related with the operation of the RI	N*	N*	Y	N	N

*Personnel Costs for Core Partners stem from RA budget within ISNHIP and/or in-kind contributions

** Eligible within INSHIP partners' budget (it should be already mentioned in the proposal which partner is responsible for which invited Industrial partner).

Table 2. **Changes on the eligible cost for the IAScheme approved by the GA members on 30 October 2019**

	Core Partner (Hosting)	**Core Partner (Visiting)**	**Networking Partner (Hosting)**	**Networking Partner (Visiting)**	**External partners**
Travel and Accommodation	N	Y	N	Y	Y**
Infrastructure consumables or, Infrastructure use costs	Y	Y	Y	Y	N
General Personnel Costs	N*	N*	**Y**	**Y**	N
Personnel costs regarding hosting activities and personnel costs related with the operation of the RI	N*	N*	Y	**Y**	N

*Personnel Costs for Core Partners stem from RA budget within ISNHIP and/or in-kind contributions

** Eligible within INSHIP partners' budget (it should be already mentioned in the proposal which partner is responsible for which invited Industrial partner).

The date of launch of the calls for proposals, the duration of the calls, and the periods established for the mobility missions were also adapted to the needs that were emerging for the successful implementation of the IAScheme, and this is described in section 4 of this document.

3.1. Definition of the procedures for the selection

Initially two calls for mobility actions were planned within the INSHIP project. The first one from 4th September 2017 until 31st December 2017, and the second one from 22nd November 2019 until 31st December 2019. The two periods stablished for mobility missions were April 2018 to September 2019 for the first call and February 2020 to October 2020 for the second call.

Joint mobility proposals should be submitted according to an application form that is available at the INSHIP website.

At the end of the call, each applicant form is reviewed by the Mobility Coordinator (MC) so that an eligible check is made according to the following criteria:

- Proposals must be led by the research infrastructure owner. Consortia must have a minimum of two INSHIP partners and the inclusion of industrial partners will be positively evaluated.
- Non-disclosure agreements should be signed by the consortia of the proposal when an industrial partner is included.
- Proposals aim the development of short term (1-4 weeks) concrete activities related to specific tasks from WPs 2 to 5.
- Proposals must include a budget detailed description and budget allocation for the different INSHIP partners.
- Budget description must include requested EC contribution and foreseen "in-kind" contribution by each INSHIP partner in the Consortium (following the general rule of a minimum 50% share of in-kind contribution). Eligible costs include travel and accommodation costs.
- For Networking partners, eligible costs might include Infrastructure consumables or, when a clear and EC approved method for Infrastructure use cost calculation is available, corresponding Infrastructure use costs.
- For Networking partners hosting activities at their Research Infrastructure (RI), personnel costs related with the operation of the RI are eligible.
- Accommodation and travel costs for invited Industrial partners are eligible within INSHIP partners' budget. It should be already mentioned in the proposal which partner is responsible for which invited Industrial partner.
- EC contribution requests must lie in the range of 5 to 10 k€ (the envisaged average EC contribution per action is of 7.4 k€).

Which as mentioned above were modified to meet the real needs of the partners and those of the IAScheme, making it more flexible and attractive to the INSHIP Project partners. The changes proposed during the 3rd Coordination Meeting in Trento in October 2019, and finally approved by the General Assembly (GA) on 30 October 2019 are the followings:

- For INSHIP partners, the budget description must include requested EC contribution and foreseen "in-kind" contribution ~~by each INSHIP partner in the Consortium (following the general rule of a minimum 50% share of in-kind contribution)~~. This in-kind contribution must be ensured over the whole INSHIP project. Eligible costs include travel and accommodation costs.

- For Networking partners hosting activities at their Research Infrastructure (RI), or visiting a RI, the personnel costs ~~related with the operation of the RI~~ are eligible.
- EC contribution ~~requests must lie in the range of 5 to 10 k€ (the envisaged average EC contribution per action is of 7.4 k€).~~ per proposal is limited by [15.000€ x number of INSHIP partners involved - distribution within proposal open], and the overall budget per proposal in total is limited by max. 50.000€ EC contribution.

Once done, the MC sends the proposals to the Independent Panel of Experts (IPE), which review them according to previously defined criteria. The IPE is composed by three experts designated from the Stakeholder group to evaluate Applications submitted in each call. IPE have one months to review the Applications remotely according to the evaluation criteria described in this document in section 3.2. Then they meet to discuss their score for the projects and rank them. The MC gathers all assessment reports.

Table 3. **Members of the Independent Panel of Experts**

Name	Organisation	Country
Miguel Frasquet	Solatom CSP s.l.	Spain
Ilknur Yilmaz	The Scientific and Technological Research Council of Turkey	Turkey
Costas Travasaros	Prime Laser Technology SA	Greece

Finally, the MC then ranks the projects and validates all scores of the proposals and makes a classification according to three categories. In the second call, priority is given to such mobility projects submitted by partners who have not been granted in the first call. The three categories to classify the proposals are:

- Accepted projects granted mobility
- Accepted projects on the reserve list
- Rejected proposals.

The MC is the one in charge of sending the letters of acceptance or rejection. For the projects rejected, a special letter will be drafted to inform on the reasons for rejection. The applicants will have the possibility to respond on the rejection of the proposal by contacting the MC. The MC will transfer the request to the IPE and together they could reopen the evaluation, should they consider that the request of the applicant is justifiable.

Once the Applicants with accepted projects are informed of their acceptance, the Facility Manager (FM) of the hosting installation will be in charge of planning the dates for the venue and supporting the visiting personnel in the logistic formalities, including office desk, internet access and all necessary technical support during the period of the mission.

Upon approval, INSHIP Project Coordinator will automatically transfer the corresponding budget to the INSHIP partners included in the Consortium. Upon budget transfer, each partner is responsible for justification of the corresponding costs according to the IAScheme proposal, to be reported in the overall Financial Cost Statement of the respective partner.

3.2. Definition of the criteria and scores

The IPE shall base its selection on the following criteria:

- Alignment with the INSHIP ECRIA objectives. Scientific excellence (originality and innovation).
- The overall quality of the proposal.
- The relevance of the proposal on the related research task within the corresponding WP.
- The in-kind contribution ratio proposed.
- Industrial partner inclusion.
- Exploitation plan for future coordinated actions.

The final ranking is decided by all panel members in a consensus basis during the meeting, by considering all relevant data. The best ranked proposals will be short-listed for mobility missions and the rest will be considered as part of a reserve list.

Proposals ranked in the reserve list could be finally granted with the mobility access if accepted proposals do not communicate with the MC for informing about the estimated mobility dates within the first month after notification.

4. Description of the Infrastructure Access Scheme Proposals/Mobilities

The first call for proposal was finally launched in September 2017 and extended until July 2018, due to the low participation of the INSHIP partners in the activity, with the idea that mobility missions would be carried out from January 2019. Note that due to the low number of proposals received for this first call, the second call was launched in January 2019, just after the evaluation process of the first proposals by the IPE was completed, with the idea that mobility missions would be carried out from June 2019 to December 2020. In addition, and due to the still low number of proposals received and the small budget requested by these proposals compared to the total budget available for the action, a third call for proposals was required and launched in November 2019. In this last stage, a period was proposed for the mobilities from January 2020 to November 2020.

In January 2020, during the 4th General Assembly meeting, the data corresponding to this third call were reviewed, noting that only one proposal had been received up to that point. In this situation, it was then decided that the members of the GA should take a decision on the need to update the document 'Guidelines for the Evaluation of Proposals in the IAScheme'. It was voted and approved at that time to establish new procedures for fast evaluation of IAScheme proposals changing the condition of waiting for 5 proposals to be evaluated by sending them for evaluation as they arrived, and at the same time the GA members voted on keeping the call open on a continuous basis. Both proposals came out ahead, so the third call has remained open on a continuous basis with the only requirement that last proposals shall be approved in such a time frame that results are achieved within the INSHIP project lifetime, and the projects have been sent to the IEP for evaluation as they arrived.

Five proposals were received in the first call, see Table 4. The evaluation process by the IPE was completed in mid-September 2018. Of these five proposals, three were approved by the IPE, and two were rejected, i.e., ARISHIP and FOC. Of the three approved proposals only two (SOLGAS and Pre-Modulus) were implemented within the established period for the first mobility missions, i.e., October 2018 to September 2019. The third one, SOLSAHP, was implemented in November 2019, during the established period for the second mobility missions.

Table 4. **Proposals received in the first call.**

Acronym (Project title)	Host Institution short name	Applicant short name
SOLSHAP (Solar reflectors shape measurement using autocollimators)	CIEMAT	IK4-TEKNIKER
Pre-Modulus (Preparing the project 'Modulus – Modular Balance of Plant)	DLR	FISE
SOLGAS (Solar gasification of waste materials)	CNRS	CEA
AIRSHIP (Aerothermal characterization of 10kW solar absorber for SHIP involving volumetric receivers)	IMDEA	FBK
FOC (Fiber Optic Characterization)	CNR INO	IST-ID

Similarly, in the second call, five proposals were received, see Table 5. The evaluation process by the IPE was completed in mid-April 2019. Of these five proposals, three were approved by IPE, and two were rejected, i.e., FOC and ETC-SC. Of these three approved proposals only one (LFSteam) has been implemented coinciding with the period established for the first mobility missions, i.e., October 2018 to September 2019. The other two proposals (M3DSHIP and ETC-SC) have been implemented remotely during the established period for the third mobility missions, i.e., January 2020 to November 2020.

Table 5. **Proposals received in the second call.**

Acronym (Project title)	Host Institution short name	Applicant short name
LFSteam (Control law of the discharge valve in heat exchangers for the production of steam under constant conditions using thermal oil from Fresnel collector)	CIEMAT	USE
M3DSHIP (Metallic 3D-printed solar absorbers for high-temperature industrial processes)	IMDEA	FBK
ETC-SC (Experimental Testing of Evacuated Tube Collector with Semi-circular Mirror)	LNEG	CRES
FOC (Fiber Optic Characterization)	CNR INO	IST-ID
ECSH (Synergistic integration of electrochemical technologies with solar heating)	CIEMAT	UNIPA

In the third and last call, four proposals were received, see Table 6. The evaluation process, as mentioned above, was carried out by the IPE at the same time as the proposals arrived, with the last evaluation for the INSTEAD proposal taking place in mid-August 2020. The four proposals received in this last stage were approved by the IPE.

Table 6. **Proposals received in the third call.**

Acronym (Project title)	Host Institution short name	Applicant short name
OPTISTEAM (Optimisation of heat transfer in concentrated solar power plants with direct steam generation technology)	CRES	UNINA
PerformSHIP (Performance comparison of solar simulators vs solar furnaces with respect to accelerated ageing of candidate materials to build high temperature solar)	IMDEA	CIEMAT
BioHidrogen (Potential of Alentejo forestry and agribusiness biomass waste for solar-driven hydrogen production)	ETHZ	UEVORA

Table 6. **Proposals received in the third call.**

Acronym (Project title)	Host Institution short name	Applicant short name
INSTEAD (Inside steam detection)	Fraunhofer	UNINA

As of today, seven of the eight projects evaluated and approved by the IPE have been implemented (SOLSHAP, Pre-Modulus, SOLGAS, LFSteam, OPTISTEAM, BioHidrogen and INSTEAD). Below is an overview of the objectives of each project and the main achievements after the implementation.

Title of the Project: **Pre-Modulus**	
Acronym:	Pre-Modulus
Name of the installation:	Sopran
Short name of the applicant institution:	Fraunhofer
Short name of the host institution:	DLR
Members of the Consortia:	DLR; Fraunhofer; Protarget AG; Industrial Solar GmbH; Solarlite GmbH; ROBA Piping Projects GmbH
Related INSHIP research WP and Task:	WP3, Task 3.1 and Task 3.2
Onsite working period:	03/07/2019 to 04/07/2019
Onsite working time (in Person week(s)):	2 days plus travels, 6 Persons
Remote working time (in Person week(s)):	7 weeks

Objectives

Currently BoP's of industrial solar heat plants are planned individually for each installation. Not many installations are being built and their size, temperature and heat transfer media differ so that each solar collector supplier has to plan and construct the BoP's individually for his plants. Especially for field sizes of several 100 m² of aperture area the relative costs for a BoP are high, increasing the solar heat generation costs significantly.
The investigations in Pre-Modulus aim at preparing a proposal to standardise and thus reduce costs for BoP's. This relates to the aims of INSHIP especially in WP3, Task 3.2 – Balance of plant concept for better cost competitiveness for market introduction.
The TRL ranges from 4 (Technology tested in lab) to 6 (technology demonstrated in relevant environment).

Main achievements

Currently BoP's of industrial solar heat plants are planned individually for each installation. Not many installations are being built and their size, temperature and heat transfer media differ so that each solar collector supplier has to plan and construct the BoP's individually for his plants. Especially for field sizes of several 100 m² of aperture area thus the relative costs for a BoP are high, increasing the solar heat generation costs significantly. Therefore, a consortium of industrial

partners in cooperation with DLR and ISE has prepared the proposal "Modulus" for standardising BoP's to reduce costs. The investigations in the Pre-Modulus project helped to prepare technical concepts for the proposal.
The tasks related are Task 3.1 Solar driven steam generation and Task 3.2 Balance of Plants concepts in WP 3 "Technology and applications to medium temperature SHIP (150°C to 400°C)"
As a coordination objective the "acceleration of knowledge transfer to the European industry, at both end-user sector and technology supplier levels, in order to ensure the industrial European leadership on SHIP" has been addressed by the integration of 4 companies (all technology suppliers) in the Pre-Modulus project.
Pre-Modulus also intended to prepare the German "Modulus" project which has been submitted by now with good chances for acceptance until May 2020. This helps to reach the goals of the INSHIP "action through the promotion of specific research activities aligned with the scientific topics of the ECRIA and setting the base for the preparation of project proposals aligned with national and EC funding objectives and engaging the participation of industrial partners".
The research objective "To ensure a swifter and efficient integration of existing Solar Thermal technologies into low and medium temperature processes." and the action "Through the implementation of specific activities aiming standardized integration of SHIP into existing facilities, …" is addressed as the Modulus project will contain standardisation of BoP's as a central topic to reduce cost.
The tests in Pre-Modulus helped to realise the KPI_8. "Number of joint tests carried out by two or more ECRIA participants" by the joint testing of ISE and DLR.
While the Pre-Modulus project could not directly help to achieve the "KPI_28 Reduction of Solar Steam Integration BoP costs" the Modulus project aims at significantly reducing these costs.
The main difficulty has been the weather condition. During the testing period only about 50% of the time sunshine was good enough to run the tests.

Title of the Project: **Solar gasification of waste materials**	
Acronym:	SOLGAS
Name of the installation:	PROMES solar furnace
Short name of the applicant institution:	CEA
Short name of the host institution:	CNRS-PROMES
Members of the Consortia:	CEA, SIBUET, CNRS-PROMES
Related INSHIP research WP and Task:	WP4
Onsite working period:	01/07/2019 to 19/07/2019
Onsite working time (in Person week(s)):	3
Remote working time (in Person week(s)):	0

Objectives

Over the last few years, solar-only and solar-hybrid gasification have demonstrated their effectiveness to convert a wide variety of feedstock such as wood, coal and petcoke, activated charcoal and corn waste. Although promising, because offering an attractive way for improving

the economical balance of solar gasification, the use of Municipal Solid Waste (MSW) and industrial waste (IW) as a primary feedstock for solar gasification was barely discussed. Due to the complex nature of waste and its high percentage of ash, its efficient solar conversion needs to be carefully examined.
Often, the recovery of material and energy from MSW and IW is carried out through the production of Refuse Derived Fuel (RDF). Prepared from plastic wastes, food packaging wastes including plastic, paper, aluminium, glass, etc. RDF presents several advantages over unprocessed waste as they are easier to handle with fairly constant physicochemical properties and a low chlorine content (generally below 1.5%). Within this framework, and with the purpose of recycling waste with natural sunlight, solar gasification of waste particles in the form of RDF or beech wood sawdust was carried out in a directly irradiated conical cavity-type solar reactor. The goal of the study was to assess the ability of the reactor to convert the millimetric waste particles and identify the potential technical issues to be tackled for improving the reliability of the solar process (TRL 4-5).

Main achievements

First solar-only and solar hybrid experiments on RDF particles were performed for various experimental conditions:

	Run# 1	Run# 2	
$T_{operating}$	1300°C	1300°C	
$m_{feedstock}$	20g	20g	
V_{motor}	12V	12V	12V
Operating mode	Allothermal	Allothermal	Hybrid
F_{RDF}	0.57 g/min	0.58 g/min	0.58 g/min
F_{steam}	0.25 g/min	0.25 g/min	0.25 g/min
F_{oxygen}	0 NL/min	0 NL/min	0.25 Nl/min
S/B	0.58	0.58	0.58
$(S/B)/(S/B)_{st}$ based on Eq.1	1.06	1.06	1.06

The results were promising and showed both high syngas quality and a good performance. Nonetheless, the continuous process suffered significantly from the instability of the injection that particularly affected the hybrid process. Another encountered issue concerned ash agglomeration at the bottom of the conical cavity (Figure 1).

Figure 1. Top view photography of the solar cavity after experiment

Co-funded by the Horizon 2020 Framework Programme of the European Union

The melting ashes agglomerated around the packed Al_2O_3 bed just above the gas injection tube, this should be correctly managed to avoid obstructing or blocking the gas passage. Further experiments were therefore performed using beech wood sawdust particles at 1200°C and at 1300°C under direct and indirect heating configurations. Thanks to their low ash content, and their more uniform size distribution, they were cleaner and easier to handle.

Title of the Project: **Control law of the discharge valve in heat exchangers for the production of steam under constant conditions using thermal oil from Fresnel collector**	
Acronym:	LFSteam
Name of the installation:	HTF Test loop (CIEMAT – PSA)
Short name of the applicant institution:	CIEMAT
Short name of the host institution:	CIEMAT
Members of the Consortia:	CIEMAT, USE
Related INSHIP research WP and Task:	WP3 – Task 3.1
Onsite working period:	01/07/2019 to 19/07/2019
Onsite working time (in Person week(s)):	8
Remote working time (in Person week(s)):	8

Objectives

To achieve a greater integration of solar energy in thermal processes, it is necessary to deepen into solar systems for the production of steam with stable conditions concerning pressure and temperature. In the bibliography several articles and projects have been identified in which analysis of the control system is carried out in order to achieve stable vapor conditions. The conclusions of the investigations indicate that the control is simpler and more stable when the pressure of steam produced is higher than 30 bar, due to a lower variability of the properties of the steam, however, for industrial processes the steam consumed is produced up to 16 bar. Hence, it is necessary to deepen the control logic of the system when the system produces steam at low pressure.

Also, most of the existing systems focus on direct steam production in the collector itself, however, no indirect steam production systems have been identified from the use of thermal oil inside the collector. This supposes a further modification in the control system, since it has to include in the control scheme the process of heat transfer inside the heat exchanger / vaporizer.

The objective of the project is to achieve a deeper knowledge in the control systems of steam production in solar driven generators when Fresnel collectors with HTF are used.

Main achievements

During the access period the Fresnel collector was installed in the test bench, and its test plan defined, but it cannot be executed due to a rupture of the HTF circulation pump. The optical and thermal model of the Fresnel collector previously developed by the University of Seville was adjusted using commercial parameters. During January and February 2020, the SOLATOM Fresnel sensor is being tested at PSA.

Regarding the development of the thermal model of a steam generator, the literature review was carried out and the model was implemented in the MATLAB SIMULINK tool. From a geometric point of view, the data from the steam generator of the DISS test bench were used. Several simulations were performed with different operating conditions of pressure inside the generator and heat provided, obtaining the variation of the steam flow and the water level in generator over time (dynamic simulation). The activities related to the modelling of the steam discharge valve from the generator and its control law were carried out. A PID control with feed-forward using the generator's linear has been selected model for the control law. Work is being done on simulations and comparison with test results to adjust the model parameters.

Title of the Project: **Solar reflectors shape measurement using autocollimators**	
Acronym:	SOLSHAP
Name of the installation:	PTTL test facility
Short name of the applicant institution:	IK4-TEKNIKER
Short name of the host institution:	CIEMAT
Members of the Consortia:	IK4-TEKNIKER; CIEMAT
Related INSHIP research WP and Task:	WP3 Task 3.4
Onsite working period:	18/11/2019 to 22/11/2019
Onsite working time (in Person week(s)):	2 person weeks
Remote working time (in Person week(s)):	13 person weeks

Objectives
The knowledge of the geometrical quality of the optical surfaces in solar collectors is crucial to determine its performance. Different techniques are available to measure the geometry of solar reflectors; close-range photogrammetry or deflectometry are techniques that have been applied in solar test facilities but also in production lines up to now. The solution proposed in this project, which has been developed by IK4-TEKNIKER is the application of an inline control of solar reflectors based on the autocollimation principle. The proposed technique outperforms previous approaches in several aspects. On the one hand, the inspection cell is only slightly larger than the reflector panel under test, as a result, the inspection cell is compact and improves the use of the layout of the plant. On the other hand, the measurements are carried out with considerably smaller uncertainties than other approaches. The compact arrangement of reflectors and autocollimators provides a solution that is very stable from the mechanical point of view. The measuring time is really short because the measurement consists of taking a simultaneous measurement with the set of autocollimators (ACs), similar to taking one photograph. The starting TRL of the system was 4 and with the project a TRL 6 was achieved. Linked to INSHIP project, WP3 Task 3.4, CIEMAT is developing a compact and innovative linear Fresnel collector that uses curved mirror panels, which are measured with the system.

Main achievements

The principal achievements that have been carry out in the application of an inline control of solar reflectors based on the autocollimation principle are summarized as follow:

1. The Control Box assembly for the control of the ACs, which composed by the next element (see Figure 2):

- Embedded PCs (One for each autocollimator): Carries out the necessary image processing of the autocollimator and offers the results and the identification of the device through an Ethernet port.
- Power supply
- Ethernet switch: To ensure the simultaneous measurement with the autocollimators

2. The autocollimators platform adaptation to ensure a correct ACs distribution that guarantee a reliable measurement of the linear Fresnel reflectors.

Figure 2. The autocollimation system adaptation

3. The first set-up to ensure the correct measurements of each AC. For this purpose, a MATLAB script has been developed in order to connect with the Embedded PCs to taking simultaneous measurements.

4. The development of the post-processing functions in MATLAB code, to obtain the solar reflector curvature using the AC's measured angels.

5. The experiments with a linear Fresnel reflector in the Tekniker installation proportionated by the PSA, the purpose of these experiments is the validation of the equip before the delivery to PSA installation.

6. The delivery of the equipment to the PSA installation. A special transport box has been manufactured.to avoid any equipment damage.

7. The set-up of the device at the PSA installation and measurement of a linear Fresnel reflector for the final validation of the equipment (see Figure 3):

Figure 3. Set-up at the PSA installations

Co-funded by the Horizon 2020 Framework Programme of the European Union

Title of the Project: **Experimental testing of evacuated tube collector with semi-circular mirror**	
Acronym:	ETC-SC
Name of the installation:	Test facility of liquid heating solar thermal collectors
Short name of the applicant institution:	CRES
Short name of the host institution:	LNEG
Members of the Consortia:	LNEG, CRES, METU
Related INSHIP research WP and Task:	WP2, Task 2.1 and Task 2.3
Onsite working period:	10/11/2020 to 20/11/2020
Onsite working time (in Person week(s)):	online collaboration only
Remote working time (in Person week(s)):	10 (METU); 4 (CRES)

Objectives

The aim of the project is to experimentally investigate the performance of the evacuated tubular collector (ETC) with semi-circular reflector, which is considered fit for SHIP applications, with working temperatures within 80-150 °C, located at the Solar Energy Laboratory of LNEG.

Main achievements

For project development a search on evacuated tubular collectors was preformed and a Chinese company was identified as having available an evacuated tubular collector with semi-circular reflector. The company sells this collector model with three different sizes. The one corresponding to average size was chosen for testing. The main achievements of the project are:

- validation of experimental results by comparison with modelled collector behaviour based on test results of the collector sizes that were tested in a previous certification process according to SRCC using ISO 9806:2013 and the Steady-state test method.
- full characterization of collector performance using as testing methodology the Quasi-Dynamic test QDT) method according to ISO 9806:2017. The Solar Energy Laboratory of LNEG is an accredited testing Laboratory to perform this type of test.

The collector optical behaviour is characterized including Transversal and Longitudinal Incidence Angle Modifier, since the collector has a biaxial geometry. The transversal IAM is a very important characteristic of this collector due to the existence of the semi-circular reflector.
For identification of the thermal performance parameters a tool (developed at LNEG) is used.
The testing results allow calculation of the long-term behaviour of the collector for reference locations as Athens, Davos, Würzburg and Stockholm using the ScenoCalc Tool (http://www.estif.org/solarkeymarknew/the-solar-keymark-scheme-rules).

Title of the Project: **OPTImisation of heat transfer in concentrated solar power plants with direct STEAM generation technology**	
Acronym:	OPTISTEAM
Name of the installation:	Solar simulations software - Tonatiuh
Short name of the applicant institution:	UNINA
Short name of the host institution:	CRES

Members of the Consortia:	CRES, UNINA, SONDAG ENERGY
Related INSHIP research WP and Task:	WP2, Task 2.1
Onsite working period:	21/09/2020 to 23/11/2020
Onsite working time (in Person week(s)):	online collaboration only
Remote working time (in Person week(s)):	16

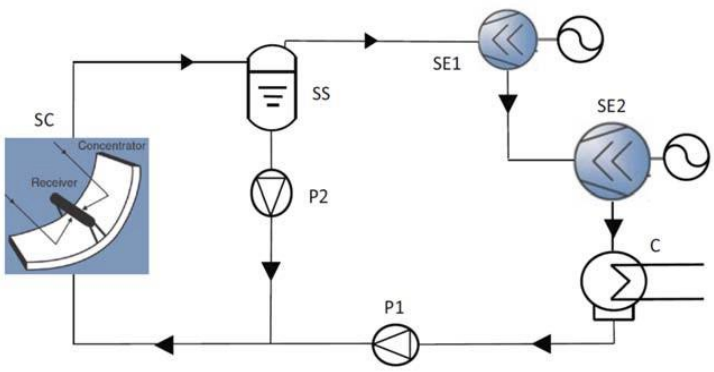
Objectives

The objective of this project is to study a direct steam generation DSG solar power plant, driven from low and medium temperatures that is characterised by simple construction, low initial and operational cost and high efficiency.

Main achievements

In terms of collaboration, the partners gained more detailed knowledge about direct steam generation in solar plants and exchanged knowledge and professional experience in the process of building and simulating a solar collector model in a ray tracing software (SOLTRACE). The partners also had the chance to interact with SONDAG ENERGY, a company that produces concentrating solar collectors of this geometry, and to transfer this knowledge about high efficiency solar evaporators to industrial applications.

In terms of scientific achievements, these primarily concern the Scheffler-type solar receiver model. The Scheffler-Type Solar Concentrator (STSC) involves the interception of the open circular area with a small side section of a parabola, and a reflector in the form of such a section directs the solar radiation to a fixed focal point, where an evaporator is installed and secured by a fixed support structure. The system uses a dual-axis tracking system, which consists of a daily tracking mechanism that moves the reflector mounted on a carriage in proportion to the solar motion and other time-tracking mechanisms, which provides for rotation of the reflector that is synchronised with the movement of the sun during the day. This angular movement of the reflector is performed around an axis oriented to maintain a fixed focal point normal to the incidence for the area of the aperture for the reflector, thus concentrating the solar radiation into the cavity where an evaporator produces steam for the plant. The system under consideration is shown in the following figure.



During the working period of the project, a simulation model of a Scheffler-type solar receiver was developed. The efficiencies in the various sunshine conditions were evaluated in order to have a complete model for the entire power generation plant. This plant uses screw expanders, which are better suited to work with saturated steam at non-high pressures.

Title of the Project: **INside STEAm Detection**	
Acronym:	INSTEAD
Name of the installation:	DIAMESYS
Short name of the applicant institution:	Fraunhofer
Short name of the host institution:	UNINA
Members of the Consortia:	Fraunhofer, UNINA, Company 1
Related INSHIP research WP and Task:	WP3, Task 3.1
Onsite working period:	26/10/2020 to 24/11/2020
Onsite working time (in Person week(s)):	online collaboration only
Remote working time (in Person week(s)):	9

Objectives

This proposal aims at a proof-of-concept of a new sensor system to monitor the two-phase flows inside a hydraulic circuit and assess the applicability in DSG solar fields of SHIP plants.

Main achievements

Main achievements could be reached by the successful assembly of the experimental facility. Considering the Action 2: of the IAS project the experimental facility has been analysed and designed. A scheme of the design is shown in Figure 4. The facility contains an electric water heater (1) with capacity of 5 litres controlled by a PID to stabilize the temperature (the range is between external temperature and 100°C). The item AB is a first part of the duct that has been joint by the first 90° connection with the down tube BC. At the end of the section BC another 90° connection joints the pipe with the expansion vessel (2). The Expansion vessel is able to give the requested pressure to the pipe and to recover and stabilized the movements of the fluid. It is important to highlight that, all measurements devices and components. are placed considering the steady conditions of the flow and so the mutual distance between a component and the measurement points is always bigger than 5 diameters. On the pipeline, section DE, takes place a volumetric flow meter and a piezoelectric sensor able to measure the inlet pressure of the centrifugal pump and on the section FG. another piezoelectric sensor measures the outlet pressure. The G point instead represents the inlet of the compressed air taken from the pressure vessel (7). This air, according with the pressure and temperature of the liquid phase, will generate a bubbles cluster of defined shape and size. The new two-phase fluid, will pass through the 90 connection, point H of the pipe, and will be routed to the vertical pipe. The vertical pipe is the track where the requested measurements will be carried out. On the section HI will be measured the temperature of the two-phase fluid and immediately after an accelerometer will be placed to record the vibration due to the bubbles presence. The following section of the pipe IL will be in transparent material (plexiglass or other materials) to verify which kind of two-phase flow has been developed. The pipe continues with the section LM where a T joint permits to mount an air vent (9) to drain the gas blown. Section MO brings the water back into the heater. The whole pipe is insulated to try have constant temperature.

This facility simulates what happens when two phase flow arise inside a duct. The facility has been discussed with Fraunhofer in accordance with the indications provided by Company 1. The role of Fraunhofer in this IAScheme was the identification of use cases in the solar thermal context. For this purpose, Fraunhofer could get in contact with several suppliers and operators of direct steam generating plants for both technologies – Parabolic Trough and linear Fresnel. Questions could be addressed like demands on the sensor, operation strategies with regard to the flow regime (steam content), safety requirements, potential of saved energy through an optimized control supported by the sensor.

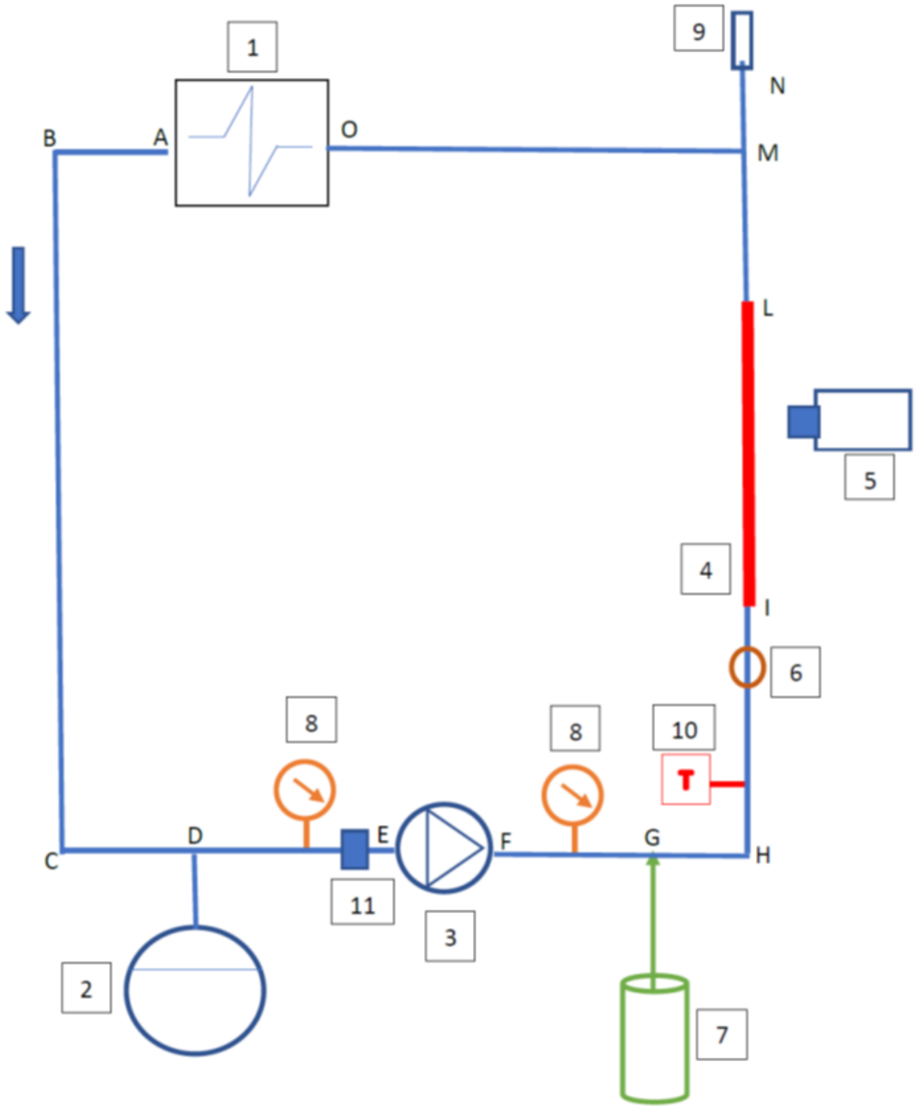


Figure 4. Experimental facility

Title of the Project: **Metallic 3D-printed solar absorbers for high-temperature industrial processes**	
Acronym:	M3DSHIP
Name of the installation:	KIRAN42
Short name of the applicant institution:	FBK
Short name of the host institution:	IMDEA
Members of the Consortia:	FBK, IMDEA, Company 2

Related INSHIP research WP and Task:	WP4, Task.3.3
Onsite working period:	30/10/2020 to 24/11/2020
Onsite working time (in Person week(s)):	online collaboration only
Remote working time (in Person week(s)):	4

Objectives

The main object of the M3DSHIP project is testing the original 3D-printed absorber concept for air heating at high-temperature at 10kW-scale using the 42kWe-High flux solar simulator and test beds located at the IMDEA Energy Institute. Main technical outcomes from this IAScheme project are: (i) Experimental confirmation of thermal performance at 10kW-scale; (ii) Validation numerical models for optimising receiver design; (iii) Move technology readiness level (TRL) using this concept from 3 to 4 (TRL3 > TRL4), promoting collaboration with industry. At this end, this proposal involves FBK, IMDEA Energy and Company 1, an industrial partner as observer, which has expressed its interest in this solar receiver concept.

Main achievements

- Several atmospheric air volumetric absorbers based on hierarchical concept and manufactured by 3D printing (Selected laser melting, SLM, technique) have been successfully tested in a 42-kW high flux solar simulator.
- Technology has been validated in lab, reaching TRL4.
- Prior to manufacturing, specific protocol and tools have been developed to analyse numerically and experimentally radiation propagation in hierarchical-based volumetric absorbers (HVR). New experimental methods lie in laser light scattering and optical transmissivity measurements. These tools have been used to upscale 1kW HVR up to 10 kW.
- In parallel, IMDEA Energy aerothermal characterization test bench has been adapted to host the FBK absorbers.
- Experimental characterization has covered the range between 12 Nm^3/h and 160 Nm^3/h and specimens has achieved up to 1150°C.
- Preliminary data analysis indicate that current technology is able to achieve performance higher than 75% and temperature distribution compatible with a volumetric effect (efficiency higher than original one).

INSHIP KPI	Description
KPI 8. Number of joint tests carried out by two or more ECRIA participants	> 36 joint tests
KPI 9. Total duration of joint tests carried out by two or more ECRIA participants	3 weeks
KPI10. Number of cross tests carried out by two or more ECRIA participants	6 tests
KPI 16. Number of reports from researchers involved in mobility and exchange programmes	1 report
KPI 32. Solar-to-fuel energy conversion efficiency in thermochemical redox cycles	KPI of RA 4.3.3 (no KPI of IAS) An improvement of optical properties and efficiency of metallic volumetric receivers have been observed. (3.8 optical properties and 5% efficiency of HVR)

Title of the Project: **Potential of Alentejo forestry and agribusiness biomass waste for solar-driven hydrogen production**	
Acronym:	BioHydrogen
Name of the installation:	Laboratories of the Professorship of Renewable Energy Carries, ETHZ
Short name of the applicant institution:	UEVORA
Short name of the host institution:	ETHZ
Members of the Consortia:	UEVORA, ETHZ
Related INSHIP research WP and Task:	WP4, Task 4.4
Onsite working period:	30/10/2020 to 27/11/2020
Onsite working time (in Person week(s)):	online collaboration only
Remote working time (in Person week(s)):	4

Objectives

The aim of the project is the assessment of the chemical potential of up to 8 biomass samples.

Main achievements

A total of eight (8) biomass samples from the region of Alentejo were collected. These biomasses are the most locally available woody-by products from agriculture and forestry and, therefore, the most viable option for hydrogen/syngas production at large-scale.

The samples were successfully chipped and sent to the Portuguese lab "Centro da Biomassa para a Energia" (https://centrodabiomassa.pt) for a full chemical analysis. The first results of the chemical analysis were received.

Together with partner ETHZ, an online interaction took place in order to perform a preliminary analysis of the potential of each biomass sample. Using the software FactSage 7.3 (https://www.factsage.com) a thermodynamic balance for different operation temperatures was carried out. A theoretical result of hydrogen and syngas production was determined both for pyrolysis and steam gasification processes. The results show that the potential of each biomass is roughly equal (similar chemical composition in terms of C, H and O) and temperatures above 500°C are required to have noticeable results for hydrogen and syngas production.

The potential of biomass samples from Alentejo region for hydrogen/syngas production was assessed, opening new opportunities for future research in this field, combining the agricultural activities and solar energy applications.

Co-funded by the Horizon 2020 Framework Programme of the European Union

5. Scientific output of the users at the installations

No.	Type[a]	Title	Authors	Title of the Journal/Proc./Book	Number, date or freq. of the Journal/Proc./Book	Is Peer-reviewed?	Is Open Access?	DOI
1	Paper in Proceeding of Conferences	Compact system for fast on-line geometry characterization of facets for solar concentrators linear fresnel reflector	B. Ahmed Chekh, Jesús Fernández-Reche, Loreto Valenzuela, Cristobal Villasante, Gorka Kortaberria, Diego Pulido-Iparraguirre	AIP Conference Proceedings		Yes	Yes	Review process

[a] Peer reviewed publication, Paper in Proceeding of Conferences/Workshops, Article/Section in an edited book series.

6. Infrastructures List of Users

Researchers who have accessed to INSHIP's research infrastructures through Union support.

Researcher		Employing organisation/Home institution			Project acronym	Installations used by the researcher	
Name	Activity Domain (Discipline)[b]	Name	Legal Status	Country		Infrastructure Short Name	Installation Short Name
Ahmed Brahim		IK4-TEKNIKER	RES	Spain	SOLSHAP	PSA	PTTL test facility
Aitor Olarra		IK4-TEKNIKER	RES	Spain	SOLSHAP	PSA	PTTL test facility
Theda Zoschke		Fraunhofer ISE	RES	Germany	Pre-Modulus	DLR	Sopran
Houssame BOUJJAT	Engineering & Technology	CEA	RES	France	SOLGAS	PROMES	PROMES small scale solar furnace
F. Javier Pino	Engineering & Technology	Universidad de Sevilla	UNI	Spain	LFSteam	PSA	HTF Test loop
Ruben Bartali[a]	Physics	FBK	RES	Italy	M3DSHIP	IMDEA	KIRAN42
Michele Bolognese[a]	Physics	FBK	RES	Italy	M3DSHIP	IMDEA	KIRAN42
Rosie Christodoulaki[a]	Engineering & Technology	CRES	RES	Greece	ETC-SC	LNEG	Test facility of liquid heating solar thermal collectors
Bayer Ozgur[a]	Engineering & Technology	METU	UNI	Turkey	ETC-SC	LNEG	Test facility of liquid heating solar thermal collectors
Amedeo Amoresano[a]	Energy	UNINA	UNI	Italy	OPTISTEAM	CRES	Solar simulations software - Tonatiuh

Researcher		Employing organisation/Home institution			Project acronym	Installations used by the researcher	
Name	Activity Domain (Discipline)[b]	Name	Legal Status	Country		Infrastructure Short Name	Installation Short Name
Giuseppe Langella[a]	Energy	UNINA	UNI	Italy	OPTISTEAM	CRES	Solar simulations software - Tonatiuh
Paolo Iodice[a]	Energy	UNINA	UNI	Italy	OPTISTEAM	CRES	Solar simulations software - Tonatiuh
Pedro Horta[a]	Energy	UEVORA	UNI	Portugal	BioHidrogen	ETHZ	Laboratories of the Professorship of Renewable Energy Carriers
Diogo Canavarro[a]	Energy	UEVORA	UNI	Portugal	BioHidrogen	ETHZ	Laboratories of the Professorship of Renewable Energy Carriers
Peter Nitz[a]		Fraunhofer	RES	Germany	INSTEAD	UNINA	DIAMESYS
Fanny Hübner[a]		Fraunhofer	RES	Germany	INSTEAD	UNINA	DIAMESYS

[a] Online collaboration only
[b] Chemistry, Earth sciences & Environment, Energy, Engineering & Technology, Humanities, Information & Communication Technologies, Life sciences & Biotech, Material sciences, Mathematics, Physics

Co-funded by the Horizon 2020 Framework Programme of the European Union

Research infrastructures made accessible to all researchers in Europe and beyond through Union support and summary of access per installation per reporting period (RP).

Participant number	Organisation short name	Short name of infrastructure	Installation Short name	Access provided in RP1 (days*)	Access provided in RP2 (days*)	Access provided in RP3 (days*)	Total access provided (days*)
1	DLR	DLR	Sopran			2	2
2	CIEMAT	PSA	PTTL test facility			5	5
2	CIEMAT	PSA	HTF Test loop			15	15
12	CNRS	PROMES	PROMES small scale solar furnace			15	15
22	IMDEA	IMDEA	KIRAN42			18	18
19	LNEG	LNEG	Test facility of liquid heating solar thermal collectors			9	9
7	CRES	CRES	Solar simulations software - Tonatiuh			46	46
88	ETHZ	PREC	Laboratories of the Professorship of Renewable Energy Carries			21	21
17	UNINA	DIAMESYS				20	20

* Onsite working time

7. Summary table of proposals received, approved and implemented

Call number	Acronym (Project title)	Host Institution short name	Applicant short name	Approved (yes/no)	Implemented (yes/no)
1	**SOLSHAP** (Solar reflectors shape measurement using autocollimators)	CIEMAT	IK4-TEKNIKER	Yes	Yes
1	**Pre-Modulus** (Preparing the project 'Modulus – Modular Balance of Plant)	DLR	FISE	Yes	Yes
1	**SOLGAS** (Solar Gasification of waste materials)	CNRS	CEA	Yes	Yes
1	**AIRSHIP** (Aerothermal characterization of 10kW solar absorber for SHIP involving volumetric receivers)	IMDEA	FBK	No	N/A.
1	**FOC** (Fiber Optic Characterization)	CNR INO	IST-ID	No	N/A
2	**LFSteam** ("Control law of the discharge valve in heat exchangers for the production of steam under constant conditions using thermal oil from Fresnel collector")	CIEMAT	USE	Yes	Yes
2	**M3DSHIP** (Metallic 3D-printed solar absorbers for high-temperature industrial processes)	IMDEA	FBK	Yes	Yes
2	**ETC-SC** (Experimental Testing of Evacuated Tube Collector with Semi-circular Mirror)	LNEG	CRES	Yes	Yes
2	**FOC** (Fiber Optic Characterization)	CNR INO	IST-ID	No	N/A
2	**ECSH** (Synergistic integration of electrochemical technologies with solar heating)	CIEMAT	UNIPA	No	N/A
3	**OPTISTEAM** (Optimisation of heat transfer in concentrated solar power plants with direct steam generation technology)	CRES	UNINA	Yes	Yes
3	**PerformSHIP** (Performance comparison of solar simulators vs solar furnaces with respect to accelerated ageing of candidate materials to build high temperature solar)	IMDEA	CIEMAT	Yes	No

Call number	Acronym (Project title)	Host Institution short name	Applicant short name	Approved (yes/no)	Implemented (yes/no)
3	**BioHidrogen** (Potential of Alentejo forestry and agribusiness biomass waste for solar-driven hydrogen production)	ETHZ	UEVORA	Yes	Yes
3	**INSTEAD** (Inside steam detection)	Fraunhofer	UNINA	Yes	Yes