Scientific and Technological Alliance for Guaranteeing the European Excellence in Concentrating Solar Thermal Energy

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Project Deliverable 4.6:

Final report on the exchange / Mobility of researchers

WP4 – Task 4.1	**Deliverable 4.2**
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1. Introduction

The objectives of the Work Package 4 "Capacity Building and Training Activities focuses are:

- Ensuring efficient implementation of the research Workplan and reinforcing cooperation and synergies among the partners through exchange/mobility of personnel between the partners. This will also raise the level of excellence of the researchers through transfer of knowledge among the partners.
- Increasing the use of complementary research infrastructures among the partners filling the gaps in CSP training programmes through the definition of training needs and mapping of existing ones.
- Fostering collaboration of the partners by creating a reference course on CSP to be delivered to scientific communities, especially the industry.
- Creating a pool of high-qualified professionals by delivering a reference course on the latest knowledge in CSP to experts, researchers, students, industry …
- Guaranteeing the sustainability of the reference course after the project to create a long-term generation of quality trained researchers.

The aim of the task 4.1. "Exchange / mobility of personnel" was to create and to reinforce the connection between the STAGE-STE institutions to try and build collaborative actions in accordance with the STAGE-STE research topics.

This deliverable reports the mobility activities for the entire duration of the STAGE-STE project. All the information related to the mobilities presented in this document has been gathered through the web-site purposely created up for the activities of the Task 4.1 "Exchange/mobility of personnel" from the beginning of the implementation of the task.

2. The management regarding the exchange of personnel

All the mobilities and related reported information, such as Mobility registration forms and Individual reports, are available on the web-site for mobilities developed by CNRS at the beginning of the Task 4.1 in order to facilitate the reporting of researchers on the planned or performed mobilities as well as to ensure a reliable management and monitoring of the mobilities for CNRS.

For this part, the next sections will briefly remind the objectives and functions of this tool following the structure of the deliverable D4.2 "Mid-report on the exchange/mobility of researchers" in order to analyse the efficiency of the established procedure of mobility management noticed during the period M24-M48.

2.1. The procedure of management of the exchange / mobility of personnel

The following parts follows the structure of the Deliverable 4.2 2 “Mid-report on the exchange/mobility of researchers”that explains in details the established procedure of administration of the mobilities of researchers through the STAGE-STE website for the mobilities. A brief analysis of the efficiency of the procedure is given at the end of each section.

Figure 1. Diagram about the procedure before a mobility

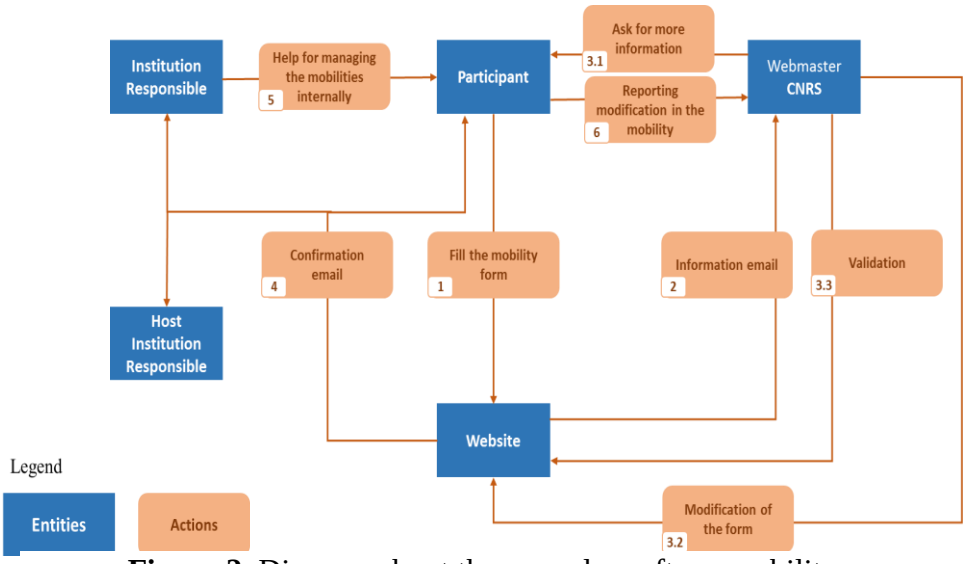
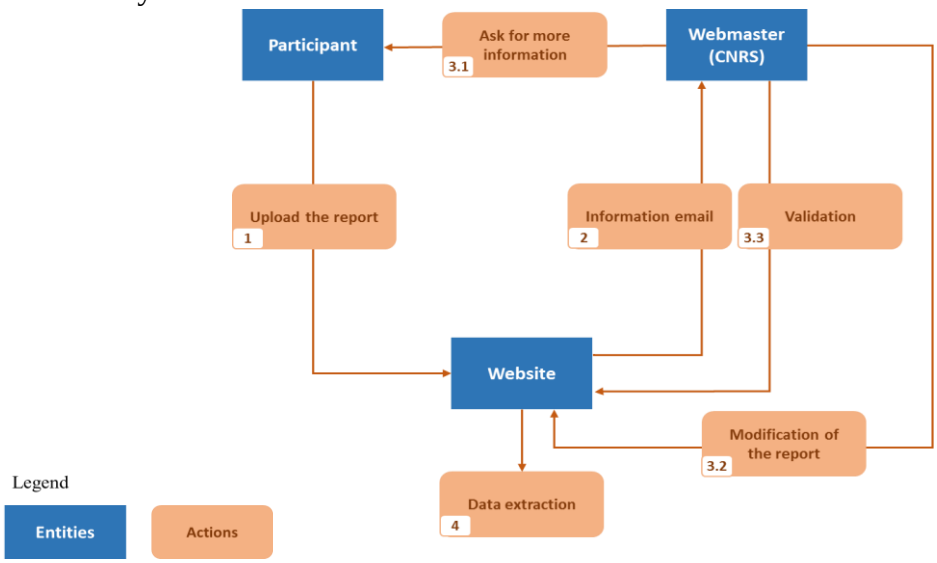


Figure 2. Diagram about the procedure after a mobility

It is to note that the established procedure has fully accomplished the aimed objectives of the comfortable and easy communication between the involved researchers and mobilities



administrator, since no important problems or misunderstanding has been tracked while mobilities progress monitoring and reporting

2.2 The registration of the mobility via a mobility form

The mobility form to be filled by the participants when they plan to perform a mobility is presented below. Three 3 kinds of information in have been required to fill by the mobility participant:

1. Information about the participant to the mobility;
2. Information about the institutions involved in the mobility: the participant's institution and the host institution;
3. Information about the mobility project.

Figure 3. The mobility form

There are notably 2 kinds of working time to be indicated in the mobility form:

- The “Onsite Working Time”: The onsite working time referring to the onsite working period of the mobility. One person week equals to 5 labour days. One person week should be justified when a minimum of 3 days of onsite labour days at the host institution have been realized, considering the time for the travel (one day before and one day after the mobility) is also part of the mobility, even if not hosted at the institution. In this sense, one person week is considered for all onsite working periods from 3 to 5 labour days.
- The “Remote Working Time”: The remote working period deals with all the preparatory work to be realized way before and after the mobility: joint work to prepare, mapping of the transfer of knowledge between both partners, preparation of experiments to do during the mobility, analysis of the experiments after the mobility, joint publications, etc. This will count for your mobility person month to declare and should be counted in the Remote working period. When the remote working time is more than 1 week, the participants have to justify the activities included in this time when filling their form.

For the detailed information on the mobilities duration, both onsite and remote working time (less than 1 week, from 1 to 3 wees, from 3 to 5 weeks and more than 5 weeks), please refer to the conclusion of this document.

2.3 The finalisation of the mobility with the individual activity report

According to the rules set up in the WP4 of the STAGE-STE project, each mobility should be finalised by the Individual activity report filled and uploaded on the web-site for mobilities by the relevant mobility participant no later than two weeks after the accomplishment of the mobility and could be considered as completer only after the validation by the Task 4.1. leader (CNRS).

It has to be mentioned that a number of delays in Individual report’s uploading has been observed despite of the clear indication of the 2-week deadline to submit the report in the automatic confirmation email of the mobility registration sent by the web-master of the web-site for mobilities after the registration and validation of the mobility. Consequently, a relevant reminder has been regularly spread among the STAGE-STE researchers involved in the mobilities and exchange of personnel to enhance their awareness on the importance of respecting 2-week period for Individual report uploading. The reminder has been diffused in a general way during the project progress meetings and individually by the Task 4.1 responsible (CNRS) the day before the deadline.

All the individual activity reports of all of the achieved mobility are accessible in the annex 1 of this deliverable in the order of the list of the achieved mobilities in the section 3.2.

The template to be filled for the activity report is presented below.

Figure 4. The personal activity report

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project:

Participant's first name and family name:

Name of the participant's institution:

Name of the host institution:

Onsite working period: dd / mm / yyyy to dd / mm / yyyy

Onsite working time (in Person week(s))*:

Remote working time (in Person week(s))**:

I. Objectives of the mobility

Please do not exceed 10 to 15 lines

II. Main achievements and difficulties encountered

Please do not exceed 10 to 15 lines

III. Joint publications foreseen /

Please do not exceed 10 to 15 lines

IV. Comments, if any

Please do not exceed 10 to 15 lines

*One person week equals to 5 labour days. One person week should be justified when a minimum of 3 days of onsite labour days at the host institution have been realized, considering that one day before and one day after the mobility are also part of the mobility, even if not hosted at the institution. In this sense, please consider one person week for all onsite working periods from 3 to 5 labour days.

**The remote working period deals with all the preparatory work to be realized way before and after the mobility: joint work to prepare, mapping of the transfer of knowledge between both partners, preparation of experiments to do during the mobility, analysis of the experiments after the mobility, joint publications, … This will count for your mobility person month to declare and should be counted in the Remote working period.

Each participant of the mobility have to fill in this document personally.
Please upload it following the instructions of the email in which this document was attached.

3. The status of the mobilities

The final status of the mobilities (M48) is presented in this section in two parts:

- Mobility plan regarding the description of Work: The Mobility plan for the 4 years of STAGE-STE presented below has been set by each institution at M11 and included in the Description of Work.

Note: Despite of the status of this mobility plan considered as the basis for the exchange of researchers, the consortium has agreed on the possibility of its modification during the implementation depending on the various unforeseen internal and external circumstances (budgetary issues, management constraints and other).

- The achieved mobility: This part lists the mobilities achieved during the entire duration of the project. From the beginning of STAGE-STE, 101 mobilities have been achieved.

Since the project is under its accomplishment, there is no mobilities planned.

3.1. The Mobility plan regarding the Description of Work

Table 1. Schedule of personnel Exchange and associated activities

Partner name	Partner to be visited	Number of weeks	Activities to be performed	WP
CIEMAT	CNRS	1	Checking of procedures used in CNRS for high flux and temperature measurements to harmonize procedures	WP8 WP12
CIEMAT	DLR	1	Checking of procedures used in DLR for high flux and temperature measurements to harmonize procedures	WP8 WP12
CIEMAT	PSI	1	Checking of procedures used in PSI for high flux and temperature measurements to harmonize procedures	WP8 WP12
CIEMAT	TEKNIKER	2	On site checking of existing facilities and procedures to evaluate feasible collaborations of mutual interest (two 1-week stays) related to WP11 Task 11.1 and WP12	WP11 WP12
CIEMAT	SENER	2	Two 1-week stays at a STE plant of TORRESOL for issues related to WP11 Task 11.2	WP11 WP12
CIEMAT	CENER	2	Technical visits to CENER during the project for working meeting concerning existing test stand for qualification of receiver tubes for parabolic trough collectors (WP11)	WP11

CIEMAT	DLR	2	Technical visits along the project to DLR for working meeting concerning existing test stand for qualification of receiver tubes for parabolic trough	WP11
CIEMAT	CEA	4	Four technical visits to CEA for on-site collaboration related to Thermocline storage systems, exchanging information and experiences on this topic (WP7)	WP7
CIEMAT	TECNALIA	2	Four short stays (2 days) at TECNALIA facilities on materials for Energy to get a first hand information on developments currently underway at these facilities, looking for synergies on collaborations for development of improved PCMs. (2 weeks in total during the project)	WP7
CIEMAT	ETH	4	Fours stays (one 1-week stay per year) at ETH for cooperation within WP9, Task 1 "Solar fuels from carbonaceous feedstock"	WP9
CIEMAT	PSI	4	Four stays (one 1-week stay per year) at PSI for cooperation within WP9, Task 2 "Solar fuels from thermochemical cycles"	WP9
CIEMAT	FRAUN-HOFER	1	Short technical visit to check existing lab facilities and the feasibility of up- scaling at PSA facilities	WP10
DLR	CNRS	1	Accelerated ageing of ceramic materials	WP8
DLR	PSI	1	Solar fuels production	WP9
DLR	CTAER	1	Round-robin tests in parabolic trough test bench	WP8
DLR	TEKNIKER	1	Characterization of thermo-phys. Properties of salts for storages	WP7
PSI	CNRS	12	Joint work on: (1) solar fuels from gasification of carbonaceous feedstock, e.g. biomass (T9.1); (2) solar fuels from thermochemical cycles, e.g., based on metals Sn and Zn (T9.2); (3) development and characterization of high- temperature materials (T9.3)	WP9
PSI	CIEMAT	6	Joint work on: (1) solar fuels from gasification of carbonaceous feedstock (T9.1); (2) solar fuels from thermochemical cycles (T9.2); (3) qualification of high-temperature materials (T9.3)	WP9
PSI	LNEG	2	Joint work on solar fuels from gasification of carbonaceous feedstock, e.g. regarding feedstock and product characterization (T9.1)	WP9

PSI	IMDEA	4	Joint work on (1) solar fuels from gasification of carbonaceous feedstock (T9.1); (2) solar fuels from thermochemical cycles (T9.2)	WP9
PSI	DLR	4	Preparation of a technology roadmap for solar thermochemical fuel production (T9.4)	WP9
CNRS-Promes	TECNALIA	1	High concentration optical systems and new receiver concepts for next generation solar towers.	WP12
CNRS-Promes	IMDEA	2	High concentration optical systems and new receiver concepts for next generation solar towers.	WP12
CNRS-Promes	CTAER	1	Fast calibration procedures for large heliostat fields	WP12
CNRS-Promes	CYI	2	Development or adaptation of an existing model to design and optimize high concentration optical systems	WP12
CNRS-Promes	LNEG	2	Development or adaptation of an existing model to design and optimize high concentration optical systems	WP12
CNRS-Promes	CNR	2	High temperature absorbers and materials	WP8
CNRS-Promes	Fraunhofer	2	Advanced thermal storage systems	WP7
Fraunhofer-ISE	CEA	4	Work on passive / active storage systems for DSG Simulation of integration/hybridization of TES in CSP plants Standardization for storage testing (WP7).	WP7
Fraunhofer-ISE	CNRS	4	Work on a) optical design of heliostats and layout of heliostat fields using simulation and ray-tracing tools; b) calibration procedures of heliostats in the field (WP12).	WP12
Fraunhofer-ISE	ENEA	8	Evaluate MS fluids for thermal storage and heat transfer, further collaboration on thermal energy storage, to perform simulation of integration/hybridization of TES in CSP plants (WP7).	WP7
Fraunhofer-ISE	UEVORA	12	Visit UEVORA will relate to development methodologies for dynamic solar field testing for linear Fresnel collectors and to the development & analysis of integration schemes for DSG collectors in thermal applications and power cycles (WP11).	WP11

Fraunhofer-ISE	CRS4	4	Numerical tools for solar tower systems (WP12) Numerical tools for thermal energy storage (WP7)	WP7 WP12
ENEA	CIEMAT	2	activities in the field of Membrane distillation	WP10
ENEA	PSI	3	Thermochemical cycle involving high temperature solid decomposition	WP9
ENEA	Tecnalia	1	Developing solar salts and nanoparticles mixtures to obtain new heat transfer fluids and heat storage media	WP7
ENEA	CNRS	1	Establishing new possible collaborations between of two laboratories to define the guideline on the arguments Adaptation of the STE Research Infrastructures according to the new standardized STE components	WP3
ENEA	ISE	1	Establishing new possible collaborations between of two laboratories to define the guideline on the arguments Adaptation of the STE Research Infrastructures according to the new standardized STE components	WP3
ENEA	DLR	1	Establishing new possible collaborations between of two laboratories to define the guideline on the arguments Adaptation of the STE Research Infrastructures according to the new standardized STE components	WP3
ENEA	CIEMAT	1	Establishing new possible collaborations between of two laboratories to define the guideline on the arguments Adaptation of the STE Research Infrastructures according to the new standardized STE components	WP3
ETHZ	IMDEA	5	Solar fuels production	WP9
CYI	ENEA	4	Integration and hybridization of TES in STE plants	WP7
CYI	CIEMAT	4	Model development and simulation of STE+D configurations	WP10
CYI	CSIRO	4	Point-focusing technology	WP12
LNEG	CIEMAT	1	Development of joint activities in the frame task 7.2 Aging of components with molten salts	WP7
LNEG	ENEA	1	Development of joint activities in the frame task 7.2 Aging of components with molten salts	WP7
LNEG	DLR	2	Exchange of experience in measurement of optical properties and characterization of mirrors and absorbers	WP8

LNEG	ETHZ	3	Participation on syngas characterization analysis during solar gasification experiments within the scope of WP9.	WP9
LNEG	CENER	2	To perform joint research activities in the area of central receiver technologies within the scope of task 12.2	WP12
LNEG	CNRS	3	To perform joint research activities in the area of central receiver technologies within the scope of task 12.2.3	WP12
CTAER	CENER	2	Activities related with test benches for parabolic trough collectors, participating in experiences and propose inter-comparison of methodologies and round-robin test activities.	WP12
CTAER	ENEA	2	Work on hybridization of solar and biomass systems to coordinate the activities and to develop a joint R&D plan in this area	WP7
CNR	ETHZ / PSI / CNRS	8	a/ Establishing new possible collaborations with advanced solar laboratories on novel conversion solutions and technologies (2 weeks 1 person) b/ Testing activity of innovative converters and materials (thermionic-thermoelectric combined converter, etc.) under development during the latest years, which need high concentration ratio optics and solar towers (3 researchers for 2 total weeks = 6 weeks)	WP8
CNR		4	Emissivity measurements at European Laboratories as described in Task 8.2.6 High Temperature characterization	WP8
CNR	CNRS	3	The study of resistance to the oxidation of ceramic refractary materials performed in PROMES-CNRS	WP8
CNR	CNRS/PSI	6	In the framework mobility of scientists we propose also two visits per year (1-2 weeks each) at the laboratories of PROMES-CNRS and PSI within the WP7 activity to perform joint research on the topic of hydrogen production by water splitting route that employs metal/metal oxide nanoparticles as catalyst	WP7
CENER	ENEA	2	T11.2. Methodologies for dynamic testing and predictive maintenance of large solar fields	WP11

CENER			T5.4: Guidelines for standardization of STE components and plant commissioning	WP5
CENER	CIEMAT	5	T11.2: Methodologies for dynamic testing and predictive maintenance of large solar fields	WP11
CENER			T12.1: Development of low cost heliostat fields (Tests execution)	WP12
CENER			T12.2: High concentration optical systems and new receiver concepts for next generation solar towers (Tests execution)	WP12
CENER	TEKNIKER	1	T12.1: Development of low cost heliostat fields	WP12
CENER	TECNALIA	1	T11.1- Small scale and low cost installations for power and industrial process heat applications. T11.2: Methodologies for dynamic testing and predictive maintenance of large solar fields.	WP11
CENER	LNEG	1	T8.2 High temperature absorbers and materials	WP8
CENER	CNRS	3	T12.1: Development of low cost heliostat fields (Tests execution and development).	WP12
CENER			T12.2: High concentration optical systems and new receiver concepts for next generation solar towers (Tests execution and development)	WP12
CENER	SENER	3	T11.2. Methodologies for dynamic testing and predictive maintenance of large solar fields	WP11
CENER			T5.4: Guidelines for standardization of STE components and plant commissioning	WP5
TECNALIA	CIEMAT	3	Activities related to WP7 (materials, latent heat storage) and to WP11 (small scale and low cost collectors and their application).	WP7 WP11
TECNALIA	CENER	3	Activities related to WP11 (smale scale and low cost collector and their applications) and WP12.	WP11 WP12
TECNALIA	UEVORA	3	Activities related to to WP11 (small scale and low cost collectors and their application).	WP11
TECNALIA	CNR	3	Activities related to WP7, PCM, synthesis of nanoparticles and their use in TES, etc.	WP7
TECNALIA	CNRS	1	High temperature materials and coatings.	WP8 WP12

UEVORA	Fraunhofer	2	Thermal and optical efficiency measurements on line-focusing systems (WP11)	WP11
UEVORA	CIEMAT	2	Study of pressurized water and thermal oil hydraulic loop control and monitoring procedures (WP11)	WP11
UEVORA	CIEMAT	1	STE+Desalination arrangements for different solar field and desalination technology pairs (WP10)	WP10
UEVORA	PSI / ETH	1	novel conversion solutions, applications and technologies concerning energy storage (WP9)	WP9
IMDEA	PSI	12	Reactor development and testing for production of solar fuels and energy storage	WP7 WP9
IMDEA	ETHZ	6	Reactor development and testing for thermochemical cycles and energy storage	WP7 WP9
IMDEA	ENEA	2	Comparative assessment of integration of high temperature electrolysis in CSP plants	WP9
IMDEA	DLR	4	Development of integrated systems for solar fuels and chemical storage	WP9
IMDEA	FBK	4	Design of SLM volumetric absorbers	WP12
IMDEA	IEECAS	4	Development and characterization of ceramic volumetric absorbers	WP12
IMDEA		4	Development and testing of solar reactor for gasification	WP9
IMDEA	ASNT	2	Thermochemical energy storage	WP7
IMDEA	CNRS	4	Development and characterization of ceramic materials for solar receivers	WP12
IMDEA	CIEMAT	6	Reactor development and testing for thermochemical cycles and energy storage	WP7 WP9
CRANFIELD	CIEMAT	3	Performance of CSP components in a desert environment	WP8
CRANFIELD	CENER	1	Dynamic Solar Field testing for predictive maintenance	WP11
IK4-TEKNIKER	DLR	1	T7.1: High temperature heat storage. Advanced heat transfer fluids.	WP7
IK4-TEKNIKER	ENEA	1	T7.2: Aging of components with MS, HTSM and PCM	WP7
IK4-TEKNIKER	CIEMAT	1	T11.2 Works on modelling and control improvement of solar power plants	WP11
IK4-TEKNIKER		1	T11.2 Works on O&M in solar power plants	WP11

IK4-TEKNIKER		3	T12.1 Testing efficient heliostat field control (2 stays)	WP12
IK4-TEKNIKER	CENER	2	T12.1 Development of new concepts for single facet small heliostats (2 stays)	WP12
IK4-TEKNIKER		1	T12.1 Development of efficient heliostat field control	WP12
IK4-TEKNIKER		1	T12.1 Development of Fast calibration procedures for large heliostat fields	WP12
UNIPA	ENEA	16	to study the coupling of a supercritical water biomass gasification reactor with the molten salt stream heated by CSP	WP9
UNIPA	CIEMAT	8	to study coupling potentials between thermal desalination processes (MED and MD) and solar energy	WP10
UNIPA	LNEG	8	Development of advanced dynamic modelling tool for the multiple effect distillation process to be implemented on different well-known platforms (gPROMS and TRNSYS)	WP10
CRS4	ENEA	2	Models and codes to describe and design both fixed and fluidized bed systems for high temperature thermal storage linked to T7.3.4	WP7
CRS4	CENER	2	Models and codes able to optimize solar field configurations for single- and multi-tower systems of any power size linked to T12.1.5	WP12
IST-ID	PSA	3	Exchange information and experiences on evaluation of durability and performance of materials at high temperatures and on methods for ageing of materials; methodologies in testing and characterization will be emphasized	WP8
IST-ID	To be decided	2	WP8 Ageing of materials	WP8
FBK	IMDEA	4	Small-scale sample validation and performance testing in collaboration with IMDEA high-flux laboratory for the new geometrical concept proposed in 12.2.4	WP12

3.2. The achieved mobilities

Table 2. Achieved mobilities and associated activities

Participant's Institution	Host Institution	Project Title	Activities performed	Onsite working time p/weeks	Remote working time p/weeks	WP	Remote working time justification
CENER	CIEMAT	Knowledge transfer about dynamic testing	Defining Methodologies for dynamic testing and predictive maintenance of large solar fields. Testing solar trackers on field.	2	0,2	11	
CENER	TKN	Testing of heliostat and calibration	To advance with the development of automatic calibration methods for heliostats, we agreed between CENER and IK4-Tekniker to perform some tests on their site, which will also allow to incorporate knowledge about the proposed small sized heliostat developed within WP12 by both institutions.	1	0	12	
CENER	CIEMAT	Heliostat calibration testing	Perform experiments and gather data for heliostat calibration which will be used during the testing of the small sized heliostat under development.	1	0	12	
CENER	CIEMAT	Heliostat calibration testing	Perform experiments and gather data for heliostat calibration which will be used during the testing of the small sized heliostat under development	1	0	12	

CENER	CNRS	Second test phase of SiC module THEMIS	The aim of the second test phase os SiC module THEMIS will be to experiment thermal and thermomechanical behaviour of this type of ceramic module on conditions of extreme solar flux (typical of critical solar flux distributions).	1	0	12	
CENER	CIEMAT	Testing of heliostat and calibration	The aim of the exchange is to advance with the development of an automatic calibration system for heliostats using the installations available at the host institution and the heliostat developed in WP12 by CENER and TEKNIKER. Finally, 3 people exchange has decided due to heliostat installation and commissioning activities and the need of post-processing some test results to continue with the test plan defined.	2	1	12	
CENER	LNEG	Knowledge transfer	Knowledge transfer within the subtask 8.2 and more particularly about high temperature absorbers and material.	1	0,2	8	
CENER	CIEMAT	Heliostat calibration testing	The aim of the exchange is to advance with the development of an automatic calibration system for heliostats using the installations available at the host institution and the heliostat developed in WP12 by CENER and TEKNIKER.	2	1	12	

CENER	CNRS	Transient modeling and simulation of the ceramic module	The complementary activities between CNRS and CNER were discussed. The main discussion was about collaboration regarding transient analysis of the pressurized receiver developed by CNRS, CENER can perform the model and CNRS can provide the experimental data. But also ceramic module thermo structural detailed analysis modeled by CNRS was discussed.	1	0,5	12	
CENER	CNRS	Transient modeling and simulation of a high-temperature plate pressurized receiver	The objective of the mobility was to visit the experimental installations at CNRS Odeillo and to discuss the work done by CNRS and by CENER in order to agree on the activities in Task 12.2.3 that would be of interest for both institutions, being of complementary nature.	0,6	0,5	12	
CENER	CIEMAT	Heliostat calibration testing	The aim of the exchange is to advance with the development of an automatic calibration system for heliostats using the installations available at the host institution and the heliostat developed in WP12 by CENER and TEKNIKER.	2	1	12	
CIEMAT	DLR	Receiver Round-Robin test	Assistance to measurements of the receiver tubes in the DLR laboratory.	0,8	0,2	8	

CIEMAT	TECNALIA	Materials for thermal storage	Both research groups will show their capabilities and necessities in terms of the materials for storage research lines they are already involved in order to see and look for possibilities of collaboration in close future under other than STAGE-STE funding schemes.	0,4	0,4	7	
CIEMAT	CEA	Thermal Storage	Creating, if possible, a collaboration related to Thermocline storage systems, exchanging information and experiences on this topic. Sharing the capabilities and priority research lines on other thermal storage activities in order to see and look for possibilities of collaboration in close future under other than STAGE-STE funding schemes	0,8	0,4	7	
CIEMAT	TKN	Development of a low cost heliostat	Preliminary design of the heliostats prototype that will be developed on Task 12.1.2 and definition of the testing procedure to be performed at PSA.	1	4	12	Remote work includes the definition of the test campaign that must be carried out at PSA in 2016 as well as the work after the stay to modify our auto-aligned heliostat design to fit with the geometrical requirements of the heliostat proposed by TEKNIKER (1PW before the stay and 2 people working 1,5 Weeks after the stay)

CIEMAT	CNRS	Definition of an effective procedure to model and test new designs for volumetric solar receivers	The main objective of this mobility project is to establish a procedure to develop a CFD (Computational Fluid Dynamics) model which reproduces the thermal behaviour of a volumetric-receiver configuration selected, including the experimental techniques required to evaluate both optical and thermophysical properties that characterise the receiver structure.	2	4	12	Prior to the mobility, the remote working time was used to organize the tasks of the mobility project. Firstly, it was identified the different strategies to simulate the behavior of a solar receiver. At this stage, it was considered the simulation of a reference absorber design by the homogenized model in order to compare the local thermal equilibrium (LTE) model with the local thermal non-equilibrium (LTNE) one. After the analysis of the initial mobility planning, it was selected the config
CIEMAT	CENER	Round Robin tests of Linear receivers	Technical visit to CENER premises in Pamplona during the Round-Robin test of linear receivers planned in WP8. During this visit the visitor will exchange information with CENER people about the Round Robin test and the test stands used by CENER and PSA for thermal characterization of linear receiver tubes	1	1	8	

CIEMAT	CRAN	Durability of solar reflectors	Technical visit to Cranfield University to check the existing facilities and to perform on-site working meetings concerning accelerated aging tests for the development of an integrated methodology for accelerated aging of solar reflectors	2	2	8	1 week working remotely before the mobility project on preparing the material. These materials consisted on several silvered-glass reflector samplesand 3 different types of sands. 1 week working remotely after the mobility project on treating the data obtanied from the experiments and preparing a draft version of the Conference Paper that will be uploaded to SolarPACES 2015.
CIEMAT	TECNALIA	Materials for thermal storage	Both research groups will show their capabilities and necessities in terms of the materials for storage research lines they are already involved in order to see and look for possibilities of collaboration in close future under other than STAGE-STE funding schemes.	0,6	0,4	7	
CIEMAT	LNEG	Durability protocol to qualify innovative materials for solar chemical reactors	Discussions to define a durability protocol to qualify innovative materials for solar chemical reactors in the frame of the Task 9.3 of STAGE-STE. The work plan will include a visit to LNEG facilities, IST Lisboa facilities, a discussion towards a proposal of an experimental work plan to evaluate novel ceria-based materials being developed at LNEG to be tested at PSA. The person in charge of the visit at	1	1	9	

			LNEG will be Dr. Fernando Oliveira. At IST Lisboa will be Dr. Luis Guerra Rosa.				
CIEMAT	LNEG	Durability protocol to qualify innovative materials for solar chemical reactors	Discussions to define a durability protocol to qualify innovative materials for solar chemical reactors in the framework of the Task 9.3 of STAGE-STE. The work plan will include a visit to LNEG facilities, IST Lisboa facilities, a discussion towards a proposal of an experimental work plan to evaluate novel ceria-based materials being developed at LNEG to be tested at PSA. The person in charge of the visit at LNEG will be Dr. Fernando Oliveira. At IST Lisboa will be Dr. Luis Guerra Rosa.	1	1	9	
CIEMAT	CEA	Materials for thermal storage	The aim of this visit is the definition of the test campaign that wants to be performed at the thermocline storage tank installation located at CEA-Lab of Grenoble during a future stay. Also this visit will help both institutions to find synergies and look for collaboration possibilities related to thermal storage.	0,8	0,2	7	

CIEMAT	CNRS	Innovative materials for next generation solar chemical reactors	To advance in definition of ageing protocol, material characterization, material development (reactor housing materials like walls, emitter plates and windows), potential joint tests for the next months in solar installations, all of these within the forthcoming Deliverable D9.3 (Durability procedures for qualifying selected materials) and milestone MS38 (Qualify solar receiver/reactor materials for use under severe operating conditions) .	1	1	9	
CIEMAT	CENER	Optical and thermal performance of PTC by dynamic testing	Joint evaluation of experimental data from tests performed in the HTF test loop of the PSA. Discussion on the results and preparation of a joint paper about the optical and thermal performance of PTCs by means of different testing methodologies. Definition of the work plan to run tests in commercial power plants for the activities planned in ST 11.2.1. And discussion on the common work for subtask 11.2.2.	1	2	11	A test campaign has been performed at Plataforma Solar to get experimental data, which are being also evaluated by the host partner. The time required for the experiments and preparatory work has required 2 weeks of additional work before the stay.

CIEMAT	FISE	Molten Salt test facility for Thermal Storage	Discussing and sharing about their respective know how on molten salt test facilities and how to get as much advantage as possible for the scientific community. Maybe some operational tests will be performed during the visit	1	0,2	7	
CIEMAT	FISE	Test campaign at HTMS thermocline tank	The aim of the test campaign is to obtain experimental data for properly validating a model previously developed by CIEMAT for predicting thermocline tanks behavior. The tests will consist in charge processes at different operating velocities and temperature ranges. This staff exchange will also help improving the collaboration between both institutions in terms of thermal storage activities.	2,2	1	7	
CNR	CNRS	Study on resistance to oxidation of ceramic refractory materials	Discussion on current activities concerning oxidation tests in solar furnace of refractory ceramics, such as ZrC, HfC at various temperatures between 1800 and 2000 K and planning of future tests. Selection of best materials for further analysis; planning and execution (if possible) of additional analytical tests in CNRS such as, XRD and XPS. Planning of further microstructural analyses in CNR-ISTEC.	1	2	8	• Production of bulk ceramic billets with composition HfC + 10 ZrSi2, HfC + 10 TaSi2 • Microstructural analyses (SEM-EDS) of the as-sintered samples. • Delivery of the samples to CNRS for oxidation tests in solar furnace. • Delivery of the samples to CNRS for oxidation tests in solar furnace.

CNR	PSI	Solar Thermionic-Thermoelectric Generator (1st mobility)	A thermionic-thermoelectric conversion module was tested under high-flux solar simulator up to 460 suns (i.e. 750 Â°C on the absorber) over a spot of 3 cm diameter. The activity involved the measurement of the output voltages and currents of the thermionic and thermoelectric stages as a function of time at a fixed radiation flux to monitor the experimental status before the achievement of temperature steady-state conditions and as a function of absorber and emitter temperatures.	1,2	3	8	Preparation with of the advanced absorber, thermionic emitter, and collector (i.e. all the active materials). Upgrade of the vacuum system and of the conversion module engineering.
CNR	PSI	Solar Thermionic-Thermoelectric Generator (2nd mobility)	The optimized conversion module will be irradiated by the high-flux solar simulator up to 500 suns over the receiver area under steady-state and dynamic conditions. The expected maximum receiver temperature will be 800 Â°C.	1,6	3	8	Preparation of the optimized components of the conversion module, following the results of the 1st mobility activity.
CNR	PSI	Solar Thermionic-Thermoelectric Generator	A thermionic-thermoelectric conversion module was tested under high-flux solar simulator up to 460 suns (i.e. 750 Â°C on the absorber) over a spot of 3 cm diameter. The activity involved the measurement of the output voltages and currents of the thermionic and thermoelectric stages as a function of time at a fixed radiation flux to	1,2	3	8	Preparation with of the advanced absorber, thermionic emitter, and collector (i.e. all the active materials). Upgrade of the vacuum system and of the conversion module engineering.

			monitor the experimental status before the achievement of temperature steady-state conditions and as a function of absorber and emitter temperatures.				
CNR	PSI	Solar Thermionic-Thermoelectric Energy Generator (2nd part)	The analysis of the data collected during the 1st visit allowed us the evaluation of the reliability of the module components. An optimized conversion module will be assembled and tested in the mobility according to: 1) dynamic output measurements at a fixed radiation flux; 2) thermionic current-to-voltage characterizations and thermoelectric output current/voltage measurements at fixed radiation flux; 3) procedures a), b) for different radiation fluxes in the range 300-800 Â°C.	1,6	3	8	1) Optimization of the high-temperature absorber; 2) Optimization of the dielectric aspacer and thermionic emitter; 3) Optimization of the module enclosure.
CNRS	IMDEA	Development of new high temperature volumetric solar receivers	The mobility will serve as an opportunity to exchange knowledge about our activities in high temperature volumetric solar receivers. Both the modelling and experimental works will be presented. Based on the discussion a joint work plan will be drawn. The topics for joint reply to	0,6	0,4	12	

			international proposals will also be discussed.				
CNRS	CNR	UHTC elaboration and characterization	This mobility, in the frame of the elaboration of ultra-high temperature ceramic (UHTC) materials that will be afterwards oxidized at PROMES aims at: - elaborating new HfC/TaSi2 and HfC/ZrSi2 materials using hot pressing and pressureless sintering techniques - characterizing the newly elaborated materials using XRD and SEM/EDS	1	2	8	To contact Laura Silvestroni in order to prepare the activities to be performed during the mobilities: - Definition of the objectives to be achieved - To establish a planning about the tasks to be performed during the mobility - preparation of the needed samble for the experiment Redaction of the individual activity report.
CNRS	DLR	Thermochemical cycles for solar energy storage	Visit installations, introduction to synthesis process employed at/by host institution, discuss and work on future collaboration.	1	1	9	
CRAN	CIEMAT	Photogrammetry to measure form of installed collectors	Photogrammetry by Peter King on 30th July to 1st August 2014 , accompanied by Paul Comley and Chris Sansom. Total 1 person week. Hosted by Loreto Valenzuela. The objective was to measure the form (shape) of representative collectors in order to prepare for the assessment of solar fields using a UAV in WP11.	0,8	0,2	11	

CRS4	CENER	Development of new algorithms for solar field optimization	A new approach has been proposed for fast solar field optimization. The solar field obtained has yearly performance comparable with that corresponding to the most known field layout (DELSOL, biomimetic, MUEEN) but with a dramatic reduction of the land occupancy. At CENER a new series of simulations will be performed to evaluate the effect of the costs of heliostats and ground surfaces on the final size of the solar field. To this aim, a parametric analysis will be performed.	1	1	12	
CRS4	ENEA	Activity related to WP7.4.1	The first goal of the visit is to reinforce the connection between ENEA and CRS4, by discussing possible common project in the field of thermal storage systems (TES).	1	1	7	
CYI	CSIRO	Exchange of knowledge on small heliostats, heliostat field design and receiver concepts	CyI, for the purposes of Task 12.1, is modelling the CSIRO small heliostats, which it is using in the Cyprus Pentakomo Field Facility. This visit will allow a further technical discussion on that subject, as well as field design and receiver concepts (Task 12.2). Finally, an MoU will be discussed between the institutions, which should contribute to WP6 as well as KPI 14	1	0,6	12	

			(Number of Memoranda of Understanding (MoU) and agreements on the joint use and development of research facilities - WP3).				
CYI	CIEMAT	Model development and experimental validation of MD and MED systems for Seawater Desalination	The existing MED model developed at CyI will be validated with experimental test results performed at PSA under controlled conditions (not transient). This phase will also try to identify the flaws of the existing model.	3	3	10	The remote working period was done before, during and after the stay. CyI and PSA met (web-meeting) a couple of times in October in order to coordinate the stay and to discuss about the experimental period and the available facilities. After some discussion a report was prepared (from CyI side) and sent to our colleagues in PSA. The report contained extensive information about the plan and the theory behind the planned experiments. During the stay and due to the PSA timetable and the experimental campaign, data had to be extracted and processed after working hours. Finally, after the stay an abstract has been prepared and already submitted to the EDS conference to be held in Rome next year. Data is also being used to prepare an article and a mathematical model.

ENEA	TECNALIA	STAGE-STE ENEA visit to Tecnalia facilities	Visit to Tecnalia facilities in Azpeitia: thermal laboratory equipped with high temperature heat pump, heat tranformer, geothermical probes. Visit to Tecnalia facilities in San Sebastian: DSC, FTIR, Glovebox, corrosion laboratory, DLS, SEM, AFD, XRD, furnaces and autoclaves for corrosion. Meeting with Tecnalia researchers in order to explore possible collaboration activities and exchange information, in particular in the field of thermochemical and thermal storage by new material solutions.	1	0	7	
ENEA	TECNALIA	STAGE-STE VISIT TO TECNALIA RESEARCH CENTER	Visit to Tecnalia Research Center facilities in order to boost the collaboration among the partners in European Project	1	0	7	
ETHZ	IMDEA	Solar Fuels	1. Assembling and testing a 50 kW solar reactor for splitting H2O and CO2. 2. Design of a water calorimeter fr the solar tower	9	0	9	
FBK	IMDEA	test on prtotype for configuration to design high concentration optical system	I. First small sample (from 3 to 4) will be manufactured with the supervison of FBK and sent to IMDEA. II. The next setp will include the performance characterization in laboratory, with the	2,6	4	12	In the framework of the European project STAGE-ST, an innovative design of volumetric receiver is being developed. Firstly, several simulations are

			support of personal from both from IMDEA and FBK.				done in order to decide the prototype to be manufactured. Ray tracing technique is used to study the optical behaviour of the receiver and to decide which the best geometry from the optical point is. The commercial software TraceproÂ® is used to perform these simulations. The results of these simulations are: frontal reflective losses, rear r
FISE	UEVORA	Linear Fresnel Collector (LFC) and field measurement methods	Mission is to compare methodology approaches of LFC characterisation: -How can the IAM behaviour be handled, when doing measurements, simulations and energy output forecasting -What accuracies can be expected -Clarification and common understanding of the issues, possibilities for measurements at Uni Evora -Contribution for the Solar Paces Conference 2015 -At least one reviewd journal paper hand-in at Solar Energy	3	0	11	

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FISE	CNRS	Preparation of a joint experimental validation of ray-tracing codes related to heliostats	Preparation of a joint experimental validation of ray-tracing codes with the flux distribution of one heliostat at Themis. Exchange on calibration procedures of heliostats in the field.	1	1	12	
FISE	CNRS	Joint experimental validation of ray-tracing codes related to heliostats	Joint experimental validation of ray-tracing codes with the flux distribution of one heliostat at Themis. Exchange on calibration procedures of heliostats in the field.	1	1	12	
FISE	CIEMAT	Evaluation of On-site reflectance measurements in real STE plants	Evaluation and comparison of on-site reflectance measurements performed in reall STE plant performed within WP11. Preparation of joint publication with Ciemat and Cranfield University.	1	2	11	
FISE	CIEMAT	Comparison of performance evaluation methods for PTC solar fields	The main objective of the activity is to facilitate meaningful comparisons of different performance evaluation methods for PTC solar fields. For this reason, solar field data was already distributed along the commited partners within WP 11. In order to assure significant comparisons and useful conclusions concerning the different evaluation methods, the onsite acitivity will enable detailed discussions and exchange concerning a proper	1	2	11	

			assessment of the different performance evaluation methods.				
FISE	CENER	Joint publication on heliostat field algorithm comparison	In STAGE-STE WP12.1.5, different heliostat field algorithms have been compared. These results will be published in a joint publication between CENER, CRS4 and Fraunhofer ISE, which is the subject of this mobility. The developed comparison procedure will be extended to include cost features. Fraunhofer ISE will perform simulations/optimizations and contribute to the publication's text. The mobility involves two persons: Shahab Rohani and Peter Schöttl (contact person).	1	2	12	

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FISE	CYI	Exchange on modelling tools with joint publication	- Knowledge transfer of modelling tools (WP7) for single tank TES with and without fillers. Focus on thermocline modelling. If possible, validation of models with experimental data. - Site visit of PROTEAS: Focus on heliostats and MS-receiver. - Reinforcing the cooperation and synergies among partners with a preparation of a proposal and publication. The mobility involves 3 persons from FISE: Martin Karl (contact), Ralf Müller and Peter Schöttl.	1	2	7	

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FISE	CIEMAT	DSG Balance of Plant concepts for Process heat applications	- Literature review; - Visit to the DISS experimental facility; - Identification of process heat related specificities - Identification of context differences to CSP applications - Line-up of most relevant diferentiating aspects for BoP in industrial or CSP applications - Identification of most suitable strategies to reduce costs on process heat related BoP for DSG systems	1,8	1	11	
IMDEA	ETHZ	CO2 valorisation to fuels via solar thermochemistry	The mobility project to be carried out by Dr. Manuel Romero at ETH Zurich, and hosted by Prof. Aldo Steinfeld, will serve to formulate a project proposal on Integrated solar thermochemical synthesis of liquid hydrocarbon fuels. The proposal will be submitted to the call LCE 11-2015 at Horizon2020 and will be related with the cooperation activities planned in WP 9.2. During the mobility a draft proposal will be discussed with definition of the work programme and partners.	4	1	9	
IMDEA	IEECAS	Volumetric ceramic absorbers for use in central receiver systems.	Staying of three weeks of Dr. Jose Gonzalez-Aguilar of IMDEA at IEECAS for screening of candidate materials, specification of tests at solar furnace and discussion on collaborative activities in 2016.	2	1	12	

IMDEA	DLR	Reactor concepts for thermal heat storage	Put in common results about previous experiences based on thermochemical heat storage.	0,6	0,4	7	
IMDEA	DLR	Reactor concepts for thermochemical heat storage	1 / Analysis of reactor concepts for thermal heat storage 2 / Participation in the design of 1kWh thermal storage system 3 / Writing up of joint publications on heat storage	14	1	7	
IMDEA	ETHZ	Analysis of atmospheric and pressurised receiver concepts	1 / Analyse new solar receiver concepts based on porous ceramic materials; 2 / Develop numerical models for analysing heat and mass transfer in porous materials; 3 / Analyse experimental protocols for testing solar receivers in the range between 1 to 50 kW and solar concentration higher that 1000 suns.	13,2	1	12	
IMDEA	CIEMAT	Testing of mixed oxides for hydrogen production	Collaboration with CIEMAT to test a solar reactor with mixed oxides for hydrogen production at PSA. Support operation and analysis of results on site.	0,6	0,4	9	

IMDEA	IEECAS	Experimental assessment of silicon carbide ceramics as solar absorbers	The main objective of this mobility is the experimental characterization of high performance siliconized silicon carbide monolithic honeycombs, to be used as open air volumetric receivers in CSP applications with central receiver system. Experiments are to be conducted employing the new high flux solar simulator developed at IEECAS, composed of 19 Xenon-arc lamps and capable of delivering 28.95 kW of thermal power on the absorber aperture plane, with peak flux in excess of 2300 kW/m2.	2,6	0	12	
IST-ID	CIEMAT	Research on materials for STE components	Taking advantage of the long experience of the Solar Concentrating Systems Unit of CIEMAT-PSA, the main objective is to evaluate the main causes of structural degradation of some STE components and the main mechanisms involved at temperatures in the range of practical appliance. The focus is given to STE componentes that work at temperatures higher than 400Â°C and are subjected to thermal shock.	1	1	8	

IST-ID	CIEMAT	Research on materials for STE components (2nd visit)	The visit of Luis Guerra Rosa to the R+D Group in charge of the solar furnaces at CIEMAT-PSA is mainly for: 1) Exchange of information and discussion on the performance of optical fiber cables as potential STE component (at medium-long term) for solar power transmission: current status of development, preliminary experimental results, and potential applications. 2) Exchange of information and discussion on issues envisaging new joint research proposal.	1	1	8	
IST-ID	CIEMAT	Research on reticulated porous ceramic for potential volumetric solar absorber receivers	The main objective is to evaluate the damage imposed on reticulated porous ceramic (RPC) materials, namely brown alumina, coated mullite, ceria and silicon carbide foams under drastic thermal shock conditions. In addition, measurements of thermal emissivity of the selected materials shall be performed using the available apparatus at PSA.	2	2	8	

LNEG	CNRS	Data collection for the validation of numerical codes to improve the efficiency of cavities	Discuss and finalize task 12.2.3 first activity: analysis and selection of new concepts of solar receivers (cavities and exchangers), identification of main advantages with respect to current existing designs. Collection of information and experimental data in the THEMIS experimental facility. This data will later be used in the development and validation of the software tool for optimization of solar radiation distribution in cavities, currently being developed under task 12.2.3 third activity.	1	0,5	12	
LNEG	ENEA	Caracterization of bio crude produzed during micralgae HTL	Definition of a shared/integrated analyses (e.g. GC-MS and CHNS) for an effective and reliable characterization of the bio-oil produced by microalgae hydrothermal liquefaction, in order to be able to compare the results obtained by different institutions, in the frame of the round robin tests defined in the project work programme.	0,8	0,3	9	

LNEG	UNIPA	Hydrothermal Liquefaction of microalgae	Experimental activities in hydrothermal liquefaction of microalgae (chlorella vulgaris). Conversion tests of the same biomass species to compare results obtained by different institutions, including process conversion, product yields and sampling procedures, in the frame of the round robin tests defined in the project work programme.	0,8	0,3	9	
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LNEG	CIEMAT	Aging of metallic components with MS	Morphological and chemical characterization on the oxide layers of the exposed stainless steels due to the direct interaction with the MS mixtures The contact person from CIEMAT is Marta Navas	1	0,2	7	

LNEG	DLR	Accelerated aging of reflectors	Comparison and discussion of results already obtained from accelerated aging tests for the development of an integrated methodology for accelerated aging of reflectors Contact persons : Florian Sutter and Arantxa Fernandez	1	0,2	8	
LNEG	FUSP	Study of cogeneration applications in the agro-industrial sector	Development of a TRNSYS model for central receiver systems fitting the USP new plant design. Simulation of the USP central receiver plant coupled to an agro-industrial application. Development of a case-study for the plant. Follow up of the construction/commissioning of the demonstration plant being built at USP premisses.	2	0,5	12	
LNEG	CIEMAT	Accelerated aging of reflectors - measurement of optical properties of reflectors	Exchange of experience on measurement of optical properties of reflectors (hemispherical solar reflectance and specular reflectance) as well as absorbers (hemispherical solar absorptance). Analises of measurements made to reflectors submitted to accelerated aging tests.	1	2	8	The preparation of the mobility involved to aspects: - the compilation of results to be discussed and related work performed in the frame of WP 8 (subtasks 8.1.2., 8.1.3 and 8.1.4) (1 week) - measurement at analyses of optical properties in LNEG equipment prior to the mobility, namely for the discussion on reference mirrors used in the frame of the project and the new reference mirror recently acquired by LNEG (1 week).

LNEG	CNRS	Hydrogen production using cork-based ceria ecoceramics	The visit to CNRS-PROMES aims at discuss with Dr. Stephane Abanades future collaboration in the area of production of solar fuels (namely H2 or CO) using cork-based ceria ecoceramics via solar thermochemical process as well as strengthen the cooperation between both institutions which began in 1997.	0,8	1	7	
LNEG	ENEA	Integration/hybridization of TES in STE plants	Under the scope of subtask 7.4.4, it is intended to study operation and control schemes for hybridized solar plants equipped with a backup heater. The hourly offset of the use of solar thermal energy increases significantly the dispatchability of STE. In order to also increase dispatchability for a bigger offset of one or two days the maintenance of the dispatchability of the solar thermal power plants will depend on the charging and discharging operation procedures.	1	0,2	7	

PSI	CIEMAT	Information exchange regarding pilot scale solar steam gasification	The objective of this mobility action is to exchange experiences and know-how from solar gasification activities at CIEMAT and PSI. In particular transfer of knowhow and experiences gained by PSI during the testing of its gasification pilot plant installed at the CESA tower (Solsyn-project) is foreseen in order to enable CIEMAT to run respective tests on its own.	0,8	1,2	9	Preparation of the mobility, including: - survey of all documents regarding all pilot plant components available for handover, including detailed plant design, purchase documents, operation manuals, photos from mounting and operation etc.. - preparation of an adapted version of the final project report of SOLSYN including interaction with the key industrial partner Holcim for approval to hand over this adapted version (the final report includes critical information of Holcim and is confidential). - Frequent interaction and half a day meeting with Peter von Zedtwitz (Holcim), the operation leader of the pilot plant in 2010/2011, to receive information about the status of the plant after the last test in November 2011 and many practical details regarding hardware and operation.

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TECNALIA	CNR	nanoparticles, nano fluids and nanosalts.	Synthesis of nanoparticles. Preparation, characterization and testing of novel Nano fluids and nanopcm.	0,6	0,4	7	
TECNALIA	ENEA	nanoparticle synthesis, nanofluids and nanopcm	Preparation of nanoparticles, nanofluids and nanoPCM based on inorganic salts.	0,6	0,2	7	
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TECNALIA	CNR	Nanosalts.	In subtask 7.3.2, led by Tecnalia, there is an activity in inorganic salts with nanoparticles.	0,6	0,2	7	
TKN	ENEA	Corrosion tests on MS	ENEA and IK4-Tekniker are working together characterizing molten salts after corrosion test is carried out. It is interesting to see how these corrosions test are carry out and that is the objective of this exchange. During the exchange will be discuss about characterization results.	1	1	7	
TKN	CIEMAT	Durability tests Analysis for coated reflectors	New protective coatings must be tested for front surface mirrors, Methods actually applied in CIEMAT accelerated ageing tests will be evaluated with the aim of knowing more about degradation mechanisms of the different samples.	0,8	1	8	
TKN	DLR	Synthesis and Characterization of new formulated molten salts	In the task 7.1.2 DLR and IK-Tekniker are working together characterizing the new molten salts formulated by DLR, in this exchange will be discuss the results obtained by DLR and ik4-tekniker during 2015	1	1	7	
TKN	CIEMAT	Modelling, control, Operation and Maintenance task inside WP11: Dynamic tests for PTs	Dynamic tests will be performed on parabolic through collectors at PSA facilities. These tests will be carried out with the aim of validating dynamically a physical detailed model of the PT loop developed in Modelica language	0,6	1,2	11	The time allocated for Remote working time correspond to the preparation of experiments, the analysis of the performed experiments as well as the time foreseen to prepare the publication submitted to SOLARPACES2016

TKN	CIEMAT	Modelling, control, Operation and Maintenance task inside WP11: Dynamic tests for PTs	Dynamic tests will be performed on parabolic through collectors at PSA facilities. These tests will be carried out with the aim of validating dynamically a physical detailed model of the PT loop developed in Modelica language	0,6	2	11	The time allocated for Remote working time correspond to the preparation of experiments, the analysis of the performed experiments as well as the time foreseen to prepare the publication submitted to SOLARPACES2016
TKN	CIEMAT	Characterisation tests for heliostats T12.1.2	The tracking accuracy of the heliostat will be tested in PSA-CIEMAT facilities.	2	3	12	Work is required to disassemble and pack the heliostat before transporting it to PSA-CIEMAT. After the 2 weeks of onsite working, the heliostat has been left in PSA in order to finish the tests that could not be finished mainly due to bad weather conditions. Coordination with PSA to carry out the remaining tests, analyses of the results and application of modifications in the control and calibration system to improve the behaviour of the heliostat are considered as remote work.
UEVORA	CIEMAT	Study of pressurized water and thermal oil hydraulic loop control and monitoring procedures	Startup, heating and cool down procedures of the PSA thermal oil and pressurized water test loops; control strategies (e.g. flow or temperature oriented); definition of monitoring variables; training on thermal oil hydraulic loop control under different operating conditions; safety	1	0,5	11	

			procedures; maintenance procedures; discussion on data evaluation to do in subtask 11.2.1.				
UEVORA	ETHZ	Energy storage in Solid Materials	Activity includes following tasks: 1- Discussion on the trade-off of the material selection performed; 2- Identification of the most critical properties for the system defined and how they could be improved; 3- Discuss design of a solid material exchange unit; 4- Discuss validation possibilities (lab scale vs prototype scale integrated in the EMSP).	1	6	7	I- Work on a model to perform simulation. II- preparation of an European Project Application.
UNIPA	CIEMAT	Dynamic modelling of multiple effects desalination systems	The work at CIEMAT premises will be focused on the collection of experimental information on the steady-state and dynamic behaviour of the Multiple Effects desalination units available at PSA premises (MED and MEMD), in order to make a tuning/validation of modelling tools developed by UNIPA.	4	4	10	2 weeks of preparation required in order to adapt the model to the operating conditions already analyzed by PSA colleagues with their steady-state model and to implement within the MED-TVC model also the equations for stationary operations of the thermo-ejector. 2 weeks of post-processing of data, aiming at the preparation of a draft of a paper (currently under a final revision by

							UNIPA) and preparation of a final technical report after the mobility period.
UNIPA	LNEG	MED-TVC modelling for coupling with CSP	Analysis of the results of the techno-economic analysis of a MED-TVC plant coupled with a CSP system; training on the use of TRNSYS simulator and presentation of the MED model implemented; discussion and planning on future exchange of UNIPA staff to LNEG within the Stage-STE WP4.	0,6	0,4	10	
UNIPA	ENEA	Conceptual study of the coupling of molten salt with hydrothermal reactor for biomass liquefaction	Aim of this mobility is to start conceptual study of the coupling between a molten salt CSP plant and a chemical reactor for hydrothermal liquefaction of microalgae to find the best strategy to drive energetically the process. The mobility will be reactivated in 2016 after the Christmas period.	3	2	9	Preparation of the kinetic model to describe liquefaction of microalgae. Definition of the first tentative process lay-out. Collection of preliminary chemico-physical data necessary to perform calculations.
UNIPA	CIEMAT	Modeling and validation of the MD process for comparison with MED	The work at CIEMAT premises will be focused on the collection of experimental information on the behaviour of MD desalination units available at PSA premises and on the final implementation and tuning of a model for the MD process to be validated with experimental data. The	3	1,5	10	1 week of preparation will be required in order to put the basis for the model implementation into a common modelling platform and to make an effective planning of the experimental campaign in collaboration with CIEMAT

			model will then be used for sensitivity analysis and for a first comparison of performances between MED and MD.				staff. 0.5 week of post-processing of data and preparation of a final technical report will be required after the mobility period.
UNIPA	ENEA	Conceptual study of the coupling between a biomass HTL reactor and a molten salts CSP plant	Continuation of the study of the coupling between the molten salts CSP plant and the biomass conversion reactor to achieve a first tentative estimation of its tecno-economical feasibility.	9	1	9	
UNIPA	ENEA	Conceptual study of coupling of CSP with hydrothermal plant for biomass conversion	Meeting to analyse the level of the study, to verify preliminary calculations and matching between actual and planned results. Discussion and implementation of the final part of the study with specific aim of publishing the study on a scientific journal.	0,8	0,2	9	
US	IMDEA	Static and dynamic analisys of Combined Cicle Power Plant based on Cavity air solar tower receptor	The activities to be perfomed during the mobility project are: - Sizing of power plant components (Brayton and Rankine cicles). - Determination of operating conditions in the design point. - Calculation of Power plant perfomance in the design point. - Dynamic analysis of power plant performance (during a year). Several plant schemes will be considered. - Writing and review of full article to SolarPACES 2017.	3	1	12	

US	CENER	Optimization models for heliostat field layouts generation	The objective of this mobility is to optimized the heliostat field layout of the representative high concentration optical system, using the heliostat and the receiver models designed by CENER-TEKNIKER (subtask 12.1.2) and CNRS (subtask 12.2.3) respectively. Throughout this mobility, results provided by different softwares will be compared and the optimal solution will be identified.	1	1	12	
US	CENER	Work package 12 documentation	The objective of this mobility is to analyze the results obtained in the frame of subtask 12.2.7, start preparing the final documentation of work package 12 and evaluate possible joint publications between partners involved in WP12.	1	1	12	
US	CENER	Optimization models for heliostat field layouts generation	The objective of this mobility is to optimized the heliostat field layout of the representative high concentration optical system, using the heliostat and the receiver models designed by CENER-TEKNIKER (subtask 12.1.2) and CNRS (subtask 12.2.3) respectively. Throughout this mobility, results provided by different softwares will be compared and the optimal solution will be identified.	1	0,5	12	

US	CENER	Work package 12 documentation	'The objective of this mobility is to analyze the results obtained in the frame of subtask 12.2.7, start preparing the final documentation of work package 12 and evaluate possible joint publications between partners involved in WP12.	1	1	12	

3.4. The status of the manpower devotion regarding the exchange of personnel

The following table summarizes the final manpower allocation of each STAGE-STE partners regarding the exchange of personnel.

The column "DoW" indicates the manpower devotion regarding the Mobility plan set in the Description of Work. There is no amount indicated for the institution of University of Seville (US) because the collaborations with this institution have been developed during the workplan execution after the initial scheduling of the program of staff scientist exchange between the different research institutions.

The column "Achieved mobilities" presents the amount of manpower allocated through the achieved mobilities.

Since the STAGE-STE project is accomplished and there is no planned mobilities in the future and the column "Planned mobilities" is empty.

Finally, the column "Deviation from DoW" provides the information on the discrepancy between the amount of manpower not fulfilled regarding the initial mobility plan from the DoW. For those institutions where there is a positive number, this means that their planned man-power devotion amount planned in the DoW has been reached with the achieved mobilities.

The deviation from the planned amount of manpower indicated in the DoW is 35 person-weeks or 11,33%. This discrepancy could be explained by the following main reasons:

- Management and/or budget constraints (both of the participant or hosting institutions) (e.g., University of Evora, University of Cranfield, CNRS, …);
- External and internal circumstances of timing or institution's functioning (e.g., CNR, CTAER, …)
- Main changes in the research fields initially chosen for the mobilities to implement (e.g., PSI, …).

All the changes and adjustments of the plan of exchange of personnel of each institution have been communicated and justified by the partners during the project progress meetings in order to regularly update the overall Mobility Plan and ensure the correct accomplishment of the Task T4.1 "Exchange/mobility of personnel".

Table 3. Manpower devotion regarding the exchanges of researchers

Partner	(Person-weeks)			
	DoW	Achieved mobilities	Planned mobilities	Deviation from DoW
CIEMAT	26	35,4	0	9,4
DLR	4	0	0	-4
PSI	28	4	0	-24
CNRS	12	6	0	-6
FISE	32	36,8	0	4,8
ENEA	10	2	0	-8
ETHZ	5	9	0	4
CYI	12	7,6	0	-4,4
LNEG	12	15,7	0	3,7
CTAER	4	0	0	-4
CNR	21	20,6	0	-0,4
CENER	16	19	0	3
TECNALIA	13	3,3	0	-9,7
UEVORA	6	8,5	0	2,5
IMDEA	48	41,8	0	-6,2
CRAN	4	1	0	-3
TKN	11	15,2	0	4,2
UNIPA	32	29,5	0	-2,5
CRS4	4	4	0	0
IST-ID	5	8	0	3
FBK	4	6,6	0	2,6
US	-	11,5	0	0
Total	**309**	**285,5**	**0**	**35**
Percentage	**100%**	**92,39%**	**0**	**11,33%**

4. Related Publication and Dissemination activities

4.1. Publication

This part presents the final status regarding the publication activities related to the achieved mobility until M48.

4.1.1 Published publication

There is currently 20 mobilities having resulted in publication activities.

The total number of the finalised publications is 15. Please see the annex 2 of this deliverable for the copy of the publications in the following order:

1. Johannes Pernpeintner, Björn Schiricke, Fabienne Sallaberry, Alberto García de Jalón, Rafael López-Martín, Loreto Valenzuela, Antonio de Luca, Andreas Georg, "Parabolic trough receiver heat loss and optical efficiency round robin 2015/2016", AIP Conference Proceedings 1850, 020012 (2017); doi: 10.1063/1.4984337;

2. R. Bayón, S. Coco, M. Barcenilla, P. Espinet , G. Imbuluzqueta, J. Hidalgo, E. Rojas, "Feasibility of Storing Latent Heat with Liquid", Applied Sciences 6 (2016) 121, doi:10.3390/app6050121;

3. Christopher Sansom, Aránzazu Fernández-García, Florian Sutter, Heather Almond, Peter King and Lucía Martínez-Arcos, "Soiling and Cleaning of Polymer Film Solar Reflectors", Energies, 9, 1006-12, 2016. Doi: 10.3390/en9121006;

4. Fabienne Sallaberry, Loreto Valenzuela, Luis G. Palacin, "On-site parabolic-trough collector testing in solar thermal power plants: Experimental validation of a new approach developed for the IEC 62862-3-2 standard", Solar Energy, Volume 155, October 2017, Pages 398-409;

5. Michael Burisch, Marcelino Sánchez, Xabier Olano, Aitor Olarra, Cristobal Villasante, David Olasolo, Rafael Monterreal, Raul Enrique and Jesús Fernández, "Scalable HeliOstat calibRation sysTem (SHORT) - How to calibrate your whole heliostat field in a single night", AIP Conf. Proc., vol. 1850, no. 1, p. 80016, 2018. (Mobilities 2, 4 and 16). Presented at 23rd SolarPACES Conference, 26 - 29 September 2017, Santiago, Chile. The corresponding paper will be published in the coming months. Please see the extract of the agenda of the SolarPACES Conference 2017 in the annex 2 of this deliverable, section "Central Receiver Sysytems";

6. A. Cipollina, M. Agnello, A. Piacentino, A. Tamburini, B. Ortega, P. Palenzuela, D. Alarcon, G. Micale, "A dynamic model for MED-TVC transient operation", Desalination, 2017, 413, 234-257. doi: 10.1016/j.desal.2017.03.005;

7. Alberto Giaconia, Giampaolo Caputo, Antonio Ienna, Domenico Mazzei, Benedetto Schiavo, Onofrio Scialdone, Alessandro Galia, "Biorefinery process for hydrothermal liquefaction of microalgae powered by a concentrating solar plant: A conceptual study", Applied Energy 208 (2017) 1139–1149, doi 10.1016/j.apenergy.2017.09.038;

8. E. Ubieta, I. del Hoyo, L. Valenzuela, R. Lopez-Martín, V. de la Peña, S. López, "Object-oriented Simulation Model of a Parabolic Trough Solar Collector: Static and Dynamic Validation", AIP Conference Proceedings 1850, 020015 (2017);

9. B. Muñoz-Sánchez, J. Nieto-Maestre, E. Veca, R. Liberatore, S. Sau, H. Navarro, Y. Ding, N. Navarrete, J. E. Juliá, Á. G. Fernández, and A. García-Romero , "Rheology of Solar-Salt based nanofluids for concentrated solar power. Influence of the salt purity, nanoparticle concentration, temperature and rheometer geometry", Sol. Energy Mater. Sol. Cells, vol. 176, pp. 357–373, 2018;

10. Miguel Ángel Reyes-Belmonte, Francisco Javier Pino, Manuel Romero, Christian Suárez, José González-Aguilar, José Guerra, "Optimization of an Integrated Solar Combined Cycle", AIP Conf. Proc., vol. 1850, no. 1, p. 80016, 2018. (Mobility 21). Presented at 23rd SolarPACES Conference as a poster, 26 - 29 September 2017, Santiago, Chile. The corresponding paper will be published in the coming months. Please refer to the annex 2 of this deliverable for the copy of the poster presented;

11. Annie Hofer, Loreto Valenzuela, Nicole Janotte, Juan Ignacio Burgaleta, Jaime Arraiza, Marco Montecchi, Fabienne Sallaberry, Tiago Osório, Maria João Carvalho, Fabrizio Alberti, Korbinian Kramer, Anna Heimsath, Werner Platzer, and Stephan Scholl, "State of the art of performance evaluation methods for concentrating solar collectors", AIP Conference Proceedings 1734, 020010 (2016); doi: 10.1063/1.4949034;

12. Ludovic Charpentier, Marianne Balat-Pichelin, Jean-Louis Sans, Diletta Sciti, Laura Silvestroni, "Effect of high temperature oxidation on the radiative properties of HfCbased ceramics", Corrosion Science 126 (2017) 255–264;

13. Fabienne Sallaberry, Loreto Valenzuela, Lui G. Palacin, Javier León, Stephan Fischer and Andreas Bohren, "Harmonization of standards for parabolic trough collector testing in solar thermal power plants", AIP Conference Proceedings, Vol. 1850, 020014 (2017);

14. Fabienne Sallaberry, Loreto Valenzuela, Alberto García de Jalón, Javier Leon, Ignacio David Bernad, "Towards Standardization of in-Site Parabolic Trough Collector Testing in Solar Thermal Power Plants", AIP Conf. Proc. 1734, 130019-1–130019-8 (2015); doi: 10.1063/1.4949229;

15. Michael Burisch, Luis Gomez, David Olasolo and Cristobal Villasante, "Heliostat Kinematic System Calibration Using Uncalibrated Cameras", AIP Conference Proceedings, Vol. 1850, No. 1, p. 030007, 2017.

The difference between the total of the publications activities related to the achieved mobilities and the number of the publications themselves should be explained by the following reasons:

1. Some publications are the result of several achieved mobilities done by the same researcher or a number of researchers from the same institution in different time or within the different host institutions:

- Johannes Pernpeintner, Björn Schiricke, Fabienne Sallaberry, Alberto García de Jalón, Rafael López-Martín, Loreto Valenzuela, Antonio de Luca, Andreas Georg, "Parabolic trough receiver heat loss and optical efficiency round robin 2015/2016", AIP Conference Proceedings 1850, 020012 (2017); doi: 10.1063/1.4984337. (Mobilities 5 and 6 of the table 5);
- Fabienne Sallaberry, Loreto Valenzuela, Luis G. Palacin, "On-site parabolic-trough collector testing in solar thermal power plants: Experimental validation of a new approach developed for the IEC 62862-3-2 standard", Solar Energy, Volume 155, October 2017, Pages 398-409. (Mobilities 1 and 9);
- B. Muñoz-Sánchez, J. Nieto-Maestre, E. Veca, R. Liberatore, S. Sau, H. Navarro, Y. Ding, N. Navarrete, J. E. Juliá, Á. G. Fernández, and A. García-Romero , "Rheology of Solar-Salt based nanofluids for concentrated solar power. Influence of the salt purity, nanoparticle concentration, temperature and rheometer geometry", Sol. Energy Mater. Sol. Cells, vol. 176, pp. 357–373, 2018. (Mobilities 11 and 15);
- Annie Hofer, Loreto Valenzuela, Nicole Janotte, Juan Ignacio Burgaleta, Jaime Arraiza, Marco Montecchi, Fabienne Sallaberry, Tiago Osório, Maria João Carvalho, Fabrizio Alberti, Korbinian Kramer, Anna Heimsath, Werner Platzer, and Stephan Scholl, "State of the art of performance evaluation methods for concentrating solar collectors", AIP Conference Proceedings 1734, 020010 (2016); doi: 10.1063/1.4949034. (Mobilities 12 and 13).

2. There is also two publications that has been accepted but will be published later in 2018. For the moment there is no copy of these publications available:

- Michael Burisch, Marcelino Sánchez, Xabier Olano, Aitor Olarra, Cristobal Villasante, David Olasolo, Rafael Monterreal, Raul Enrique and Jesús Fernández, "Scalable HeliOstat calibRation sysTem (SHORT) - How to calibrate your whole heliostat field in a single night", AIP Conf. Proc., vol. 1850, no. 1, p. 80016, 2018. (Mobilities 2, 4 and 16). Presented at 23rd SolarPACES Conference, 26 - 29 September 2017, Santiago, Chile. The corresponding paper will be published in the coming months. Please see the extract of the agenda of the SolarPACES Conference 2017 in the annex 2 of this deliverable.
- Miguel Ángel Reyes-Belmonte, Francisco Javier Pino, Manuel Romero, Christian Suárez, José González-Aguilar, José Guerra, "Optimization of an Integrated Solar Combined Cycle", AIP Conf. Proc., vol. 1850, no. 1, p. 80016, 2018. (Mobility 21). Presented at 23rd SolarPACES Conference as a poster, 26 - 29 September 2017, Santiago, Chile. The corresponding paper will be published in the coming months. Please refer to the annex 2 of this deliverable for the copy of the poster presented.

3. Is it also to note that a few publications resulted from one single mobility:

- Fabienne Sallaberry, Loreto Valenzuela, Alberto García de Jalón, Javier Leon, Ignacio David Bernad, "Towards Standardization of in-Site Parabolic Trough Collector Testing in Solar Thermal Power Plants", AIP Conf. Proc. 1734, 130019-1–130019-8 (2015); doi: 10.1063/1.4949229. (Mobility 1);

- Fabienne Sallaberry, Loreto Valenzuela, Lui G. Palacin, Javier León, Stephan Fischer and Andreas Bohren, “Harmonization of standards for parabolic trough collector testing in solar thermal power plants”, AIP Conference Proceedings, Vol. 1850, 020014 (2017). (Mobility 9).

The details regarding the related mobility are presented below. For more information about this mobility, refer to the part 3.2.

Table 4. Exchange of personnel information regarding joint publication

Participants information				Mobility information					
N°	**Institution**	**First Name**	**Last Name**	**Host Institution**	**Project Title**	**Activities performed**	**WP**	**Person-weeks**	**Information about publication**
1	CENER	Fabienne	Sallaberry	CIEMAT	Knowledge transfer about dynamic testing	Defining Methodologies for dynamic testing and predictive maintenance of large solar fields. Testing solar trackers on field.	11	2,2	– Fabienne Sallaberry, Loreto Valenzuela, Luis G. Palacin, "On-site parabolic-trough collector testing in solar thermal power plants: Experimental validation of a new approach developed for the IEC 62862-3-2 standard", Solar Energy, Volume 155, October 2017, Pages 398-409. – Fabienne Sallaberry, Loreto Valenzuela, Alberto García de Jalón, Javier Leon, Ignacio David Bernad, "Towards Standardization of in-Site Parabolic Trough Collector Testing in Solar Thermal Power Plants", AIP Conference Proceedings **1734**, 130019 (2016); doi: 10.1063/1.4949229.
2	CENER	Michael	Burisch	CIEMAT	Heliostat calibration testing (2016)	The aim of the exchange is to advance with the development of an automatic calibration system for heliostats using the installations available at the host institution and the heliostat developed in WP12 by CENER and TEKNIKER.	12	3	– Michael Burisch, Marcelino Sánchez, Xabier Olano, Aitor Olarra, Cristobal Villasante, David Olasolo, Rafael Monterreal, Raul Enrique and Jesús Fernández, "Scalable HeliOstat calibRation sysTem (SHORT) - How to calibrate your whole heliostat field in a single night". Presented at 23rd SolarPACES Conference, 26 - 29 September 2017, Santiago, Chile. The

									corresponding paper will be published in the coming months.
3	CENER	Michael	Burisch	CIEMAT	Heliostat calibration testing (2015)	Perform experiments and gather data for heliostat calibration which will be used during the testing of the small sized heliostat under development.	12	1	– Michael Burisch, Luis Gomez, David Olasolo and Cristobal Villasante, "Heliostat Kinematic System Calibration Using Uncalibrated Cameras", AIP Conference Proceedings, Vol. 1850, No. 1, p. 030007, 2017.
4	CENER	Luis	Gomez	CIEMAT	Heliostat calibration testing (2016)	The aim of the exchange is to advance with the development of an automatic calibration system for heliostats using the installations available at the host institution and the heliostat developed in WP12 by CENER and TEKNIKER.	12	3	– Michael Burisch, Marcelino Sánchez, Xabier Olano, Aitor Olarra, Cristobal Villasante, David Olasolo, Rafael Monterreal, Raul Enrique and Jesús Fernández, "Scalable HeliOstat calibRation sysTem (SHORT) - How to calibrate your whole heliostat field in a single night". Presented at 23rd SolarPACES Conference, 26 - 29 September 2017, Santiago, Chile. The corresponding paper will be published in the coming months.
5	CIEMAT	Rafael Antonio	Lopez Martin	DLR	Receiver Round-Robin test at DLR	- Assistance to measurements of the receiver tubes in the DLR laboratory.	8	1	– Johannes Pernpeintner, Björn Schiricke, Fabienne Sallaberry, Alberto García de Jalón, Rafael López-Martín, Loreto Valenzuela, Antonio de Luca, Andreas Georg, "Parabolic trough receiver heat loss and optical efficiency round robin 2015/2016", AIP Conference Proceedings 1850, 020012 (2017); doi: 10.1063/1.4984337.

6	CIEMAT	Rafael Antonio	Lopez Martin	CENER	Round Robin tests of Linear receivers	- Technical visit to CENER premises in Pamplona during the Round-Robin test of linear receivers planned in WP8. During this visit the visitor will exchange information with CENER people about the Round Robin test and the test stands used by CENER and PSA for thermal 7characterization of linear receiver tubes.	8	2	– Johannes Pernpeintner, Björn Schiricke, Fabienne Sallaberry, Alberto García de Jalón, Rafael López-Martín, Loreto Valenzuela, Antonio de Luca, Andreas Georg, "Parabolic trough receiver heat loss and optical efficiency round robin 2015/2016", AIP Conference Proceedings 1850, 020012 (2017); doi: 10.1063/1.4984337.
7	CIEMAT	Rocio	Bayon	TECNALIA	Materials for thermal storage	- Both research groups will show their capabilities and necessities in terms of the materials for storage research lines they are already involved in order to see and look for possibilities of collaboration in close future under other than STAGE-STE funding schemes.	7	1	– R. Bayón, S. Coco, M. Barcenilla, P. Espinet , G. Imbuluzqueta, J. Hidalgo, E. Rojas, "Feasibility of Storing Latent Heat with Liquid", Applied Sciences 6 (2016) 121, doi:10.3390/app6050121.
8	CIEMAT	Aránzazu	Fernández-García	CRAN	Durability of solar reflectors at CRAN	- Technical visit to Cranfield University to check the existing facilities and to perform on-site working meetings concerning accelerated aging tests for the development of an integrated methodology for accelerated aging of solar reflectors.	8	4	– Christopher Sansom, Aránzazu Fernández-García, Florian Sutter, Heather Almond, Peter King and Lucía Martínez-Arcos, "Soiling and Cleaning of Polymer Film Solar Reflectors", Energies, 9, 1006-12, 2016. Doi: 10.3390/en9121006.

9	CIEMAT	Loreto	Valenzuela	CENER	Optical and thermal performance of PTC by dynamic testing methodologies	- Joint evaluation of experimental data from tests performed in the HTF test loop of the PSA. Discussion on the results and preparation of a joint paper about the optical and thermal performance of PTCs by means of different testing methodologies. Definition of the work plan to run tests in commercial power plants for the activities planned in ST 11.2.1. And discussion on the common work for subtask 11.2.2.	11	3	– Fabienne Sallaberry, Loreto Valenzuela, Luis G. Palacin, "On-site parabolic-trough collector testing in solar thermal power plants: Experimental validation of a new approach developed for the IEC 62862-3-2 standard", Solar Energy, Vol 155, pp. 398-409. – Fabienne Sallaberry, Loreto Valenzuela, Lui G. Palacin, Javier León, Stephan Fischer and Andreas Bohren, "Harmonization of standards for parabolic trough collector testing in solar thermal power plants", AIP Conference Proceedings, Vol. 1850, 020014.
10	CNR	Laura	Silvestroni	CNRS	Study on resistance to oxidation of ceramic refractory materials	- Discussion on current activities concerning oxidation tests in solar furnace of refractory ceramics, such as ZrC, HfC at various temperatures between 1800 and 2000 K and planning of future tests. Selection of best materials for further analysis; planning and execution (if possible) of additional analytical tests in CNRS such as, XRD and XPS. Planning of further microstructural analyses in CNR-ISTEC.	8	3	– Ludovic Charpentier, Marianne Balat-Pichelin, Jean-Louis Sans, Diletta Sciti, Laura Silvestroni, «Effect of high temperature oxidation on the radiative properties of HfCbased ceramics", Corrosion Science 126 (2017) 255–264.
11	ENEA	Raffaele	Liberatore	TECNALIA	STAGE-STE ENEA visit	- Visit to Tecnalia facilities in Azpeitia: thermal laboratory equipped with high	7	1	– Muñoz-Sánchez B, Nieto-Maestre J, Veca E, Liberatore R, Sau S, Navarro H, Ding Y et al., "Rheology of Solar-

					to Tecnalia facilities	temperature heat pump, heat tranformer, geothermical probes. Visit to Tecnalia facilities in San Sebastian: DSC, FTIR, Glovebox, corrosion laboratory, DLS, SEM, AFD, XRD, furnaces and autoclaves for corrosion. Meeting with Tecnalia researchers in order to explore possible collaboration activities and exchange information, in particular in the field of thermochemical and thermal storage by new material solutions.			Salt based nanofluids for concentrated solar power. Influence of the salt purity, nanoparticle concentration, temperature and rheometer geometry", Solar Energy Materials and Solar Cells 2018, 176: 357-373
12	FISE	Annie	Hofer	UEVORA	Linear Fresnel Collector (LFC) and field measurement methods	Mission is to compare methodology approaches of LFC characterization. - How can the IAM behaviour be handeled, when doing measuremnts, simulations and energy output forecastings; - What accuracies can be expected; - Clarification and common understanding of the issues, possibilities for measurements at Uni Evora; - Contribution for the Solar Paces Conference 2015; - At least one reviewd journal paper hand-in at Solar Energy.	11	3	– Annie Hofer, Loreto Valenzuela, Nicole Janotte, Juan Ignacio Burgaleta, Jaime Arraiza, Marco Montecchi, Fabienne Sallaberry, Tiago Osório, Maria João Carvalho, Fabrizio Alberti, Korbinian Kramer, Anna Heimsath, Werner Platzer, and Stephan Scholl, "State of the art of performance evaluation methods for concentrating solar collectors", AIP Conference Proceedings 1734, 020010 (2016); doi: 10.1063/1.4949034.

13	FISE	Korbinian	Kramer	UEVORA	Linear Fresnel Collector (LFC) and field measurement methods	Mission is to compare methodology approaches of LFC characteristation. - How can the IAM behaviour be handeled, when doing measuremnts, simulations and energy output forecastings; - What accuracies can be expected; - clarification and common understanding of the issues, possibilities for measurements at Uni Evora; - contribution for the Solar Paces Conference 2015; - at least one reviewd journal paper hand-in at Solar Energy.	11	4	– Annie Hofer, Loreto Valenzuela, Nicole Janotte, Juan Ignacio Burgaleta, Jaime Arraiza, Marco Montecchi, Fabienne Sallaberry, Tiago Osório, Maria João Carvalho, Fabrizio Alberti, Korbinian Kramer, Anna Heimsath, Werner Platzer, and Stephan Scholl "State of the art of performance evaluation methods for concentrating solar collectors", AIP Conference Proceedings 1734, 010001 (2016)
14	TECN	Javier	Nieto	ENEA	nanoparticle synthesis, nanofluids and nanopcm	preparation of nanoparticles, nanofluids and nanoPCM based on inorganic salts.	7	0,8	– B. Muñoz-Sánchez, J. Nieto-Maestre, E. Veca, R. Liberatore, S. Sau, H. Navarro, Y. Ding, N. Navarrete, J. E. Juliá, Á. G. Fernández, and A. García-Romero, "Rheology of Solar-Salt based nanofluids for concentrated solar power. Influence of the salt purity, nanoparticle concentration, temperature and rheometer geometry", Sol. Energy Mater. Sol. Cells, vol. 176, pp. 357–373, 2018.
15	TKN	David	Olasolo	CIEMAT	Characterisation tests for heliostats T12.1.2	The tracking accuracy of the heliostat will be tested in PSA-CIEMAT facilities.	12	5	– M. Burisch, X. Olano, M. Sanchez, A. Olarra, C. Villasante, D. Olasolo, R. Monterreal, R. Enrique, J. Fernández, "Scalable HeliOstat calibRation sysTem

									(SHORT) - Calibrate a Whole Heliostat Field in a Single Night", Presented at 23rd SolarPACES Conference, 26 - 29 September 2017, Santiago, Chile. The corresponding paper will be published in the comming months
16	TKN	Itzal	Del Hoyo	CIEMAT	Modelling, control, Operation and Maintenance task inside WP11: Dynamic tests for PTs	Dynamic tests will be performed on parabolic through collectors at PSA facilities. These tests will be carried out with the aim of validating dynamically a physical detailed model of the PT loop developed in Modelica language.	11	2,6	– E. Ubieta, I. del Hoyo, L. Valenzuela, R. Lopez-Martín, V. de la Peña, S. López, "Object-oriented Simulation Model of a Parabolic Trough Solar Collector: Static and Dynamic Validation", AIP Conference Proceedings 1850, 020015 (2017)
17	TKN	Edurado	Ubieta	CIEMAT	Modelling, control, Operation and Maintenance task inside WP11: Dynamic tests for PTs	Dynamic tests will be performed on parabolic through collectors at PSA facilities. These tests will be carried out with the aim of validating dynamically a physical detailed model of the PT loop developed in Modelica language.	11	1,8	– E. Ubieta, I. del Hoyo, L. Valenzuela, R. Lopez-Martín, V. de la Peña, S. López, "Object-oriented Simulation Model of a Parabolic Trough Solar Collector: Static and Dynamic Validation", AIP Conference Proceedings 1850, 020015 (2017)
18	UNIPA	Andrea	Cipollina	CIEMAT	Dynamic modelling of multiple effects desalination systems	The work at CIEMAT premises will be focused on the collection of experimental information on the steady-state and dynamic behaviour of the Multiple Effects desalination units available at PSA premises (MED and MEMD), in order to	10	8	– A. Cipollina, M. Agnello, A. Piacentino, A. Tamburini, B. Ortega, P. Palenzuela, D. Alarcon, G. Micale, "A dynamic model for MED-TVC transient operation", Desalination, 2017, 413, 234-257. doi: 10.1016/j.desal.2017.03.005

						make a tuning/validation of modelling tools developed by UNIPA.			
19	UNIPA	Alessandro	Galia	ENEA	Conceptual study of coupling of CSP with hydrothermal plant for biomass conversion	Meeting to analyse the level of the study, to verify preliminary calculations and matching between actual and planned results. Discussion and implementation of the final part of the study with specific aim of publishing the study on a scientific journal.	9	1	– Alberto Giaconia, Giampaolo Caputo, Antonio Ienna, Domenico Mazzei, Benedetto Schiavo, Onofrio Scialdone, Alessandro Galia, "Biorefinery process for hydrothermal liquefaction of microalgae powered by a concentrating solar plant: A conceptual study", Applied Energy 208 (2017) 1139–1149, doi 10.1016/j.apenergy.2017.09.038
20	US	Francisco Javier	Pino Lucena	IMDEA	Static and dynamic analisys of Combined Cicle Power Plant based on Cavity air solar tower receptor	The activities to be perfomed during the mobility project are: - Sizing of power plant components (Brayton and Rankine cicles). - Determination of operating conditions in the design point. - Calculation of Power plant perfomance in the design point. - Dynamic analysis of power plant performance (during a year). Several plant schemes will be considered. Writing and review of full article to SolarPACES 2017.	12	4	– Miguel Ángel Reyes-Belmonte, Francisco Javier Pino, Manuel Romero, Christian Suárez, José González-Aguilar, José Guerra, "Optimization of an Integrated Solar Combined Cycle", AIP Conf. Proc., vol. 1850, no. 1, p. 80016, 2018. (Mobility 18). Presented at 23rd SolarPACES Conference as a poster, 26 - 29 September 2017, Santiago, Chile. The corresponding paper will be published in the coming months. Please refer to the annex 2 of this deliverable for the copy of the poster presented.

4.1.2 Planned publication

The following table presents the researchers who plan to publish a publication related to an achieved mobility in the future after the end of the STAGE-STE project.

Table 5. Exchange of researchers information regarding the planned joint publications

	Related mobility to further publication					
N°	**Participant's institution**	**First name**	**Last name**	**Host institution for the mobility**	**Title of the mobility**	**WP**
1	CIEMAT	Jesús	Fernández-Reche	TKN	Development of a low cost heliostat	12
2	CIEMAT	M. Esther	Rojas Bravo	CEA	Thermal Storage	7
3	CIEMAT	Rocio	Bayon	FISE	Test campaign at HTMS thermocline tank	7
4	CIEMAT	Rafael Antonio	López Martín	DLR	Receiver Round-Robin test at DLR	8
5	CIEMAT	Rafael Antonio	López Martín	CENER	Round Robin tests of Linear receivers	8
6	CNR	Alessandro	Bellucci	PSI	Solar Thermionic-Thermoelectric Generator	8
7	CNR	Daniele	Trucchi	PSI	Solar Thermionic-Thermoelectric Energy Generator	8
8	CRAN	Peter	King	CIEMAT	Photogrammetry to measure form of installed collectors	11
9	CRS4	Erminia	Leonardi	CENER	Development of new algorithms for solar field optimization	12

10	ETHZ	Erik	Koepf	IMDEA	Solar Fuels	12
11	FISE	Gregor	Bern	CNRS	Preparation of a joint experimental validation of ray-tracing codes related to heliostats	12
12	FISE	Peter	Schöttle	CENER	Joint publication on heliostat field algorithm comparison	12
13	FISE	Peter	Schöttle	CYI	Exchange on modelling tools with joint publication	7
14	FISE	Annie	Zirkel-Hofer	CIEMAT	Comparison of performance evaluation methods for PTC solar fields	11
15	FISE	Annie	Zirkel-Hofer	UEVORA	Linear Fresnel Collector (LFC) and field measurement methods	11
16	FISE	Anna	Heimsath	CIEMAT	Evaluation of On-site reflectance measurements in real STE plants	11
17	FISE	Martin	Karl	CYI	Exchange on modelling tools with joint publication	7
18	IMDEA	Sandra	Álvarez	DLR	Reactor concepts for thermal heat storage	7
19	IMDEA	Salvador	Luque	IEECAS	Experimental assessment of silicon carbide ceramics as solar absorbers	12
20	IST-ID	Luis	Guerra Rosa	CIEMAT	Research on materials for STE components	8
21	IST-ID	José Jorge	Cruz Fernandez	CIEMAT	Research on reticulated porous ceramic for potential volumetric solar absorber receivers	8
22	LNEG	João	Cardoso	FUSP	Study of cogeneration applications in the agro-industrial sector	12

23	LNEG	Fernando	Oliveira	CNRS	Hydrogen production using cork-based ceria ecoceramics	7
24	LNEG	Teresa	Diamantino	CIEMAT	Aging of metallic components with MS	7
25	LNEG	Teresa	Diamantino	DLR	Accelerated aging of reflectors	8
26	TECNALIA	Javier	Nieto Maestre	CNR	Nanoparticles, nanofluids and nanosalts.	7
27	TECNALIA	David Alfredo	Pacheco Tanaka	CNR	nanosalts	7
28	TKN	David	Olasolo	CIEMAT	Characterisation tests for heliostats T12.1.2	12
29	EUVORA	João	Marchã	CIEMAT	Startup, heating and cool down procedures of the PSA thermal oil and pressurized water test loops; control strategies (e.g. flow or temperature oriented); definition of monitoring variables; training on thermal oil hydraulic loop control under different operating conditions; safety procedures; maintenance procedures; discussion on data evaluation to do in subtask 11.2.1.	11
30	US	Elena	Pérez Aparicio	CENER	Work package 12 documentation	12
31	US	Francisco Javier	Cabello Núñez	CENER	Work package 12 documentation	12
32	US	Francisco Javier	Pino Lucena	IMDEA	Static and dynamic analisys of Combined Cicle Power Plant based on Cavity air solar tower receptor	12

4.2. Dissemination

This part indicates the actual status about the dissemination activities related to the activities performed through the achieved mobilities.

4.2.1 Achieved Disseminations

There are currently 14 dissemination events reported related to the exchange of personnel performed.

The details regarding the disseminated information as well as the related mobilities are presented in the table below. For more information about these mobilities, refer to the part 3.2.

Table 6. Dissemination activities and related exchanges of reaserchers

Information about the related mobility							**Information about the dissemination**		
N°	**Participant's institution**	**First name**	**Last name**	**Host institution**	**Title of the mobility**	**WP**	**Event**	**Date**	**Presentation title**
1	CENER	Michael	Burisch	TKN	Testing of heliostat and calibration	12	SolarPACES 2015	15/10/2015	Heliostat Calibration Using Attached Cameras And Artificial Targets
2	CENER	Fabienne	Sallaberry	CIEMAT	Knowledge transfer about dynamic testing	11	SolarPACES congress	16/10/2015	Towards Standardization of in-Site Parabolic Trough Collector Testing in Solar Thermal Power Plants
3	CENER	Michael	Burisch	CIEMAT	Heliostat calibration testing (2015)	12	SolarPACES2016	11/10/2016	Heliostat Kinematic System Calibration Using Uncalibrated Cameras

4	CENER	Michael	Burisch	CIEMAT	Heliostat calibration testing (2016)	12	SolarPACES 2017	26/09/2017	Scalable HeliOstat calibRation sysTem (SHORT) - How to calibrate your whole heliostat field in a single night
5	CENER	Luis	Gomez Palacin	CIEMAT	Heliostat calibration testing (2016)	12	SolarPACES 2017	26/07/2017	Scalable HeliOstat calibRation sysTem (SHORT) - How to calibrate your whole heliostat field in a single night
6	CIEMAT	Rocío	Bayón	TECN	Materials for thermal storage	7	European Conference on Liquid Crystals, Manchester (UK)	09/09/2015	Storing latent heat with liquid crystals. Is it a feasible option?
7	CIEMAT	Jose	Rodriguez	LNEG	Durability protocol to qualify innovative materials for solar chemical reactors	9	3th STAGE-STE WP9 Technical Meeting in Tabernas, Spain	26/11/2015	Draft Proposal of a common protocol for durability tests
8	CIEMAT	M. Esther	Rojas	TECN	Materials for thermal storage	7	European Conference on Liquid Crystals, 2015	11/09/2015	Storing latent heat with liquid crystals. Is it a feasible option?

9	CIEMAT	Inmaculada	Cañadas	LNEG	Durability protocol to qualify innovative materials for solar chemical reactors	9	3rd Technical Meeting of STAGE-STE WP9 celebrated in Tabernas (Spain).	26/11/2015	Proposal of a common durability test methodology
10	CIEMAT	Loreto	Valenzuela	CENER	Optical and thermal performance of PTC by dynamic testing methodologies	11	SolarPACES Conference 2016	10/10/2016	Harmonization of Standards for Parabolic Trough Collector Testing in Solar Thermal Power Plants
11	CNR	Laura	Silvestroni	CNRS	Study on oxidation resistance of refractory ceramic materials	8	15th HTMC - High Temperature Materials Chemistry	29/03/2016	Ultra-High Temperature Ceramics in Extreme Environment
12	CNRS	Laurie	André	DLR	Thermochemical cycles for solar energy storage	9	SolarPACES 2017	27/07/2017	Mixed Co, Cu and Mn-Based Metal Oxides for Thermochemical Energy Storage Application
13	LNEG	Teresa	Diamantino	DLR	Accelerated aging of reflectors	8	European Corrosion Congress Eurocorr 2017	03/09/2017	Influence of severe atmospheres on degradation of aluminium reflectors for CSP plants
14	TKN	Eduardo	Ubieta	CIEMAT	Modelling, control, Operation and Maintenance task inside WP11:	11	22nd SolarPACES Conference, 11 - 14 October 2016, Abu Dhabi, UAE	12/10/2016	Object-oriented Simulation Model of a Parabolic Trough Solar Collector: Static and Dynamic Validation

					Dynamic tests for PTs				

4.2.2 Mobilities related to the planned disseminations

There are currently 22 planned dissemination events related to the mobilities achieved during the first half of the STAGE-STE project.

The details regarding the related mobilities are presented in the table below. For more information about these mobilities, refer to the part 3.2.

Table 7. Exchange of researchers information regarding the planned dissemination activities

N°	Participant's institution	First name	Last name	Host institution	Title of the mobility	WP
1	CIEMAT	Loreto	Valenzuela	CENER	Optical and thermal performance of PTC by dynamic testing methodologies	11
2	CIEMAT	Rocio	Bayon	FISE	Test campaign at HTMS thermocline tank	7
3	CNR	Laura	Silvestroni	CNRS	Study on oxidation resistance of refractory ceramic materials	8
4	CNR	Alessandro	Bellucci	PSI	Solar Thermionic-Thermoelectric Generator	8
5	CNR	Daniele M.	Trucchi	PSI	Solar Thermionic-Thermoelectric Energy Generator	8
6	CNRS	Ludovic	Charpentier	CNR	UHTC elaboration and characterization	8
7	ENEA	Raffaele	Liberatore	TECNALIA	STAGE-STE ENEA visit to Tecnalia facilities	7
8	ETHZ	Erik	Koepf	IMDEA	Solar Fuels	9
9	FISE	Peter	Schöttle	CENER	Joint publication on heliostat field algorithm comparison	12
10	FISE	Peter	Schöttle	CYI	Exchange on modelling tools with joint publication	7

11	FISE	Martin	Karl	CYI	Exchange on modelling tools with joint publication	7
12	IMDEA	Salvador	Luque	IEECAS	Experimental assessment of silicon carbide ceramics as solar absorbers	12
13	IST-ID	Luis Guerra	Rosa	CIEMAT	Research on materials for STE components	8
14	IST-ID	José Jorge	Cruz Fernandes	CIEMAT	Research on reticulated porous ceramic for potential volumetric solar absorber receivers	8
15	LNEG	Teresa	Diamantino	DLR	Accelerated aging of reflectors	8
16	LNEG	João	Cardoso	FUSP	Study of cogeneration applications in the agro-industrial sector	12
17	LNEG	Fernando	Oliveira	CNRS	Hydrogen production using cork-based ceria ecoceramics	7
18	LNEG	Teresa	Diamantino	CIEMAT	Aging of metallic components with MS	7
19	TKN	Nerea	Uranga	ENEA	Corrosion tests on MS	7
20	US	Francisco Javier	Pino Lucena	IMDEA	Static and dynamic analisys of Combined Cicle Power Plant based on Cavity air solar tower receptor	12
21	US	Elena	Pérez Aparicio	CENER	Work package 12 documentation	12
22	US	Francisco José	Cabello Núñez	CENER	Work package 12 documentation	12

5. KPI Statement

The final statement regarding the exchanges of personnel throughout the entire life of the STAGE-STE project is described in this part. The KPIs are focused on the following information:

- Number of researchers involved in mobilities
- Number of reports from researches involved in a mobility
- Number of days of mobilities (taking into account the remote working time)
- Number of joint publication
- Number of dissemination events
- Number of industry stakeholders involved in a mobility

Table 8. KPI information within the final analysis of the total of the exchanges of personnel

KPI no.	KPI description	2014 – 2018 years value
KPI_15	Number of researchers involved in mobility and exchange programmes	80
KPI_16	Number of reports from researchers involved in mobility and exchange programmes	101
KPI_17	Number of days of mobility and exchange	1427,5
KPI_18	Number of joint publications related to the participation in the exchange programmes	15 (32 planned)
KPI_19	Number of dissemination events related to the participation in the exchange programmes	14 (22 planned)
KPI_26.	Number of industry stakeholders involved in IRP R&D, or accessing IRP research facilities, or licensees of the IP generated within the IRP, or partners in the mobility programme	0

Conclusion

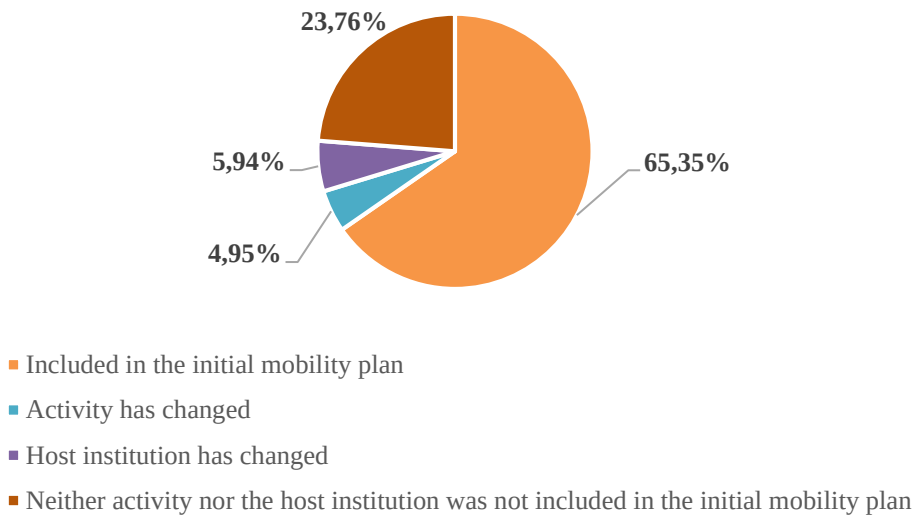
The WP4 “Capacity Building and training Activities” of the STAGE-STE project aimed to establish and enhance R&D cooperative actions among the partners through numerous effective exchange and mobility of personnel between project participant institutions with the long-term aim of raising the level of excellence of the researchers within the STAGE-STE research topics.

Within the STAGE-STE project with its solid consortium of the major stakeholders in CSP in Europe and worldwide, the WP4 helped to ensure that the project partners share their skills and approaches, work methods and practical knowledge in order to fine-tune the research programs and, therefore, take on greater productivity and viability in the common R&D contribution to long-term progress in the CSP sectors.

Since the beginning of the STAGE-STE project, 92,39% of the mobility plan has been achieved in term of manpower devotion.

Foreseen at the proposal stage and confirmed at the implementation step, the modifications of the initial Mobility plan have been made by the partners after the M24. In this way, 66 out of 101 achieved mobilities have been included in the initial mobility plan with 24 mobilities newly planned and performed by the researchers. 5 mobilities have changes of activity focus and 6 out of 101 have been achieved at another host institution than it has been planned initially.

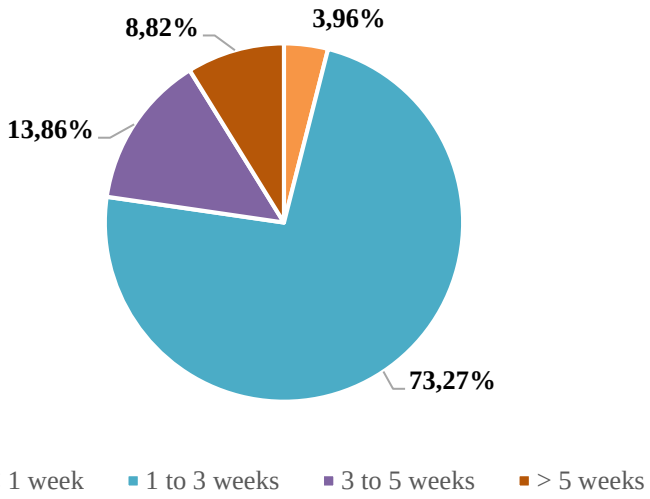
Figure 5. Deviation from the initial mobility plan regarding the 101 achieved mobilities



Regarding the duration of mobilities – both the onsite working time and remote working time – according to the received mobility forms and individual reports, 4,90% are less than a 1-week-

duration-mobilities, 72,55% represent those that lasted from 1 to 3 weeks and 13,73% from 3 to 5 weeks. 8.82% of mobilities achieved had the duration up to 5 weeks.

Figure 6. Distribution of the mobilities regarding the duration of the mobilities (% calculated on the number of achieved mobilities on the mobility website)



All the partners have been involved in the task 4.1 either as participating institution or as host institution. Also there is one partner (University of Seville, Seville, Spain) has not been included in the Mobility Plan set in the Document of Work of the STAGE-STE project, but joined later, achieved a number of mobilities as participating institution and hosted the researchers from others institutions as well. It is important to mention that 11 partners out of the 21 partners (excluding the University of Seville) mentioned in the DoW Mobility Plan at M11 have not achieved personnel exchange at M48. This could be explained by the budget and management constraints of participant or hosting institutions of the mobility as well as global changes in the previously set research objectives to accomplish trough the mobilities. 10 out of 21 partners have fulfilled their objective in term of personnel exchange with 9 out 10 partners that went beyond the planned objective in term of manpower devotion (for more information, refer to the part 3.4).

The analysis of the final results of the mobilities and exchange of researchers, especially during the 3rd and 4th year of the project duration, allowed to witness their growing interest and commitment in knowledge sharing and cooperation among the European and non-European research partners and, thus, the efficiency of the mobility process within the STAGE-STE project and successful implementation of the task 4.1.

Annexes

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Knowledge transfer about dynamic testing

Participant's first name and family name: Fabienne Sallaberry

Name of the participant's institution: CENER

Name of the host institution: CIEMAT

Onsite working period: 25/05/2015 to 05/06/2015

Onsite working time (in Person week(s))*: 2

Remote working time (in Person week(s))**: 0,2

I. Objectives of the mobility

The objective of the stay was to exchange about the testing methodology of parabolic trough collectors.

The methodology discussed and tested were the standard method under quasi-dynamic state according to ISO 9806:2013 and the proposal method according to AENOR and IEC committees.

Another objective of this stay was to characterize the accuracy of the tracking system of a parabolic trough collector, and by this way to validate the proposal method according to AENOR and IEC committee using a digital inclinometer.

Additionally, this stay was an opportunity to share experiences about characterization techniques for other WP (durability tests of reflectors within WP8.1, heat losses and optical characterization of receiver tubes within WP8.2.)

II. Main achievements and difficulties encountered

Several testing days were obtained during this stay with different conditions of inner temperature, flowrate, and solar irradiance.

During 4 days, the inner temperature inside the collector was fixed and maintained constant during the whole day (±1ºK), for inner temperature values between 200 and 330ºC.

During 5 days the accuracy of the solar tracker was characterized in one axis. For this test, a digital inclinometer with an accuracy of ± 0.01 ° was mounted on the structure of the collector, close to the rotation axis. The data were registered during the whole day by connecting the digital inclinometer through a cable to a laptop.

The problems encountered were that during two days the weather was cloudy, so no efficiency test could be performed. Moreover, the efficiency at low temperature (<270ºC) needed a change in the collector structure, so it could not be performed during the stay. But apart from those points, the stay was really fruitful and rich in new collaboration.

III. Joint publications foreseen

It has been discussed to publish some studies about the testing methodology of parabolic trough collectors for CSP plants.

One publication could be about the comparison of the efficiency testing of collectors.
Another publication could be about the tracking characterization of a single-axis tracker.

IV. Comments, if any

We would like to thank the technical crew of the Medium concentration unit at PSA. In special thanks to Loreto Valenzuela for all the support provided during my stay. Also thanks to Agustín Perez and the maintenance staff for all the assistance during the mounting of the inclinometer on the collector structure. Finally thanks to Rafael Lopez and Arantxa Fernandez for the visit to their laboratories.

*One person week equals to 5 labour days. One person week should be justified when a minimum of 3 days of onsite labour days at the host institution have been realized, considering that one day before and one day after the mobility are also part of the mobility, even if not hosted at the institution. In this sense, please consider one person week for all onsite working periods from 3 to 5 labour days.

**The remote working period deals with all the preparatory work to be realized way before and after the mobility: joint work to prepare, mapping of the transfer of knowledge between both partners, preparation of experiments to do during the mobility, analysis of the experiments after the mobility, joint publications, … This will count for your mobility person month to declare and should be counted in the Remote working period.

STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Testing of heliostat and calibration

Participant's first name and family name: Michael Burisch

Name of the participant's institution: CENER

Name of the host institution: IK4-TEKNIKER

Onsite working period: 20 / 04 / 2015 to 24 / 04 / 2015

Onsite working time (in Person week(s))*: 1

Remote working time (in Person week(s))**: 0

I. Objectives of the mobility

The aim of the exchange is to advance with the development of an automatic calibration system for small sized heliostats. Based on developments so far we wanted to make some tests whether the approach considered so far would work n a setup somewhat similar to those encountered in solar fields, while still operating within a controlled environment.

II. Main achievements and difficulties encountered

Before the testing could start everything had to be setup (namely cameras and a heliostat). To be able to quantify the quality of the calibration we needed precise knowledge about the setup, i.e. position and orientation of all the components. This proved to be more time consuming than anticipated due to the distribution of the components and there somewhat large distances with respect to each other.
Furthermore it was detected that some attachments were not rigid enough and, therefore, some components moved slightly over night hindering the repeatability of the tests. After fixing these issues test could be performed and a good amount of testing data was gathered. First analysis show that the calculated results do match with the measured data, therefore showing that the calibration approach works. Further evaluation is currently in process.

III. Joint publications foreseen

Based on the data gathered it is planned to make a joint publication in SolarPACES 2015 about a calibration approach which was tested.

IV. Comments, if any

Please do not exceed 10 to 15 lines

Each participant of the mobility have to fill in this document personally.
Please upload it following the instructions of the email in which this document was attached.

*One person week equals to 5 labour days. One person week should be justified when a minimum of 3 days of onsite labour days at the host institution have been realized, considering that one day before and one day after the mobility are also part of the mobility, even if not hosted at the institution. In this sense, please consider one person week for all onsite working periods from 3 to 5 labour days.

**The remote working period deals with all the preparatory work to be realized way before and after the mobility: joint work to prepare, mapping of the transfer of knowledge between both partners, preparation of experiments to do during the mobility, analysis of the experiments after the mobility, joint publications, … This will count for your mobility person month to declare and should be counted in the Remote working period.

STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Testing of heliostat and calibration

Participant's first name and family name: Michael Burisch

Name of the participant's institution: CENER

Name of the host institution:CIEMAT-PSA

Onsite working period: 28 / 09 / 2015 to 02 / 10 / 2015

Onsite working time (in Person week(s))*: 1

Remote working time (in Person week(s))**: 0

I. Objectives of the mobility

The aim of the exchange is to advance with the development of an automatic calibration system for small sized heliostats. Using the installations available at the host institution, specifically their heliostat field we wanted to gather real data to adapt the algorithm. Furthermore, keeping in mind the upcoming tests of the small sized heliostat developed within WP12 we also wanted to get familiar with the facilities, which we plan to use for the tests.

II. Main achievements and difficulties encountered

The main difficulty encountered was the setup of our equipment and especially the interconnections, considering the long distances found in heliostat fields. As mentioned before this visits also served as a familiarization with the facilities. This will allow setting up the equipment faster next time, thereby, facilitating to focus on heliostat performance and calibration tests on the heliostat developed within WP12.
Apart from this a series of real world data has been gathered which will aid in the development of the calibration algorithm, considering effects encountered in actual heliostat fields.

III. Joint publications foreseen

Currently none as further investigation into the gathered data is required to determine whether a publication from the data is useful.

IV. Comments, if any

Please do not exceed 10 to 15 lines

Each participant of the mobility have to fill in this document personally.
Please upload it following the instructions of the email in which this document was attached.

*One person week equals to 5 labour days. One person week should be justified when a minimum of 3 days of onsite labour days at the host institution have been realized, considering that one day before and one day after the mobility are also part of the mobility, even if not hosted at the institution. In this sense, please consider one person week for all onsite working periods from 3 to 5 labour days.

**The remote working period deals with all the preparatory work to be realized way before and after the mobility: joint work to prepare, mapping of the transfer of knowledge between both partners, preparation of experiments to do during the mobility, analysis of the experiments after the mobility, joint publications, … This will count for your mobility person month to declare and should be counted in the Remote working period.

STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Testing of heliostat and calibration

Participant's first name and family name: Irene Santana

Name of the participant's institution: CENER

Name of the host institution: CIEMAT-PSA

Onsite working period: 28 / 09 / 2015 to 02 / 10 / 2015

Onsite working time (in Person week(s))*: 1

Remote working time (in Person week(s))**: 0

I. Objectives of the mobility

The aim of the exchange is to advance with the development of an automatic calibration system for small sized heliostats. Using the installations available at the host institution, specifically their heliostat field we wanted to gather real data to adapt the algorithm. Furthermore, keeping in mind the upcoming tests of the small sized heliostat developed within WP12 we also wanted to get familiar with the facilities, which we plan to use for the tests.

II. Main achievements and difficulties encountered

The main difficulty encountered was the setup of our equipment and especially the interconnections, considering the long distances found in heliostat fields. As mentioned before this visits also served as a familiarization with the facilities. This will allow setting up the equipment faster next time, thereby, facilitating to focus on heliostat performance and calibration tests on the heliostat developed within WP12.
Apart from this a series of real world data has been gathered which will aid in the development of the calibration algorithm, considering effects encountered in actual heliostat fields.

III. Joint publications foreseen

Currently none as further investigation into the gathered data is required to determine whether a publication from the data is useful.

IV. Comments, if any

Please do not exceed 10 to 15 lines

Each participant of the mobility have to fill in this document personally.
Please upload it following the instructions of the email in which this document was attached.

*One person week equals to 5 labour days. One person week should be justified when a minimum of 3 days of onsite labour days at the host institution have been realized, considering that one day before and one day after the mobility are also part of the mobility, even if not hosted at the institution. In this sense, please consider one person week for all onsite working periods from 3 to 5 labour days.

**The remote working period deals with all the preparatory work to be realized way before and after the mobility: joint work to prepare, mapping of the transfer of knowledge between both partners, preparation of experiments to do during the mobility, analysis of the experiments after the mobility, joint publications, … This will count for your mobility person month to declare and should be counted in the Remote working period.

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Second test phase of SiC module THEMIS

Participant's first name and family name: Idoya Goñi

Name of the participant's institution: CENER

Name of the host institution: CNRS PROMES

Onsite working period: 28 / 09 / 2015 to 02 / 10 / 2015

Onsite working time (in Person week(s))*: 1

Remote working time (in Person week(s))**: 0

I. Objectives of the mobility

The main objective of the mobility is attend and participate in the second test phase of SiC module THEMIS. The aim of the second test phase of SiC module THEMIS will be to experiment thermal and thermomechanical behavior of this type of ceramic module on conditions of extreme solar flux (typical of critical solar flux distributions).

II. Main achievements and difficulties encountered

The problems encountered were that during this week the bad weather did not allow to carry out the testing activities. Because of this, I used mobility to visit the facilities, take information on the whole experiences at THEMIS and discuss about the CENER's and CNRS PROMES's contribution in STAGE-STE Task 12.2.3.

III. Joint publications foreseen

No.

IV. Comments, if any

After these activities testing, CENER and CNRS PROMES should establish a way of exchanging experimental data that will allow us to improve the thermal and optical models that we are developing within STAGE -STE.

*One person week equals to 5 labour days. One person week should be justified when a minimum of 3 days of onsite labour days at the host institution have been realized, considering that one day before and one day after

the mobility are also part of the mobility, even if not hosted at the institution. In this sense, please consider one person week for all onsite working periods from 3 to 5 labour days.

**The remote working period deals with all the preparatory work to be realized way before and after the mobility: joint work to prepare, mapping of the transfer of knowledge between both partners, preparation of experiments to do during the mobility, analysis of the experiments after the mobility, joint publications, … This will count for your mobility person month to declare and should be counted in the Remote working period.

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Heliostat calibration testing

Participant's first name and family name: Luis Gómez Palacín

Name of the participant's institution: CENER

Name of the host institution: CIEMAT

Onsite working period: 17 / 10 / 2016 to 28 / 10 / 2016

Onsite working time (in Person week(s))*: 2

Remote working time (in Person week(s))**: 1

I. Objectives of the mobility

The aim of the exchange is to advance with the development of an automatic calibration system for heliostats using the installations available at the host institution and the heliostat developed in WP12 by CENER and TEKNIKER.

II. Main achievements and difficulties encountered

The calibration system has been successfully deployed and put into operation. With a camera on the heliostat a number of targets have been observed and based on these observations the parameters for controlling the heliostat have been estimated.

One of the major difficulties during the testing was to correctly correlate the positions of the targets with the coordinate system defined by the solar field, especially with the global orientation in order to reflect the sun. For a second set of targets also deployed this resulted impossible due to lack of well-known reference positions in the vicinity of the targets.

After the calibration process had been successfully done, the heliostat could be put into tracking mode and was able to track the sun seemingly stable. However, due to the weather conditions (some rain and mainly cloudy) tracking the sun was only limited for short periods of time, what effectively hindered drawing on-site conclusions up to a point that no numerical test results of the tracking quality could be gained during the site visit. In regard to this, the heliostat has been left on-site in order to make the tests with the help of the host institution under better ambient conditions.

III. Joint publications foreseen

Depending on the yet to be determined results, the calibration system and heliostat should be presented in a scientific environment.

IV. Comments, if any

Please do not exceed 10 to 15 lines

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: High temperature absorbers and material

Participant's first name and family name: Fabienne Sallaberry

Name of the participant's institution: CENER

Name of the host institution: LNEG

Onsite working period: 22 / 02 / 2016 to 26 / 02 / 2016

Onsite working time (in Person week(s))*: 1

Remote working time (in Person week(s))**: 0.2

I. Objectives of the mobility

The main objective of the mobility a "knowledge transfer" within the subtask 8.2 and more particularly about high temperature absorbers and material.

II. Main achievements and difficulties encountered

During the first day, a visit of the laboratory LMR was done with Teresa Diamantino. The visit consists in seeing the different corrosion test chambers (UV, NSS, acid environment, gases, etc).
A microscope was used to visualize the defects of corrosion on some glass mirrors. Some photos were taken from the corrosion of our samples.

A spectrophotometer was used to measure the color of organic coating in the back side of the mirrors by colorimetry technique (CIE 1976 L*, a*, b* color space) on the samples without test and on the samples after some durability tests. A yellowing of the samples after the tests (Δb* positive) was shown with this equipment by calculating the color difference.

A visit of the laboratory for metals was also done with Fernando Oliveira.

During the second day, an outdoor exposure testing site in Sines was visited. This testing site is mounted within an oil refinery on the Atlantic coast, at about 2 hours' drive from Lisbon.
There are several metallic testing benches for exposure small samples. Some facing the ocean (north) and the other facing south (facing the refinery). There are also some solar thermal collectors exposed facing south, for the national project DURASOL. A weather station measures the horizontal and tilted global solar radiation, the UV radiation, the ambient temperature and the contaminants in the air.
The glass mirror samples from Flabeg for the STAGE WP8 Round-Robin are mounted for exposure too. Some samples present some signs of corrosion.

During the third day, the solar energy laboratory was visited with Maria Joao Carvalho. Some optical measurements were performed, between 280 nm and 250nm, with a spectrophotometer brand name Perkin Elmer, model 950.

First, one measurement of the reflectance of a tubular absorber sample is done. Then, the reflectance of some glass mirrors samples (from WP8 Round-Robin) was measured using a mirror standard as a reference.
A measurement of the transmittance of a tubular glass cover sample is performed, using the air as a reference.

Finally the IR reflectance of the absorber was measured with a Perkin Elmer FTIR spectrophotometer between 2000nm and 15000 nm, using a gold sample as a reference.
A comparison will be done between CENER and LNEG measurements.
The only problem encountered was the bad weather during the outdoor installation visit.

III. Joint publications foreseen

One paper is planned to be sent to SolarPACES congress about the Round-Robin for durability tests of solar mirrors.

IV. Comments, if any

We would like to thank the technical crew of the LMR at LNEG. In special thanks to Teresa Diamantino for all the support provided during my stay.

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Heliostat calibration testing

Participant's first name and family name: Michael Burisch

Name of the participant's institution: CENER

Name of the host institution: CIEMAT

Onsite working period: 17 / 10 / 2016 to 28 / 10 / 2016

Onsite working time (in Person week(s))*: 2

Remote working time (in Person week(s))**: 1

I. Objectives of the mobility

The aim of the exchange is to advance with the development of an automatic calibration system for heliostats using the installations available at the host institution and the heliostat developed in WP12 by CENER and TEKNIKER.

II. Main achievements and difficulties encountered

The calibration system has been successfully deployed and put into operation. With a camera on the heliostat a number of targets have been observed and based on these observations the parameters for controlling the heliostat have been estimated.

One of the major difficulties during the testing was to correctly correlate the positions of the targets with the coordinate system defined by the solar field, especially with the global orientation in order to reflect the sun. For a second set of targets also deployed this resulted impossible due to lack of well-known reference positions in the vicinity of the targets.

After the calibration process had been successfully done, the heliostat could be put into tracking mode and was able to track the sun seemingly stable. However, due to the weather conditions (some rain and mainly cloudy) tracking the sun was only limited for short periods of time, what effectively hindered drawing on-site conclusions up to a point that no numerical test results of the tracking quality could be gained during the site visit. In regard to this, the heliostat has been left on-site in order to make the tests with the help of the host institution under better ambient conditions.

III. Joint publications foreseen

Depending on the yet to be determined results, the calibration system and heliostat should be presented in a scientific environment.

IV. Comments, if any

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Transient modeling and simulation of high-temperature plate pressurized receiver and structural analysis of the ceramic module.

Participant's first name and family name: Leticia Aldaz Asurmendi

Name of the participant's institution: CENER

Name of the host institution: CNRS Odeillo

Onsite working period: 11 / 04 / 2016 to 15 / 04 / 2016

Onsite working time (in Person week(s))*:1

Remote working time (in Person week(s))**: 0.5

I. Objectives of the mobility

The objectives of the mobility were visit experimental capabilities of CNRS at Odeillo, mainly Themis solar tower facility and the tower level where is located the ceramic module experiment, and also discuss about the CENER and CNRS models, including ceramic module thermo structural simulations performed by CNRS.

II. Main achievements and difficulties encountered

Facilities are visited during the mobility, and detailed explanations of the experiments are given with great hospitality by CNRS.
The work conducted by CNRS and CENER was presented. The complementary activities between CNRS and CNER were discussed.
The main discussion was about collaboration regarding transient analysis of the pressurized receiver developed by CNRS, CENER can perform the model and CNRS can provide the experimental data.
But also ceramic module thermo structural detailed analysis modeled by CNRS was discussed. For ceramics the maximum stress that the material can withstand before failure may vary from sample to sample. The stress criterion concerning failure of ceramic was explained and some boundary conditions needed were clarified. Specifically calculation of heat transfer coefficient to perform the thermal analysis and probabilistic references are discussed and different viewpoints are exchanged.

III. Joint publications foreseen

The future job will be publications and activities regarding transient Modelica model of the receiver from CENER and the validation with experimental data from CNRS.

IV. Comments, if any

The solar thermal energy department of CENER would like to thank Dr. Gabriel Olalde, Dr. Adrien Toutant, Dr. Alain Ferrière as well as Cédric Leray for the very informative and pleasant stay at CNRS Odeillo.

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Transient modeling and simulation of a high-temperature plate pressurized receiver

Participant's first name and family name: Fritz Zaversky

Name of the participant's institution: CENER

Name of the host institution: CNRS Odeillo

Onsite working period: 12 / 04 / 2016 to 14 / 04 / 2016

Onsite working time (in Person week(s))*: 0.6

Remote working time (in Person week(s))**: 0.5

I. Objectives of the mobility

The objective of the mobility was to visit the experimental installations at CNRS Odeillo and to discuss the work done by CNRS and by CENER in order to agree on the activities in Task 12.2.3 that would be of interest for both institutions, being of complementary nature.

II. Main achievements and difficulties encountered

The outcome of the meeting was that the transient analysis of the pressurized receiver developed by CNRS is an interesting complementary activity between CNRS and CENER. CENER will apply its Modelica model library to develop a 1-D transient model of the pressurized receiver. CNRS will provide the data of already recorded experiments to validate the model.
The activity can be divided into two stages:

The first and short-term approach is to reproduce the transient behavior of one receiver module as currently tested at the THEMIS tower. For this module, measurement data of the gas inlet temperature, the gas outlet temperature, the gas inlet pressure, as well as the gas mass flow is available. This measurement data, together with the receiver flux map in time series format (e.g. data at every 5 seconds) would already be sufficient for validating the transient model of the module. Additionally, thermocouples are also placed inside the channels of the module at several positions along the module length, which could serve for validation purposes of intermediate receiver temperatures. However, this intermediate measurement points have to be considered very carefully and critically as the thermocouple will likely measure everything but the real gas temperature at this position. Note that the intermediate thermocouples are quite randomly placed with respect to the channel's cross section, i.e. they could touch one of the channel's walls or not. In summary, this first activity is the transient modeling and simulation of one receiver module as developed by CNRS. It will be part of D12.4.

The second and long-term approach is the development of a transient model of the whole pressurized receiver, including the active cavity as well as the matrix of receiver modules at the main receiver surface. Again, CENER's model library will be used to reproduce the receiver, coupling several 1-D model components. Besides the modeling of the air flow setup, an important feature of the model will be the consideration of thermal radiation exchange inside the cavity. This will be considered via modeling the cavity as an enclosure of gray surfaces discretizing the cavity into a number of surfaces that correspond to the number of nodes of the fluid flow model. The shape factor matrix will be calculated by a Monte Carlo code. Thermal losses by convection will be considered using empirical correlations from literature.

The transient Modelica model of the receiver and its validation against experimental data could be subject of a future joint publication. In summary, this second activity considers a more complex global receiver model which is able to capture thermal performance and its transient behavior. It has to be noted that this activity has to be seen as an extra and is not linked to any deliverable of STAGE-STE.

III. Joint publications foreseen

The modeling and the validation against experimental data could be published in the form of a conference paper.

IV. Comments, if any

The solar thermal energy department of CENER would like to thank Dr. Gabriel Olalde, Dr. Adrien Toutant, Dr. Alain Ferrière as well as Cédric Leray for the very informative and pleasant stay at CNRS Odeillo.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Heliostat calibration testing

Participant's first name and family name: Xabier Olano

Name of the participant's institution: CENER

Name of the host institution: CIEMAT

Onsite working period: 17 / 10 / 2016 to 28 / 10 / 2016

Onsite working time (in Person week(s))*: 2

Remote working time (in Person week(s))**: 1

I. Objectives of the mobility

The aim of the exchange is to advance with the development of an automatic calibration system for heliostats using the installations available at the host institution and the heliostat developed in WP12 by CENER and TEKNIKER.

II. Main achievements and difficulties encountered

The calibration system has been successfully deployed and put into operation. With a camera on the heliostat a number of targets have been observed and based on these observations the parameters for controlling the heliostat have been estimated.

One of the major difficulties during the testing was to correctly correlate the positions of the targets with the coordinate system defined by the solar field, especially with the global orientation in order to reflect the sun. For a second set of targets also deployed this resulted impossible due to lack of well-known reference positions in the vicinity of the targets.

After the calibration process had been successfully done, the heliostat could be put into tracking mode and was able to track the sun seemingly stable. However, due to the weather conditions (some rain and mainly cloudy) tracking the sun was only limited for short periods of time, what effectively hindered drawing on-site conclusions up to a point that no numerical test results of the tracking quality could be gained during the site visit. In regard to this, the heliostat has been left on-site in order to make the tests with the help of the host institution under better ambient conditions.

III. Joint publications foreseen

Depending on the yet to be determined results, the calibration system and heliostat should be presented in a scientific environment.

IV. Comments, if any

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Receiver Round-Robin test at DLR

Participant's first name and family name: Rafael Antonio López Martín

Name of the participant's institution: CIEMAT

Name of the host institution: DLR

Onsite working period: 09 / 02 / 2015 to 12 / 02 / 2015

Onsite working time (in Person week(s))*: 0,8

Remote working time (in Person week(s))**: 0.2

I. Objectives of the mobility

Within the WP8 of the STAGE-STE project, it is going to be realized a round-robin of measurement of thermal losses and optical parameters in receiver tubes. These parameters are critical for characterization of receivers, which contributes to a correct dimensioning of thermal solar plants of parabolic trough collectors.
The main objective of this mobility is to be present in the measures of thermal losses and optical parameters of receivers of two different manufacturers in one of the institutions (DLR) participants in the round-robin. This will enable a comparison and exchange of ideas of the measurement procedures to assess the different results obtained in the round-robin.

II. Main achievements and difficulties encountered

The main achievement has been the knowledge and the comparative of the different measurement techniques and the exchange of ideas that will contribute to a better comparison of the results obtained in the round-robin.

III. Joint publications foreseen

Results of round-robin will be published within SolarPACES.

IV. Comments, if any

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Materials for thermal storage

Participant's first name and family name: Esther Rojas

Name of the participant's institution: Ciemat

Name of the host institution: Tecnalia

Onsite working period: 01 / 06 / 2015 to 02 / 06 / 2015

Onsite working time (in Person week(s))*: 0.4

Remote working time (in Person week(s))**: 0.4

I. Objectives of the mobility

Share the capabilities and necessities in terms of the materials for storage research lines of both Tecnalia and Ciemat, in order to see and look for possibilities of collaboration in close future under other than STAGE-STE funding schemes.

II. Main achievements and difficulties encountered

It was foreseen to explore a collaboration for synthesizing liquid crystals with attractive features as thermal storage materials. Ciemat will make a proposal and Tecnalia, through its group working in organic synthesis, will try to manufacture the material.

III. Joint publications foreseen

Some joint publication may be done, depending of the success of liquid crystal synthesis.

IV. Comments, if any

Tecnalia was very generous and made its best to help us for making the measurements we asked for, even asking other Tecnalia Units not so close to CSP or to the Energy Division, that are the people involved directly in STAGE-STE project.

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STAGE-STE
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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Thermal Storage

Participant's first name and family name: Esther Rojas

Name of the participant's institution: Ciemat

Name of the host institution: CEA

Onsite working period: 03 / 11 / 2015 to 06 / 11 / 2015

Onsite working time (in Person week(s))*: 0.8

Remote working time (in Person week(s))**: 0.4

I. Objectives of the mobility

Creating, if possible, a collaboration related to Thermocline storage systems, exchanging information and experiences on this topic. Sharing the capabilities and priority research lines on other thermal storage activities in order to see and look for possibilities of collaboration in close future under other than STAGE-STE funding schemes

II. Main achievements and difficulties encountered

It was agreed that Dr. Rocío Bayon will have a stay in CEA-INES between 2 to 3 weeks in order to help performing some tests in its STONE facility, in order to better study the creation of the thermocline curve at the beginning of any charging/discharging process of a thermocline tank.
Awareness of the other partner's capabilities has been risen.

III. Joint publications foreseen

A joint publication is likely to be done.

IV. Comments, if any

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: **Development of a low cost heliostat (WP12.1)**

Participant's first name and family name: **Jesús Fernández-Reche**

Name of the participant's institution: **CIEMAT-PSA**

Name of the host institution: **IK4-TEKNIKER**

Onsite working period: **23 / 03 / 2015 to 27 / 03 / 2015**

Onsite working time (in Person week(s))*: **1**

Remote working time (in Person week(s))**: **4**

I. Objectives of the mobility

To share information between IK4-TEKNIKER, CENER and CIEMAT-PSA on the different approach institutions have been followed before STAGE project in the development of low cost heliostats.
Definition of the testing protocol to be performed on the heliostat prototype developed on WP 12.1 at the end of 2015.
Definition of heliostat fields calibration protocols and possibility to test some protocols at the PSA.

II. Main achievements and difficulties encountered

We have detected the interfaces to install the CIEMAT's auto-aligned optic on the TEKNIKER's tracker under development. No problems or difficulties found.
We have planned a test campaign to the heliostat prototype for the whole characterization, in a first step, of his tracking behavior. This campaign has been planed for the end of 2015: October till December.
We also discussed with CENER the possibility to star testing the fast calibration procedures (WP12.1.4) at the PSA CESA-I field. A CENER one-week stay is planned for summer this year to check their procedures on the PSA heliostats.

III. Joint publications foreseen

No publications foreseen in short term. After the testing period we will decide it.

IV. Comments, if any

No comments

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: "Definition of an effective procedure to model and test new designs for volumetric solar receivers"

Participant's first name and family name: María Isabel Roldán Serrano

Name of the participant's institution: CIEMAT (Centro de Investigaciones, Energéticas, Medioambientales y Tecnológicas)

Name of the host institution: CNRS (Centre National de Recherche Scientifique)

Onsite working period: 06 / 07 / 2015 to 17 / 07 / 2015

Onsite working time (in Person week(s))*: 2

Remote working time (in Person week(s))**: 4

I. Objectives of the mobility

The main objective of this mobility project is to establish a procedure in order to develop a CFD (Computational Fluid Dynamics) model which reproduces the thermal behavior of a volumetric configuration selected, including the techniques required to evaluate both optical and thermophysical properties that characterize the receiver structure.
The selected configuration of the receiver consists of several different layers of alumina pebbles. The study of this design is included in the task 8.2.6 (WP 8).

II. Main achievements and difficulties encountered

Different alternatives for the development of a CFD model focused on the selected receiver configuration were analyzed. The comparison between homogenized and detailed CFD models led to select a well-defined geometry to study the pebble configuration and to predict its thermal behavior in a first step.
Main difficulties of this work were found in the definition of the optical and thermal properties which characterize the selected design of the solar receiver.

III. Joint publications foreseen

It has been planned to publish the results obtained from the CFD model developed in this mobility project. The content of this work will include a model description and a prediction of the receiver thermal behavior.

IV. Comments, if any

Prior to the mobility, the remote working time was used to organize the tasks of the mobility project. Firstly, it was identified the different strategies to simulate the behavior of a solar receiver. At this stage, it was considered the simulation of a reference absorber design by the homogenized model in order to compare the local thermal equilibrium (LTE) model with the local thermal non-equilibrium (LTNE) one.
After the analysis of the initial mobility planning, it was selected the configuration considered in the mobility project. It consists of several different layers of alumina pebbles because it is the design regarded in the task 8.2.6. (WP 8). Due to the simply geometry of this configuration, it was proposed a detailed 3D model to study the receiver behavior instead of the homogenized one. Thus, during the onsite working time, a preliminary model was developed.
The model is still being refined in order to be validated with ongoing experimental data. Therefore, the remote working time is extended until the entire development and validation of the CFD model. It has also been proposed a mobility plan in the future in order to finish the activity defined in this mobility project.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Round Robin tests of Linear receivers

Participant's first name and family name: Rafael Antonio López Martín

Name of the participant's institution: CIEMAT

Name of the host institution: CENER

Onsite working period: 18 / 05 / 2015 to 22 / 05 / 2015

Onsite working time (in Person week(s))*: 1.0

Remote working time (in Person week(s))**: 1.0

I. Objectives of the mobility

Within the WP8 of the STAGE-STE project, it is going to be realized a round-robin of measurement of thermal losses and optical parameters in receiver tubes. These parameters are critical for characterization of receivers, which contributes to a correct dimensioning of thermal solar plants of parabolic trough collectors. The main objective of this mobility is to be present in the measures of thermal losses and optical parameters of receivers of two different manufacturers in one of the institutions (CENER) participants in the round-robin. This will enable a comparison and exchange of ideas of the measurement procedures to assess the different results obtained in the round-robin.

II. Main achievements and difficulties encountered

The main achievement has been the knowledge and the comparative of the different measurement techniques and the exchange of ideas that will contribute to a better comparison of the results obtained in the round-robin.

III. Joint publications foreseen

Results of round-robin will be published within SolarPACES.

IV. Comments, if any

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Durability of solar reflectors at CRAN

Participant's first name and family name: Dr. Aránzazu Fernández-García

Name of the participant's institution: CIEMAT

Name of the host institution: Cranfield University

Onsite working period: 20 / 04 / 2015 to 01 / 05 / 2015

Onsite working time (in Person week(s))*: 2

Remote working time (in Person week(s))**: 2

I. Objectives of the mobility

The main objective of this mobility project, which is framed in the WP8 Task 8.3 of STAGE-STE project, was to perform an accelerated aging test campaign with solar reflectors to simulate erosion in desert environments due to contact cleaning. The solar reflector material included in the study was ReflecTech®PLUS silvered-polymer film, glued on an aluminium sheet. The cleaning device used to simulate the real cleaning tasks during the CSP plant operation was the Cranfield's FANUC robot with nylon brush attachment. Three different types of brushes were used, with low, medium and high hardness, in order to find the proper cleaning protocol to avoid or at least minimize any damage on the surfaces. Soiling of the mirrors was introduced to take into account the real conditions. Sand/dust collected from the PSA, Sahara desert and Arizona (being this last one an artificial product) was applied to the surfaces to study the influence on the erosion produced by the contact cleaning. Samples without any soiling on the surface were also studied. Cleaning tests also assessed the behaviour of the reflector samples when demineralized water was applied. Therefore, 24 reflector samples were submitted to the testing, to cover 3 brushes, 4 soiling states and 2 water condition (with and without water). Optical measurements of specular and hemispherical reflectance were taken before and after the tests to assess the durability of the reflector samples under the contact cleaning tasks.

II. Main achievements and difficulties encountered

The objective proposed for the mobility project was successfully covered. In particular, the accelerated aging test campaign to simulate erosion due to contact cleaning was accomplished, achieving the following interesting conclusions:

- Marks (mainly scratches) on the sample surfaces were detected after the cleaning tests. The amount and severity of these marks were higher as the brush hardness increase. Reflectance loss was also more significant when harder brush was employed.
- More damage was suffered by the samples when the test was performed without adding water.
- Differences in the reflectance degradation were not significant depending on the kind of sand deposited on the reflector surfaces.

Although some difficulties were encountered during the tests, they were properly solved. Particularly:

- Brushes received could not be installed directly on the robot. So, the brush holders were adapted.
- Reflector surface presents a very hydrophilic behavior, involving an important challenge when the sand was deposited. After several tests, the required amount of water, sand and drying time was achieved.
- The cleaning robot did not incorporate a wetting system. To apply the water during the tests, a water system was successfully installed.

III. Joint publications foreseen

It is expected that the results achieved during this mobility project are presented in an International Conference. An abstract with the summary of them has already been uploaded, with the following data:
Conference: Concentrating Solar Power and Chemical Energy Systems, SolarPACES
Title: "Contact cleaning of polymer film solar reflectors"
Authors: Christopher Sansom (Cranfield University), Aránzazu Fernández-García (CIEMAT), and Florian Sutter (DLR)
Date: October, 13-16, 2015
Place: Cape Town (South Africa)

IV. Comments, if any

Please do not exceed 10 to 15 lines

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Materials for thermal storage

Participant's first name and family name: Rocío Bayón

Name of the participant's institution: Ciemat

Name of the host institution: Tecnalia

Onsite working period: 01/ 06 / 2015 to 03 / 06 / 2015

Onsite working time (in Person week(s))*: 0.6

Remote working time (in Person week(s))**: 0.4

I. Objectives of the mobility

Share the capabilities and necessities in terms of the materials for storage research lines of both Tecnalia and Ciemat, in order to see and look for possibilities of collaboration in close future under other than STAGE-STE funding schemes.

II. Main achievements and difficulties encountered

During the visit, Tecnalia offered some of their equipment for characterizing materials and Ciemat got the advantage to perform characterizations of some PCMs already under study. Three different kinds of measurements were carried out: Differential Scanning Calorimetry (DSC),Thermogravimetric Analyisis (TGA) and dynamic viscosity.

III. Joint publications foreseen

In all the publications where the measurements performed during this visit will be used.

IV. Comments, if any

Tecnalia staff was very generous and made its best to help us for doing the measurements we required, even involving other Tecnalia Units not so close to CSP or to the Energy Division, which is the one involved directly in STAGE-STE project.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

Individual activity report

Each participant of the mission have to fill in this document personally.
Please upload it following the mail in which this document was attached.

Title of the mission: Durability protocol to qualify innovative materials for solar chemical reactors

Group Leader first name and family name: Alfonso Vidal

Participant's first name and family name: Inmaculada Cañadas

Name of participant's institute: CIEMAT-PSA

Name of the home institute: LNEG

Working stay period: 09/11/15-13/11/15

Individual person-day: 5 days

I. Objectives of the project *(Please do not exceed 10 to 15 lines)*

Define a durability protocol to qualify innovative materials for solar chemical reactors in the frame of the Task 9.3 of STAGE-STE. The work plan included a visit to LNEG facilities, IST Lisboa facilities, meetings and discussion towards a proposal of an experimental work plan to evaluate novel ceria-based materials being developed at LNEG to be tested at PSA in future.
The person in charge of the visit at LNEG was Dr. Fernando Oliveira.

II. Main achievements and difficulties encountered *(Please do not exceed 1 page)*

Achievements : Steps to define a durability protocol to qualify innovative materials for solar chemical reactors in the frame of the Task 9.3 of STAGE-STE.
Difficulties : we need more information about previous tests and analysis methods developed and used in other solar research centers.

III. Personal contribution for the mission *(Please do not exceed 10 to 15 lines)*

Personal expertise about materials testing using concentrated solar energy, solar ageing tests, and solar reactors design and test..
Participation on meetings and discussions about a durability test methodology draft proposal based on available expertise in conventional ageing tests of porous gas burners (by LNEG) as well as materials ageing tests using concentrated solar energy, and materials for solar reactors (by CIEMAT).

IV. Joint publications foreseen *(Please do not exceed 10 to 15 lines)*

A draft proposal of durability test methodology to qualify materials for next generation solar thermochemical reactors developed by LNEG and CIEMAT has been presented in the 3rd Technical Meeting of STAGE-STE WP9 celebrated in Tabernas (Spain). November 26-27, 2015.

A proposal of durability test methodology to qualify materials for next generation solar thermochemical reactors will be prepared by LNEG and CIEMAT to be presented to CNRS and distributed to all task 9.3 partners.

V. Comments, if any *(Please do not exceed 1 page)*

The work plan included :

- A meeting with the director of Solar Energy Division, Joao Farinha Mendes,
- a visit to LNEG facilities,
- a meeting with Paula Costa, responsible of STAGE-STE task 9.1
- a visit to IST Lisboa facilities (incluiding different materials and characterization labs),
- and a visit to a Portuguese industry interested on concentrated solar energy, SECIL.

Individual activity report

Each participant of the mission have to fill in this document personally.
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Title of the mission: Joint preparation with LNEG of a durability protocol to qualify innovative materials for solar chemical reactors

Group Leader first name and family name: Alfonso Vidal

Participant's first name and family name: Jose Rodriguez

Name of participant's institute: CIEMAT-PSA

Name of the home institute: LNEG

Working stay period: 9/11/2015-13/11/2015

Individual person-day: 5

I. Objectives of the project *(Please do not exceed 10 to 15 lines)*

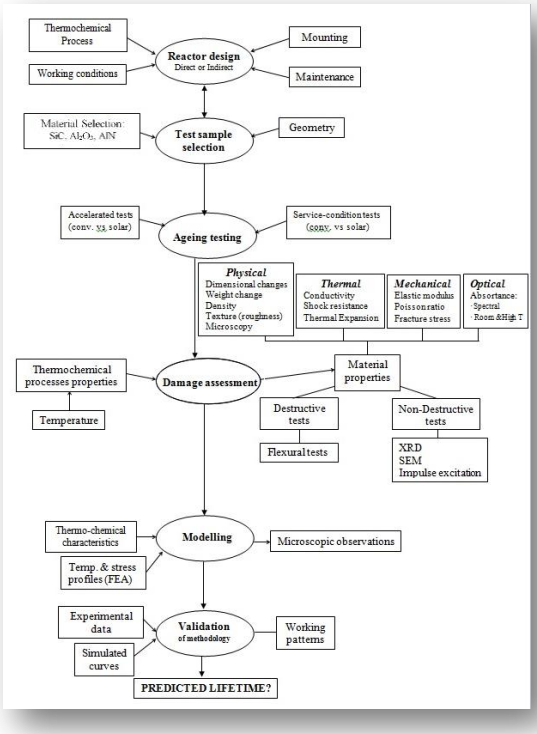
To define a durability protocol to qualify innovative materials for solar chemical reactors in the framework of the Task 9.3 of STAGE-STE. The work plan will include a visit to LNEG and IST Lisboa facilities, discussions towards a proposal of an experimental work plan to evaluate novel ceria-based materials being developed at LNEG to be tested at PSA.

II. Main achievements and difficulties encountered *(Please do not exceed 1 page)*

A draft protocol to qualify innovative materials for next generation solar chemical reactors has been prepared

III. Personal contribution for the mission *(Please do not exceed 10 to 15 lines)*

Joint preparation of a draft protocol in collaboration with colleagues from LNEG and IST:



IV. Joint publications foreseen *(Please do not exceed 10 to 15 lines)*

A report on durability protocol to qualify innovative materials for solar chemical reactors is in preparation, and will be presented in the 4th STAGE-STE WP9 Technical Meeting

V. Comments, if any *(Please do not exceed 1 page)*

The work plan included :

- A meeting with the director of Solar Energy Division, Joao Farinha Mendes,
- a visit to LNEG facilities,
- a meeting with Paula Costa, responsible of STAGE-STE task 9.1
- a visit to IST Lisboa facilities (incluiding different materials and characterization labs),
- and a visit to a Portuguese industry interested on concentrated solar energy, SECIL.

STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Thermal Storage

Participant's first name and family name: Rocío Bayón

Name of the participant's institution: CIEMAT

Name of the host institution: CEA

Onsite working period: 03 / 11 / 2015 to 06 / 11 / 2015

Onsite working time (in Person week(s))*: 0.8

Remote working time (in Person week(s))**: 0.2

I. Objectives of the mobility

The main objective of this mobility was to explore de possibility of stablishing collaborations related to thermocline storage systems together with the exchange of both information and experiences on this topic. Another objective we to share the capabilities and priority research lines on other thermal storage activities in order to see and look for possibilities of collaboration in close future under funding schemes other than STAGE-STE framework.

II. Main achievements and difficulties encountered

During this visit it was agreed that I would make a stay of 3 weeks in 2016 at CEA labs for performing some tests in its STONE facility, in order to study and better understand the development of the temperature distribution curve at the beginning of any charging/discharging process of a thermocline tank.
Awareness of the other partner's capabilities has been also raised.

III. Joint publications foreseen

A joint publication is likely to be done with the results of the thermoclines tests

IV. Comments, if any

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STAGE-STE
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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Innovative materials for next generation solar chemical reactors

Participant's first name and family name: ALFONSO VIDAL DELGADO

Name of the participant's institution: CIEMAT

Name of the host institution: CNRS

Onsite working period: 27 / 06 / 2016 to 01 / 07 / 2016

Onsite working time (in Person week(s))*: 1person-week

Remote working time (in Person week(s))**: 1person-week

I. Objectives of the mobility

Durability protocol to qualify innovative materials for solar chemical reactors

II. Main achievements and difficulties encountered

Discussions to define durability protocol to qualify innovative materials for solar chemical reactors in the frame of the Task 9.3 of STAGE-STE. The work plan during the stage included a visit to CNRS facilities, in particular at the REHPTS reactor and participation on some scheduled tests. Furthermore, a draft has been prepared regarding M38 "Qualify solar receiver reactor materials for use under severe operating conditions_revised" and some meetings were held to discuss the structure of this report. The person in charge of the visit at CNRS will be Dr. Ludovic Charpentier.

III. Joint publications foreseen

A collaboration has been established throughout the Task 9.3 within CNRS, LNEG and CIEMAT. Round robin test with some materials: SiC reinforcedand CeO2 materials have been planned between different Institutions. CIEMAT will be carried out of some cycling oxidation tests with Steam in the laboratories in Madrid. A potential publication is foressen.

IV. Comments, if any

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Optical and thermal performance of PTC by dynamic testing

Participant's first name and family name: Loreto Valenzuela

Name of the participant's institution: CIEMAT

Name of the host institution: CENER

Onsite working period: 25 / 04 / 2016 to 29 / 04 / 2016

Onsite working time (in Person week(s))*: 1

Remote working time (in Person week(s))**: 2

I. Objectives of the mobility

Within the WP11 of the STAGE-STE project, it is planned to work on methodologies for measuring the optical and thermal performance of line-focusing STE collectors, both small-sized collectors for industrial process heat applications (subtask 11.1.1), and large solar collectors (parabolic-troughs and linear Fresnel collectors) (subtask 11.2.1) installed in commercial power plants. CIEMAT and CENER are collaborating in this topic. Specific tests campaigns have been performed in a solar collector installed at the Plataforma Solar de Almería. The join collaboration started in 2015 with the visit of CENER staff at PSA.Besides, the development of devices and methodologies to perform on-site inspection of solar components (receiver tubes, mirrors, sun-tracking systems) is also carried out in subtask 11.2.2, and CENER and CIEMAT are also exchanging knowledge and collaborating in this topic.Finally, within the WP8 – subtask 8.2.4, it has been realized a round-robin of heat losses and optical parameters measurement in receiver tubes. CENER and CIEMAT are participating in this round-robin.

II. Main achievements and difficulties encountered

During the 1-week stay, 1 day and a half was devoted to discuss the experimental results of the test campaign performed at the PSA in the HTF test loop. This test campaign had the objective of collect data following different testing methods approaches (ISO 9806, IEC NIP 62862-3-2), which are now under discussion in national and international standardization committees working on concentrating solar thermal energy systems. A detailed study and analyses of the experimental data collected are being carried out. Results will be published in a journal article. During the stay, different visits to the several CENER's laboratories, where qualification of solar components (solar collectors, solar mirrors, and receiver tubes) is carried out, have been also performed and discussions with the CENER technical staff have been done about the testing methods, details on the equipment, post-processing of experimental data, etc. In particular, it has been discussed incidences detected during the round robin test of receiver tubes and how the protocol of testing should be improved. This activity has been done in the framework of subtask 8.2.4 of the project, where both institutions are also participating. Finally, the exchange of knowledge on simulation tools used by both institutions to study different aspects of line-focusing STE systems has been done. The parabolic-trough collector tested at PSA is being simulated by means of the ray-tracing code Tonatiuh to compare simulation results and experimental results collected at the PSA during the test campaign performed in a EuroTrough-type collector. The simulated and measured incidence angle modifier will be compared.

III. Joint publications foreseen

1. F. Sallaberry, L. Valenzuela, L. Gómez, A. García de Jalón, J. León. Towards standardization of on-site parabolic trough collector testing in solar thermal power plants. To be submitted to Solar Energy, June 2016.
2. F. Sallaberry, L. Valenzuela, L. Gómez, J. León, S. Fischer, A. Bohern. Harmonization of Standards for Parabolic Trough Collector Testing in Solar Thermal Power Plants. Submitted to 22nd SolarPACES Conference, October 11-14, 2016, Abu Dhabi, UAE.
3. J. Pernpeintner, B. Schiricke, F. Sallaberry, A. García de Jalón, R. López-Martín, L. Valenzuela, A. de Luca. Results of the parabolic trough receiver heat loss round robin test 2015/2016. Submitted to 22nd SolarPACES Conference, October 11-14, 2016, Abu Dhabi, UAE.

IV. Comments, if any

The remote working period is 2 weeks because previous to the stay at CENER, we have been running experiments at the Plataforma Solar de Almería. The experimental data were analyzed in collaboration with CENER and during the stay, we were working in the final evaluation to prepare the joint publications.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Molten Salt test facility for Thermal Storage

Participant's first name and family name: Margarita Rodríguez-García

Name of the participant's institution: Ciemat

Name of the host institution: FISE

Onsite working period: 05 / 09 / 2016 to 09 / 09 / 2016

Onsite working time (in Person week(s))*: 1PW

Remote working time (in Person week(s))**: 0.2

I. Objectives of the mobility

Discussing and sharing about the respective know how on molten salt test facilities and how to get as much advantage as possible for the scientific community. Maybe some operational tests will be performed during the visit

II. Main achievements and difficulties encountered

The operation experience exchange has taken place through an information exchange regarding the main operation problems. The facility was prepared to operate since first day. During the first day operation a leakage occurred that delayed the tests start-up during the second day. A short test could only be performed during this second day. The third day the test was performed without major problems.

Valuable knowledge exchange regarding all operational aspects and difficulties met during construction and start-up.

III. Joint publications foreseen

A joint conference paper is foreseen from the comparison results.

IV. Comments, if any

Please do not exceed 10 to 15 lines

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Test campaign at HTMS thermocline tank

Participant's first name and family name: Rocio BAYON

Name of the participant's institution: CIEMAT-PSA

Name of the host institution: FISE

Onsite working period: 06 / 09 / 2017 to 20 / 09 / 2017

Onsite working time (in Person week(s))*: 2.2

Remote working time (in Person week(s))**: 1.0

I. Objectives of the mobility

The objective of this mobility was to perform a test campaign in order to obtain experimental data for properly validating a model previously developed by CIEMAT for predicting thermocline tanks behavior. The tests should consist in charge processes at different operating velocities and temperature ranges. This staff exchange was also expected to improve the collaboration between both institutions in terms of thermal storage activities.

II. Main achievements and difficulties encountered

During the mobility period it has been possible to perform up to 9 charge tests under different experimental conditions of fluid velocities and temperature ranges. Having worked directly with the technical operator, the participant has been able to realize and understand all issues associated to an experimental installation such as a storage prototype with molten salts. Moreover it has been also possible for the participant to discuss with FISE experts in thermal storage about different subjects not only related with thermocline tanks and their simulation but also related to other kind of storage options and materials.

III. Joint publications foreseen

One conference contribution or/and a joint paper in the mid-term future

IV. Comments, if any

The participant would like to acknowledge the whole FISE team, especially Dr. Tom Fluri, Ralf Müller and Martin Karl, for the warm welcome and all the help provided during the mobility period.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Study on resistance to oxidation of ceramic refractory materials

Participant's first name and family name: Laura Silvestroni

Name of the participant's institution: CNR, Italy

Name of the host institution: CNRS, France

Onsite working period: 19 / 01 / 2015 to 23 / 01 / 2015

Onsite working time (in Person week(s))*: 1.0

Remote working time (in Person week(s))**: 2.0

I. Objectives of the mobility

- Discussion on current activities concerning oxidation tests in solar furnace of refractory ceramics, such as ZrC and HfC at various temperatures between 1800 and 2000 K and planning of future tests.
- Selection of best materials for further analysis;
- Planning of additional analytical tests in CNRS, such as XPS.
- Planning of further microstructural analyses in CNR, such as SEM of the cross sections of the oxidized samples.

II. Main achievements and difficulties encountered

- Analysis of data concerning the oxidation of HfC- and ZrC-based materials in oxidative environment in the temperature range 1400-2200K. Summary of the results obtained by video capture during oxidation, XRD and SEM images of the surfaces.
- Selection of best materials: the effect of the sintering additive is of paramount importance during oxidation, for example HfC containing 10 vol% of different silicides ($MoSi_2$, $TaSi_2$ or $ZrSi_2$) gave notably different results. Samples containing $MoSi_2$ were strongly damaged by the oxidation and the samples did not survive the test at any temperature. On the contrary, the addition of $TaSi_2$ or $ZrSi_2$ enabled to endure the oxidation at 2200 K. Further investigations are needed to understand the oxidation mechanisms as a function of the temperature range and additive. Analysis by SEM at CNR and XPS at CNRS will be fundamental in disclosing the main microstructural modifications.
- Definition of further materials to be produced by CNR: HfC + $TaSi_2$ or $ZrSi_2$ to be tested at different temperatures and different atmospheres while monitoring the emissivity.

III. Joint publications foreseen

- "Effect of the sintering additive on the oxidation behavior of HfC for solar applications".
- "Oxidation behavior of ZrC-SiC composites for application as solar absorbers".

IV. Comments, if any

During the stage, it has been suggested to submit a joint proposal between CNR-ISTEC and CNRS-PROMES in the frame of the "Project International de Coopération Scientifique (PICS)". The program has duration of 3 years and has the scope to consolidate already existing collaborations.
The project will be focused on the effect of different dopants in form of particles or fibers to ZrC matrices which emerged as the best material for solar applications.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: **Solar Thermionic-Thermoelectric Energy Generator**

Participant's first name and family name: **Daniele M. Trucchi**

Name of the participant's institution: **Consiglio Nazionale delle Ricerche (CNR)**

Name of the host institution: **Solar Technology Laboratory of Paul Scherrer Institute (CH)**

Onsite working period: **07/06/2017 to 14/06/2017**

Onsite working time (in Person week(s))*: **1.2**

Remote working time (in Person week(s))**: **3.0**

I. Objectives of the mobility

The objectives of the mobility consisted of an experimental activity performed at the High-Flux Solar Simulator (HFFS) of PSI and aimed at the characterization of high-temperature absorbers and materials, and of the thermionic-thermoelectric generator developed for concentrated solar energy conversion. The Solar Thermionic-Thermoelectric prototype (ST^2G), encapsulated in a specifically developed ultra-high vacuum (UHV) chamber, has been tested for evaluating its performance in terms of conversion efficiency and operational reliability. The solar receiver is an ultra-refractory ceramic material which was surface-textured with fs-laser, characterized by a solar absorptance higher than 95%. On the other receiver side, a thin film of polycrystalline diamond was deposited to exploit its low work function (2.0 eV). A commercial thermoelectric module was installed in the prototype for the thermal-to-electric conversion of the residual thermal energy coming from the thermionic stage: the difference of temperature between the hot thermionic anode and a copper water-cooled plate is the key for the energy conversion. The use of the HFFS tools allowed a fine control of the radiation input power, that is essential to verify the operating conditions of ST^2G as well as to understand the technology potential and the possible present limitations.

II. Main achievements and difficulties encountered

The experimental activity permitted to acquire a significant amount of data to process as well as to reach conditions able to stress the ST^2G technology so to overcome the issues in the near future. Thermionic current-to-voltage characteristics and thermoelectric open-circuit voltage and short-circuit current were collected at different receiver temperatures (from 350 to 750 °C), obtained by different levels of radiation (from 20 to 500 suns over a 10 cm^2 area). The electro-mechanical shutter available at HFFS allowed us the achievement of very stable steady-state conditions for all the measurements.

Positive results achieved:

- High stability of the engineered ceramic receiver under operating conditions, up to the highest radiation fluxes.
- Several thermionic characteristics allow us to extract a lot of information about the device operational behavior and performance.
- Thermoelectric stage output power under operating conditions overlapped the best behavior declared by the producer.

The main issues encountered:

- Slowness to achieve UHV conditions at the highest radiation flux. It means that some days were necessary to obtain UHV regime due to degassing of all the components of ST^2G. A bake-out process will be carried out before the next experiment to avoid waiting a long time before the starting of the measurements.
- Misalignment of the 100 μm-thickness thermionic inter-electrode dielectric spacer during the experiment.
- Maximum operating temperature for the thermoelectric module (250 °C) was found too low for working at the highest radiation flux with the available coolant flowrate. The commercial thermoelectric module has to be removed and substituted during the experiment.
- Over-heating of the viton vacuum sealing, that slowly melted at the highest radiation fluxes and absorber temperatures (>700 °C). For the next experiment, a metallic seal will be considered.

III. Joint publications foreseen

One or two papers will be submitted after a careful data processing.

IV. Comments, if any

The activity at HFFS will be carried in a second stage in November 2017. The encountered difficulties are being overcome by working on the prototype technology and some scientific improvements are resulting by the collected data analysis.

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: **Solar Thermionic-Thermoelectric Energy Generator / 2nd Stage**

Participant's first name and family name: **Daniele M. Trucchi**

Name of the participant's institution: **Consiglio Nazionale delle Ricerche (CNR)**

Name of the host institution: **Solar Technology Laboratory of Paul Scherrer Institute (CH)**

Onsite working period: **01/11/2017 to 11/11/2017**

Onsite working time (in Person week(s))*: **1.6**

Remote working time (in Person week(s))**: **3.0**

I. Objectives of the mobility

The main challenge for the ST2G technology involves the development of innovative materials and coatings for high performance thermionic conversion at high but practical temperatures (<1000 °C) that can be achieved with a point-focus solar concentrator. A proof-of-concept of ST^{2}G has been designed, fabricated, and tested under concentrated solar radiation in the previous FP7-Energy collaborative project E^{2}PHEST^{2}US (Grant Agreement n. 241270), to demonstrate feasibility, limitations, and potential of the proposed technology.

Here we provided an improved version of the ST^{2}G prototype, with technological evolutions applied to the materials involved in the thermionic stage, to the other prototype components, and to the vacuum enclosure technology. The main aim was demonstrating an enhancement of the electron emission performance as a function of the radiation flux, inducing increasing operating temperatures. The other objectives are connected to the reliability testing of components at operating temperatures, and application of different dielectric spacers ranging from the macroscale down to the microscale, in order to quantify the effect of space charge on the device performance. On the other hand, the experiments provided important and clear indications about possible present bottlenecks of the technology.

II. Main achievements and difficulties encountered

The research activity was carried out in two stays, in June and in November 2017. During the first stay, clear indications in the behaviour of active materials composing the thermionic electrodes were found up to moderate temperatures (<700 °C). During the first stay, difficulties in maintaining the operating vacuum conditions at the high radiation flux caused, at the highest temperatures (750-800 °C), a significant leakage and even breakage of the vacuum. However, an improved solution applied in the second stay, consisiting of copper gasket instead of viton vacuum sealing, allowed us to overcome these problems. Vacuum levels as low as 10^{-8} - 10^{-7} mbar were obtained during all the operations as well as rapid achievements of the vacuum conditions by the explotation of a new geometry for the prototype converter (Fig.s 1a and 1b).

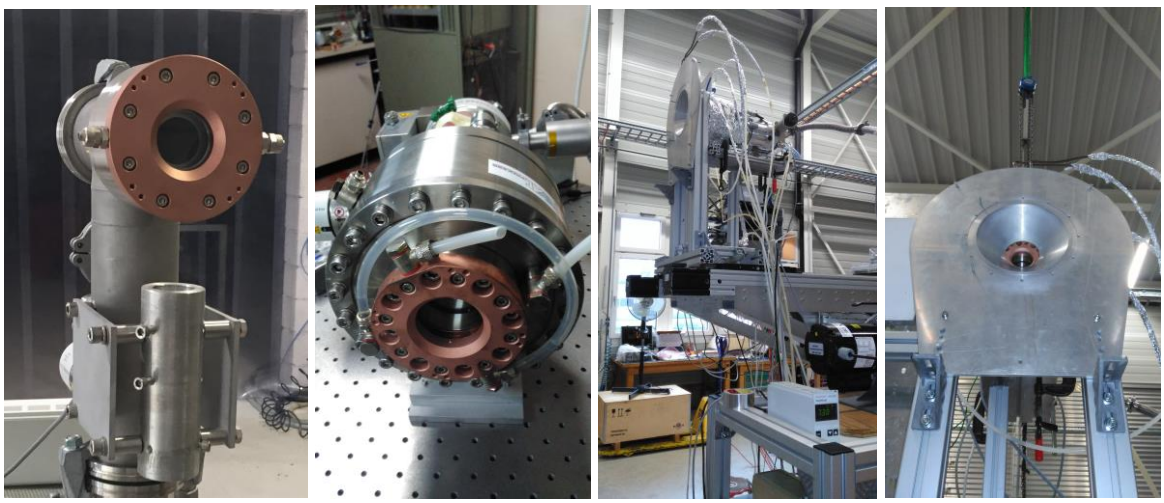

Fig. 1: Evolution in the prototypes tested a) during the first stay in June and b) during the second one in November 2017; c) and d) show the ST²G prototype installed for operations during the send stay.

The prototype used in November 2017, shown in Fig.s 1c and 1d once installed for operations at PSI HFSS, was able also to maximize the thermal flow in terms of heat removal from the thermionic collector (i.e. anode). This occurrence improved both the thermal and electrical behavior of the thermionic and thermoelectric stages. The electrode active materials operated well enough, even though a new recipe for the CVD diamond composing the thermionic emitter was expected to furnish far higher emission currents. Besides, the anode coating provided a good stability and a low work function, especially during the second stay, where heat removal from it was performed with a more efficient geometry.

Three different dielectric bulky spacers were used (100, 300, and 1000 μm gap between the electrodes) to verify the influence of space charge effects. Unfortunately, the dielectric microspacers (1.5 μm gap between the electrodes) prepared on different tested anodic components did not ensure the desired electric insulation. This limited the impact of the device performance, since dielectric microspacers, if properly working, are connected to the almost complete reduction of space charge. In any case, the technology will be further optimized and its application feasibility will be verified in the near future.

An important finding was the possibility to obtain suitable operating temperatures of 750 °C with a low level of irradiation (150 average suns impinging on the absorber): it means that the nanotextured absorber is extremely efficient in capturing sunlight and the components are well designed and fabricated to manage the input thermal flux without energy losses.

III. Joint publications foreseen

The work performed within SFERA 2 at HFFS of PSI was fundamental to determine possible improvements and present bottlenecks of the ST^{2}G technology. The material's challenge is deeply focused on the engineering of the both electrodes' work function, which is a fundamental step to make the technology definitively applicable and competitive on the CSP market.

SFERA 2 project permitted to emphasize once more the importance of the absorber: the surface texturing of ultra-high temperature carbide ceramic plays the key-role for obtaining a selective solar absorber, able to efficiently feed the thermionic emitters minimizing thermal losses.

The other components were submitted to severe thermal testing, and no mechanical damage or break was registered for the prototype tested during the second stay.

Moreover, we obtained relevant results on the combined thermionic-thermoelectric converter under operating conditions: a detailed analysis of the data collected by changing some components within the converter during the experiments (different inter-electrode spacing, collector material, emitting layer) will allow publishing one or two scientific papers on the physical mechanisms controlling the energy conversion and on the overall technology.

IV. Comments, if any

HFFS of PSI demonstrated itself as a very useful facility for achieving reproducible experiments and results. The stable conditions of the impinging radiation flux, the availability of equipment provided by all the necessary options, combined to an extremely professional staff able to resolve any kind of problem, allowed us performing technically perfect experiments and achieving important results to be analyzed in the near future.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: **Solar Thermionic-Thermoelectric Energy Generator**

Participant's first name and family name: **Alessandro Bellucci and Daniele M. Trucchi**

Name of the participant's institution: **Consiglio Nazionale delle Ricerche (CNR)**

Name of the host institution: **Solar Technology Laboratory of Paul Scherrer Institute (CH)**

Onsite working period: **07/06/2017 to 14/06/2017**

Onsite working time (in Person week(s))*: **1.2**

Remote working time (in Person week(s))**: **3.0**

I. Objectives of the mobility

The objectives of the mobility consisted of an experimental activity performed at the High-Flux Solar Simulator (HFFS) of PSI and aimed at the characterization of high-temperature absorbers and materials, and of the thermionic-thermoelectric generator developed for concentrated solar energy conversion. The Solar Thermionic-Thermoelectric prototype (ST^2G), encapsulated in a specifically developed ultra-high vacuum (UHV) chamber, has been tested for evaluating its performance in terms of conversion efficiency and operational reliability. The solar receiver is an ultra-refractory ceramic material which was surface-textured with fs-laser, characterized by a solar absorptance higher than 95%. On the other receiver side, a thin film of polycrystalline diamond was deposited to exploit its low work function (2.0 eV). A commercial thermoelectric module was installed in the prototype for the thermal-to-electric conversion of the residual thermal energy coming from the thermionic stage: the difference of temperature between the hot thermionic anode and a copper water-cooled plate is the key for the energy conversion. The use of the HFFS tools allowed a fine control of the radiation input power, that is essential to verify the operating conditions of ST^2G as well as to understand the technology potential and the possible present limitations.

II. Main achievements and difficulties encountered

The experimental activity permitted to acquire a significant amount of data to process as well as to reach conditions able to stress the ST^2G technology so to overcome the issues in the near future. Thermionic current-to-voltage characteristics and thermoelectric open-circuit voltage and short-circuit current were collected at different receiver temperatures (from 350 to 750 °C), obtained by different levels of radiation (from 20 to 500 suns over a 10 cm^2 area). The electro-mechanical shutter available at HFFS allowed us the achievement of very stable steady-state conditions for all the measurements.

Positive results achieved:

- High stability of the engineered ceramic receiver under operating conditions, up to the highest radiation fluxes.
- Several thermionic characteristics allow us to extract a lot of information about the device operational behavior and performance.
- Thermoelectric stage output power under operating conditions overlapped the best behavior declared by the producer.

The main issues encountered:

- Slowness to achieve UHV conditions at the highest radiation flux. It means that some days were necessary to obtain UHV regime due to degassing of all the components of ST^2G. A bake-out process will be carried out before the next experiment to avoid waiting a long time before the starting of the measurements.
- Misalignment of the 100 μm-thickness thermionic inter-electrode dielectric spacer during the experiment.
- Maximum operating temperature for the thermoelectric module (250 °C) was found too low for working at the highest radiation flux with the available coolant flowrate. The commercial thermoelectric module has to be removed and substituted during the experiment.
- Over-heating of the viton vacuum sealing, that slowly melted at the highest radiation fluxes and absorber temperatures (>700 °C). For the next experiment, a metallic seal will be considered.

III. Joint publications foreseen

One or two papers will be submitted after a careful data processing.

IV. Comments, if any

The activity at HFFS will be carried in a second stage in November 2017. The encountered difficulties are being overcome by working on the prototype technology and some scientific improvements are resulting by the collected data analysis.

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: **Solar Thermionic-Thermoelectric Energy Generator / 2nd Stage**

Participant's first name and family name: **Alessandro Bellucci**

Name of the participant's institution: **Consiglio Nazionale delle Ricerche (CNR)**

Name of the host institution: **Solar Technology Laboratory of Paul Scherrer Institute (CH)**

Onsite working period: **01/11/2017 to 11/11/2017**

Onsite working time (in Person week(s))*: **1.6**

Remote working time (in Person week(s))**: **3.0**

I. Objectives of the mobility

The main challenge for the ST2G technology involves the development of innovative materials and coatings for high performance thermionic conversion at high but practical temperatures (<1000 °C) that can be achieved with a point-focus solar concentrator. A proof-of-concept of ST^{2}G has been designed, fabricated, and tested under concentrated solar radiation in the previous FP7-Energy collaborative project E^{2}PHEST^{2}US (Grant Agreement n. 241270), to demonstrate feasibility, limitations, and potential of the proposed technology.

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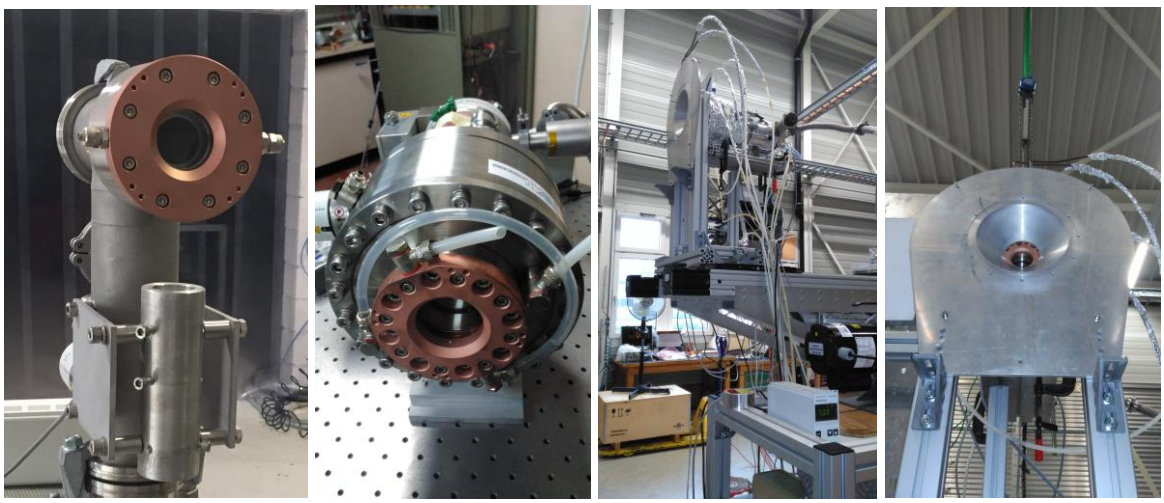

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III. Joint publications foreseen

The work performed within SFERA2 at HFFS of PSI was fundamental to determine possible improvements and present bottlenecks of the ST^{2}G technology. The material's challenge is deeply focused on the engineering of the both electrodes' work function, which is a fundamental step to make the technology definitively applicable and competitive on the CSP market.

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IV. Comments, if any

HFFS of PSI demonstrated itself as a very useful facility for achieving reproducible experiments and results. The stable conditions of the impinging radiation flux, the availability of equipment provided by all the necessary options, combined to an extremely professional staff able to resolve any kind of problem, allowed us performing technically perfect experiments and achieving important results to be analyzed in the near future.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Development of new high temperature volumetric solar receivers

Participant's first name and family name: Cyril Caliot

Name of the participant's institution: CNRS

Name of the host institution: IMDEA Energy Institute

Onsite working period: 17 / 06 / 2015 to 19 / 06 / 2015

Onsite working time (in Person week(s))*: 0.6

Remote working time (in Person week(s))**: 0.4

I. Objectives of the mobility

The objective of the mobility was to exchange knowledge about our research activities in high temperature volumetric solar receivers which include the modelling and the experimental works. The discussion following the presentation was used to define a common research project.

II. Main achievements and difficulties encountered

The main achievements were threefold: 1) thorough scientific discussion and exchange of idea, 2) establishment of guidelines for future collaboration (starting a scientific common research project) and 3) dissemination of scientific knowledge in the concentrated solar energy field to a wide audience at the conference room of IMDEA (presentation of C. Caliot)

III. Joint publications foreseen

The scientific project outlined during the mobility includes two publishing topics: 1) a comparison of the test setups developed by both institutions and 2) the development and experimental validation of a new model of heat transfer in a high temperature solar volumetric receiver. These topics are expected to lead to about 3 articles in international peer-reviewed journals and 3 international conference articles and communications.

IV. Comments, if any

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: UHTC elaboration and characterization

Participant's first name and family name: Ludovic Charpentier

Name of the participant's institution: PROMES (CNRS)

Name of the host institution: ISTEC (CNR)

Onsite working period: 16 / 03 / 2015 to 20 / 03 / 2015

Onsite working time (in Person week(s))*: 1

Remote working time (in Person week(s))**: 2

I. Objectives of the mobility

The mobility aims at enforcing the collaboration between laboratory PROMES-CNRS (France) and ISTEC-CNR (Italy). ISTEC uses its sintering facilities to prepare Ultra-Hig Temperature Ceramics Materials, PROMES uses its solar facilities to characterize the performance of such materials submitted to extreme conditions (2000 - 2200 K in air). PROMES facilities are unique, enabling to heat ceramic materials with rate around 50 $K.s^{-1}$.
Ludovic Charpentier (LC), French young scientist at PROMES-CNRS, used the mobility program to visit ISTEC-CNR, and to discover the sintering equipment and the analysis tools (SEM/EDS, XRD) of the Italian partner. Both laboratories aim at improving their collaboration, applying to get some financial support from the PICS program (http://www.cnrs.fr/derci/spip.php?article51) in order to improve the collaboration between the elaborations and experimentations on ceramics.

II. Main achievements and difficulties encountered

The visit of the ISTEC laboratory enabled LC to discover the important equipment ISTEC-CNR is disposing, such as hot-pressing and pressureless sintering, resistive furnaces, mechanical tests (isostatic compression, flexural tests, high temperature compression…), and several characterization tools (SEM/EDS, XRD for powders and massive samples, optical roughness measurement, wettability…), including some equipments from groups not related to his specialization (such as biomaterial analysis). LC performed with the help of Laura Silvestroni some EDS characterization of the UHTC samples (HfC + $TaSi_2$ – HCT – or $ZrSi_2$ – HCZ – additives) that were prepared at ISTEC, then oxidized in air at 2000 and 2200 K at PROMES. Some mixed oxide phases were identified (such as oxicarbides and mixed Hf-Zr-oxides), enabling to understand the role of the additive on the oxidation mechanisms. Main difficulty is that the sintering of new materials could not be achieved during the mission; these will be delivered to PROMES afterwards.
LC also attended two meetings:

- One at ISTEC-CNR with Diletta Sciti and Laura Silvestroni on March, 17 10:30: evaluating the current collaboration and further advancement. Alida Bellosi, director of ISTEC, is also willing the collaboration to be continued.
- One at ENEA with Claudio Mingazzini and Giuseppe Magnani, studying further collaboration in te frame of H2020 project, one being redacted with Antonio Rinaldi (ENEA Rome) in the NMP16 frame.

III. Joint publications foreseen

New samples of HCT and HCZ will be oxidized at 1800 K inside PROMES laboratory, and characterized in return at ISTEC. We expect to submit a joint publication on the oxidation mechanisms. This paper will follow the previous ones already published by LC and ISTEC:

- Microstructural characterization of ZrC-$MoSi_2$ composites oxidized in air at high temperatures, *Applied Surface Science*, vol. 283 (2013), pp. 751-758
- High temperature oxidation of Zr- and Hf-carbides: Influence of matrix and sintering additive, *Journal of the European Ceramic Society*, vol. 33 [15–16] (2013), pp. 2867-2878
- Zirconium carbide doped with tantalum silicide: Microstructure, mechanical properties and high temperature oxidation, *Materials Chemistry and Physics*, vol. 143 [1] (2013), pp. 407-415

High temperature emissivity measurement in vacuum and air are also planned at PROMES on the HCT and HCZ samples, we are also planning to publish jointly a comparative study on the influence of the oxidation on the ratio between the solar flux absorbance and infrared remission (α/ε) of one surface. The higher this ratio is, the more adequate the material is for High-Temperature solar applications.

IV. Comments, if any

This visit was fruitful and I hope this collaboration will continue so that we can keep on publishing relevant characterization of new materials, I hope we will get through European and/or bilateral call some supports to go deeper and to make this collaborative work fruitful for an industrial exploitation in the high temperature thermal exchangers (such as solar receivers).

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EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Thermochemical cycles for solar energy storage

Participant's first name and family name: Laurie André

Name of the participant's institution: PROMES-CNRS

Name of the host institution: DLR

Onsite working period: 19 / 09 / 2015 to 26 / 09 / 2015

Onsite working time (in Person week(s))*:1

Remote working time (in Person week(s))**: 1

I. Objectives of the mobility

Following the meeting for WP9 (april 2015) it was pointed out that my thesis shared a common research activity with the group of C. Sattler in DLR. As such, it was decided that I would go to DLR to present my work and work with them for one week to see what they are researching on this subject and on which subjects we might collaborate. At the end of this meeting, we would discuss if a collaboration between CNRS and DLR is possible on Thermochemical Heat Storage.

II. Main achievements and difficulties encountered

Upon my arrival at DLR, I presented my thesis work during my first year and the outlines for the next year. After this, during the week I spent a day with different researches who work on Thermochemical Heat Storage to see what in our works is different, and to see if we can collaborate on certain parts. With C. Agrafiotis, we discussed on the work done for Manganese oxide, doped, mixed, and analyzed in TGA. He presented me briefly works on other materials used for Thermochemical Heat Storage. I was then oriented to T. Block to study methods to put the material into shape and we discussed further on her previous work about doped metal oxides for Thermochemical Heat Storage. Another day I met with C. Friedemann and worked with his PhD student and master student to get used to an oxygen analyzer coupled with a TGA and its various parameters. This additional instrument proves useful when working with metal oxides to have data on the oxygen produced and stored by the material. T. Stefania showed me around to see the solar installations, where I was explained the different settings and applications by researchers working at each place. On the last day I participated in an experiment for Thermochemical Heat Storage on large scale at Jülich Solar Tower.
The main difficulty encountered is to find a project on which to have a collaboration. While both parties work on similar research, they are too similar for a collaboration to settle quickly. Nevertheless, the idea of a collaboration is not forgotten and will be discussed further in the future, as my thesis work progresses.

III. Joint publications foreseen

None at the moment.

IV. Comments, if any

DLR participates in external projects that bring them in contact with the laboratory at PROMES Odeillo in the future. This will allow us to keep contact and discuss new ideas about a collaboration on Thermochemical Heat Storage.

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EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Photogrammetry to measure the form of installed collectors

Participant's first name and family name: Peter King

Name of the participant's institution: Cranfield University

Name of the host institution: CIEMAT

Onsite working period: 31 / 07 / 2014 to 01 / 08 / 2014

Onsite working time (in Person week(s))*: 1.0

Remote working time (in Person week(s))**: 0.0

I. Objectives of the mobility

To measure the form (shape) of representative collectors in order to prepare for the assessment of solar fields using a UAV.

II. Main achievements and difficulties encountered

Photogrammetry measurements were made of a whole collector assembly unit of 12m length determining the large scale form errors present in three collector positions. The large scale form errors presented as both structural movements during tracking and static alignment errors between adjacent facets.
Close up measurements were made of four mirror facets determining the small scale form errors present in the same three collector positions. The small scale form errors presented as movement of individual facets during tracking and some static shape errors of facets. The level of static errors was consistent with high performance collectors.
Evaluation and improvements to photogrammetry technique were made to resolve issues with solar reflections, target contrast and unobtainable camera positions.

III. Joint publications foreseen

Please do not exceed 10 to 15 lines

IV. Comments, if any

Please do not exceed 10 to 15 lines

Each participant of the mobility have to fill in this document personally.
Please upload it following the instructions of the email in which this document was attached.

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Development of new algorithms for solar field optimization

Participant's first name and family name: Erminia Leonardi

Name of the participant's institution: CRS4

Name of the host institution: CENER

Onsite working period: 28 / 05 / 2017 to 3/ 06 / 2017

Onsite working time (in Person week(s))*:1

Remote working time (in Person week(s))**1:

I. Objectives of the mobility

A new algorithm has been developed for fast solar field optimization based on an original approach. An expression to find the optimal land coverage is derived which corresponds to the maximal collectable energy from the solar field. According to this expression, the solar field is discretized in a grid, and, for each grid point, an optimal land coverage is calculated. The coverage grid values are then interpolated using an adequate interpolation function. The field layout is finally built disposing the heliostats with a density as close as possible to that corresponding to the optimal coverage. Optimal coverage taking into account of ground and heliostats surface costs has been computed and their effect have been evaluated. In particular, a parametric analysis has been performed where the parameter, K, is the ratio between the ground surface and the heliostat surface costs. A series of simulations has been performed, varying K from 0 to 0.04 (where zero correspond to the case with 0 land cost and 0.04 to the case with a land cost equal to 4% of the heliostat surface cost) to calculate the yearly field efficiency and land occupancy as function of the parameter K. Results have shown that the final optimal solar fields are strongly affected from these costs, as expected, but, most importantly, they have shown that a new fast approach can be considered to perform this kind of analysis.

II. Main achievements and difficulties encountered

One of the objectives of WP12 was the improvement of solar field performances. To this aim, different existing layouts have been compared in terms of yearly field efficiency and land occupancy. Then, a new approach has been proposed for fast solar field optimization. The solar field obtained has yearly performance comparable with that corresponding to the most known field layout (DELSOL, biomimetic, MUEEN) but with a dramatic reduction of the land occupancy (about 30 %). The collaboration with CENER has been very exciting, exchange of information easy and validation activity together fairly conducted.

III. Joint publications foreseen

In our opinion, the results of this study can be published. In fact, actually, we are working at the preparation of a paper where, considering the new approach for solar field layouts generation, a parametric analysis of the yearly field efficiency and land occupancy is presented, where the parameter is the ratio between the ground surface and the heliostats surface cost.

IV. Comments, if any

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Activity related to WP7.4.1

Participant's first name and family name: Lorenzo Pisani

Name of the participant's institution: CRS4

Name of the host institution: ENEA

Onsite working period: 11 / 12 / 2016 to 17 / 12 / 2016

Onsite working time (in Person week(s))*: 1

Remote working time (in Person week(s))**: 1

I. Objectives of the mobility

The first goal of the visit is to reinforce the connection between ENEA and CRS4, by discussing possible common project in the field of thermal storage systems (TES). The second goal is to acquire the technical knowledge necessary to reach the objectives of subtask 7.4.1, by discussing with ENEA experts about the modeling of solar plants with TES.

II. Main achievements and difficulties encountered

The first goal of the visit was to reinforce the connection between ENEA and CRS4, by discussing possible common project in the field of thermal storage systems (TES).This goal was achieved with discussions with ENEA directors and, after my coming back, with CRS4 president. A general CRS4-ENEA cooperation deal is now under discussion. The second goal was to acquire the technical knowledge necessary to reach the objectives of subtask 7.4.1, by discussing with ENEA experts about the modeling of solar plants with TES. This goal was achieved with discussions with ENEA researchers about several aspects of plant modeling, concerning, in particular, the power unit and the solar receiver. It helped me to choose the more appropriate approach to deal with these plants components; the model now is complete and working.

III. Joint publications foreseen

none

IV. Comments, if any

none

Each participant of the mobility have to fill in this document personally.
Please upload it following the instructions of the email in which this document was attached.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: STAGE-STE: CyI mission to CSIRO

Participant's first name and family name: Prof. Costas N. Papanicolas

Name of the participant's institution: The Cyprus Institute

Name of the host institution: CSIRO

Onsite working period: 30/03/15 to 02/04/15

Onsite working time (in Person week(s))*: 0.8

Remote working time (in Person week(s))**: 0.6

I. Objectives of the mobility

This mission was a contribution to Subtask 6.4.1 of WP6 (Australia) and more specifically to activity A (Development of small, low-cost heliostat and field layout software). The heliostats at the Pentakomo CSP facility of the Cyprus institute were designed by CSIRO and installed in August/September 2014 under the STEP-EW project. The idea of this return visit by CyI was to sign a Memorandum of Understanding for further cooperation in this domain and to discuss the testing of the small heliostats as a contribution to STAGE subtask 12.1.2 (Development of a new concept of single facet small heliostat), as well as the further characterisation of the small heliostat field as part of STAGE subtask 12.1.5 (Efficient heliostat field layout design). This can also be seen as a mobility exercise in the context of WP4.

II. Main achievements and difficulties encountered

The main achievement of the visit was the signature of an MoU between CyI and CSIRO, a direct contribution to STAGE Key Performance Indicator (KPI) 14: "Number of Memoranda of Understanding and agreements on the joint use and development of research facilities", which is linked to WP3, as well as the discussions on proceeding with our obligations under STAGE subtasks 12.1.1 and 12.1.5. This mission report should also be integrated into STAGE MS23 (intermediate report on STAGE-STE international collaboration – due in Month 24) and STAGE D6.6 (Intermediate report on STAGE-STE international collaboration activities – due in Month 24), both of which are linked to WP6. Under the MoU, CyI and CSIRO agreed to develop activities in the following areas: Technoeconomic studies for the implementation of solar technologies in various applications; Concentrating solar power for generation of electricity, desalinated water and polygeneration; Energy storage; Testing and aging of solar system components; Innovation in heliostat design and control systems. The following activities are envisaged under the agreement: exchange of subject-related information; basic and applied research work; development, upgrade and testing of experimental and pilot facilities; joint evaluation of and expert opinions on general or specific problems; Exchange of personnel; Joint use of experimental facilities relevant to the above research at CyI and CSIRO; Joint publications; Patenting of joint innovations; Submission of joint research proposals

III. Joint publications foreseen

As stated above, joint publications are envisaged under the agreement, in one or more of the following fields: Technoeconomic studies for the implementation of solar technologies in various applications; Concentrating solar power for generation of electricity, desalinated water and polygeneration; Energy storage; Testing and aging of solar system components; Innovation in heliostat design and control systems. Most likely such publications would relate on the joint work of CyI and CSIRO on the heliostat field of the CyI Pentakomo CSP facility in Cyprus, which will be inaugurated on 3rd October 2015.

IV. Comments, if any

None

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: STAGE-STE: CyI mission to PSA

Participant's first name and family name: Elena Guillen, PhD

Name of the participant's institution: The Cyprus Institute

Name of the host institution: PSA

Onsite working period: 09/11/2015 to 27/11/2015

Onsite working time (in Person week(s))*: 3

Remote working time (in Person week(s))**: 3

I. Objectives of the mobility

This stay was a contribution to Subtask 10.1.5 (State of the art and development of innovative low temperature distillation systems) of WP10 and 10.3 (Model development and simulation of STE+D configurations). The Cyprus Institute research group EEWRC has been working on solar MED modelling since 2011 and it is part of the WP10 of the STAGE-STE project, which combines the efforts of different institutions around Europe to implement solar desalination technologies. The interest of the Cyprus Institute is to validate the models that have been already developed for MED and to develop new ones for MD. The models would be evaluated according to their ability to calculate thermal energy and power consumption together with recovery ratio as a function of mass flow, temperature, pressure and salinity. Aspects related to capital and operating costs will be also identified during the stay in order to use them within the techno-economic analysis to be performed.
The facilities at PSA include a solar powered 14-effect MED plant and several well equipped solar MD modules with test facilities and monitoring systems to develop and validate the models as well as experienced staff to assist in the experimental evaluation. The stay at PSA will provide the Cyprus Institute researchers with priceless experimental experience and operating data for the modelling validation and development. It will be also a good opportunity to discuss future collaborations between the two institutions.

II. Main achievements and difficulties encountered

Due to the absence of one of the researchers of the Cyprus Institute (Mr. Marios Georgiou) who was in charge of the MED part of the project, the objectives had to be slightly modified and only work on MD could be carried out. However, the activities done in the MD facilities allowed characterizing the membrane in different operational modes as well as their mass transfer coefficient. The use of the small MD (APRIA) and big MD system (ORYX) allowed acknowledging the differences between the operation with small membrane areas not limited by heat transfer (APRIA) and big membrane areas in which conduction and poorer flow regimes determine higher heat transfer resistances (ORYX). The characterization of the different operation modes was carried out with the exception of the DCMD mode because of structural problems in the installation. Also, the comparison between methods to calculate the mass transfer coefficient was only possible operating in AGMD mode (due to the limitations of the set-up). More experiments would be needed to complete the expected outputs. Nevertheless, enough data was collected in order to build a simple mathematical model which was the final objective of the stay which is linked to WP10, subtasks 10.1.5 and 10.3.

More specifically, the activities carried out in the different facilities are summarized below:

APRIA (small MD characterization unit): As mentioned above, the mass transfer coefficient of the MD membrane was characterized in different operational modes with the exception of the DCMD mode due to leaks in the APRIA installation. The membrane cell is optimized to work with a much thicker stack between the main plaques and unfortunately when operating in DCMD the stack thickness is greatly reduced and so the cell is prone to leak.Also, the fact that the design of the cell was such that the gaskets were pierced by the tightening bolts might help to the leaking problem. Apart from that, the mass transfer coefficients operating in PGMD and AGMD could be determined with high accuracy in the APRIA facility.A measuring problem was detected in the cold side of the APRIA system. The PT-100 installed were measuring different temperatures and having a noticeable electrical noise at low temperatures. They were hardly able to detect the temperature differences operating in AGMD mode. This caused a serious problem when trying to determine the heat transfer coefficient operating in this mode, because the temperature differences were minimal and weren't detected. Instead, it was decided to measure the heat transfer coefficient operating in DCMD mode. Although there were no leaks during these measurements, the geometry and layout of the cell didn't allow determining precisely the linear velocity reached in the flow channel (key to the calculation of the heat transfer coefficient) so an average value was adopted. It is therefore recommended to modify the MD cell in order to be able to place the spacers in an optimal position (right now, they are "floating" between the flow channel and the membrane) so the geometry of the channel is defined and the velocity can be determined accurately. It is also recommended to calibrate the PT-100 of the whole installation as well as their location (some of them weren't placed counter currently).

ORYX (big scale PGMD module coupled to a solar field of static collectors): After some technical problems that were diligently solved by the PSA fellows, the operation with the MD module and the solar field was smooth and the mass transfer coefficient of this system was measured with relative accuracy(the solar conditions are much more variable). However, it wasn't possible to operate with the second MD module (Aquastill) that was initially projected because its aero refrigerator wasn't working.
Overall, the time was too limited to complete the experimental plan intended. More coordination/feedback is advisable in terms of status of equipment, ranges, accuracy of the instrumentation is advisable in terms of status of equipment, ranges, accuracy of the instrumentation and advice on time needed depending on the experiments that are willing to be performed.

III. Joint publications foreseen

Joint publications are envisaged and already one abstract has been submitted to the EDS congress in Rome 2016. The available data on B coefficients is very scarce in MD literature. One possible publication might deal with the comparison of the different operation modes, their respective B coefficients and the comparison of the two methods to calculate them. At the same time, these experimentally calculated B coefficients can be compared to those predicted by the theory. A second publication will deal with the effect of polarization effect on the actual delta T through modelling and through experimental comparison likewise the analysis explained above. Nevertheless, due to the limited amount of time and the problems faced, more experiments will be needed. We hope that PSA is willing to complete this interesting study.

IV. Comments, if any

None

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: STAGE STE ENEA visit to Tecnalia Facilities

Participant's first name and family name: Elisabetta Veca

Name of the participant's institution: ENEA (Italy)

Name of the host institution: Tecnalia (Spain)

Onsite working period: 06 / 02 / 2017 to 10 / 02 / 2017

Onsite working time (in Person week(s))*: 1

Remote working time (in Person week(s))**: 0

I. Objectives of the mobility

The purpose of our visit to Tecnalia was to exchange informations among the partners about each one's expertise, focusing more in detail on the issue of Thermal Energy Storage.

II. Main achievements and difficulties encountered

We visited the Tecnalia facilities in Azpeitia, the thermal laboratory equipped with a high temperature heat Pump, heat transformer, and geothermical probes. Moreover, we visited the labs located in San Sebastian concerning the thermal characterization of heat transfer fluids and the equipment for the material characterization and production (composites, corrosion laboratory, and furnaces).
Enea also presented all the heat exchange facilities regarding the heat transfer fluids and storage media employed.
The presentation listed some activities in order to find research issues able to boost collaboration among the partners in RTD programs.

III. Joint publications foreseen

The following publication that includes the ENEA and Tecnalia contribution on this topic has already been presented in the poster session at the last SolarPaces International Conference: Muñoz-Sánchez, B., Nieto-Maestre, J., Gonzalez-Aguilar, José and Julia, N., Veca, E., Sau, S., and al. "Round Robin Test on the Measurement of the Specific Heat of Solar Salt, International Conference on Concentrating Solar Power and Chemical Energy Systems", SolarPACES 2016, 11.-14.10.2016, Abu Dhabi, United Arab Emirates. Other publications can be produced if the objects of discussion find a location in some new project.

IV. Comments, if any

Tecnalia's researches are very professional and they were very kind with us during our visit, we appreciated that much.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: STAGE STE ENEA visit to Tecnalia Facilities

Participant's first name and family name: Raffaele Liberatore

Name of the participant's institution: ENEA (Italy)

Name of the host institution: Tecnalia (Spain)

Onsite working period: 06 / 02 / 2017 to 10 / 02 / 2017

Onsite working time (in Person week(s))*:1

Remote working time (in Person week(s))**: 0

I. Objectives of the mobility

This personnel mobility was planned to deepen the common interests on some activities related to the Thermal Energy Storage for STE plants that are activities also scheduled in the WP7 of STAGE-STE project. In particular the main field of interest were the thermal storage using: phase change materials (topic in which we already collaborated together for the task 7.3.2), concrete and thermochemical reactions (activities related to the task 7.3.5 too).

With this aim it was envisaged:

- visit to the Tecnalia facilities in Azpeitia: thermal laboratory equipped with high temperature heat pump, heat transformer, geothermal probes.

- visit to Tecnalia facilities in San Sebastian: DSC, FTIR, Glovebox, corrosion laboratory, DLS, SEM, AFD, XRD, furnaces and autoclaves for corrosion.

- meetings with Tecnalia researchers in order to explore possible collaboration activities and exchange information in the field of thermochemical and thermal storage by new material solutions.

II. Main achievements and difficulties encountered

With Tecnalia researchers in Aspeitzia we finded common interests in the improvement of concrete mixtures for thermal storage; even though the starting point was different because ENEA aimed to make this work for thermal storage for CSP to be linked to ORC system in particular, while Tecnalia aimed to deepen this field for thermal exchange optimization in the buildings. We think the facilities and the know-out of the two research centres can contribute to a common activities with useful results for both.

With Tecnalia researchers in San Sebastian we explored the possibility to deepen the analysis on the coating and the related corrosion tests of the exchangers where different mixtures of molten salts flow, as well as the material characterization taking advantage of the Tecnalia high precision facilities, working also at high temperature and pressure. It has been also interesting to analyse the possibilities that can be offered from the synthesis of ionic liquids for the extraction of metals by waste and the electrodeposition of these metals.

III. Joint publications foreseen

The following publication that include the ENEA and Tecnalia contribution on this topic has been already presented in the poster session of the last SolarPaces International Conference:

Muñoz-Sánchez, B., Nieto-Maestre, J., Gonzalez-Aguilar, José and Julia, N. , Veca, E. , Sau, S. and al. "Round Robin Test on the Measurement of the Specific Heat of Solar Salt, International Conference on Concentrating Solar Power and Chemical Energy Systems", SolarPACES 2016, 11.-14.10.2016, Abu Dhabi, United Arab Emirates.

Other publications can be produced if the objects of discussion will find a location in some new project.

IV. Comments, if any

I received great welcome from all the Tecnalia researchers, they were all prepared to give me valuable advice on topics of common interest and I could appreciate their professionalism and the quality of the equipment used.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Solar Fuels

Participant's first name and family name: Erik Koepf

Name of the participant's institution: ETH

Name of the host institution: IMDEA

Onsite working period: 01 / 10 / 2017 to 30 / 11 / 2017

Onsite working time (in Person week(s))*: 9

Remote working time (in Person week(s))**: 0

I. Objectives of the mobility

1. Assembling a solar thermochemical reactor at the solar tower of IMDEA Energy
2. Design of a water calorimeter for the high-flux solar tower of IMDEA Energy

II. Main achievements and difficulties encountered

1. Assembling a solar thermochemical reactor at the solar tower of IMDEA Energy

A novel solar reactor for splitting H_2O and CO_2 has been designed and fabricated for a solar radiative power input of 50 kW and a solar flux concentration of 2000 suns, to be provided by the new solar tower and heliostat field at IMDEA Energy in Madrid. The solar reactor consists of a cavity-receiver containing a porous reticulated structure made of ceria for effecting the redox thermochemical cycle. This 2-step cycle consists of the solar-driven endothermic reduction of ceria followed by its oxidation with water and CO_2 for generating H_2 and CO – syngas, the precursor of liquid hydrocarbon fuels. The solar reactor and its peripheral components have been assembled and preliminary cold-testing has been performed for checking flows, joints, vacuum operation, and measurement instrumentation.

2. Design of a water calorimeter for the high-flux solar tower of IMDEA Energy

Accurate solar radiative power measurements are required in the new solar tower of IMDEA Energy for characterizing the performance of the heliostat field. In addition, accurate measurements are also needed for calculating the efficiency of the solar reactor (see 1). An optical flux measurement using a CCD camera and a Lambertian target provide good spatial resolution but inherently suffers from optical errors that may reach up to 10%. A water calorimeter provides a more accurate measurement at the expense of the special resolution. Thus, it can be used to calibrate the optical flux measurement system. A water calorimeters has been designed for this purpose. It consists of a well-insulated cylindrical cavity-receiver with an apparent absorptivity approaching 1. The inner walls are lined with a coiled copper tube for the water flow. In/out water temperatures and water mass flow rate are measured for calculating Q = mxCpxDT. In parallel, the flux measurement is integrated over the aperture area of the cavity and compared to the value obtained by the water calorimeter.

No difficulties encountered.

III. Joint publications foreseen

Journal paper is foreseen on the development of the solar thermochemical fuel processing system that includes the integration of the solar tower, the solar reactor, and the gas-to-liquid synthesis unit.

IV. Comments, if any

Please do not exceed 10 to 15 lines

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility: Innovative volumetric receivers (VP12)

Participant's first name and family name: Fabrizio Alberti

Name of the participant's institution: FBK

Name of the host institution: IMDEA

Working stay period: 11 / 05 / 2015 to 27 / 05 / 2015

Onsite working time (in Person week(s))*: 2,6

Remote working time (in Person week(s))**: 4

I. Objectives of the mobility

Experimental Characterization of innovative Volumetric Receivers by SLM

Each participant of the mobility have to fill in this document personally.
Please upload it following the instructions of the email in which this document was attached.

II. Main achievements and difficulties encountered

The FBK absorber has been compared to the SG monolith used as a reference. The sample compared are 005_SG_H4_410W and 010_FBK_H4_551W. The homogenizer used is the homogenizer V3.
The efficiency was calculated as the ratio between the power transferred to the air and the incident power. The power transferred to the air is calculated using the following expression:

$$Q_{air} = \dot{m} * \int_{T_{inlet\ air}}^{T_{outlet\ air}} C_p \, dT$$

Where $\dot{m}$ is the air mass flow, Cp is the thermal capacity of the air at constant pressure and Tinlet and Toutlet are the temperatures of the air at the entrance and at the exit of the absorber respectively. .
The efficiency of FBK and SG absorbers is shown in Figure 1.

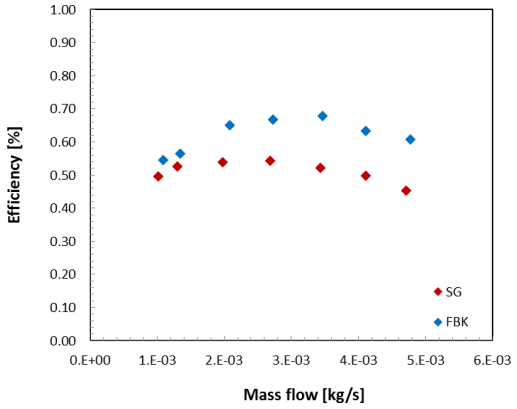

Figure 1 – Efficiency as a function of the air mass flow

In the case of SG absorber the maximum efficiency is 0.54 and it is reached for an air flow of 2.7g/s. In the case of FBK absorber the maximum efficiency is 0.68, 25% higher than SG maximum efficiency and it is reached for an air flow of 3.47g/s.
The main conclusion of these tests is that the FBK absorber shows better thermal performance than the Saint Gobain absorber taken as a reference. It has been also demonstrated that the gradual porosity geometry improves the thermal transfer between the solid and the air by convection.

III. Joint publications foreseen

Paper acepted at the Solar Paces Conference 2015

Numerical Analysis of Radiation Propagation in Innovative Volumetric Receivers based on Selective Laser Melting Techniques

Fabrizio Alberti[1], Sergio Santiago Sacristán[2], Mattia Roccabruna[3], José González-Aguilar[4] Luigi Crema[5&] and Manuel Romero[6*]

[1] MSc. Nucl. Eng, Researcher, [2]MSc. Mech. Eng., Predoctoral researcher; [3] MSc. Mech. Eng., Researcher; [4]PhD Physics, Senior researcher; [5]MSc. Physics, Senior Researcher, [6] PhD. Chem. Eng., Principal researcher.

[1,3,5]Fondazione Bruno Kessler, ARES Unit, Via Sommarive, 18, 38123, Trento, Italy; phone[&]:+39 0461 314941; e-mail[&]: alberti@fbk.eu

[2,4,6]IMDEA Energy, Avda. Ramón de la Sagra, 3, 28935 Móstoles, Spain; phone[*]: +34-917371123; e-mail[*]: manuel.romero@imdea.org.

Future Pubblication

Experimental Performance for Innovative Volumetric Receivers based on Selective Laser Melting Techniques

IV. Comments, if any

Please do not exceed 1 page

STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Linear Fresnel Collector (LFC) and field measurement methods

Participant's first name and family name: Sven Fahr

Name of the participant's institution: Fraunhofer Institute for Solar Energy Systems

Name of the host institution: Evora University

Onsite working period: 20 /07 / 2015 to 07 / 08 / 2015

Onsite working time (in Person week(s))*: 3

Remote working time (in Person week(s))**:

I. Objectives of the mobility

- Finish the final document of deliverable D3.1 of IEA Task 49
- Finish joint publication for SolarPACES within partner of WP11
- Within this context, discuss and elaborate together with staff from Evora University the methodologies of IAM-determination for line focusing collectors, especially Linear Fresnel Collectors.
- Visit existing test benches for concentrating collectors at Evora University, discuss difficulties with local staff and support them to put it into service

II. Main achievements and difficulties encountered

- IEA Task 49 deliverable finished to 85%
- Finished publication for SolarPACES Conference 2015
- Developped a better understanding for different perceptions of existing testing standards and their most urgent short-comings
- Preparation for EU-proposals for Horizon 2020 on LFC development
- Plans for joint usage of Mitra LFC-Testing Platform

III. Joint publications foreseen

- Deliverable D3.1 of IEA Task 49
- A.Hofer , L. Valenzuela, N. Janotte, JI.. Burgaleta, J. Arraiza, M. Montecchi, F. Sallaberry, T. Osório, M. J. Carvalho, F. Alberti, K. Kramer, A. Heimsath, W. Platzer11 and S. Scholl: "State of the Art of Performance Evaluation Methods for Concentrating Solar Collectors", SolarPACES Conference 2015
- Joint publication between UEVORA and FISE about use of different HTF for QDT testing
- Report on integration of LFC into Solar Keymark Certification Scheme

IV. Comments, if any

Please do not exceed 10 to 15 lines

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Linear Fresnel Collector (LFC) and field measurement methods

Participant's first name and family name: Korbinian Kramer

Name of the participant's institution: Fraunhofer ISE (FISE)

Name of the host institution: UEVORA

Onsite working period: 20 / 07 2015 to 07 / 08 / 2015

Onsite working time (in Person week(s))*: 3

Remote working time (in Person week(s))**: 1

I. Objectives of the mobility

- Finish the final document of deliverable D3.1 of IEA Task 49
- Finish joint publication for SolarPACES within partner of WP11
- Within this context, discuss and elaborate together with staff from Evora University the methodologies of IAM-determination for line focusing collectors, especially Linear Fresnel Collectors.
- Visit existing test benches for concentrating collectors at Evora University, discuss difficulties with local staff and support them to put it into service

II. Main achievements and difficulties encountered

- IEA Task 49 deliverable finished to 85%
- Finished publication for SolarPACES Conference 2015
- Developped a better understanding for different perceptions of existing testing standards and their most urgent short-comings
- Preparation for EU-proposals for Horizon 2020 on LFC development
- Plans for joint usage of Mitra LFC-Testing Platform

III. Joint publications foreseen

- Deliverable D3.1 of IEA Task 49
- A.Hofer , L. Valenzuela, N. Janotte, JI.. Burgaleta, J. Arraiza, M. Montecchi, F. Sallaberry, T. Osório, M. J. Carvalho, F. Alberti, K. Kramer, A. Heimsath, W. Platzer11 and S. Scholl: "State of the Art of Performance Evaluation Methods for Concentrating Solar Collectors", SolarPACES Conference 2015
- Joint publication between UEVORA and FISE about use of different HTF for QDT testing
- Report on integration of LFC into Solar Keymark Certification Scheme

IV. Comments, if any

Please do not exceed 10 to 15 lines

*One person week equals to 5 labour days. One person week should be justified when a minimum of 3 days of onsite labour days at the host institution have been realized, considering that one day before and one day after the mobility are also part of the mobility, even if not hosted at the institution. In this sense, please consider one person week for all onsite working periods from 3 to 5 labour days.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Linear Fresnel Collector (LFC) and field measurement methods

Participant's first name and family name: Annie Hofer

Name of the participant's institution: Fraunhofer Institute for Solar Energy Systems ISE

Name of the host institution: Universidad de Evora

Onsite working period: 20 / 07 / 2015 to 07 / 08 / 2015

Onsite working time (in Person week(s))*: 3

Remote working time (in Person week(s))**: 0

I. Objectives of the mobility

- Finish the final document of deliverable D3.1 of IEA Task 49
- Finish joint publication for SolarPACES within partner of WP11
- Within this context, discuss and elaborate together with staff from Evora University the methodologies of IAM-determination for line focusing collectors, especially Linear Fresnel Collectors.
- Visit existing test benches for concentrating collectors at Evora University, discuss difficulties with local staff and support them to put it into service

II. Main achievements and difficulties encountered

- IEA Task 49 deliverable finished to 85%
- Finished publication for SolarPACES Conference 2015
- Developped a better understanding for different perceptions of existing testing standards and their most urgent short-comings
- Preparation for EU-proposals for Horizon 2020 on LFC development
- Plans for joint usage of Mitra LFC-Testing Platform

III. Joint publications foreseen

- Deliverable D3.1 of IEA Task 49
- Paper: A.Hofer , L. Valenzuela, N. Janotte, JI.. Burgaleta, J. Arraiza, M. Montecchi, F. Sallaberry, T. Osório, M. J. Carvalho, F. Alberti, K. Kramer, A. Heimsath, W. Platzer and S. Scholl: "State of the Art of Performance Evaluation Methods for Concentrating Solar Collectors", SolarPACES Conference 2015
- Joint publication between UEVORA and FISE about use of different HTF for QDT testing
- Report on integration of LFC into Solar Keymark Certification Scheme

IV. Comments, if any

Please do not exceed 10 to 15 lines

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Individual activity report

Each participant of the mission have to fill in this document personally.
Please upload it following the mail in which this document was attached.

Title of the mission: Joint experimental validation of ray-tracing codes related to heliostats

Group Leader first name and family name: Peter Schöttl

Participant's first name and family name: Peter Schöttl

Name of participant's institute: Fraunhofer ISE (FISE)

Name of the home institute: CNRS

Working stay period: 15/09/21 – 15/09/25

Individual person-day: 10 person-days (5 person-days on-site + 5 person-days remote) = 2 person-weeks

I. Objectives of the project *(Please do not exceed 10 to 15 lines)*

Joint experimental validation of ray-tracing codes with the flux distribution of one heliostat at Themis. Exchange on calibration procedures of heliostats in the field

II. Main achievements and difficulties encountered *(Please do not exceed 1 page)*

Difficulties:

- Detailed surface slope measurements for the mirror surfaces of the heliostats were not available
- Detailed canting information for the heliostat facets was not available

Achievements:

- To overcome the difficulties, a new concept has been proposed
- Several free parameters will be adapted / iteratively optimized to fit a measured flux map to a simulated flux map for one heliostat
- This is done in several levels of detailing
- Measurements of the flux map of several single heliostat on the flux target at THEMIS have been conducted

III. Personal contribution for the mission *(Please do not exceed 10 to 15 lines)*

Conceptual work
Optical modeling of THEMIS heliostat
Optical simulations with the aim of quantifying the impact of surface slope deviations / canting on flux map.

IV. Joint publications foreseen *(Please do not exceed 10 to 15 lines)*

A publication is foreseen. The title of the publication is not yet set. The publication should give an outline on the simulations performed and the correlation between the simulated and measured flux distributions. Based on these findings, potential canting errors of the heliostat facets can be identified.

V. Comments, if any *(Please do not exceed 1 page)*

We wish to thank the colleagues from CNRS for their very welcoming and collaborative teamwork. The stay could frame the basis for future cooperation. Some topics for future projects could be identified already during the mobility.

Individual activity report

Each participant of the mission have to fill in this document personally.
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Title of the mission: Joint experimental validation of ray-tracing codes related to heliostats

Group Leader first name and family name: Peter Schöttl

Participant's first name and family name: Gregor Bern

Name of participant's institute: Fraunhofer ISE (FISE)

Name of the home institute: CNRS

Working stay period: 15/09/21 – 15/09/25

Individual person-day: 10 person-days (5 person-days on-site + 5 person-days remote) = 2 person-weeks

I. Objectives of the project *(Please do not exceed 10 to 15 lines)*

Joint experimental validation of ray-tracing codes with the flux distribution of one heliostat at Themis. Exchange on calibration procedures of heliostats in the field

II. Main achievements and difficulties encountered *(Please do not exceed 1 page)*

Difficulties:

- Detailed surface slope measurements for the mirror surfaces of the heliostats were not available
- Detailed canting information for the heliostat facets was not available

Achievements:

- To overcome the difficulties, a new concept has been proposed
- Several free parameters will be adapted / iteratively optimized to fit a measured flux map to a simulated flux map for one heliostat
- This is done in several levels of detailing
- Measurements of the flux map of several single heliostat on the flux target at THEMIS have been conducted

III. Personal contribution for the mission *(Please do not exceed 10 to 15 lines)*

Conceptual work
Flux measurements of 3 different heliostats with CNRS equipment, for later comparison with simulations. Relative distributions on a large target, covering the whole spot of one heliostat were taken to allow the comparison of the relative distribution. On a smaller target absolute flux measurements utilizing an installed photo sensor were taken.

IV. Joint publications foreseen *(Please do not exceed 10 to 15 lines)*

A publication is foreseen. The title of the publication is not yet set. The publication should give an outline on the simulations performed and the correlation between the simulated and measured flux distributions. Based on these findings, potential canting errors of the heliostat facets can be identified.

V. Comments, if any *(Please do not exceed 1 page)*

We wish to thank the colleagues from CNRS for their very welcoming and collaborative teamwork. The stay could frame the basis for future cooperation. Some topics for future projects could be identified already during the mobility.

STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Evaluation of On-site reflectance measurements in real STE plants

Participant's first name and family name: Anna Heimsath

Name of the participant's institution: Fraunhofer Institut für Solare Energiesysteme (ISE)

Name of the host institution: CIEMAT

Onsite working period: 29 / 05 / 2017 to 02 / 06 / 2017

Onsite working time (in Person week(s))*: 1

Remote working time (in Person week(s))**: 2

I. Objectives of the mobility

The mobility action was related to WP 11.2 in the Stage-STE Project. Aim was the collaboration on the topic of soiling measurements. It was related to measurements conducted in the solar field of two different parabolic trough tougher plants in autumn 2016. Measurements were taken with three different portable reflectometer by Ciemat, Cranfield and Fraunhofer ISE.

II. Main achievements and difficulties encountered

Main achievement was the definition of a common methodology for field soiling data evaluation and comparison of results from different instruments. Secondly the data have been evaluated in preparation of the deliverable report on soiling measurements in the context of performance evaluation for solar thermal power plants. Further a presentation on comparative soiling measurements and steps for future standardization was prepared to be presented at a Solar Paces Task 3 Workshop on reflectance measurements.

III. Joint publications foreseen

A joint publication with Ciemat, Cranfield and Fraunhofer is prepared.

IV. Comments, if any

Dissemination is related to participation of both partners (Ciemat and Fraunhofer ISE) in Solar Paces Task3 reflectance workshop and Solar Paces Task meeting in Santiago de Chile in October 2017.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Comparison of performance evaluation methods for PTC solar fields

Participant's first name and family name: Annie Zirkel-Hofer

Name of the participant's institution: Fraunhofer ISE

Name of the host institution: CIEMAT

Onsite working period: 17 / 07 / 2017 to 21 / 07 / 2017

Onsite working time (in Person week(s))*: 1 week

Remote working time (in Person week(s))**: 2 weeks

I. Objectives of the mobility

The main objective of the activity was to facilitate meaningful comparisons of different performance evaluation methods for PTC solar fields. For this reason, solar field data was already distributed along the committed partners within WP 11 before the mobility. In order to assure significant comparisons and useful conclusions concerning the different evaluation methods, the on-site activity enabled detailed discussions and exchange concerning a proper assessment of the different performance evaluation methods.

II. Main achievements and difficulties encountered

The results of the different evaluation procedures and its discussion were included in the joint deliverable report D11.5 of WP 11, with main contributions from FISE, CIEMAT and UEVORA, LNEG, CENER. During the on-site activity the different evaluation results of the partners were discussed and reasons for remaining deviations analyzed. The close communication and parallel evaluations of FISE and CIEMAT allowed a proper assessing and comparing of the different evaluation results.

III. Joint publications foreseen

A joint publication of the evaluation partner of WP 11 concerning the applicability of the current normative quasi-dynamic testing method to solar field performance evaluation is discussed.

IV. Comments, if any

The activity was regarded indispensable for the preparation of a comprehensive deliverable report D 11.5 including an actual application of solar field performance methods by showing valuable and meaningful results of real solar field measurement data.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Comparison of Heliostat Field Layout Algorithms

Participant's first name and family name: Peter Schöttl

Name of the participant's institution: Fraunhofer ISE

Name of the host institution: CENER

Onsite working period: 18 / 09 / 2017 to 22 / 09 / 2017

Onsite working time (in Person week(s))*: 1

Remote working time (in Person week(s))**: 2

I. Objectives of the mobility

The aim of the mobility is to continue the work on the joint activity on comparison of heliostat field layout algorithms between CENER, CRS4 and Fraunhofer ISE, which eventually will lead to a joint publication on the topic. The already developed methodology for deriving pattern-based heliostat fields optimized for annual efficiency will be extended to take into account ground costs. The latter will be integrated in a dimensionless manner, such that the results will be helpful for a wide range of applications.
The simulations and results required for the joint publication will be determined, so that the partners can finalize the work on the different layout patterns: DELSOL, MUEEN, CRS4 and Biomimetic.

II. Main achievements and difficulties encountered

A first approach to integrate ground cost based on the local heliostat density has been found to be not applicable for all algorithms. Therefore, a new method for integration of the ground cost in the both the evaluation function assessing a heliostat field's performance and in the selection function designing a field has been developed and agreed upon among the partners. The new method includes an internal optimization based on heliostat efficiency and slant range which is executed in each iteration of the external optimization. The latter optimizes the free parameters of each heliostat field layout pattern.
The test scenarios for the publication have been selected: Seville (Spain) and Maria Elena (Chile). These sites differ enough in latitude to cover a rather wide range of typical CSP locations.

III. Joint publications foreseen

Eventually, a joint peer-reviewed publication between CENER, CRS4 and Fraunhofer ISE will be written and published.

IV. Comments, if any

I thank CENER for the friendly hosting and the fruitful cooperation.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Heliostat field algorithm comparison

Participant's first name and family name: Shahab Rohani

Name of the participant's institution: Fraunhofer ISE

Name of the host institution: CENER

Onsite working period: 18 / 09 / 2017 to 22 / 09 / 2017

Onsite working time (in Person week(s))*: 1

Remote working time (in Person week(s))**: 1

I. Objectives of the mobility

The aim of the mobility is to continue the work on the joint activity on comparison of heliostat field layout algorithms between CENER, CRS4 and Fraunhofer ISE, which eventually will lead to a joint publication on the topic. The already developed methodology for deriving pattern-based heliostat fields optimized for annual efficiency will be extended to take into account ground costs. The latter will be integrated in a dimensionless manner, such that the results will be helpful for a wide range of applications.
The simulations and results required for the joint publication will be determined, so that the partners can finalize the work on the different layout patterns: DELSOL, MUEEN, CRS4 and Biomimetic.

II. Main achievements and difficulties encountered

A first approach to integrate ground cost based on the local heliostat density has been found to be not applicable for all algorithms. Therefore, a new method for integration of the ground cost in the both the evaluation function assessing a heliostat field's performance and in the selection function designing a field has been developed and agreed upon among the partners. The new method includes an internal optimization based on heliostat efficiency and slant range which is executed in each iteration of the external optimization. The latter optimizes the free parameters of each heliostat field layout pattern.
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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: *Exchange on modelling tools with joint publication*

Participant's first name and family name: *Martin Karl*

Name of the participant's institution: *Fraunhofer ISE*

Name of the host institution: *The Cyprus Institute*

Onsite working period: 22 / 01 / 2018 to 26 / 01 / 2018

Onsite working time (in Person week(s))*: 1

Remote working time (in Person week(s))**: 2

I. Objectives of the mobility

The aim of the mobility is to trigger a discussion and achieve knowledge transfer of numeric modelling and tools (as they have been developed within WP7) for single tank TES with and without filler material, with special focus on the modelling of the thermocline, as well as validation of models with experimental data, which eventually will lead to a joint publication on the topic.
Furthermore, a field visit to CyI's in-house test laboratories, as well as the PROTEAS facility (Pentakomo field) with focus on heliostats and molten salt receiver is of main interest. In WP12.1.5 this field has been optically simulated by Fraunhofer ISE, therefore discussions about expanding the simulation tool with a thermal model are planned, as well as a knowledge exchange about hardware equipment used within the PROTEAS facility and comparison of results from simulations of water desalination using MED, performed at both institutes.
Further, the visit aims at reinforcing the cooperation and synergies among the two STAGE-STE institutions, with a preparation of a project proposal and – if possible – a joint publication (topic proposal: validation of simulation results against experimental data).

II. Main achievements and difficulties encountered

CyI gave us a brought insight into their research activities related to the linear Fresnel and solar tower technology (➔ PROTEAS facility) and thermocline storage modeling, which triggered a vivid discussion and general agreement from both sides to share data and models for cross-evaluation of experimental data from Fraunhofer ISE´s molten salt thermocline storage. From CyI's side, willingness to share experimental data from their desalination research facility using MED was also shown.
From the discussion with researchers at CyI, joint fields of interest and synergies were discovered as a potential base for subsequent knowledge exchange and cooperation with Fraunhofer ISE, addressing the topics: Parameter identification for LFC, astigmatism-corrected heliostats, soiling in maritime environments, heliostat shape measurement data (photogrammetry) and thermal storage modeling using Fraunhofer ISE's tool ColSIM CSP as well as CFD-models, which have been developed in both institutes. With this very prosperous exchange between the institutes the existing connection has been reinforced as well as new relations forged, which will lead to a closer collaboration in the future.

III. Joint publications foreseen

Presumably, a peer-reviewed and/or conference publication by the Cyprus Institute and Fraunhofer ISE will be written and published.

IV. Comments, if any

I thank CYI for the friendly hosting, their time and the fruitful cooperation.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: *Exchange on modelling tools with joint publication*

Participant's first name and family name: *Ralf Müller*

Name of the participant's institution: *Fraunhofer ISE*

Name of the host institution: *The Cyprus Institute*

Onsite working period: 22 / 01 / 2018 to 26 / 01 / 2018

Onsite working time (in Person week(s))*: 1

Remote working time (in Person week(s))**: 2

I. Objectives of the mobility

The aim of the mobility is to trigger a discussion and achieve knowledge transfer of numeric modelling and tools (as they have been developed within WP7) for single tank TES with and without filler material, with special focus on the modelling of the thermocline, as well as validation of models with experimental data, which eventually will lead to a joint publication on the topic.
Furthermore, a field visit to CyI's in-house test laboratories, as well as the PROTEAS facility (Pentakomo field) with focus on heliostats and molten salt receiver is of main interest. In WP12.1.5 this field has been optically simulated by Fraunhofer ISE, therefore discussions about expanding the simulation tool with a thermal model are planned, as well as a knowledge exchange about hardware equipment used within the PROTEAS facility and comparison of results from simulations of water desalination using MED, performed at both institutes.
Further, the visit aims at reinforcing the cooperation and synergies among the two STAGE-STE institutions, with a preparation of a project proposal and – if possible – a joint publication (topic proposal: validation of simulation results against experimental data).

II. Main achievements and difficulties encountered

CyI gave us a brought insight into their research activities related to the linear Fresnel and solar tower technology (➔ PROTEAS facility) and thermocline storage modeling, which triggered a vivid discussion and general agreement from both sides to share data and models for cross-evaluation of experimental data from Fraunhofer ISE´s molten salt thermocline storage. From CyI's side, willingness to share experimental data from their desalination research facility using MED was also shown.
From the discussion with researchers at CyI, joint fields of interest and synergies were discovered as a potential base for subsequent knowledge exchange and cooperation with Fraunhofer ISE, addressing the topics: Parameter identification for LFC, astigmatism-corrected heliostats, soiling in maritime environments, heliostat shape measurement data (photogrammetry) and thermal storage modeling using Fraunhofer ISE's tool ColSIM CSP as well as CFD-models, which have been developed in both institutes. With this very prosperous exchange between the institutes the existing connection has been reinforced as well as new relations forged, which will lead to a closer collaboration in the future.

III. Joint publications foreseen

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IV. Comments, if any

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: *Exchange on modelling tools with joint publication*

Participant's first name and family name: *Peter Schöttl*

Name of the participant's institution: *Fraunhofer ISE*

Name of the host institution: *The Cyprus Institute*

Onsite working period: 22 / 01 / 2018 to 26 / 01 / 2018

Onsite working time (in Person week(s))*: 1

Remote working time (in Person week(s))**: 2

I. Objectives of the mobility

The aim of the mobility is to trigger a discussion and achieve knowledge transfer of numeric modelling and tools (as they have been developed within WP7) for single tank TES with and without filler material, with special focus on the modelling of the thermocline, as well as validation of models with experimental data, which eventually will lead to a joint publication on the topic.
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Further, the visit aims at reinforcing the cooperation and synergies among the two STAGE-STE institutions, with a preparation of a project proposal and – if possible – a joint publication (topic proposal: validation of simulation results against experimental data).

II. Main achievements and difficulties encountered

CyI gave us a brought insight into their research activities related to the linear Fresnel and solar tower technology (➔ PROTEAS facility) and thermocline storage modeling, which triggered a vivid discussion and general agreement from both sides to share data and models for cross-evaluation of experimental data from Fraunhofer ISE´s molten salt thermocline storage. From CyI's side, willingness to share experimental data from their desalination research facility using MED was also shown.
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III. Joint publications foreseen

Presumably, a peer-reviewed and/or conference publication by the Cyprus Institute and Fraunhofer ISE will be written and published.

IV. Comments, if any

I thank CYI for the friendly hosting, their time and the fruitful cooperation.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: DSG Balance of Plant concepts for Process heat applications

Participant's first name and family name: Pedro Horta

Name of the participant's institution: Fraunhofer Institut für Solare Energiesysteme (ISE)

Name of the host institution: CIEMAT

Onsite working period: 20 / 07 / 2017 to 01 / 08 / 2017

Onsite working time (in Person week(s))*: 1,8

Remote working time (in Person week(s))**: 1,0

I. Objectives of the mobility

The mobility action was related to WP 11.1 in the Stage-STE Project. Aim was the collaboration on the topic of Balance of Plant concepts for DSG integration into existing industrial steam distribution networks. Basing approaches on the existing experience with DSG for CSP applications, the mobility aimed at: Literature review; Visit to the DISS experimental facility; Identification of process heat related specificities; Identification of context differences to CSP applications; Line-up of most relevant differentiating aspects for BoP in industrial or CSP applications; Identification of most suitable strategies to reduce costs on process heat related BoP for DSG systems.

II. Main achievements and difficulties encountered

Main achievement was the definition of a common understanding on available references and on the contextual differences for DSG BoP in the CSP and process heat contexts. Discussion on a possible joint project proposal was drafted along those lines. Discussion of possible objectives, workplan and Consortium was also concluded, enabling the establishment of first contacts and the identification of possible funding.

III. Joint publications foreseen

A joint activity on this topic was outlined. A thorough definition will be developed within the framework of INSHIP ECRIA.

IV. Comments, if any

Discussion at German partners level is leading to Nationally funded proposal.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: CO2 valorisation to fuels via solar thermochemistry

Participant's first name and family name: Manuel Romero

Name of the participant's institution: IMDEA (Fundacion IMDEA Energia)

Name of the host institution: ETHZ (Eidgenoessische Tecnische Hochschule Zurich)

Onsite working period: 01/ 07 / 2014 to 31/ 07 / 2014

Onsite working time (in Person week(s))*: 4

Remote working time (in Person week(s))**: 1

I. Objectives of the mobility

Coordinate collaborative work between ETHZ and IMDEA on the production of solar fuels through solar-driven thermochemical processes.

II. Main achievements and difficulties encountered

During the stage two types of collaborations have been elaborated with concrete results. The first one was the draft elaboration of a project proposal entitled SUNlight-to-LIQUID: Integrated solar-thermochemical synthesis of liquid hydrocarbon fuels that has been finally submitted in September 2014 to the Call H2020-LCE-2015-1. LCE 11 – 2014/2015: Developing next generation technologies for biofuels and sustainable alternative fuels. The proposal includes other STAGE-STE partners as DLR and ASNT. The primary objective of SUN-to-LIQUID is the scale-up and experimental validation of the complete process chain to solar liquid hydrocarbon fuels from H2O, CO2 and solar energy at a pre-commercial scale. Moving from a 4 kW setup in the laboratory to a 50 kW pre-commercial. The second one was the discussion about a proposal on a ITN on Solar Fuels that has been finally submitted to the Call Marie Curie H2020-MSCA-ITN-2015 in January 2015, coordinated by IMDEA with the participation of ETHZ, ASNT, DLR, ASNT, ENEA and LNEG.

III. Joint publications foreseen

No publications foreseen. Two project proposals to EC calls instead.

IV. Comments, if any

None.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Volumetric ceramic absorbers for use in central receiver systems

Participant's first name and family name: José González

Name of the participant's institution: IMDEA (Fundacion IMDEA Energia)

Name of the host institution: IEECAS (Institute of Electrical Engineering – Chinese Academy of Science)

Onsite working period: 2014-09-22 to 2014-10-05

Onsite working time (in Person week(s))*: 2

Remote working time (in Person week(s))**: 1

I. Objectives of the mobility

Screening of candidate materials for volumetric absorbers, defining specifications of tests at solar furnace and discussion on work program in 2014 and collaborative activities in 2015.

II. Main achievements and difficulties encountered

During the stage, several meetings were organized with various research institutes from the Chinese Academy of Science in order to exchange information concerning our common activities on R&D and to explore new collaboration routes.

Candidate materials to be tested from the IEECAS were established (monolith and foam types). A monolith configuration was defined as reference material in order to compare experimental results in the solar furnace in China and in the high-flux solar simulator in Europe.

2015 Work program was updated taken into account the progress in 2014.

III. Joint publications foreseen

No publications are directly foreseen from this mobility action. Invited participation in the Chinese-USA-Australian Workshop hold at IEECAS on September 22, 2014.

IV. Comments, if any

None.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Reactor concepts for thermal heat storage

Participant's first name and family name: Ms. Sandra ALVAREZ

Name of the participant's institution: IMDEA (Fundación IMDEA Energía)

Name of the host institution: DLR

Onsite working period: 2015-11-23 / 2015-11-25

Onsite working time (in Person week(s))*: 0.6

Remote working time (in Person week(s))**: 0.4

I. Objectives of the mobility

- Put in common results about previous experiences based on thermochemical heat storage.
- Define long-stay at DLR during first trimester of 2016

II. Main achievements and difficulties encountered

- Preliminary discussion on various conceptual approaches for the design of a thermochemical storage reactor.
- Framework and schedule of a research stay (from January the 4th until April the 7th) was established.

III. Joint publications foreseen

From the work to be developed in the research stay in 2016, it is foreseen a publication on activities developed.

IV. Comments, if any

None.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Reactor concepts for thermochemical heat storage

Participant's first name and family name: Sandra ALVAREZ DE MIGUEL

Name of the participant's institution: IMDEA Energy

Name of the host institution: DLR

Onsite working period: 04 / 01 / 2016 to 07 / 04 / 2016

Onsite working time (in Person week(s))*: 14

Remote working time (in Person week(s))**: 1

I. Objectives of the mobility

(1) To cooperate on a reactor design for reduction of metal oxides with 3 kW capacity and 30 min continuous operation
(2) A paper with theoretical comparison between fluidized, stationary and moving bed with metal oxides in direct contact.

II. Main achievements and difficulties encountered

Preliminary analyses performed at IMDEA Energy have shown that manganese oxides is a promising material for thermochemical heat storage. In addition to the material, the reactor must provide the suitable conditions for working with the storing material in terms of (reactor and reactant) material durability and charging/discharging duration. Within this mobility, main obtained achievement are:
(1) An extended list of gas-solid heat transfer coefficients obtained by literature survey;
(2) Reactor dimensions assuming moving bed concepts taking into account heat and mass transfers as a function of reactor and reactant pellet diameters and reaction enthalpies.
(3) Experimental assessment of the building materials of the reactor.

III. Joint publications foreseen

It is planned a joint publication between DLR and IMDEA Energy on theoretical comparison between various particle reactor concepts applied to handling thermal storage based on gas-solid chemical reactions using metal oxides.

IV. Comments, if any

None.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Analysis of atmospheric and pressurised receiver concepts

Participant's first name and family name: José GONZÁLEZ-AGUILAR

Name of the participant's institution: IMDEA Energy (Spain)

Name of the host institution: ETHZ (Switzerlan)

Onsite working period: 01 / 03 / 2017 to 31 / 05 / 2017

Onsite working time (in Person week(s))*: 13.2

Remote working time (in Person week(s))**: 1

I. Objectives of the mobility

1 / Scientific discussions on high-temperature concentrating solar energy applications, which would serve to establish new collaborations between IMDEA and ETH;
2 / Joint research on high-temperature solar volumetric receivers involving computational fluid dynamics and high-flux experimental testing.
3 / Identification of common research topics in the field of concentrating solar energy.

II. Main achievements and difficulties encountered

1 / Identification of promising concepts for the efficient production of solar thermal power and thermochemical fuels.
2 / Elaboration of an EU proposal on Solar Heat for Industrial Processes
3 / Participation in local workshops and seminars addressed to ETH staff.

III. Joint publications foreseen

Dr. Gonzalez and Prof. Steinfeld worked on editing a special issue of Solar Energy Journal (Elsevier) dedicated on solar thermochemical fuels (Volume 156, Pages 1–168 (1 November 2017)).

IV. Comments, if any

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Testing of mixed oxides for hydrogen production

Participant's first name and family name: José GONZALEZ AGUILAR

Name of the participant's institution: IMDEA Energy

Name of the host institution: CIEMAT

Onsite working period: 06 / 06 / 2016 to 08 / 06 / 2016

Onsite working time (in Person week(s))*: 0.6

Remote working time (in Person week(s))**: 0.4

I. Objectives of the mobility

Collaboration with CIEMAT to test a solar reactor with mixed oxides for hydrogen production at Plataforma Solar de Almería (PSA). Support operation and analysis of results on site.

II. Main achievements and difficulties encountered

(1) First tests on a 250kW thermal solar reactor in the CRS facility at PSA were successful performed. They addressed to verify the reliability of the control and data acquisition subsystems as well as to check the thermal shielding, thermal insulation and ceramic components of the reactor.
(2) Maximum radiation power in the reactor aperture was around 50 kW.
(3) In a next step, hydrogen production will be verified. For this, gas analysis will be implemented.

III. Joint publications foreseen

None.

IV. Comments, if any

None.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Experimental assessment of silicon carbide ceramics as solar absorbers

Participant's first name and family name: Dr. Salvador Luque

Name of the participant's institution: Fundación IMDEA Energía

Name of the host institution: IEECAS

Onsite working period: 10 / 10 / 2017 to 26 / 10 / 2017

Onsite working time (in Person week(s))*: 2.6

Remote working time (in Person week(s))**: 0

I. Objectives of the mobility

Proposed objectives of the mobility are listed below:

1. Increase the use of complementary research infrastructures among the partners (WP4).
2. Identification and development of absorber materials and volumetric receivers for high temperature solar towers (WP12).
3. Performance testing under high flux solar radiation of suitable materials for absorbers in volumetric receivers, for use in concentrating solar power applications with central receiver systems (WP12).

In particular, the research mobility focused on the experimental characterisation of high performance siliconized silicon carbide monolithic honeycombs, to be used as open volumetric solar receivers, employing air as the heat transfer fluid.

II. Main achievements and difficulties encountered

Experiments were conducted employing the new high flux solar simulator developed at IEECAS, composed of 19 Xenon-arc lamps and capable of delivering 28.95 kW of thermal power on the absorber aperture plane, with peak flux in excess of 2300 kW/m^2. Measurements conducted included absorber wall temperatures, air inlet and outlet temperatures, mass flow rate, and steady-state overall thermal efficiency. For a given incident power, set by adjusting the electric current in the solar simulator lamps, the absorber characterization facility would be operated at a range of decreasing mass flow rates at which the flow would be allowed to stabilize. The overall thermal conversion efficiency was calculated as the ratio between the power that is transferred to the working fluid by forced convection and the incident radiative power over the absorber front face. The latter was measured by a high accuracy heat flux mapping and acquisition system, which employed a water-cooled Lambertian target and a Gardon radiometer. Images of the irradiated target were acquired by means of a CCD camera and calibrated against measurements of the radiometer.

III. Joint publications foreseen

[1] Luque, S., Shunzhou, C., Bai, F., González-Aguilar, J., Wang, Z. and Romero, M., 2018. Influence of scale on the overall thermal conversion efficiency of volumetric solar receivers. *International Journal of Energy Research*.

IV. Comments, if any

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Research on materials for STE components

Participant's first name and family name: Luis Guerra ROSA

Name of the participant's institution: IST-ID

Name of the host institution: CIEMAT (PSA)

Onsite working period: 10 / 09 / 2017 to 16 / 09 / 2017

Onsite working time (in Person week(s))*: 1.0

Remote working time (in Person week(s))**: 1.0

I. Objectives of the mobility

Taking advantage of the long experience of the Solar Concentrating Systems Unit of CIEMAT-PSA, the main objective was to evaluate the main causes of structural degradation of some STE components and the main mechanisms involved at temperatures in the range of practical appliance. The focus is given to STE components that work at temperatures higher than 400°C and are subjected to thermal shock.

II. Main achievements and difficulties encountered

During the stay different discussions and tasks have been accomplished related to the objectives of the mobility:

- Discussions about the problems detected on receiver tubes (HCEs) of solar power plants, in particular of standard HCEs installed in parabolic-trough collectors (PTC). Understanding on the performance indicators, commercial solar receiver designs, and degradation mechanisms in this type of STE components.
- Presentation about the potential of using optical fibers as potential STE component at medium-long term. Current status of development, preliminary experimental results and potential applications.
- Preliminary analysis on the combination of a PTC and a Heat Recovery System from a Cement industry located in Portugal to feed an ORC power block and increase the yearly electricity output of the complete system.

III. Joint publications foreseen

Joint publications will be prepared, dealing with experimental results and also with theoretical modelling.

IV. Comments, if any

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Research on materials for STE components (2nd visit)

Participant's first name and family name: Luis Guerra ROSA

Name of the participant's institution: IST-ID

Name of the host institution: CIEMAT (PSA)

Onsite working period: 21 / 01 / 2018 to 27 / 01 / 2018

Onsite working time (in Person week(s))*: 1.0

Remote working time (in Person week(s))**: 1.0

I. Objectives of the mobility

The objectives of the mobility of Luis Guerra Rosa to the R+D Group in charge of the solar furnaces at CIEMAT-PSA were: 1) Exchange of information and discussion on the performance of optical fiber cables as potential STE component (at medium-long term) for solar power transmission: current status of development, preliminary experimental results, and potential applications. 2) Exchange of information and discussion on issues envisaging new joint research proposal.

II. Main achievements and difficulties encountered

The mobility allowed the accomplishment of the objectives, namely:
- Preparation of a test setup for measuring the radiation at the entrance and at the exit of a prototype fiber cable. Solar Furnace SF40 was used for the experiments.

- Detailed discussions on using optical fibers as a STE component. Current status of development, obtained experimental results and potential applications.

- The Numerical Aperture (NA) of the optical fibers requires the development of an optical system in order to allow higher transmission efficiency.

III. Joint publications foreseen

Joint publications will be prepared, dealing with experimental results and also with theoretical modelling.

IV. Comments, if any

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Research on reticulated porous ceramic for potential volumetric solar absorber receivers

Participant's first name and family name: José Jorge Cruz FERNANDES

Name of the participant's institution: IST-ID

Name of the host institution: Plataforma Solar de Almeria

Onsite working period: 17 / 07 / 2016 to 30 / 07 / 2016

Onsite working time (in Person week(s))*: 2

Remote working time (in Person week(s))**: 2

I. Objectives of the mobility

The main objective was to evaluate the damage imposed on reticulated porous ceramic (RPC) materials, namely brown alumina, coated mullite, ceria and silicon carbide foams under drastic thermal shock conditions. In addition, measurements of thermal emissivity of the selected materials performed using the available apparatus at PSA.

II. Main achievements and difficulties encountered

Dr José Jorge da Cruz Fernandes visited the CIEMAT-PSA facilities from 18 July 2016 till 29 July 2016. During his stay, he followed the thermal cycling tests being performed at the SF40 Horizontal Solar Furnace aiming at assessing the damage induced by thermal shock on several reticulated porous ceramic foams with potential application as solar receivers and catalysts for solar fuels production by water splitting. Typically, the surface temperature of the foams ranged from 700ºC and 1100ºC for 50, 100 and 150 cycles. This corresponds to a temperature difference of 400 K. In addition, other temperature differences adopted were 200 K and 600 K, under thermal cycling up to a maximum of 150 cycles. The materials investigated were iron-oxide coated mullite (commercial grade) as well as brown alumina and ceria foams developed at LNEG. Further characterisation of the tested materials will be carried out at both LNEG and IST-UL, namely microstructural evaluation and crushing strength in order to identify their damage mechanisms.
In brief, this was a very fruitful exchange experience allowing the possibility to discuss topics of common interest with the partners involved, namely CIEMAT-PSA, IST-UL and LNEG and follow up the thermal shock testing of highly porous ceramics performed under well controlled conditions.

III. Joint publications foreseen

One publication based on the crushing strength results of iron-oxide coated mullite (porous ceramic) after the thermal shock performed in Almeria (PSA).

IV. Comments, if any

The 50 specimens submitted to thermal shock in Almeria (PSA) will be tested by Dr. Cruz Fernandes in compression, followed by fractographic analysis, at Instituto Superior Técnico, in order to measure their damage and to identify the correspondent mechanisms. After that we intend to prepare one scientific publication. The remote working time (before and after the mobility) related with this activity is two person weeks.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Data collection for the validation of numerical codes to improve the efficiency of cavities

Participant's first name and family name: João Cardoso

Name of the participant's institution: LNEG

Name of the host institution: CNRS

Onsite working period: 21 /04 / 2015 to 24 / 04 / 2015

Onsite working time (in Person week(s))*:1

Remote working time (in Person week(s))**:0.5

I. Objectives of the mobility

One of the activities being developed within WP12, Point Focusing Technologies, is the development of evaluation models to build and optimize the receiver (sub-task 12.2.3). Within this task LNEG is involved in the review of concepts of solar receivers and in the development of a computational code to evaluate the efficiency of cavities, with a special focus on the optimization of solar radiation distribution into the cavities and the minimization of radiative loses. Given that CNRS/PROMES has long experience in point focusing technologies, particularly developing, building and operating a central receiver experimental facility and in the development of tower receivers, LNEG has proposed mobility actions to CNRS aimed at enhancing current and future cooperation between the two centres and to perform joint research activities in the area of central receiver technologies. The first mobility action was proposed in order to discuss and finalize the review of concepts of solar receivers, define how to proceed with the modelling activity (ongoing under T12.2.3) and collect information and data regarding the experimental facility that will be used to validate the model.

II. Main achievements and difficulties encountered

During the mobility period at CNRS several meetings between the LNEG researcher and CNRS researchers were performed resulting in the:

- exchange of information on the relevant works being developed in both institutions;
- assessment of the current state of the work being performed within WP12 task 12.2.3;
- jointly advance of such work by solving the main issues identified;
- discussion and conclusion of the review of concepts of solar receivers (activity 1 of T 12.2.3);
- definition of the main features of the computational model to evaluate the performance of cavities with a particular emphasis on the solar radiation distribution in the cavities and minimization of radiative loses (activity 3 of task 12.2.3);
- visit of experimental facilities;
- acquisition of previous experience and experimental data that will support the development of the code being developed under T12.2.3;
- planning of future actions within the T12.2.3 activities.

III. Joint publications foreseen

Joint publications with the results of the new code validation with CNRS experimental data and comparison between LNEG and CNRS code are foreseen for the end of 2016/beginning of 2017 within the scope of WP12 task 12.2.3 whose work was addressed during this mobility action.

IV. Comments, if any

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Caracterization of bio crude produzed during micralgae HTL

Participant's first name and family name: Paula Costa

Name of the participant's institution: LNEG (Laboratorio Nacional de Energia e Geologia I.P.)

Name of the host institution: ENEA

Onsite working period: 18 / 09 / 2017 to 21 / 09 / 2017

Onsite working time (in Person week(s))*: 0.8

Remote working time (in Person week(s))**: 0.25

I. Objectives of the mobility

Definition of a share/integrated analysis (GC/MS and CHNS) for an effective and reliable characterization of the bio-oil produced during microalgae HTL.

II. Main achievements and difficulties encountered

The main achievement was the definition of the GC/MS and CHNS analytic procedures to be implemented by LNEG and ENEA during the microalgae chlorella and HTL bio-oil (obtained by UNIPA and LNEG experimental testes) characterization. This definition makes possible the comparison of the results obtained by both institutions in the frame of the round robin test defined the project work program.
The main difficulty was that some of the equipment was not working due to technical problems.
It was also possible to visit other research group linked with solar fuels and discuss other collaboration topics.

III. Joint publications foreseen

It is expected to publish the work performed by UNIPA, LNEG and ENEA in the hydrothermal liquefaction of microalgae. UNIPA and LNEG have been performing experimental tests with the aim of optimizing the experimental conditions in order to maximize the bio-oil yield and quality. ENEA and LNEG are involved in the raw material and products characterization. The main analytical technics used are the gas chromatography/mass spectrometry and the elementary analysis (CHNS). The work in on going so is expected to submit the paper in the begging of 2018.

IV. Comments, if any

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Hydrothermal Liquefaction of microalgae

Participant's first name and family name: Filomena Pinto

Name of the participant's institution: LNEG (Laboratorio Nacional de Energia e Geologia I.P.)

Name of the host institution: UNIPA (Universita Degli Studi di Palermo)

Onsite working period: 03/07/2017 to 06/07/2017

Onsite working time (in Person week(s))*: 0.8

Remote working time (in Person week(s))**: 0.25

I. Objectives of the mobility

The main objective was to do experimental tests about hydrothermal liquefaction (HTL) of microalgae (chlorella vulgaris) to compare the differences of the procedures used by different institutions and their eventual effect on the results obtained and to define the best HTL experimental technique and analysis procedures of HTL products.
Results obtained by different institutions were compared, including process total conversion, product yields and product composition, in the frame of the round robin tests defined in the project work programme. The activities performed allowed to discuss different HTL experimental techniques and sampling and analysis procedures of HTL products and define the best technical procedures.

II. Main achievements and difficulties encountered

No big difficulties were found and the main objective of the mobility was achieved: the definition of the best HTL experimental technique and sampling and analysis procedures of HTL products.

III. Joint publications foreseen

It is expected to publish the work performed by UNIPA, LNEG and ENEA in the hydrothermal liquefaction of microalgae. UNIPA and LNEG have been performing experimental tests with the aim of optimizing the experimental conditions in order to maximize the bio-oil yield and quality. ENEA and LNEG are involved in the raw material and products characterization. The main analytical technics used are the gas chromatography/mass spectrometry and the elementary analysis (CHNS). The work in on going so is expected to submit the paper in the begging of 2018.

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IV. Comments, if any

The activities performed during this exchange and mobility of research staff was very useful to identify and discuss the differences between the procedures used by LNEG and UNIPA. After the agreement has been reached the best HTL experimental technique and sampling and analysis procedures of HTL product were defined.

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**The remote working period deals with all the preparatory work to be realized way before and after the mobility: joint work to prepare, mapping of the transfer of knowledge between both partners, preparation of experiments to do during the mobility, analysis of the experiments after the mobility, joint publications, … This will count for your mobility person month to declare and should be counted in the Remote working period.

STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Hydrothermal Liquefaction of microalgae

Participant's first name and family name: Paula Costa

Name of the participant's institution: LNEG (Laboratorio Nacional de Energia e Geologia I.P.)

Name of the host institution: UNIPA (Universita Degli Studi di Palermo)

Onsite working period: 03/07/2017 to 06/07/2017

Onsite working time (in Person week(s))*: 0.8

Remote working time (in Person week(s))**: 0.25

I. Objectives of the mobility

The main objective was to perform experimental tests of hydrothermal liquefaction (HTL) of the microalgae chlorella vulgaris, in order to compare the different procedures used by both institutions and their eventual effect on the results obtained. The results obtained by UNIPA and LNEG were compared, including process total conversion, product yields and product composition, in the frame of the round robin tests defined in the project work programme. The activities performed allowed to discuss and define different HTL experimental techniques, sampling and analysis procedures of HTL products and define the best technical procedures.

II. Main achievements and difficulties encountered

No big difficulties were found and the main objective of the mobility was achieved. The activities performed during this exchange and mobility of research staff was very useful to define the of the best HTL experimental technique, sampling and analysis procedures of HTL products, as the differences between the procedures used by LNEG and UNIPA were identified and discussed. After the agreement has been reached the best HTL experimental technique, sampling and analysis procedures of HTL product were defined.

III. Joint publications foreseen

It is expected to publish the work performed by UNIPA, LNEG and ENEA in the hydrothermal liquefaction of microalgae. UNIPA and LNEG have been performing experimental tests with the aim of optimizing the experimental conditions in order to maximize the bio-oil yield and quality. ENEA and LNEG are involved in the raw material and products characterization. The main analytical technics used are the gas chromatography/mass spectrometry and the elementary analysis (CHNS). The work in on going so is expected to submit the paper in the begging of 2018.

IV. Comments, if any

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Thermal Energy Storage for STE Plants_Aging of components with molten salts

Participant's first name and family name: Teresa Cunha Diamantino

Name of the participant's institution: LNEG

Name of the host institution: CIEMAT

Onsite working period: 06 / 03 / 2017 to 10 / 03 / 2017

Onsite working time (in Person week(s))*: 1

Remote working time (in Person week(s))**: 0.2

I. Objectives of the mobility

The main objective of the mobility was the knowledge transfer within WP 7.2 Aging of metallic components with MS, namely to complement, with advanced techniques, the morphological and chemical characterization of oxide layers formed by direct interaction of stainless steels with the MS mixtures.

II. Main achievements and difficulties encountered

- Visit to the CIMEAT facilities, namely to the following technical areas (Laboratories):
  1) Microscopy and surface Analysis with the following operational parameters: - Scanning Electron Microscopy (Field emission gunFEGSTEM). Hitachi. EDX, BSE, EBSD, TEM detectors. - Auger Spectroscopy; - X-ray Photoelectron Spectroscopy (XPS); - Transmission Electron Microscopy (TEM)- Diffraction R-X (DRX).
  2) Mechanical characterization: tensile, facture toughness, fatigue, impact, hardness and nano-indentation of irradiated materials.
  3)  Corrosion: static corrosion tests (furnaces with molten salts), natural and forced recirculation loops of water and liquid metals at high temperature.
  4) Laboratory of Solar Concentrating System Unit. Advanced optical coatings. This laboratory line is devoted to the development and complete study of new selective coatings for absorbent materials used in solar concentrating systems at medium and high temperature (up to 600°C), as well as for anti-reflective treatments for glass covers used in some receiver designs, such as receiver tubes in parabolic-trough collectors.

- Discussion of research lines with the objective of finding joint projects with focus on structural materials behavior in energy production systems with TES.

- Experimental work for morphological and chemical characterization of oxide layers formed by direct interaction of stainless steels with the MS mixtures with Auger Spectroscopy PHI 660 Scanning Auger Microprobe and with Scanning Electron Microscopy (FEGSTEM) Hitachi SU6600 with EDX and EBSD detectors.

- Discussion of Project Deliverable 7.4 (White Paper on “Compatibility of structural materials with storage materials for Thermal Energy Storage (TES) system)

No problems were found.

III. Joint publications foreseen

Yes. 1 paper in a Journal with peer-review

IV. Comments, if any

We would like to thank the technical and scientifically staff of CIEMAT from the Materials of Energy Interest Division, namely to Corrosion in Power Plants Unit and to Microestructural Characterization and Microanalyses Unit. Special thanks to Marta Navas for the exceptional support provided during my stay.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Thermal Energy Storage for STE Plants_Accelerated aging of reflectors

Participant's first name and family name: Teresa Cunha Diamantino

Name of the participant's institution: LNEG

Name of the host institution: DLR

Onsite working period: 03 / 04 / 2017 to 07 / 04 / 2017

Onsite working time (in Person week(s))*: 1

Remote working time (in Person week(s))**: 0.2

I. Objectives of the mobility

The main objective of the mobility was the knowledge transfer within WP 8.1 Accelerated aging of reflectors-, namely to comparison and discussion of results already obtained from accelerated aging tests and from outdoor exposure testing sites for the development of an integrated methodology for accelerated aging of reflectors.

II. Main achievements and difficulties encountered

- Visit to the "Plataforma Solar de Almeria – PSA" facilities, namely OPAC Laboratory (Optical Aging Characterization) including different optical characterization equipment, outdoor exposure test sites, artificial test chambers and wind tunnels, visit the parabolic trough collector test field and Linear Fresnel concentrator technology pilot demonstration plant.
- Discussion of research lines with the objective of finding joint projects with focus in durability of different materials for CSP.
- Experimental work for the evaluation of specular reflectance and the degradation, by optical microscopy, of different aluminium reflectors exposed in outdoor exposure testing site (Sines_Portugal) comparatively with the aluminium reflectors exposed in desert (Erfoud - Morocco).
- Discussion of experimental details about the evaluation of the corrosivity of outdoor testing sites
- Discussion of the structure of an internal report (Degradation mechanisms of outdoor exposed reflectors) to be presented under WP8.1 under the responsibility of LNEG.
-Evaluation the possibility of exposure of additional reflectors materials in outdoor exposure testing sites in Sines_Portugal and the comparison of results between different accelerated aging tests.

No problems were found.

III. Joint publications foreseen

Yes. 2 communications, 1 in Eurocorr'2017 and the other in SolarPaces 2017.

IV. Comments, if any

We would like to thank the technical and scientifically staff of PSA (CIEMAT and DLR) namely to the team from the OPAC Laboratory. Special thanks to Florian Sutter (DLR), Arantxa Fernandez (CIEMAT) and Johannes Wette (DLR) for all the support provided during my stay.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Study of cogeneration applications in the agro-industrial sector

Participant's first name and family name: João Cardoso

Name of the participant's institution: LNEG

Name of the host institution: FUSP

Onsite working period: 02 /10 / 2017 to 13 / 10 / 2017

Onsite working time (in Person week(s))*:2

Remote working time (in Person week(s))**: 0.5

I. Objectives of the mobility

Within WP6, International Cooperation, Task 6.3.2 – Brasil, LNEG and USP are collaborating in central receiver systems research, aiming for the development of hybrid systems and co-generation applications in agro-industrial applications. This collaboration encompasses two major areas: the development of suitable models for the simulation of central receiver systems (CRS) for co-generation applications in the agro-industrial sector and the study of co-generation applications within the agro-industrial sector. While LNEG has long experience in modelling and simulation of solar thermal systems (namely with the TRNSYS software), USP has valuable knowledge regarding agro-industrial processes, being also developing an experimental facility within their premises at Pirassununga, consisting of a small CRS powering a slaughterhouse (SMILE project). This mobility action aimed at enhancing the collaboration between the two institutions through the performance of specific joint R&D activity, namely:

- Development of a TRNSYS model for central receiver systems fitting the USP new plant design;
- Simulation of the USP central receiver plant coupled to an agro-industrial application;
- Development of a case-study for the plant, to be included in D6.4;
- Follow up of the construction/commissioning of the demonstration plant being built at USP-Pirassununga.

II. Main achievements and difficulties encountered

During the mobility period joint R&D activities were performed by LNEG and USP researchers resulting in:

- Development of a CHCP system model in TRNSYS consisting of a small CRS with pressurized air receiver coupled with a gas turbine;
- Development of a CHCP system model in TRNSYS consisting of a small CRS with atmospheric pressure air receiver coupled with an ORC, following USP new plant design;
- Definition of the main features of the agro-industrial application to be considered as case study for D6.4 – particularly thermal and electrical load;
- Exchange of knowledge regarding the demonstration plant being built at USP-Pirassununga.

Due to USP lack of experience regarding TRNSYS modelling and in order to enable a suitable collaborative R&D activity it was necessary to perform some basic training in TRNSYS modelling, thus, a short course (4h) on TRNSYS was performed during the stay.

The experimental plant construction is delayed due to a power block technology change which required a project reformulation, thus no experimental data was available to calibrate and validate the models.

III. Joint publications foreseen

Two publications can be foreseen: a first, based on the developed models, presenting the results of the feasibility study of the application of the USP CRS to a slaughterhouse, as a case study; a second, after the commissioning of the plant (thus after the end of the STAGE-STE project) presenting an improved model, developed and validated with the experimental data collected at USP.

IV. Comments, if any

Please do not exceed 10 to 15 lines

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: "Accelerated aging of reflectors - measurement of optical properties of reflectors"

Participant's first name and family name: Maria João Carvalho

Name of the participant's institution: LNEG

Name of the host institution: CIEMAT/PSA

Onsite working period: 29 / 05 / 2016 to 3 / 06 / 2016

Onsite working time (in Person week(s))*: 1

Remote working time (in Person week(s))**: 2

I. Objectives of the mobility

The objectives of the mobility were centered in the discussion of the measurement of the optical properties of mirrors – hemispherical reflectivity and specular reflectance. These properties measured before and after accelerated aging tests and natural exposure of mirror samples allow quantitative evaluation of the degradation of the mirrors. They are key measurements in the frame of WP8 and subtasks 8.1.2., 8.1.3 and 8.1.4
A key factors in the measurement of hemispherical reflectivity is the standard mirror used. Since LNEG recently acquired a calibrated standard mirror, one important aspect was the discussion of results obtained with this new standard mirror.
Since LNEG does not have the equipment for measurement of specular reflectivity, another objective was to discuss the equipment's available for this measurement as information for a possible future acquisition.

II. Main achievements and difficulties encountered

During the mobility I was received by the colleagues at OPAC, Arantxa Fernandez from CIEMAT and Florian Sutter from DLR. I visited the Laboratories at OPAC where accelerated aging tests are performed as well as the part of the Laboratory dedicated to the measurement of optical properties.
The mirrors used at LNEG as reference mirrors for measurements done in the frame of WP8, subtask 8.1.3 that have been previously calibrated at OPAC were measured again and results compared. It was possible to see that no relevant changes occurred in their optical properties in a two years period. Comparison with the measurement of the mirrors made with the calibrated reference standard recently acquired showed the need to check with calibration laboratory the calibration results.
The exchange of experience with colleagues at OPAC will allow improvement of the measuring methodologies at LNEG.
It was also possible to visit the outdoor test stands for mirrors at PSA in a visit guided by Florian Sutter.
Although not in the initial objectives of the mobility, it was also possible to have a meeting with Loreto Valenzuela related to the work in WP11, subtask 11.2.1.
A general visit of the Plataforma Solar de Almeria was also performed profiting from the fact that the ExCO members of TCP of IEA – Solar heating and Cooling were received at the same time at PSA.

III. Joint publications foreseen

In the frame of the WP8, subtask 8.1.3 results of Round Robin for measurement of optical properties and future subtasks 8.1.3 and 8.1.4 results of the accelerated aging tests and natural exposure of mirror samples may result in joint publications and are also part of internal reports of the WP8.

IV. Comments, if any

The possibility to be in PSA with CIEMAT and DLR colleagues and discuss all the work jointly performed in the frame of WP 8 was very important for the continuation of this work. They received me in very open and collaborative way.
The same ambience was felt in the meeting with Loreto Valenzuela and will for sure reflect on the work to be performed within WP11, sub task 11.2.1.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: **Hydrogen production using cork-based ceria ecoceramics**

Participant's first name and family name: Fernando Oliveira

Name of the participant's institution: LNEG I.P. (Portugal)

Name of the host institution: CNRS-PROMES, Odeillo (France)

Onsite working period: 09 / 05 / 2017 to 12 / 05 / 2017

Onsite working time (in Person week(s))*: 0.8

Remote working time (in Person week(s))**: 1

I. Objectives of the mobility

Meeting with Dr. Stéphane Abanades and preliminary tests of ceria foams under development at LNEG for planning of collaborative future activities in the area of innovative materials for the next generation solar chemical reactors for water splitting under solar irradiation for the production of solar fuels (e.g. H_2 and/or CO).
The major achievements of the work carried out on the topic mentioned above which were obtained in the frame of Task 9.3 of STAGE-STE project were presented and discussed at the 6th Technical meeting held in the afternoon of May 11th and planned actions were agreed.

II. Main achievements and difficulties encountered

Ceria foams developed at LNEG showed typical behavior under redox conditions similar to that of pure CeO_2 powder (~ 50 µmol/g of O_2 release) when using CO_2 as oxidizing gas in a thermobalance. In order to enhance kinetics, it has been agreed that both CeO_2-based ecoceramics derived from cork templates and foams made from polyurethane substrates will require additions of Zr (25-50 at%); this must be defined and agreed between the University of Aveiro and LNEG.
Once the required amounts of materials (roughly 10 g for each test) will be available, a test campaign will be carried out under SFERA II project, according to the proposal H2SOLAR (registed as P1701250237), either in the second half of July or the first half of September. Prior to the tests under solar irradiation, preliminary tests shall be carried out using a TG-SETARAM equipment for evaluating the reactivity of the developed materials and define the optimum conditions to perform tests under solar thermochemical cycles.
A thoroughly characterization of the materials by means of XRD, SEM and specific surface area will be performed prior and after solar irradiation. Cyclic tests will assess reproducibility of the thermochemical reaction yield using CO_2 (H_2O tests are also scheduled providing suitable weather conditions are prevalent).

III. Joint publications foreseen

Results of this joint collaboration will be published in a SCI journal from this area of expertise reporting major findings.

IV. Comments, if any

The experiments to be undertaken at the CNRS-PROMES laboratory should provide useful information on whether ceria ecoceramics can be regarded as a potential solution towards improving the overall efficiency of solar fuel production or not using solar facilities which are not available in Portugal.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: **Integration/hybridization of TES in STE plants**

Participant's first name and family name: **Pedro Azevedo**

Name of the participant's institution: **LNEG**

Name of the host institution: **ENEA**

Onsite working period: **10 / 12 / 2017 to 15 / 12 / 2017**

Onsite working time (in Person week(s))*: **1**

Remote working time (in Person week(s))**: **0,2**

I. Objectives of the mobility

LNEG is currently devoted to CSP technology research in areas such as thermal energy storage, plant simulation and control strategies. Simulation models are being developed for parabolic trough and central receiver plants using Trnsys and Python, as well as for thermal energy storage, namely in a single tank system, using Ansys.The development of these simulation tools are important not only due to the research abilities and knowledge it creates but also because it allows greater support to the development and installation of CSP plants in Portugal through accurate study and simulation of the feasibility, behavior and yield of future CSP plants operating in the country both for power generation and for integration of solar heat in industry. The proposed work aims to visit and study the operation and control schemes of hybrid solar systems used in Casaccia Research Center (ENEA), namely the PCS (Prova Colletori Solari) and the ORC-PLUS (Organic Rankine Cycle – Prototype Link to Unit Storage) facilities. The first using molten salts as transport fluid and the latest using thermal oil.

II. Main achievements and difficulties encountered

Pedro Azevedo visited ENEA with the objective of getting a better knowledge of several high temperature thermal energy storage solutions including system operation parameters and monitoring system, namely regarding the heat sources and the heat sinks, as well as used materials.The preparation of the works to be developed throughout the STAGE-STE mobility period was organized with Dr. Walter Gaggioli. The development of the proposed work had full collaboration of Dr. Walter Gaggioli and his colleagues team: Massimo Falchetta, Salvatore Sau, Valeria Russo, Elisabetta Veca, Domenico Mazzei and Carlo Rocca as well as Tommaso Crescenzi, Responsible of division, and Antonio De Luca, Responsible of laboratory.The work developed allowed the identification of computational limitations and the implementation of experimental solutions that will allow to improve the computational models under development and to be developed.Additionally, experimental data will be gathered in order to validate some models components' for numerical simulation of thermal energy storage systems being developed at LNEG.Nevertheless, climate restrictions (bad weather, including frequent showers and clouded skies) made impossible to acquire online data and to testify the PCS plant in operation. However, the participant gathered information regarding plant operating and monitoring equipment.Finally, the ENEA facilities were fully prepared and offered excellent reception conditions, both on the technical and administrative levels.

III. Joint publications foreseen

Participation in the final version of deliverable D7.16 of STAGE-STE and, eventually, the preparation of a scientific article for publication in journal or in a conference.

IV. Comments, if any

Please do not exceed 10 to 15 lines

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Individual activity report

Each participant of the mission have to fill in this document personally.
Please upload it following the mail in which this document was attached.

Title of the mission: Information exchange regarding pilot scale solar steam gasification

Group Leader first name and family name: Christian Wieckert

Participant's first name and family name: Christian Wieckert

Name of participant's institute: CIEMAT-PSA

Name of the home institute: PSI

Working stay period: Nov. 30 – Dec 3, 2015

Onsite working time (person-week): 0.8

Remote working time (person-week): 1.2

I. Objectives of the project *(Please do not exceed 10 to 15 lines)*

Within the joint project SOLSYN of PSI-ETHZ-Holcim a complete packed-bed solar steam gasification plant including all required upstream and downstream components and balance of plant infrastructure had been build and operated at the large tower of the Plataforma Solar de Almeria within the years 2010 and 2011. The experiments have been performed by HOLCIM and PSI staff, with the personal from the Plataforma Solar de Almeria just being responsible for the on demand provision of solar radiation from the heliostat field and for the media provision. After the finalization of the Solsyn-project the pilot plant was owned by PSI. In spring 2015 PSI transferred the ownership of the pilot plant "in its present condition and without any warranty" to CIEMAT/Plataforma Solar de Almeria. This also includes the process control system including control hardware and a set of spare materials.

The objective of this mission was the detailed know how transfer about the components of the plant, about its process control and its operation in order to enable CIEMAT-personal in the future to do the required maintenance and to be able to operate this complex thermochemical solar reactor and system on their own.

II. Main achievements and difficulties encountered *(Please do not exceed*

After a significant activity to prepare the mission beforehand the further main action have been performed:

- Detailed explanation of the whole plant including its operation and the respective finding regarding hardware and process behavior
- Handover of all available documentation of the plant components, including the final report of the project (slightly adapted by omitting certain specifically confidential parts related to the strategy of HOLCIM) and including thousands of photos from the installation and operation period in 2010/2011.
- Restart and explanation of the process control system after being 4 years out of operation.

As expected and partially known not all components are still fully operational. Prior to a full restart of the plant certain repairs have to be performed. This includes replacement of parts of the beam down mirrors, installation of a new quartz window and at least some of the emitter plates, maintenance of the steam distribution, replacement of broken thermocouples etc..

1 page)

III. Personal contribution for the mission *(Please do not exceed 10 to 15 lines)*

Leader of the mission; explanation of the process and the plant components, preparation, selection and brief explanation of the huge amount of (mostly virtual) documents handed over to CIEMAT.

IV. Joint publications foreseen *(Please do not exceed 10 to 15 lines)*

At this point no publications. Joint publications might be generated based on future further solar operation of the plant.

V. Comments, if any *(Please do not exceed 1 page)*

A follow-up stay of persons from PSI at the Plataforma Solar de Almeria might be considered in case first new experiments should be started.

Individual activity report

Each participant of the mission have to fill in this document personally.
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Title of the mission: Information exchange regarding pilot scale solar steam gasification

Group Leader first name and family name: Christian Wieckert

Participant's first name and family name: Yvonne Bäuerle

Name of participant's institute: CIEMAT-PSA

Name of the home institute: PSI

Working stay period: Nov. 30 – Dec 3, 2015

Onsite working time (person-week): 0.8

Remote working time (person-week): 1.2

I. Objectives of the project *(Please do not exceed 10 to 15 lines)*

Within the joint project SOLSYN of PSI-ETHZ-Holcim a complete packed-bed solar steam gasification plant including all required upstream and downstream components and balance of plant infrastructure had been build and operated at the large tower of the Plataforma Solar de Almeria within the years 2010 and 2011. The experiments have been performed by HOLCIM and PSI staff, with the personal from the Plataforma Solar de Almeria just being responsible for the on demand provision of solar radiation from the heliostat field and for the media provision. After the finalization of the Solsyn-project the pilot plant was owned by PSI. In spring 2015 PSI transferred the ownership of the pilot plant "in its present condition and without any warranty" to CIEMAT/Plataforma Solar de Almeria. This also includes the process control system including control hardware and a set of spare materials.

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II. Main achievements and difficulties encountered *(Please do not exceed 1 page)*

After a significant activity to prepare the mission beforehand the further main action have been performed:

- Detailed explanation of the whole plant including its operation and the respective finding regarding hardware and process behavior
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- Restart and explanation of the process control system after being 4 years out of operation.

As expected and partially known not all components are still fully operational. Prior to a full restart of the plant certain repairs have to be performed. This includes replacement of parts of the beam down mirrors, installation of a new quartz window and at least some of the emitter plates, maintenance of the steam distribution, replacement of broken thermocouples etc..

III. Personal contribution for the mission *(Please do not exceed 10 to 15 lines)*

Electrical Engineer; Recommissioning of the complete process controlling. Explanation and demonstration on how to start up and operate the plant. Plus some small program improvements.

IV. Joint publications foreseen *(Please do not exceed 10 to 15 lines)*

At this point no publications. Joint publications might be generated based on future further solar operation of the plant.

V. Comments, if any *(Please do not exceed 1 page)*

A follow-up stay of persons from PSI at the Plataforma Solar de Almeria might be considered in case first new experiments should be started.

STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: nanoparticles, nanofluids and nanosalts.

Participant's first name and family name: Javier Nieto

Name of the participant's institution: TECNALIA

Name of the host institution: CNR

Onsite working period: 11 / 11 / 2015 to 13 / 11 / 2015

Onsite working time (in Person week(s))*: 0.6

Remote working time (in Person week(s))**: 0.4

I. Objectives of the mobility

Similar to the mobility performed to ENEA previously this year, the main objective of the mobility was to share working methods on the field of molten salt based nanofluids to be used as Thermal Energy Storage (TES) and/or Heat Transfer Fluid. Both research centers are actively working on the enhancement of thermophysical properties of these materials by dopping with different types of nanoparticles.

Preparation and analytical procedures were compared and a guideline for collaboration was established. Together with this, collaboration in simulation of nano-salts was established.

II. Main achievements and difficulties encountered

The main achievements were:

- To share the activities that are being developed by CNR and TECNALIA on the field of molten salt based nanofluids for TES applications.
- To establish a guideline for collaboration in the sense of synthesis and characterization of these kind of materials and also their simulations.
- Different nanoparticles synthesized by CNR are being now employed by Tecnalia for the novel nanosalt synthesis.
- Thermophysical properties by nanosalts developed by Tecnalia have been shared with CNR for their use in simulation studies.

No major difficulties were encountered, but a long distance between the different research centers, that implied longer time in displacements.

III. Joint publications foreseen

Future publications are foreseen. A good collaboration is seen in terms of novel nanoparticle synthesis, novel nanofluids and their characterization and also in simulation of these.

IV. Comments, if any

The visit was very interesting as CNR and TECNALIA's capabilities were complementary, and it was a good starting point for collaboration in the following months. A guideline of tasks has already been designed, and future participation in common projects have been foreseen.

Apart from this, the visit helps Tecnalias work in coordinating subtask 7.3.2 activities where nanosalts are being considered.

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STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: nanosalts.

Participant's first name and family name: Javier Nieto

Name of the participant's institution: TECNALIA

Name of the host institution: ENEA

Onsite working period: 10 / 03 / 2015 to 12 / 03 / 2015

Onsite working time (in Person week(s))*: 0.6

Remote working time (in Person week(s))**: 0.2

I. Objectives of the mobility

The main objective of the mobility was to share working methods on the field of molten salt based nanofluids to be used as Thermal Energy Storage (TES) and/or Heat Transfer Fluid. Both research centers are actively working on the enhancement of thermophysical properties of these materials by dopping with different types of ceramic nanoparticles. Preparation and analytical procedures were compared and a guideline for collaboration was established. Another objective of the mobility was to visit ENEA facilities for testing TES in Casaccia. These semindustrial facilities are a good starting point for further collaboration. Today, ENEA is working closely with the University of Perugia. A one-day visit to Perugia laboratories was planned and performed. Different characterization methods for salt based nanofluids were exposed and further collaboration on this field was proposed.

II. Main achievements and difficulties encountered

The main achievements were:

- To share the activities that are being developed by ENEA and TECNALIA on the field of molten salt based nanofluids for TES applications.
- To establish a guideline for collaboration in the sense of synthesis and characterization of these kind of materials.
- To know the semiindustrial ENEA facilities for TES in molten salt based nanofluids, either as heat transfer fluid (HTF) or as phase change material (PCM)
- To know the University of Perugia laboartories and capabilities for salt based nanofluids characterization, and plan new collaboration tasks.

No major difficulties were encountered, but a long distance between the different research centers, that implied longer time in displacements.

III. Joint publications foreseen

A future publication was foreseen, where the synthesis of nanofluids and initial characterization of nanofluids (size distribution) will be performed by TECNALIA, and further characterization (viscosimetry) will be performed by ENEA.

IV. Comments, if any

The visit was very interesting as ENEA and TECNALIA's capabilities were complementary, and it was a good starting point for collaboration in the following months. A guideline of tasks has already been designed, and future participation in common projects have been foreseen.

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Nanosalts.

Participant's first name and family name: David Alfredo Pacheco Tanaka

Name of the participant's institution: TECNALIA

Name of the host institution: ENEA

Onsite working period: 10 / 03 / 2015 to 12 / 03 / 2015

Onsite working time (in Person week(s))*: 0.6

Remote working time (in Person week(s))**: 0.1

I. Objectives of the mobility

The main objective of the mobility was to share working methods on the field of molten salt based nanofluids to be used as Thermal Energy Storage (TES) and/or Heat Transfer Fluid. Both research centers are actively working on the enhancement of thermophysical properties of these materials by dopping with different types of ceramic nanoparticles. Preparation and analytical procedures were compared and a guideline for collaboration was established. Another objective of the mobility was to visit ENEA facilities for testing TES in Casaccia. These semindustrial facilities are a good starting point for further collaboration. Today, ENEA is working closely with the University of Perugia. A one-day visit to Perugia laboratories was planned and performed. Different characterization methods for salt based nanofluids were exposed and further collaboration on this field was proposed.

II. Main achievements and difficulties encountered

The main achievements were:

- To share the activities that are being developed by ENEA and TECNALIA on the field of molten salt based nanofluids for TES applications.
- To establish a guideline for collaboration in the sense of synthesis and characterization of these kind of materials.
- To know the semiindustrial ENEA facilities for TES in molten salt based nanofluids, either as heat transfer fluid (HTF) or as phase change material (PCM)
- To know the University of Perugia laboartories and capabilities for salt based nanofluids characterization, and plan new collaboration tasks.

No major difficulties were encountered, but a long distance between the different research centers, that implied longer time in displacements.

III. Joint publications foreseen

A future publication was foreseen, where the synthesis of nanofluids and initial characterization of nanofluids (size distribution) will be performed by TECNALIA, and further characterization (viscosimetry) will be performed by ENEA.

IV. Comments, if any

The visit was very interesting as ENEA and TECNALIA's capabilities were complementary, and it was a good starting point for collaboration in the following months. A guideline of tasks has already been designed, and future participation in common projects have been foreseen.

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Nanosalts.

Participant's first name and family name: David Alfredo Pacheco Tanaka

Name of the participant's institution: TECNALIA

Name of the host institution: CNR

Onsite working period: 11 / 11 / 2015 to 13 / 11 / 2015

Onsite working time (in Person week(s))*: 0,6

Remote working time (in Person week(s))**: 0.2

I. Objectives of the mobility

Similar to the mobility performed to ENEA previously this year, the main objective of the mobility was to share working methods on the field of molten salt based nanofluids to be used as Thermal Energy Storage (TES) and/or Heat Transfer Fluid. Both research centers are actively working on the enhancement of thermophysical properties of these materials by dopping with different types of nanoparticles.

Preparation and analytical procedures were compared and a guideline for collaboration was established. Together with this, collaboration in simulation of nano-salts was established.

II. Main achievements and difficulties encountered

The main achievements were:

- To share the activities that are being developed by CNR and TECNALIA on the field of molten salt based nanofluids for TES applications.
- To establish a guideline for collaboration in the sense of synthesis and characterization of these kind of materials and also their simulations.
- Different nanoparticles synthesized by CNR are being now employed by Tecnalia for the novel nanosalt synthesis.
- Thermophysical properties by nanosalts developed by Tecnalia have been shared with CNR for their use in simulation studies.

No major difficulties were encountered, but a long distance between the different research centers, that implied longer time in displacements.

III. Joint publications foreseen

Future publications are foreseen. A good collaboration is seen in terms of novel nanoparticle synthesis, novel nanofluids and their characterization and also in simulation of these.

IV. Comments, if any

The visit was very interesting as CNR and TECNALIA's capabilities were complementary, and it was a good starting point for collaboration in the following months. A guideline of tasks has already been designed, and future participation in common projects have been foreseen.

Apart from this, the visit helps Tecnalias work in coordinating subtask 7.3.2 activities where nanosalts are being considered.

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: *Corrosion tests on MS* at ENEA

Participant's first name and family name:Nerea Uranga

Name of the participant's institution: Ik4_Tekniker

Name of the host institution:ENEA

Onsite working period: 08 / 06 / 2015 to 12 / 06 / 2015

Onsite working time (in Person week(s))*:1

Remote working time (in Person week(s))**:1

I. Objectives of the mobility

ENEA has a large experience measuring thermal properties and the objective of this mobility was to share the characterization techniques between ENEA and IK4-Tekniker. The measurement of some parameters shows a big difficulty such as heat capacity measurement. The objective was to see the protocol that it is used to measure them. For other side, in ENEA is carried out the measurement of some parameters that in Ik4-Tekniker is not possible such as viscosity and density

II. Main achievements and difficulties encountered

- Measure IK4-tekniker samples thermal properties in ENEA
- Measure IK4-tekniker samples chemical composition in ENEA
- Carry out the measurement of new parameters with IK4-Tekniker samples, such as viscosity and density
-

III. Joint publications foreseen

It is not any publication foreseen

IV. Comments, if any

Please do not exceed 10 to 15 lines

Each participant of the mobility have to fill in this document personally.
Please upload it following the instructions of the email in which this document was attached.

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: *Durability tests Analysis for coated reflectors*

Participant's first name and family name: *Julen Vadillo*

Name of the participant's institution: *IK4-Tekniker*

Name of the host institution: *CIEMAT*

Onsite working period: *22 / 06 / 2015 to 25 / 06 / 2015*

Onsite working time (in Person week(s))*: *0.8*

Remote working time (in Person week(s))**: *1.0*

I. Objectives of the mobility

The main objective of the mobility was to acquire knowledge about the characterization of coated mirrors before degradation process made in CIEMAT. In addition to this, another objective was to know more about the procedure of the degradation process itself and the correct analysis of the coated samples. Another interest was to know more about the use of artificial dirt to make anti soiling tests.

II. Main achievements and difficulties encountered

During my mobility I have learned successfully different types of tests to study the durability of the mirrors and also I learn from the experience of the personal of CIEMAT on the analysis of mirrors finding rust spots and defects in the mirror, and some tricks to detect them.

I received information and tip to make my own artificial dirt too, although they did not use any artificial dirt for anti-soiling test because obviously they use the sand of the desert. Any way they gave me some intersecting articles about the procedure to make artificial dirt.

III. Joint publications foreseen

-

IV. Comments, if any

Highlight the great behavior of all the personal of the CIEMAT during my mobility, answering all my questions and showing me their equipment and methods; and also for giving me the opportunity to acquire helpful information for my future work in Stage project.

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: *Synthesis and Characterization of new formulated molten salts* at DLR

Participant's first name and family name: Nerea Uranga

Name of the participant's institution: IK4-tekniker

Name of the host institution: DLR

Onsite working period: 18 / 04 / 2016 to 22 / 04 / 2016

Onsite working time (in Person week(s))*:1

Remote working time (in Person week(s))**: 1

I. Objectives of the mobility

The exchange was divided into two

1) Preparation of the deliverable 7.1 and the paper
2) Synthesis and characterization of new molten salts

Preparation of the deliverable 7.1 and the paper

DLR and IK4-tekniker have discussed about the contents of the deliverable and paper. It is decided to have webex meeting to ask to other partners their contributions.

Synthesis and characterization of new molten salts

- Synthesis of new molten salts:
  DLR has shown the reactor where they do the new salts
- Characterization of molten salts
  - DLR has shown the different equipment (DSC, Tg, LFA (thermal conductivity) and they have explain the method used for measuring different parameters

II. Main achievements and difficulties encountered

Main achivemets

Deilverable and paper contents definition

Heat capacity measurement method discussion

III. Joint publications foreseen

It is going to prepare a paper related with the work done in the task 7.1

IV. Comments, if any

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EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Modelling, control, Operation and Maintenance task inside WP11: Dynamic tests for PTs

Participant's first name and family name: Eduardo Ubieta

Name of the participant's institution: IK4-TEKNIKER

Name of the host institution: PSA-CIEMAT

Onsite working period: 18/05/2016-21/05/2016

Onsite working time (in Person week(s))*: 0.6

Remote working time (in Person week(s))**: 1.2

I. Objectives of the mobility

The objective of the mobility to the PSA was to acquire the data needed for the dynamic validation of the Parabolic-Trough Solar Collectors in order to validate the developed Dymola´s model. It has also been possible to see the different technologies used for the exploitation of solar energy, focusing on the operation of PTCs.

II. Main achievements and difficulties encountered

- We have been able to see different systems for the exploitation of solar energy.
- We have seen how the PTCs are operated, and obtain the data necessary for the dynamic validation of the PTC model of Dymola.
- The difficulties we have found there have been due to the climate, which has not allow us to obtain as much information as we would have liked.

III. Joint publications foreseen

IV. Comments, if any

The behaviour of the personal of the PSA-CIEMAT has been very good, showing us all the systems and methods and answering all the questions.

Each participant of the mobility have to fill in this document personally.
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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Modelling, control, Operation and Maintenance task inside WP11: Dynamic tests for PTs

Participant's first name and family name: Itzal del Hoyo

Name of the participant's institution: IK4-TEKNIKER

Name of the host institution: PSA-CIEMAT

Onsite working period: 18/05/2016-21/05/2016

Onsite working time (in Person week(s))*: 0.6

Remote working time (in Person week(s))**: 2

I. Objectives of the mobility

The objective of the mobility to the PSA was the fulfillment of some dynamic tests with the aim of validating a previously developed CCP physical model

II. Main achievements and difficulties encountered

- Main achievement: data-results for validating the model from both the steady state and dynamic tests
- Other achievements:
  - Comprehension of the way to carry out this kind of measurements and tests in a CCP system
  - Development of a sort of dynamic test:
    - Change in inlet mass flow
    - Change in incoming radiation
    - Change in inlet temperature
  - Understanding of the operation of different solar system technologies present in PSA
- The difficulties encountered were uniquely related to the weather, which impeded to obtain all the data needed, nevertheless, the PSA staff promised to perform the pending tests in the following weeks, and they sent us in some days after our return the information

III. Joint publications foreseen

SolarPACES 2016 congress accepted our abstract

IV. Comments, if any

The staff of PSA-CIEMAT gave us a warm welcome and shared with us all the time and information needed for achieving our aim.

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: **Characterisation tests for heliostats**

Participant's first name and family name: David Olasolo

Name of the participant's institution: IK4-TEKNIKER

Name of the host institution: CIEMAT

Onsite working period: 17 / 10 / 2016 to 28 / 10 / 2016

Onsite working time (in Person week(s))*: 2

Remote working time (in Person week(s))**: 3

I. Objectives of the mobility

The objective is to test the behaviour of the heliostat developed by Tekniker and Cener, together with a calibration system.

II. Main achievements and difficulties encountered

The heliostat was transported from Tekniker to the Plataforma Solar de Almeria and was installed in the solar field of the CESA-1 facilities, at a distance of 377m to the tower. After the setup and calibration process, the heliostat was put into tracking mode and was able to reflect the sun onto the target in the tower. However, due to the bad weather and the lack of sunlight during a long period of time, PSA could not run the tracking tests, so the accuracy of the tracking could not be measured. Because of this, the heliostat was left there in order to be tested later by PSA under better weather conditions.

III. Joint publications foreseen

Publications may be made after the completion of the tests.

IV. Comments, if any

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Study of pressurized water and thermal oil hydraulic loop control and monitoring procedures

Participant's first name and family name: João Marchã

Name of the participant's institution: Universidade de Évora

Name of the host institution: CIEMAT

Onsite working period: 20 / 11 / 2016 to 25 / 11 / 2016

Onsite working time (in Person week(s))*: 1.0

Remote working time (in Person week(s))**: 0.5

I. Objectives of the mobility

The main objective of the mobility was to gain expertise in the operation of thermal oil and pressurized water loops used for solar collector testing.
Since a new test loop was recently built in the University of Évora this activity was an opportunity to learn from the vast experience CIEMAT have in this field not only from the main researchers but also from the technical personal and plant operators.
The activities focused on: startup, heating and cool down procedures; control strategies; definition of monitoring variables; control under different operating conditions; safety procedures and maintenance procedures.
This mobility gave also the opportunity to discuss with the work package 11 leader the ongoing work on the subtasks University of Evora is involved.

II. Main achievements and difficulties encountered

Extensive information was gathered related to the design, construction, operation and maintenance of parabolic through collectors thermal loops. The data acquisition and control systems were studied in detail. No difficulties were encountered and the host institution (CIEMAT) provided everything to make this activity to fulfill all its goals.

III. Joint publications foreseen

Due to the technical objective of the visit no joint publications are foreseen directly related with this action. Nevertheless future collaboration in several different research topics was discussed and is expected to result in joint publication.

IV. Comments, if any

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Energy storage in Solid Materials

Participant's first name and family name: Luis Guerreiro

Name of the participant's institution:University of Evora

Name of the host institution: ETHZ

Onsite working period: 19 / 04 / 2015 to 25 / 04 / 2015

Onsite working time (in Person week(s))*: 1

Remote working time (in Person week(s))**: 6

I. Objectives of the mobility

Objectives:
1- Define a joint research program related to energy storage
2- Write down a joint publication or Project Proposal

Activities includes following tasks:
1- Select good candidates for solid materials as HSM
2- Discussion on the trade-off of the material selection performed
3- Identification of the most critical properties for the system defined and how they could be improved
4- Discuss design of a solid material exchange unit
5- Discuss validation possibilities (lab scale vs prototype scale integrated in the EMSP)

II. Main achievements and difficulties encountered

Achievements:
1- Presentation of research performed / to be performed in a Thermal Energy Symposium on April 2015
2- Joint research proposal to H2020 program written (which was later approved)

III. Joint publications foreseen

Joint Publications:
1- Project Proposal "Newsol" to the H2020 Program, to perform long term research on the topic
2- 1 joint publication foreseen (under preparation)

Communications:
1- Presentation of research performed / to be performed in a Thermal Energy Symposium held on April 2015

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IV. Comments, if any

From this experience, it turns out to be clear, that mobilities are key for the success of joint projects / proposals.

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility: ***Advanced modelling of the transient operations of a MED-TVC plant***

Participant's first name and family name: ***Andrea Cipollina***

Name of the participant's institution: ***UNIPA***

Name of the host institution: ***CIEMAT - Plataforma Solar de Almeria***

Working stay period: 0***1/06/2015 to 30/06/2015***

Onsite working time (in Person week(s))*: 4

Remote working time (in Person week(s))**: 4

I. Objectives of the mobility

The objectives of the mobility focus on the analysis of the steady-state and dynamic behaviour of solar-powered MED and MED-TVC desalination units. The original plan contemplated either experimental activities, aiming at collecting experimental information on the MED unit available at PSA facilities, and theoretical/modelling activities, aiming to further implement a dynamic modelling tool already available at UNIPA. The final goal was the tuning and validation of the model, in order to develop, implement and provide to the technical-scientific community a reliable simulation tofol for the prediction of transient operations of MED and MED-TVC desalination plants.

II. Main achievements and difficulties encountered

The mobility period has allowed a very successful integration of UNIPA staff member with the staff of CIEMAT-PSA research unit. A fruitful joint activity has been carried out in order to make a careful comparison of the two models so fare developed by PSA and UNIPA and highlight the main strengths and weakness of each one, thus defining the routes for improvement of both modelling approaches.
This was applied both to the model for the MED unit and to the model for the thermo-ejector. This latter, in particular, has been implemented for the first time using first principles equations making the model (after calibration with experimental data from a real ejector) a fully predictive tool for the simulation of the behaviour of the thermo-ejector under very different operating conditions.
As it concerns the collection of experimental data from the MED plant at the PSA facilities, this was not possible due to some maintenance activities going on during the mobility period. However, other experimental data, available form the industrial MED-TVC plant operating in Trapani (Italy), were adopted for the model validation.
Moreover, during the mobility period several visits were performed at all the solar-desalination experimental facilities available at PSA, attending also some commissioning activities performed on new installations. This has allowed the UNIPA researcher and PSA staff to identify a number of possible future collaboration actions (e.g. on the performance analysis and modelling activity of steam-ejectors; on the use of Forward Osmosis and Pressure Retarded Osmosis for energy recovery and efficiency enhancement in solar-powered desalination plants; on the development of new strategies for improving operations, control & optimization of solar membrane distillation systems; etc.), which will strengthen the cooperation between the two institutions and allow the achievement of interesting outcomes in terms of development of new modelling tools and performing novel experimental campaign for collection of operating data in solar-powered pilot desalination systems.

III. Joint publications foreseen

The following article has been prepared and will be submitted for publication on a ISI journal within the end of October:
A dynamic model for the prediction of transient operation in a MED-TVC desalination plant. A. Cipollina, M. Agnello, A. Piacentino, A. Tamburini, B. Ortega, P. Palenzuela, D. Alarcon, G. Micale

Another joint publication is foreseen, where the two models developed by UNIPA and PSA will be compared, improved, thus leading to a unified modeling tool including the best features of the two models.

IV. Comments, if any

Please do not exceed 1 page

STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: **Modeling the MED-TVC process coupled with CSP by TRNSYS**

Participant's first name and family name: **Andrea Cipollina**

Name of the participant's institution: **Università degli Studi di Palermo (UNIPA)**

Name of the host institution: **Laboratorio Nacional de Energia e Geologia (LNEG)**

Onsite working period: **03 / 11 / 2015 to 05 / 11 / 2015**

Onsite working time (in Person week(s))*: **0.6**

Remote working time (in Person week(s))**: **0.4**

I. Objectives of the mobility

- analysis of the results of the techno-economic analysis of a MED-TVC plant coupled with a CSP system;
- training on the use of TRNSYS simulator and presentation of the MED model implemented;
- discussion and planning on future exchange of UNIPA staff to LNEG within the Stage-STE WP4.

II. Main achievements and difficulties encountered

LNEG staff presented the modeling activities carried out for the simulation of a CSP-MED plant. Simulations were performed using TRNSYS, a modeling platform widely used by the CSP community for the transient simulation of CSP plants, but not yet adopted for the simulation of desalination units. With this respect, the work performed at LNEG is very original and the transfer of knowledge to UNIPA staff has been very useful in order to highlight differences and potentials of using such new modeling platform instead of the one presently adopted by UNIPA (gPROMS). The discussion has been also extended to other possible research activities, which could be the focus of a longer mobility of UNIPA staff at LNEG in the near future. In particular, the following topics have been identified as suitable for a joint activity relevant to WP10:

- Experimental testing, modeling and optimization of a Humidification/De-Humidification pilot system powered by solar energy or waste heat from a CSP plant;
- modeling novel co-generation schemes (including DES) for CSP plants;
- CFD modeling of molten-salts thermal storage systems for 24H operations of solar-powered desalination plants.

III. Joint publications foreseen

Not planned yet

IV. Comments, if any

Please do not exceed 10 to 15 lines

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: **Conceptual study of the coupling between a biomass hydrothermal conversion reactor and a CSP plant using molten salts as heat transfer fluid**

3DUWLFLSDQWLVWQPHDQLGPLOQPH **Antonio Ienna**

Name of the SDUWLFLSDWLQJRUJDQLVDWLRQ **Università degli Studi di Palermo (UNIPA)**

Name of the host institution: **Centro ricerche ENEA di Casaccia – Roma (ENEA)**

Onsite working period: **30 / 11 / 2015 to 19 / 12 / 2015**

Onsite working time (in Person week(s))*: **3**

Remote working time (in Person week(s))**: **2**

I. Objectives of the mobility

Conceptual study of the coupling between a biomass hydrothermal conversion reactor and a CSP plant using molten salts as heat transfer fluid: feasibility study with the implementation of a first tentative layout of the microalgae hydrothermal liquefaction (HTL) process to be used with a process simulator

II. Main achievements and difficulties encountered

Remote working period

During the two preliminary weeks at University of Palermo (UNIPA) the following activities have been carried out:

- design of a first tentative layout for the microalgae HTL process;
- review of the state of the art and implementation of a kinetic model taken from the literature for the estimation of the product yields

Onsite working period

First, the reference annual production rate (i.e. the capacity) of the biomass conversion plant was chosen and fixed for subsequent calculations. To this aim, different case studies of annual microalgae production of different commercial plants were considered: a standard quantity of 10,000 t/y of microalgae processed was chosen. Then the energy duty of the plant was estimated considering the following main process stages: water and biomass slurry pre-treatment and compression, feed heating and enthalpy change associated to the reactions involved in the HTL process.

In the last part of the stay at ENEA the implementations of the aspects reported above in the process simulator Aspen Plus was started to compare the results of energy balance with those calculated earlier.

The main detected difficulties concern the modeling of the raw material (microalgae), of the reaction products (bio-oil, aqueous and gaseous products) and, consequently, of the heat of reactions. In addition, the technological feasibility of pumping an initial feed highly concentrated in biomass (e.g. 75 wt%) to high pressures with commercial pumps is an issue still to be fixed.

III. Joint publications foreseen

Not planned yet

IV. Comments, if any

The activity will be continued in the period January-March 2016 for other 9 weeks of onsite work at ENEA to reach a reliable estimation of the potentiality of the coupling CSP+HTL.

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: ***Modelling and validation of the MD process for comparison with MED***

Participant's first name and family name: ***Andrea Cipollina***

Name of the participant's institution: ***UNIPA***

Name of the host institution: ***CIEMAT - Plataforma Solar de Almeria***

Onsite working period: 14 / 07 / 2016 to 03 / 08 / 2016

Onsite working time (in Person week(s))*: 3.0

Remote working time (in Person week(s))**: 1.5

I. Objectives of the mobility

The work at CIEMAT premises was focused on the development of a mathematical model and its relevant validation with experimental data, purposely collected using the PSA experimental facilities. The new model was implemented on Matlab® platform starting from a simplified model previously developed by UNIPA researchers.
After a validation with experimental data, the model aims at being used for sensitivity analysis of the solar-powered MD process operating under non-conventional conditions in terms of type of solute and salinity characterizing the solution.
A comparison with the results of a previously developed model for the MED process under similar conditions will also highlight the differences between the two technologies.

II. Main achievements and difficulties encountered

Thanks also to the presence of two UNIPA students, working at the PSA premises under an Erasmus Traineeship agreement, the activities for the development of the model led to the fast implementation of a distributed parameters model for the MD process with air-gap or permeate-gap configuration. The model included also a number of constitutive equations allowing to calculate highly saline solutions' physical properties and heat & mass transfer rates. Focused experiments were performed in a laboratory-scale test-rig in order to validate the model. NaCl solutions with salinities up to 100 gr/lt were considered.
A first comparison of model predictions with experiments has shown a fair agreement and the model was then adopted for a preliminary sensitivity analysis aiming to assess the variation of process performance when varying module configuration, path length, feed inlet temperature and salinity.
However, concerning the preliminary validation step, some difficulties were encountered, which prohibited a quantitative comparison and validation of the model, namely: complex geometry of the feed channel in the experimental test rig, which did not allow a proper description of polarization phenomena; lack of information on the morphological structure of the MD membrane supporting layer; shortness of the MD feed channel, not allowing for a proper measurement of inlet-outlet Temperature difference.
In order to by-pass such difficulties some modifications in the test-rig and in the model formulations have been identified and a plan for actions to be undertaken soon after the summer vacation by the PSA team has been defined in collaboration with the UNIPA staff. This will lead in the next few months to the finalization of the validated model, which will be used for repeating and extending all sensitivity analysis.

III. Joint publications foreseen

The activities on the development and validation of the model for the MD process will likely bring to a publication. However, this has not been planned yet, waiting first for a finalization of the model validation.

Another joint publication, relevant to the development of a dynamic model for the MED-TVC process, has been submitted to the international journal "Desalination". These are the details:
Manuscript title: *A dynamic model for MED-TVC transient operation*
Authors: *A. Cipollina, M. Agnello, A. Piacentino, A. Tamburini, B. Ortega, P. Palenzuela, D. Alarcon, G. Micale*

IV. Comments, if any

Please do not exceed 10 to 15 lines

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: **Conceptual study of the coupling between a biomass hydrothermal conversion reactor and a molten salts CSP plant**

Participant's first name and family name: **Antonio Ienna**

Name of the participant's institution: **Università degli Studi di Palermo (UNIPA)**

Name of the host institution: **Centro ricerche ENEA di Casaccia (Roma)**

Onsite working period: **11 / 01 / 2016 to 11 / 03 / 2016**

Onsite working time (in Person week(s))*: **9**

Remote working time (in Person week(s))**: **1**

I. Objectives of the mobility

-computation of mass and energy balances for the HTL process
-design of the main process equipment
-design of the solar field used to power the process
-estimation of plant cost
-estimation of a minimum selling price of the produced biocrude

II. Main achievements and difficulties encountered

In the first part of the mobility the main objective of the work was to make complete mass and energy balances for the process, in particular it was necessary to calculate the power required to heat the feeds to reaction temperature and the fraction of heat recoverable by heat integration with the product stream. The unrecoverable power was used to design the solar field, in particular it was chosen to use the solar radiation data referring to the area of Priolo (Sicily), and to use the HITECH molten salts mixture. Studies were performed on the kinetic model in order to define the most appropriate interpolation between data points found in literature, and it was decided to interpolate only the points that referred to temperature close by the one used in this work by Arrhenius equation. The model was integrated by using Microsoft Excel and Matlab in order to calculate the yield of the products at different inlet temperature and in the case of temperature change inside of the reactor. The collected data were used to design the heat exchangers required in the plant. Finally, an economic analysis was performed by estimating the equipment cost and the required investment for the plant; operating expenses were also estimated using correlations found in literature. The expenses were used to calculate the minimum selling price of the biocrude in order to make the process economically sustainable, not considering taxes, depreciation allowance and interest on the investment. Different plant configuration were studied, by choosing the most efficient one it was possible to reduce biocrude price under 2.5 €/kg, a value close to others reported in literature.

III. Joint publications foreseen

Alberto Giaconia, Luca Turchetti, Antonio Ienna, Domenico Mazzei, Benedetto Schiavo, Onofrio Scialdone, Giampaolo Caputo, Alessandro Galia, Conceptual study of the coupling of a biorefinery process for hydrothermal liquefaction of microalgae with a concentrating solar power plant, in preparation.

IV. Comments, if any

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: **Conceptual study of coupling of CSP with hydrothermal plant for biomass conversion**

Participant's first name and family name: **Alessandro Galia**

Name of the participant's institution: **Università degli Studi di Palermo (UNIPA)**

Name of the host institution: **Centro ricerche ENEA di Casaccia – Roma (ENEA)**

Onsite working period: **15 / 02 / 2016 to 18 / 02 / 2016**

Onsite working time (in Person week(s))*: **0.8**

Remote working time (in Person week(s))**: **0.2**

I. Objectives of the mobility

To verify preliminary calculations and the matching between actual and planned results. To discuss any critical issue and take final decisions to conclude the techno-economical study and publish the results.

II. Main achievements and difficulties encountered

Remote working period

- Study of the conceptual design as it was implemented to understand the structure of the plant and the logic behind any design choice

Onsite working period

Discussion with the colleagues of ENEA concerning the issue of optimization of the solar field. Compared two different criteria for the design of the plant: maximum biocrude yield and maximum heat recovery form the effluent stream from the reactor. The latter was found the best choice to decrease global cost and was then selected to conclude the study.
Discussed the impact of pressure on the cost estimation of all the equipment of the HTL plant.
Planned the activities to be completed during the final part of the stage of Antonio Ienna at ENEA and those necessary to publish the study.

III. Joint publications foreseen

In preparation.

IV. Comments, if any

The conceptual study could be added to those considered for task 9.4 even if not originally planned. This aspect will be discussed with other partners of WP9 in the meeting that will be guested by University of Palermo on 21st of April 2016.

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: **Steady-state and dynamic analysis of Solar Thermal Power Plants based on Combined Cycles**

Participant's first name and family name: Francisco Javier Pino Lucena

Name of the participant's institution: University of Seville

Name of the host institution: IMDEA Energía

Onsite working period: 10/07/2017 to 28/07/2017

Onsite working time (in Person week(s))*: 3

Remote working time (in Person week(s))**: 1

I. Objectives of the mobility

The main objective of the mobility project was to perform an analysis of Solar Thermal Power Plants based on Combined Cycles in a static and dynamic mode. The activities performed are included in subtask 12.2.7 of WP 12.

II. Main achievements and difficulties encountered

Main achievements obtained during the mobility are: Size of power components in the Power Cycles (Brayton and Rankine cycles), optimum operation conditions at Design point, global plant efficiency and component behavior at design point, and dynamic analysis of power plant and performance during a typical year of operation. Initial technical objectives of mobility were reached so there is no difficulties encountered.

III. Joint publications foreseen

The result of the mobility is partially published and presented in SolarPaces 2017 conference at Santiago de Chile. The communication was titled: "Optimization of an Integrated Solar Combined Cycle". Actually, both research centers are working in the publication of a research paper in a peer-reviewed journal.

IV. Comments, if any

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Optimization models for heliostat field layouts generation

Participant's first name and family name: Francisco José Cabello Núñez

Name of the participant's institution: University of Seville (US)

Name of the host institution: Centro Nacional de Energías Renovables (CENER)

Onsite working period: 17/07/2017 to 21/07/2017

Onsite working time (in Person week(s))*: 1.0

Remote working time (in Person week(s))**: 1.0

I. Objectives of the mobility

The aim of subtask 12.2.7 is to identify the detail design of a representative high concentration optical system and receiver module type. Results obtained throughout the previous tasks will make it possible to lead to a design in accordance with the desired specifications. To carry out this activity properly is necessary to obtain the heliostat field efficiency matrix in the early stages, using the heliostat and the receiver models designed by CENER-TEKNIKER (subtask 12.1.2) and CNRS (subtask 12.2.3) respectively.
Since different softwares to obtain the heliostat field layout are currently available the objective of this mobility is to analyze their performance, compare the results that they provide and finally identify the optimal efficiency matrix. Throughout this mobility results provided by two softwares are analyzed, a software developed by CENER and a free use software developed by NREL (SolarPILOT).

II. Main achievements and difficulties encountered

The main achievement reach in the frame of this mobility has been the comparison of the different software currently available to obtain the heliostat field optimal efficiency matrix.
No significant difficulties were found during the mobility.

III. Joint publications foreseen

Please do not exceed 10 to 15 lines

IV. Comments, if any

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Work package 12 documentation

Participant's first name and family name: Francisco José Cabello Núñez

Name of the participant's institution: University of Seville (US)

Name of the host institution: Centro Nacional de Energías Renovables (CENER)

Onsite working period: 13/11/2017 to 17/11/2017

Onsite working time (in Person week(s))*: 1

Remote working time (in Person week(s))**: 1

I. Objectives of the mobility

The aims of this mobility are analyze the results obtained in the frame of work package 12.2.7, evaluate the opportunity to prepare a joint publication between partners involved in the work package 12, start preparing the final documentation and coordinate the last follow-up meeting of the same work package.

II. Main achievements and difficulties encountered

The main achievements reach in the frame of this mobility have been the coordination in the preparation of the last follow-up meeting of work package 12 and the progress in the pending deliverables of this work package, mainly deliverables D12.8 "Report with the flux measurement system specifications and design" and D12.9 "Final Report with Conclusions and Systems Identified"

No significant difficulties were found during the mobility.

III. Joint publications foreseen

Please do not exceed 10 to 15 lines

IV. Comments, if any

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EUROPEAN ENERGY RESEARCH ALLIANCE

INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Optimization models for heliostat field layouts generation

Participant's first name and family name: Elena Pérez Aparicio

Name of the participant's institution: University of Seville (US)

Name of the host institution: Centro Nacional de Energías Renovables (CENER)

Onsite working period: 17/07/2017 to 21/07/2017

Onsite working time (in Person week(s))*: 1.0

Remote working time (in Person week(s))**: 0.5

I. Objectives of the mobility

The aim of subtask 12.2.7 is to identify the detail design of a representative high concentration optical system and receiver module type. Results obtained throughout the previous tasks will make it possible to lead to a design in accordance with the desired specifications. To carry out this activity properly is necessary to obtain the heliostat field efficiency matrix in the early stages, using the heliostat and the receiver models designed by CENER-TEKNIKER (subtask 12.1.2) and CNRS (subtask 12.2.3) respectively.
Since different softwares to obtain the heliostat field layout are currently available the objective of this mobility is to analyze their performance, compare the results that they provide and finally identify the optimal efficiency matrix. Throughout this mobility results provided by two softwares are analyzed, a software developed by CENER and a free use software developed by NREL (SolarPILOT).

II. Main achievements and difficulties encountered

The main achievement reach in the frame of this mobility has been the comparison of the different software currently available to obtain the heliostat field optimal efficiency matrix.
No significant difficulties were found during the mobility.

III. Joint publications foreseen

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IV. Comments, if any

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INDIVIDUAL ACTIVITY REPORT

Title of the mobility project: Work package 12 documentation

Participant's first name and family name: Elena Pérez Aparicio

Name of the participant's institution: University of Seville (US)

Name of the host institution: Centro Nacional de Energías Renovables (CENER)

Onsite working period: 13/11/2017 to 17/11/2017

Onsite working time (in Person week(s))*: 1

Remote working time (in Person week(s))**: 1

I. Objectives of the mobility

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II. Main achievements and difficulties encountered

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No significant difficulties were found during the mobility.

III. Joint publications foreseen

Please do not exceed 10 to 15 lines

IV. Comments, if any

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