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

FP7 Grant Agreement number:	**609837**
Start date of project:	**01/02/2014**
Duration of project:	**48 months**

Project Deliverable 4.2:

Mid-term report on the exchange / Mobility of researchers

WP4 – Task 4.1	**Deliverable 4.2**
Due date:	**M24**
Submitted	**February 2016**
Partner responsible	**CNRS**
Person responsible	**Laurent Gaubert**
Author(s):	**Laurent Gaubert**
Document version:	**1**
Reviewed/supervised by:	**Marie Prouteau**
Dissemination Level	**PU**

Table of contents

Figures

Tables

1. Introduction

The Work Package 4 “Capacity Building and Training Activities focuses on the following objectives:

- 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 objective of STAGE-STE concerning the mobility is intended 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.

Therefore, researchers compare their approach, methodologies, ideas and share their previous experiences by way of workshops or seminar and/or visit of the plants, if applicable at the partners.

This deliverable is dedicated to reporting the mobility activities for the first half of STAGE-STE (M1-M24). To this end, a website has been set up in order to collect all the useful information from the participants concerning the mobilities.

2. The management regarding the exchange of personnel

In order to help the monitoring of the mobility activities and to check if the activities performed during mobilities are in accordance with the STAGE-STE mobilities objectives, CNRS has developed a website dedicated to the participants of mobilities where they have to report their mobility activities.

This section is dedicated to presenting this helpful tool and how it is used for the mobility monitoring.

2.1. The procedure for managing the exchange of personnel

The following parts are dedicated to explaining the procedure regarding the management of the mobilities of researchers through the STAGE-STE website for the mobilities. The procedure is divided into 2 part, before and after the mobility.

2.1.1 Before the mobility

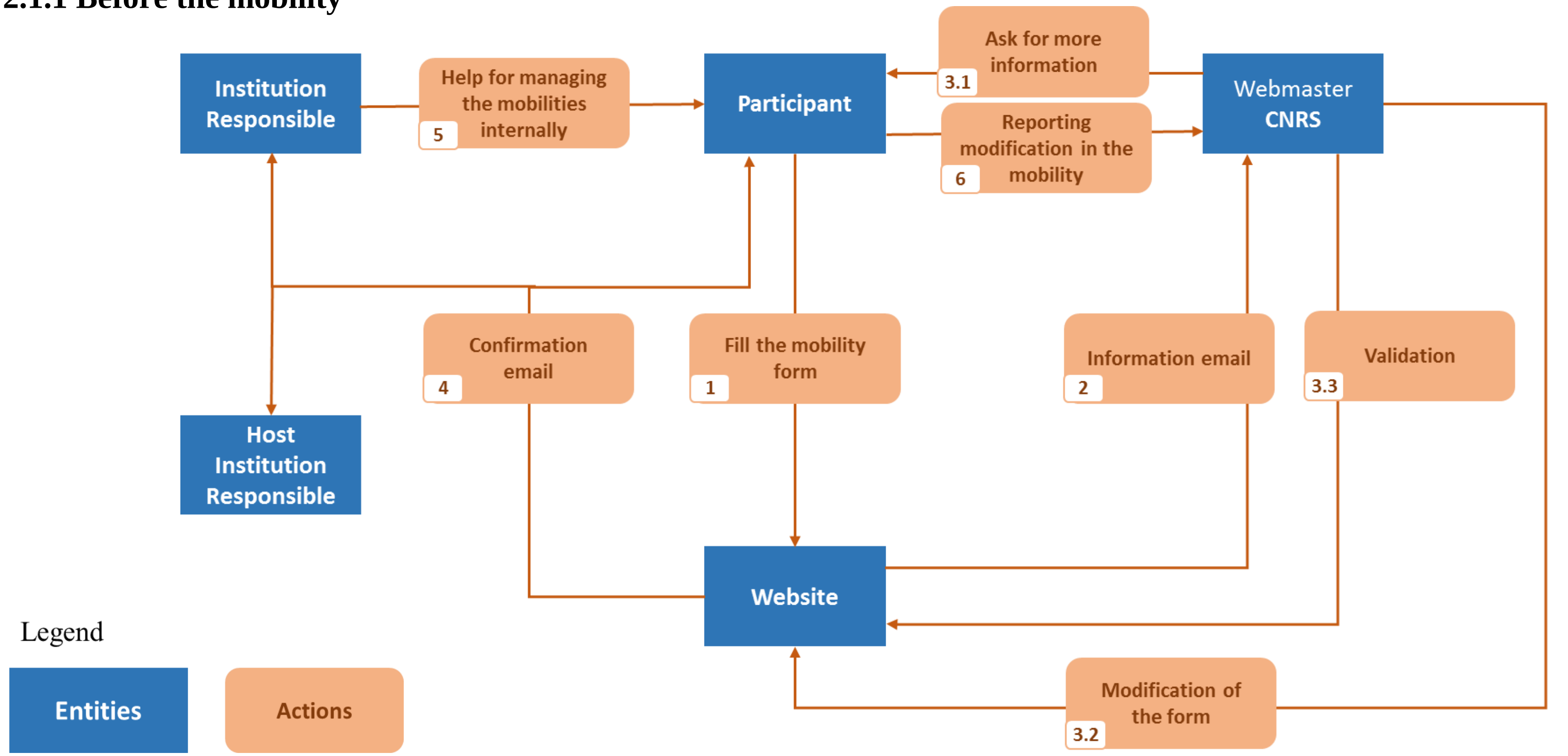


Figure 1: Diagram about the procedure before a mobility

The several actions before a mobility, which are presented in the diagram above, are explained below:

- 1. Fill the mobility form: When a mobility is planned and the researcher has contacted the host institution to organize the activities to be done as well as the period of the mobility, the participant have to fill in a form in order to report the information related to his/her mobility. The dedicated form is accessible on the official STAGE-STE website: *http://www.sollab.eu/stage-ste/*. For more information about the mobility form, refer to the part 3.3.

- 2. Information email: When a mobility form has been filled, the webmaster (CNRS) receives a notification email to check the information filled in the mobility form.

- 3: Form validation:
    - 3.1: If some information are missing about the planned activities in the mobility, or if the submitted information are wrong, the webmaster (CNRS) contact the participant of the mobility by email to complete or to correct the information filled in the mobility form.
    - 3.2: From the administrator part of the website, the webmaster (CNRS) can modify the information in the submitted forms.
    - 3.3: When all the mobility information are correct, the webmaster (CNRS) validates the form

- 4. Confirmation email: When a form is validated, the participant of the mobility receives a confirmation email about the validation of his form. The confirmation email also includes a copy of the validated form as well as the template of the individual activity report to be filled after the mobility, and a personal login / password for uploading the report on the mobility website. The mobility responsible from the participant’s institution and the mobility responsible from the host institution receive an email including a copy of the mobility form to inform them that a mobility has been planned involving their institution.

- 5. Help for managing the mobilities internally: For each institution, a mobility responsible has been chosen. The mobility responsible helps the leader of the task 4.1 (CNRS) to manage the mobilities internally.

- 6. Report modification in the mobility: The participant of a mobility can contact the webmaster (CNRS), or his/her institution responsible, to report a modification in his/her planned mobility. Then, the webmaster can change the participant’s form information.

2.1.2 After the mobility

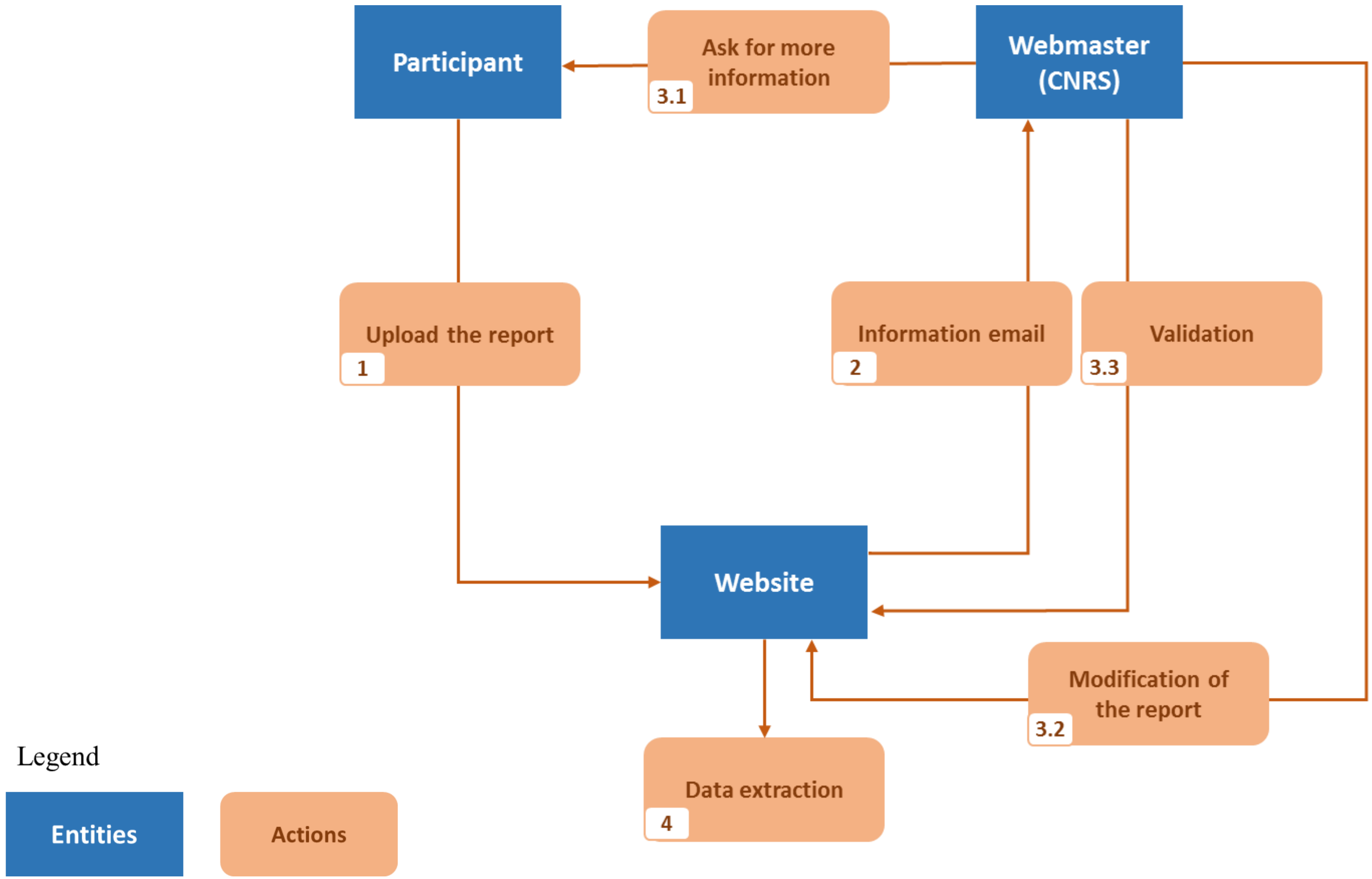


Figure 2: Diagram about the procedure after a mobility

The several actions after a mobility, which are presented in the diagram above, are explained below:

- 1. Upload the report: No later than 2 weeks after achieving his/her mobility, the participant has to fill in an individual activity report about the activities performed during the mobility. The participant submits the report on the STAGE-STE website for the mobilities by using his/her personal login and password received in the confirmation email (see part 3.2.1, action 4). For more information about the activity report, refer to the part 3.4

- 2. Information email: When an individual activity report has been submitted, the webmaster (CNRS) receives an email notification to check the filled information in the mobility report.

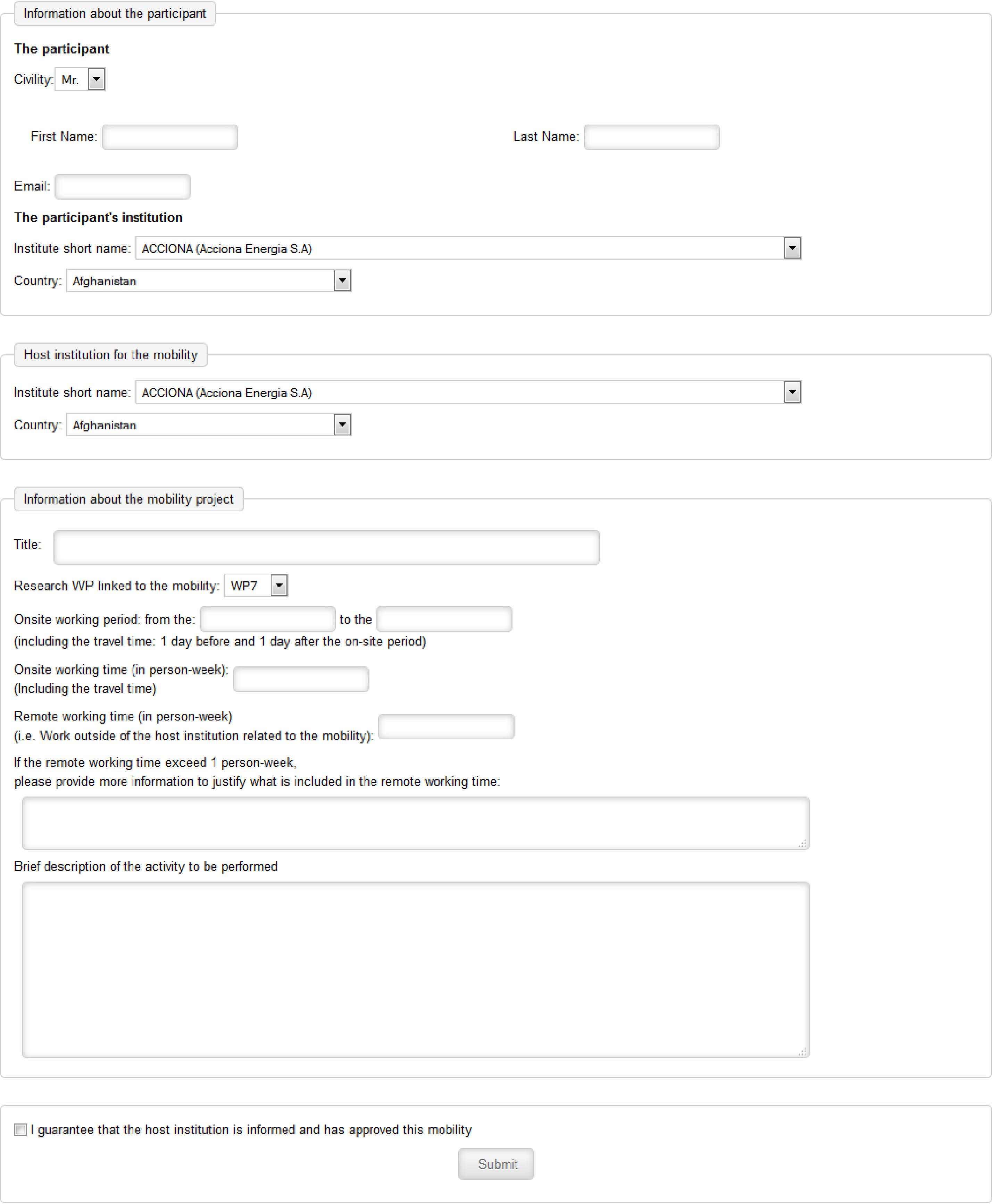
- 3. Individual activity report validation:
    - 3.1. Ask for more information: If some information are missing in the activity report about the activities performed during the mobility, or if there is contradiction between the information filled in mobility form and in the activity report, the webmaster (CNRS) contact the participant to the mobility to clarify the information about the mobility.
    - 3.2. Modification of the report: When receiving the feedback from the participant, the webmaster modifies the report or the mobility form. If the report doesn't satisfy the expectations, the webmaster can ask the participant for uploading another version.
    - 3.3. Validation: When the activity report is satisfying the expectation and the information correspond to the mobility form, the webmaster (CNRS) validates the report and the mobility is considered as completed.

- 4. Data extraction: From the administrator part of the website, the webmaster (CNRS) can extract the activity reports and the data collected through the mobility forms.

2.2 The mobility form

This part is dedicated to presenting the mobility form to be filled by the participants when they plan to perform a mobility. There are 3 kinds of information to fill in:

- Information about the participant to the mobility
- Information about the institutions involved in the mobility: the participant's institution and the host institution
- Information about the mobility project


Information about the participant

The participant

Civility: Mr.

First Name:

Last Name:

Email:

The participant's institution

Institute short name: ACCIONA (Acciona Energia S.A)

Country: Afghanistan

Host institution for the mobility

Institute short name: ACCIONA (Acciona Energia S.A)

Country: Afghanistan

Information about the mobility project

Title:

Research WP linked to the mobility: WP7

Onsite working period: from the: to the
(including the travel time: 1 day before and 1 day after the on-site period)

Onsite working time (in person-week):
(Including the travel time)

Remote working time (in person-week)
(i.e. Work outside of the host institution related to the mobility):

If the remote working time exceed 1 person-week,
please provide more information to justify what is included in the remote working time:

Brief description of the activity to be performed

I guarantee that the host institution is informed and has approved this mobility

Submit

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.

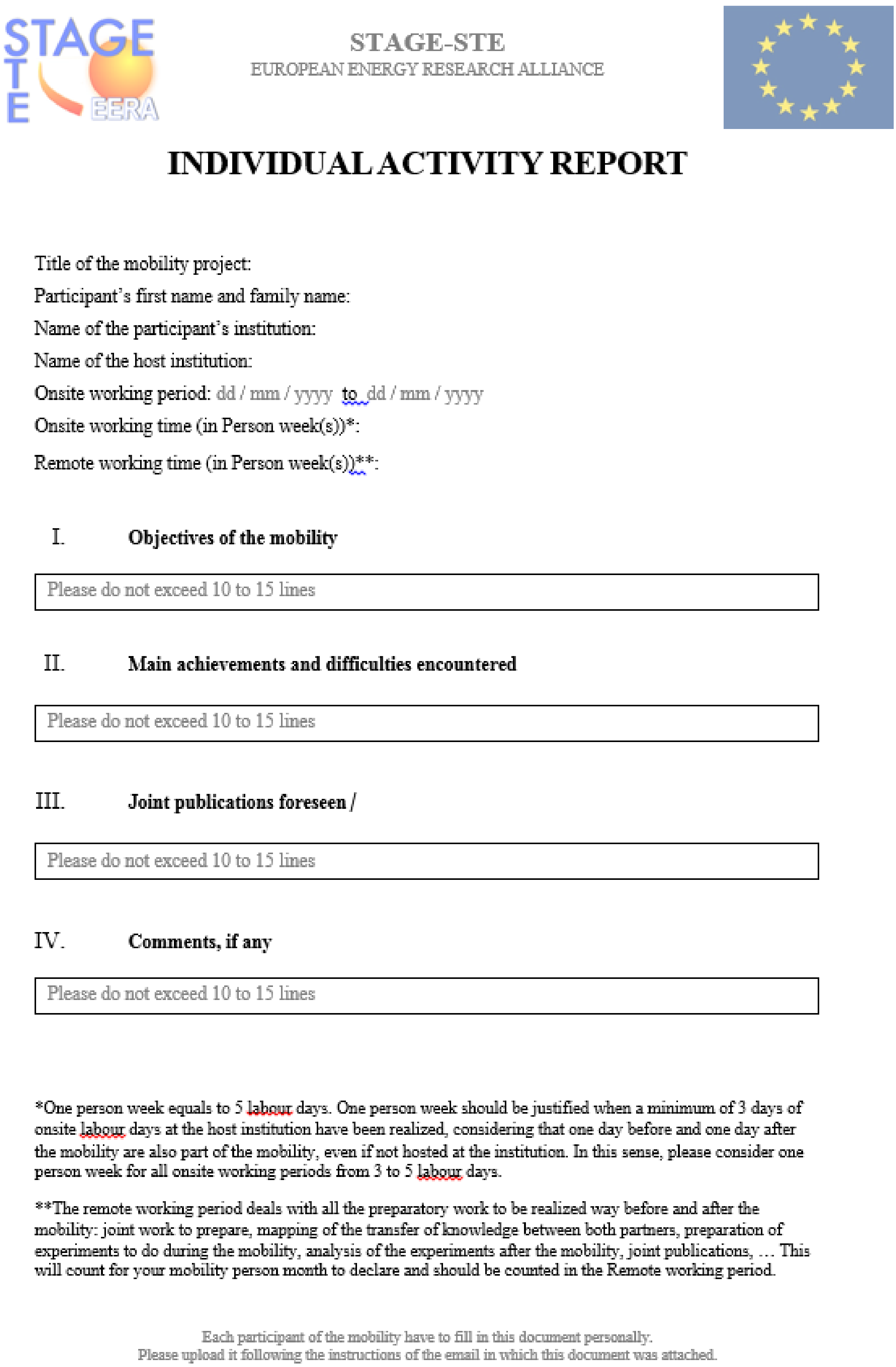
- The “Remote Working Time”: The remote working period deals with all the preparatory work to be realized way before and after the mobility: joint work to prepare, mapping of the transfer of knowledge between both partners, preparation of experiments to do during the mobility, analysis of the experiments 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.

2.3 The individual activity report

For each mobility, the participants have to fill in an individual activity report after their mobility and upload on the STAGE-STE website for the mobilities. This report has to be filled individually by each participant of the mobilities as well as the mobility form. When the individual activity report has been uploaded and validated by the task 4.1 leader (CNRS), the mobility is considered as completed.

All the individual activity reports collected regarding the actual achieved mobility are accessible in the annexe 1 of this deliverable.

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



STAGE-STE
EUROPEAN ENERGY RESEARCH ALLIANCE

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.

Figure 4: The personal activity report

3. Mobility status

This part is dedicated to present the actual (M24) mobilities status in three parts:

- Mobility plan regarding the description of Work: At M11 each institution submitted a mobility plan for the 4 years of STAGE-STE. This mobility plan is included in the Description of Work.

  Note: This mobility have to be considered as the basis about the exchange of researchers, but this planning could change during the project due to unexpected circumstances.

- The achieved mobility: This part is dedicated to present the mobilities achieved during the first half of the project. From the beginning of STAGE-STE, 44 mobilities have been achieved.

- The future planned mobilities: This part is dedicated to present the planned mobilities regarding the mobility forms collected through the STAGE-STE website. These mobilities still have not started yet. There are currently 45 planned mobilities

3.1. 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	WP7

			splitting route that employs metal/metal oxide nanoparticles as catalyst	
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	UNAM	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	
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 LNEG will be Dr. Fernando Oliveira. At IST Lisboa will be Dr. Luis Guerra Rosa.	1	1	9	
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	

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.
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 international proposals will also be discussed.	0,6	0,4	12	
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	
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 support of personal from both from IMDEA and FBK.	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 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

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	
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	* 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.
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	* revisiting and getting acquainted again with the complex process control software after about 5 years including modifications made during the experiments (Yvonne Bäuerle did program the original version in 2009/2010, but significant changes had been made afterwards by Peter von Zedtwitz (HOLCIM) during the operation). * 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.
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	
TECNALIA	ENEA	nanoparticle synthesis, Nano fluids and nanopcm	Preparation of nanoparticles, Nano fluids and nanoPCM based on inorganic salts.	0,6	0,1	7	
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	
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	0,6	0,4	10	

			of UNIPA staff to LNEG within the Stage-STE WP4.				
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.
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	
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.

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	
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	3	0	11	

			least one reviewd journal paper hand-in at Solar Energy				
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 reviewed journal paper hand-in at Solar Energy	3	1	11	
FISE	UEVORA	Linear Fresnel Collector (LFC) and field measurement methods	Mission is to compare methodology approaches of LFC characteristation. -What accuracies can be expected -How can the IAM behaviour be handeled, when doing measuremnts, simulations and energy output forecasting -clarification and common understanding of the issues, possibilities for measurements at Uni Evora -contribution for the Solar Paces Conference 2015 -at least one reviewed journal paper hand-in at Solar Energy	3	0	11	

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	

3.3. The planned mobility

Table 3: Planned mobilities and associated activities

Participant institution	**Host Institution**	**Project Title**	**Description**	**Onsite working time p/weeks**	**Remote working time p/weeks**	**WP**	**Remote working time justification**
CENER	CNRS	Workshop	Workshop on solar flux simulation. Comparison of methodologies and simulation results.	2	0,5	12	
CENER	LNEG	Knowledge transfer	High temperature absorbers and material	1	0,2	8	
CENER	ENEA	Knowledge transfer	Methodologies for dynamic testing and predictive maintenance of large solar fields. Guidelines for standardization of STE components and plant commissioning	2	0,2	11	
CENER	SENER	Test execution for dynamic testing	Methodologies for dynamic testing and predictive maintenance of large solar fields. Guidelines for standardization of STE components and plant commissioning	1	0,2	11	
CENER	TECNALIA	Knowledge transfers	Small scale and low cost installations for power and industrial process heat applications. Methodologies for dynamic testing and predictive maintenance of large solar fields.	1	0,2	11	

CIEMAT	TKN	Modelling, control and O and M issues of solar fields with PTCs	Review of methods and procedures for analysing the performance of PTCs installed in large solar fields: modelling approaches and on-site testing/monitoring of whole collectors and single components	1	1	11	
CIEMAT	CENER	Parabolic trough collectors standardization / characterization	Technical visit to CENER premises in Pamplona for joint discussion and preparation of standardization/qualification procedures for parabolic trough collectors. The test results obtained during a previous visit of CENER people to PSA will be discussed and used for the procedures to be developed (WP11)	1	1	11	
CIEMAT	UNIPA	State of the art and model development of MD	The main approach for modelling membrane distillation as an innovative low temperature distillation process (i.e. the core of task T10.1.5) will be discussed. A strategy will be agreed and a plan for model developments and validation will be layed out.	1	1	10	
CIEMAT	PSI	Cooperation within WP9, Task 9.2: Solar fuels from thermochemical cycles	Long-term solar fuel production technologies for H2 and syngas production will be studied and innovative solar chemical reactor concepts will be experimentally tested at laboratory scale (1-10 kWth). Thermochemical cycles based on metal oxide redox reactions require further RTD efforts for process optimisation and subsequent pilot demonstration of their technical and economic feasibility.	4	0	9	

CIEMAT	PSI	Cooperation within WP9, Task 1	Near-term processes such as solar steam reforming of natural gas or solar steam gasification of carbonaceous materials will be studied both conceptually and experimentally using innovative solar chemical reactors for different feedstock including coal, coke, carbonaceous wastes and various types of biomass. CIEMAT will participate in system modelling, thermodynamic and kinetic analyses of those processes in PSI installations.	4	0	9	
CNRS	CYI	Development or adaptation of existing evaluation models to build and optimize the receiver design	Development of numerical CFD (commercial or open source) tools to improve the selected concepts of solar receiver (exchangers), principally the intensification of heat transfer and minimization of thermal losses, thermo-mechanical stress.	1	1	12	
CNRS	LNEG	Development or adaptation of existing evaluation models to build and optimize the receiver design	Development of numerical CFD (commercial or open source) tools to improve the selected concepts of solar receiver (exchangers), principally the intensification of heat transfer and minimization of thermal losses, thermo-mechanical stress.	1	1	12	

CNRS	TECNALIA	Modelling of heat transfer in porous foams and applications to industry	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 and the industrial applications. Based on the discussion a joint work plan will be drawn including possible industrial partners. The topics for joint reply to international proposals will also be discussed.	1	1	7	
CRS4	CENER	Development of algorithms for solar field optimization linked to T12.1.5	Development of algorithms for solar field optimization	3	1	12	
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	1	0,2	8	
LNEG	CIEMAT	Aging of 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	1	0,2	7	

UNIPA	ENEA	Conceptual study of the coupling of molten salt with hydrothermal reactor for biomass liquefaction	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 techno-economical feasibility.	9	1	9	
CTAER	CENER	Heliostat field layout optimization	Development and comparison of heliostat field layout design methodologies.	1	1	12	
CTAER	CENER	Tonatiuh	Exchange of information about Tonatiuh regarding post-processing methods, flux distribution computation, implementation of some essential functionality for the heliostats field design, within the framework of task 12.2.1.	1	1	12	
PSI	LNEG	Characterisation of feedstocks for gasification and of gasification products	The objective of this mobility action is to exchange experiences about the (solar) gasification activities at LNEG and PSI and in particular on the complex topic of analytical characterisation methods for the various involved feedstocks, products (syngas and potentially soot and tars) as well as partially unreacted gasification residues. The provided details (schedule etc.) of this mobility are preliminary and may still be subject to change.	1	1	9	

CRAN	CENER	Development of an efficient heliostat field control system	The planned visit is in connection with Subtask 12.1.3: the development of wireless control systems for small heliostats. It would also be useful to share knowledge on other heliostat systems and heliostat manufacture and installation.	1	1	12	
CRAN	CIEMAT	Outdoor weathering and accelerated ageing of collector materials	This is a follow-on visit from the similar staff exchange a year earlier (May 2016). The visit is concerned with the long-term weathering and accelerated ageing of collector materials.	1	1	8	
CRAN	CIEMAT	Outdoor weathering and accelerated ageing of collectors	This is a follow-on visit from the similar staff exchange a year earlier (May 2016). The visit is concerned with the long-term weathering and accelerated ageing of collector materials.	1	1	8	
TECNALIA	UEVORA	small scale and low cost collectors	Medium temperature collectors, coatings (anti-soiling, reflective, selective...), ray-tracing. Designing of collectors.	0,6	0,1	11	
TECNALIA	UEVORA	small scale and low cost collectors	Medium temperature collector designing, novel coating testing and simulations.	0,2	0,1	11	
TECNALIA	CENER	small scale and low cost collectors	Medium temperature collectors, coating preparation and testing and medium temperature collector designing.	0,2	0,2	11	
TECNALIA	CENER	small scale and low cost collectors	Medium temperature collectors. Coatings (anti-reflective, reflective, selective), medium temperature absorber tubes and designing of novel collectors.	0,6	0,2	11	

TECNALIA	CIEMAT	small scale and low cost collectors	Small scale collectors, their designing and novel coatings (preparation and testing) of them.	0,4	0	11	
TECNALIA	CIEMAT	Thermal Energy Storage and Materials for it.	Activities linked to small scale concentrating collectors for process heat generation.	0,4	0	11	
TECNALIA	CIEMAT	small scale collectors	Novel collector designing and novel coating testing.	0,2	0	11	
TECNALIA	HITIT	new medium temperature collector development	Novel development of medium temperature collector. Collaboration in this activity.	0,4	0,2	11	
TECNALIA	HITIT	Novel medium temperature collector designing.	Development of novel medium temperature collector.	0,2	0,2	11	
TKN	CIEMAT	modelling, control, Operation and Maintenance task inside WP11	Review of methodologies and arrangement of common tools and procedures related to modelling, control, Operation and Maintenance in Parabolic Through collector fields	1	1	11	
TKN	CENER	Testing of heliostats at lab conditions	A heliostat must be tested at lab conditions before sending it to the PSA-CIEMAT for testing on the field	1	2	12	The prototype must be prepared at Tekniker before sending it for testing at CENER

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	Characterisation tests for heliostats T12.1.2	One heliostat will be sent for tests at the PSA. It must be sent, installed, commissioned and tested.	1	2	12	The prototype must be prepared at Tekniker before sending it for testing at PSA
IMDEA	ASNT	New materials for thermochemical energy storage	Collaboration in the characterization of new synthetised materials for thermochemical energy storage.	2	0	7	
IMDEA	DLR	Roadmap hydrogen production	Ellaboration of Roadmap on hydrogen production processes in the framework of Task 9.4.	3	1	9	
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.	5	1	9	
IMDEA	PSI	Testing of different metal oxides geometries in solar reactors	Collaboration with PSI to test metal oxides pellets with different shapes in solar reactors. Determination of apparent kinetics and conversions.	5	1	9	

IMDEA	FBK	Development of volumetric absorber by selective laser melting	Optical modelling of volumetric absorbers and CFD modelling in collaboration with FBK to optimize internal structure manufactured by SLM techniques. Elaboration of a joint manuscript for publication in scientific journal.	3	1	12	
IMDEA	DLR	Reactors concepts for thermochemical storage	Collaboration with DLR in the analysis of reactor concepts for thermochemical storage.	14	1	7	
FISE	ENEA	Paper about molten salt steam generator	Evaluation of experimental data. Coordination of tasks. Writing the paper	1	1	7	
FISE	ENEA	STAGE-STE	* collaboration on single-tank thermal Energy storage * proposal preparation	1	1,5	7	
FISE	CEA	STAGE-STE	* collaboration on single-tank thermal Energy storage * proposal preparation	1	2	7	

3.4. Status of the manpower devotion regarding the exchange of personnel

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

The column "DoW" is referring to the manpower devotion regarding what is planned in the Description of Work

The column "Achieved mobilities" is referring to the amount of manpower actually allocated through the achieved mobilities.

The column "Planned mobilities" is referring to the amount of manpower which will be allocated with all the future planned mobilities already registered in the STAGE-STE website for the mobilities.

Finally, the column "Deviation from DoW" is the amount of manpower still missing regarding the initial mobility plan from the DoW. For those institutions where there is a positive number, this means that with the planned mobilities or with the achieved mobilities, they have already reached the number planned in the DoW.

Table 4: Manpower devotion regarding the exchanges of researchers

Partner	(Person-weeks)			
	DoW	Achieved mobilities	Planned mobilities	Deviation from DoW
CIEMAT	26	26	14	14
DLR	4	0	0	-4
PSI	28	4	2	-22
CNRS	12	6	6	0
FISE	32	14	7,5	-10,5
ENEA	10	0	0	-10
ETHZ	5	0	0	-5
CYI	12	7,6	0	-4,4
LNEG	12	1,5	2,4	-8,1
CTAER	4	0	4	0
CNR	21	3	0	-18
CENER	16	6,2	8,3	-1,5
TECNALIA	13	3,3	4,2	-5,5
UEVORA	6	0	0	-6
IMDEA	48	9	37	-2
CRAN	4	1	6	3
TKN	11	3,8	10	2,8
UNIPA	32	14	10	-8
CRS4	4	0	4	0

IST-ID	5	0	0	-5
FBK	4	6,6	0	2,6

4. Related Publication and Dissemination activities

4.1. Publication

This part is dedicated to present the actual status regarding the publication activities related to the achieved mobility until M24.

4.1.1 Published publication

There is currently no published publication related to exchange of personnel, but one publication has been finalised, and is about to be published in March 2016.

A copy of the publication is accessible in the annexe 2 of this deliverable.

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

Table 5: Exchange of personnel information regarding joint publication

Participants information			Mobility information				
Institution	**First Name**	**Last Name**	**Host Institution**	**Project Title**	**Activities performed**	**WP**	**Person -weeks**
FISE	Annie	Hofer	UEVORA	Linear Fresnel Collector (LFC) and field measurement methods	Mission is to compare methodology approaches of LFC characterisation -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

4.1.2 Planned publication

The following table presents the researchers who plan to publish a publication related to an achieved mobility.

Table 6: Exchange of researchers information regarding the planned joint publications

Related mobility to further publication					
Participant's intitution	**First name**	**Last name**	**Host intitution for the mobility**	**Title of the mobility**	**WP**
CENER	Michael	Burisch	TKN	Testing of heliostat and calibration	12
CENER	Fabienne	Sallaberry	CIEMAT	Knowledge transfer about dynamic testing	11
CIEMAT	Maria Isabel	Roldán Serrano	CNRS	Definition of an effective procedure to model and test new designs for volumetric solar receivers	12
CIEMAT	Aránzazu	Fernández-García	CRAN	Durability of solar reflectors at CRAN	8
CIEMAT	Rocío	Bayón	TECN	Materials for thermal storage	7
CIEMAT	Rocío	Bayón	CEA	Materials for thermal storage	7
CIEMAT	Rafael Antonio	López Martín	DLR	Receiver Round-Robin test	8
CIEMAT	Rafael Antonio	López Martín	CENER	Round Robin tests of Linear receivers	8
CIEMAT	Jesús	Fernández-Reche	TKN	Development of a low cost heliostat	12
CIEMAT	M. Esther	Rojas Bravo	CEA	Thermal Storage	7
CIEMAT	Inmaculada	Cañadas	LNEG	Durability protocol to qualify innovative materials for solar chemical reactors	9
CNR	Laura	Silvestroni	CNRS	Study on oxidation resistance of refractory ceramic materials	8
CNRS	Ludovic	Charpentier	CNR	UHTC elaboration and characterization	8
CRAN	Peter	King	CIEMAT	Photogrammetry to measure form of installed collectors	11
CYI	Elena	Guillen	CIEMAT	Model development and experimental validation of MD and MED systems for Seawater Desalination	10
FISE	Annie	Hofer	UEVORA	Linear Fresnel Collector (LFC) and field measurement methods	11
FISE	Korbinian	Kramer	UEVORA	Linear Fresnel Collector (LFC) and field measurement methods	11

FISE	Peter	Schöttl	CNRS	Joint experimental validation of ray-tracing codes related to heliostats	12
FISE	Gregor	Bern	CNRS	Preparation of a joint experimental validation of ray-tracing codes related to heliostats	12
IMDEA	Sandra	Álvarez	DLR	Reactor concepts for thermal heat storage	7
LNEG	João	Cardoso	CNRS	Data collection for the validation of numerical codes to improve the efficiency of cavities	12
TECN	Javier	Nieto Maestre	ENEA	nanoparticle synthesis, nanofluids and nanopcm	7
TECN	Javier	Nieto Maestre	CNR	Nanoparticles, nanofluids and nanosalts.	7
TECN	David Alfredo	Pacheco Tanaka	ENEA	nanoparticle synthesis, nanofluids and nanopcm	7
TECN	David Alfredo	Pacheco Tanaka	CNR	nanosalts	7
UNIPA	Andrea	Cipollina	CIEMAT	Dynamic modelling of multiple effects desalination systems	10

4.2. Dissemination

This part is dedicated to present the actual status about the dissemination activities related to the activities performed through the achieved mobilities.

4.2.1 Achieved Disseminations

There are currently seven 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 7: Dissemination activities and related exchanges of reaserchers

Information about the related mobility						Information about the dissemination		
Participant's intitution	**First name**	**Last name**	**Host intitution**	**Title of the mobility**	**WP**	**Event**	**Date**	**Presentation title**
CENER	Michael	Burisch	TKN	Testing of heliostat and calibration	12	SolarPACES 2015	15/10/2015	Heliostat Calibration Using Attached Cameras And Artificial Targets
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
CIEMAT	Rocío	Bayón	TECN	Materials for thermal storage	7	European Conference on Liquid Crystals,	09/09/2015	Storing latent heat with liquid crystals. Is it a feasible option?

						Manchester (UK)		
CIEMAT	Jose	Rodriguez	LNEG	Durability protocol to qualify innovative materials for solar chemical reactors	9	3th STAGE-STE WP9 Technical Meeting	26/11/2015	Draft Proposal of a common protocol for durability tests
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?
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
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

4.2.2 Mobilities related to the planned disseminations

There are currently 14 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 8: Exchange of researchers information regarding the planned dissemination activities

Participant's institution	First name	Last name	Host institution	Title of the mobility	WP
CENER	Fabienne	Sallaberry	CIEMAT	Knowledge transfer about dynamic testing	11
CIEMAT	Aránzazu	Fernández-García	CRAN	Durability of solar reflectors	8
CIEMAT	Jesús	Fernández-Reche	TKN	Development of a low cost heliostat	12
CIEMAT	M. Esther	Rojas Bravo	CEA	Materials for thermal storage	7
CNR	Laura	Silvestroni	CNRS	Study on oxidation resistance of refractory ceramic materials	8
CNRS	Laurie	André	DLR	Thermochemical cycles for solar energy storage	9
CNRS	Ludovic	Charpentier	CNR	UHTC elaboration and characterization	8
CYI	Elena	Guillen	CIEMAT	Model development and experimental validation of MD and MED systems for Seawater Desalination	10
FISE	Annie	Hofer	UEVORA	Linear Fresnel Collector (LFC) and field measurement methods	11
FISE	Sven	Fahr	UEVORA	Linear Fresnel Collector (LFC) and field measurement methods	11
FISE	Korbinian	Kramer	UEVORA	Linear Fresnel Collector (LFC) and field measurement methods	11
LNEG	João	Cardoso	CNRS	Data collection for the validation of numerical codes to improve the efficiency of cavities	12
TKN	Nerea	uranga	ENEA	Corrosion tests on MS	7
UNIPA	Andrea	Cipollina	CIEMAT	Dynamic modelling of multiple effects desalination systems	10

5. KPI Statement

This part is dedicated to present the actual KPI statement regarding the exchanges of personnel during the first half of the STAGE-STE project. 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 9: Exchange of researchers information regarding the planned dissemination activities

KPI no.	KPI description	2015 year value
KPI_15	Number of researchers involved in mobility and exchange programmes during the last 2 years	37
KPI_16	Number of reports from researchers involved in mobility and exchange programmes (last 2 years)	44
KPI_17	Number of days of mobility and exchange during the last 2 years	530
KPI_18	Number of joint publications related to the participation in the exchange programmes (last 2 years)	1 (26 planned)
KPI_19	Number of dissemination events related to the participation in the exchange programmes during the last 2 years	7 (14 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

With the project STAGE-STE, which is a collaborative project between the major stakeholder in CSP in Europe and worldwide, the exchanges of researchers realized within the WP4 is a concrete opportunity to create and to reinforce the partnerships between the STAGE-STE partners.

The exchanges of personnel are then a good opportunity to realize collaborative projects and to enhance the common R&D efforts on CSP which is the major objective of the STAGE-STE project. By creating concrete partnerships between the partners, the mobility process ensures the sustainability of the common R&D effort on CSP after the STAGE-STE project and then participate in improving the global development of the CSP sectors.

The initial mobility plan has quite changed since its definition at M11. But it was predictable regarding the long duration of the STAGE-STE project. The potentiality for changes was already envisaged when writing the proposal and reconfirmed after finalizing MS14 "Definition of the complete and final schedule of personnel exchange and associated activities". Among the achieved mobilities, 35 mobilities were included in the initial mobility plan, but only 3 were not planned in the initial mobility plan. Among the 6 last achieved mobilities, only the activity performed during the mobility, or the host institution was changed.

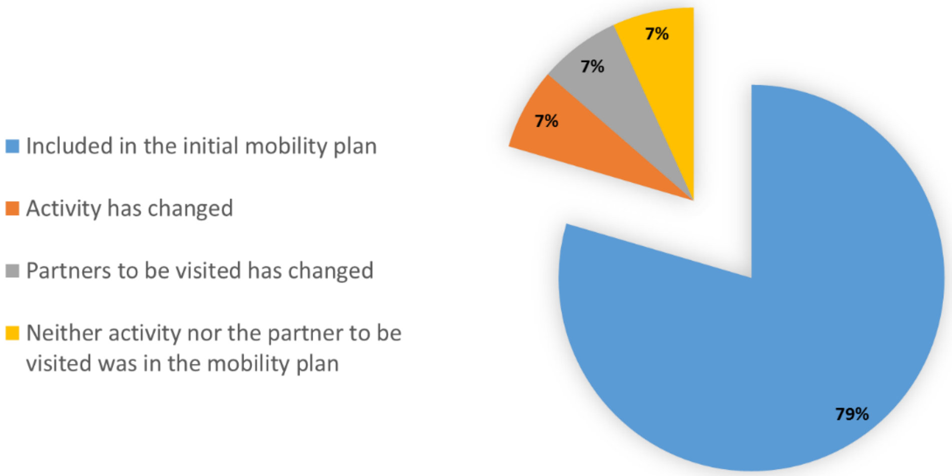


Figure 5 Deviation from the initial mobility plan regarding the 44 mobilities already achieved

Seven partners still have not achieved personnel exchange at M24, nevertheless almost all the partners involved in the task 4.1 were involved in the mobilities as the participating institution or as the host institution. This trend shows the general interest of the researchers to create and to reinforce the collaborative actions with the others European stakeholders on CSP.

Since the beginning of the STAGE-STE project, 34% of the mobility plan has been achieved in term of manpower devotion. Only 4% were achieved at the end of the first year and the rest was achieved during the second year. Despite that the exchanges of researchers have taken a long time to begin due to a delay in achieving the final schedule of personnel exchange (delayed from M3 to M11), we can conclude that the mobility process is well engaged now and the objectives in term of manpower allocation would be achieved at the end of STAGE-STE.

This objective could go beyond what was planned for some partners (for more information, refer to the part 3.4). This trend shows the efficiency of the mobility process within the STAGE-STE project.

Regarding the received mobility forms, 15% are less than a 1-week-duration-mobility, taking into account both the onsite working time and the remote working time.

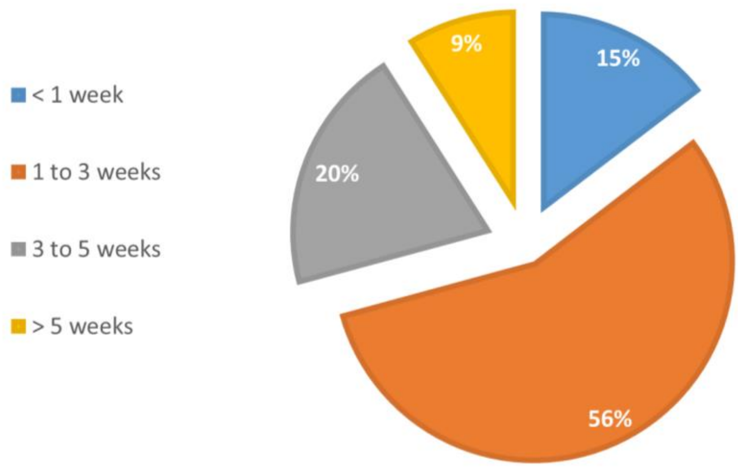


Figure 6: Distribution of the mobilities regarding the duration of the mobilities (% calculated on the number of mobilities achieved and planned on the mobility website)

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.

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.

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

*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: 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

*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: 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.

*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

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.
Please upload it following the mail in which this document was attached.

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)*

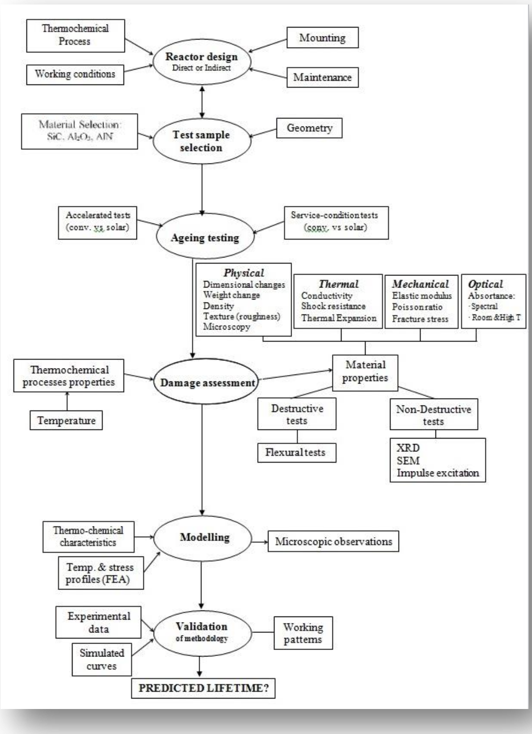
To define a durability protocol to qualify innovative materials for solar chemical reactors in the framework of the Task 9.3 of STAGE-STE. The work plan will include a visit to LNEG and IST Lisboa facilities, discussions towards a proposal of an experimental work plan to evaluate novel ceria-based materials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

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

*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: **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

*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: 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

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.

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.

*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: 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

*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: "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.

*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: 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

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.

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.

Please upload it following the instructions of the email in which this document was attached.

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

*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: 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.

*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: 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

-

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: 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).

*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: 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.

*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: 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

*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: 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

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.

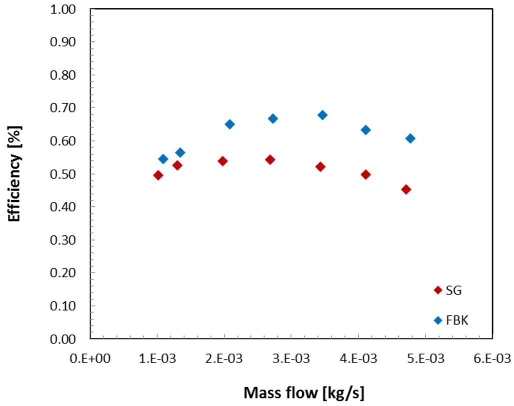


Figure 1 – Efficiency as a function of the air mass flow

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

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

*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

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.
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: 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.

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 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
- 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..

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.

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.

*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: 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.

*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: 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.

*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: 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.

*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: **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

*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: **Conceptual study of the coupling between a biomass hydrothermal conversion reactor and a CSP plant using molten salts as heat transfer fluid**

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 (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.

*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: ***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

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.

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: *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

*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: 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

*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: 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.

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

*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: 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.

*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: 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.

*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: 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.

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: 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.

**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: 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, Jl.. 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

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.

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.

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, Jl.. 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

*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

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.
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: 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.

State of the Art of Performance Evaluation Methods for Concentrating Solar Collectors

Annie Hofer[1, a)], Loreto Valenzuela[2], Nicole Janotte[3], Juan Ignacio Burgaleta[4], Jaime Arraiza[5], Marco Montecchi[6], Fabienne Sallaberry[7], Tiago Osório[8], Maria João Carvalho[9], Fabrizio Alberti[10], Korbinian Kramer[11], Anna Heimsath[11], Werner Platzer[11] and Stephan Scholl[12]

[1] Dipl.-Ing., Scientific Researcher, Fraunhofer Institute for Solar Energy Systems ISE, Heidenhofstr. 2, 79110 Freiburg, Germany.
[2] CIEMAT – Plataforma Solar de Almería, Crta. Senes, km. 4.5, 04200 Tabernas (Almería), Spain.
[3] German Aerospace Center (DLR), Linder Hohe, 51147 Cologne, Germany.
[4] SENER, Engineering Division, Adva. Zugazarte, 56, 48930 Las Arenas, Bizkaia, Spain.
[5] Acciona Energía, S.A., Avda. Ciudad de la Innovación Nº 5, 31621 Sarriguren, Navarra, Spain.
[6] Researcher Physicist, ENEA CR Casaccia, Via Anguillarese 301, 00123 S. Maria di Galeria (Roma), Italy.
[7] National Renewable Energy Centre of Spain (CENER), Solar Thermal Energy Department, Ciudad de la Innovación 7, 31621 Sarriguren, Navarra, Spain.
[8] University of Évora – ST Renewable Energies Chair, Palácio do Vimioso, Largo Marquês de Marialva, 7002-554, Évora, Portugal.
[9] Senior Researcher, LNEG, Laboratório Nacional de Energia e Geologia, Estrada do Paço do Lumiar, 22, 1649-038 Lisboa, Portugal.
[10] Fondazione Bruno Kessler, ARES Unit, Via alla Cascata 56/C, 38123 Trento, Italy.
[11] Scientific Researchers, Fraunhofer ISE, Heidenhofstr. 2, 79110 Freiburg, Germany.
[12] Prof. Dr.-Ing., Head of Institute for Chemical and Thermal Process Engineering ICTV, Technical University Braunschweig, Langer Kamp 7, 38106 Braunschweig, Germany.

[a)] annie.hofer@ise.fraunhofer.de

Abstract. For the development and establishment of concentrating solar thermal collectors a reliable and comparable performance testing and evaluation is of great importance. To ensure a consistent performance testing in the area of low-temperature collectors a widely accepted and commonly used international testing standard (ISO 9806:2013) is already available. In contrast to this, the standard ISO 9806:2013 has not completely penetrated the testing sector of concentrating collectors yet. On that account a detailed literature review has been performed on published testing procedures and evaluation methodologies as well as existing testing standards. The review summarizes characteristics of the different steady-state, quasi-dynamic and fully dynamic testing methods and presents current advancements, assets and drawbacks as well as limitations of the evaluation procedures. Little research is published in the area of (quasi-) dynamic testing of large solar collectors and fields. As a complementary a survey has been conducted focusing on currently implemented evaluation procedures in this particular field. Among the ten participants of the survey were project partners of relevant industry and research institutions within the European project STAGE-STE (Work package 11 - Linear focusing STE technologies). The survey addressed general aspects of the systems under test, as well as required process conditions and detailed characteristics of the evaluation procedures. In congruence with the literature review, the survey shows a similar tendency: the quasi-dynamic testing method according ISO 9806:2013 presents the most common and advanced evaluation procedure mainly used in the context of tracking concentrating collectors for the performance assessment of parabolic trough collectors operating with thermal oil or pressurized water. These common solar systems can be evaluated with minor adaptions to the testing standard. Evaluation procedures focused on in-situ measurements in solar fields or collectors are scarce and complex as well as an evaluation of linear Fresnel collectors or other systems operating

with non-common heat transfer media like molten salt and direct steam. As those are still presenting niche products and testing wise challenging systems under real test conditions a more sophisticated evaluation procedure such as the dynamic testing method is expected to be better suited.

INTRODUCTION

For the development and establishment of concentrating solar thermal collectors a reliable and comparable performance testing and evaluation is of great importance. To ensure a consistent performance testing in the area of low-temperature collectors a widely accepted and commonly used international testing standard (ISO 9806:2013) is already available[1]. In contrast to this, the standard ISO 9806:2013 has not completely penetrated the testing sector of concentrating collectors yet. The reasons for this are diverse. Among them are technical limitations in the established methods which increase the effort of applying the methods to an inappropriate extent. Furthermore some specific characteristics of concentrating collectors are not represented by the given theoretical models (e.g. two-dimensional incidence angle modifier including the effect of row end losses, cleanliness of mirrors during testing, use of different heat transfer media and in-situ measurements).

On that account a detailed literature review has been performed on published testing procedures and evaluation methodologies as well as existing testing standards, which will be presented in the first section of this article. As a complement a survey has been conducted among ten participants of relevant industry and research institutions within the European project STAGE-STE (Work package 11 - Linear focusing STE technologies), giving indications on the up-to-date state of the art of currently implemented testing procedures. The survey addresses general aspects of the system under test, as well as required process conditions and detailed characteristics of the evaluation procedure.

LITERATURE OVERVIEW

Literature screening showed a multiplicity of different publications in the field of solar thermal collector testing procedures. Therefore, the publications with their respective testing procedures were differentiated into two aspects: their testing methodology on the one hand side and their application on the other hand side, allowing a more structured and traceable comparison of the different testing methods. In Figure 1 the detailed literature review is summed up according to the introduced categories. The methodologies are grouped into steady-state (SST), quasi-dynamic (QDT) and dynamic (DT) testing, whereas the application of the published testing procedures are classified into non-tracking (stationary) collectors, tracking concentrating collectors and large solar fields of tracking concentrating collectors.

The upper part of Figure 1, highlighted in light blue, shows that the majority of publications in the field of collector testing is dealing with non-tracking collectors. In this area a multiplicity of diverse testing and evaluation procedures has been published. For clarity reasons, publications of steady-state testing for non-tracking collectors have not been listed, as they are plenty and of less interest concerning testing procedures for concentrating collectors. Especially the quasi-dynamic testing procedure was investigated, adapted and applied in several publications for different technologies, mainly based on the work done by the research group of Perers (e.g. see Perers (1997)[2]). Moreover the QDT-method presents part of the basis of the current testing standard ISO 9806:2013[1] and other standards (see Kramer et al. (2011)[3]). As a counterpart to the QDT-procedure the dynamic testing method has firstly been introduced by Muschaweck and Spirkl (1993), containing a more sophisticated collector simulation tool, but less restriction in measurement data[4]. The QDT-method is based on a linear collector equation and quite strict boundary conditions, which allow the use of multiple linear regression (MLR). In contrast the DT-method is based on different kinds of specific (dynamic) collector simulation models allowing a more flexible combination with an optimization algorithm consisting for example of a non-linear least-squares (NLS) minimization approach. A comparison of both mathematical approaches by Fischer et al. (2003) showed that they are equivalent in their results, NLS minimization only being more flexible[5].

In the area of tracking concentrating collectors there does exist an American testing standard ASTM E 905-87 based on steady-state testing[6]. Even a guideline for the acceptance testing of parabolic trough solar fields is based on stationary measurements[7]. An approach of steady-state testing has been applied for measuring the performance of large parabolic-trough collectors[8]. It is currently considered as a first reference approach for the proposal of a national standard in the Spanish National Committee AENOR (see Sallaberry et al. (2015)[9]) and will be an input for discussion in the International Committee IEC TC 117 (Solar thermal electric plants). Nevertheless these testing procedures are either very time consuming or (if not the latter) mostly not comprehensively characterizing the collector or field performance, as they are limited to particular conditions (high DNI, normal incidence at solar noon etc.).

In Figure 1 the testing standard ISO 9806:2013 is marked with dotted lines in the area of tracking concentrating collectors, as it is not fully applicable to all concentrating collectors without modifications. Publications in this field show, that the QDT-method is successfully applied particularly for small-scale parabolic trough collectors (marked with an S), as restrictions to measurement conditions can still be met (see Fischer et al. (2006)[10] and Janotte et al. (2009)[11]). For a global characterization of large-scale collectors (marked with an L), either parabolic trough or linear Fresnel, mainly the dynamic testing method is applied, as with higher working temperatures, energy loads to be cooled to meet stationary inlet conditions cannot easily be fulfilled. In particular for the characterization of linear

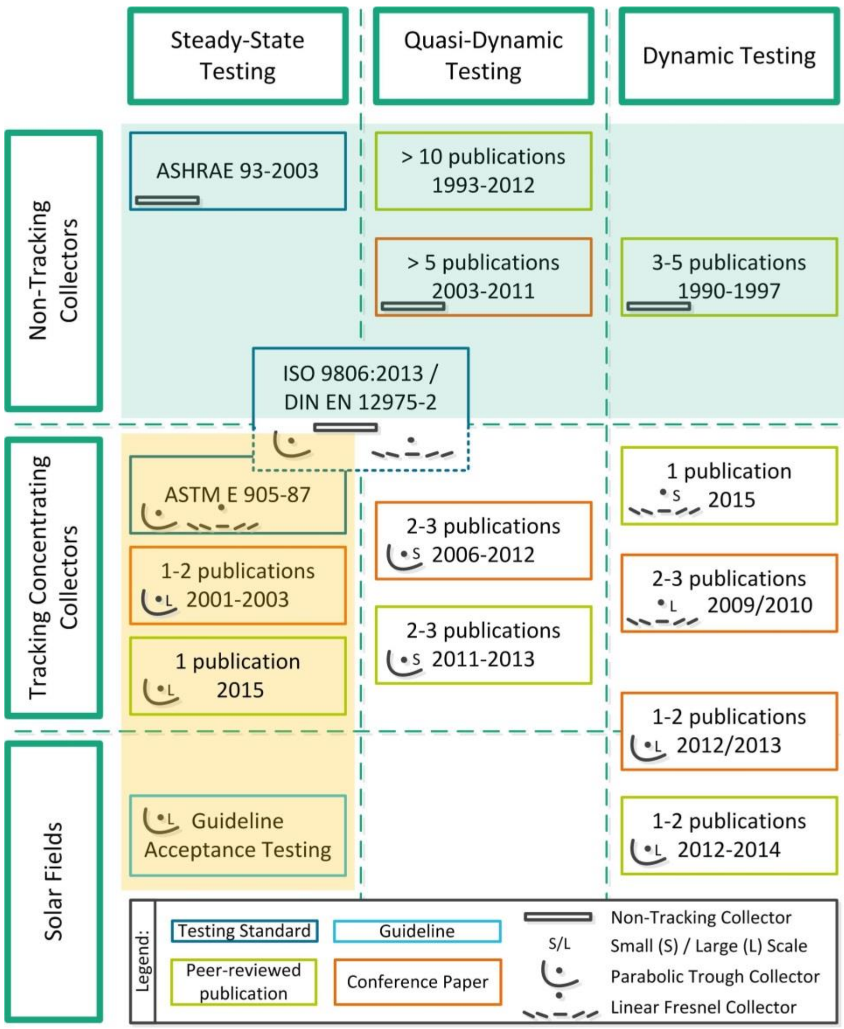


FIGURE 1. Summary of published testing and evaluation procedures with focus on concentrating solar collectors (overview compiled by Fraunhofer ISE).

Fresnel collectors due to their special optical characteristics in terms of a two-dimensional IAM, new approaches by dynamic parameter identification[12,13], or modifications to the QDT-methods are inevitable (compare with Hofer et al. (2015)[13]).

Apart from the steady-state guideline for the acceptance testing of solar fields, there are few publications presenting a more sophisticated characterization and acceptance testing of parabolic trough solar fields based on dynamic testing procedures (see Janotte (2012)[14]). Quasi-dynamic testing is rarely applied to large collectors or solar fields, which might be an indication, that the QDT-method with its restriction in measurement data is not entirely suited for the performance evaluation of larger systems. A guideline focusing on characteristics, assets and drawbacks as well as practical indications for the use of dynamic solar collector and solar field performance testing is currently being compiled (see Hofer and Janotte (2015/16)[15]).

With the existence of testing standards for non-tracking collectors (in Figure 1 highlighted area in light blue) and for steady-state testing procedures (in Figure 1 highlighted area in light orange), standardization in the area of dynamic testing procedures for tracking concentrating solar collector and fields is still lacking, while research and its publication is existing, but scarce. To get a more comprehensive overview on current testing approaches, a survey on (not necessarily published) currently implemented dynamic testing and evaluation procedures was conducted, which will be presented in the following section.

SURVEY ON DYNAMIC EVALUATION PROCEDURES FOR SOLAR COLLECTORS AND FIELDS

As an addition to the literature review, a survey has been set up focused on the characteristics of currently used evaluation methods for the performance evaluation of solar collectors and fields. The participants of the survey are linked to the working group of WP 11 (Linear focusing STE technologies) of the European project STAGE-STE and consist of: Fraunhofer ISE (subtask leader), CIEMAT, DLR, SENER, Acciona, ENEA, CENER, University of Évora, LNEG and FBK. According to the list of participants, the survey is not designed to address the complete solar thermal sector. It is particularly concentrated on research institutions and relevant industries focused on tracking/concentrating solar thermal collectors and fields, as the literature review showed a gap of publications in this area (see right bottom part of Figure 1).

Within the ten participants, the characteristics of 12 different testing/evaluation procedures were analyzed. Table 1 summarizes the general aspects of the different evaluation procedures concerning system characteristics, such as the type of collector to be evaluated or the heat transfer fluid being used. It shows that the majority (83 %) of the evaluation procedures are used for the characterization of parabolic trough collectors, whereas only 25 % are used for linear Fresnel collectors and 33 % for CPC collectors and other non-tracking medium temperature collectors. The percentages do not add up to 100 % as there are several methods that can be used for several collector types. 83 % of the evaluation methods are designed for solar collector evaluation, only 25 % can be applied to solar fields. Concerning the used heat transfer fluid for the characterization of the systems, mainly thermal oil (67 %) and pressurized water (50 %) are used, whereas only 8 % of the evaluation methods are performed with molten salt. A performance evaluation with direct steam based on a dynamic measurement approach does currently not exist within

TABLE 1. Survey results concerning general aspects of testing system characteristics for the different evaluation procedures.

Category	Type	Share
Evaluated collector type	Parabolic trough	83 %
	Linear Fresnel	25 %
	Non-tracking collectors	33 %
System under test	Solar collector	83 %
	Solar field	33 %
Heat transfer fluid used	Thermal oil	67 %
	Pressurized water	50 %
	Molten salt	8 %
	Direct Steam	0 % (DT) / 16 % (SST)

the partners of the survey. 16 % indicate, that performance evaluation based on steady-state measurements can be performed. The figures show that the most commonly used evaluation method is designed for parabolic trough collector operating with thermal oil or pressurized water. A reason why the evaluation methods can rarely be applied to other collector types and heat transfer fluids may have to do with the dispersion of the solar system on the one side and with the complexity and peculiarities linked to these systems under test on the other side.

Details of the evaluation methodology for the testing procedures under review can be found in Table 2. The results show that around 67 % of the evaluation procedures are based on a quasi-dynamic testing approach. 25 % are based on dynamic testing procedures and 8 % are only able to evaluate in steady-state measurement conditions. Concerning the mathematical approach of the reviewed evaluation procedures, 50 % are identifying performance parameters with multiple linear regression (MLR) while the other 50 % are using a parameter identification method based on a non-linear least-squares minimization (NLS) approach. This indicates that the testing method itself is independent of the mathematical approach. While QDT-data can be evaluated with MLR or NLS, the DT-method requires a NLS approach, as it provides higher flexibility due to the simulation model being more complex than a linear one-node collector equation of the QDT-method. Concerning the required process conditions during testing, 75 % of the procedures are based on constant inlet temperature and mass flow, which is in accordance with the summed share of QDT- and SST-procedures. Likewise 25 % are able to tolerate variations in irradiance, inlet temperature and inlet mass flow in agreement to the percentage of the DT-method.

One aspect of the survey also implies the analysis of parameters included in the evaluation procedure corresponding results can be found in Table 3. As all of the testing procedures assess the collector output power of the system under test, inlet/outlet temperatures and mass flow rates are always taken into account, as well as direct normal irradiance. Ambient temperature is considered in the evaluation procedure similar evident in 92 % of the cases. With respect to collector parameters, optical efficiency at normal incidence $\eta_{opt,0}$ and heat loss parameters are always taken into account. Additionally direct IAM values are included in the majority (92 %) of the reviewed methods.

For wind velocity (50 %), global irradiance (42 %) and pressure (17 %) measurements no clear statement can be drawn from the survey. Diffuse IAM-values as well as cleanliness of the mirrors are taken into account in 33 % of the methods. This indicates that the different evaluation procedures are adapted to the particular situation and needs of the system under test. No strict conclusions on the relevance or irrelevance of these parameters can be given within the context of the survey. The particular adaptions of the procedures show that a testing and evaluation proce-

TABLE 2. Survey results concerning evaluation methodology for the different evaluation procedures.

Category	Type	Share
Testing method	QDT	65 %
	DT	25 %
	SST	8 %
Mathematical approach	Multiple linear regression	50 %
	Non-linear least-squares minimization	50 %

TABLE 3. Survey results concerning considered parameters for the different evaluation procedures.

Category	Type	Share
Process conditions	Mass flow	100 %
	Inlet and outlet temperature	100 %
	Pressure	17 %
Ambient conditions	Direct normal irradiance	100 %
	Global irradiance	42 %
	Ambient temperature	92 %
	Wind velocity	50 %
Collector conditions	Optical efficiency at normal incidence	100 %
	Heat loss parameters	100 %
	IAM direct irradiance	92 %
	IAM diffuse irradiance	33 %
	Cleanliness	33 %

dure for concentrating solar collectors needs to be flexible enough for a large spectrum of diverse collector systems to be tested.

Having an overall look onto the shares of the survey, it becomes evident, that 80 % of the evaluation methods for solar collectors use the QDT-procedure of the current testing standard ISO 9806:2013 with smaller adaptions. Similarly 67 % of the methods for solar field performance evaluation use a dynamic testing approach. This indicates, that for the majority of collectors tested among the survey partners (mainly parabolic trough collectors operating with thermal oil or pressurized water), the QDT-procedures are suited for the determination of the collector performance, whereas for the majority of solar fields a more flexible, dynamic testing approach is required. With respect to the application of the DT-procedure the survey showed, that dynamic testing is required either for testing of solar fields or for in-situ testing of solar collectors, as these systems do not allow an extensive intrusion into the process conditions and therefore require a more flexible evaluation routine.

CONCLUSION

A detailed literature review focused on dynamic testing procedures for concentrating solar collectors was performed. In addition, a survey among ten project partners of the European project STAGE-STE WP 11 was conducted. Both analyses showed the same tendency: the quasi-dynamic evaluation procedure according to the testing standard ISO 9806:2013 is mainly used in the context of tracking concentrating collectors for the performance assessment of parabolic trough collectors operating with thermal oil or pressurized water. These common solar systems can be evaluated with minor adaptions to the testing standard.

Nevertheless similar to published literature, the survey showed that evaluation procedures focused on in-situ measurements in solar fields or collectors are scarce and complex as well as an evaluation of linear Fresnel collectors or other systems operating with non-common heat transfer media like molten salt and direct steam. As those are still presenting niche products and testing wise challenging systems under real test conditions a more sophisticated evaluation procedure such as the dynamic testing method is likely to be better suited.

In terms of testing standardization, the DT-method may present a considerable alternative to overcome the limitations of QDT-procedures and assure a reliable and comparable performance assessment of large concentrating solar systems. Still advanced research is necessary in the development of improved or alternative testing procedures, especially with respect to linear Fresnel systems, large solar fields and systems operating with direct steam.

ACKNOWLEDGMENTS

The research leading to these results has received funding from the *European Union Seventh Framework Programme* (FP7/2007-2013) under grant agreement n° 609837 (Scientific and Technological Alliance for Guaranteeing the European Excellence in Concentrating Solar Thermal Energy, STAGE-STE).

The authors would also like to thank the *German Federal Ministry of Economic Affairs and Energy BMW*i for the financial support in the project *"StaMeP*", 16UM0095. Moreover, the authors would like to thank the *Deutsche Bundesstiftung Umwelt DBU* for the financial support in the context of their PhD Scholarship Programme.

T. Osório gratefully acknowledges the Portuguese funding institution FCT – Fundação para a Ciência e a Tecnologia – for supporting his research.

REFERENCES

1. ISO 9806:2013, Solar energy - Solar thermal collectors - Test methods (2013).
2. B. Perers, "An improved dynamic solar collector test method for determination of non-linear optical and thermal characteristics with multiple regression," in Solar Energy **59** (4-6), 163–178 (1997).

3. K. Kramer, S. Mehnert, and S. Fischer, “Testing process heat collectors – an overview on methodologies and categories,” in *SolarPACES 2011*, Proceedings of the 17th Solar Power and Chemical Energy Systems International Symposium (2011).
4. J. Muschaweck and W. Spirkl, “Dynamic solar collector performance testing,” in Solar Energy Materials and Solar Cells **30** (2), 95–105 (1993).
5. S. Fischer, W. Heidemann, and H. Müller-Steinhagen, “Collector parameter identification - Iterative methods versus multiple linear regression,” in *ISES Solar World Congress (International Solar Energy Society (ISES), 2003).*
6. ASTM E 905 – 87, Standard Test Method for Determining Thermal Performance of Tracking Concentrating Solar Collectors (1987 (Reapproved 2007)).
7. D. Kearney, Utility-scale parabolic trough solar systems - Performance acceptance test guidelines, April 2009 - December 2010 NREL/SR-5500-48895, (2011).
8. L. Valenzuela, R. López-Martín, E. Zarza, “Optical and thermal performance of large-size parabolic-trough solar collectors from outdoor experiments: A test method and a case study,” in Solar Energy **70**, 456–464 (2014).
9. F. Sallaberry, A. Bello, J.I. Burgaleta, A. Fernández, J. Fernández, J.A. Gomez, S. Herrero, E. Luepfert, R. Morillo, M.G. San Vicente, M. Sanchez, P. Santamaría, J. Terradillos, J. Ubach, L. Valenzuela, “Standards for components in concentrating solar thermal power plants - status of the Spanish working group,” in *SolarPACES 2015*, Proceedings of the 21th Solar Power and Chemical Energy Systems International Symposium (2015).
10. S. Fischer, E. Lüpfert, and H. Müller-Steinhagen, “Efficiency testing of parabolic trough collectors using the quasi-dynamic test procedure according to the European Standard EN 12975,” in *SolarPACES 2006*, Proceedings of the13th Solar Power and Chemical Energy Systems International Symposium (2006).
11. N. Janotte, S. Meiser, D. Krüger, E. Lüpfert, R. Pitz-Paal, S. Fischer, and H. Müller-Steinhagen, “Quasi-dynamic analysis of thermal performance of parabolic trough collectors,” in *SolarPACES 2009*, Proceedings of the 15th Solar Power and Chemical Energy Systems International Symposium (2009).
12. W. Platzer, A. Heimsath, and H. Hülsey, “Parameter identification technique for the determination of optical efficiency of concentrating collectors,” in *SolarPACES 2009*, Proceedings of the 15th Solar Power and Chemical Energy Systems International Symposium (2009).
13. A. Hofer, D. Büchner, A. Heimsath, S. Fahr, K. Kramer, W. Platzer, and S. Scholl, “Comparison of Two Different (Quasi-) Dynamic Testing Methods for the Performance Evaluation of a Linear Fresnel Process Heat Collector,” in Energy Procedia **69**, 84–95 (2015).
14. N. Janotte, “Requirements for representative acceptance tests for the prediction of the annual yield of parabolic trough solar fields,” Ph.D. Thesis, Shaker, Aachen, 2012.
15. A. Hofer, N. Janotte, “Best Practice Guideline: Dynamic in situ Performance and Acceptance Testing of Line-Concentrating Collectors and Solar Fields,” (to be published 2015/16).