Horizon 2020

Call: H2020-LCE-2016-2017
(COMPETITIVE LOW-CARBON ENERGY)

Topic: LCE-11-2017

Type of action: IA
(Innovation action)

Proposal number: 792103

Proposal acronym: SOLWATT

Deadline Id: H2020-LCE-2017-RES-IA

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How to fill in the forms

The administrative forms must be filled in for each proposal using the templates available in the submission system. Some data fields in the administrative forms are pre-filled based on the previous steps in the submission wizard.

1 - General information

Topic	LCE-11-2017
Call Identifier	H2020-LCE-2016-2017
Type of Action	IA
Deadline Id	H2020-LCE-2017-RES-IA
Acronym	SOLWATT
Proposal title*	Solving Water Issues for CSP Plants
Duration in months	*48*
Fixed keyword 1	*Concentrated Solar Power*
Free keywords	*Concentrated solar power, sustainable renewable energy, water saving, cleaning, cooling, water recovery, demonstration*

Note that for technical reasons, the following characters are not accepted in the Proposal Title and will be removed: < > " &

Add

Proposal ID **792103** Acronym **SOLWATT**

Abstract

SOLWATT targets to significantly reduce the water used by CSP plants (by 35% for wet cooled & by 90% for dry cooled). The project proposes to demonstrate the efficiency of innovations on solar field cleaning, power-block cooling, water recycling system, and plant operation strategy. Among these are solutions to reduce solar field water cleaning needs, an operation and maintenance optimizer software including soiling forecaster, a MEE water recovery technology running on otherwise dumped heat from the solar field, and a cooling concept for the turbine condenser storing excess heat when ambient is too warm, then releasing it during cool night times.
The solutions will be implemented at two CSP operational sites, “La Africana” parabolic trough plant in Spain and “Ashalim” central receiver plant in Israel, to demonstrate significant reduction in water use while making CSP more cost effective, and achieving near-to-market status. The solutions are best applied together, but each will also bring water and cost savings on its own, thanks to their ability to fit any kind of CSP plant; dry, wet, or hybrid cooled, existing or future ones, tailored to location and policy framework. Their application will save more than 0.5 M€/year of operational cost for a 50 MW CSP plant. Regarding competition on water resources and humanitarian issues, the social acceptance of CSP will be increased by detailed analysis of case studies and education of local population to the benefits of solar energy.
The targeted savings of water and operation costs will increase CSP’s competitiveness compared to other renewable energy and the electricity market in general, as well as its acceptance within local communities, achieving a big step forward in the SET plan goals for CSP technology by 2020. The consortium, led by TSK Electrónica y Electricidad S.A. (Spain), is made up of 13 partners from 6 European countries plus Israel, including 5 industrials partners, 2 SMEs, 5 RTOs and one University.

Remaining characters 5

Has this proposal (or a very similar one) been submitted in the past 2 years in response to a call for proposals under Horizon 2020 or any other EU programme(s)? ○ Yes ◉ No

Proposal ID **792103** *Acronym* **SOLWATT**

Declarations

1) The coordinator declares to have the explicit consent of all applicants on their participation and on the content of this proposal.	☒
2) The information contained in this proposal is correct and complete.	☒
3) This proposal complies with ethical principles (including the highest standards of research integrity — as set out, for instance, in the European Code of Conduct for Research Integrity — and including, in particular, avoiding fabrication, falsification, plagiarism or other research misconduct).	☒

4) The coordinator confirms:

- to have carried out the self-check of the financial capacity of the organisation on http://ec.europa.eu/research/participants/portal/desktop/en/organisations/lfv.html or to be covered by a financial viability check in an EU project for the last closed financial year. Where the result was "weak" or "insufficient", the coordinator confirms being aware of the measures that may be imposed in accordance with the H2020 Grants Manual (Chapter on Financial capacity check); or	◉
- is exempt from the financial capacity check being a public body including international organisations, higher or secondary education establishment or a legal entity, whose viability is guaranteed by a Member State or associated country, as defined in the H2020 Grants Manual (Chapter on Financial capacity check); or	○
- as sole participant in the proposal is exempt from the financial capacity check.	○

5) The coordinator hereby declares that each applicant has confirmed:

- they are fully eligible in accordance with the criteria set out in the specific call for proposals; and	☒
- they have the financial and operational capacity to carry out the proposed action.	☒

The coordinator is only responsible for the correctness of the information relating to his/her own organisation. Each applicant remains responsible for the correctness of the information related to him/her and declared above. Where the proposal to be retained for EU funding, the coordinator and each beneficiary applicant will be required to present a formal declaration in this respect.

According to Article 131 of the Financial Regulation of 25 October 2012 on the financial rules applicable to the general budget of the Union (Official Journal L 298 of 26.10.2012, p. 1) and Article 145 of its Rules of Application (Official Journal L 362, 31.12.2012, p.1) applicants found guilty of misrepresentation may be subject to administrative and financial penalties under certain conditions.

Personal data protection

The assessment of your grant application will involve the collection and processing of personal data (such as your name, address and CV), which will be performed pursuant to Regulation (EC) No 45/2001 on the protection of individuals with regard to the processing of personal data by the Community institutions and bodies and on the free movement of such data. Unless indicated otherwise, your replies to the questions in this form and any personal data requested are required to assess your grant application in accordance with the specifications of the call for proposals and will be processed solely for that purpose. Details concerning the purposes and means of the processing of your personal data as well as information on how to exercise your rights are available in the privacy statement. Applicants may lodge a complaint about the processing of their personal data with the European Data Protection Supervisor at any time.

Your personal data may be registered in the Early Detection and Exclusion system of the European Commission (EDES), the new system established by the Commission to reinforce the protection of the Union's financial interests and to ensure sound financial management, in accordance with the provisions of articles 105a and 108 of the revised EU Financial Regulation (FR) (Regulation (EU, EURATOM) 2015/1929 of the European Parliament and of the Council of 28 October 2015 amending Regulation (EU, EURATOM) No 966/2012) and articles 143 - 144 of the corresponding Rules of Application (RAP) (COMMISSION DELEGATED REGULATION (EU) 2015/2462 of 30 October 2015 amending Delegated Regulation (EU) No 1268/2012) for more information see the Privacy statement for the EDES Database).

List of participants

#	Participant Legal Name	Country
1	TSK ELECTRONICA Y ELECTRICIDAD SA	Spain
2	COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES	France
3	DEUTSCHES ZENTRUM FUER LUFT - UND RAUMFAHRT EV	Germany
4	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT	Spain
5	CRANFIELD UNIVERSITY	United Kingdom
6	FUNDACION TEKNIKER	Spain
7	RIOGLASS SOLAR SA	Spain
8	ARCHIMEDE SOLAR ENERGY SRL	Italy
9	INGENIERIA PARA EL DESARROLLO TECNOLOGICO SL	Spain
10	FENIKS CLEANING & SAFETY S.L.	Spain
11	BARCELONA SUPERCOMPUTING CENTER - CENTRO NACIONAL DE SUPERCOMPUTACION	Spain
12	BRIGHTSOURCE INDUSTRIES ISRAEL LTD	Israel
13	AMIRES SRO	Czech Republic

2 - Administrative data of participating organisations

PIC	***Legal name***
938799078	*TSK ELECTRONICA Y ELECTRICIDAD SA*

Short name: TSK

Address of the organisation

Street AVENIDA BYRON 220 PARQUE CIENTIFICO Y

Town GIJON

Postcode 33203

Country Spain

Webpage www.tsk.es

Legal Status of your organisation

Research and Innovation legal statuses

Public body .... no

Legal person .... yes

Non-profit .... no

International organisation .... no

International organisation of European interest .... no

Secondary or Higher education establishment .... no

Research organisation .... no

Enterprise Data

SME self-declared status........ unknown

SME self-assessment .... unknown

SME validation sme .... unknown

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Department(s) carrying out the proposed work

Department 1

Department name: Technology ☐ not applicable

☒ Same as organisation address

Street: AVENIDA BYRON 220 PARQUE CIENTIFICO Y TE

Town: GIJON

Postcode: 33203

Country: Spain

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **792103** *Acronym* **SOLWATT** *Short name* **TSK**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Mr. Sex: (●) Male ( ) Female

First name: **Luis** Last name: **Millán**

E-Mail: **luis.millan@grupotsk.com**

Position in org.: R&D Engineer

Department: Tecnhology ☐ Same as organisation

☒ Same as organisation address

Street: AVENIDA BYRON 220 PARQUE CIENTIFICO Y TECNOLOGICO

Town: GIJON Post code: 33203

Country: Spain

Website:

Phone 1: +34 984 495351 Phone 2: +xxx xxxxxxxxx Fax: +xxx xxxxxxxxx

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Vaclav	SMITKA	smitka@amires.eu	+420732304379
Eduardo	Lago	eduardo.lago@grupotsk.com	
Rogelio	Peón	rogelio.peon@grupotsk.com	+34 984 495881

PIC	***Legal name***
999992401	*COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES*

Short name: CEA

Address of the organisation

Street RUE LEBLANC 25

Town PARIS 15

Postcode 75015

Country France

Webpage www.cea.fr

Legal Status of your organisation

Research and Innovation legal statuses

Public body .... yes

Legal person .... yes

Non-profit .... yes

International organisation .... no

International organisation of European interest ...... no

Secondary or Higher education establishment .... no

Research organisation .... yes

Enterprise Data

SME self-declared status.................................. 01/10/2008 - no

SME self-assessment .... unknown

SME validation sme .... 01/10/2008 - no

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Department(s) carrying out the proposed work

Department 1

Department name	Heat Biomass and Hydrogen department
	☐ not applicable
	☐ Same as organisation address
Street	50 avenue du lac Léman
Town	Le Bourget du Lac
Postcode	73375
Country	France

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **792103** *Acronym* **SOLWATT** *Short name* **CEA**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Mrs

Sex: ◯ Male ◉ Female

First name: **Delphine**

Last name: **Bourdon**

E-Mail: **delphine.bourdon@cea.fr**

Position in org.: Laboratory European Projects Manager

Department: Heat Biomass and Hydrogen department

☐ Same as organisation

☐ Same as organisation address

Street: 50 avenue du lac Léman

Town: Le Bourget du Lac

Post code: 73375

Country: France

Website:

Phone 1: +33 479 792 129

Phone 2: +xxx xxxxxxxxx

Fax: +xxx xxxxxxxxx

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Laurent	Bedel	laurent.bedel@cea.fr	
Arnaud	Bruch	arnaud.bruch@cea.fr	
Roland	Baviere	roland.baviere@cea.fr	

PIC	***Legal name***
999981731	*DEUTSCHES ZENTRUM FUER LUFT - UND RAUMFAHRT EV*

Short name: DLR

Address of the organisation

Street	Linder Hoehe
Town	KOELN
Postcode	51147
Country	Germany
Webpage	www.dlr.de

Legal Status of your organisation

Research and Innovation legal statuses

Public body ....no

Legal person .... yes

Non-profit ....yes

International organisation ....no

International organisation of European interest ......no

Secondary or Higher education establishment ....no

Research organisation ....yes

Enterprise Data

SME self-declared status..................................28/10/2008 - no

SME self-assessment .... unknown

SME validation sme ....28/10/2008 - no

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Department(s) carrying out the proposed work

Department 1

Department name	Institute of Solar Research, Dept of Qualification	☐ not applicable
	☐ Same as organisation address	
Street	Plataforma Solar de Almería,	
Town	Tabernas	
Postcode	04200	
Country	Spain	

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **792103** *Acronym* **SOLWATT** *Short name* **DLR**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Mr.
Sex: (•) Male ( ) Female

First name: **Fabian** Last name: **Wolfertstetter**

E-Mail: **fabian.wolfertstetter@dlr.de**

Position in org.: Scientist

Department: Institute of Solar Research, Dept of Qualification ☐ Same as organisation

☐ Same as organisation address

Street: Plataforma Solar de Almería,

Town: Tabernas Post code: 04200

Country: Spain

Website:

Phone 1: +34950611877 Phone 2: +xxx xxxxxxxxx Fax: +xxx xxxxxxxxx

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Tobias	Hirsch	tobias.hirsch@dlr.de	
Florian	Sutter	florian.sutter@dlr.de	
Stefan	Wilbert	stefan.wilbert@dlr.de	
Natalie	Hanrieder	natalie.hanrieder@dlr.de	
Ana Carolina	do Amaral Burghi	ana.doamaralburghi@dlr.de	
Miriam	Schuster	miriam.schuster@dlr.de	

PIC	***Legal name***
999614877	*CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEM*

Short name: CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT

Street Avenida Complutense 40

Town MADRID

Postcode 28040

Country Spain

Webpage http://www.ciemat.es

Legal Status of your organisation

Research and Innovation legal statuses

Public body .... yes

Legal person .... yes

Non-profit .... yes

International organisation .... no

International organisation of European interest ...... no

Secondary or Higher education establishment .... no

Research organisation .... yes

Enterprise Data

SME self-declared status................................. unknown

SME self-assessment .... unknown

SME validation sme .... unknown

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Department(s) carrying out the proposed work

Department 1

Department name: Solar Desalination Unit ☐ not applicable

☐ Same as organisation address

Street: Senés Road, Km. 4.5; P.O. Box 22

Town: Tabernas

Postcode: 04200

Country: Spain

Dependencies with other proposal participants

Character of dependence	***Participant***	

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Mrs

Sex: ◯ Male ◉ Female

First name: **Patricia**

Last name: **Palenzuela Ardila**

E-Mail: **patricia.palenzuela@psa.es**

Position in org.: Researcher

Department: Solar Desalination Unit

☐ Same as organisation

☐ Same as organisation address

Street: Senés Road, Km. 4.5; P.O. Box 22

Town: Tabernas

Post code: 04200

Country: Spain

Website:

Phone 1: +34950387800 (950

Phone 2: +xxx xxxxxxxxx

Fax: +xxx xxxxxxxxx

Other contact persons

First Name	Last Name	E-mail	Phone
Diego	Alarcón Padilla	diego.alarcon@psa.es	
Loreto	Valenzuela Gutiérrez	loreto.valenzuela@psa.es	
Aránzazu	Fernández García	arantxa.fernandez@psa.es	
Rosa	García	rosa.garcia@psa.es	

PIC	***Legal name***
999440762	*CRANFIELD UNIVERSITY*

Short name: CRANFIELD UNIVERSITY

Address of the organisation

Street	College Road
Town	CRANFIELD - BEDFORDSHIRE
Postcode	MK43 0AL
Country	United Kingdom
Webpage	www.cranfield.ac.uk

Legal Status of your organisation

Research and Innovation legal statuses

Public body ....yes

Legal person .... yes

Non-profit ....yes

International organisation ....unknown

International organisation of European interest ......unknown

Secondary or Higher education establishment ....yes

Research organisation ....yes

Enterprise Data

SME self-declared status.................................25/06/2014 - no

SME self-assessment .... unknown

SME validation sme .... unknown

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Department(s) carrying out the proposed work

Department 1

Department name: Precision Engineering Institute

☐ not applicable

☒ Same as organisation address

Street: College Road

Town: CRANFIELD - BEDFORDSHIRE

Postcode: MK43 0AL

Country: United Kingdom

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **792103** *Acronym* **SOLWATT** *Short name* **CRANFIELD UNIVERSITY**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr.

Sex: (●) Male ( ) Female

First name: **Christopher** Last name: **Sansom**

E-Mail: **c.l.sansom@cranfield.ac.uk**

Position in org.: Associate Professor in Concentrating Solar Power

Department: Precision Engineering Institute

☐ Same as organisation

☒ Same as organisation address

Street: College Road

Town: CRANFIELD - BEDFORDSHIRE

Post code: MK43 0AL

Country: United Kingdom

Website:

Phone 1: +44 1234 752955 Phone 2: +xxx xxxxxxxxx Fax: +xxx xxxxxxxxx

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Kumar	Patchigolla	k.patchigolla@cranfield.ac.uk	
Nazmiye	Ozkan	n.ozkan@cranfield.ac.uk	
Heather	Almond	h.j.a.almond@cranfield.ac.uk	
Peter	Turner	peter.turner88@btinternet.com	
Faisal	Asfand	faisal.asfand@cranfield.ac.uk	

PIC	***Legal name***
999959227	*FUNDACION TEKNIKER*

Short name: IK4-TEKNIKER

Address of the organisation

Street CALLE INAKI GOENAGA 5

Town EIBAR GUIPUZCOA

Postcode 20600

Country Spain

Webpage www.tekniker.es

Legal Status of your organisation

Research and Innovation legal statuses

Public body ....no

Legal person .... yes

Non-profit ....yes

International organisation ....no

International organisation of European interest ......no

Secondary or Higher education establishment ....no

Research organisation ....yes

Enterprise Data

SME self-declared status.................................31/12/2015 - no

SME self-assessment .... unknown

SME validation sme ....31/12/2010 - no

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Department(s) carrying out the proposed work

Department 1

Department name	Head of Surface Chemistry and Nanotechnologies Unit	☐ not applicable
	☒ Same as organisation address	
Street	CALLE INAKI GOENAGA 5	
Town	EIBAR GUIPUZCOA	
Postcode	20600	
Country	Spain	

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **792103**	Acronym **SOLWATT**	Short name **IK4-TEKNIKER**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Mrs
Sex: ◯ Male ◉ Female

First name: **Estibaliz**
Last name: **Aranzabe**

E-Mail: **earanzabe@tekniker.es**

Position in org.: Head of Surface Chemistry and Nanotechnologies Unit

Department: Head of Surface Chemistry and Nanotechnologies Unit
☐ Same as organisation

☒ Same as organisation address

Street: CALLE INAKI GOENAGA 5

Town: EIBAR GUIPUZCOA
Post code: 20600

Country: Spain

Website: www.tekniker.es

Phone 1: +34943206744
Phone 2: +xxx xxxxxxxxx
Fax: +xxx xxxxxxxxx

Other contact persons

First Name	Last Name	E-mail	Phone
Itziar	Azpitarte	iazpitarte@tekniker.es	+34943206744
Cristobal	Villasante	cvillsante@tekniker.es	+34943206744
Jon Ander	Sarasua	jonandersarasua@tekniker.es	+34943206744
Roberto	Calvo	rcalvo@tekniker.es	+34943206744
Jon	Pagoaga	jon.pagoaga@tekniker.es	+34943206744

PIC	***Legal name***
952105635	*RIOGLASS SOLAR SA*

Short name: RIOGLASS SOLAR SA

Address of the organisation

Street POLIGONO IND. SOVILLA STA. CRUZ S/N

Town SANTA CRUZ DE MIERES ASTURIAS

Postcode 33612

Country Spain

Webpage www.rioglassolar.com

Legal Status of your organisation

Research and Innovation legal statuses

Public body .... no

Legal person .... yes

Non-profit .... no

International organisation .... no

International organisation of European interest ...... no

Secondary or Higher education establishment .... no

Research organisation .... no

Enterprise Data

SME self-declared status................................. unknown

SME self-assessment .... unknown

SME validation sme .... unknown

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Department(s) carrying out the proposed work

Department 1

Department name: R&D ☐ not applicable

☐ Same as organisation address

Street	Pol. Ind. Villallana
Town	Pola de Lena – Asturias
Postcode	33695
Country	Spain

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **792103** *Acronym* **SOLWATT** *Short name* **RIOGLASS SOLAR SA**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Mrs

Sex: ◯ Male ◉ Female

First name: **Gema**

Last name: **Pérez Sánchez**

E-Mail: **g.perez@rioglass.com**

Position in org.: IP manager

Department: R&D

☐ Same as organisation

☐ Same as organisation address

Street: Pol. Ind. Villallana

Town: Pola de Lena – Asturias

Post code: 33695

Country: Spain

Website:

Phone 1: +34 984 499 000

Phone 2: +xxx xxxxxxxxx

Fax: +xxx xxxxxxxxx

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Josep	Ubach Cartategui	j.ubach@rioglass.com	

PIC	***Legal name***
986013343	*ARCHIMEDE SOLAR ENERGY SRL*

Short name: ARCHIMEDE SOLAR ENERGY SRL

Address of the organisation

Street Localita' Cimacolle 464

Town MASSA MARTANA

Postcode 06056

Country Italy

Webpage www.archimedesolarenergy.com

Legal Status of your organisation

Research and Innovation legal statuses

Public body ....no

Legal person .... yes

Non-profit ....no

International organisation ....no

International organisation of European interest ......no

Secondary or Higher education establishment ....no

Research organisation ....no

Enterprise Data

SME self-declared status.................................15/10/2007 - yes

SME self-assessment .... unknown

SME validation sme .... 15/10/2007 - no

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Department(s) carrying out the proposed work

Department 1

Department name: R&D

☐ not applicable

☐ Same as organisation address

Street: voc Flaminia Vetus 88,

Town: Massa Martana

Postcode: 06056

Country: Italy

Dependencies with other proposal participants

Character of dependence	Participant	

Proposal ID **792103**	*Acronym* **SOLWATT**	*Short name* **ARCHIMEDE SOLAR ENERGY SRL**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Mr.

Sex: ◉ Male ○ Female

First name: **Augusto**

Last name: **Maccari**

E-Mail: **augusto.maccari@libero.it**

Position in org.: R&D Manager

Department: R&D

☐ Same as organisation

☐ Same as organisation address

Street: voc Flaminia Vetus 88,

Town: Massa Martana

Post code: 06056

Country: Italy

Website:

Phone 1: +39 (0)8954722

Phone 2: +xxx xxxxxxxxx

Fax: +xxx xxxxxxxxx

Other contact persons

First Name	*Last Name*	*E-mail*	*Phone*
Sandro	Donnola	sandro.donnola@archimdesolarenergy.it	
Francesca	Matino	francesca.matino@archimedesolarenergy.it	
Francesca	Biancifiori	francesca.biancifiori@archimedesolarenergy	

PIC	***Legal name***
938742430	*INGENIERIA PARA EL DESARROLLO TECNOLOGICO SL*

Short name: INDETEC SL

Address of the organisation

Street CALLE CIUDAD DE ELDA 11 POL IND DEL JA

Town PATERNA

Postcode 46988

Country Spain

Webpage www.grupovento.com

Legal Status of your organisation

Research and Innovation legal statuses

Public body ....no

Legal person .... yes

Non-profit ....no

International organisation ....no

International organisation of European interest ......no

Secondary or Higher education establishment ....no

Research organisation ....no

Enterprise Data

SME self-declared status.................................31/12/2013 - yes

SME self-assessment ....31/12/2013 - yes

SME validation sme .... unknown

Based on the above details of the Beneficiary Registry the organisation is an SME (small- and medium-sized enterprise) for the call.

Department(s) carrying out the proposed work

Department 1

Department name: R&D Department

☐ not applicable

☒ Same as organisation address

Street: CALLE CIUDAD DE ELDA 11 POL IND DEL JARR

Town: PATERNA

Postcode: 46988

Country: Spain

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **792103** *Acronym* **SOLWATT** *Short name* **INDETEC SL**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Mr.

Sex: (●) Male ( ) Female

First name: **Chema**

Last name: **CARRILLO**

E-Mail: **chema.carrillo@grupovento.com**

Position in org.: R&D Manager

Department: R&D Department

☐ Same as organisation

☒ Same as organisation address

Street: CALLE CIUDAD DE ELDA 11 POL IND DEL JARRO

Town: PATERNA

Post code: 46988

Country: Spain

Website:

Phone 1: + 34 961340663

Phone 2: *+xxx xxxxxxxxx*

Fax: *+xxx xxxxxxxxx*

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Alvaro	Casañ Perpiñà	alvaro.casan@grupovento.com	
Javier	Izquierdo	verco@grupovento.com	

PIC	***Legal name***
911351182	*FENIKS CLEANING & SAFETY S.L.*

Short name: FENIKS CLEANING & SAFETY S.L.

Address of the organisation

Street CARRETERA EL CORONIL KM 1

Town ARAHAL

Postcode 41600

Country Spain

Webpage www.feniks.es

Legal Status of your organisation

Research and Innovation legal statuses

Public body .... unknown

Legal person .... yes

Non-profit .... unknown

International organisation .... unknown

International organisation of European interest ...... unknown

Secondary or Higher education establishment .... unknown

Research organisation .... unknown

Enterprise Data

SME self-declared status................................. unknown

SME self-assessment .... unknown

SME validation sme .... unknown

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Department(s) carrying out the proposed work

Department 1

Department name: Production

☐ not applicable

☒ Same as organisation address

Street: CARRETERA EL CORONIL KM 1

Town: ARAHAL

Postcode: 41600

Country: Spain

Dependencies with other proposal participants

Character of dependence	Participant	

Proposal ID **792103** *Acronym* **SOLWATT** *Short name* **FENIKS CLEANING & SAFETY S.L.**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Mr.

Sex: (•) Male ( ) Female

First name: **Manuel**

Last name: **de Novales Jiménez**

E-Mail: **mnovales@feniks.es**

Position in org.: Production director & Founding partner

Department: Production

☐ Same as organisation

☒ Same as organisation address

Street: CARRETERA EL CORONIL KM 1

Town: ARAHAL

Post code: 41600

Country: Spain

Website:

Phone 1: +34 955951548

Phone 2: +xxx xxxxxxxxx

Fax: +xxx xxxxxxxxx

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Roberto	Serrano Cabello	rserrano@feniks.es	
Antonio	Perea Palma	aperea@feniks.es	
Félix	Mondéjar Pineda	fmondejar@feniks.es	
Rosario	Infantes Montiel	oficinatecnica@feniks.es	
José	Saucedo	jsaucedo@feniks.es	

PIC	***Legal name***
999655520	*BARCELONA SUPERCOMPUTING CENTER - CENTRO NACIONAL DE SUPERCOMPUTACION*

Short name: BSC

Address of the organisation

Street	Calle Jordi Girona 31
Town	BARCELONA
Postcode	08034
Country	Spain
Webpage	www.bsc.es

Legal Status of your organisation

Research and Innovation legal statuses

Public body ....yes

Legal person .... yes

Non-profit ....yes

International organisation ....no

International organisation of European interest ......no

Secondary or Higher education establishment ....no

Research organisation ....yes

Enterprise Data

SME self-declared status..................................01/03/2005 - no

SME self-assessment .... unknown

SME validation sme .... unknown

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Department(s) carrying out the proposed work

Department 1

Department name	Earth Sciences Department	☐ not applicable
	☒ Same as organisation address	
Street	Calle Jordi Girona 31	
Town	BARCELONA	
Postcode	08034	
Country	Spain	

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **792103** *Acronym* **SOLWATT** *Short name* **BSC**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr.

Sex: (●) Male ( ) Female

First name: **Carlos**

Last name: **Pérez García-Pando**

E-Mail: **carlos.perez@bsc.es**

Position in org.: Atmospheric Composition Group Manager

Department: Earth Sciences Department

☐ Same as organisation

☒ Same as organisation address

Street: Calle Jordi Girona 31

Town: BARCELONA

Post code: 08034

Country: Spain

Website:

Phone 1:

Phone 2: +xxx xxxxxxxxx

Fax: +xxx xxxxxxxxx

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Sara	Basart	sara.basart@bsc.es	
Albert	Soret	albert.soret@bsc.es	
Dorota	Chmielewska	dorota.chmielewska@bsc.es	

PIC	***Legal name***
926830539	*BRIGHTSOURCE INDUSTRIES ISRAEL LTD*

Short name: BRIGHTSOURCE INDUSTRIES ISRAEL LTD

Address of the organisation

Street	KIRYAT MADA 11, AMOT BUILDING, HAR HO
Town	JERUSALEM
Postcode	91450
Country	Israel
Webpage	http://www.brightsourceenergy.com/

Legal Status of your organisation

Research and Innovation legal statuses

Public body ....no

Legal person .... yes

Non-profit ....no

International organisation ....no

International organisation of European interest ......no

Secondary or Higher education establishment ....no

Research organisation ....no

Enterprise Data

SME self-declared status................................. unknown

SME self-assessment .... unknown

SME validation sme .... unknown

Based on the above details of the Beneficiary Registry the organisation is not an SME (small- and medium-sized enterprise) for the call.

Department(s) carrying out the proposed work

Department 1

Department name: Receiver Design

☐ not applicable

☒ Same as organisation address

Street: KIRYAT MADA 11, AMOT BUILDING, HAR HOTZV

Town: JERUSALEM

Postcode: 91450

Country: Israel

Dependencies with other proposal participants

Character of dependence	*Participant*	

Proposal ID **792103** *Acronym* **SOLWATT** *Short name* **BRIGHTSOURCE INDUSTRIES ISRAEL LTD**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Mr.
Sex: (•) Male ( ) Female

First name: **Arnon**
Last name: **Turner**

E-Mail: **aturner@brightsourceenergy.com**

Position in org.: Project Manager

Department: Receiver Design
☐ Same as organisation

☒ Same as organisation address

Street: KIRYAT MADA 11, AMOT BUILDING, HAR HOTZVIM

Town: JERUSALEM
Post code: 91450

Country: Israel

Website: +972 772025789

Phone 1:
Phone 2: +xxx xxxxxxxxx
Fax: +xxx xxxxxxxxx

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Yaniv	Binyamin	ybinyamin@brightsourceenergy.com	
Rotem	Hayut	rhayut@brightsourceenergy.com	
Avishay	Chalfon	achalfon@brightsourceenergy.com	
Smuel	Huss	shuss@brightsourceenergy.com	

PIC	***Legal name***
956723805	*AMIRES SRO*

Short name: AMIRES SRO

Address of the organisation

Street STAVITELSKA 1099/6

Town PRAHA 6

Postcode 160 00

Country Czech Republic

Webpage

Legal Status of your organisation

Research and Innovation legal statuses

Public body ....no

Non-profit ....no

International organisation ....no

International organisation of European interest ......no

Secondary or Higher education establishment ....no

Research organisation ....no

Legal person .... yes

Enterprise Data

SME self-declared status.................................31/03/2017 - yes

SME self-assessment ....31/03/2017 - yes

SME validation sme ....16/11/2011 - yes

Based on the above details of the Beneficiary Registry the organisation is an SME (small- and medium-sized enterprise) for the call.

Department(s) carrying out the proposed work

No department involved

Department name ☒ not applicable

☐ Same as organisation address

Street *Please enter street name and number.*

Town

Postcode

Country

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **792103** *Acronym* **SOLWATT** *Short name* **AMIRES SRO**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr.

Sex: (•) Male ( ) Female

First name **Rudolf** Last name **Fryček**

E-Mail **frycek@amires.eu**

Position in org.: CEO

Department: AMIRES SRO

☒ Same as organisation

☒ Same as organisation address

Street: STAVITELSKA 1099/6

Town: PRAHA 6 Post code: 160 00

Country: Czech Republic

Website:

Phone 1: +41796784295 Phone 2: +xxx xxxxxxxxx Fax: +xxx xxxxxxxxx

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Lenka	Bajarová	bajarova@amires.eu	

Proposal ID **792103** *Acronym* **SOLWATT**

3 - Budget for the proposal

No	Participant	Country	(A) Direct personnel costs/€	(B) Other direct costs/€	(C) Direct costs of sub-contracting/€	(D) Direct costs of providing financial support to third parties/€	(E) Costs of inkind contributions not used on the beneficiary's premises/€	(F) Indirect Costs / € (=0.25(A+B-E))	(G) Special unit costs covering direct & indirect costs / €	(H) Total estimated eligible costs / € (=A+B+C+D +F+G) BENEFICIARY	(I) Reimburse-ment rate (%) BENEFICIARY	(J) Max.EU Contribution / € (=H*I) BENEFICIARY	(K) Costs of third parties linked to participant THIRD PARTIES	(L) Max.EU Contribution / € THIRD PARTIES	(M) Total Costs for BENEFICIARY & THIRD PARTIES (=H+K)	(N) Max.EU Contribution / € BENEFICIARY & THIRD PARTIES (=J+L)	(O) Requested EU Contribution / € BENEFICIARY & THIRD PARTIES
1	Tsk	ES	1038240	430055	103800	0	0	367073,75	0	1939168,75	70	1357418,13	0	0	1939168,75	1357418,13	1357418,13
2	Cea	FR	878309	174370	0	0	0	263169,75	0	1315848,75	100	1315848,75	0	0	1315848,75	1315848,75	1315848,75
3	Dlr	DE	876330	222200	65664	0	0	274632,50	0	1438826,50	100	1438826,50	0	0	1438826,50	1438826,50	1438826,50
4	Centro De Investigaciones Energeticas, Medioambientales Y	ES	736736	150180	0	0	0	221729,00	0	1108645,00	100	1108645,00	0	0	1108645,00	1108645,00	1108645,00
5	Cranfield University	UK	910150	441050	0	0	0	337800,00	0	1689000,00	100	1689000,00	0	0	1689000,00	1689000,00	1689000,00
6	Ik4-tekniker	ES	504639	159000	0	0	0	165909,75	0	829548,75	100	829548,75	0	0	829548,75	829548,75	829548,75
7	Rioglass Solar Sa	ES	176240	154847	0	0	0	82771,75	0	413858,75	70	289701,13	0	0	413858,75	289701,13	289701,13
8	Archimede Solar Energy Srl	IT	335250	160900	0	0	0	124037,50	0	620187,50	70	434131,25	0	0	620187,50	434131,25	434131,25
9	Indetec Sl	ES	205285	18500	0	0	0	55946,25	0	279731,25	70	195811,88	959945	671962	1239676,25	867773,88	867773,88
10	Feniks Cleaning & Safety S.l.	ES	99640	207175	40000	0	0	76703,75	0	423518,75	70	296463,13	0	0	423518,75	296463,13	296463,13
11	Bsc	ES	220500	22718	0	0	0	60804,50	0	304022,50	100	304022,50	0	0	304022,50	304022,50	304022,50
12	Brightsource Industries Israel Ltd	IL	464000	343000	0	0	0	201750,00	0	1008750,00	70	706125,00	0	0	1008750,00	706125,00	706125,00
13	Amires Sro	CZ	156000	40000	5000	0	0	49000,00	0	250000,00	70	175000,00	0	0	250000,00	175000,00	175000,00
	Total		6601319	2523995	214464	0	0	2281328,50	0	11621106,50		10140542,02	959945,00	671962,00	12581051,50	10812504,02	10812504,02

4 - Ethics issues table

1. HUMAN EMBRYOS/FOETUSES		Page
Does your research involve Human Embryonic Stem Cells (hESCs)?	◯ Yes ◉ No	
Does your research involve the use of human embryos?	◯ Yes ◉ No	
Does your research involve the use of human foetal tissues / cells?	◯ Yes ◉ No	
2. HUMANS		**Page**
Does your research involve human participants?	◯ Yes ◉ No	
Does your research involve physical interventions on the study participants?	◯ Yes ◉ No	
3. HUMAN CELLS / TISSUES		**Page**
Does your research involve human cells or tissues (other than from Human Embryos/ Foetuses, i.e. section 1)?	◯ Yes ◉ No	
4. PERSONAL DATA		**Page**
Does your research involve personal data collection and/or processing?	◯ Yes ◉ No	
Does your research involve further processing of previously collected personal data (secondary use)?	◯ Yes ◉ No	
5. ANIMALS		**Page**
Does your research involve animals?	◯ Yes ◉ No	
6. THIRD COUNTRIES		**Page**
In case non-EU countries are involved, do the research related activities undertaken in these countries raise potential ethics issues?	◯ Yes ◉ No	
Do you plan to use local resources (e.g. animal and/or human tissue samples, genetic material, live animals, human remains, materials of historical value, endangered fauna or flora samples, etc.)?	◯ Yes ◉ No	
Do you plan to import any material - including personal data - from non-EU countries into the EU?	◯ Yes ◉ No	
Do you plan to export any material - including personal data - from the EU to non-EU countries?	◯ Yes ◉ No	
In case your research involves low and/or lower middle income countries, are any benefits-sharing actions planned?	◯ Yes ◉ No	
Could the situation in the country put the individuals taking part in the research at risk?	◯ Yes ◉ No	

Proposal ID **792103** *Acronym* **SOLWATT**

7. ENVIRONMENT & HEALTH and SAFETY		Page
Does your research involve the use of elements that may cause harm to the environment, to animals or plants?	○ Yes ◉ No	
Does your research deal with endangered fauna and/or flora and/or protected areas?	○ Yes ◉ No	
Does your research involve the use of elements that may cause harm to humans, including research staff?	○ Yes ◉ No	
8. DUAL USE		**Page**
Does your research involve dual-use items in the sense of Regulation 428/2009, or other items for which an authorisation is required?	○ Yes ◉ No	
9. EXCLUSIVE FOCUS ON CIVIL APPLICATIONS		**Page**
Could your research raise concerns regarding the exclusive focus on civil applications?	○ Yes ◉ No	
10. MISUSE		**Page**
Does your research have the potential for misuse of research results?	○ Yes ◉ No	
11. OTHER ETHICS ISSUES		**Page**
Are there any other ethics issues that should be taken into consideration? Please specify	○ Yes ◉ No	

I confirm that I have taken into account all ethics issues described above and that, if any ethics issues apply, I will complete the ethics self-assessment and attach the required documents. ☒

How to Complete your Ethics Self-Assessment

5 - Call specific questions

Extended Open Research Data Pilot in Horizon 2020

If selected, applicants will by default participate in the Pilot on Open Research Data in Horizon 2020[1] , which aims to improve and maximise access to and re-use of research data generated by actions.

However, participation in the Pilot is flexible in the sense that it does not mean that all research data needs to be open. After the action has started, participants will formulate a Data Management Plan (DMP), which should address the relevant aspects of making data FAIR – findable, accessible, interoperable and re-usable, including what data the project will generate, whether and how it will be made accessible for verification and re-use, and how it will be curated and preserved. Through this DMP projects can define certain datasets to remain closed according to the principle "as open as possible, as closed as necessary". A Data Management Plan does not have to be submitted at the proposal stage.

Furthermore, applicants also have the possibility to opt out of this Pilot completely at any stage (before or after the grant signature). In this case, applicants must indicate a reason for this choice (see options below).

Please note that participation in this Pilot does not constitute part of the evaluation process. Proposals will not be penalised for opting out.

We wish to opt out of the Pilot on Open Research Data in Horizon 2020.	◯ Yes	◉ No

Further guidance on open access and research data management is available on the participant portal: http://ec.europa.eu/research/participants/docs/h2020-funding-guide/cross-cutting-issues/open-access-dissemination_en.htm and in general annex L of the Work Programme.

[1] *According to article 43.2 of Regulation (EU) No 1290/2013 of the European Parliament and of the Council, of 11 December 2013, laying down the rules for participation and dissemination in "Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020)" and repealing Regulation (EC) No 1906/2006.*

HORIZON 2020

SOLWATT

SOLving WATer Issues for CSP planTs

Call: LCE-11-2017

Topic: Near-to-market solutions for reducing the water consumption of CSP Plants

Type of action: Innovation Action

Duration of the project: 48 months

Coordinating person details:

Name	Rogelio Peón Menéndez
Organisation	**TSK Electrónica y Electricidad S.A.**
Email	rogelio.peon@tsk.es
Phone	+34 984 495881

List of participants:

Part no.	Participant organisation name	Short name	Country	Nature
1	TSK Electrónica y Electricidad S.A.	**TSK**	ES	**IND**
2	Commissariat à l'Énergie Atomique et aux Énergies Alternatives	**CEA**	FR	**RTD**
3	Deutsches Zentrum für Luft - und Raumfahrt e.V.	**DLR**	DE	**RTD**
4	Centro de Investigaciones Energéticas, Medioambiental Technologicas – CIEMAT	**CIE**	ES	**RTD**
5	Cranfield University	**CU**	UK	**UNI**
6	Fundacion Tekniker	**TEK**	ES	**RTD**
7	Rioglass Solar S.A.	**RIO**	ES	**IND**
8	Archimede Solar Energy S.r.l.	**ASE**	IT	**IND**
9	Ingenieria Para el Desarrollo Tecnologico S.l.	**INDETEC**	ES	**SME**
10	Feniks Cleaning & Safety S.L.	**FNK**	ES	**IND**
11	Barcelona Supercomputing Center – Centro Nacional de Supercomputación	**BSC**	ES	**RTD**
12	BrightSource Industries Israel Ltd	**BSII**	IL	**IND**
13	Amires s.r.o.	**AMI**	CZ	**SME**

TABLE OF CONTENTS

1. EXCELLENCE

The electricity production from concentrated solar thermal power (CSP) has to cope with two main challenges, the reduction of the water consumption, since a high insolation often occurs in locations with a lack of water resources, and also the improvement of the cost-effectiveness of the CSP technology.

Water at CSP plants is required for the following tasks. Firstly, it is necessary for cleaning of the solar field collectors, accounting for up to 0.3 m^3/MWh_e, what is crucial for maintenance of the solar mirror and absorber performances in a dusty arid environment. Secondly, roughly 3.5 m^3/MWh_e are necessary to cool the power block condenser in the case of a water-cooled steam turbine to maintain the energy conversion efficiency. Thirdly, to make up water in the steam cycle requests for up to 0.5 m^3/MWh_e, in order to avoid chemical concentration adversely affecting the steam quality. To be more specific, in CSP wet cooled plants at “La Africana” (Spain), “Bokpoort” (South Africa) and “Noor-1” (Morocco) the water consumption is respectively about 5.65 m^3/MWh_e, 3.41 m^3/MWh_e and 3.65 m^3/MWh_e and significantly lower in the CSP dry cooled plant “Shagaya” (Kuwait) (where it is about 0.53 m^3/MWh_e [1]).

To obtain an efficient electrical power generation, the turbine condenser must be cooled efficiently. Wet cooling is the traditional solution, despite its high-water requirements, representing up to 90% of the total water used in a wet cooled CSP plant. Moving to a dry cooled power block avoids this high-water usage but reduces turbine efficiency compared to a wet cooled system. Indeed, as assessed in the case study CSP Plant in Ma’an in Jordan[2], for equal electricity productions, implementation of dry cooling technology compared to wet one increases the investment cost by 16.4% and the LCOE by 16.1%. For those reasons, Engineering, Procurement, and Construction (EPC) contractors turn to dry cooling only when local regulations on the water use force them to do so. Therefore, by reducing the amount of water used for solar field cleaning, steam generation and for wet cooling, and by addressing the lack of efficiency of dry cooled CSP plants, SOLWATT project will actively support a significant reduction in water usage in CSP plants and improve efficiency of dry ones.

Water costs vary within a wide range from 0.03€/m³ (“La Africana”, Spain) to 4€/m³ (“Shagaya”, Kuwait) and are closely linked to local water availability. This range allows the definition of specifications of new technologies in terms of investment and operating costs to ensure a higher competitiveness or reduced LCOE compared to current CSP plants.

The overall purpose of the SOLWATT project is to upscale, implement and demonstrate cost-effective technologies and strategies that bring about a significant reduction of water of CSP plants while ensuring excellent performance of electrical power production. The SOLWATT approach proposed will tackle all segments of water consumption in a CSP plant by:

- 90 % for reduction of cleaning operations;
- 15 to 28 % for cooling of turbine condenser;
- 90 % for recovery and recycling of water;

Then, a total reduction of water consumption by:

- 35 % for a wet cooled CSP plant
- 90 % for a dry cooled CSP plant

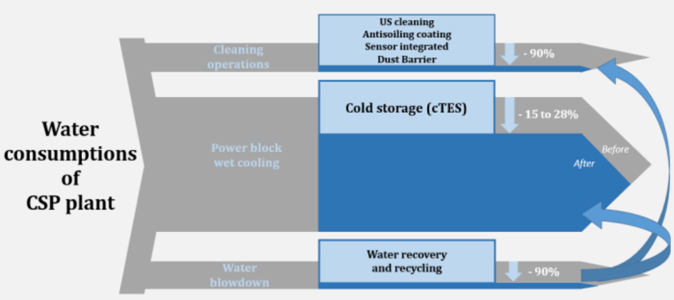


Figure 1. SOLWATT overall objectives

The continuous online determination of optimal plant operation, including water consumption criteria, will contribute towards achieving water consumption reduction and subsequently the LCOE reduction. To facilitate the social acceptance of CSP plants and of the technical solutions proposed by SOLWATT, socio-economic, environmental studies and humanitarian issues and their impact on CSP plants will also be assessed using comprehensive and detailed case studies in representative locations for CSP plant deployment. This overall approach of the project will maximize the opportunities for the emergence of our innovative technologies and near-to-market solutions for CSP plants.

[1] Data supplied by TSK

[2] Evaluation of dry cooling option for parabolic trough (CSP) plants including related technical and economic assessment”. “Case study CSP Plant in Ma’an/Jordan”. Ahmad Abdel-Latif Mohammad Liqreina. 2012.

https://www.uni-kassel.de/eecs/fileadmin/datas/fb16/remena/theses/batch2/MasterThesis_Ahmad_Liqraina.pdf

1.1. Objectives

The main objective of SOLWATT will be reached by addressing the following specific transdisciplinary (technical, economic, social) objectives. It is worth mentioning that all technologies involved in the SOLWATT project have been already developed and successfully tested and validated in previous projects (e.g. the project WASCOP dealing with reduction of water consumption in CSP plants or the PreFlexMS project). SOLWATT intends to push these and other technologies to TRL7, i.e. closer to market.

➔ **Specific objective 1: Reduction of water cleaning operations**

SOLWATT targets a **reduction of water consumption by 90%, i.e. savings nearly 0.25m³/MWh$_e$** depending on the soiling rate and the location of the solar field. The detailed objectives are the following:

- Upscaling and implementation of an ultrasonic cleaning device for reflectors consuming nearly zero water (98% reduction in comparison with common cleaning methods) to remove adhered particles from reflector surfaces.
- Implementation of an integral **heliostat cleaning device** targeting reduction in water consumption for mirrors cleaning of 0.27 m³/MWh.
- Upscaling and implementation of 100 m long **dust barriers** reducing the soiling rate on the nearby collector mirrors by up to 50%.
- Upscaling and implementation of **antisoiling coatings on 50 reflectors** reducing the cleaning frequency by 50%:
- Upscaling and implementation of **antisoiling coatings on glass 36 receiver tubes** reducing cleaning frequency by 30%.
- Upscaling and implementation of **integrated sensors on reflector** for a continuous real-time measurement of reflectance to optimize cleaning operation and thus reduce their frequency by 25%.

➔ **Specific objective 2: Delayed cooling of turbine condenser**

To keep a low temperature at the turbine condenser, i.e. a high efficiency while reducing the water consumption, SOLWATT will demonstrate the efficiency of a cold storage reservoir, regenerated by the lower temperatures that occur at night. The detailed objectives are the following:

- Implementation of a nocturnal cold thermal energy storage (cTES) reservoir reducing water **consumption on a wet cooled CSP plant by 15-28% i.e.** 0.5 to 1.5 m³/MWh according to the location of the solar field**,** while **increasing electricity production by 1 % for any dry cooled CSP** plant and reducing parasitic load by 1% are targeted.
- Assessment and the validation of the performances of the cold storage with a capacity of 500-1000 m³ and a thermal efficiency of 90%.

➔ **Specific objective 3: Water recovery technologies**

SOLWATT will demonstrate the efficiency of using a Multiple Effect Evaporation (MEE) system to **recycle and re-use 90% of these waste water streams** (0.5 m³/MWh$_e$) using thermal energy otherwise dumped by defocussing parts of the solar field, achieving a water consumption reduced to 0.05 m³/MWh$_e$. Fresh water production will save up to 0.45 m³/MWh$_e$. The detailed objectives are the following:

- Optimization of the water treatment plant operating conditions to minimize the energy consumption and maximize the recovered water production in order to achieve a maximum water saving
- Implementation of a 6-8 effects MEE with production up to 200 m³/day and best control strategies
- Assessment and validation of the performances of the MEE system (with performance criteria at 90 % of recycled water, and with fresh water production at 9.1 m³/MWh$_{th}$ from defocus).

➔ **Specific objective 4: Plant operation optimizer including soiling rate forecast**

The probabilistic treatment of forecasts for the following days is essential for optimisation of CSP plant operations. **SOLWATT will demonstrate the efficiency of the optimized global control of the plant thanks to a dedicated application.** The detailed objectives are the following:

- Combination of a dispatch optimizer with water usage minimization, including cooling systems scheduling, water blow-down reduction, soiling prediction and cleaning schedule decision making, which will bring the minimization of water use (i.e. reduction by at least 35 % for wet cooled CSP plants and at least 90% for dry cooled CSP plants) and increase the annual plant profit by 1 % to 4 %.
- Implementation of soiling rate forecasting product and soiling rate map for site selection. The latter will additionally reduce the water consumption and cleaning operation costs for future power plants.

➔ **Specific objective 5: Socio-economic and environmental studies**

Social, economic and environmental impacts on local communities close to CSP plants are a point of concern. SOLWATT will investigate:

- Socio-economic and humanitarian issues in CSP plants through development and application of methodology using five case studies to assess detailed socio-economic impact on local communities,
- Economic modelling of market solutions for water reduction technologies tested in the project,
- Environmental impact analysis and LCA of selected market solutions in order to validate a reduction of approximately 2.5%, i.e. 4x10^5 Kg of CO_2 eq. for a typical 50 MW_e plant with the implementation of SOLWATT technologies
- Practice-oriented training and knowledge transfer through development, delivery, and assessment of practical courses for both engineering and technical levels, design and construction of distance-learning package for use by remote learners with interests in CSP technology and management and organization of a 2-day workshop for selected CSP stakeholders to disseminate the results and other outcomes from the SOLWATT project that will increase acceptance in local communities.

➔ **Specific objective 6: Demonstration and validation of SOLWATT technologies**

All technologies will be installed, demonstrated and validated under real conditions at following CSP plants:

- "La Africana" CSP plant in Spain, which is a CSP plant of 49.9 MW_e, including 8,064 solar collectors, i.e. 225,792 mirrors, and producing 173 GWh/year (will be used for validation of all technologies except heliostat cleaning device),
- "Ashalim" solar thermal power station in Israel**,** which is a CSP plant of 121 MW_e, including 50,000 heliostats and 200,000 solar reflectors (will be used for validation of heliostat cleaning device).

1.2. <u>Relation to the Work Programme</u>

Table 1. Challenge and scope of LCE-11-2017 work programme topic addressed by SOLWATT

LCE-11-2017	SOLWATT
"drastically reduce water consumption as well as costs" and "demonstrate cost-effective technical solutions which significantly reduce or replace the water consumption of CSP plants."	SOLWATT targets all components of CSP technology consuming water. SOLWATT solution comprises innovative technologies and optimized strategies for cleaning, cooling and water recovery. SOLWATT reduces water consumption while ensuring excellent performance of electrical power production due to development of cleaning technologies (based on ultrasound, dust barriers, and anti-soiling coatings, novel cooling approaches (cold storage) and water recovery technologies and prediction and assessment tools.
The demonstration shall take place in a region with very good solar resource values (Direct Normal Irradiation > 2000 kWh/m2 year)	The demonstration will be conducted at La Africana CSP plant with a solar resource of 2183 kWh/m^2/year and Ashalim CSP plant with solar resource of 2192 kWh/m^2/year.
Water resources particularly in arid areas are linked to broader socioeconomic and livelihood issues and therefore of particular relevance to local communities, multidisciplinary research designs that integrate contributions also from the social sciences and humanities are encouraged.	SOLWATT develops a dedicated methodology for assessment of detailed socio-economic impact on local communities. Deep economic, technical, environmental and life-cycle analysis of the results achieved during the testing operation in an operational CSP plant will be performed.
TRL 7 shall be achieved at the end of project activities	All technologies investigated in SOLWATT will reach TRL 7 by being demonstrated at La Africana and Ashalim CSP plants.
Opening the project's test sites, pilot and demonstration facilities, or research infrastructures for practice oriented education, training or knowledge exchange is encouraged.	Technical site visit will be scheduled and offered to stakeholders. In addition, practical courses for both engineering level and technical level will be delivered. A distance learning package will be available to remote learners

1.3. Concept and approach

1.3.1. SOLWATT concept

SOLWATT proposes an integrated concept applicable to both CSP plant configurations, dry or wet cooled but also whether existing or yet to be built. It will ensure a significant reduction of all water consumption items in CSP plants and also an improvement of electricity production to reduce the LCOE.

The main water consumption points in a wet cooled CSP plant are the following[3] (see Figure 2):

- 82-94% of the water is dedicated to wet cooling operations within the power-block
- 2-10% to cleaning of the optical surfaces of the solar field
- 4-8% to replace losses used for steam generation within the thermal power cycle.

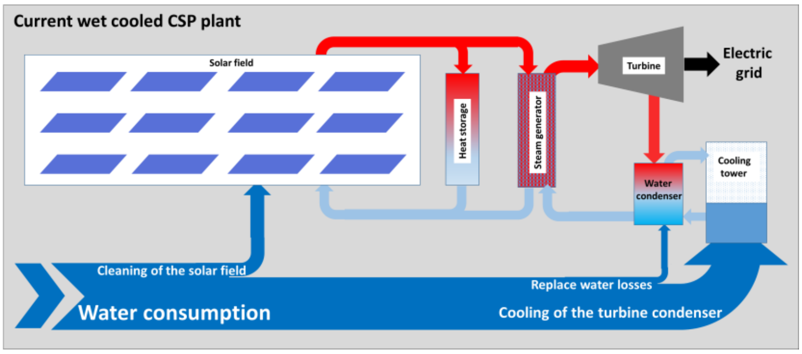


Figure 2. Items of Water consumption in wet cooled CSP

The SOLWATT concept is based on the implementation of the following technologies:

A. Cleaning of the solar field

a. Ultrasonic cleaner

The concept of ultrasonic cleaning of soiling and dust accumulation on reflectors surface is based on the cavitation of water when exposed to pressure waves (sound). During the cavitation process, millions of micro bubbles implode, releasing heat and strong shock waves detaching dirt and dust particles attached to the surface. As reflectors cannot be immersed totally in water, ultrasonic vibrations are applied on a previously deposited thin water layer, c. Non-immersion ultrasonic cleaning (USc) concentrates all the vibrations in a very small water volume making it much more powerful. This concept has been validated at TRL5.

To be applied in “La Africana” in an operational environment, ultrasonic cleaning module will be firstly upscaled from 1 m length to a real size parabolic trough solar reflector of 6.24 m aperture. A subsequently robotized arm including the ultrasonic head will be integrated in a mobile vehicle. The approaching movement of the robotized arm will be controlled to avoid excessive pressure on mirror’s surface.

b. Heliostat integral cleaning device

In SOLWATT, an autonomous, waterless cleaning device performing periodic cleaning of heliostat mirrors will be developed into a proven working product. The device does not require any use of water in day-to-day cleaning operation. Acceptable results have been achieved through field testing of preliminary prototypes, and a potential cleaning head material has already been verified by testing various options. The mechanism is designed to be driven by an electric DC motor, which allows sufficient pressure on the heliostat surface in order to optimize cleaning performance. Device operation is controlled through the Solar Field control system and is fully automated and powered by the existing PV panel and electrical storage system that power BSII’s wireless heliostats. The device can be designed for a new plant, or adjusted as a retrofit to already existing solar fields. It will significantly reduce water consumption and O&M costs while opening up new markets in very dusty environments such as the MENA region, for CSP. The SOLWATT project will include modification of the existing prototype cleaning device per operational site parameters, manufacturing of units of the integral heliostat cleaning device, installation in “Ashalim” plant, and full testing and qualification for use at industrial scale.

c. Dust barriers

Current CSP plants are surrounded by fences, but these are primarily designed for security purposes and to act as wind-breaks. They can also function as dust and sand barriers but are not optimised for that purpose. In SOLWATT dust barriers will be constructed to significantly reduce soiling and the need for cleaning, leading to a substantial reduction in both water consumption and cleaning costs. Porous and aerodynamically shaped

[3] Data from C. Turchi (NREL) presentation: Water Use in Concentrating Solar Power (CSP) (2009)

dust barriers have been developed to TRL5 on the WASCOP project, proven to prevent approximately 50% of particles from passing through their structure (as determined by particle weight). In SOLWATT the concept will be tested by the erection of a full-height porous aerodynamically-shaped dust barrier of total length of 100 m around one corner of the La Africana CSP plant to demonstrate that enclosing a CSP plant with an aerodynamically profiled porous dust barrier will reduce soiling rate on the nearby collector mirrors by up to 50%.

d. Antisoiling coating on reflectors

The antisoiling coating in reflectors is based on a TiO_2 thin coating. This coating has the characteristic of forming a super-hydrophilic surface, as well as converting the organic matter to carbon dioxide and water due to the photocatalytic properties of titanium oxide. This coating reduces the soiling rate and facilities cleaning operations.

The thin layer applied by spray sol gel method within the manufacturing process improves the coating durability generating covalent bond between the mirror and the coating ensuring a high adhesion without any reflectance loss and colour variation. This coating has been evaluated at TRL5 on WASCOP project. In SOLWATT, the coating process will be up scaled to cover real size mirror facets (1700 x 1700 mm^2). The concept of these coatings will be validated in an operational environment at La Africana plant.

e. Anti-soiling glass coating on receiver tubes

For receivers, the concept of the antisoiling coating is based on hydrophobic layer to reduce the dust attachment force to the surface and thus overall soiling. The sol gel coating process has been optimised to reduce porosity and strengthen the durability. In SOLWATT, upscaling the deposition process, real size tubes will be covered and assessed in La Africana plant.

f. Integrated soiling sensors on reflectors

The soiling sensor technology uses the projection of a controlled infrared light beam under the soiling in a sensitive transparent substrate and the measurement of the light scattered from the particle spots, the grade signal from the sensor indicates when cleaning is needed. In the SOLWATT approach, the integrated solution is a combination of the innovative soiling measurement technique based on low cost scattering measurement, that is already developed at TRL5 level, and another innovative approach called Smart Mirrors (Confidential concept Patent pending) that will be developed in the SOLWATT project. This integration will bring the advantage of a sensor technology embedded on mirrors that will allow a simple installation in the solar plant. This technology will provide a continuous and real-time soiling measurement that will permit selective and guided cleaning procedures, focusing on the dirtiest areas of the solar plant and implementing a threshold reflectivity for cleaning action to start.

The SOLWATT project will target upscaling of sensor module with a soiling measurement repeatability equivalent of reflectance differences (for homogenous soiling composed of 50 μm sand particles) $< 0.5\%$, implementation of 1 sensor each in 30 reflectors distributed in the solar field. Direct communications will be implemented in order to achieve a realistic soiling distribution in the solar plant at La Africana to assess the reflectance in real time and assist in cleaning scheduling.

B. <u>Cooling of turbine condenser</u>

The solution proposed will both reduce the water consumption of a wet cooled plant and increase the performance of a dry cooled plant. The solution proposed has the additional benefit of being easily implemented in an existing plant or built into a new plant.

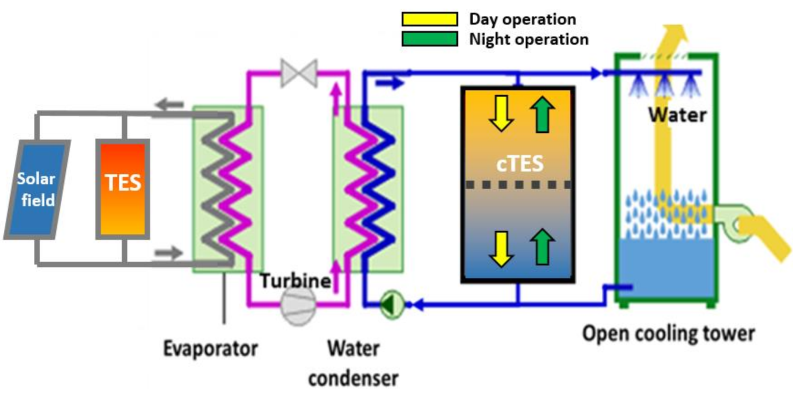


Figure 3. Cold thermal energy storage operation concept

It consists of **a water pond thermocline storage, named "cold thermal energy storage (cTES)"**. During the hottest hours of the day, when the external ambient temperatures are very high, the cTES will recover part of the heat load to be exhausted from the turbine condenser, and store it in the upper part of the pond, while the lower part of the pond will provide low temperature water to ensure efficient cooling of the condenser. During the night, when the external temperatures are significantly lower, the heat stored is then efficiently removed from the upper part of the cTES. In parallel, the lower cold part of the cTES is regenerated by the cooler night-time temperatures.

To lower the system cost, the cTES is realized only with cheap materials: A pond excavated from the ground is preferred to an aboveground tank. Components as membranes, possibly with thermal insulation will ensure and maintain the hot/cold temperature interface, will protect the surface from evaporation, and will minimise solar temperature gain. No additional pumping, heat exchanger or insulation is required.

C. Water recovery

To recover and recycle water, the concept in SOLWATT proposes an alternative solution to the current technology reverse osmosis, since it is not suitable to treat the waste water streams from a CSP plant to be re-used. The concept of the solution proposed in SOLWATT is based on the well-known Multiple Effect Evaporation technology (MEE). This technology includes successive processes of evaporation of the feedwater and subsequent condensation of the generated vapour thanks to the external energy supply from dumped energy of CSP plants (that would be otherwise discarded to the atmosphere). This makes the MEE technology more competitive against other water treatment technologies. The reduction of dumping also reduces solar field output temperature fluctuations, increases the stability of BOP operation, HTF flow rate and collector tracking mode, thus increasing the lifetime of components such as turbines, ball joints and HTF pumps. This MEE technology also helps to reduce the size of the evaporation ponds currently used in CSP plants to spill the waste water streams.

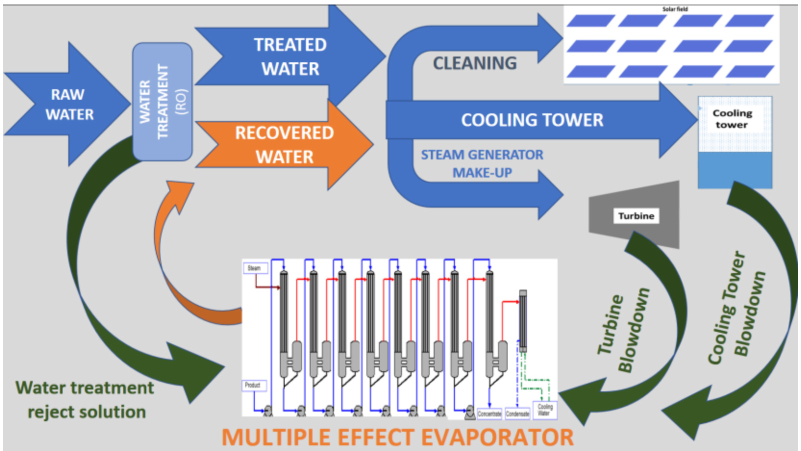


Figure 4. Items of wastewater production and recovery by MEE

D. O&M Optimizer and soling forecast model

Overall plant performance in market environment is highly dependent on scheduling of power delivery, especially on the schedule of thermal energy storage use. Some implementations of dispatch optimization exist for CSP plants. In SOLWATT, the dispatch optimizer, currently reaching TRL 5 in the H2020 project PreFlexMS, is extended to all water-related issues to reach an "operation and maintenance" (O&M) Optimizer. The concept is shown in Figure 5. Principle of extended O&M Optimizer with new soiling rate forecast and three additionally derived outputs (framed in yellow). The optimization is based on the weather forecast, the electricity price and the soiling rate forecast described below. It will support the decision making of plant operators and make full use of all water-saving technologies, while increasing profit (which otherwise might be contradictory in some situations). Obvious examples for such decisions are to stop cleaning once a dust storm or a heavy rainfall is announced for the next day. The goal is to reach a profit increase of 1% to 4% with the optimization of electricity dispatch, while saving water – highly depending on actual components in the plant to be optimized. The final O&M Optimizer Tool will be integrated into TSK's FoSyS plant operation system and serve the La Africana plant for optimal scheduling as TRL 7 implementation. An existing dust forecast system is extended to a dedicated soiling rate forecast product for CSP plants that will be brought to TRL7 and is an essentially

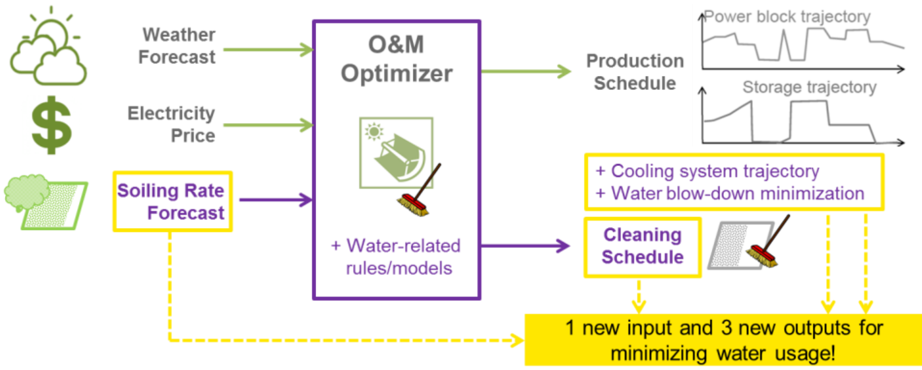


Figure 5. Principle of extended O&M Optimizer with new soiling rate forecast and three additionally derived outputs (framed in yellow)

new input for optimizing existing plant control and selecting future plant locations by integrating the soiling rate map derived from a forecast reanalysis.

1.3.2. SOLWATT approach

As was already mentioned, SOLWATT proposes to implement a flexible integrated solution, based on several different technologies fitting any type of CSP plant, existing or to be build, wherever their location.

The advantages of the SOLWATT project is that even though the whole solution is being developed, individual solutions can be separately applied to achieve water savings. The project aims to elevate each technology from a TRL 5 (assessed in relevant environment) to TRL 7 (demonstrated in operational environment).

Through the project, every solution will be implemented and demonstrated at relevant scale in operating CSP power plants ("La Africana" in Spain, "Ashalim" in Israel) with DNI yearly sums of 2183 kWh/m^2/yr and 2192 kWh/m^2/yr, respectively. The solutions will be operated and assessed for 1-2 years. Final results analysis will perform both technical and economic analysis to maintain or improve the global profitability while reducing the water consumption.

In parallel, socio-economic and environmental studies will be conducted from five worldwide cases to build recommendations on humanitarian issues and rank the potential impacts on population and environment. Links with local population and stakeholders will be created while ensuring practice-oriented training, knowledge transfer and a dissemination workshop.

Table 2: Targeted Project acronym TRLs

Element/technology	**Associated specific objective**	**Starting TRL**	**Description**	**Expected final TRL**
Ultrasonic cleaner	**#1**	TRL 5	Section 1.4.1 a	TRL 7
Heliostat cleaning device	**#1**	TRL 5	Section 1.4.1 b	TRL 7
Dust barriers	**#1**	TRL 5	Section 1.4.1 c	TRL 7
Antisoiling coating on reflectors	**#1**	TRL 5	Section 1.4.1 d	TRL 7
Antisoiling glass coating on absorber tubes	**#1**	TRL 5	Section 1.4.1 e	TRL 7
Integrated soiling sensors on reflectors	**#1**	TRL 5	Section 1.4. 1 f	TRL 7
Cold storage system	**#2**	TRL 5	Section 1.4.2	TRL 7
Water recovery by MEE system	**#3**	TRL 6-7	Section 1.4.3	TRL 8
Dispatch and O&M optimization	**#4**	TRL 5	Section 1.4.4	TRL 7
Soiling forecasting system for the O&M optimizer	**#4**	TRL 5-9	Section 1.4.4	TRL 7
Socio-economic and environmental studies	**#5**	TRL 2	Section 1.4.5	TRL 6

1.3.3. Complementarity with previous R&D projects and activities

SOLWATT will benefit from substantial know-how acquired during previous national or European projects. Many of these projects contributed to development of proof of concepts of individual technologies, which will be used as a starting point for SOLWATT, with its integrating and translational mission. The most representative projects and their contributions are described below.

Most of the members of SOLWATT consortium (CEA, DLR, CIE, CU, TEK, RIO, ASE, AMI) are involved in the **H2020 WASCOP** project (Water Saving for Solar Concentrated Power). This project aims to develop a revolutionary innovation in water management of Concentrating Solar Power plants, a more flexible integrated solution comprising different innovative technologies and optimized strategies for the cooling of the power-block and the cleaning of the solar field optical surface. WASCOP is a promising project permitting this consortium to enhance the commercialization of efficient CSP plants through the project SOLWATT.

The coordinator of SOLWATT is an experienced actor in the CSP field. Indeed, TSK has previously worked with some members of the consortium on successful EU projects such as the **H2020 CAPTURE** project (with CEA and TEK) which aims to increase concentrated solar power plant efficiencies and reduce LCOE by developing the key components of an innovative plant configuration.

TEK is currently coordinating the **H2020 MOSAIC** project (Modular High Concentration Solar Configuration) in which the companies AMI and RIO are involved as well. This project aims to exceed the goal of the Strategic Energy Technology (SET) Plan - European Commission of producing CSP electricity at a cost below 0.10 €/kWh by creating a commercial CSP plant of > 1GW of nominal capacity in which high nominal capacity of CSP plant is reached in a modular way where each MOSAIC module delivers thermal energy to linked thermal energy storage systems that supply their energy to a high capacity power block (>1GW). This modular configuration guarantees reliability, flexibility and dispatchability according to the needs of the electrical grid while reduces significantly the specific cost of the Power block.

CIE is coordinating **FP7 STAGE-STE** project (Scientific and Technological Alliance for Guaranteeing the European Excellence in Concentrating Solar Thermal), while some members of the present consortium (CEA, DLR, TEK, CU, ASE) are key players in the consortium. Project engages all major European research institutes, with relevant and recognized activities on STE and related technologies, in an integrated research structure to convert the consortium into a reference institution for concentrating solar energy research in Europe and enhance the cooperation between EU research institutions participating in the IRP to create EU added value.

Three partners (CEA, CU, ASE) participated in the **FP7 MATS** project (Multipurpose applications by Thermodynamic Solar). It aims at promoting the exploitation of concentrated solar energy through small and medium scale facilities, suitable to fulfil local requirements of power and heat, and easily to back-up with the renewable fuels locally already available or that can be expressly produced.

FP7 SFERA (Solar Facilities for the European Research Area) project, where DLR and CEA were involved as participants while CIE acted as coordinator, was aiming at the creation of a stable framework for co-operation in which resources are shared, common standards developed, duplication of research effort is avoided and interaction with European research, education and industry is encouraged.

FP7 OPTS (Optimization of a Thermal Energy Storage system with integrated Steam Generator) project with CEA and CIE participation was dedicated to development of a new Thermal Energy Storage (TES) system based on single tank configuration using stratifying Molten Salts as heat storage medium, integrated with a Steam Generator (SG), to provide efficient, reliable and economic energy storage for the next generation of trough and tower plants.

DLR is the coordinator of the **H2020 RAISELIFE** (Raising the Lifetime of Functional Materials for Concentrated Solar Power Technology) project, in which CIE and BSII is also participating. It focuses on extending the in-service lifetime of five key materials for concentrated solar power technologies: 1) protective and anti-soiling coatings of primary reflectors. 2) high-reflective surfaces for heliostats. 3) high-temperature secondary reflectors. 4) receiver coatings for solar towers and line-focus collectors. 5) corrosion resistant high-temperature metals and coatings for steam and molten salts.

Within the **H2020 PREFLEXMS** (Predictable and Flexible solar power with Molten Salt energy storage) project, DLR is further developing its Dispatch Optimizer for a Solar Tower System with Molten Salt as heat transfer fluid. The optimizer shall make use of the full dispatchability of such STE plants. It will be demonstrated at the Evora Molten Salt Platform during the project, including DNI forecasts. DLR further develops and installs an innovative once-through steam generator for molten salt plants at the Evora Molten Salt Platform within the project, together with industry partners such as GE.

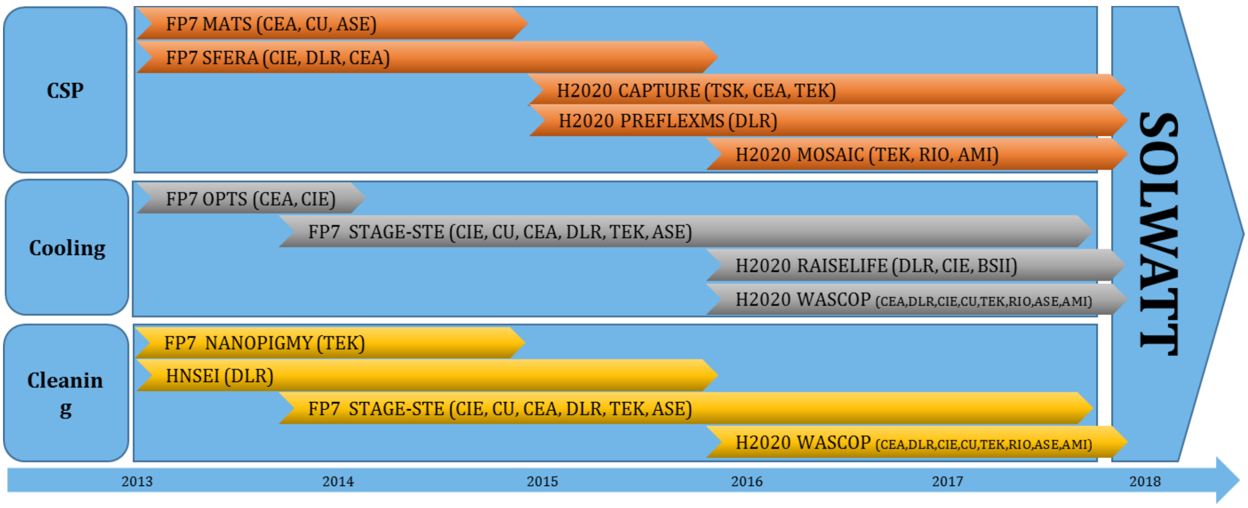


Figure 6 . R&D projects and built synergies for H2020 SOLWATT project

The know-how generated in previous projects within all-important segments can be translated into the proposed project and generate globally unique foreground. This project demonstrates the capability to significantly leverage the previous EU and national investments in research projects within the CSP field.

1.3.4. Consideration of gender aspects

It is widely known that Europe suffers from a lack of female scientists especially in the key domains related to the project: CSP, energy management, water saving. The SOLWATT project will address gender equality via several means. Partners will involve both female and male experts in the project's WPs and in leadership roles. Partners have gender equality policies to support the personal career development of female and male employees. These gender policies will be applied to those employees involved in the project. It will be ensured that project dissemination materials - website, poster, leaflet, film and news releases, etc. - display a balance of female/male imagery.

Notably, the following female experts will perform key roles in the project: **Itziar Azpitarte (TEK)** – WP3 leader, **Delphine Bourdon (CEA)** – WP4 leader, **Patricia Palenzuela (CIE)** – WP5 leader, **Lenka Bajarová (AMI)**- Dissemination manager and WP7 leader, **Ana Carolina do Amaral Burghi** – WP2 main optimization expert, **Nazmiye Ozkan** – WP1 socio-economic aspects.

The equal representation of men and women will be promoted as far as possible in the frame of the project. Additionally, since four out of eight WP´s will be led by female experts, SOLWATT could be considered as an example for other H2020 projects in terms of the inclusion of women in leading roles.

1.4. Ambition

1.4.1. Solar field cleaning technology (specific objective #1)

CSP plants are typically implemented in hot and arid areas, where soiling can significantly reduce efficiency. Dust accumulation can reduce the reflectors' initial reflectance by 5% to 25% between two cleaning operations depending on location, cleaning schedule and reflector surface material. The lack of reflectance significantly lowers the solar field efficiency. Prior work on WASCOP H2020 project has shown that up to 1 litre of water per m^2 of collector surface is used for each cleaning run. For a 50MW$_e$ plant (e.g. La Africana in Spain) where about 600,000 m^2 of mirrors are exposed, 600 m^3 of water are thus needed to clean all solar field mirrors once.

SOLWATT proposes a significant progress by demonstrating the ability of technologies to reduce water use by (i) cleaning of reflectors by ultrasonic cleaning, (ii) application of anti-soiling coatings on reflectors, (iii) integrated sensor to detect soiling to trigger a cleaning operation when it is needed and (iv) implementation of a dust barrier around the CSP plant. The progress proposed on the four points is described below:

a. Ultrasonic cleaning technology

The ultrasonic cleaning technology has been widely used in different applications during the last decades due to its high efficiency and low price. The cleaning principle is based on the cavitation of a liquid (water) when it is exposed to pressure waves (sound).

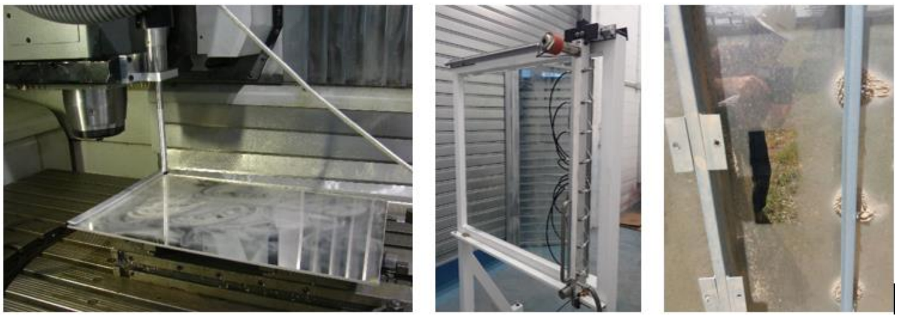


Figure 7. From left to right: a) 300mm length system, b) 1000mm length system and c) experiments at PSA

The concept of non-immersion ultrasonic cleaning faces the problem of how to apply ultrasonic cleaning to an object that cannot be immersed, such as a reflector. The solution lies on applying ultrasonic vibration on a previously deposited thin water layer. In other words, generation of cavitation on a solid body without immersion is possible on the condition is that it must be wet. There are several patents applying this concept under different configurations (as Patent US 4768256A[4] applying ultrasonic vibration on the car windscreen).

Compared to conventional cleaning, non-immersion cleaning concentrates all the vibration in a very small volume of water, making shock waves more efficient. Non-immersion ultrasonic cleaning system has been tested on real mirror probes at different process conditions and it has been compared with conventional pressured water jet cleaning. It has demonstrated under laboratory conditions to be able to obtain better cleaning results (up to 99% of relative reflectance) with about 600 times less water.

[4] Kenro Motoda "Ultrasonic wiper" US 4768256 A 1986

The ultrasonic technology has already been tested for 300 mm long stretches of mirrors and has also been upscaled for 1000 mm long mirrors. Soiled mirrors exposed in a representative environment (PSA) have been used to validate the efficiency of the ultrasonic technology. It has also been tested at PSA's facilities for heavily soiled mirrors, obtaining excellent results. The ambition of the present work is to upscale the system for a whole plant of parabolic collectors.

The present project aims to go a step further than the state of the art in integrating ultrasonic technology into an automatic cleaning truck capable of sweeping a complete parabolic-through module. This integration involves the sizing of the resonating band, shaping and the attachment to the truck's automatic approaching system. In order to transfer the current TRL5 system to TRL7, the project aims to clean a complete parabolic cylinder module (4 rows by 7 columns) whose parabola draws a curve of 6,284 m in length. It is estimated a consumption of water around 0.25l/m^2 and a power of the order of 4 kW, both values are lower than the technologies currently used (brushes and pressurized water). The system will be validated for a period of one year in a single module in order to demonstrate its advantages compared to traditional systems. It is clear that although the implementation is focused on a single module, the equipment to be developed will be able to retire and move to the next module, so that the project result is a device capable of cleaning the whole plant.

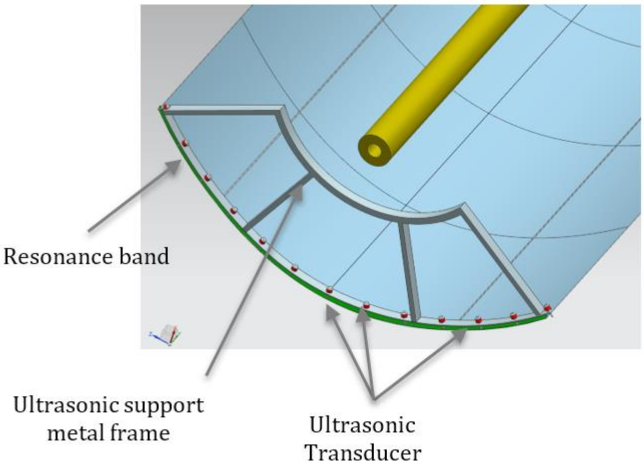


Figure 8. Cleaning system for a whole parabolic module

Table 3: Ultrasonic cleaning vs. conventional cleaning methods

SOA limitations	SOLWATT
Large volume of water needed for cleaning	Very small volume of water is needed for USc cleaning
Weak against micrometric particles	Principle based on ultrasound is much more efficient for micrometric particles such as desert dust
Bad cleaning results	Very good cleaning results (up to 99% of relative reflectance)
Mirror´s permanent damage due to scratching (Brushes)	No damage

b. Heliostat cleaning device

Conventional methods to control dust accumulation on heliostats waste large amounts of precious water resources. They are also labor-intensive, expensive and applied intermittently. In SOLWATT the development of a waterless, automated mechanical cleaning solution replacing conventional process will be demonstrated.

Key aspects of the technology include: a dry-cleaning automated process that requires no water on a regular basis maintaining sufficient and even pressure on the heliostat surface by use of a small DC motor, using the heliostat's installed PV cell as a power source and sophisticated integration with the solar power plant's control system to optimize performance. The system will enable more frequent cleaning that will increase annual electricity production while reducing operating costs.

Figure 9. Images of 1st (right) and 2nd (left) generation integral cleaning devices installed on a heliostat in BrightSource Solar Energy Development Center (SEDC)

The current design features a 3rd generation of a heliostat cleaning device which is based on the studies and tests performed on the previous generations. Those tests show improved cleanliness of the heliostat over time as can be seen in the trend below, when 3 heliostats with installed integral cleaning device shows steady reflective values of ~90%, while the performance of a reference heliostat without the device installed is gradually degraded between each manual cleaning operation.

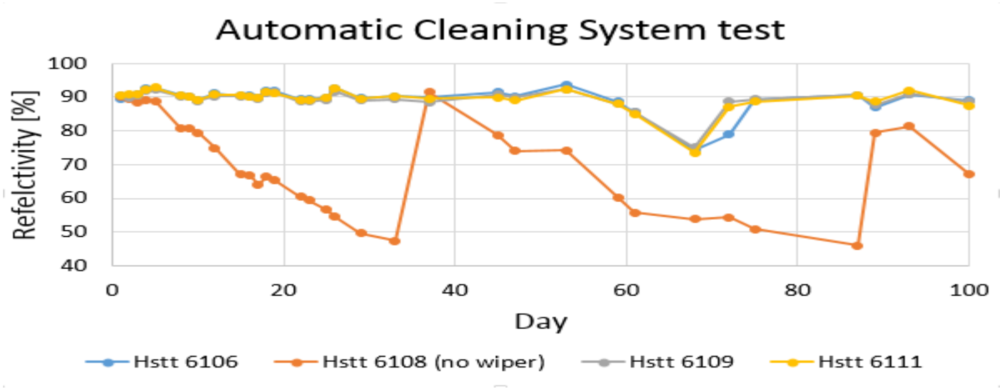


Figure 10. Prototype cleaning efficiency test results

Table 4: Heliostat integral cleaning device vs. common heliostat cleaning solutions

SOA limitations	SOLWATT
Costly and partial solutions	System enabling more frequent cleaning that will increase annual electricity production while reducing operating costs.
Requirement of a large amount of water	Waterless solution
Not efficient manual cleaning	Requires no labor

Implementation of an automatic cleaning device will reduce water consumption, reduce O&M cost and increase plant revenues by maintaining high reflectivity values as well as provide immediate solution post dust storm events.

c. Dust Barriers

Current barriers erected around the perimeter of CSP plants are essentially wind barriers (see Figure 11), intended to reduce the wind loading on the outer collectors in the solar field where mirror breakages are often a significant problem, or sand barriers to prevent plants from stilting (see Figure 12). These are solid or porous barriers and are effective in reducing the velocity of the airflows as the wind hits the barrier.

Figure 11 . Typical wind and sand barrier erected in SHAMs (UAE)

The barriers, which are not constructed at all CSP sites since the benefits do not always justify the costs, also reduce the transport of airborne particles into the solar field in two ways. Firstly, they block larger airborne particles by providing a solid barrier. Secondly, by reducing the wind velocity they reduce the forward momentum of an incoming particle and its probability of soiling a mirror in the solar field. Since the barriers are designed for wind speed reduction rather than airborne particle blocking, they are not optimised for this task and an opportunity still exists to design a barrier to carry out this dual role – reduce wind loading and also significantly reduce the number of airborne dust and sand particle that soil the collectors. The reduction of wind speed forces particles to fall to ground under gravity. Once this is achieved, the water consumed to clean the mirrors can also be significantly reduced with a corresponding net reduction in operating cost.

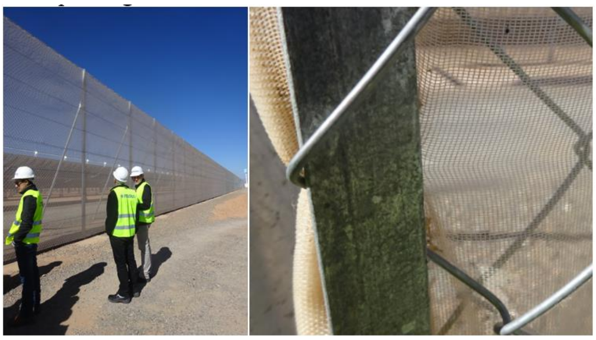


Figure 12. NOOR I (Morrocco) wind barrier

During the EU-funded WASCOP project dust barriers for both airflow velocity reduction and airborne particle inhibition were developed from TRL3 to TRL5 from Cranfield's unique aerodynamics experience. Facilities were used to transfer barrier designs from CFD modelling into practical wind tunnel experiments. A new wind tunnel was designed and built specifically to test scale models of the dust and wind barriers. Thereafter scaled-down versions of the most promising aerodynamically-shaped barriers were tested outdoors showing efficiency in stopping 50% of dust particles by weight. An example of the CFD modelling, the wind-tunnel designed for barrier testing, and the outdoor experiments, are all shown in Figure 13 below.

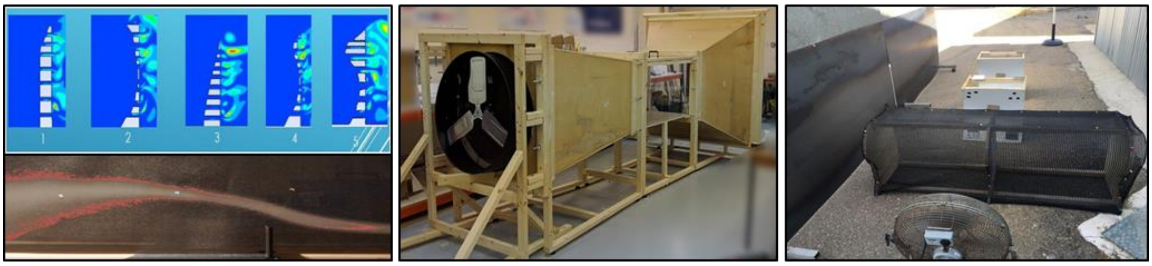


Figure 13. CFD results (top left), wind tunnel experiments (bottom left and centre) and outdoor PSA tests (right)

In SOLWATT the dust barriers will progress from TRL5 to TRL7. The selected barrier shape will be validated by intensive wind tunnel and scale model testing. It will allow us to define the exact location of the barrier which will be implemented at La Africana, selecting the appropriate perimeter of the plant in order to maximise exposure to the prevailing winds. The barriers will be designed to be durable and low-maintenance. The barriers will be full-height and will either replace existing perimeter fencing or be erected inside existing in agreement with La Africana plant management team. The effectiveness of the dust barriers will be validated by comparing the reflectance of collector facets that are protected by the barriers with mirror facets that are nearby but unprotected by the new barriers. The measurements will be made manually on a weekly basis using a portable reflectometer, although it is possible that soiling sensors will also be used in the validation exercise. It should be stressed that the dust barrier will be a robust and permanent structure and applicable not only the CSP plants but also to other industries where protection from dust is important, making it a high-impact commercial product.

Table 5: Dust barriers vs. conventional barriers

SOA limitations	SOLWATT
Barriers designed for wind speed reduction, not so suitable for dust reduction	Innovative design of dust barriers for both airflow velocity reduction and airborne particle inhibition

d. Antisoiling coating for reflectors

The deposition of an antisoiling coating at the mirror surface ensures the reduction of soiling accumulation, and consequently the water consumption reduction without any external power source and at affordable cost. Regarding the different types of antisoiling coatings, i.e. hydrophobic water “repellent”, hydrophilic water “attracting”, [5] and hydrophilic and photocatalytic coatings[6], those last ones have the ability of forming a very thin water film over the surface increasing thus the conductivity and preventing the localization of the electrostatic charges. In particular, titanium dioxide has photocatalytic properties[7] . A very thin layer of TiO_2 is to be performed in order to have a minor impact on the reflectance properties of solar mirrors[8] because of the colour modification.

Another factor to be improved within this technology is the mechanical and chemical durability of these layers[9].

During WASCOP project, an advanced anti-soiling coating has been developed (patent “Coated glass for solar reflectors (WO 2016177709 A1”). The coating is based on a Titanium dioxide layer of ≈120nm thickness with photocatalytic properties with no effect in the reflectance properties of the reflector. The main advantage of the antisoiling coating developed by IK4-Tekniker & Rioglass, is the improved durability, associated with its manufacturing process. The sol gel coating is applied over the glass, and once deposited, a conventional heat treatment of the glass allows the formation of a chemical covalent bond between the coating and the glass resulting in a durable and homogeneous dense coating which shows excellent antisoiling properties due to the hydrophilic behaviour of the titanium dioxide and good durability.

[5] T. Lorenz, et al. “Soiling and anti-soiling coatings on surfaces of solar thermal systems– featuring an economic feasibility analysis”, Energy Procedia (2014)
[6] Y Oto, N Ahmad, K Nishioka. “ A 3.2% output increase in an existing photovoltaic system using an anti-reflective and antisoiling silica-based coating”, Solar Energy, Volumen 136, 15 October 2016, Pg 547-552.
[7] P periyat, K.V Baiju, P mukundan, P.K, Pilloi.” High temperature stable mesoporous anatase TiO_2 photocatalyst achieved by silica addition” Applied catalysis, Volumen 349, October 208, Pages 13-19.
[8] Akina Fujishima, Zintang Zhang, Donald A. tryk. “ TiO_2 photocatalysis and realted surface phenomena”, Volumen 63, 15 december 2008, Pages 515-582.

The efficiency and durability of the coating has been proved by outdoor exposure tests by different accelerated ageing tests with good results.

The efficiency of the antisoiling coating and the coating robustness has been demonstrated with samples exposed during 8 months in 45-degree tilt south direction. No cleaning of the samples was performed, the only washing of the mirrors occurred when it rained.

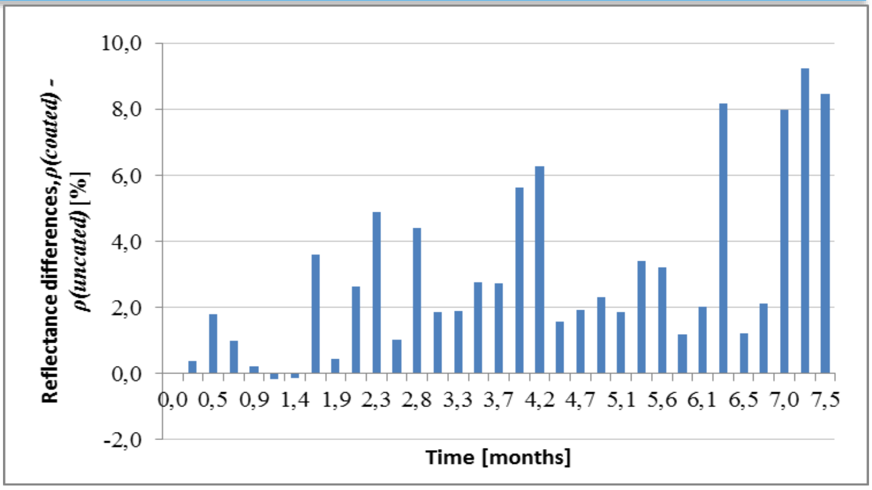


Figure 14. Reflectance differences outdoor exposure during 7.5 month

Figure 15 shows the monochromatic specular reflectance differences of the coated samples during the outdoor exposure. Results express the average reflectance differences between coated and uncoated side for each sample type, that is, *ρ(coated) – ρ(uncoated)*, in percentage points, showing a good average reflectance difference of 3.3 and a maximum reflectance difference of 9.5 percentage points for coated samples.

In addition, durability of coatings was assessed thanks to more than 3 years exposure time, samples showing a proper anti-soiling performance, with an average reflectance difference of 0.4 percentage.

In SOLWATT the up-scaling from samples size (TRL5) to reflector size (TRL7) and the implementation of the antisoiling coating in manufacturing company by spray-coating technique will be performed. 50 coated samples will be produced and installed strategically in the CSP field.

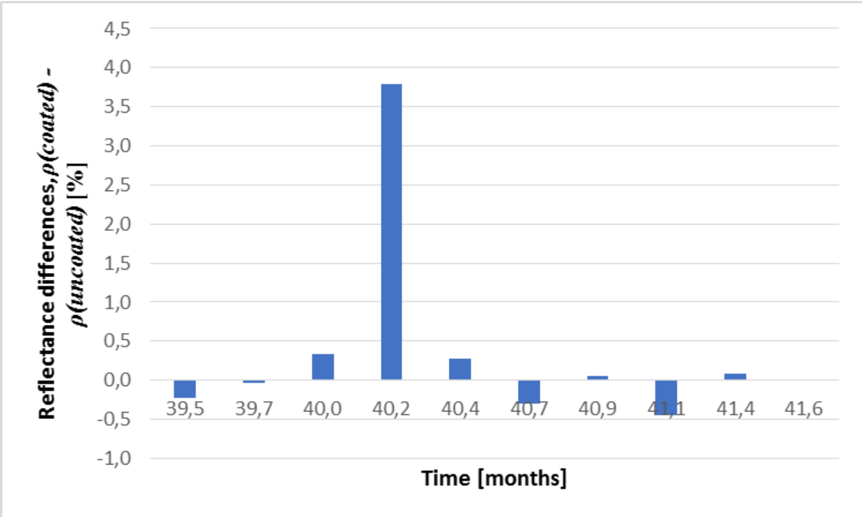


Figure 15. Monochromatic specular reflectance samples during the outdoor exposure at PSA (3 years) and 6 months at Tekniker

The effectiveness of the antisoiling and durability of these prototypes' efficiency, will be assessed during 36 months in La Africana, measuring the difference between coated and nearby uncoated samples each week manually with the portable spectrophotometer.

Table 6: Antisoiling coatings vs. SOA anti-soiling coatings

SOA limitations	SOLWATT
Big impact on the reflectance properties of solar mirrors (colour modification)	minimal impact on the reflectance properties of solar mirrors (No colour modification)
Not proven mechanical and chemical durability	Very high mechanical and chemical durability proved by laboratory testing

e. Anti-soiling glass coatings for receiver tubes

The majority of the commercially available solar receivers have external glass tubes coated with porous sol-gel based anti-reflective layers. The main issue here is that dust and non-deionized water on the surface usually result in residuals sticking on the glass surface, which decrease the transmittance properties of the anti-reflective structure. To limit these effects, usually hydrophobic layers are also deposited upon it.

In the framework of WASCOP H2020 project different approaches have been investigated in order to find a glass coating with improved anti-soiling properties. One possibility, for instance, is the implementation of alternative sol-gel solution containing nanoparticles of proper chemical nature and size able to decrease the surface porosity of the anti-reflective coating. Analogously, also the hydrophobic layers can be tailored with convenient organic functional group in order to increase their hydrophobic character. There are also several commercial products available, which show promising anti-soiling properties. In WASCOP, tests have been performed in order to verify the anti-soiling coating robustness and to optimize the cleanings in terms of cleaning tools and frequency. In fact, a well performing anti-soiling coating will enable Solar Field Operators to reduce the amount of consumed water and/or the number of cleaning events per month (or year), thus reducing the yearly water consumption.

Antisoiling coatings with improved durability and reduced water consumption have been lab-evaluated in WASCOP, but not industrialized and implemented in Solar Plant. The sol gel coating process has to be up-scaled to real size glass tubes for solar receivers (L 3974 x OD 125 mm) with control over the deposition parameters and transmittance properties.

In SOLWATT, the optimized combination of nanoparticles based anti-reflective and organic hydrophobic coating will be exploited. It will be devoted to up-scale and industrialize the deposition process from small flat samples to long glass tubes in ASE factory. The produced anti-soiling coating on glass tube will undergone optical and durability test in order to prove the successful industrialization. 36 innovative solar receiver tubes with the new anti-soiling coating will be produced and installed at La Africana plant, while 36 standard tubes will be installed in parallel for comparison. The validation of these prototypes, the anti-soiling behaviour and durability will be tested during 24 month. Solar Field Operators do not usually perform measurements on receiver´s glass. In SOLWATT, the behaviour of the anti-soiling will be periodically checked (before and/or after the cleanings) by measuring the Solar Transmittance properties by means of a portable spectrometer. The anti-soiling coating evolution with time, cleanings tools and frequency will be evaluated. A Solar Transmittance decay not exceeding 2% between consecutive cleanings and a high resistance to soiling and cleaning events are expected.

Table 7: Antisoiling coatings vs. SOA coatings

SOA limitations	SOLWATT
Residuals sticking on the glass surface - decrease of transmittance	optimized combination of nanoparticles based anti-reflective and organic hydrophobic coating securing transmittance features
Durability of the coating beyond three years	High coating robustness proved by laboratory testing

f. Soiling sensors embedded in mirrors

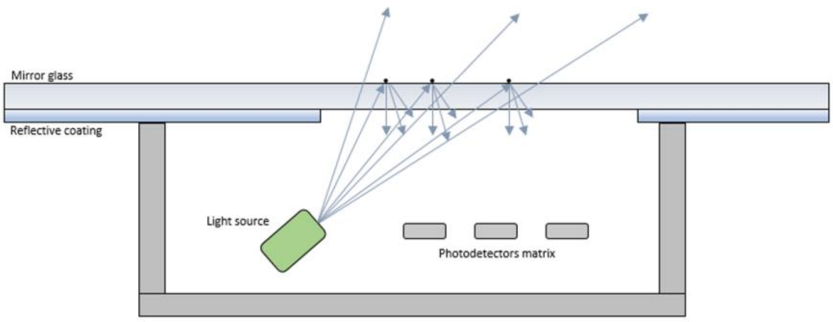


Figure 16. Scattering soiling measurement technology integrated in a mirror

To optimize the cleaning operations, the implementation of a continuous and real-time soiling measurement embedded on each individual mirror is proposed. In that way, cleaning operations will be focused on the dirtiest areas of the solar plant. Due to the high number of mirrors used in this type of facilities, the economic feasibility of the continuous reflectance measurement solution [10] will only be achieved by offering a reduced unit cost and easy deployment procedure. Additionally, the solution should provide for adequate sensibility and uncertainty in a wide temperature range and in severe environmental conditions. The market provides commercial devices that support reflectance measurement on both flat surfaces and also on curved mirror surfaces but they are not low-cost devices designed for autonomous monitoring operation at large scale [11, 12, 13]. The technology investigated in the WASCOP project proposes a more practical technology which is based in an innovative low-

[10] "High precision (1 part in 104) reflectivity measurement for the study of reflective materials used in solar collectors". Y.T. Chen*, B.H. Lim, C.S. Lim, K.K. Chong, B.K. Tan Solar Energy Materials & Solar Cells 80 (2003) 305–314.
[11] "Equipment and methods for measuring reflectance of concentrating solar reflector materials". A. Fernández-García, F. Sutter, L. Martínez-Arcosa, C. Sansom, F. Wolfertstetter, C. Delord. Solar Energy Materials and Solar Cells 167 (2017) 28–52
[12] "Reflector Soiling and Cleaning Methods". Fabian Wolfertstetter, DLR@ SFERA Summer School Hornberg, May 15th – 16th 2013.
[13] "Monitoring of mirror and sensor soiling with TraCS for improved quality of ground based irradiance measurements" F. Wolfertstettera* *, K. Pottlera, N. Geuderb, R. Affolterb, A. A. Merrounic, A. Mezrhabc, R. Pitz-Paald. SolarPACES 2013. Energy Procedia 49 (2014) 2422 – 2432.

cost solution designed to measure the soiling by means of scattering[14]. The principle of operation is the projection of a controlled infrared light bean under the soiling in the sensitive substrate and the measurement of the light scattered from the particles or bonded spots. This concept is basically represented in the Figure 16.

This technology has been developed and several pre-prototypes of stand-alone devices (no integrated in mirrors) were developed for the validation stage of the WASCOP project: pre-prototypes components validated at testing sites. Figure 17 shows the pre-prototypes already developed for the TRL5 validation. These prototypes were manufactured by fast prototyping methodologies with full functionality and optomechanical properties integrated. All the assembly was integrated in a compact device (Enclosure, optomechanical and optic devices and the electronic processing unit) that was also thermally stabilized before the validation tests.

Figure 17. Internal view of the prototypes with the processing electronics in the fore front

Performances at laboratory scale have been validated and 20 prototypes are implemented to validate the performances under representative outdoor conditions of CSP plants: (i) 10 prototypes of sensors and implemented at CIEAMT-PSA CSP plant, (ii) 6 prototypes are tested at a solar tower facility, called CESA-1 and (iii) 4 prototypes at the DISS parabolic-trough testing loop.

The low-cost sensing technology based on scattering is an innovative approach related with the actual more expensive and intrusive solution based on reflectometers. SOLWATT proposes then to develop a hybrid solution sensor technology/mirror fully integrated. The proposed solution combines an innovative soiling measurement technique based on low cost scattering measurement with also another innovative approach called "Smart Mirror - sensorized, connected and calibrated autonomous mirror" (Confidential concept Patent pending) that allows to integrate both concepts in an integrated combined solution with the advantage of a simple installation in the deployment of the solar plant.

Based on this design the manufacturing and validation tests of 30 final prototypes (mirrors with its sensor) is defined. These tests will be realized at La Africana PTC Solar Power Plant.

Table 8: Smart mirrors vs. conventional sensors

SOA limitations	SOLWATT
High price	Low cost solution
Designed for manual measurements	Designed for real-automatic measurements
Complex to integrate in the plants	Fully pre-integrated in the mirrors. No additional mechanical support necessary. Simple install.

1.4.2. Power block cooling: cold storage technology (specific objective #2)

Operating the condenser with a constant source of cold water ensures high efficiency of the steam cycle. Depending on the location of a power plant, different technologies of cooling the turbine condenser exist. Most of Rankine cycle cooling operates by open water cooling loop (taken and send back to a river for example) or using open or closed cooling tower (without or with flow condensation and recirculation). In this latest technology, the condenser is cooled by water circulation and the water cooling is performed in a dedicated tower with air flow. Water is partially evaporated as well as water consumption (absolute humidity in the air, and water droplets taken in the air flow).

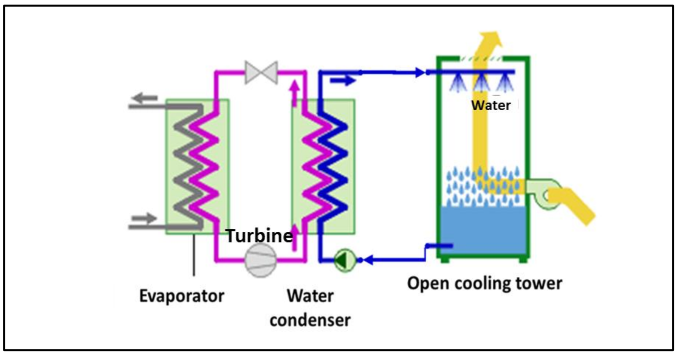


Figure 18. Actual cooling system of a wet cooled CSP plant

Such technology is a really efficient method for water cooling, i.e. low water temperature at the inlet of the condenser. However, a large water volume is required (typically from 3 to 5 m^3/MWh_e) which is a critical issue for CSP power plant (see image on right). Most CSP power plants use wet cooling, but dry cooling is increasingly being considered due to water prices and legal restriction on water consumption. Dry cooling is

[14] "Equipment and methods for measuring reflectance of concentrating solar reflector materials". Aránzazu Fernández-Garcíaa, Florian Sutterb, Lucía Martínez-Arcosa, Christopher Sansomc, Fabian Wolfertstetterb, Christine Delordd. Solar Energy Materials and Solar Cells 167 (2017) 28–52

characterized by no water consumption but reduces the net electricity production (both by decreasing the turbine efficiency by a few percent and by increasing the fan power demand) and increases the CAPEX which is critical for the economic balance of a CSP plant.

Table 9: cold storage vs. conventional cooling technologies

SOA limitations	SOLWATT
Large water volume needed because of wet cooling evaporation effect	Less water evaporated (up to 28%)
Dry cooling performances reduced due to hot ambient temperatures	Dry cooling performances significantly
Thermocline water pond never applied to power block cooling and CSP technologies	Implementation of a cTES in existing operating plant for power block cooling benefits.

Technology proposed as "cTES" in SOLWATT refers to a water thermocline at large scale to maintain a source of low and constant temperature of cooling water to the inlet of the condenser. The cold part of the cTES will be used during the hottest period of the day. The excess of heat stored in the cTES will be discharged during the night and the water cooled and regenerated by lower night-time temperatures, typically 10 °C cooler, to recover the whole capacity of the cTES cold storage.

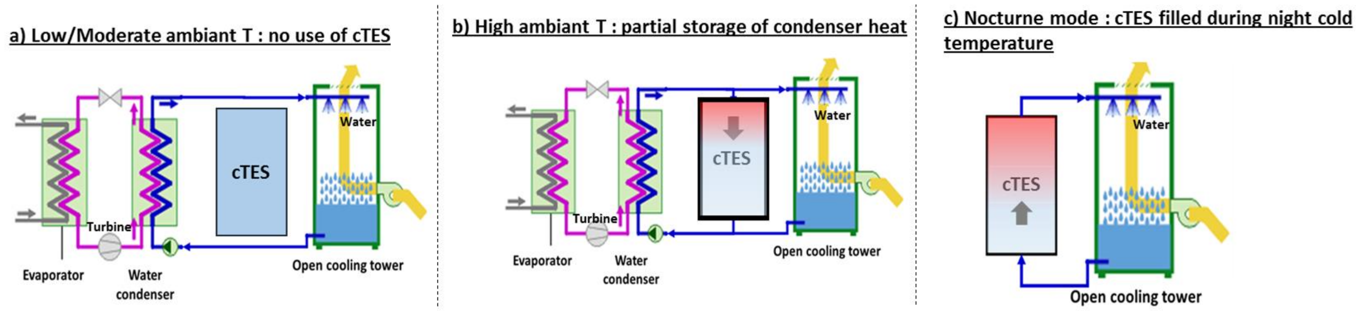


Figure 19. Operation of the cTES

a. The cTES is integrated in parallel with the actual cooling system. During period of low ambient temperature, the cTES will not be used;
b. Water mass flow rate can be partially sent to the cold TES with high ambient temperature during the day. During the charge, a thermocline region is moving from the top to the bottom of the storage, separating **hot fluid (nearly 35°C**) and **cold fluid (temperature between 12 & 20°C** according to the location and the period of the year). Water sent to the condenser is a mix between water coming from the cold storage and the cooling tower;
c. The stored water is cooled during the night using the open cooling tower. At the end of this process, the storage is entirely filled with cold fluid.

Water thermocline: thermal energy storage

Water thermocline has already been deployed and used in seasonal heat storage for residential and/or district heating. In this case, for example, heat is stored during the summer and discharged during the winter. As an example, heating company Vojens Fjernvarme is in 2014/2015 in the process of establishing the world largest solar heating plant (70,000 m²) and the world largest underground thermal storage pit (200,000 m³)[15].

The cold storage will limit water evaporation and then will reduce significantly water consumption by 28% compared to a system w/o cold storage. In case of a dry cooling system, the cold storage will ensure a higher efficiency of the turbine and so a gain in electrical production by 1%. A cold storage will be designed, manufactured and implemented by ASE, CEA, CU, BSII and TSK to demonstrate the efficiency of the TES on the reduction of water consumption. CEA has a great experience with thermocline TES from 3 m³ to 35 m³, which include operation, control and definition. In parallel, CEA has a relevant experience on fluid distribution for water thermocline TES to maintain a high stratification.

Thus, at the end of the project, the demonstration of a cold pit storage with a significant size (from 500 to 1000 m³ of water) will be tested and validated in real conditions in La Africana CSP power plant.

[15] https://stateofgreen.com/en/profiles/ramboll/solutions/world-largest-thermal-pit-storage-in-vojens

1.4.3. Waste water recovery and recycling technology (specific objective #3)

CSP plants currently discharge large amounts of waste water streams that could be re-used for water saving. The waste water streams flowrate is around 75 m^3/h during operation time for a 50MW_e plant with wet cooling and around 35 m^3/h for a 50MW_e plant with dry cooling.

Currently, most of CSP plants use Reverse Osmosis (RO) units to treat the raw water (from river, lake, wells, etc.), which consumes much electricity and needs sophisticated pre-treatments to prolong the membrane life and prevent fouling. Sometimes, in arid areas, CSP plants have to make use of water transportation by trucks, which mean a cost of around 4 €/m^3. The electricity consumption of RO is significant, ranging between 2.5 and 7 kWh/m^3 [16]. They are usually driven by the power produced by the turbine, which lead to a reduction in the net electricity produced. Furthermore, the water product has total dissolved solid (TDS) values of between 200 and 500 mg/L[3] and then requires a demineralized step to be suitable for mirror cleaning and power block needs, which raise the price of the process. Also, these RO plants are not suitable to treat the waste water streams from CSP plant and convert them into suitable water to be re-used due to the characteristics of this water (high concentration and content of components that are not easily removed by this technology).

Figure 20. MEE plant installed in El Sauz (Mexico) MEE is coupled to a Combined Cycle Gas Turbine

A thermal water treatment plant is a very robust process that can be used to treat harsh waters that are not otherwise possible to treat with RO, being also useful to exploit the energy content of the blowdown from the power block to carry out the own process. This system can be used to recycle all waste water streams to be re-used again for mirror cleaning or for the power block. The problem of thermal water treatment processes is the high energy consumption, which lead to slightly higher water costs than using RO. However, if waste heat from a certain process is used as the thermal energy source, the thermal water treatment process becomes competitive against RO. In CSP plants, the solar collectors are normally defocused once the maximum power and the maximum flow to the HTF (Heat Transfer Fluid)-Salt exchangers is reached. For example, in "La Africana" (50 MW_e) with an annual DNI of 2183 kWh/m^2/yr, the annual dumped energy is 135 GWh, which means a 30% of the total energy exploited of the solar field. The MEE process is based on successive processes of evaporation of the feedwater and subsequent condensation of the generated vapor. These processes take place inside connected vessels, called effects, each one at a pressure lower than the previous one, in order to be able to reuse the latent heat of the vapor. The more number of effects the greater the thermal efficiency. The only external thermal energy addition occurs in the first evaporator, usually using vapor. This sequence is repeated until the last effect, where the remaining vapor releases its latent heat in the end condenser, which is used as the refrigeration system of the process. INDETEC has broad experience in designing, commissioning and running 1 to 8 effects industrial MEE plants from 0.1 to 25 m^3/h of treatment capacity for water recovery processes from different sources such as biodiesel production, vegetable oil refining, olive pickling or wastewater from Combined Cycle Gas Turbine power plant. MEE also has been implemented for other industrial applications such as juice or milk concentration among others.

On the other hand, CIEMAT has a large experience in the operation of MEE plants and modelling and simulation of this kind of systems. Also, CIEMAT has widely worked in the implementation of control strategies for water treatment processes driven by solar energy.

Table 10: MEE vs. conventional water recovery technologies

SOA limitations	SOLWATT
Water treatment technologies with high electricity consumption	Water treatment technology with lower electricity consumption
High concentration and content of components in the waste water streams that are not easily removed by the current water treatment technologies	Water treatment technology able to remove any component present in the waste water streams

[16] P. Palenzuela, D.C. Alarcón-Padilla, G. Zaragoza., "Concentrating Solar Power and Desalination Plants", 2015. Ed. Springer. Switzerland. ISBN 978-3-319-20534-2

Low concentration factors with the current water treatment technologies	Water treatment technology with very high concentration factor (up to 99%)

SOLWATT proposes to install a Water Recovery system (WRS) in “La Africana” CSP plant (to be managed by TSK) based on a MEE (manufactured by IND) capable to produce a valuable product (almost pure water) reaching very high concentration factors (up to 99% depending on the water composition) that is able to reduce significantly the water discharge to the evaporation ponds due to the concentration of the waste water streams and the reduction of the raw water needed to temper the blowdown by using the WRS.

1.4.4. Dispatch and O&M optimization and Soiling forecast map (specific objectives #4)

The dispatchability of CSP plants with thermal storage is a key advantage for the upcoming role of this technology on electricity markets. The possibility of providing an accurate delivery schedule for the following days, based on electricity demand and weather and dust forecasts, underlines the importance of such plants in the pathway to a highly renewable energy mix. Nevertheless, electricity pricing and weather/dust forecasts include uncertainties, which the dispatch schedule needs to take into account. Especially soiling rate forecasts have the potential to improve plant efficiency while reducing water consumption when seen within the framework of the technical specifications of a given power plant, i.e. when included in the O&M optimizer.

Dispatch and O&M optimization

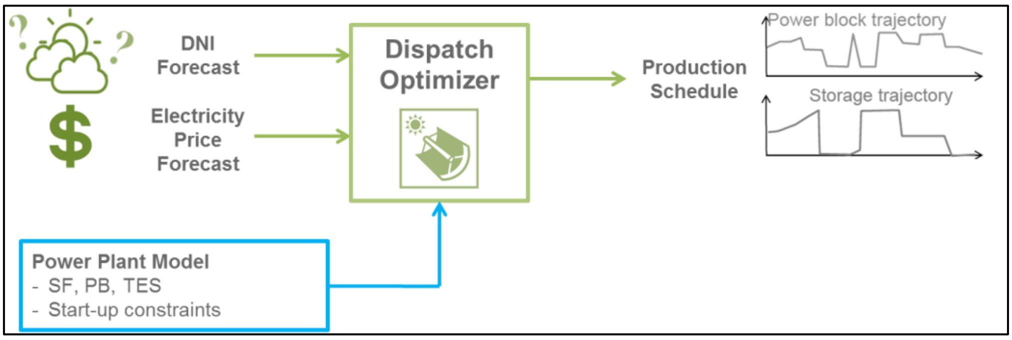


Figure 21. State-of-the-art dispatch optimization scheme

Various approaches exist for STE dispatch optimization, such as dynamic programming (DP)[17], Robust Stochastic Linear Programming (RSLP)[18], and Mixed Integer Linear Programming (MILP)[19]. These approaches include a robustness parameter to consider the uncertainties, if at all, generalizing all the incertitude in one single criterion. However, the sources of uncertainty on dispatch scheduling are plural, especially when considering different market setups and weather forecast methods. Therefore, the state-of-the-art Dispatch Optimizer by DLR goes beyond those approaches. First, besides the use of a weather forecast including DNI, the use of a mineral dust forecast system is planned. The use of the MONARCH forecast system[20,21] developed by BSC aims to forecast daily dust outbreaks. The dust forecast will be combined with DLR’s soiling model from the WASCOP project which derives the soiling rate of concentrating mirrors from meteorological data including the dust concentration as the most prominent input parameter. The soiling model is presented in more detail below. Second, the optimizer DLR´s Dispatch Optimizer can consider weather, soiling rate and electricity pricing forecasts with a special focus on the incorporation of uncertainty associated to the forecasts. Particular focus is put on non-linear models valid for all plant states and algorithm performance, and, thus, problem-specific assumptions are already made in the optimization structure[22]. In a first step, a rule-based heuristic optimization is performed; which is done for each scenario of, e.g., various different DNI and soiling rate forecasts. In the second step, a probabilistic post-processing is applied to the ensemble of individually optimal trajectories. Thereby, a plant trajectory with the highest probability of very high (ideally maximum) revenue is selected (see Figure 21). The plant operator’s market strategy and risk readiness can be included in the optimization.

[17] Wittmann M., Breitkreuz H., Schroedter-Homscheidt M. & Eck M.: Case Studies on the Use of Solar Irradiance Forecast for Optimized Operation Strategies of Solar Thermal Power Plants. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, Vol. 1, 1 (2008) p. 18-27.
[18] R. Dominguez, L. Baringo, A.J. Conejo. Optimal offering strategy for a concentrating solar power plant. Applied Energy, 98 (2012) 316-325.
[19] H.M. Pousinho, J. Contreras, P. Pinson, V.M.F Mendes. Robust optimization for self-scheduling and bidding strategies of hybrid CSP-fossil power plants. Electrical Power and Energy Systems 67 (2015) 639-650.
[20] Pérez C., Nickovic S., Pejanovic G., Baldasano J. M., E. Özsoy. Interactive dust-radiation modeling: A step to improve weather forecasts. J. Geophys. Res., 111 (2006) D16206. Pérez, C., et al. "Atmospheric dust modeling from meso to global scales with the online NMMB/BSC-Dust model–Part 1: Model description, annual simulations and evaluation." Atmospheric Chemistry and Physics 11.24 (2011): 13001-13027.
[21] Pérez, C., et al. "Atmospheric dust modeling from meso to global scales with the online NMMB/BSC-Dust model–Part 1: Model description, annual simulations and evaluation." Atmospheric Chemistry and Physics 11.24 (2011): 13001-13027.
[22] D.H. Wolpert and W.G. Macready. No Free Lunch Theorems for Optimization. IEEE Transactions on Evolutionary Computation, Vol.1, No. 1 (1997).

Our ambition for the SOLWATT project is to go beyond the pure revenue optimization. Especially, the water consumption, water recovery and other water-related aspects will be included in the optimizer. This allows for an integrated optimization of overall costs for plant operation and maintenance and makes the tool a Dispatch and O&M Optimizer. Its scheme and ambitions are shown in Figure 22. Such overall plant constraints are not yet included in any other dispatch optimizer (to the knowledge of the consortium) and will define a new benchmark for all future STE plant optimizers. Furthermore, the Optimizer will enable the advantageous use of the new proposed cooling system as an integral part of the dispatch strategy. The cooling system has a cold-water storage which adds another degree of freedom to the optimization. The challenge of the Optimizer is to consider all relevant aspects of the whole O&M chain, especially related to revenue, efficiency and water use. More variable inputs, such as soiling, must be included and an overall cost function must be found, for which an efficient algorithm is needed. This ambitious goal can only be reached by the bundling of all involved partners' competences and sound integration of models and experience. The O&M Optimizer will thus be an enabler to fully make use of all the individual technologies' potential. For the La Africana system, we assume a water reduction of up to 35% only by optimizing cleaning schedules. Pure revenue optimization is expected to give up to 5% revenue increase with perfect pricing forecasts. By including the O&M Optimizer, our ambition is to increase profit of the plant by 1% to 4%, depending on the quality of real uncertain weather and price forecasts.

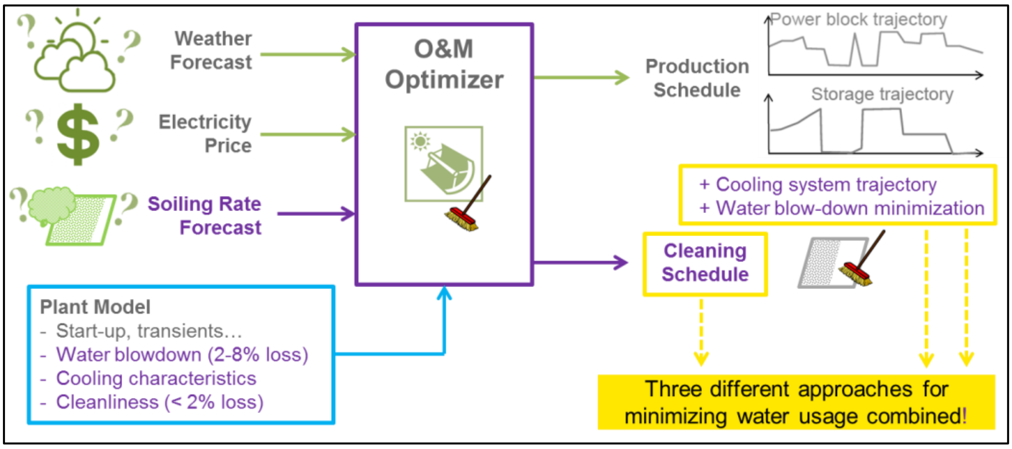


Figure 22. Ambition of the O&M Optimizer: not only focus on revenue by optimal power block and storage trajectories, but integrate whole relevant O&M chain with emphasis on water use

The Optimizer will be integrated into the commercial FoSyS tool by TSK and serve the plant operators routinely. At the end of the SOLWATT project, we will thus achieve a prototype demonstration in a full operational environment, i.e. TRL 7, at the La Africana plant in Spain.

In addition, an operational soiling rate forecast product, based on mature weather forecast and dust transportation physical model, for MENA and Europe will be implemented at the regional (72h ~10 km) domain.

Table 11: O&M optimizer vs. conventional solutions

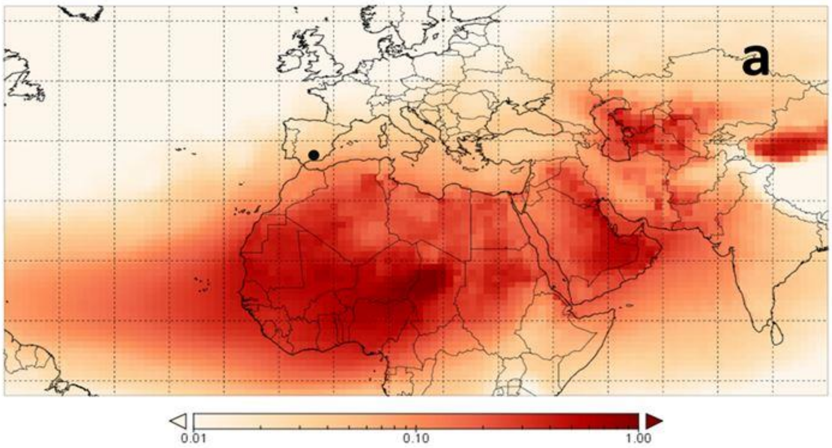
SOA limitations	SOLWATT
pure focus on revenues in the optimizer's 'cost-function'	the water consumption, water recovery and other water-related aspects included in the optimizer
no consideration of weather and soiling rate forecasts for cleaning scheduling;	smart optimization considering positive and negative soiling rate events including extreme events such as dust storms, red rain events and heavy rainfall; consideration of overload dumping for the cleaning schedule

Soiling rate forecasting product and soiling rate map

The soiling rate forecasting is one of the main inputs for the optimizer as mentioned above. Here we present further details on this model and the soiling rate map that is derived with the same method but for the past.

In the SOLWATT project, our ambition is to implement an operational soiling rate forecast product for the Middle East, North Africa and Europe. The product will be based on the combination of the WASCOP soiling model developed by DLR (TRL5) and the MONARCH dust forecast system developed and operated by BSC (TRL9). The resulting soiling forecast system will be implemented operationally to help operators optimizing cleaning schedules and to serve as an input to the O&M optimizer described above.

The DLR soiling model developed in the WASCOP project is a physical model that predicts the soiling rate for a CSP collector from simultaneously measured weather parameters like wind speed, particle number concentration, relative humidity and temperature. The model is currently at TRL5 being validated in relevant environments in Morocco and Spain. The model combines physical deposition and attachment processes like impaction, gravitational settling and Brownian motion in order to best reproduce the soiling rate from the weather and dust concentration parameters. The MONARCH model is at TRL9 and provides dust deposition and near surface aerosol concentration 3 day ahead forecasts (see Figure 23a,b) at regional domain in southern Europe and the MENA region that will serve as inputs to the WASCOP model. Currently, the model produces dust forecasts at the SDS-WAS Regional Center for a regional domain where it is combined with other dust model forecasts from collaborating institutions and evaluated in near-real time. The model also runs operationally (7 days a week, 365 days a year) at the Barcelona Dust Forecast Center (BDFC; http://dust.aemet.es/) with a horizontal resolution of 10 km for the same region.



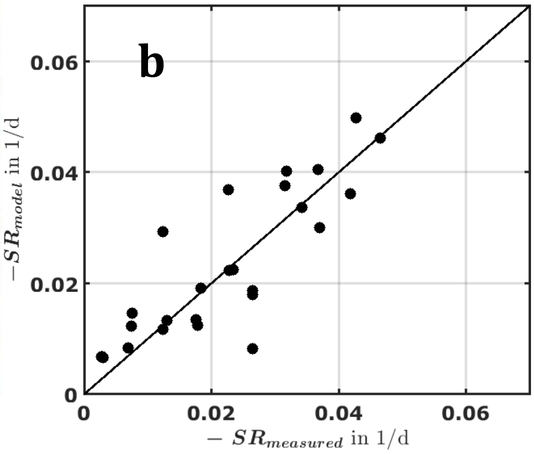


Figure 23. a) Annual average of modelled column-dust optical depth at 550 nm for 2015 based on MONARCH. b) Calculated soiling rate (SR) determined with the WASCOP model and plotted against the measured soiling rate for PSA. Data in daily resolution from 2.5 years, binned equidistantly for the Soiling Rate.

In addition to the soiling forecasts, SOLWATT will deliver a soiling rate map over the region based also on the WASCOP and MONARCH models. It will provide mean and daily soiling rates over the last five years that will be used to determine the best suitable amount of cleaning vehicles to be purchased in order to profit best from the optimizer innovation. Apart from the application in the optimizer activities, the soiling rate map is a much-requested product that serves project planners in site selection and resource analysis during the project planning phase. After the soiling rate forecasting and historical maps are in operation for CSP it is only a small step to apply it to photovoltaic energy generation or architectural glass in the future.

Table 12: Soiling rate map product vs. conventional solutions..

SOA limitations	SOLWATT
No soiling information available for GIS studies in site assessment	The soiling map will give detailed information on the soiling characteristics for the MENA and southern Europe region

1.4.5. Socio economic and environmental aspects

Decisions regarding the location of CSP plants correctly consider the solar resource, capital plus O&M costs and the LCOE, and the energy demand profile. The impact on local inhabitants of building an RE power plant in a remote and water sensitive region is often a secondary consideration. However, the influences on livelihood can be considerable and far-reaching, and can act as a catalyst for a range of economic and social benefits if handled in an appropriate and sensitive way. There have been attempts to assess these impacts before (for example: Wuppertal Institute; Germanwatch (2015): “Social CSP – Energy and development: exploring the local livelihood dimension of the Noor I CSP project in Southern Morocco”).

A range of social, economic and environmental impacts on local communities near to CSP plants will be investigated. The approach will be conducted for 5 sites which will be selected to ensure a representative cross-section of communities, taking into consideration the socio-economic profile of the region and the projected environmental impact over the lifetime of the plant. These case studies will include much local interaction with the selected communities and will call on the excellent international networks and collaborations that the project partners have built up over many years in pursuing CSP research and commercialisation. By studying the positive and negative impacts and barriers to implementation (including cultural and gender-related matters), we will build a framework within which these impacts can be

understood, stratified, and ranked for use by planners and recipients of future CSP plants in regions of water shortages.
SOLWATT will address both a top-down and bottom-up approach. Initially a top-level systems analysis will provide the framework within which to understand the many issues that influence the local community and its relationship with the plant and its operating infrastructures. By classifying the communities according to their socio-economic groups we will then be able to make an objective selection of locations to maximise the effectiveness of our findings. The case study approach will be built on our significant experience of interacting with remote communities in developing countries, and will focus on semi-structured interviews with individuals and focus-group events, always attempting to ensure a diverse spread of participants. Socio-technical matters are addressed through the medium of technical training, whereby we undertake to provide a unique opportunity for practice-oriented training and knowledge transfer to three distinct groups of learners. For technician-level training the project provides unprecedented access to both a working CSP plant ("La Africana") and the test lines at the largest European solar research Institute at the nearby Plataforma Solar de Almeria (PSA). This experiential learning course will include the methods, tools, and techniques required to carry out the practical tasks related to the technological solutions being deployed on the SOLWATT project, with its strong central thread of water consumption and cost reduction. A higher-level course will also be presented to plant engineers, managers, and technical experts on the deployment and management of water-related solutions in CSP plants; again including the new commercialised technologies from this project. Both the above courses will be developed by CIEMAT-PSA, who have considerable experience in the delivery of CSP training and educational courses, such as the SFERA-II project which includes summer schools and courses for industry professionals. It is recognised that the wider CSP community would benefit from the training and knowledge transfer opportunities described above, but will not be able to experience this in person. In order to broaden the scope of the training still further we will construct a distance-learning package to be distributed, either by DVD or accessible on-line, to deliver the core learning from both of the CIEMAT-PSA courses in a condensed unit. Cranfield University has much experience in the design and delivery of distance-learning packages and will be assisted by CIEMAT-PSA and DLR in devising and delivering a high-quality output.

2. IMPACT

2.1. Expected impacts

2.1.1. Improved technological performance towards cost-effectiveness

The European Union has established challenging targets for making a transition to a sustainable energy system in Europe, including that the EU's electricity supply should achieve essentially zero emissions of greenhouse gases by 2050. Concentrating Solar Power is one of the most promising and sustainable renewable energy and according to International Energy Agency (IEA) is positioned to play a significant role in the future global generation mix, alongside wind, hydro and solar photovoltaic technologies. IEA´s roadmap projections to 2050 say that with appropriate support, CSP could provide 11.3 % of global electricity. [23]

Although there is definitely the potential for the technology to achieve rapid growth, success of CSP will ultimately rely on the ability to overcome obstacles that prevent its mass adoption. Only then investors will be more willing to add a greater share of CSP into the renewable energy sector. These obstacles are mainly the large financial demands, associated with high investment costs (2000 to 8000€ per kW) and operation and maintenance costs (60€ per kW per year)[24]. In line with higher financial demands, there is also a certain need for the reduction of the LCOE. Another major barrier is limited accessibility of water. Given that most CSP plants need to be located in hot arid areas (due to the need for high direct solar irradiation) and that CSP plant permits, plans and cooling processes rely on access to and planned use of water, the availability of water for CSP in competition with domestic consumption and thus the social acceptance could be a limiting factor in CSP plant deployment.

SOLWATT proposes revolutionary innovation in water management of CSP plants – holistic breakthrough solution comprising different innovative technologies for the cleaning of the solar field optical surfaces, cooling of the power-block, water recovery & recycling system and optimal strategies for CSP plant operation. SOLWATT brings not only significant reduction (35% for wet CSP plant and 90% for dry CSP plant) of the water consumption, but also improvement in the electrical power production while reducing the O&M costs, leaving

[23] IEA Technology Roadmap: Concentrating Solar Power. Available at: http://www.iea.org/publications/freepublications/publication/technology-roadmap-concentrating-solar-power.html
[24] Concentrating Solar Power. SBC Energy Institute. June 2013

space for an increased competitiveness of CSP energy. Nevertheless, the LCOE for CSP including SOLWATT's technologies cannot be yet honestly estimated since this criterion is strongly impacted by the plant location including local labour cost, water prices, bank interest rate, insurance costs, and potential subsides.

The relevance of SOLWATT strategy lies in its flexibility. It offers a range of technologies that can be applied in various parts of the electricity generation process in CSP to reduce water consumption. SOLWATT´s advantage is also the ability to reflect and adapt to the specific conditions prevailing at individual CSP plants, unlike other competitive approaches proposing a single generic solution applicable only on some referenced cases.

The SOLWATT project is expected to reduce the total water consumption at CSP facility by 35% for a wet cooled and by 90% for dry cooled CSP plants. Table 13 shows detailed information on water savings (estimated for La Africana CSP plant) according to individual SOLWATT technologies. These figures are based on preliminary tests and estimations performed by the project partners in order to validate the primary concept. For cleaning technologies, ultrasonic cleaner technology itself can reduce water consumption by 90%. The reduction of the frequency of cleaning operations, and then cost, will be ensured by the implementation of dust barrier, anti-soiling coatings and sensors.

Table 13. Water savings of SOLWATT solution (estimated for La Africana CSP plant in Spain)

Technology	Water cons. savings	State-of-the-art KPI	SOLWATT KPI*
Ultrasonic cleaner	0.26 m^3/MWh	0.29 m^3/MWh (cleaning consumption)	0.03 m^3/MWh (cleaning consumption)
Heliostat integral cleaning device	0.27 m^3/MWh	0.29 m^3/MWh (cleaning consumption)	0.02 m^3/MWh (cleaning consumption)
Dust barriers	0.12 m^3/MWh	0.29 m^3/MWh (cleaning consumption)	0.17 m^3/MWh (cleaning consumption)
Antisoiling coatings on reflectors	0.13 m^3/MWh	0.29 m^3/MWh (cleaning consumption)	0.16 m^3/MWh (cleaning consumption)
Antisoiling coatings on receivers	0.08 m^3/MWh	0.29 m^3/MWh (cleaning consumption)	0.21 m^3/MWh (cleaning consumption)
Sensors integrated on reflectors	0.07 m^3/MWh	0.29 m^3/MWh (cleaning consumption)	0.22 m^3/MWh (cleaning consumption)
O&M optimizer (soiling forecast)	0.10 m^3/MWh	0.29 m^3/MWh (cleaning consumption)	0.19 m^3/MWh (cleaning consumption)
Soiling rate map product	0.8 m^3/MWh (for future plants)	0.29 m^3/MWh (cleaning consumption)	0.21 m^3/MWh (cleaning consumption)
Nocturnal cold storage	1.20 m^3/MWh	4.95 m^3/MWh (cooling consumption)	3.75 m^3/MWh (cooling consumption)
Water recovery system	0.45 m^3/MWh	0 m^3/MWh (No water recovery)	-0.45 m^3/MWh (water gain by recycling)

One of the main benefits of developing the SOLWATT solution is the substantial reduction in terms of operation & maintenance costs (O&M) which are strongly connected with the water consumption of CSP technology. These savings are possible due to reduction of the number of maintenance operations and enhancing of their efficiency. The investment required to install the individual technologies (CAPEX) can be recovered after few years. Values of CAPEX and OPEX savings of individual SOLWATT technologies are summarized in table below.

Table 14. CAPEX and OPEX savings of SOLWATT solution

Technology	SOLWATT CAPEX*	SOLWATT OPEX savings**
Ultrasonic cleaner	300,000 €	110,500 €/year
Heliostat integral cleaning device	2,000,000 €	700,000 €/year
Dust barriers	394,000 € (0.2 €/m^2 of the total plant area)	51,000 €/year
Anti-soiling coatings on reflectors	181,000 € (0.3 €/m^2)	55250 €/year
Anti-soiling coatings on receivers	60,000 € (2.5 €/receiver)	34,000 €/year
Sensors integrated on reflectors	13,300 € (0.007 €/m^2 of solar field)	29,750 €/year
Nocturnal cold storage	900,000 €	510,000 €/year
Water recovery system	640,000 €	34,000 €/year
O&M optimizer	10,000 €	1 – 4 % profit increase

* Calculated based on data from La Africana plant; ** Calculated for 50MW_e plant, 2.5 €/m^3 water cost

By improving the economic feasibility of renewable energy solutions, the uptake of such solutions will be greatly increased. This will facilitate reaching expansion rates high enough for ambitious goals for the share of renewable energy in the total energy mix to be achieved.

2.1.2. Economic impact

European CSP plants had a total installed capacity of more than 2300 MWe at the end of 2014[25]. According to the solar thermal energy growth paths based on the National Renewable Energy Action Plans (NREAPs), an average annual growth of over 15% in the total installed capacity should be expected from 2010 to 2020 despite the constraints emerged from the financial crisis. It is thus expected that the market will continue to grow, mainly in Mediterranean countries like in Italy, Greece, Cyprus or Malta.[26]

The growth of installed CSP capacity, which is expected not only in Europe but also in other world regions such as the Middle East and North Africa (MENA), will provide SOLWATT with tremendous opportunity for market penetration. Since transition to new technologies is the least financially and technologically challenging during the phase of design and planning, SOLWATT has the biggest added value specifically during this time. Due to this fact, various proposed SOLWATT solutions are primarily designed for future CSP plants, which offers an alternative to solutions currently available on the market. However, several technologies included in SOLWATT (e.g. innovative cleaning technologies, soiling rate forecast and O&M optimizer) can be applied to existing plants as well, which also increases the chance for success on the market.

Expected market share as well as savings, which are targeted by implementing SOLWATT solutions, is demonstrated in the table below. This business case study is based on the moderate scenario expected by STELA for the CSP industry. We have estimated a fair ratio of new CSP plants integrating SOLWATT technologies from 2022. An average price of water of 2.5€/m^3 is considered.

Table 15. Market projection of SOLWATT project

Year	2022	2023	2024	2025	2026	2027
Global CSP capacity (MW)	33,310	40,639	49,173	59,007	70,219	82,858
New plants (150 MW)	42	49	57	66	75	84
Ratio new plants with SOLWATT	0.01	0.03	0.05	0.07	0.09	0.11
New plants with SOLWATT	1	2	3	5	7	10
Total plants with SOLWATT	1	3	6	11	18	28
SOLWATT market share	**0.5%**	**1.1%**	**1.8%**	**2.8%**	**3.8%**	**5.1%**
SOLWATT technologies investment (M€)	4.2	8.4	12.6	21	29.4	42
Water savings with SOLWATT (Mm3/y)	1.2	3.6	7.2	13.2	21.6	33.6
Expected annual savings (M€)	-1.2	0.6	5.4	12	24.6	42
Cumulative savings (M€)	**-1.2**	**-0.6**	**4.8**	**16.8**	**41.4**	**83.4**

Data presented in the Table 15 shows that the application of SOLWATT technologies at CSP plants will lead to savings of tens of millions €. These savings shall significantly contribute to the reduction of the financial investment of CSP technology and increase their competitiveness in comparison with other renewable energy sources.

2.1.3. Environmental and social impact

One of the SET-plan initiatives (European Industrial Initiative on solar energy - Concentrating solar power) identified the demonstration of the competitiveness and readiness for mass deployment in the near future as most challenging task in the field of CSP.

SOLWATT proposes to contribute to this objective by improving the CSP water management and increase of the cost-effectiveness of the CSP technologies. Water is scarce and very expensive commodity - especially in arid regions with large amount of solar radiation, and its saving is considered as one of the essential tools to enhance the overall performance of CSP technology. However, benefits of improved water management should not be considered only in economic terms. The second and equally important factor that must be taken into account is the influence of water savings on the environment, whether in local or global scale.

[25] L. Crespo, "Las centrales termosolares: Situación y perspectivas internacionales", GENERA 2015
[26] "Solar Thermal and Concentrated Solar Power Barometer", Available at: http://www.solarserver.com/solar-magazine/solar-news/current/2014/kw25/eurobserver-european-solar-csp-market-shifts-to-italy-solar-thermal-market-contracts-in-2013.html

Locally, lower water consumption has positive effect mainly on landscape and the ecosystems in the close proximity to the plant. Of particular importance is the fact that SOLWATT is able to prevent further desertification of soil, which ensures almost no modifications of local fauna and flora. By developing more effective methods SOLWATT will also limit the amount of chemical additives in the water currently used especially during the cleaning methods. The water consumed in the cooling and cleaning within a CSP plant comes from one (or both) of two sources. If pumped from local rivers or wells it potentially denies the use of that water for other purposes and especially in arid area with the competition with domestic uses which induces a reluctance of local population of the deployment of CSP plants. Furthermore, in these arid regions, where the local economy often relies on subsistence farming, depleting water stocks can be a long-term barrier to economic development. It also prevents the environment from recovering from short-term desertification which would otherwise be cyclic. In true desert environments, the water will be delivered by pipeline or in tankers by road, often over considerable distances. Both of these contribute to CO_2 or other GHG emissions, and it is clear that by significantly reducing water consumption within SOLWATT we will have a significant positive impact on these metrics.

From a global perspective, the significant increase of the CSP capacity in Europe will enable to reduce the consumption of fossil fuels and thus contribute to solving the global climate challenge. This fact can be easily demonstrated by comparing the emissions of Greenhouse gas. Emissions for CSP plants are estimated to be in the range 15-20 grams CO_2-equivalent/kWh, much lower than CO_2 emissions from fossil-fired plants which are 400-1000 g CO_2-eq/kWh. It is expected, that the technologies of the SOLWATT project will be able to further reduce CO_2 emissions by approximately 2.5% (i.e. $4x10^5$ Kg of CO_2 eq. for a typical $50MW_e$ plant) compared to the state-of-the-art CSP plants.

By reducing the unfavourable environmental impact SOLWATT will be a powerful tool to demonstrate sustainability of CSP technology and to further increase its social acceptance. SOLWATT will also enable stakeholders to extend the technology to new locations without hampering environment and societal considerations. SOLWATT carries out a comprehensive analysis of the impact of a CSP plant on the local inhabitants and their livelihoods. The approach taken initially is a top-down systems approach, grouping and linking the component causes of the impact on the local population. This then provides the framework for a bottom-up analysis where a representative number of communities are analysed using semi-structured interviews and questionnaires. Thus, SOLWATT integrates the socio-economic and livelihood issues into the main body of the project, as described in detail in WP1.

2.1.4. Relevance to the call

SOLWATT meets the requirements of the H2020 SET Plan integrated roadmap. More specifically SOLWATT meets the requirements as listed in the H2020 LCE-11-2017 call.

Table 16. Expected impact of LCE-11-2017 work programme topic addressed by SOLWATT

Call expected impact	Relevance of the SOLWATT project
Significant exploitation prospects for the European technology in the field of CSP	The participation of TSK, BSII, RIO, ASE, FNK, TEK and IND in SOLWATT aims at industrializing and implementing new technologies in current and future CSP plants. Their utmost objective is to bring new technologies on the market for CSP and to create an advantage against their competitors. As coordinator, TSK was vigilant to select in SOLWATT the most promising technologies with a high probability of exploitation for their implementation in CSP plants.
Cost effective solutions that improve the environmental profile	As presented in the Table 13 and in the Table 14, the technologies selected in SOLWATT will reduce OPEX cost that will in turn reduce the LCOE. All the technologies will allow a significant reduction of water consumption for all plant components.

2.1.5. Potential obstacles that may determine whether the expected impacts will be achieved

Obstacles	Description	Planned action
New cleaning technologies	Owners of the plants are usually reticent to install equipment or elements which have not been used before.	The planned tests in a real plant are the best way to demonstrate the different technologies and to consider them proven. Furthermore, a techno-economic assessment will be conducted during the project to validate and prove the economic benefits of implementation of the technologies.

Cooling technologies of the power block – cTES	Owners of the plants are reticent to implement this technology which has not been used before and they estimate that CAPEX is too high to be competitive.	A water pond thermocline technology is mature and demonstrated in other fields than CSP. Furthermore, it's cheap and efficient for this application. Preliminary assessments show potential of electricity production improvement, significant water savings and a reduction in the cost of production. The aim of the project is to demonstrate this technology for the CSP community benefit and to give strong arguments to EPC and industrial partners for the implementation of this solution in future CSP plants as well as existing ones.
Social acceptance	Local communities may be reluctant to install CSP plants regarding their huge water consumption and its competitive position with domestic and agriculture usages.	The SOLWATT project aims at reducing this CSP plant water consumption, and in addition, socio-economic and livelihood studies on 5 different sites will ensure a representative cross-section of communities are analysed.

2.2. Measures to maximise impact

2.2.1. Reinforced European leadership in the CSP market

Successful development and exploitation of such complex innovative solutions cannot be performed by one single entity. Therefore, the SOLWATT consortium is designed to involve all relevant key players in the domain of concentrated solar power. The pool of project partners has been selected to cover the complete knowledge needed for the creation of a holistic next generation solutions for improvement of the CSP water management system. The SOLWATT project includes partners from R&D domains providing the necessary development and testing infrastructure as well as industrial representatives and SMEs capable of manufacturing and commercializing final solutions. Furthermore, TSK and BSI will be able to propose and to integrate SOLWATT technologies in future tenders which will be a strong advantage to competitors in terms of water consumption and economic output of CSP plants.

Strong added value of this proposed project is in the quality of new and previously established partnerships, which are prerequisites for successful cooperation with a common goal. The Figure 24 describes the selection of partnerships (from R&D phase to implementation) that were created for several partial steps of this challenging proposal. These partnerships will also contribute to **creation of the full value chain** for successful SOLWATT development, which is strongly supported by **outstanding industrial involvement in this project (more than 50%).**

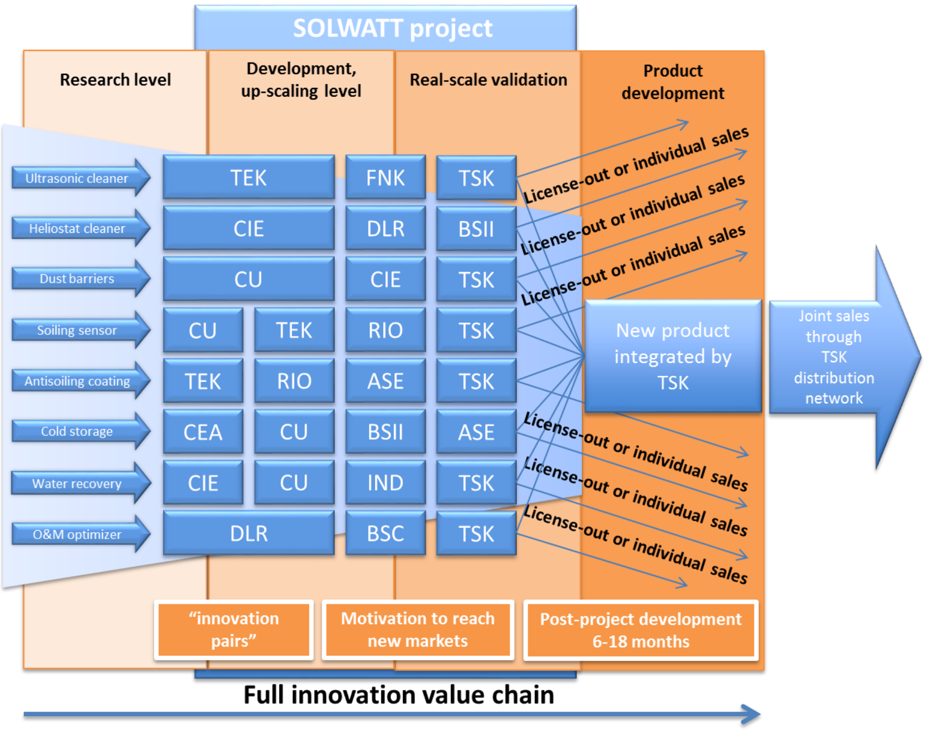


Figure 24. SOLWATT value chain

SOLWATT will also enlarge the European industrial technology basis by enabling companies to enhance their market perspectives by entering the CSP market with disruptive ambitions. The industrial partners will bring their skills in engineering development and the supply of facilities (TSK, BSII), anti-soiling and self-cleaning coatings

(Archimede Solar Energy, Rioglass), constructional design and engineering (INDETEC) as well as innovative solutions for cleaning and maintenance of solar thermal plants (Feniks) to develop and implement innovative processes at demo scale.

The SOLWATT consortium is globally unique and was assembled to improve European competitiveness in the field of CSP, as well as to increase market share of European industries and SMEs in the value chain of new products and services.

2.2.2. Successful exploitation towards improvement in the CSP

The SOLWATT industrial partners (especially TSK, which is intended to be the core end-user of developed solutions) have created a draft of an exploitation strategy. Some partners provided rather extensive exploitation plans, which can't be presented in their full length, due to the page limits. The essential information from several partners is given below (other exploitation plans can be found in Annex I). Partners will evaluate the impact of technologies or partnership creation within this project (WP7).

Concerning Research and Technology Organisations, since they are not expected to exploit the results into commercial products and services, their exploitation strategy, mainly consisting of R&D collaborative contracts and licensing, is presented in Table 19 under a lighter description.

Individual exploitation plans:

TSK exploitation strategy of SOLWATT results
Market description: CSP technologies

Exploitation plan: TSK is a leading engineering company in the field of CSP. It has already participated in the construction of 8 plants with different technologies (parabolic trough, linear Fresnel, and integrated solar combined cycle) and it is currently in the construction of 2 more. TSK has been experienced a continuous growth in the last years, and has reached a turnover of 977 M€ in 2016.

As an EPC contractor, the know-how obtained during the development of the project, will be used in the future bids for the construction of new CSP plants in which TSK participate. The solutions developed in this project will be able to reduce the price of the different sections included in the offers which generally include the engineering, construction and also the operation and maintenance for the first years of the plant. Thus, all the solutions successfully proven in SOLWATT are feasible to be implemented in the next project of TSK, and therefore, they will be able to reach the market promptly. The reduction in the water consumption of the plants is not only economically beneficial, but also is high valuable to our possible clients as the water is scarce in many of the potential locations of future plants and is a criterion of selection of tenders. Finally, the solutions proposed in SOLWATT are environmentally friendly and will have a positive impact upon communities in the local environment. All these issues are the great interest to the governments, which are usually the final owners of the plants.

In conclusion, it can be stated that including the SOLWATT solutions to the TSK's portfolio reinforce the leadership of the company in the industry.

Expected revenues and market share: The main profit obtained with the success of this project will be offer new solutions to reduce the water consumption of the plant in future bids. It will be easier to keep within the water restrictions so TSK will be able to guarantee the lowest water consumption among all the bidders. This plus point will imply more chances to win CSP projects. Therefore, the revenues obtained with this project are heavily dependent on the number of bids that will be opened in the future. As stated in the economic impact, it is expected an important growth of the CSP sector once SOLWATT project is finished. Assuming the same scenario, the benefits and market share expected for TSK are detailed in the table below, where the impact of the SOLWATT project is stablished. An increase in the turnover of more than 15% is expected after 5 years once the project is successfully completed.

Table 17: TSK's expected revenues and market share

Year	2022	2023	2024	2025	2026	2027	Total
New plants	2	2	3	3	4	4	**18**
Market share (new plants)	4.8%	4.1%	5.3%	4.5%	5.3%	4.8%	**4.8%**
New plants with SOLWATT solutions	3	3	3	3	4	5	**21**
Market share with SOLWATT solutions	7.1%	6.1%	5.3%	4.5%	5.3%	6.0%	**5.7%**
Turnover (M€)	1400	1400	2100	2100	2800	2800	**12600**
Turnover with SOLWATT solutions (M€)	2100	2100	2100	2100	2800	3500	**14700**
Difference (M€)	700	700	0	0	0	700	**2100**

Potential commercial barriers: The international bids for the construction of CSP plants include several restrictions which could prevent to implement the solutions from SOLWATT project. The owners of the plant, which are usually the clients of TSK, sometimes do not accept unproven elements or technologies. For this reason, proving the technologies in an operating plant, like La Africana, will help to remove this obstacle and to convince owners of CSP plants of the economic benefit of advanced technologies for future CSP plants.

ARCHIMEDE SOLAR ENERGY exploitation strategy of SOLWATT results
Market description: anti-soiling glass coatings and solar plant engineering

Exploitation plan: The outcome of the project could be very important for the commercial strategy of the company. The possibility to have a validation on real site of an improved anti-soiling glass coating represents an important added value and competitive factor versus the other receiver manufacturers.

It will be used directly by our own sales network and, if possible, would be used exclusively. Nevertheless, in case of cleaning procedures, the usage could not be exclusive and the benefit shared even with other player giving anyway a common understanding and benchmark for such kind of critical operation.

As concern the engineering activities, the storage control design and implementation will complement the knowledge and the know-how of ASE.

Expected revenues and market share: As stated in the economic impact, it is expected an important growth of the CSP sector once SOLWATT project is finished. Assuming the same scenario, the benefits and market share expected for ASE are detailed in the table below:

Table 18: ASE´s expected revenues and market share

Year	2022	2023	2024	2025	2026	2027	Total
New CSP Plants	42	49	57	66	75	84	373
New Linear Focus Technology CSP	21	25	29	33	38	42	187
New plants - as per the current technology	4	5	5	6	7	8	36
Market share (new linear focus tech. plants)	19%	19%	19%	19%	19%	19%	19%
New plants with SOLWATT solutions	5	6	7	8	9	10	44
Market share with SOLWATT solutions	24%	24%	24%	24%	24%	24%	24%
Turnover(M€)	108	126	147	170	193	216	959
Turnover with SOLWATT solutions (M€)	135	158	183	212	241	270	1199
Difference (M€)	27	32	37	42	48	54	240

ASE production capacity is currently of 75000 receivers per year but, depending on the potential market growth, it can be increased to match the sales requirements. With the development to be achieved by the project, we can assume that it will be possible, rather than to increase the receiver prices, to increase our market share with an increase of the yearly revenue of an additional 5%. We can consider an increased market of 60000 (year 2022)-120000 (year 2027) tubes per year.

The improved skills in the design of storage control system will permit a potential increase of 10% of the current engineering services of ASE.

2.2.3. Management of intellectual property

As was already mentioned, SOLWATT proposes to develop integrated solution, based on different innovative technologies/materials. Their unique combination and synergies will lead to an unmatched improvement in the field of CSP technologies and processes. The project aims to elevate individual technologies from TRL 5-6 to TRL 7-8. Through the SOLWATT project, prototypes and concepts of selected technologies developed during previous research projects will be upscaled. Afterwards, individual technologies will be manufactured and installed in the testing site for validation under real conditions. Beyond the end of the project, additional investments will be needed to make the final push to the market of several developed technologies. Those investments are expected to be found in private sector. Nevertheless, several results that will be gained during the project are expected to be ready for commercialization just after the end of the SOLWATT project.

Within the project, **a dedicated prospective manager from TSK** with the support of the WP7 (dissemination and exploitation) participants will periodically (yearly at least) provide a review of the relevant IPR developments (i.e. recently published patent application, granted patents) and will be responsible for advising the consortium about continuation of research activities, e.g. in case of changes of prior art and IP protection. Any proposed and performed tasks should be of nature allowing the consortium to fully exploit their knowledge and provide the maximum freedom to operate to the consortium members with respect to the prior art.

The preliminary analysis of relevant existing patent portfolio (prior art) shows no evidence of any blocking IPR. However, the following IPR on partial technological blocks exist and shall be considered when protecting a new approach.

TEKNIKER holds a portfolio of patents and know-how acquired in different developments related to solar thermal energy related to: i) Heat transfer fluids development (PCT_ES2012_070414); ii) Solar collectors (P201431102); iii) Smart mirror (P201631313).

BSII has a broad portfolio of patents and pending patent applications covering a range of CSP technologies, including heliostat reflectors. BSII has also has an unrestricted license to certain third-party waterless reflector cleaning technology that it has developed further to the level of long-term prototype testing.

Antisoiling coating for reflectors is protected by **TEKNIKER** and **RIOGLASS** by "Coated glass for solar reflectors WO 2016177709 A1"). The low-cost soiling sensor concept is protected by **TEKNIKER** patent applications PCT/ES2015/070308 and P201430605. The ultrasonic device for cleaning reflectors is protected by **TEKNIKER** (16382293.5-1703 and P201730981).

For the existing project, **RIOGLASS** will make use of the patent application CT/EP2016/059858. International Report of Patentability released by the International Preliminary Examining Authority (PCT) is positive in terms of novelty, inventive step and industrial applicability, not disclosing any document available in the SoA that could affect the freedom to operate of RIO coated reflectors.

CEA holds a portfolio of more than 30 patents and a huge know-how acquired with its industrials partners for the design and development of CSP plants (Alsolen Company) with Linear Fresnel Collector and thermal storage (TES) capabilities. In addition, patents related to control optimization of thermal systems from monitored data is also in the scope of CEA's portfolio thanks to modelling and simulation softwares.

CIEMAT holds a portfolio of a huge know-how acquired in thermal water treatment plant, with the technology of multiple effect evaporation: i) Thermal characterization of a pilot multiple effect evaporation (MEE) plant; ii) Modelling and simulation of MEE plants (with and without steam ejectors); iii) Modelling and simulation of concentrating solar powered cogeneration plants (water and electricity).

INDETEC has developed tailored made solutions for water recovery and effluent minimization for wastewater from different industrial sources (i.e. biodiesel production, vegetable oil refining, olive pickling or wastewater from a Combined Cycle Gas Turbine power plant and landfill leachate) based on Multiple Effect Evaporation (MEE). This technology has also been implemented for other industrial applications such as concentration of grape and orange juice and natural extracts. As a result, several patents have been developed in the field of MEE (ES 2110912A1, ES2259260B1, ES2078879A1).

In conclusion, the SOLWATT concept and the proposed work plan can already count on extensive number of patents already filed by the consortium members (as consortium has access rights to these patents).

A small portion of the budget is reserved for potential IPR protection. In case of need, this amount will be used for services of experienced patent attorneys in the field. If those services will not be needed, they will be used according to agreements between General Assembly and EC project officer.

Methodology of protection of all intangible project outcomes will be addressed in the Consortium Agreement (CA), which will be signed by all parties, before the project starts. The standard EU IPR conditions will be used. Below is an **extract of the most important ones.**

IP Ownership

- It is understood that each partner is and remains the sole owner of its intellectual and industrial property rights over its background. The beneficiaries must identify and agree (in writing) on the background in the appendix of the CA.
- The result is owned by the beneficiary that generated it. If it is not possible to determine exactly the ownership of that result, i.e. it is not possible to (i) establish the respective contribution of each beneficiary, or to (ii) separate them for the purpose of applying for, obtaining or maintaining their protection, the joint owners must agree (in writing) on the allocation and terms of exercise of their joint ownership ('joint ownership agreement'), to ensure compliance with their obligations under the H2020 model grant agreement (MGA). The establishment of a joint ownership agreement between the co-owning parties must be ensured prior to any industrial/commercial application.

Access Rights to Background and Results IP

- Each project partner shall make available its background and results, on a royalty-free basis, to other project partners to the extent that such background and results is needed for the execution of their work within SOLWATT, unless the beneficiary informed the other beneficiaries that access to its background is subject to legal restrictions or limits.
- Background and results shall be made available to the other project partners for exploitation purposes (if it is needed to use their own results) on fair and reasonable conditions.
- If possibilities to commercialize or exploit the results arise, all the partners of whom intellectual property is concerned will be contacted and will be involved in the negotiations.

The guiding principle for intellectual property ownership is that it will belong to the consortium partner(s) responsible for the invention and the relevant parties will have accessed to the IP during the term of the project for the completion of the purpose. Already, the consortium partners have reached a preliminary agreement with respect to the project's expected foreground knowledge. The following table of expected foreground knowledge reflects this preliminary agreement.

Table 19 shows the expected foreground knowledge which would be generated during the project by all partners. Joint IP is expected to be developed among partners.

Table 19: Expected Foreground Knowledge (exploitable results)

Expected Foreground Knowledge	Exploitation strategy
TSK	
Engineering, procurement and construction, operation and maintenance of the CSP plants	New solutions available in portfolio of products offered to the costumers, which will result in reduction of prices in future bids
CEA	
Design and monitoring of a thermocline pond storage dedicated to delayed heat exhaust for CSP plants.	publication in scientific literature, new service in the field of CSP can be later extended to other application field in term of electricity production
Simulation and optimized control of a cold storage dedicated to heat exhaust.	The methodology service can be extended to the control optimization of any other thermal system including thermal storage.
DLR	
Operation and maintenance optimizer software package including a module that adapts and integrates soiling rate forecasts for CSP solar fields, and includes water-related aspects within the optimization.	Expansion of offered services as industry-oriented research and developing institute, which will attract new customers and strengthen DLR's ties to industry. The DLR technology marketing will assess the potential of the O&M Optimizer and promote its commercialization either for DLR by licenses or for establishing of a related spin-off company.
New, improved yield analysis calculations based on soiling rate map and cleaning cost estimations	The development will strengthen DLRs position as leading experts in CSP technology and increase the ties to industry Efforts will be made to standardize the integration of soiling data into yield analysis that can serve as a basis for licensing contracts and spin-off companies to emerge.
CIE	
Optimal operating conditions and control strategies of MEE plant	Scientific papers will be prepared with the research works, which will be sent to international journals related to the topics (Solar Energy, Applied Energy, Applied Thermal Engineering, Desalination and Water Treatment, Solar Energy Materials and Solar Cells, etc). Also, researchers will attend international conferences and workshops to presents their research works.
Simulator with graphical interface that includes the model of the water recovery system	
Accelerated aging tests properly reproducing real outdoor conditions, including operating environment.	

CU	
Full-scale aerodynamically shaped porous dust barriers	Potential for licensing to UK company "Dustscan"
Soiling data of solar collecting mirrors and the impact on reflectance	Scientific papers will be prepared for high impact-factor journals related to the topics. Also, academic staff will attend international conferences and workshops to present their project results.
Data collection of socio-economic and environmental impact on local communities	
Benefits in terms of annual generated output and water use with and without the cTES	
Benefits of using a cTES technology for different types of CSP technologies	
TEK	
Non-immersion ultrasonic cleaning systems for mirror cleaning	Based on co-titular of the patent in many countries and using the knowhow for other sectors such as building, roads, pavements, etc…
Integrated Sensor-in-Mirror and the integration method for production plants	License the solution (Sensor-in-Mirror) and engineering projects for modifying both, technology and production methods, to other sectors such as building infrastructures.
RIO	
Assessment of durability and efficiency of the coated mirror vs conventional mirror to support bankability of new projects.	Based on IP protection in many countries and using RIO own and existing sales network.
ASE	
Assessment of the efficiency of the receivers coated with new antisoiling coating to support bankability of new projects	Based on possible IP protection in many countries and using ASE existing sales network.
Enhanced engineering services through the development of know-how in design and control of Storage system.	
IND	
Knowledge generated in coupling MEE to CSP plants where the available heat is not steady	Installation of MEE for water recovery altogether with TSK in their current and future CSP power plants
FNK	
Cleaning truck	New solutions available in portfolio of products offered to the costumers using FNK existing sales network.
BSC	
Operational regional/global dust forecasting	If the BSC operational dust forecasting is considering inside the soiling forecasting tool (managed by DLR), the BSC will receive a proportional economic compensation (i.e. royalty) to get access to the daily BSC operational dust forecast
Soiling risk map	Beyond the project, each petition of this dataset will be evaluated individually.
BSII	
Autonomous waterless cleaning system technologies involving motorized approaches	Exploitation strategy will be the introduction of the technology into "BSII" projects, i.e., projects where BSII either provides or specifies the solar field technologies to be implemented.

2.2.4. Dissemination and Communication strategy (incl. data management)

Partner **AMIRES (Lenka Bajarová, WP7 leader)** will be responsible for dissemination and communication. She will monitor the latest achievements of the project and will suggest the best dissemination channels for scientific and industrial awareness.

The dissemination of the project's achievements should never jeopardize the potential protection of generated intellectual property (e.g. patent, product design) and further industrial application. Therefore, before any dissemination activity (publication, presentation, etc.) **strict rules of prior notice to all partners will be applied, according to EC guidelines**. Partners will have the possibility to refuse dissemination of their own know-how (background or results) when it could potentially harm the partner's interests. The Dissemination Manager in cooperation with the Exploitation Manager will follow all the above described approval processes and will act as an internal executive approval body for any dissemination action organized by different partners. A **Dissemination and Communication Strategy** document will be developed at the beginning of the project and will be regularly updated so that all possible dissemination and communication routes are used during the whole course of the project.

All project outcomes will acknowledge the support of the European Commission as it is requested by the Article 29 (Dissemination of Results, Open Access, Visibility of EU Funding) and Article 38 (Promoting the Action, Visibility of EU Funding) of the H2020 MGA and follow its principles. The proper dissemination details (e.g. time schedule for prior notice and partner's approval) will be covered by signed Consortium Agreement before the project's start.

Partners agree to generate peer-reviewed articles resulting from projects to an institutional or subject-based repository, and to make their best efforts to ensure open access to these articles at the latest on publication or within six months after publication. **The open access to scientific publications will be ensured in line with Article 29.2 H2020 MGA on Open access to scientific publication and "green" or "gold" model would be used depending on the strategy of consortium with regard to the specific peer-reviewed scientific publication.**

<u>**Data Management Plan**</u>

This proposal takes part in the pilot on Open Research Data therefore the SOLWATT partners will make their effort to make the data accessible to the general public for verification, further re-use and preservation. However, it is necessary to take into account that some of the data will be part of the IPR of individual partners and some will be sensitive data, therefore will be protected and not freely accessible. **Data Management Plan (DMP)** document will be developed as a deliverable in line with the EC's Guidelines on Data Management in Horizon 2020 within the first six months of the project. The aim of the Data Management Plan is to describe the data management life cycle for all data sets that will be collected, processed or generated by the SOLWATT project. It will specify what data will be generated and what methodology and standards will be followed, whether and how the data will be exploited or made accessible for verification and re-use, and how will be curated and preserved. In case some research data will not be made openly accessible the DMP will provide an explanation for it. The position of the Project knowledge / data manager will be created. It will be Lenka Bajarová (AMIRES).

<u>**Communication activities**</u>

The content of the communication will be in line with Article 38 (Promoting the Action, Visibility of EU Funding) of the H2020 MGA and will not jeopardize either confidentiality obligations stated in Article 36 or the security obligations in Article 37 of the Grant Agreement. Therefore, the same rules **of prior notice to all partners will be applied** as for the dissemination activities, however, considering the character of the information and the communication channel.

Various communication tools will be used and will be tailored to the needs of various stakeholders and audiences. The target audiences will include **scientific community, industry, policy makers, standardization bodies, students, public and the media**. The identified channels and tools for the communication (and dissemination) are the following (also depicted above).

- **Project webpage:** A user friendly website with easy navigation will be set up by the end of month 4 for both public and consortium members' access. The website will be actively maintained during the lifespan of the project. It will give different audiences access to project's facts and figures, published periodic activity reports, a summary page on progress and achievements and also to downloadable publishable presentations, leaflets and .pdf files of journal publications as well as to press releases and other media outputs. Links to project's potential new social media tools (e.g. Twitter, LinkedIn) would be visibly placed on the website. General information about the state-of-the-art of the project's related fields (Concentrated Solar Power, energy efficiency, renewables, etc.) could be found there too and project's contribution to tackling renewable energy challenges. It will be globally linked to other relevant websites including other EU funded projects in the domain and EC websites. A private area will be used to provide a centralized access to all materials generated by the project.

- **Frequently Asked Questions (FAQ):** On the SOLWATT webpage, there will be a frequently asked question board, where visitors can post public questions, whose reply will be made permanently available on the FAQ page.
- **Project folders and leaflets** for large non-specialized scientific community and stakeholders will be created and distributed to partner's institutions, EC and on dissemination events. If possible, infographics will be used for better visualization of the information and project's objectives.
- **Testing site visit** will be prepared for journalists and CSP experts in order to give them the latest information on solutions developed in the SOLWATT project and allowing them to inform the general public on the possibilities of CSP plants improvements. At the end of the project the **final SOLWATT event** will be held in La Africana testing site.
- **Technology news servers**: Project will comply with knowledge sharing arrangement and will actively contribute to CORDIS - periodically, each time after the latest achievements, at least at the beginning and at the end of the project.
- **Presentation at conferences, symposia, meetings** (e.g. SmartGrids ETP conferences / workshops, ZEP conference / workshops, ESTELA Conference & Exhibition, SolarPACES conferences, Grid+ events, Industrial Technologies conference). Moreover, policy-structuring meeting will be proactively attended, e.g. DG RTD clustering and brokerage meetings in the LCE domain. Cooperation with the different clustering activities will be introduced.
- **E-mail newsletter** will be distributed periodically to identified stakeholders.
- Tools like **Facebook, LinkedIn, Wikipedia, YouTube, Twitter** etc. will be considered to address the potential impact especially to the younger generation and to have the feedback from various audiences.
- **Video spot:** A short video spot about the project will be made and distributed through the project's communication channels. Video as being a different tool might attract another audience and at the same time support the already established communication and dissemination routes.
- **Press conference and press releases:** At least one press conference will be organized during the project's lifespan to inform the media about the project's content, intentions and/or the achievements. Project beneficiaries could be interviewed for TV/print media outcomes. Press releases will be written and circulated to relevant media list, at least at the beginning, in the middle and at the end of the project. English version could be translated in other languages (Spanish, French, German) to have a broader and local impact.

Communication activities will be monitored and followed-up to maximize their impact. Project Officer will be regularly informed about the communication outcomes and based on her/his decision EC communication channels could be used too. Table 20 presents a provisional Dissemination Plan.

Table 20. SOLWATT Dissemination Plan

Target groups	Indicators for measuring the effectiveness of the approach	Min target value	Feedbacks expected
Research community *CSP, renewable energy researchers & industries*	Publications at international conferences	10	-Disseminate the latest results towards CSP, renewable energy actors -Designing new collaborative research proposals.
	Publications in international journals	7	
	Participation with presentation of results at international events with industry	3	
	Workshops	1	
General public *Public and Private*	Non-scientific publications (articles, press releases, videos); Participation in national events promoting new solutions for renewable energy	10	-Attract attention and generate interests for an optimal exploitation of the project's results.
	Flyers/Poster distributed at conferences, workshops, etc.	1000	
	Project Website (M4): Number of Visits Public deliverables will be made available: N° of downloads	3000 200	
Customers *CSP owners and managers, CSP developers and professionals, Local authorities*	Customer request for other projects deployment	50	-Discussions at our booth on industrial and commercial fairs -Request for specific features to address specific integration needs -Direct contact following press coverage and communication
	Interest of industrial customers on Technology Exploitation via partnerships and/or licence agreements	10	
Standards & regulation bodies	Standardisation groups SOLWATT will interact with	2	-Promoting the SOLWATT results and making sure that they can be integrated and contribute in future standards
	Participation in EU commission's consultation & other worldwide regulatory in the field of interest	1	
Education *Students (PhD Master students)*	Integration of modules with project results in regular courses; organisation of workshops, test sites visits	2	-Education of future technology users
Final SOLWATT event	Presentation & inauguration of the installed demonstrator: A large panel of invitees will be addressed, including EU representatives, several companies involved in the field of CSP & renewable energy, smart grids, local authorities from several European regions, policy makers, CSP associations active in Europe, etc.	1	- Better knowledge of the potential of the technology
Visits of the Testing site	During the last year of the project, visits of the SOLWATT testing sites will be organised by the project partners	2	Education & raising awareness of potential customers.

2.2.5. Contribution to standardization

A strategic development and use of standardization and effective promotion of relevant standards worldwide can help European industry as leader in global markets. SOLWATT partners are actively involved in standardization bodies and they will evolve their effort and will assure that standards that make energy management improvements streamlined are established.

CIE, DLR and RIO are members of the Spanish AENOR committee (AENOR/CTN 206), which is the most advanced and is currently in the process of publishing several national standards for CSP components.

CIE and DLR also participate in international committee under the framework of SolarPACES IEA organization, advances achieved in this project concerning on-site soiling measurements will be transferred to that committee to assure a synchronized approach with other international institutions. DLR also participates in a national standardization group on the topic of artificial soiling methods where the results from the soiling modelling activities integrated as to specify those weather parameters that dominate dust deposition. CU will take the outputs of the advances in soiling measurements achieved during this project for discussion with the UK National Physical Laboratory (NPL) which is the keeper of UK standards.

3. IMPLEMENTATION

3.1. Work plan – Work Packages, Deliverables and Milestones

3.1.1. Pert diagram + work plan description

The structure of the work plan is divided into eight work packages (WPs), each targeting different objectives, tasks and expected results. **WP1** of the SOLWATT project is focused on Socio-economic and environmental aspects of the CSP including also practice-oriented training activities. **WP2** will deal with the improvement of the O&M Optimizer (by soiling forecast, cleaning scheduling, cooling system and other water usage effects) and implementation of the suitable optimization algorithm and cost-function for water use effects. Two work packages will deal with the reduction in the water consumption in different parts of the CSP processes - one for the improvement of cleaning means and methods related to solar field components **(WP3)** and one for enhancement of cooling technologies efficiency **(WP4) -** and their common objective is to upscale previously developed technologies and prepare them for the installation in the testing site. Another work package **(WP5)** will deal with dimensioning and engineering of the water recovery system. Within **WP6,** all proposed technologies will be deployed and validated under the real conditions at testing sites. The technical conclusions obtained from WP6, combined with the economic, social and environmental analysis performed in WP1, will be compiled in a synthesis of the whole SOLWATT toolbox. Last two WP´s **(WP7, WP8)** runs in parallel with the whole project covering dissemination and exploitation as well as project management activities.

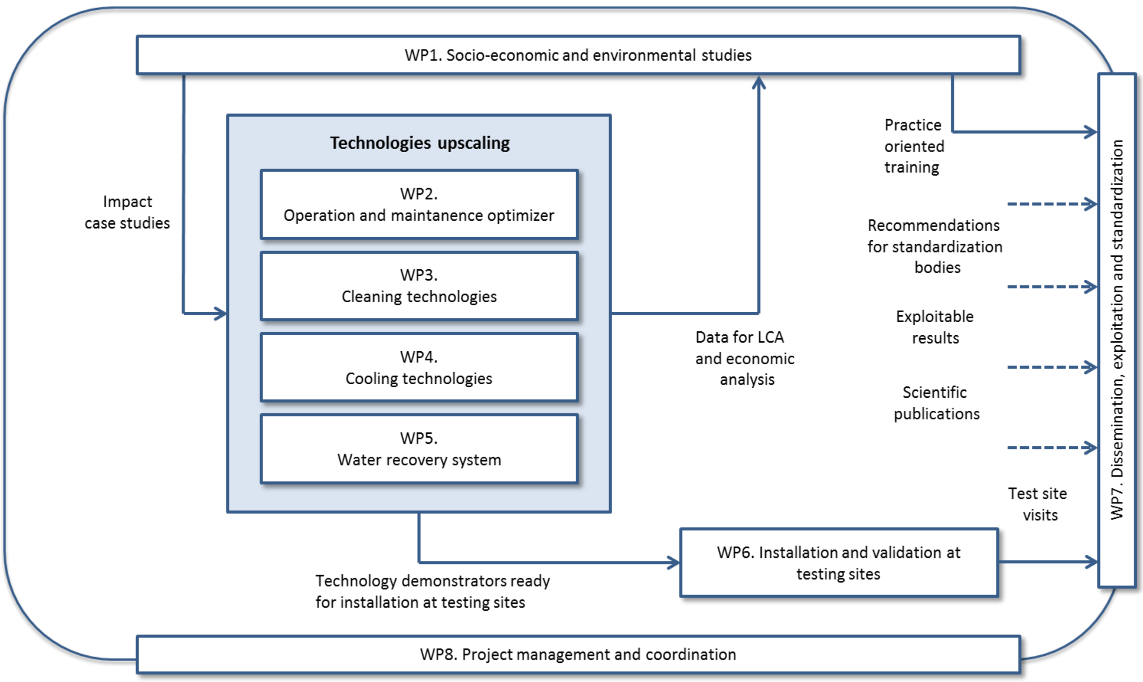


Figure 25. SOLWATT pert chart

3.1.2. Gantt chart

	SOLWATT			Year 1												Year 2												Year 3												Year 4											
		WPL, TL	Task participants	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
WP1	**Socio-economic and environmental studies**	**CU**																			M						M															M									
T1.1	Developing a framework to analyse socio-economic and livelihood aspects of CSP plants	CU	all partners												D																																				
T1.2	Community acceptability and livelihood impact: case studies	CU	all partners																																										D						
T1.3	Economic modelling of market solutions for water reduction	TSK	CU, DLR, TEK, CEA, CIE																																													D			
T1.4	Environmental impact analysis and key component LCA	CU	DLR, TEK, CEA, CIE																																										D						
T1.5	Practice oriented training and knowledge transfer	CIE	CU, DLR, TEK, CEA, TSK																																													D			
WP2	**Operation and maintenance optimizer**	**DLR**																																			M		M												
T2.1	Extension of Dispatch Optimizer to O&M Optimizer	DLR	TSK, CIE, CU, CEA						D																														D												
T2.2	Integration of extended optimizer to FoSyS plant forecasting and advisory system	TSK	DLR												D																								D												
T2.3	Application of extended optimizer for technology potential identification	DLR	TSK, CI, CEA, CIE																																																D
T2.4	Implementation of a soiling rate forecasting product	DLR	BSC, CU																																				D												
T2.5	Soiling rate map	BSC	DLR																																										D						
WP3	**Cleaning technologies**	**TEK**																			M						M																								
T3.1	Soiling sensor optimization, upscaling and integration	TEK	RIO, TSK, CIE						D												D																														
T3.2	Ultrasonic cleaner upscaling and integration in a moving devices	TEK	FNK, TSK						D																		D																								
T3.3	Heliostat integral cleaning device	BSII	CIE, DLR																																																
T3.4	Technologies preventing soiling	TEK	RIO, CU, ASE, CIE, DLR, TSK												D												D							D																	
WP4	**Cooling technologies**	**CEA**																							M								M																		
T4.1	Storage pre-sizing and design	CU	CEA, ASE, BSII												D																																				
T4.2	cTES Engineering	ASE	CEA, CU, BSII, TSK																						D																										
T4.3	Development of storage control for the demonstration	CEA	CU, BSII																						D								D																		
T4.4	cTES construction	BSII	CU, CEA																														D																		
T4.5	Results analysis, Model validation and Simulation assessments for benefits prediction	CU	CEA																																										D						D
WP5	**Water recovery technologies**	**CIE**																									M												M						M						
T5.1	Water recovery system dimensioning and engineering	IND	CIE, TSK												D																																				
T5.2	Water recovery system manufacturing	TSK	IND, CIE, CU																								D																								
T5.3	Modelling, optimization and control	CIE	IND, TSK, CU																														D						D						D						
WP6	**Installation and validation at testing sites**	**TSK**													M																	M														M					
T6.1	Experimental campaign design	CIE	all partners																		D																														
T6.2	Installation at the testing sites	TSK																																																	
T6.2.1	Installation of FoSyS tool with O&M Optimizer in power plant	TSK	DLR																																										D						
T6.2.2	Installation of soiling sensors and smart mirrors	TEK	DLR, CIE, TSK																						D																										
T6.2.3	Installation of dust barriers	CU	TSK, CIE																		D																														
T6.2.4	Installation of mirrors and receivers with antisoiling coatings	RIO	ASE, TEK TSK CIE																													D																			
T6.2.5	Installation of the thermal storage system for cooling	CEA	CU, TSK																													D																			
T6.2.6	Installation of the water recovery system	IND	CIE, CU, TSK																													D																			
T6.3	On-site validation	TSK	all partners																																											D					
T6.4	Results assessment	CIE	all partners																																																D
WP7	**Dissemination, exploitation and standardization**	**AMI**																																																	M
T7.1	Dissemination and public events	AMI	all partners				D																																D												D
T7.2	Exploitation strategy development	TSK	all partners																								D												D												D
T7.3	Business model development	TSK	all partners																																																D
T7.4	Contribution to standardization activities	CIE	DLR, CI, TEK, RIO, ASE																																																D
WP8	**Project management and coordination**	**TSK**																									M																								M
T8.1	General Assembly coordination	TSK	AMI	D												D												D												D											
T8.2	Day-to-day management via WPLs, quality assurance	TSK	AMI, WP leaders														D												D												D										D

3.1.3. Socio-economic and Environmental studies (WP1)

Work package N°	1	**Start date:**	M1	**Work package leader:**	Chris Sansom (CU)							
Work package title	*Socio-economic and Environmental studies*											
Participant short name	**TSK**	**CEA**	**DLR**	**CIE**	**CU**	**TEK**	**RIO**	**ASE**	**IND**	**FEN**	**BSC**	**BSII**	**AMI**
Person-months	4	1	1	25	61	0	0	0	0	0	0	0	0

Objectives:

- To establish the socio-economic consequences of locating CSP plants in a range of locations
- To forecast the environmental impact on communities over the operating period (25 years)
- To devise and deliver effective knowledge transfer and practice-oriented training to stakeholders
- To provide technical evaluation and cost estimation of market solutions for water reduction compared to conventional routes

Description of work

T1.1: Developing a framework to analyse socio-economic and livelihood aspects of CSP plants (CU, all partners)

This task aims to investigate the impact of the construction, O&M, and decommissioning of a CSP plant on different stakeholders such as communities, policy makers and utilities with a specific focus on the local economy and environment. This task is a top-level systems overview and feeds into T1.2 and T1.3.

Building on existing livelihood and environmental impact assessment frameworks, this task will undertake an extensive literature review of the effect of installing large scale plants on all stakeholders in terms of human, natural, physical, social and financial capital. Given early stages in the operations of CSP plants, the aim will be to draw lessons from other industrial experiences, for example, in mining, chemical processing, and forestry as well as analyzing the relevance of other analytical frameworks around vulnerability and resilience of communities, water resources and ecosystem services in a changing climate. The review will cover both academic and practitioner sources. There is much highly relevant expertise to be found in the many Institutes with which the project partners are connected, such as ENIT (Tunisia), MASEN (Morocco), CDER (Algeria), CSERS (Libya), MASDAR (Abu Dhabi), and ASRT (Egypt).

It is immediately apparent that simply "engaging" with the local community is no recommendation that a major project such as the siting of a CSP plant, will be accepted by those whose lives it impinges upon. The task will identify underlying constraints and barriers (whether cultural, social, economic, gender-related or ethical) to implementation.

T1.2: Community acceptability and livelihood impact: case studies (CU, all partners)

This task investigates in detail the impact of a CSP plant on local communities using an empirical bottom-up approach. Building on our extensive networks via our project partners and outputs of T1.1, five global locations that are representative of the communities facing a particular type of challenge (the principal differentiation being by water shortage, water stress, or water crisis) will be selected. Initially, analysis of the importance of these issues within the wider context of the national economy and regional/ local policy framework via semi-structured interviews (N=10-15) for each case study area will be performed. These interviews will target utilities, policy makers and community leaders. They will be guided via a questionnaire framework and carried out either by phone or face-to-face, hence creating opportunities to seek clarification and more in-depth information. They will be recorded and translated to English.

This high-level analysis will be complemented by direct interactions with local communities via two focus groups (with around 5-10 participants) in each case study area with a view to determining the impacts of CSP plants on socio-economic development and livelihood of local communities. In organizing these workshops, local culture and traditions in terms of having mixed gender groups will be taken into account, even though ideally, we would like to have a mix of gender, income and age groups. In particular, their perceptions of the costs and benefits of CSP plants, their impacts on the availability of water resources, any changes impinged upon their daily lives (for better or worse) will be investigated. In doing this, the aim will be to build on insights from energy studies literature on lack of public trust towards utilities, importance of place attachment, community ownership and community benefits on public acceptability of renewable energy projects. In uncovering these issues, focus will be on longitudinal impacts.

All interviews and focus groups data will be analysed using thematic coding.

The output of this task is a report on the socio-economic impact of CSP plants in arid locations.

T1.3: Economic modelling of market solutions for water reduction (TSK, CU, DLR, TEK, CEA, CIE)
As an input to this task, the existing Cranfield model developed in MATLAB and cost data from partners including open literature data will be used as an input in the economic evaluation of water reduction technologies for CSP. The parameters for the comparative assessment (value of water) of these technologies with respect to other usages such as agricultural, industrial, domestic, and general drinking usage e.g. water extraction and consumption rates in each option and value of water, will be set according to T1.1 and T1.2, which is based on the results of the stakeholders' engagement workshops.

Techno-economic assessments will be investigated for the selected cases investigated in WP3-5 and indexes such as cost of water (€/m^3 water usage), CAPEX and OPEX, for the re-value of water at the end of each process, will be calculated, for each of the available aforementioned technologies with the same economic and operational boundary conditions.

T1.4: Environmental impact analysis and key component LCA (CU, DLR, TEK, CEA, CIE)
This task addresses the environmental impact of the siting of a CSP plant throughout its' entire life cycle – this includes the effects on the physical environment (fauna and flora) but also social, cultural and health impacts. The review carried out in T1.1 will have highlighted many of the issues relevant to this particular work. In addition, a necessary task will be the assessment of the environment "as is" (i.e. prior to installation of the plant) using the five case study locations from T1.2. The impact over the expected lifetime of the plant will then be assessed. This will consider projections of climate change and demographic changes (brought about through the siting of the plant) in the different localities. A significant element of this task will concern water usage.

A life cycle analysis (LCA) will focus on a selection of key components of the technological market solutions to be installed and validated in WP6, in accordance with ISO 14040-14044.

T1.5: Practice oriented training and knowledge transfer (CIE, DLR, CU, TEK, CEA, TSK)
This task aims to raise awareness amongst the CSP community regarding water related issues and the technological solutions that can be implemented to reduce the water consumption. In parallel, awareness of the impact of the solutions on local communities and their infrastructure will also be explained. These goals will be achieved by devising and delivering a set of educational, training, and interactive events, with the following main elements:

- One distance learning package (M12-M45) devoted to the impact of CSP plants on local communities and their infrastructure. This blended learning package will be created and recorded by CU (with the contribution from the partners involved in this task) and will be available on-line. It is expected that participants will provide feedback to the CU teaching team which will involve some valuable information for the preparation of the case studies of T1.2.
- Three knowledge exchange and transfer courses devoted to plant designers, engineers, researchers and post-graduate students (M12-M30). Topics will include the selection and management of technologies for solar field mirror cleaning, plant cooling, and water recovery. The courses will be designed, organized, delivered, and evaluated by CIEMAT (with contributions from the other partners involved in this task) and will take place at the PSA (Almeria, Spain). Every course will last for one week and will also include a visit to the La Africana CSP plant in Cordoba, Spain.
- Two practice oriented training courses devoted to O&M technicians (M31-M45). These sessions will have a high practical content for experiential learning. Topics will include the methods, techniques and tools to carry out tasks related to the technological solutions being developed on this project to reduce water consumption and lower costs. The courses will be designed, organized, delivered, and evaluated by CIEMAT (with the contribution from the partners involved in this task) and will take place at the PSA (Almeria, Spain). Every course will last for one week and will also include a visit to the La Africana CSP plant in Cordoba, Spain.

This activity will provide a unique opportunity for participants (about 20 per course) to visit the PSA site, which is biggest research infrastructure in the world for CSP technologies. In particular, practical activities at the PSA will provide access to the real-scale facilities as part of the practice oriented training courses. Additionally, at least one recognized internationally renowned expert will be invited to give a lecture in each of the five on-site courses.

The educational courses will be planned in detail during the first year of the project (M1-M12).

Del. No.	Leader	Deliverable description	Type	Diss. level	Delivery date
D1.1.1	**CU**	Systems study of CSP-related socio-economic and livelihood issues	R	PU	M12
D1.2.1	**CU**	Case studies of social and livelihood issues (consequences of CSP plants and water usage)	R	CO	M42
D1.3.1	**TSK**	Economic assessment for water reduction	R	CO	M45
D1.4.1	**CU**	Environmental impact of CSP plants	R	CO	M42
D1.5.1	**CIE**	Summary report of knowledge transfer activities	R	PU	M45

Mil. No.	Milestones list and expected results	Means of verification	Date
MS1.1	Locations for case-studies selected	Five global locations that are representative of the communities facing a particular type of challenge selected	M18
MS1.2	Economic input data gathered	Economic data received from stakeholder	M24
MS1.3	Knowledge Transfer and practice-oriented training completed	Five stakeholder courses and one distance learning package delivered	M39

3.1.4. Operation and maintenance optimizer (WP2)

Work package N°	2	**Start date:**	M1	**Work package leader:**	Tobias Hirsch (DLR)								
Work package title	*Operation and maintenance optimizer*												
Participant short name	**TSK**	**CEA**	**DLR**	**CIE**	**CU**	**TEK**	**RIO**	**ASE**	**IND**	**FEN**	**BSC**	**BSII**	**AMI**
Person-months	24	6	80	4	9	0	0	0	0	0	48	0	0

Objectives:

- Extend existing non-linear and stochastic Dispatch Optimizer to overall “O&M Optimizer” (by soiling forecast, cleaning scheduling, cooling system and other water usage effects)
- Implement an operational Soiling Forecasting system for specific locations as stand-alone product and as input to O&M Optimizer
- Identify and include relevant transient water usage constraints to O&M Optimizer
- Extend optimized operation schedule by optimal cooling system trajectory and cleaning schedule
- Identify and implement suitable optimization algorithm and cost-function for water use effects
- Integrate O&M Optimizer to TSK’s plant forecasting and advisory system FoSyS
- Promote potential of technology options from optimization studies
- Estimate the annual soiling rate over the MENA region and Europe for managing and planning that will be included in O&M optimizer

Description of work

The performance of the O&M Optimizer is promoted by various simulation runs, outlining the potential of recommended technology and operation options. Furthermore, TSK and DLR integrate the O&M Optimizer into the commercial plant forecasting system FoSyS (this WP2) and demonstrate it in the real plant (WP6).

T2.1: Extension of Dispatch Optimizer to O&M Optimizer (<u>DLR</u>, TSK, CIE, CU, CEA)

We will define a reference power plant for the project (most likely parabolic trough plant with oil similar to La Africana) together with a reference data set (e.g. sequence of DNI, soiling, temperature and other variable data) for comparing simulation and optimization runs during the whole project. We will identify important effects, interactions, models and rules that influence the overall plant performance, especially related to the water use and technology developments from the project. DLR will then outline, implement, and validate the derived algorithms for the O&M Optimizer. For the first time, we will put special emphasis on the “cost-functional” and, thereby, not only consider economic, but also water usage and socio-environmental aspects within the optimization itself.

The O&M Optimizer will use soiling forecasts and cleaning technology inputs (from T2.4, WP3, FNK and TSK) to provide cleaning schedules for the next days. The O&M Optimizer will use technological models/rules of cooling system and water recovery (by WP4, WP5, and former projects such as WASCOP), transient influences on water-related issues (e.g. blow-down behavior depending on transient plant operation, based on TSK experience) as well as socio-environmental parameters (by WP1) to provide optimal trajectories for all related subsystems, e.g. storage of the cooling system. The control systems of the subsystems (developed in WPs) will then take care of meeting the optimal trajectories from the O&M Optimizer.

The development will be performed on a two-stage basis. First, we will define all interfaces and use rough models, allowing DLR to start the extension of the O&M Optimizer. Second, when we will have derived more detailed models and rules in the various WPs, we will perform simulations to show the subsystems' characteristics and constraints. Then, a design-freeze for the derived models for the optimizer will be put in place (M32) and DLR will include the final models to provide a reliable optimization. DLR will use the O&M Optimizer to perform simulation runs with the reference data set.

T2.2: Integration of extended optimizer to FoSyS plant forecasting and advisory system (TSK, DLR)

TSK and DLR will define the required information to be exchanged, e.g. interface variables, time frames, interface type, and software environment. We will implement the corresponding interfaces to the tools (O&M Optimizer and FoSyS) and DLR will provide a black box program of the Optimizer to be used by FoSyS system. We will validate its proper performance and, especially, implement consistent evaluation and visualization to the FoSyS tool, such that future operators will be able to take full advantage of the tool. Finally, we will provide the system for demonstration to WP6.

T2.3: Application of extended optimizer for technology potential identification (DLR, TSK, CU, CEA, CIE)

The advantages (and possible drawbacks) of the O&M Optimizer and the project's technologies will be promoted by showing their potential for current and future STE plants. Emphasis will be placed on the additional value of the new and flexible technologies and their optimized combined operation by the O&M Optimizer. The reference case and two additional use cases will be considered, e.g. adapted current market conditions or a cooling system variation. Results will be critically discussed amongst the partners to evaluate the strength and weaknesses of the approaches. It will be clearly shown how much water saving and profit increase can be achieved by applying the O&M Optimizer.

T2.4: Implementation of a soiling rate forecasting product (DLR, BSC, CU)

Forecasting soiling rates requires the integration of dust forecasts into a soiling model. We will couple the MONARCH dust forecast system at TRL 9 developed and operated by BSC; and the WASCOP soiling model developed by DLR, currently at TRL 5. Both models represent the state-of-the-art and their coupling and operational implementation represents a key innovation of this proposal. The outcome of T2.4. will be the implementation of operational soiling rate forecasts 3 to 5 days ahead. In order to perform the coupling of both models, both models will exchange several parameters like particle number concentration by size, and other measured weather parameters like wind, relative humidity, temperature. Also, a coupler that will facilitate the exchange of data between the WASCOP and the MONARCH models will be developed taking into account their specific features (DLR, BSC). The resulting soiling forecast rates will be evaluated for the various forecasting horizons (up to 5 days) with existing data sets in Missour, Morocco and PSA, Spain (DLR, BSC). The results will be used to stepwise improve their accuracy (DLR, BSC). Finally, 6-hourly soiling rate forecast products will be operationally produced during one year for the specific locations considered in this project, i.e. La Africana and PSA in Spain. The data will be evaluated with the data continuously acquired during the project duration.

T2.5: Soiling rate map (BSC, DLR)

We will estimate the time-dependent soiling profiles over the MENA region and Europe. The resulting soiling rate map will be implemented in the O&M Optimizer innovation to support site selection during the planning phase but also to fully benefit from the O&M Optimizer potential by correctly dimensioning the cleaning vehicle fleet. A tool will be created to specify the number of cleaning vehicles necessary to maintain the solar field cleanliness above a given threshold throughout 95 % of the plant's lifetime (DLR). The soiling rate map over the MENA region and Europe will be based on MONARCH and WASCOP. A 5-year dust reanalysis will be first produced with MONARCH at high-spatial resolution (~10km x 10km) using assimilation of satellite products over source regions with specific observational constraints for dust. The maps of dust concentration derived from the 5-year dust reanalysis (at 3-hourly basis) will be translated to a dust soiling rate for CSP solar fields based on the coupling with the WASCOP model implemented in T2.4 (BSC, DLR). The results will be presented in the form of a soiling rate map for CSP mirrors comprising a five year history of soiling rate data for each 10x10 km^2 pixel as well as considering three different CSP plant types (tower, parabolic trough and Fresnel) (DLR, BSC). Parallel soiling rate measurements from PSA taken during the project duration at different collector types will serve to adapt the model to the different technologies (CIE, DLR). The experimental technology distinction will be supported by FEM analysis and wind tunnel experiments (CU). The methodology developed to obtain representative soiling rate maps for different CSP plant types will be tested into the operational forecasting system (T2.4).

Del. No.	Leader	Deliverable description	Type	Diss. level	Delivery date
D2.1.1	**DLR**	Relevant effects of water usage in STE plants and optimizer inputs/outputs defined	R	PU	M6
D2.1.2	**DLR**	Providing O&M Optimizer's first results for reference plant, considering water-related effects and models from other WPs	DEM	CO	M36
D2.2.1	**DLR**	Defined interface variables between O&M Optimizer and FoSys environment	R	CO	M12
D2.2.2	**TSK**	O&M Optimizer provided for demonstration in WP6	DEM	CO	M36
D2.3.1	**DLR**	Results analysis of O&M Optimizer impact on operation of reference plant	R	PU	M48
D2.4.1	**BSC**	Operational CSP soiling rate forecast with specified accuracies implemented for measurement sites	R	PU	M36
D2.5.1	**BSC**	Soiling rate map	DEM	PU	M42

Mil. No.	Milestones list and expected results	Means of verification	Date
MS2.1	O&M Optimizer works in office environment	Result change between old DO and new O&M Optimizer for reference case optimization	M34
MS2.2	O&M Optimizer integrated to FoSyS tool and ready for demonstration	FoSys tool controls inputs and outputs of O&M optimizer in software environment as in plant	M36
MS2.3	Implementation of soiling rate forecasting product for CSP solar fields	Regularly (6h) updated operational soiling rate forecasts published on BSC websites	M36

3.1.5. Cleaning technologies (WP3)

Work package N°	3	**Start date:**	M1	**Work package leader:**	Itziar Azpitarte (TEK)							
Work package title	*Cleaning technologies*											
Participant short name	**TSK**	**CEA**	**DLR**	**CIE**	**CU**	**TEK**	**RIO**	**ASE**	**IND**	**FEN**	**BSC**	**BSII**	**AMI**
Person-months	21	0	16	26	15	68	27	35	0	32	0	52	0

Objectives:
In order to reduce water consumption for cleaning the optical surfaces, three specific objectives have been defined:

- Integration of solar field status monitoring (T3.1) as the basis to make decisions on when to clean.
- Optimisation of the cleaning operations (T3.2, T3.3).
- Reduction of cleaning needs for optical surfaces, including reflectors and absorber glasses (T3.4).

Description of work
T3.1: Soiling sensor optimization, upscaling and integration (<u>TEK</u>, RIO, TSK, CIE)
The activities to be delivered within this task are aligned with the main objective of the real time solar field status monitoring in terms of soiling on reflectors.

The work to be accomplished is based on the technical achievements carried out along the WASCOP project with regard to soiling sensor development from TEK for analysing the effective soiling loss in a solar field.

The solar reflectors will be monitorized with an in-mirror sensor provided by TEK. This soiling sensor provides continuous, real–time reflector soiling measurements based on scattering measurements and has been evaluated during the WASCOP project, achieving a TRL5 (validated in CESA-CEA & CIEMAT-PSA).

The technical activity within this task will be devoted for taking the sensor one step forward, integrating it within the solar reflectors during their manufacturing process, towards obtaining a true Smart Mirror (achieving a ~TRL7 solution). Therefore, this task covers activities such as solving the sensor attachment to the mirror, minimizing the sensor total height to avoid impacting in total mirror's height, defining processes to verify and calibrate the sensorized mirror in manufacturing stages

The technical requirements for the complete integration of the sensor in the mirror will be defined (TEK, RIO) and 30 smart mirrors will be manufactured and deployed strategically in LA AFRICANA, assessing their performance for 12 months (WP6).

In addition, in a second step, the Smart Mirrors provided by TEK and RIO will be calibrated to the effective soiling loss in a solar field, i.e. the combination of the loss during reflection at the solar mirror and transmission at the absorber tubes' cover glass.

During this task, CIE will define and perform the Smart Mirror calibration strategy, which will be later validated at PSA and in a second step in La AFRICANA power plant, as described in WP6.

T3.2: Ultrasonic cleaner upscaling and integration in a moving device (TEK, FNK, TSK)

This task is focused on the upscaling of US devices, as an alternative to conventional rollers and pressurized water system.

To achieve the TRL7, based on the previous lab scale results, to parabolic trough collectors, it´s necessary to reshape the band to fits the parabolic curve and the system developed will cover a 6.284 m parabola.

The cleaning head prototype will be scaled up in design (TEK) and manufacture to adapt it to CSP mirror. This system includes all the ultrasonic elements (bands and transducers) hydraulic feeding system and support structure to adapt it to CSP mirror collectors. This new configuration will be integrated (FENIKS) in a cleaning truck where the actual configuration (conventional roller or pressured water) will be substituted by the US device. The new device will be tested in La Africana solar field for 12 months.

T3.3: Heliostat integral cleaning device (BSII, CIE, DLR)

This task is focused on scale-up and modification of a first generation of integral, waterless heliostat cleaning devices to serve in harsh desert environments. The cleaning system prototypes tested thus far were based on a gravimetric concept that used local PV-generated power only for moving the heliostat. To achieve the program goals of achieving TRL7 status, BSII will modify the previous-generation designs make improve the efficacy, reliability and manufacturability of the system. The final product will electric power generated by the heliostat's own PV panel and stored by its on-board electrical energy storage, which are currently used to power the heliostat drive motors and communications systems. Materials will be selected and tested in accordance with commercial deployment in the field. DLR and CIE will perform accelerated aging tests at the PSA to evaluate the possible degradation of the mirrors by abrasion of the different cleaning blade under analysis and to select the best one in this sense. Silvered-glass mirrors with and without anti-soiling coating will be included in the tests. After completing design and construction, final testing and qualification will be conducted by BSII at a solar site such as the 126MW Ashalim Solar Power Plant in southwestern Israel, or equivalent environment, on 10-50 heliostats for the various studies and analyses (efficiency, water saving, power consumption and material durability) for 12 months.

T3.4: Technologies preventing soiling (TEK, RIO, CU, ASE, CIE, DLR, TSK)

Within this task, three different solutions dedicated to the soiling reduction are proposed: Dust Barriers, Antisoiling coating for mirrors and Antisoiling coating for receivers.

T3.4.1 Dust barriers (CU, CIE, TSK)

In order to progress the work to TRL 7, further work using CFD and the Cranfield University wind tunnel will lead to the construction of full-height barriers of a porosity in the range 30-50% with a length of 100 m. The aerodynamically shaped barriers will be tested either as a replacement for existing fencing or as a secondary barrier, and will be located around a corner of the plant in order to maximize the exposure to wind directions that are forecast during the test. The testing of the barrier will be for a minimum of 12 months, and its effectiveness will be assessed by measuring the reflectance of nearby collector facets.

T3.4.2 Antisoiling coating or reflectors (TEK, RIO, DLR, CIE, TSK)

The work proposed in SOLWATT, is to optimize (RIO/TEK) the application method (spray-coating) and the composition to be capable of preparing real parabolic-through facets of 1700 x 1700 mm^2 as maximum.

The efficiency and durability of the coating will be validated by testing 50 real-size samples (parabolic – through facets) in long term outdoor experiments at La Africana plant under real operating conditions for at least 1 year (WP6). During the exposure period, researchers from DLR and CIEMAT will visit La Africana plant at least twice to evaluate the status of the facets. After the outdoor testing, some facets will be sent to the OPAC laboratory at the PSA to be analysed in detail by DLR and CIEMAT.

Small 150x300mm^2 mirror pieces will be produced by RIO/TEK with the same process as for the coated facets, or cut out of the entirely coated facet. The small samples will be tested under accelerated aging conditions to check their environmental stability in the OPAC laboratory at PSA. The previously gained experience in WASCOP and RAISELIFE projects will be used to initiate the standardization process of anti-soiling characterization and durability (WP7). The most representative durability tests will be selected by comparison of the accelerated degradation mechanisms with the detected degradation from real operating conditions. In addition to the reflectance measurements, the samples will be analysed microscopically after the tests in order to detect any type of coating damaging or degradation. In addition, the contact angle of a small water droplet will be measured before and after testing.

<u>T3.4.3 Antisoiling coating for receivers (ASE, DLR, CIE, TSK)</u>

Up-scaling of the deposition process from small flat samples (10x10cm^2) to long glass tubes (L=3974mm, ϕ=125mm) will be carried out in ASE factory. Small 10 x 10 cm^2 curved glass samples will be cut (ASE) from the coated glass tube prototypes. These small samples will be tested under accelerating aging conditions to check on the upscaling from the lab coating process (as performed in WASCOP). The obtained results will be compared to the lab coated samples from WASCOP (DLR). The optimized anti-soiling deposition process at the end of the up-scaling phase will be exploited to produce the receiver prototypes to be installed on the solar field.

72 receiver tubes of 4060 mm length, will be prepared. 36 of those tubes will contain the new anti-soiling coating and 36 tubes will only be coated with the standard anti-reflective coating from ASE and will be installed on two Solar Collector Assemblies at LA AFRICANA CSP plant. The efficiency of the coating will be evaluated by performing periodic transmittance measurements with a mobile spectrometer. In addition, CIEMAT will support ASE to the industrial implementation of the antisoiling coatings by assessing in their lab some tube samples produced by ASE.

In addition, to follow with the standardization process of the anti-soiling coatings characterization, the most representative durability test will be selected by comparison of the accelerated degradation mechanism, and the optimized protocols will be transferred to national and international standardization committees (WP7).

Del. No.	Leader	Deliverable description	Type	Diss. level	Delivery date
D3.1.1	**TEK**	Design for integrated soiling sensor (smart mirror concept)	R	CO	M6
D3.1.2	**TEK**	30 Smart mirrors manufactured for real scale tests	DEM	CO	M18
D3.2.1	**TEK**	Design for integrated ultrasonic cleaner	R	CO	M6
D3.2.2	**TEK**	Ultrasonic cleaning device manufactured for real scale tests	DEM	CO	M24
D3.3.1	**BSII**	Design for heliostat integrated cleaning device	R	CO	M6
D3.3.2	**BSII**	Heliostat integrated cleaning devices (10-50) manufactured for real scale tests	DEM	CO	M24
D3.4.1	**CU**	Sand Barrier candidate/pre-tested design for real scale test selected	R	PU	M12
D3.4.2	**CU**	Full-height dust barriers of a porosity in the range 30-50% with a length of 100 m manufactured for real scale tests	DEM	CO	M24
D3.4.3	**RIO**	50 real-size samples delivered through optimized manufacturing process for coated reflectors of 1700 x 1700 mm^2 as maximum	DEM	CO	M24
D3.4.4	**ASE**	72 receiver tubes of 4060 mm length, will be prepared (36 of those tubes will contain the new anti-soiling	DEM	CO	M24

		coating and 36 tubes will only be coated with the standard anti-reflective coating			
D3.4.5	**CIE**	Results of the accelerated aging of the anti-soiling coatings for reflectors	R	CO	M31
D3.4.6	**DLR**	Results of the accelerated aging of the anti-soiling coatings for receivers	R	CO	M31

Mil. No.	**Milestones list and expected results**	**Means of verification**	**Date**
MS3.1	Innovative smart mirror ready for WP6	Smart mirrors manufactured and shipped to La Africana	M18
MS3.2	Innovative novel ultrasonic cleaning device ready for the validation in WP6	Ultrasonic cleaning device upscaled and integrated in cleaning truck	M24
MS3.3	Reflectors and receivers with anti-soiling coating ready to be installed for WP6	Real size samples manufactured and shipped to La Africana	M24
MS3.4	Full-scale dust barriers available	Real size samples manufactured and shipped to La Africana	M24

3.1.6. Cooling technologies (WP4)

Work package N°	4	**Start date:**	M1	**Work package leader:**	Delphine Bourdon (CEA)							
Work package title	*Cooling technologies*												
Participant short name	**TSK**	**CEA**	**DLR**	**CIE**	**CU**	**TEK**	**RIO**	**ASE**	**IND**	**FEN**	**BSC**	**BSII**	**AMI**
Person-months	1	61	0	0	36	0	0	36	0	0	0	6	0

Objectives:

- Design, sizing and realization of the cold Thermal Energy Storage (cTES) for the test site at "La Africana" plant. This cold storage will be realized as water pond thermocline, including if necessary additional breakthrough components as membranes.
- Development through two-steps approach of an optimum control strategy for the cold heat storage (for the wet cooled demonstration plant and for dry cooled ones system located in an arid desert environment).
- Performance assessment by simulated prediction:
  - For dry and wet cooled plants,
  - For several CSP plant technologies, including solar towers, parabolic trough and Linear Fresnel,
  - For several potential plant locations like MENA regions.

Description of work

T4.1 Storage pre-sizing and design (<u>CU</u>, CEA, ASE, BSII)

With a typical 50MWe plant requiring a circulation of 2.5 tonnes of cooling water per second, the storage capacity, considering heat recover for the full daily heat load from the power block, would require a pond of about 90,000 m^3 (about 100m x100m x 9m), which is the theoretical limit size to be considered. To optimize both the cTES CAPEX, plant production efficiency and water consumption, only a fraction of the power block heat will be recovered and stored for delayed exhaust within a range to be determined, depending on plant operating parameters and location.

CU will lead the task, with support from CEA, ASE and BSII, of pre-designing and pre-sizing the cTES for the demonstration plant employing wet cooling towers for power block cooling. The CU team will use the tools developed under H2020-WASCOP to check the overall impact of the scheme at the demonstration plant:

- Using TMY data for the demonstration location and two alternative locations, the plant generated output and water consumption will be calculated for the plant with and without the cold heat storage taking into consideration any increase in plant auxiliary load. The study will use the tools developed at Cranfield to time-step through the plant's annual operational cycle.

- Both experimental tests and simulations will be performed to predict and investigate the performance of the cold heat storage in the demonstration plant employing wet cooling towers. Simulation results will be validated with the experimental test results.
- Overall a pre-design of a cTES sub subsystem will be produced, also using the evaluations and benefits of the heat storage performances simulator to evaluate both existing technologies on the market that could be adapted and used in the cold heat storage specifications, and new components as flexible membranes with potential technological breakthrough.

T4.2 cTES Engineering (ASE, CEA, CU, BSII, TSK)

In La Africana plant, a demonstration thermocline pond about 1000 m^3 capacity (to be adjusted) will be designed, which is sufficient to demonstrate technology effectiveness without any risk of compromising the operational plant production. Water ponds at larger scale are commonly built and the individual elements for such technology are well understood and are not sophisticated. Nevertheless, it has never been developed or applied at such a scale for such a use.

The storage pond will have two inlets and two outlets.

Inlets:

- Hot water coming from the condenser will be stored at the hot part of the tank during day.
- Cold water coming from the cooling tower will be stored at the cold side during night.

Outlets:

- Hot water will be pumped to the cooling tower during night.
- Cold water will be pumped to the condenser during day via tower basin.

With support of T4.1, and from existing plant documentations provided by TSK, ASE, supported by CU and CEA, will perform the detailed design of the water pond thermocline, including engineering activities for civil works, piping, electrical connections and all necessary services needed to operate cTES system. All the connections, valves, pumps, insolation and instrumentation will be defined during this task.

Instrumentation of the cTES will also be defined within this task to be able to monitor and optimize its control.

An effective and highly reliable interconnection with the commercial plant will be considered in order to prevent problems arising, and to avoid interference with La Africana operation and at the same time to ensure that the experimental plant will work continuously. The cTES system implementation in La Africana with existing cooling circuit will be part of planned programme or will be carried out at short notice during a breakdown.

T4.3 Development of storage control for the demonstration (CEA, CU, BSII)

Control management of the cTES is a key parameter to ensure its efficient implementation within the cooling system of the plant.

The CEA will take the lead in proposing a two-step approach for defining a control strategy both adapted to the wet cooled demonstration plant and other dry cooled plants located in an arid desert.

- In a first step, a control strategy based an expert law model will be proposed and implemented within the dedicated control of the cTES storage. The key parameters such as energy demand, solar resources, cooling flow, condenser and surrounding temperatures and humidity will be considered. The cTES management strategy will then be implemented in the CU simulation tool used in T4.1, using TMY data for the onsite implementation. CU will undertake to make comparisons of alternative adjustments to the proposed control strategy to enable CEA to propose a robust optimum strategy.
- In second step, a more advanced predictive control strategy based on optimal control and Mixed Integer Linear Programming (MILP) approach will be developed and its performances will be assessed by CEA. Depending on benefits improvement, this approach will be implemented on the cTES control tool to gain storage-assisted cooling.

T4.4 cTES construction (ASE, CU, CEA, TSK)

Based on preliminary results and know-how from T4.1 and T4.2, the cTES will be constructed on the La Africana plant. The supply, on-site construction and commissioning of the cold heat storage will be carefully coordinated by ASE and TSK for a proper management of the interfaces with the operating plant. The aim is to optimise the time and costs by improving reliability of civil works related to the plant such as excavation and earth moving, foundations, flexible membranes with ground anchors around the perimeter and supplying of service circuits (electrical, compressed air, water). CU and CEA will support and install their measurement components and participate in the experimental programme which is defined in work package 6. All other components and auxiliary elements will be fulfilled by the selected manufacturer from the T4.2 outputs.

T4.5 Results analysis, Model validation and Simulation assessments for benefits prediction (CU, CEA)

From experimental results gained in T6.4, CU will update and fit its simulation tools.

The CU team will then use the simulation software to check the overall impact for CSP plants located in arid desert regions where dry cooling systems are employed for power block cooling to predict the benefit of cTES at two other alternative locations more representative of arid deserts, such as North Africa where a dry cooling technology is likely to be required.

Simulations of alternative CSP technologies will be developed to work in conjunction with the time-stepping tools developed under task 4.1 and the optimized control developed in T4.3. It should be expected that the effect of the temperature of the steam cycle, which can be significantly higher for solar tower technology, will change the impact of dry cooling and the use of cTES. These changes and the implications of alternative CSP technologies will be examined.

Simulation of plant operation in a range of weather conditions will enable conclusions to be drawn on the way in which the potential benefit of using cTES as a way of mitigating the effects of dry cooling can change. Characteristic generalisations will be extracted from predicted results using the tools developed in earlier tasks. In this way, it is hoped that it will be possible to draw general conclusions as to factors that influence the size of the benefits of using the technology.

Del. No.	Leader	Deliverable description	Type	Diss. level	Delivery date
D4.1.1	**CU**	Predicted benefits in terms of annual generated output and water use with and without the cTES at the wet cooled demonstration site.	R	CO	M12
D4.2.1	**ASE**	Detailed design for the cTES to be implemented in La Africana	R	CO	M22
D4.3.1	**CEA**	Expert law control strategy for the test site using wet cooling towers.	R	CO	M22
D4.3.2	**CEA**	Optimal control strategy for a plant with a dry cooling solution.	R	CO	M30
D4.4.1	**ASE**	cTES constructed in testing site	DEM	CO	M30
D4.5.1	**CU**	Predicted benefits in terms of annual generated output and/or power savings with and without the cTES for plants using dry cooling systems at two arid locations that are more representative of where dry cooling technology may be deployed	R	CO	M36
D4.5.2	**CU**	Benefits of using a cTES technology for different types of CSP technologies depending on climate and weather conditions	R	PU	M42
D4.5.3	**CU**	Comparison between test site results (part of WP6) and predictions, the lessons learnt and the way future plant performance predictions can take into account these results to improve accuracy.	R	CO	M48

Mil. No.	Milestones list and expected results	Means of verification	Date
MS4.1	Detailed design of the CTES achieved	Engineering documents to be available in D4.2	M22
MS4.2	First synchronised cTES implemented	Building confirms operational readiness	M30
MS4.3	Expert law control strategy implemented	cTES management operational	M30

3.1.7. Water Recovery Technologies (WP5)

Work package N°	5	**Start date:**	M1	**Work package leader:**	Patricia Palenzuela Ardila (CIE)								
Work package title	*Water Recovery Technologies*												
Participant short name	**TSK**	**CEA**	**DLR**	**CIE**	**CU**	**TEK**	**RIO**	**ASE**	**IND**	**FEN**	**BSC**	**BSII**	**AMI**
Person-months	54	0	0	40	8	0	0	0	103	0	0	0	0

Objectives:

- Design and development of a water treatment plant that uses the dumped energy from a CSP solar field
- Recover the blowdown from the steam cycle to reduce the waste water and minimize the water consumption of the plant
- Dynamic modelling, calibration and validation of the water treatment plant
- Optimization of the water treatment plant operating conditions to maximize the water saving
- Implementation of the best control strategies that achieve the optimum operating conditions

Description of work

T5.1: Water recovery system dimensioning and engineering (IND, CIE, TSK)

T5.1 aims to optimize the design of a water recovery system to be driven by the available thermal energy from the solar collectors that are currently defocused once the maximum power is reached on real CSP plants. This system will be used to recover the water coming from the blowdown of the Rankine cycle and from any of the waste streams discharged from the CSP plant. The energy recovery from the blowdown through the water treatment plant, as it leaves the Rankine cycle at high temperature, will be also considered.

First, the hourly data of the thermal energy dumped from the solar field will be assessed and analyzed in order to determine the daily water production using numerical models (CIE/IND). Then, a cost-effective optimization will be conducted (IND/CIE/TSK) to simplify the equipment and structures. Also, other aspects will be taken into account for the design, like the location of the water recovery system, its coupling with the solar field (i.e. using steam or the heat transfer fluid as the thermal energy source), the need of intermediate components (i.e. a thermal storage tank) between the solar field and the water recovery system, the size of the equipment (number of effects, materials to be used, steam recompression), the raw water (composition and theoretical concentration factor), electricity and cooling supply. Also, an exhaustive analysis that determines the quality, flow, pressure and temperature of the water to be treated, depending upon its final use, will be required during the design phase in order to establish the maximum achievable concentration factor in the water recovery system. Likewise, the cooling and cleaning needs of the CSP plant will be taken into account for the design of the water recovery system. Furthermore, lab scale tests will be performed with wastewater samples from a CSP plant in order to assess their individual and global effect in the MEE system.

From all these analyses, the water recovery system will be designed and sized (IND with the help of CIE and TSK) to optimize the amount of water recovered (covering the main part of the year with the water treatment plant operating between a 40 and 110% load) and the plant overall economics (by minimizing the initial CAPEX for the plant installation through equipment sharing). The reduction of the required evaporation ponds and the water consumption will be also taken into account.

With all the above a set of block flow diagram, P&ID diagram, detail 2D and3D layout will be drawn and validated so the final design of the necessary water recovery system will be adjusted to the needs of the overall process.

T5.2: Water recovery system manufacturing (TSK, IND, CIE, CU)

Once designed, a prototype of the water treatment plant will be manufactured by VENTO, in order to install it in an operating CSP plant.

TSK will be in charge of the required modifications in the real CSP plant to integrate the water recovery system. The connections between the existing elements of the plant and the prototype will be defined. The thermal energy will be supplied as hot heat transfer fluid (HTF) from the solar field, while the income water will come from the blowdown of the steam cycle and from the existing waste water streams from the CSP plant. The resulting fresh water will be delivered to the service water tank of the plant for its reuse. The returning HTF will be conducted back to the HTF system and the concentrated water will be headed again to the water recovery plant. The water reuse will be done until the maximum concentration factor is achievable, which will reduce the size of the evaporation ponds based on Zero Liquid Discharge.

CIE and CU will advise and revise the instrumentation to be acquired and installed with the aim of fulfilling the objectives of the experimental campaign to be performed in WP6.

An operational manual for the water recovery system will be developed by IND including the P&ID. It will be used for the development of a SCADA system of the plant that will allow monitor and control the operating parameters of the plant. A working memory of the water recovery system will be developed altogether with the P&ID in order to integrate, monitor and control the operating parameters into the plant SCADA.

T5.3: Modelling, optimization and control (<u>CIE</u>, IND, TSK, CU)
This task aims to find the optimal operating conditions of the water recovery system according to energetic and exergetic criteria.

<u>5.3.1. Modelling and calibration of the water recovery system (CIE, IND, CU)</u>
A dynamic computer model of the water recovery system with the same configuration as the one designed and manufactured by IND in T5.1 and 5.2 will be developed and implemented (CIE). The model will be developed both for optimization purposes and for the design, testing and validation of control strategies. Finally, the model will be calibrated and validated with real data collected within WP6. Some specific parameters of the required for the calibration of the model will be provided by IND. On the other hand, CU will develop a model of the whole CSP plant (solar field plus the power block) with the Parabolic Trough technology in Thermoflex/MATLAB to perform simulations whose results will be used to evaluate the operation of the water recovery system in different scenarios.

<u>5.3.2. Process optimization in the water recovery system (CIE, IND, TSK, CU)</u>
Within this task, energetic and exergetic analyses of the process under nominal conditions will be firstly performed to identify the greatest energy and exergy consumption sources (CIE). Then, using the dynamic model developed in T5.3.1, multi-objective optimization algorithms will be employed in order to perform an optimization process according to energetic and exergetic criteria. The optimization process will be addressed following two different purposes: minimize the energy consumption and maximize the recovered water production (which is equivalent to optimize the concentration factor as function of the chemistry of the raw water to be treated). CIE and CU will collaborate with TSK and IND to plan the experimental campaign to be performed in WP6 in order to verify the optimization results.

<u>5.3.3. Control strategies for process optimization (CIE, IND, TSK, CU)</u>
Once the optimized operation points have been identified in T5.3.2, control strategies will be developed to follow the same energetic and exergetic criteria. Next, these control strategies will be implemented in the SCADA of the plant and will be tested and validated with the experimental campaign performed in WP6. The control strategy highly influences the plant performance since the energy source in the water recovery system is not controllable. The goal of the automatic control system is to ensure that the water recovery system operates at optimal conditions regardless of the energy source inlet conditions. CIE and CU will collaborate with TSK and IND to plan the experimental campaign to be performed in WP6 in order to verify the control strategies.

Del. No.	Leader	Deliverable description	Type	Diss. level	Delivery date
D5.1.1	**IND**	Optimum design of a water recovery system driven by the thermal energy dumped from a solar field of a CSP plant	R	CO	M12
D5.2.1	**IND**	Prototype of the water recovery plant	DEM	CO	M24
D5.3.1	**CIE**	Calibrated mathematical model of the water recovery system	R	CO	M30
D5.3.2	**CIE**	Optimal operating conditions of the water recovery system according to energetic and exergetic criteria	R	CO	M36
D5.3.3	**CIE**	Control strategies to optimize the water recovery process	R	CO	M42

Mil. No.	Milestones list and expected results	Means of verification	Date
MS5.1	Innovative water recovery system manufactured for WP6 installation and testing	Means of verification: Deliverable D5.1.1 & the water recovery system manufactured	M24
MS5.2	Availability of dynamic models including optimized water recovery operating conditions	Means of verification: Deliverables D5.3.1 & D5.3.2	M36
MS5.3	Availability of control techniques for a water recovery plant with a variable energy source	Means of verification: Deliverables 5.3.1 & D5.3.3	M42

3.1.8. Installation and validation at testing site (WP6)

Work package N°	6	**Start date:**	M6	**Work package leader:**	Luis Millán Monte (TSK)							
Work package title	*Installation and validation at testing sites*											
Participant short name	**TSK**	**CEA**	**DLR**	**CIE**	**CU**	**TEK**	**RIO**	**ASE**	**IND**	**FEN**	**BSC**	**BSII**	**AMI**
Person-months	84	41	5	59	32	25	2	1	35	15	0	0	0

Objectives:

- Extend existing non-linear and stochastic Dispatch Optimizer to overall “O&M Optimizer” (by soiling forecast, cleaning scheduling, cooling system and other water usage effects)
- Include soiling uncertainty models as input to O&M Optimizer
- Identify and include relevant transient water usage constraints to O&M Optimizer
- Extend optimized operation schedule by optimal cooling system trajectory and cleaning schedule
- Identify and implement suitable optimization algorithm and cost-function for water use effects
- Integrate O&M Optimizer to TSK’s plant forecasting and advisory system FoSys
- Promote potential of cooling system and operational flexibility from optimization studies

Description of work

T6.1: Experimental campaign design (<u>CIE</u>, all partners)

This task will be focused on the detailed preparation of the experimental campaign to be done in T6.3 in “La Africana” CSP plant, which includes the testing of all water-saving technologies to be installed and tested within the project. The test plan will state all the required information for accomplishing the installation of the technologies (T6.2), performing of the on-site validation tests (T6.3) and assessing of the results obtained (T6.4). In particular, the testing strategy will answer in detail what, who, when, where and how. In addition, the material definition, assembly, installation, setting-up, testing and validation will be defined within this task. A bill of material and a detailed Gantt chart will also be prepared.

The testing and validation campaign will be precisely defined and agreed by the partners, through the specification of the measuring and monitoring of the representative parameters and variables, data to be recorded and analysis, testing frequency, measuring equipment required, O&M personnel to be involved, software required and any other requirements for the proper development of the testing campaign. The test plan will take into consideration both the requirements of the different technologies and the characteristics of the testing site, in order to avoid significant disturbances in the correct operation of the plant. The experimental campaign will be designed with the main aim of evaluating the water consumed by each technology under different scenarios and of proving the concepts under real conditions.

T6.2: Installation at testing site (<u>TSK</u>, BSII)

<u>T6.2.1 Installation of FoSyS tool with O&M Optimizer in power plant (TSK, DLR)</u>

The operational forecasting system FoSys will be replaced/ extended by a version running with the O&M Optimizer of WP 2. Its installation can be initiated as soon as a proper version is available, at latest after reaching MS2.2. The boundary conditions of the La Africana plant with the new installations of the other WPs are considered by adapted parameters in the O&M Optimizer (model-freeze at M32 for those adaptations). TSK provides all required data for parameterization of the La African plant model. DLR provides the appropriate O&M Optimizer version as a black box program or installed on a separate hardware (to be defined during T6.1/T2.1). TSK integrates the O&M Optimizer to the FoSys tool on site, sets up the operational system, including data management and forecasts, and trains corresponding users. DLR supports on occasion during commissioning and training.

T6.2.2 Installation of soiling sensors and smart mirrors (TEK, DLR, CIE, TSK)
Tekniker soiling measurement device will be set up at La Africana plant and connected to the FoSyS tool and, at a later stage, to the O&M optimizer software.

30 smart mirrors manufactured by RIOGLASS with the TEKNIKER soiling sensor integrated will be distributed and installed (replacing the existing ones) in the solar field of La Africana.

A mobile meteorological measurement station comprising an optical particle counter, wind sensor, relative humidity, pressure and temperature sensors and dew sensors as well as autonomous data acquisition will be set up in the La Africana solar field for demonstration of the soiling model of T2.4 (DLR).

T6.2.3 Installation of dust barriers (CU, TSK, CIE)
A total length of 100m of an aerodynamically shaped porous dust barrier will be tested either as a replacement for existing fencing or as a secondary barrier, and will be located around a corner of the La Africana plant in order to maximize the exposure to wind directions that are forecast during the test. The barrier will be of the same height as the solar collectors, and will be installed as a permanent metal-framed structure of commercial quality with concrete foundations. During the project, the barrier will be tested over a calendar year but, if effective, there is no reason to dismantle the structure thereafter.

T6.2.4 Installation of mirrors and receivers with antisoiling coatings (RIO, ASE, TEK, TSK, CIE)
50 mirrors with the antisoiling coatings manufactured by RIOGLASS and with the same size of the existing mirrors in La Africana plant will be distributed around the solar field, replacing the existing ones. Each mirror with antisoiling coating should be installed next to one without the coating, in order to compare the performance of the coating.

The installation of new HCE tubes is a very laborious work, which require the drainage of the corresponding loop, cut the existing HCE and the welding of the new one. It is planned to substitute two whole SCAs (Solar Collector Assembly) with tubes to be tested. The 36 tubes of the first SCA will have the antisoiling coating and the 36 tubes of the second SCA will not have this coating. All the 72 tubes will be manufactured by ASE, and they will be exactly the same except for the coating. To calculate the performance of the two kind of tubes, several thermocouples will be installed at the beginning and at the end of each SCA, to measure the temperature increase of the HTF for each one.

T6.2.5 Installation of the thermal storage system for cooling (CEA, CU, TSK)
The construction of the storage will be done during the WP4. In this task, the rest of the system will be installed and connected to the existing cooling system of La Africana plant.

T6.2.6 Installation of the water recovery system (IND, CIE, CU, TSK)
The water recovery system constructed in the WP5 will be installed by IND (VENTO), as well as all the connections required with the existing systems of the plant will be installed at La Africana plant during this task. The instrumentation and the SCADA system defined during the WP5 will be installed and implemented during this task as well.

T6.3: On-site validation (TSK, all partners)
All the elements and systems installed in T6.2, will be validated in the operational environment of La Africana plant during several months. The test will be carried out mainly by TSK staff with the supervision of the rest of the partners. All the measurements for the result assessment will be obtained during this task:

T6.3.1 FoSyS tool with O&M Optimizer
The operation of the FoSys tool with the O&M Optimizer is performed by TSK and La Africana plant operators. DLR will join up to 3 operation weeks in order to validate and improve the O&M Optimizer. Time series of operation data is provided to DLR for the analysis of underlying situations (plant state data from relevant subsystems and forecasts) in order to validate and improve the O&M Optimizer. Furthermore, structured feedback will be foreseen in order to further improve the user experience and the optimizer's overall performance.

T6.3.2 Ultrasonic cleaning device
The ultrasonic cleaning device will clean a row of the solar field regularly, taking reflectance measurements before and after the cleaning to check the efficiency. The water and electricity consumptions will be measured as well.

T6.3.3 Soiling sensors and smart mirrors
Weekly reflectance measurements will be taken around the solar field to obtain the soiling rate. The measured soiling rate will be compared to the measurements of the smart mirrors.

T6.3.4 Dust barrier
Weekly reflectance measurements will be taken on the mirrors protected by the dust barrier, as well as on the mirrors not protected by it. The comparison between the two kinds of mirrors will serve to stablish the efficiency of the dust barrier.

T6.3.5 Mirrors and receivers with antisoiling coatings
Weekly reflectance measurements will be taken around the solar field to obtain the soiling rate for regular mirrors and for coated mirrors. The comparison between the two kinds of mirrors will serve to establish the efficiency of the coatings in the reflectors. Additionally, the degradation on the coatings will be established with all the data obtained during the duration of the project.

Weekly transmittance measurements of the glass from the tested receivers will be taken to establish the performance of the antisoiling coating. The transmittance will be measured in the ASE tubes installed without coating as well. The efficiency of the new tubes will be calculated with the data provided by the thermocouples installed at the beginning and at the end of each SCA (one with the antisoiling coating and one without one.

T6.3.6 Thermal Storage System for cooling
The thermal storage system will be operated daily, cooling the water of the storage at night, and using the cold water during day. Temperatures, flows, electricity consumption and other data will be recorded for the performance evaluation. Validation at this scale demonstrates the viability of the proposed technology for TSK and other stakeholders to increase focus on international markets and its application. Test results from the plant will be compared to calculated predictions using Cranfield time-stepping simulation tools used to investigate the performance of the nocturnal heat storage integrated with the wet cooling tower. Results obtained will be validated with the experimental test results obtained from the prototype/small scale nocturnal heat storage integrated with a wet cooling tower at the demonstration plant by CU in T 4.1. Any significant differences will be explained and the tools enhanced to take any new affects into account. The methodology will be then applied to a dry cooling system (as part of T 4.5) to investigate benefits in terms of annual generated power output and/or power saving with and without the nocturnal heat storage for two arid locations with dry cooling towers.

T6.3.7 Water Recovery System
The on-site tests of the water recovery system will be divided in three stages: in the first stage, an experimental campaign will be focused on the calibration and validation of the model developed in T5.3.1. For this purpose, different experiments will be carried out varying the feedwater flow rate and temperature, the temperature and flow rate of the hot transfer fluid and the flow rate of the refrigeration system used in the water recovery plant. In the second stage, the test campaign will be aiming the validation of the optimum operating points found in T5.3.2. These tests will be mainly focused on the evaluation of the thermal consumption and the fresh water production at the optimum operating points. Finally, a third stage will consist in performing an experimental campaign to test and validate the control strategies developed by CIE in T5.3.3.

The water recovery system will be operated daily. The recovered water will be used in the normal operation of the plant. Temperatures, flows, electricity consumption and other data will be recorded for the performance evaluation.

T6.4: Results assessment (CIE, all partners)
In this task, all the results obtained during the on-site validation (T6.3) will be analysed in terms of water consumption, performance, water reduction and costs. The data and experience gained from the experimental campaigns will be used to update and validate the models developed in other WPs. The results will allow achieving important conclusions to be used to elaborate a series of recommendations for the proper exploitation of the technologies. The evaluation of the results shall include all the information needed to interpret the results of the experiments performed in the CSP plant, the uncertainty associated to the values achieved and, when possible, how to extrapolate the conclusions to other location and CSP technologies (solar towers, Fresnel collectors, etc.)

Del. No.	Leader	Deliverable description	Type	Diss. level	Delivery date
D6.1.1	**CIE**	Experimental campaign designed	R	CO	M18
D6.2.1	**TSK**	Operation of FoSyS with integrated Optimizer for 4 weeks	DEM	CO	M42
D6.2.2	**TEK**	Soiling sensors and smart mirrors installed	DEM	CO	M22
D6.2.3	**CU**	Dust barrier installed	DEM	CO	M18
D6.2.4	**TSK**	Mirrors and receivers with antisoiling coatings installed	DEM	CO	M29
D6.2.5	**CEA**	Thermal storage system installed	DEM	CO	M29
D6.2.6	**IND**	Water recovery system installed	DEM	CO	M29
D6.3.1	**TSK**	All systems validated in La Africana plant	R	CO	M43
D6.4.1	**CIE**	Results assessment of the on-site testing and validation	R	CO	M48

Mil. No.	Milestones list and expected results	Means of verification	Date
MS6.1	Experimental campaign designed	Deliverable D6.1.1 finalized and approved by all partners	M18
MS6.2	Elements and systems installed in La Africana	All systems and components successfully installed in La Africana	M29
MS6.3	Operation of the systems successful	All systems successfully operated in LA Africana	M43

3.1.9. Dissemination, exploitation and standardization (WP7)

Work package N°	7	**Start date:**	M1	**Work package leader:**	Lenka Bajarová (AMI)								
Work package title	*Dissemination, exploitation and standardization*												
Participant short name	**TSK**	**CEA**	**DLR**	**CIE**	**CU**	**TEK**	**RIO**	**ASE**	**IND**	**FEN**	**BSC**	**BSII**	**AMI**
Person-months	3	4	3	9	3	5	0	1	2	0	1	0	12

Objectives:
The proposed objectives of this Work Package are to:

- increase public awareness of the potential of concentrated solar power and its application through introduction of a dedicated project webpage, preparation of printed materials, organization of project events and participation in the top level European conferences;
- manage the collective impact of the consortium throughout the course of the project by
    - evaluating the market potential and determine product opportunities in relation to customer/product requirements,
    - identifying and managing individual and collective opportunities of exploitation of project results by partners (exploitation plans),
- monitoring new IPR creation inside (opportunity) and outside (threat) of the consortium;
- develop an innovative business model for SOLWATT tools
- contribute to new and on-going international standardization efforts on CSP

Description of work
T7.1: Dissemination and public events (AMI, all partners)
The objective of this task is to assure that the results of the project will be disseminated to the European research and industrial community, will target all important stakeholders in the field of CSP technologies and will assure an on-going communication between general public, experts, technicians, etc. on one side and partners of the project on the other. At the beginning of the project the partners will define a working document outlining the dissemination strategy and tools to be used during the life of the project. The document will be updated following project results.

The following actions are proposed to be carried out in this task:

SOLWATT website

A comprehensive dedicated website for the project updated on a regular basis will be created. SOLWATT web site will be established at the beginning of the project and will be set up both for consortium members' and public access. The website will be actively maintained during the project period and will be used also as a management tool. A private area (in combination with FTP server) will be used to provide a centralized access to all materials generated by the project, i.e. progress reports, preliminary scientific and popular manuscripts, lecture notes, hand-outs, selected publications and patents will be stored in a central archive and access will be provided to all consortium partners but with different access and security levels for public and confidential data (more information on dissemination in part 2.2). Because SOLWATT website will act also as a management tool, it will hold large amount of confidential data and security of such website will be periodically monitored and protection against intruders will be ensured.

Promotional materials, press releases

Promotional material like leaflets, flyers, brochures, posters, etc. will be created and distributed widely in all key events and through a regularly updated database of contacts (including newcomers registering through the web site). Journalist (from television, periodicals, magazines, newspapers) will be regularly updated on SOLWATT progress, results and events by publishing dedicated press releases. Tools like Wikipedia, or social networks (Facebook, YouTube, Twitter, etc.) will also be considered to reach the young generation and to feed followers with public, validated and fresh data. Upcoming events such as the WP1 knowledge transfer workshops will be announced via the abovementioned channels.

Publication of SOLWATT results

Publication of the SOLWATT results to relevant scientific and industrial periodicals, journals and key conferences in Europe (e.g. SmartGrids ETP conferences / workshops, ZEP conference / workshops, ESTELA Conference & Exhibition, SolarPACES conferences, DLR Sonnenkolloquium, SuNEC Sun New Energy Conference, ISES SWC Grid+ events, Industrial Technologies conference), will be assured during the whole project lifetime. A set of conferences on CSP will be selected and articles, papers and posters will be prepared for them. A short publication highlighting the results of the project under the form of best practices for wider adoption and distribution will be prepared. Joint publications from different partners are encouraged.

Organization of SOLWATT events

The consortium will organize several events as a part of WP1. These activities will be dedicated to practice oriented training and knowledge transfer (for more details see WP1 description). In addition to abovementioned events, testing site visit will be prepared for journalists in order to give them the latest information on solutions developed in the SOLWATT project and allowing them to inform the general public on the possibilities of CSP plants improvements. Final SOLWATT event will take place in La Africana testing site to show the outcomes of the project in real time conditions.

EU and national projects clustering activity

Dissemination manager responsibility will be also to monitor and to contribute to necessary information related to policy making (market failure, European benchmark, systemic barriers for better European competitiveness, etc.) towards Project Officers, related to the EU clustering activity. In particular, it is expected the consortium activities will be reported to Smart Grids ETP, ESTELA Association and other relevant European Technology Platforms and similar activities are expected also on the national levels

T7.2: Exploitation strategy development (TSK, all partners)

The aim of this task is to evaluate the collective impact potential of the consortium by evaluating the market potential and to determine product opportunities in relation to the customer/product requirements throughout the course of the project. The input will be from all the task consortium participants, with special attention to the industrial and economic impact in the EU following the different innovation opportunities along the value chain.

Firstly, the aim is to clearly identify and define the outcomes and results of the SOLWATT project that can be exploited. Secondly, it should be made clear who owns them, or who the Intellectual Property (IP) belongs to, and also who can exploit them, how, and to whom. As such, exploitation plans for each SOLWATT partner will be developed with the intention of maintaining, and hopefully increasing, the impact of SOLWATT beyond the project's duration. By the time the task (and project) reaches its conclusion, all partners should have a clear idea of how they can exploit the SOLWATT outcomes, including the requirements for, and definition of, any Intellectual Property Rights (IPRs) and/or licence agreements and terms.

This task can and will make special recommendations for the completion of the consortium from an exploitation point of view (e.g. additional members). The task will deliver the preliminary and final consortium exploitation plan. Task leader will organize, collect and consolidate the various inputs over the course of the project.

T7.3: Business model development (TSK, all partners)

In this task, a new business model for the system will be also developed, that takes into account the scope of activity and business models of the existing players in the CSP industry to allow a swift market penetration of the new toolbox.

This activity will rely on the one side on the involvement of the industrial partners of the consortium, and on the other side on the information gathered in the previous activities related to the market analysis. The new business model to be developed will include a description of a strategy and its specific characteristics with respect to value creation on the one hand and market-orientation on the other hand to successfully put on the market the new technology, so that each actor involved in the value chain will have direct economic and business benefits. The business model will include the following key elements: the value proposition, the configuration of the value creation, the definition of all aspects related to the customers, the partnership, the key resources as well as the mechanisms for revenue generation. The outputs of these business-focused studies will orient the activities of the partners aiming at the commercial exploitation of the project results.

T7.4: Contribution to standardization activities (CIE, DLR, CU, TEK, RIO, ASE)

As part of this activity, the task participants will contribute to the development and validation of new testing standards, thanks to their active involvement in all the standardization bodies related to CSP and their remarkable role within the EERA CSP community. CIE, DLR and RIO are members of the Spanish AENOR committee (AENOR/CTN 206), which is the most advanced and is currently in the process of publishing several national standards for CSP components. These national standards will later on be transferred to the international committee IEC/TC-117 standard entitled "Solar Thermal Electric Plants". The advances in the field of durability and performance testing of anti-soiling coatings for reflectors and glass envelope tubes will be transferred to the AENOR GT2 committee to be considered for inclusion in future updated versions of the Spanish national standards.

In addition, an international committee under the framework of SolarPACES IEA organization is working on standardizing the measurement methods for assessing CSP components (Task III). As CIE and DLR also participate in this committee, advances achieved in this project concerning on-site soiling measurements will be transferred to that committee to assure a synchronized approach with other international institutions. DLR also participates in a national standardization group on the topic of artificial soiling methods where the results from the soiling modelling activities (WP3) will be integrated as to specify those weather parameters that dominate dust deposition. CU will take the outputs of the advances in soiling measurements achieved during this project for discussion with the UK National Physical Laboratory (NPL) which is the keeper of UK standards.

Del. No.	Leader	Deliverable description	Type	Diss. level	Delivery date
D7.1.1	**AMI**	Dissemination and Communication strategy document prepared	R	PU	M4
D7.1.2	**AMI**	Development and maintenance of SOLWATT webpage	DEC	PU	M4
D7.1.3	**AMI**	Final SOLWATT event	DEC	PU	M48
D7.2.1	**TSK**	Consortium exploitation plans, periodical updates	R	CO	M24,M36 M48
D7.3.1	**TSK**	Business model for SOLWATT technologies	R	CO	M48
D7.4.1	**CIE**	Recommendations for standardization bodies	R	PU	M48

Mil. No.	Milestones list and expected results	Means of verification	Date
MS7.1	Business model developed	Deliverable D7.3.1 achieved and presented	M48
MS7.2	The exploitation routes selected	Deliverable D7.2.1 presented in its final version, after contribution of all partners	M48

3.1.10. Project management and coordination (WP8)

Work package N°	8	**Start date:**	M1	**Work package leader:**	Rogelio Peón Menendez (TSK)							
Work package title	*Project management and coordination*											

Participant short name	**TSK**	**CEA**	**DLR**	**CIE**	**CU**	**TEK**	**RIO**	**ASE**	**IND**	**FEN**	**BSC**	**BSII**	**AMI**
Person-months	15	2	2	2	3	2	0	2	0	0	0	0	12

Objectives:

- Coordinating the actions of participants and progress monitoring for achievements of project goals;
- Financial and administrative management;
- Reliable interface to the EC services;
- The project will be managed according to well-defined procedures built up over many years of scientific project management. In particular, the project management activities include:
    - coordination of the project WPs (through WP leaders) according to the work plan, ensuring the high quality of the project outcomes;
    - efficient and high-quality communication between all the partners;
    - distribution of the financial support received from the Commission to the partners;
    - considering relevant gender issues;
    - identification and mitigation of project risks by performing an effective risk management;
    - due reporting of consortium activities and achievements.

Description of work

T8.1 General Assembly coordination (<u>TSK</u>, AMI)

The General Assembly will meet once a year and the partners will report in a form suitable to be collected and submitted to the Commission. Different reports are seen as methods for monitoring and reporting progress. These reports will cover the work carried out, the results, any reason for delay, any change in time table, any change in manpower requirements and planned actions for the next year. At the beginning of the project the General Assembly will review the individual tasks and customize them, if needed.

T8.2 Day-to-day management via WPLs, quality assurance (<u>TSK</u>, AMI + all WPLs)

<u>Day-to-day management</u>

Technical tasks within WPs will be a responsibility of the Work Package Leaders, but the project coordinator will provide procedures for progress monitoring and reporting.

The project will be managed and directed according to the work plan authorised by the European Commission, and the management will make sure that the requirements set by the Commission concerning reporting, information, etc. will be fulfilled. Furthermore, the Coordinator and project manager will take care of the distribution of the financial support amongst the partners paid by the Commission. They will also resolve any incorrect, inappropriate or unauthorised changes during project duration. Project Coordinator and Project Manager tasks are also described in chapter 3.2.

The partnership expects to conclude a consortium agreement in which the commercial exploitation of the results of the project is explained, the various responsibilities of each partner are specified, the market shape is defined and the rewards identified. The Consortium Agreement will be prepared by the project manager and approved by the legal department of TSK and subsequently by legal departments of all partners to allow reaching a multilateral consensus before the project start. Academic partners will publish their results in theses, conferences and scientific journals within the following constraint: Where developments have commercial exploitation potential and one of the partners intends to file a patent request, research publications will be delayed allowing patent coverage. The Project Coordinator will work with the Dissemination and Exploitation Manager to ensure proper management of intellectual property and dissemination.

<u>Quality Assurance for successful project management</u>

The Project Coordinator assisted by partners' representatives in the Project Steering Committee (PSC) coordinates the quality assurance management. Timely awareness and reaction to potential problems is crucial for the quality assurance management effectiveness. In the event of technological changes that cannot be addressed directly by WP Leaders or WP Deputies, the PSC will investigate and advise appropriate actions. The WP Leader will implement the actions. Following activities will be realised:

- **Quality procedures -** A procedures for specific quality checks are in place and described in part 3 - Implementation. The 6 months periodicity for the PSC meeting is foreseen to perform internal assessment of the project and assure the conformity and the quality of all project deliverables with the requirements.
- **Risk contingency management -** The risk management process deals with project risks, making sure that the Consortium manages to fulfil the project goals on time and budget. Project risks will be constantly assessed and evaluated within the whole project duration.

The methodology to be followed for risk contingency consists in four steps:

- **Risk identification**: areas of potential risk will be identified and classified.
- **Risk evaluation**: the probability of events will be determined and the consequences associated with their occurrence will be examined.
- **Risk response**: methods will be produced to reduce or control the risk.
- **Risk control and report**: lessons learnt will be documented.

All risk management issues will be documented in the Periodic activity and Management Reports (D8.2.1)

Del. No.	Leader	Deliverable description	Type	Diss. level	Delivery date
D8.1.1	**AMI**	Minutes of the GA meting	R	CO	M1,M13, M25,M37
D8.2.1	**AMI**	Periodic activity and management report	R	CO	M14,M26 M38,M48

Mil. No.	Milestones list and expected results	Means of verification	Date
MS8.1	Mid-term review and assessment	Successful achievement of projected milestones and next 24 months plan	M24
MS8.2	Final meeting and report	Successful achievement of projected milestones	M48

3.1.11. Work package list, list of deliverables, list of milestones

WPs No.	Work package title	WP leader	Person months	Start month	End month
WP1	Socio-economic and environmental studies	**CU**	**92**	M1	M45
WP2	Operation and maintenance optimizer	**DLR**	**171**	M1	M48
WP3	Cleaning technologies	**TEK**	**292**	M1	M31
WP4	Cooling technologies	**CEA**	**140**	M1	M48
WP5	Water recovery technologies	**CIE**	**205**	M1	M42
WP6	Installation and validation at testing site	**TSK**	**299**	M7	M48
WP7	Dissemination, exploitation and standardization	**AMI**	**43**	M1	M48
WP8	Project management and coordination	**TSK**	**40**	M1	M48
		TOTAL	**1282**		

Table 21. List of deliverables

Del. No.	Leader	Deliverable description	Type	Diss. level	Delivery date
D1.1.1	**CU**	Systems study of CSP-related socio-economic and livelihood issues	R	PU	M12
D1.2.1	**CU**	Case studies of social and livelihood issues (consequences of CSP plants and water usage)	R	CO	M42
D1.3.1	**TSK**	Economic assessment for water reduction	R	CO	M45
D1.4.1	**CU**	Environmental impact of CSP plants	R	CO	M42
D1.5.1	**CIE**	Summary report of knowledge transfer activities	R	PU	M45

D2.1.1	**DLR**	Relevant effects of water usage in STE plants and optimizer inputs/outputs defined	R	PU	M6
D2.1.2	**DLR**	Providing O&M Optimizer's first results for reference plant, considering water-related effects and models from other WPs	DEM	CO	M36
D2.2.1	**DLR**	Defined interface variables between O&M Optimizer and FoSys environment	R	CO	M12
D2.2.2	**TSK**	O&M Optimizer provided for demonstration in WP6	DEM	CO	M36
D2.3.1	**DLR**	Results analysis of O&M Optimizer impact on operation of reference plant	R	PU	M48
D2.4.1	**BSC**	Operational CSP soiling rate forecast with specified accuracies implemented for measurement sites	R	PU	M36
D2.5.1	**BSC**	Soiling rate map	DEM	PU	M42
D3.1.1	**TEK**	Design for integrated soiling sensor (smart mirror concept)	R	CO	M6
D3.1.2	**TEK**	30 Smart mirrors manufactured for real scale tests	DEM	CO	M18
D3.2.1	**TEK**	Design for integrated ultrasonic cleaner	R	CO	M6
D3.2.2	**TEK**	Ultrasonic cleaning device manufactured for real scale tests	DEM	CO	M24
D3.3.1	**BSII**	Design for heliostat integrated cleaning device	R	CO	M6
D3.3.2	**BSII**	Heliostat integrated cleaning devices (10-50) manufactured for real scale tests	DEM	CO	M24
D3.4.1	**CU**	Sand Barrier candidate/pre-tested design for real scale test selected	R	PU	M12
D3.4.2	**CU**	Full-height dust barriers of a porosity in the range 30-50% with a length of 100 m manufactured for real scale tests	DEM	CO	M24
D3.4.3	**RIO**	50 real-size samples delivered through optimized manufacturing process for coated reflectors of 1700 x 1700 mm^2 as maximum	DEM	CO	M24
D3.4.4	**ASE**	72 receiver tubes of 4060 mm length, will be prepared (36 of those tubes will contain the new anti-soiling coating and 36 tubes will only be coated with the standard anti-reflective coating	DEM	CO	M24
D3.4.5	**CIE**	Results of the accelerated aging of the anti-soiling coatings for reflectors	R	CO	M31
D3.4.6	**DLR**	Results of the accelerated aging of the anti-soiling coatings for receivers	R	CO	M31
D4.1.1	**CU**	Predicted benefits in terms of annual generated output and water use with and without the cTES at the wet cooled demonstration site.	R	CO	M12
D4.2.1	**ASE**	Detailed design for the cTES to be implemented in La Africana	R	CO	M22
D4.3.1	**CEA**	Expert law control strategy for the test site using wet cooling towers.	R	CO	M22
D4.3.2	**CEA**	Optimal control strategy for a plant with a dry cooling solution.	R	CO	M30
D4.4.1	**ASE**	cTES constructed in testing site	DEM	CO	M30
D4.5.1	**CU**	Predicted benefits in terms of annual generated output and/or power savings with and without the cTES for plants using dry cooling systems at two arid locations that are more representative of where dry cooling technology may be deployed.	R	CO	M36

D4.5.2	**CU**	Benefits of using a cTES technology for different types of CSP technologies depending on climate and weather conditions	R	PU	M42
D4.5.3	**CU**	Comparison between test site results (part of WP6) and predictions, the lessons learnt and the way future plant performance predictions can take into account these results to improve accuracy.	R	CO	M48
D5.1.1	**IND**	Optimum design of a water recovery system driven by the thermal energy dumped from a solar field of a CSP plant	R	CO	M12
D5.2.1	**IND**	Prototype of the water recovery plant	DEM	CO	M24
D5.3.1	**CIE**	Calibrated mathematical model of the water recovery system	R	CO	M30
D5.3.2	**CIE**	Optimal operating conditions of the water recovery system according to energetic and exergetic criteria	R	CO	M36
D5.3.3	**CIE**	Control strategies to optimize the water recovery process	R	CO	M42
D6.1.1	**CIE**	Experimental campaign designed	R	CO	M18
D6.2.1	**TSK**	Operation of FoSyS with integrated Optimizer for 4 weeks	DEM	CO	M42
D6.2.2	**TEK**	Ultrasonic cleaning device on truck installed	DEM	CO	
D6.2.3	**TEK**	Soiling sensors and smart mirrors installed	DEM	CO	M22
D6.2.4	**CU**	Dust barrier installed	DEM	CO	M18
D6.2.5	**TSK**	Mirrors and receivers with antisoiling coatings installed	DEM	CO	M29
D6.2.6	**CEA**	Thermal storage system installed	DEM	CO	M29
D6.2.7	**IND**	Water recovery system installed	DEM	CO	M29
D6.3.1	**TSK**	All systems validated in La Africana plant	R	CO	M43
D6.4.1	**CIE**	Results assessment of the on-site testing and validation	R	CO	M48
D7.1.1	**AMI**	Dissemination and Communication strategy document prepared	R	PU	M4
D7.1.2	**AMI**	Development and maintenance of SOLWATT webpage	DEC	PU	M4
D7.1.3	**AMI**	Final SOLWATT event	DEC	PU	M48
D7.2.1	**TSK**	Consortium exploitation plans, periodical updates	R	CO	M24,M36 M48
D7.3.1	**TSK**	Business model for SOLWATT technologies	R	CO	M48
D7.4.1	**CIE**	Recommendations for standardization bodies	R	PU	M48

Table 22. List of milestones

Mil. No.	Milestones list and expected results	Means of verification	Date
MS1.1	Locations for case-studies selected	Five global locations that are representative of the communities facing a particular type of challenge selected	M18
MS1.2	Economic input data gathered	Economic data received from stakeholder	M24
MS1.3	Knowledge Transfer and practice-oriented training completed	Five stakeholder courses and one distance learning package delivered	M39
MS2.1	O&M Optimizer works in office environment	Result change between old DO and new O&M Optimizer for reference case optimization	M34
MS2.2	O&M Optimizer integrated to FoSyS tool and ready for demonstration	FoSys tool controls inputs and outputs of O&M optimizer in software environment as in plant	M36
MS2.3	Implementation of soiling rate forecasting product for CSP solar fields	Regularly (6h) updated operational soiling rate forecasts published on BSC websites	M36

MS3.1	Innovative smart mirror ready for WP6	Smart mirrors manufactured and shipped to La Africana	M18
MS3.2	Innovative novel ultrasonic cleaning device ready for the validation in WP6	Ultrasonic cleaning device upscaled and integrated in cleaning truck	M24
MS3.3	Reflectors and receivers with anti-soiling coating ready to be installed for WP6	Real size samples manufactured and shipped to La Africana	M24
MS3.4	Full-scale dust barriers available	Real size samples manufactured and shipped to La Africana	M24
MS4.1	Detailed design of the CTES achieved	Engineering documents to be available in D4.2	M22
MS4.2	First synchronised cTES implemented	Building confirms operational readiness	M30
MS4.3	Expert law control strategy implemented	cTES management operational	M30
MS5.1	Innovative water recovery system manufactured for WP6 installation and testing	Means of verification: Deliverable D5.1.1 & the water recovery system manufactured	M24
MS5.2	Availability of dynamic models including optimized water recovery operating conditions	Means of verification: Deliverables D5.3.1 & D5.3.2	M36
MS5.3	Availability of control techniques for a water recovery plant with a variable energy source	Means of verification: Deliverables 5.3.1 & D5.3.3	M42
MS6.1	Experimental campaign designed	Deliverable D6.1.1 finalized and approved by all partners	M18
MS6.2	Elements and systems installed in La Africana	All systems and components successfully installed in La Africana	M29
MS6.3	Operation of the systems successful	All systems successfully operated in LA Africana	M43
MS7.1	Business model developed	Deliverable D7.3.1 achieved and presented	M48
MS7.2	The exploitation routes selected	Deliverable D7.2.1 presented in its final version, after contribution of all partners	M48

3.2. Management structure and procedures

3.2.1. Decision making bodies

A challenging, large-sized and multidisciplinary project like SOLWATT requires an effective, efficient and well-defined management structure. The proposed management scheme must ensure a flawless exchange of know-how between the various WPs. It must provide interfaces with the project officer; mechanisms to take decisions that will affect the project's outcome as well as administrative, technical and scientific coordination of the project. Moreover, the defined structure will ensure the effective dissemination of the tasks achieved during the project and will help to select the most appropriate exploitation routes of the generated know-how.

General Assembly (GA)

A General Assembly is a consortium body at the strategic level. A General Assembly will be established at the beginning of the project, composed of key senior representatives from each partner organization. The Project Coordinator will chair the General Assembly and will be assisted by the Project Manager. All the GA members have numerous years of experience in the relevant technological domains and most of them have already participated in previous EC funded programmes.

The General Assembly is responsible for Project and Exploitation strategies in order to guarantee their mutual consistency, monitoring of the SOLWATT project progress, its achievements and costs, supervision of the technical developments and coordination of dissemination and communications actions and of exploitation activities, preparation of contract amendments (if required) (budgets, resources, plans, etc.), solving problems with a potential impact on project strategies, resources and objectives, defining the necessary contingency plans, solving conflicts on strategic issues, and keeping track of medium and long term objectives. The General Assembly will be organized, will act and make decisions in line with the Consortium Agreement.

3.2.2. Day to day management

Project Coordinator

On behalf of TSK, **Dr. Rogelio Peón Menendez** will act as the SOLWATT Project Coordinator responsible for the overall coordination of activities. **Dr. Peón** has gained more than 20 years of experience in the management of industrial projects as well as projects in the solar thermal business, while most of them were supported by European Commission.

The Coordinator will be assisted in this management task by the Project Manager, by Work-Package Leaders and by the General Assembly, which will be empowered to make high-level decisions on every aspect of the project. The organizational structure and the rights and duties of the operational bodies responsible for the decision-making in the SOLWATT project will be explained and described in detail in the Consortium Agreement.

The Project Coordinator is responsible for technical monitoring of the overall progress of the project. He will follow the project throughout its whole lifecycle, on a day-to-day basis. His main interlocutors in the consortium - apart from the Project Manager - will be the WP leaders, from whom he will gather the necessary information for efficient communication both with the Commission (activity, financial and final reports, audits, etc.) and within the consortium (periodic consortium meetings, deliverables, progress reports, etc.). The Project Coordinator is the sole interface between the Commission and the consortium, and the contact point for communication with other projects in the programme. Should any major problem arise, the Project Coordinator has the possibility to call for the Steering Committee or for an extraordinary meeting of the General Assembly.

Project Manager

The Project Manager, Ms. Lenka Bajarová from AMIRES, will support the coordinator and WP leaders in their administrative, financial, dissemination and communication organisation role. She will ensure prompt negotiation and seamless project execution, consortium agreement preparation, project amendments and competitive call preparation (if needed), monitoring and timing of technical deliverables and milestones, timely and quality reporting, check the partners budget follow-up (e.g. preparing and checking cost statements, distribution of funding, etc.). The Project Manager will be responsible for proper information flow between General Assembly and Coordinator on one side and WP leaders and partners on the other (minutes of meetings, decisions taken, to do lists, deadlines etc.). Moreover, the Project Manager will be responsible for coordination of project meetings and dissemination and communication (e.g. webpages, press releases, leaflets, newsletters) and exploitation planning (support to Exploitation Manager and liaising with other SMEs and industrials).

Project Steering Committee (PSC)

The Project Steering Committee (PSC), comprising of all Work Package Leaders, will act as a managerial decision-making body for the project and will be responsible for supporting the Project Coordinator. The PSC will be responsible for taking decisions in those cases where it is not necessary to refer to the General Assembly. The PSC will aim to reach a consensus wherever possible. If no consensus can be reached, decisions will be taken after a simple majority vote. **The PSC should meet at least twice a year on an ordinary basis and at least monthly through teleconferences.**

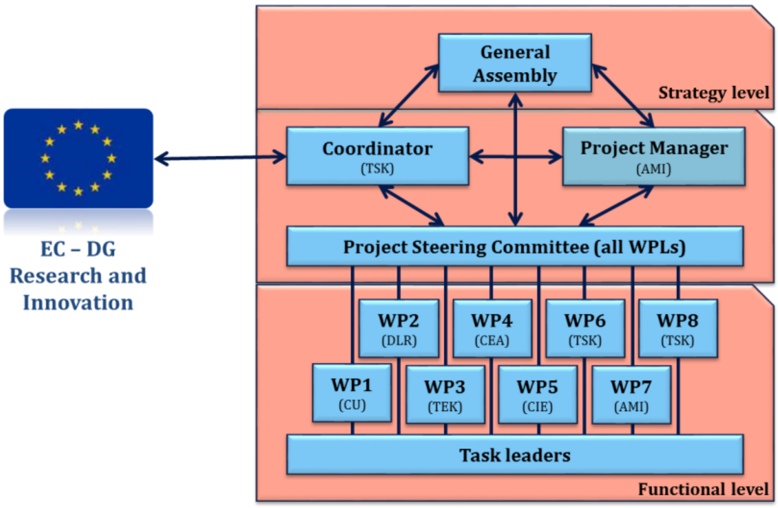


Figure 26. SOLWATT project management structure

The PSC will ensure that both deliverables are produced (to the agreed quality) and milestones achieved. It will also control whether decisions needed for further progress are taken, all the results are disseminated on time, the exploitation plans are investigated in detail, support and motivation are provided to partners where and when this is appropriate, regular project meetings are held, amendments to the contract and Consortium Agreement are initiated and the Intellectual Property Rights issues are regularly reviewed, etc.

Work Package Leaders (WPL)

For each Work Package, a Leader (functional level) is nominated. WPL's tasks will be to control the progress of the scheduled work within the WP in terms of technical achievement, planned deliverables and expenses and to inform the General Assembly and the other WPLs with a project Progress Status Report. The Progress Status Report should include items like the results obtained and problems encountered, the scheduled work, decisions and questions.

The following tasks of WPLs are considered in particular:

- to collect the information (technical, programmatic) needed to prepare periodic progress reports and to transmit them to the Project Coordinator,
- to transmit information from the Project Coordinator to the partners involved in the Work Package,
- to manage topic-oriented meetings, and to report to the Project Coordinator on all matters related to the topic (planning, costs, etc.),
- to allow a fluid upstream and downstream exchange of information, regular contact will be kept between the Project Coordinator, the Project Manager and WP leaders.

The personnel responsible for the efficient and effective running of SOLWATT Work Packages are mentioned in table below.

Table 23. List of SOLWATT Work Package Leaders

WP	WP name	WP Leader	Partner
1	Socio-economic and environmental studies	Chris Sansom	CU
2	Operation and maintenance optimizer	Tobias Hirsch	DLR
3	Cleaning technologies	Itziar Azpitarte	TEK
4	Cooling technologies	Delphine Bourdon	CEA
5	Water recovery technologies	Patricia Palenzuela Ardila	CIE
6	Installation and validation at testing site	Luis Millán Monte	TSK
7	Dissemination, exploitation and standardization	Lenka Bajarová	AMI
8	Project management and coordination	Rogelio Peón Menendez	TSK

Exploitation Manager

Luis Millán Monte (TSK) will be responsible for continuous assessment of the market potential of the developed know-how. The data extraction of market characteristics and determination of the actual market trends is imperative to realize the full commercial potential of the project results. Therefore, the Exploitation Manager will lead the work on market analysis survey and benchmarking activity, including preparation of exploitation plans (performed individually by all, Industrial partners and SMEs). His task is also the identification of potential users outside the project partners and as the main contact point for business related issues (together with PSC and GA).

Dissemination Manager

During the project lifetime, several dissemination and communication activities will be undertaken (see the dissemination and communication activities) and the executive power will be a Dissemination Manager **Lenka Bajarová (AMI).** The aim of the dissemination activity will be twofold:

- To inform the specialized research community, but also recognized sub-system providers, integrators and end-users about the latest achievements of European research and progress in CSP technologies.
- To allow the consortium to reinforce the links between the European R&D communities and end-users clustered around other European or National research activities.

3.2.3. Conflict resolution procedures

It can be expected that most of the decisions will be taken by consensus of all the partners. In a first step, it is the role of the Project Coordinator to identify and possibly resolve potential conflicts in a proactive manner in collaboration with WPLs. All cases will be discussed among the conflicting parties in good faith. However, in case of a serious conflict, when the Project Coordinator is unable to mediate between conflicting parties, either partner can ask the GA in writing to organise a conflict resolution meeting. The General Assembly will organise such a meeting within 30 days following the receipt of the written request and attempts for arbitration will be performed in increasing order of authority from the level of the WPLs to the General Assembly level. Within the meeting, agreements are searched for by dialogue and mutual concession. In case of a failure to find an agreement, the General Assembly will make the final decision by the voting rules described above (i.e. majority vote). The conflict resolution procedures will be agreed upon in the preparation of the Consortium Agreement.

3.2.4. Meeting plans

Ordinary meetings will be organised according to the best practise developed during previous cooperative research projects and to fully comply with H2020 rules. Responsible personnel will inform at least 2 months prior the meeting about the agenda and location of the physical meeting. To save time and resources, operational meetings could be performed also by using a teleconferencing system (e.g. CISCO WEBEX), arranged according to the nearest possible availability.

Table 24. SOLWATT management meetings and communication

		GA	PSC	WPs	Tasks
Periodicity	**Respons.**	Coord.	Coord.	WPLs	Task leaders
Annually		X			
Biannually			X	X	
Quarterly			telecon	telecon	X (to monthly)

3.2.5. Quality Control Assurance

Progress made in reaching the deliverables in each Work Package will be regularly assessed by integrating all inputs from the WPLs and Coordinator (with PSC). The progress of the project will be assessed at two levels with the help of general indicators, which are representing objectives, milestones and deliverables and appropriate use of budget. On top of that a quality control by Exploitation Manager will ensure efficient translation of generated know-how to the commercialized products and services.

All deliverables generated by the persons in charge (see list of deliverables) will be checked and controlled in this sequence: WP leader > Project Manager > Exploitation Manager > Project Coordinator and PSC > submission to EC > EC Project Officer or reviewer. Moreover, the PSC will conduct the internal quality assessment of milestones and deliverables that are based on the quantified objectives detailed in section 1.1 and within the WPs' descriptions. The 6 months' periodicity for the PSC meeting is foreseen to perform internal assessment of the project and ensure the conformity and the quality of all project deliverables with the requirements. Management and coordination efficiency will be quantified by the regularity of reporting and the absence of delay in the delivery of documents. The WP leaders are responsible for monitoring progresses in their own WP, identifying risks (e.g. non-performing partners) and rapidly informing the PSC.

3.2.6. Innovation management

The implementation of SOLWATT follows several latest best practises and trends for successful innovation management. First, the technical and product oriented innovation is based on combination of several technologies and process blocks, which could be hardly exploited alone and without clearly defining market needs. SOLWATT innovation is pulled by the end-user needs with clearly defined target and adapted methodology. The applied project structure is based on extensive technology assessment and market survey and evaluation during proposal writing level. This activity has been supported by individual partners, and by the product manager of TSK.

Several innovation management tools and processes are planned for the project, e.g. fast innovation cycles during specification, end-user involvement during specification and validation phase, periodic IPR assessment, product-focused project management (incl. phasing of project – laboratory & industrial, focus on manufacturing, strict prior notice procedure), etc.

3.2.7. Involvement of the European Commission

It is foreseen that the project will establish a cooperative relation with the appointed EC Project Officer and external reviewers (should they be used). They will receive full access to the member's restricted area of the webpage to monitor progress and control the latest version of documents (meeting minutes, deliverables, reports, etc.) in preparation. Any deviations from the work plan will be proactively reported and contingency measures offered. Moreover, consortium members commit themselves to be supportive for any policy-making activity in the R&D "power-to-chemical" technologies and energy management in general (see also the Impact part).

3.2.8. Critical risks for implementation

The extensive risk analysis was performed identifying more than 15 potential risks, including their probability and impact evaluation. The consortium has collectively prepared contingency measures, which should avoid the occurrence of these risks. None of the identified risk shows serious problem for the project implementation (mitigation solution is acceptable). Particular attention during the project lifetime will be given to those in the moderate and high region.

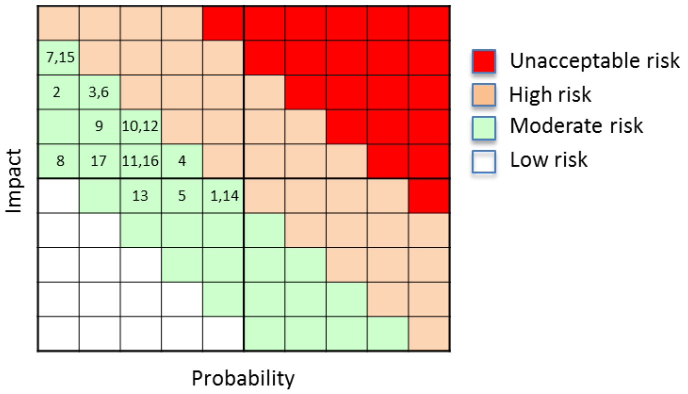


Figure 27. SOLWATT risk table

Table 25: SOLWATT implementation risks

	Risk description & Level of probability/impact (1 - 10)			**Relat. MIL**	**Contingency plan and risk management** (after project amendment and EC approval)
n.	**Description**	**Prob**	**Imp**		
1	Significant delay in collecting socio-economic data from Case Study sites	**5**	**5**	**MS1.2**	Preparatory work in YR1, including use of the extensive networks of the project partners which cover all countries of interest.
2	Water-related models are too complex to efficiently implement in optimizer	**1**	**8**	**MS2.1**	Models would have to be simplified; results might be suboptimal; good planning at start of project needed to foresee corresponding variables and relations already at project start.
3	Coupling of O&M Optimizer and FoSyS tool does not work	**2**	**8**	**MS2.2**	Good information exchange and interface planning at a very early stage of the project required between DLR and TSK. Principle feasibility has already been proven by coupling of DLR-Matlab tool to FoSys (for different purpose, though)
4	MONARCH runs have technical problems leading to late delivery of dust simulations	**4**	**6**	**MS2.5**	Produce outline document of the procedures for obtaining HPC resource, along with the timescales involved.
5	Data access related problems to real-time mineral dust forecast	**4**	**5**	**MS2.4**	To ensure the duplicity of the mineral dust forecast system, it will be implemented in another cluster at BSC and the operations team will ensure the proper management of the system.
6	Smart Mirror sensor accuracy drift over long periods of time (>2-3 years)	**2**	**8**	**MS3.2**	integration in the reflector structure may introduce additional unknown sources of drift (e.g. micromechanical tolerances) that would be amended with programmed in-situ calibration processes.
7	Antisoiling coating durability in mirror is less than 3 years.	**1**	**9**	**MS3.4**	The preliminary results indicate the durability of the antisoiling coating for the mirrors are higher than 3 years. In case, the target will not have achieved it will be changed the thickness, and the coating formulation.
8	Anti-soiling coated lab samples are more durable than full receivers	**1**	**6**	**MS3.4.**	Up-scaling process is checked by comparing lab and full-size samples under accelerated aging. If necessary several test campaigns will be carried out until satisfactorily results are achieved

9	Difficulties in the scaling-up of the deposition process due to the selected antisoiling coating to be applied on real size glass tube for receivers	**2**	**7**	**MS3.4.**	Alternative coating to be chosen among the several evaluated in WASCOP, with similar antisoiling properties
10	Manufacture and delivery of dust barriers delayed	**3**	**7**	**MS3.4**	Preparatory work in YR1, including the identification of at least three suppliers
11	Delay in realization of the cTES and its connection to the existing plant	**3**	**6**	**MS4.2**	The timeline established for the tests is quite large (2 years) to cover possible delays
12	Benefits of the cTES lower than expected	**3**	**7**	**MS4.3**	Models for pre-assessment are constructed and will be improved. In addition, pre-experimental works will be done to check components benefits (as membranes).
13	Delay in the manufacturing of the plant, which will affect to the on-site validation	**3**	**5**	**MS5.1**	The timeline established for the tests is quite large (2 years) to cover possible delays
14	Delay in the experimental campaign, which will affect in the optimization, calibration and control	**5**	**5**	**MS5.2** **MS5.3**	The timeline established for the tests is quite large (2 years) to cover possible delays
15	Installation of O&M Optimizer not feasible at FoSys System at plant site	**1**	**9**	**MS6.x**	On-site installation requirements and restrictions are discussed and agreed on already at an early stage of the project. Consortium agreement will foresee contractual right to test on site.
16	Delay in the manufacturing of the components, which will lead to a delay in the installation.	**3**	**6**	**MS6.2**	Testing periods would be extended if possible. Otherwise, the test will be shortened. As the planned testing periods are quite long, results would be still valid.
17	Lack of in-house management skills	2	6	**MS8.1** **MS8.2**	Rogelio Peón Menendez (PC) has a lot of international research experience which she has gained during the participation in number of R&D projects, most of them EU funded. We also count on the governance skills of the GA.

3.3. Consortium as a whole

The project partners have very complementary background know-how, which is indispensable for this challenging project. Only by the collaboration of selected leading European groups, and in several cases by their very recent discoveries, the ambitious goals of this project can be achieved.

The project is bringing together key European players, each one being among the top performers in their respective field in Europe and/or world-wide. The pool of SOLWATT project partners has been selected to cover the complete knowledge needed for significant progress towards defined objectives and beyond. Partners are assembled around the value-chain (more information in section 2 Impact). The strong added value of this proposed project is the quality of new and previously established partnerships, which are prerequisites for successful cooperation with a common goal.

In principle, industrial partners can rely on RTD focused partner, which will help to address various issues and to include fundamental knowledge, should this be necessary.

Table 26: SOLWATT partners and their complementary roles

SOLWATT	TSK	CEA	DLR	CIE	CU	TEK	RIO	ASE	IND	FNK	BSC	BSII	AMI
Ultrasonic cleaner	X					X				X			
Heliostat cleaning device			X	X								X	
Dust barriers	X			X	X								
Anti-soiling coating	X		X	X		X	X	X					
Integrated soiling sensors	X					X	X						
Cold storage system	X	X			X			X				X	
Water recovery by MEE system	X			X	X				X				
Dispatch and O&M optimization	X	X	X	X	X						X		
Social, econ., environment. studies	X	X	X	X	X	X	X	X	X	X	X	X	
Dissemination, exploitation	X	X	X	X	X	X	X	X	X	X	X	X	X
Project management	X	X	X	X	X	X							X

The SOLWATT consortium has been specifically put together:

- to have all the diverse, multi-disciplinary and complementary expertise required for this ambitious project (see also section 2 – Impact),
- to support the participating European industry with new disruptive knowledge which will be implemented through their products and services and will allow them to expand know-how to other market as well.

European approach: On a national or local basis only, this project would be unthinkable or would significantly suffer from lack of selected theoretical and practical expertise and technical equipment needed for design, development and validation of new CSP technologies. The SOLWATT project represents a unique opportunity to connect well reputed scientific and technology teams in this medium group. Therefore, only the complex response will allow better understanding and disruptive progress in CSP technologies and for new market creation. Only by the collaboration of specialized leading groups at European level the ambitious goals of SOLWATT project can be achieved (Figure 28).

Figure 28. European dimension of the SOLWATT

Additional partners: All necessary partners have been identified prior to the project preparation. At present, there is no need to include additional partners to reach the objectives of the project. If such need should arise, the coordinator may organize a competitive call (respecting the articles 55 and 56 of the Multi-beneficiary General Model Grant Agreement) on request by the General Assembly.

3.1. Resources to be committed

The personnel costs represent **55 %** of the total direct costs and they are kept on a reasonable level, considering a 4 years research project. The overall personal effort is **1282 person-months**, which represents well the effort needed for this -large cooperative challenging demonstration project.

The distribution of person-months was diligently evaluated per individual tasks and they represent the best-estimated effort to achieve them, the highest personal effort will be carried out by TSK (project coordinator, key partner for the demonstration of technologies), CIE (Developer of Ultrasonic cleaner, integrated soiling sensor, co-developer of antisoiling coatings), CU (coupling with socio-economic and environmental aspects, developer of dust barriers, co-developer of cTES) and IND (key partner for water recovery system). The cost of requested person-months was prepared according to internal rules for the salary of intended personnel. All entered data are auditable.

The equipment costs are at a very low level representing **4%** of the overall budget and corresponding to depreciation of IT-hardware for O&M optimizer (DLR), Antisoiling equipment (RIO, ASE), structure supporting the cleaning device (FNK). All other partners have the necessary equipment available. **The consumable and supplies costs** are at the level of **14%** in this project which is appropriate to this kind of demonstration project. The details are indicated in the table of other direct costs. **Travelling (4 %)** represents travels connected with the installations at testing sites, travels to technical and coordination project meetings (up to 2 persons per participant) and to dissemination and exploitation events for included personnel (see also SOLWATT dissemination and communication plan). **Other direct costs (1%)** include costs for dissemination and communication and audit certificates (CFS). Audits to be run at the end of the project are expected for TSK, CEA, DLR, CIE, CU, TEK, ASE, IND and BSII. **Subcontracting** of 214,464€ is foreseen for technical support for Installation of mirrors, HCEs and dust barrier. Mechanical and electrical installation of the WRS. Authorized Control Body for the installations of the plants (TSK), Laboratory assistant for anti-soling coating sample investigation (DLR), design of PLC for the truck and programming of the parameters of control system for the cleaning system (FNK), creating and running of the project website (AMI). All subcontracting will be managed according to Article 13 of H2020 Multi-beneficiary General Model Grant Agreement. Costs for large research infrastructure (LRI) are planned for CEA.

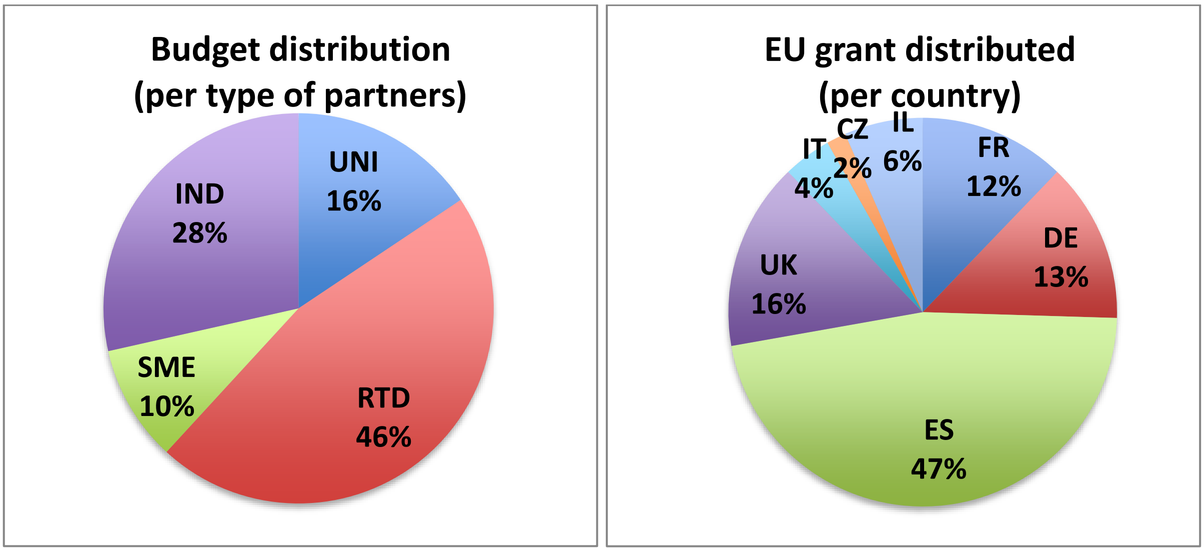


Figure 29. Budget distribution (per type of partners) and EU grant distribution (per country)

Table 27. Project total costs and EU requested grant divided per type of costs (in round numbers)

Partner	Person.	Equip.	Cons. & Supplies	Travel	LRI	Other costs (IPR, Audits)	Subcon.	Total direct costs	Total indirect costs	Total costs	EU requested
TSK	1 038 240	0	311 000	111 055	0	8 000	103 800	1 572 095	367 074	1 939 169	1 357 418
CEA	878 309	0	130 000	30 000	6 870	7 500	0	1 052 679	263 170	1 315 849	1 315 849
DLR	876 330	81 200	72 000	46 000	0	23 000	65 664	1 164 194	274 633	1 438 827	1 438 827
CIE	736 736	0	87 880	41 000	0	21 300	0	886 916	221 729	1 108 644	1 108 644
CU	910 150	0	358 250	53 400	0	29 400	0	1 351 200	337 800	1 689 000	1 689 000
TEK	504 639	0	126 000	27 000	0	6 000	0	663 639	165 910	829 549	829 549
RIO	176 240	138 850	4 597	11 400	0	0	0	331 087	82 772	413 859	289 701
ASE	335 250	112 900	23 000	22 000	0	3 000	0	496 150	124 038	620 188	434 131
IND (VEN)	535 741	0	410 500	20 000	0	5 500	0	996 741	242 935	1 239 676	867 773
FNK	99 640	191 340	0	15 835	0	0	40 000	346 815	76 704	423 519	296 463
BSC	220 500	3 218	0	14 000	0	5 500	0	243 218	60 805	304 023	304 023
BSII	464 000	0	280 000	50 000	0	13 000	0	807 000	201 750	1 008 750	706 125
AMI	156 000	0	5 000	20 000	0	15 000	5 000	201 000	49 000	250 000	175 000
Total	**6 931 774**	**527 508**	**1 808 227**	**461 690**	**6 870**	**137 200**	**214 464**	**10 112 733**	**2 468 318**	**12 581 050**	**10 812 502**
%	55%	4%	14%	4%	0%	1%	2%	80%	20%	100%	86%

3.1.1. Summary of effort

Approximately one half of the project budget is distributed among industrial and SMEs partners, which is a good pre-requisite for successful cooperative project, with high exploitable potential and reflects the application driven philosophy of this project as well as “close to the market” orientation of H2020.

The entities included in this project represent **6 European and 1 non-EU country** (H2020 associated country) with essential know-how. The largest part of the EU contribution is attributed to Spain (Coordinator + main industrial partners), followed by United Kingdom, Germany and France.

Table 28. Project Effort Form - Indicative efforts per activity type per beneficiary (WPLs highlighted)

	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	Total
TSK	4	24	21	1	54	84	3	15	206
CEA	1	6	0	61	0	41	4	2	115
DLR	1	80	16	0	0	5	3	2	107
CIE	25	4	26	0	40	59	9	2	165
CU	61	9	15	36	8	32	3	3	167
TEK	0	0	68	0	0	25	5	2	100
RIO	0	0	27	0	0	2	0	0	29
ASE	0	0	35	36	0	1	1	2	75
IND	0	0	0	0	103	35	2	0	140
FNK	0	0	32	0	0	15	0	0	47
BSC	0	48	0	0	0	0	1	0	49
BSI	0	0	52	6	0	0	0	0	58
AMI	0	0	0	0	0	0	12	12	24
Total	92	171	292	140	205	299	43	40	1282
%	7%	13%	23%	11%	16%	23%	3%	3%	100%

The upscaling, manufacturing, integration and demonstration WPs (WP2 – WP6) are representing close to 87 % of the overall SOLWATT effort.

Socio-economic and environmental aspects of the project represent 7% of the overall effort. **Dissemination and exploitation activities** of project results are an integral part of this ambitious project and they represent 3% of the overall effort. The **activities related to management** (coordinator + project manager + running costs of Project Steering Committee members) stand for 3% of the effort.

3.1.2. “Other direct cost” items

TSK	Cost (€)	Justification
Travel	111,055	Participation to project and technical meetings (2 meetings per year for 2 persons), participation to dissemination events, Testing in La Africana
Other goods & services	319,000	Computer for the O&M optimizer in La Africana (1 k€), Piping and insulation for the connection of the WRS with "La Africana" (150 k€), Pumps and valves for the connection of the WRS (100 k€), Instrumentation for the WRS (30 k€), Wiring and control for the WRS (30 k), Audit certificate (8 k€)
Total	**430,055**	
Subcon.	103,800	Installation of mirrors, HCEs and dust barrier. Mechanical and electrical installation of the WRS. Authorized Control Body for the installations of the plants.

CEA	Cost (€)	Justification
Travel	30,000	Participation to project and technical meetings (2 meetings per year for 2 persons), participation to dissemination events
Other goods & services	144,370	Licenses (30 k€), Sensors and controller (80 k€), Floating membrane testing (25 k€), dissemination costs (5 k€)
LRI	6,870	INES platform costs
Total	**174,370**	

DLR	Cost (€)	Justification
Travel	46,000	Participation to project and technical meetings (2 meetings per year for 2 persons), participation to dissemination events
Equip.	81,200	IT-hardware for optimizer, particle counters and soiling measurement devices for soiling measurements
Other goods & services	95,936	Maintenance for laboratory measurement instrumentation and remote meteo stations, software licences (72 €k), 3 conference fees and 3 open access fees (15 k€), Audit certificates (8 k€)
Total	222,200	
Subcon.	65,664	Laboratory assistant for anti-soling coating sample investigation

CIE	Cost (€)	Justification
Travel	41,000	Participation to project and technical meetings (2 meetings per year for 2 persons), participation to dissemination events
Other goods & services	109,180	Organization of training courses (35 k€), chemicals, UV lamps for climate chambers, abrasive materials for abrasion tests (15 k€), Software licenses (36.8 k€), Journal open access (12 k€), Registration fees to congresses (4.8 k€), UV lamps for spectrophotometer (1 k€), Audit certificate (4.5 k€), Dissemination costs (16.8 k€)
Total	150,180	

CU	Cost (€)	Justification
Travel	53,400	Participation to project and technical meetings (2 meetings per year for 2 persons), participation to dissemination events
Other goods & services	387,650	Translate/transcript for WP1 (9,750 €), Dust barriers materials for WP3 (10 k€), Dust barriers materials for WP6 (20 k€), thermoflex license for Wp4-6 (7.5 k€), laptops for postdocs (5 k€), distance learning package for WP1 (6 k€), construction of cTES--1000m^3 pond for WP4 &6 (120 k€), connecting pipe works to La Africana plant for WP4&6 (180 k €) dissemination costs (14.4 k€), audit certificate (15 k€)
Total	441,050	

TEK	Cost (€)	Justification
Travel	27,000	Participation to project and technical meetings (2 meetings per year for 2 persons)
Other goods & services	132,000	Rs485 Serial Comms. Hub for sensor information collection (5 k€), Industrial PC Station for Sensor Information Collection and Processing (3 k€), Precision Moulds for sensor parts (30 k€), Components for sensor parts (15 k€), Fabrication costs for sensors prototypes (15 k€), Tooling for sensor installation process (12 k€), consumables for ultrasound cleaning TBC (30 k€), Materials for coatings TBC (16 k€), Dissemination costs (3 k€), Audit certificate (3 k€)
Total	159,000	

RIO	Cost (€)	Justification
Travel	11,400	Participation to project and technical meetings (2 meetings per year for 2 persons), participation to dissemination events
Equip.	138,850	Pilot installations - Antisoiling equipment: Tent and air conditioning equipment and pressurized (30 k€), Pressurized roll tunnel with T control (25 k€), Spraying pilot cabin modification for real size parts (18 k€), Ionic curtain (15 k€), Nozzles (800 €); Smart mirror equipment : Design and construction of positioning table and tooling for bonding the box (45 k€), Tooling for verifying adherence and sealing (7 €k), Transport rack Redesign and construction (2.5 €), Adhesive cutting die (3.5 €k), Tool for mirroring window (2 €k)
Other goods & services	4,597	Antisoiling material: Mirrors for trials (1,367 €), Mirrors for 50 prototypes (513€), Transport of the mirrors to "La Africana" (500€), Samples (450€); Smart mirror material: Mirrors for 30 prototypes (256.2€), Adhesive material (500€), Mirrors for trials (512.4€), Transport of the mirrors to "La Africana" (500€)
Total	154,847	

ASE	Cost (€)	Justification
Travel	22,000	Participation to project and technical meetings (2 meetings per year for 2 persons)
Equip.	112,900	Receiver tubes with standard glass coating (31.6 k€), Scale-up and industrialization of new anti-soiling deposition process (30.5 k€), Receiver tubes with new anti-soiling glass coating (36.8 k€), Depreciation of equipment and instrument (14 k€)
Other goods & services	26,000	Materials, Samples and Supplies (23k€), dissemination costs (3 k€)
Total	**160,900**	

IND	Cost (€)	Justification
Travel	15,000	Participation to project and technical meetings (2 meetings per year for 2 persons), participation to dissemination events
Other goods & services	3,500	Consumable and supplies (500€), Dissemination costs (500€), Audit certificate (2,500€)
Total	**18,500**	

FNK	Cost (€)	Justification
Travel	15,835	Participation to project and technical meetings (2 meetings per year for 2 persons), participation to dissemination events
Equip.	191,340	Chassis (carrier) (69 k€), Crane (25 k€), Hydrostatic equipment for driving at low speed (8.5 k€), Oleo-hydraulic circuit for moving crane and cleaning device (13 k€), PLC, sensors, etc (37,690 €), Structure for supporting the cleaning device (22 k€), Others (16 k€)
Total	**207,175**	
Subcon.	40,000	Design of PLC for the truck and programming of the parameters of control system for the cleaning system

BSC	Cost (€)	Justification
Travel	14,000	Participation to project and technical meetings (2 meetings per year for 2 persons), participation to dissemination events
Equip.	3,218	Data Cartridge 20 Pack HPE T10KD (3 k€)
Other goods & services	5,500	2 Scientific publication
Total	**22,718**	

BSI	Cost (€)	Justification
Travel	50,000	Participation to project and technical meetings (2 meetings per year for 2 persons)
Other goods & services	293,000	Plastic Molds, Plastic, GRP Pultrusions, Aluminium, CNC machining of parts, Electric Motors, Gears, Controls, Tooling (280 k€), Dissemination costs (9 k €), Audit certificate (4 k€)
Total	**343,000**	

AMI	Cost (€)	Justification
Travel	20,000	Participation to project and technical meetings (2 meetings per year for 2 persons), participation to dissemination events
Other goods & services	20,000	Preparation and consumables of SOLWATT dissemination materials (posters, leaflets, roll-up, booklets etc.), conference and event fees & dissemination activities organization.
Total	**40,000**	
Subcon.	5,000	Subcontracting for the development of the website

4. MEMBERS OF THE CONSORTIUM

4.1. Individual participants (applicants)

1. TSK Electrónica y Electricidad S.A. (TSK), Spain

TSK is a leading business group in engineering development and supply of facilities of the highest quality with 30 years of experience. It is specialized in developing EPC (Engineering, Procurement and Construction) projects in different sectors: conventional power, renewable power, handling and mining, Oil&Gas, electrical infrastructures and industrial plants.

After years of continuous growth, the company reached in 2016 a turnover of around € 1000 million, with over 1000 professionals and international presence in more than 35 countries. TSK is based in Spain, however, the international market has a very important role, with over 95% of the sales.

TSK has an extensive experience in Concentrated Solar Power plants. So far, TSK has participated in the construction of the following plants: Shagaya (Kuwait), Bokpoort (South Africa), Noor I (Morocco), Puerto Errado 2 (Spain), La Africana (Spain), Andasol III (Spain), La Florida (Spain), Kuraymat (Egypt) and La Dehesa (Spain).

The innovation is part of the long-term strategy of the company, which results in strong investments in R&D projects. These projects are usually carried out in collaboration with technology centres, universities and companies within the framework of local, national and European programs.

Main tasks attributed in the project

TSK will act as the coordinator of the project, ensuring that the objectives stablished during the proposal will be reached along the length of the project. It will be responsible for the good communication among all the partners to reach agreements when needed, setting up periodical meetings to monitor the progress of the project and stablishing guidelines. The company will be as well, the interlocutor with the European Commission.

Besides the coordination of the project, TSK will be the responsible of the WP6, installation and validation at testing sites. In this work package, TSK will be in charge of the installation of the equipment and will perform the tests of the different technologies developed in the project.

Including TSK in the consortium, an important EPC contractor, can help the rest of the partners thanks to all the industrial experience obtained during the construction of several CSP plants. Additionally, the participation of TSK allows the consortium to test the technologies in a real plant.

Finally, TSK will be able to install in the future plants all the innovations developed.

List of relevant previous projects or activities (max. 5)

- **CAPTURE - Competitive Solar Power Towers (H2020)**
  The main objective of the CAPTURE project is to reduce the costs of solar thermal plants by implementing an innovative plant configuration. The configuration is based on several independent towers operating with air at 1100 ° C, each coupled to a Brayton cycle. The residual heat of these cycles is used to store thermal energy, which will feed a Rankine cycle.
- **HPS-2 – Demonstration of a solar thermal parabolic trough power plant and steam generation system using molten salt as the Heat Transfer Fluid**
  The use of molten salts as a heat transfer fluid has important advantages. The operating temperature can be increased substantially to 500 ° C, and the plant is considerably simplified by using the same fluid for storage and as heat transfer fluid. To validate the technology and identify possible problems during the operation, a test loop will be built in Évora (Portugal), where the TSK-FLAGSOL Heliotrough 2.0 collector will be installed.
- **MATSAL – New materials for thermosolar plants with salts as heat transfer fluid**
  This project proposes to study a mixture of ternary salts known as HITEC, which has a freezing temperature of 142° C. This low temperature would facilitate the operation of the plant, and drastically reduce the costs of solar field tracing. However, the thermal stability of this salt mixture at an elevated temperature and the corrosive effect of these salts are unclear. It is proposed to test these salts for 6 months in order to compare the results with binary salts and the HITEC XL ternary salt mixture. The

behaviour and resistance to corrosion of two types of coatings in contact with HITEC salts will also be tested in this project.

- **WOBAS – Operating strategies based on cloud cameras for thermosolar plants**
The aim of the Wobas project is to develop a tool which, using cloud cameras, can predict the direct radiation that a solar thermal plant will receive in a very short term. Cameras record the sky and detect the presence of clouds and their movement to determine when and to what extent they will reach the plant. This very short-term prediction will optimize the operation strategy at any given time. During the project, a prototype will be installed in the "La Africana" solar thermal plant to test the system in a real plant

Description of any significant infrastructure and/or any major items of technical equipment

TSK is owner of the CSP plant "La Africana", which is located in the south of Spain. The plant will be used to test different technologies in an operational environment.

Curriculum vitae of the key persons

Dr. Rogelio PEÓN (M) will be the project coordinator**.** He holds a PhD as Industrial Engineer, he has over 20 years of experience in managing industrial projects. He was consultant in the company Agere Systems (PA, USA) for several years. He is currently working as Director of Technology department in TSK. His recent projects in the solar thermal business concerned the following: Shagaya (50MW), NOOR1 (160MW), BOKPOORT (50MW), La Africana (50MW), Florida (50MW).

Luis MILLÁN (M) will be the explotation manager and the WP6 leader**.** He is an Industrial Engineer, with a specialization in mechanical engineering. He works in the technology department of TSK since 2015 as technical coordinator of the R&D projects related with Concentrated Solar Power plants. He has worked as project engineer for the Bokpoort (South Africa) and Shagaya (Kuwait) plants.

Oscar José RODRÍGUEZ (M) is an industrial engineer. He works for TSK since 2008. He has participated in the the construction of many different electrical generation plants. In CSP, he was involved in the construction of SAMCA I and II, Puerto Herrado II, Calasparra, La Africana, Bokpoort and Noor I.

Antonio CORRAL (M) is an industrial engineer with the electrical specialization. He has more than 25 years of experience in the field of energy production. He has worked in TSK for 11 years, participating in 37 projects of renewable energy (mainly solar).

List of relevant publications and/or products, services, software (max. 5)

- Alvarez Barcia L., Peón Menéndez R., Martínez Esteban Juan A.A, José Prieto M., Martín Ramos J.A., Javier de Cos Juez F., and Nevado Reviriego A. : Dynamic Modeling of the Solar Field in Parabolic Trough Solar Power Plants, 2015.
- Alvarez Barcia L., Peón Menéndez R., Nuño F., Martínez Esteban J.J., José Prieto M.A., Nevado A., : Optimized Control of the Solar Field in Parabolic Trough Solar Power Plants.
- **Peón Menéndez R., Martinez J.A., Prieto M.J., Á. Barcia L. and Martín Sánchez J.M.**: A Novel Modeling of Molten-Salt Heat Storage Systems in Thermal Solar Power Plants, 2014.
- **Mielgo E., Conejero O., Millán L.**: Influencia del contenido en cloruros en la corrosión bajo tensión de aceros inoxidables austeníticos inmersos en nitratos fundidos, 2016.
- Alvarez Barcia L., De Cos Juez F.J., Martinez Esteban J.A., José Prieto M.A., Nevado A., Peón R.: Modelado de Sistemas de Almacenamiento Térmico de Sales Fundidas para Centrales Solares.

2. Commissariat à l'Énergie Atomique et aux Énergies Alternatives (CEA), France

CEA (France's Alternative Energies and Atomic Energy Commission) is a Research and Technology Organization (RTO) and a full member of EARTO. It aims to produce, integrate and transfer science and technology to help resolve the main EU challenges (low carbon energies, defense and security, information and healthcare technologies) and to exploit opportunities for new wealth creation, improved standards of living, and economic competitiveness. CEA brings together key players across the whole innovation chain, from fundamental to technological research, from product and process development to prototyping and demonstration, and support full-scale implementation in the public and private sectors. CEA has a budget of 4.3 billion€ (2013), > 16 000 employees and file more than 500 patents /year.

Within CEA, LITEN (Laboratory for Innovation in New Energy Technologies) is fully dedicated to the program on new technologies for renewable energy and energy efficiency, in line with the French Grenelle environment summit, the Lisbon strategy and the European strategic plan for energy technologies. This includes research in solar energy (photovoltaic and thermal solar, integration in buildings, solar mobility, smart grids, massive storage etc.), conducted by INES (Institut national de l'énergie solaire), the production and storage of energy (hydrogen, fuel cells, batteries for electric vehicles), the development of 2nd and 3rd generation biofuels, and nanomaterials for energy. LITEN hires 1400 people, has a budget of 170 M€, and works with more than 350 industrial partners.

Main tasks attributed in the project

CEA-LITEN will have the charge of the design and development of the cold Thermal Energy Storage (cTES). CEA will participate to its integration and monitoring within the operational plant in La Africana. The definition of the control strategy and the optimization tool related will also be investigated by CEA. For its technical activities, CEA-LITEN will use the complementarity of several of its laboratories gathered within a dedicated Heat, Biomass and Hydrogen department. The Laboratory of High Temperature System, based in CEA-INES site, and the laboratory of Heat Storage, based in CEA-Grenoble, will mainly take part of the cooling aspects proposing investigations on the optimization of the cooling process as a way to shift the heat exhaust to heat production **(WP4)**.

List of relevant previous projects or activities (max. 5)

- **WASCOP – Water Savings on Solar Concentrated Power (H2020 Project)**
  WASCOP project aims at development, assessment and promotion of innovative solutions to foster the reduction of the water consumed by CSP plant from solution at TRL2-3 to TRL5. The WASCOP project is coordinated since 2016 by CEA.
- **STAGE-STE – Scientific and Technical Alliance for Guaranteeing the European Excellence in Concentrating Solar Thermal Energy (FP7 project)**
  Project comprising a WP about "Materials for Solar receivers and STE Components" is an opportunity to compare accelerated aging tests protocols between the involved partners. There is also a WP on "Storage", which task on "Innovative Storage Systems" is leading by Ciemat. WP10, which is about "STE plus Desalination", includes the subtask 10.2 "STE cooling issues and desalination" in which the different cooling methods for a solar thermal plant are investigated.
- **MATS – Multipurpose applications by Thermodynamic Solar (FP7 project)**
  The proposed MATS Project aims at promoting the exploitation of concentrated solar energy through small and middle scale facilities, suitable to fulfil local requirements of power and heat, and easily to back-up with the renewable fuels locally already available or that can be expressly produced.
- **SOLAR PACES – Solar Power And Chemical Energy Systems**
  Task III of the Solar PACES Program, which comprises a Round Robin Test to demonstrate the validity of the Solar Reflectance Guidelines drafted by an expert group. It enables the validation of the methods and protocols used and the opportunity to confirm the measurements reproducibility. The good results validate that the measurements of the hemispherical solar reflectance from the six research centres are comparable.

Description of any significant infrastructure and/or any major items of technical equipment

On the CEA-INES site, a **solar durability platform** has been set up to study the optical components for solar thermal applications. Several climate chambers are dedicated to components ageing, representative of different kinds of environmental constraints (temperature, UV, rains, humidity, sand erosion and abrasion and saline mist). The optical performances are characterized in terms of reflectance, absorbance, emittance and transmittance thanks to spectrophotometers. The structural and chemical composition of the materials are also investigated thanks to FTIR and microscopic analysis.

The **Solar thermal Plateform of CEA-Cadarache** (South of France) is dedicated to the validation of solar components in real scale environment as to support the technical innovation from CEA-INES. It comprises several solar fields up to 400 kWth (Linear Fresnel reflectors and parabolic trough technologies). Different kinds of heat storage media are also set up on the platform to be representative of a thermodynamic solar power plant.´

RUTH facility has been used to test dry chiller in two French projects on energy recovery (ALTERECO and VALENTHIN). In ALTERECO, the moch-up was instrumented with a first generation of fouling probes.

Curriculum vitae of the key persons

Ing. Delphine BOURDON (F) is graduated in 1999 at the National Polytechnic Institute of Grenoble (France), specialized in thermal fluid dynamics and energetic analysis, she is permanent researcher as thermal system expert at CEA-LITEN since 2005 and has several patents. She is member of the High Temperature System Laboratory since 2012 where she's experienced as project leader on thermodynamics solar systems for European programs. Delphine is coordinating since 2016 the H2020-WASCOP project, dealing with the development of solutions to push forward the reduction of the water consumed by CSP Plants.

Dr. Arnaud BRUCH (M) will be involved in thermal storage studies. He was graduated in 2003 at the National Polytechnic Institute of Grenoble and he is specialized in thermal fluid dynamics and energetic analysis. He is a permanent researcher as thermal system and thermal storage expert at CEA. His main fields of experience are thermal energy storage and thermodynamics solar systems with special attention to conception and design of experimental set-up.

Dr. Roland BAVIERE (M) Engineer degree from INPG Grenoble in 2001 in fluid mechanics with a speciality in heat and mass transfer. He graduated as doctor in 2005 after defending his work on the characterization of hydrodynamics and forced convection heat transfer for single phase liquid flows in micro-ducts. He worked for 3 years for a software company developing full-scope nuclear power plant training simulators. In 2008, he then joined CEA in a team developing several thermal-hydraulics simulation codes used in the domain of safety assessment and verification for nuclear power plants. He joined LITEN in 2013 as a project manager. In charge of industrial projects and task/WP leader in FP7 European projects, he currently works on the development of decision support/making tools for operational optimization of district heating systems.

Dr. Raphael COUTURIER (M) Engineer degree from INSA Lyon in material sciences. PhD degree from Ecole des Mines on metallurgical optimization of powder metallurgy stainless steel for nuclear applications. He began his career at CEA with research projects on high temperature mechanical properties and welding technologies for high strength stainless steels and nickel based superalloys. In 2014, he took the lead of a laboratory dedicated to R&D projects on thermal storage with sensible, latent and thermochemical technologies deployed for solar, industrial and district heating applications. He is author or co-author of 34 patents. He managed European and French research projects for the development of new alloys used for high pressure turbine discs and blades. In 2009, he joined the thermal management team of CEA to work on the fabrication of compact heat exchangers/reactors for chemical applications. Ha was then in charge of an industrial project devoted to the development of a Fresnel concentrated solar power plant with thermocline thermal storage.

List of relevant publications and/or products, services, software

- **Raccurt O., Disdier A., Bourdon D., Donnola S. Gioconia A.** Study of the stability of a selective solar absorber coating under air and high temperature conditions. International conference on concentrating solar power and chemical solar power and chemical energy systems, solarpaces 2014, energy procedia, vol. 69, 1551-1557, 2015; doi: 10.1016/j.egypro.2015.03.107
- **Vuillerme V.** Design and modelling of an innovative three-stage thermal storage system for direct steam generation CSP plants. High-power power particle beams (BEAMS°, international conference on vol: 1734 (2016), ISSN : 0094-243X.
- **Bruch, A., Fourmigue, J.F., Couturier, R.** Experimental and numerical investigation of stability of packed bed thermal energy storage for CSP power plant, Energy Procedia, 2013.

- **Bruch, A., Fourmigué, J.F., Couturier, R.** Experimental and numerical investigation of a pilot-scale thermal oil packed bed thermal storage system for CSP power plant, Solar Energy, 2014.
- **Giraud L., Bavière R., Vallée M., Paulus C.** Recent advances in Modelling, Simulation and Operational Optimization of District Heating Systems. EuroHeat & Power, Issue IV, 2016.
- **Giraud L., Merabet M., Baviere R., Vallée M.** Optimal Control of District Heating Systems using Dynamic Simulation and Mixed Integer Linear Programming. Proceedings of the 12th International Modelica Conference May 15-17, 2017, Prague, Czech Republic DOI 10.3384/ecp17132141

3. Deutsches Zentrum für Luft - und Raumfahrt EV (DLR), Germany

DLR, the German Aerospace Center, is Germany‘s national research center for aeronautics and space. Its research and development work in aeronautics, space, energy, transport, defence and security is integrated into national and international cooperative ventures. As Germany‘s Space Agency, DLR is tasked with the planning and implementation of Germany‘s space program. In addition, two project management agencies have been established to promote DLR's research. DLR employs 7300 people; the center has 32 institutes and facilities at 16 locations in Germany and also has offices in Brussels, Paris, Singapore and Washington DC. DLR is member of the Helmholtz Association of National Research Centers.

The DLR Institute of Solar Research (SF) is the largest research entity in Germany investigating and developing concentrating solar technologies to provide heat, electricity and fuel. DLR has been conducting research in this field for more than 30 years and has bundled its activities in the newly founded Institute of Solar Research in 2011. Over 100 scientist and engineers belonging to the DLR Institute of Solar Research represent one of the world's leading research groups in the field of concentrating solar systems. R&D work is performed at own test facilities and laboratories in Cologne, Jülich and Stuttgart and furthermore through its permanent delegation at the leading test center for concentrating solar technologies, the Plataforma Solar in Almería, Spain, within a long-lasting collaboration with CIEMAT.

Main tasks attributed in the project

DLR will mainly provide its optimization and modelling experience to the consortium, especially regarding Soiling Rate Forecast and O&M Optimization. DLR will create a soiling forecast system for CSP collectors **(WP2)** based on the successful activities from the WASCOP project that will be transferred to numerical dust transport prediction models. In addition, DLR will extend its Dispatch Optimizer to an "O&M Optimizer" **(WP2)**, considering not only storage dispatch for revenue increase of a CSP plant, but also cooling system dispatching, soiling forecast, cleaning scheduling and water usage minimization. This O&M Optimizer will be integrated to TSK's Plant Supervisory system and be demonstrated at the La Africana power plant **(WP6)**.

Testing of anti-soiling coatings for reflectors and glass envelope tubes will be performed in lab, outdoor environment and in the solar field. A main focus will be set on proving their durability under operating conditions and initiating the standardization process of the coatings' characterization.

List of relevant previous projects or activities (max. 5)

- **WASCOP – Water Saving for Concentrated Solar Power (H2020 project)**
  DLR leads subtask 3.2 on the development of a soiling model that has been validated for two sites. The financial effects of soiling and cleaning for CSP projects have also been investigated in this task. DLR is involved in the qualification of anti-soiling coatings for CSP mirrors and absorber tubes.
- **STAGE-STE – Scientific and Technical Alliance for Guaranteeing the European Excellence in Concentrating Solar Thermal Energy (FP7 project)**
  DLR is work package leader in WP8 of the EU project STAGE in which a guideline for reflector testing is being developed as well as meteo data to characterize sand erosion is collected.
- **HNSEI – Helmholtz-NREL Solar Energy Initiative**
  Helmholtz Association´s Initiative and Networking fund project in cooperation with US National Renewable Energy Laboratory. In HNSEI, the TraCS system for the continuous measurement of soiling rates of reflectors for resource assessment was developed.
- **PREFLEXMS – Predictable and Flexible solar power with Molten Salt energy storage (H2020 project)**
  Within this EU-H2020 project, DLR is further developing its Dispatch Optimizer for a Solar Tower System with Molten Salt as heat transfer fluid. The optimizer shall make use of the full dispatchability of such STE plants. It will be demonstrated at the Evora Molten Salt Platform during the project, including DNI forecasts. DLR further develops and installs an innovative once-through steam generator for molten salt plants at the Evora Molten Salt Platform within the project, together with industry partners such as GE.

- **RAISELIFE – Raising the Lifetime of Functional Materials for Concentrated Solar Power Technology (H2020 project)**
  Anti-soiling coatings for reflectors are tested under accelerated climate chamer tests and in 2 outdoor sites.

Description of any significant infrastructure and/or any major items of technical equipment

OPAC (Optical Aging Characterization Laboratory) at the Plataforma Solar jointly operated with Ciemat. DLR have access to climate simulation chambers and to optical measurement equipment.

ENERMENA Meteo network. 8 operational meteorological stations with meteorological measurements for resource assessment spread over the MENA region. DLR has and can grant access to stations. Technical staff performs daily visits to the station for maintenance works. Meteo- and material data is collected regularly.

METAS (Meteorological station for solar technologies) at the PSA is jointly operated by Ciemat and DLR. Large number of continuous meteorological measurements is performed at PSA.

Curriculum vitae of the key persons

Fabian WOLFERTSTETTER (M) Dipl. Phys Fabian Wolfertstetter is a researcher in the Institute of Solar Research at DLR at the Plataforma Solar de Almeria. He has been involved as instructor in various capacity building courses throughout the MENA region and as a leading scientific partner in a bilateral research projects between Morocco and Germany. His field of expertise is the measurement of solar radiation and solar resource assessment, especially the effect of soiling on the components of CSP plants. He studied Physics at the University of Munich (LMU) and completed his PhD thesis on the effect of soiling on CSP plants at the University of Aachen.

Ana Carolina DO AMARAL BURGHI (F) is a researcher in the DLR Institute of Solar Research. She carried out research in the State University of Sao Paulo, Brazil (UNESP) regarding fuzzy logic methodologies for environment impact assessments. Since 2016, she has been working at DLR on the topics of control and simulation and is currently performing her PhD studies regarding “Dispatch Optimization of Solar Thermal Power Plant considering Uncertainties in Weather Forecasts”. She is an environmental engineer graduated by UNESP, with a master’s degree by the European Joint Masters in Management and Engineering of Environment and Energy, with academic semesters in Universidad Politécnica de Madrid, Ecole des Mines de Nantes and Budapest University of Technology and Economics. Within the SOWAT project, Ms. Do Amaral Burghi will extend and adapt the Dispatch Optimizer by soiling uncertainty models and all water-related boundary conditions, which allows for an overall non-linear optimization of operation and maintenance of an STE plant.

Dr. Florian SUTTER (M) Dr.-Ing. Florian Sutter is a team leader of the group ‚durability of components‘. He has been working as a scientist for six years at DLR. He is responsible for durability testing and optical measurements of solar materials, especially reflectors. He works in a joint laboratory that is shared with CIEMAT at the Plataforma Solar de Almería, Spain. He has participated in various industry and research projects as scientist and project leader.

Dr. Stefan WILBERT (M) works in the Institute of Solar Research at the German Aerospace Center (DLR) in the permanent delegation at the Plataforma Solar de Almería, Spain. He is leader of the research group “Solar Energy Meteorology” within the department “Qualification” and was subtask leader in the IEA Solar Heating and Cooling Task 46 “Solar Resource assessment and Forecasting”. He is also leading a subtask in the joint activities inSolar PACES Task V and IEA Photovoltaic Power Systems Task 16 “Solar resource for high penetration and large-scale applications”. He has more than 10 years of experience in the field of meteorological measurements, radiative transfer modeling, nowcasting with fisheye cameras and CST plant simulation. He studied physics at the University of Bonn and obtained his PhD from the University of Aachen with a thesis related to the determination of circumsolar radiation and its effect on CST plants.

Dr. Natalie HANRIEDER (F) is a researcher at the DLR Institute of Solar Research at the Plataforma Solar de Almeria. Her scientific focus is the effect of aerosols on the performance of solar power plants. She is experienced in the measurement of aerosol particle concentration, aerosol optical depth, meteorological optical range and other meteorological parameters. She has been involved as instructor in capacity building courses regarding solar resource in the MENA region and in India. She holds a PhD from the University of Aachen with a thesis dealing with the determination of atmospheric extinction of solar radiation in CST tower plants.

Dr. Marion SCHROEDTER-HOMSCHEIDT (F) works as a scientist at DLR German Remote Sensing Data Centre, climate and atmospheric products department since 1998. Ms M. Schroedter-Homscheidt has experience in managing projects with scientific experts and public and commercial users involved. She took part or led sub-projects in EC projects Heliosat-3 (Method development for solar resource assessment), MESOR (standardization of solar resource assessment), EnerGEO (GEOSS use for energy system transition studies). For ESA, she took part/led the projects ENVISOLAR dealing with earth observation for solar energy technologies; ESA pre-feasibility study for a concentrating solar power production forecast system in Spain (CSP-FoSyS). She also participated in the International Energy Agency Task 46 on 'Solar Resource assessment and Forecasting' and is now involved in the new PVPS task 16/SolarPACES task V. Overall, she has more than 15 years professional experience in developing user driven applications of Earth Observation in the areas of air quality, land surface and renewable energies (focus since more than 10 years).

Dr. Tobias HIRSCH (M) has been working at the DLR Institute of Solar Research since 2002. Starting with a PhD period on dynamic simulation of direct steam generation power plants, he was involved in several national and international research projects as an expert for dynamic behaviour and control system design for solar thermal power plants. Since 2011, he leads a research group on process development which covers topics such as direct steam generation, molten salt technologies, and process control and optimization. In the SOWAT project, he is responsible for the model integration of the various water usage and cooling effects, and, thus, together with Ms. Do Amaral Burghi, interacts with all relevant project partners. He has experience in preparing and leading large research projects with various partners. Since 2012 he has been actively pushing forward international guideline activities regarding STE plant performance calculations. Since 2014, he has been giving lectures on STE technology at the University of Stuttgart, Germany.

List of relevant publications and/or products, services, software (max. 5)

- **Wolfertstetter F., Pottler K., Geuder N., Affolter R., Merrouni A.A., Mezrhab A., Pitz-Paal R.:** Monitoring of mirror and sensor soiling with TraCS for improved quality of ground based irradiance measurements, in: SolarPACES Conference, Las Vegas, USA, 2013.
- **Wolfertstetter F.**: Effects of soiling on concentrating solar power plants, PhD thesis at Aachen University. To be published in 2017
- **Schüler, D., et al:** "The enerMENA meteorological network–Solar radiation measurements in the MENA region." AIP Conference Proceedings. Vol. 1734. No. 1. AIP Publishing, 2016.
- **Burghi A. C. d. A., Hirsch T. and Pitz-Paal R.,** CSP Dispatch Optimization Considering Forecast Uncertainties, submitted/accepted for SolarPACES 2017 Conference, Santiago de Chile, Chile, 2017.
- **SolarPACES** (2017) Guideline for Bankable Solar Thermal Electricity Yield Assessment; Editor T. Hirsch. Available at: http://www.solarpaces.org/press-room/news/item/119-guideline-for-bankable-ste-yield-assessment

4. Centro de Investigaciones Energéticas, Medioambiental Technologicas (CIEMAT), Spain

CIEMAT is a Spanish Public Research Institution owned by the Ministry of Economy and Competitiveness (www.ciemat.es). Since its founding in 1951, it has developed and led R+D projects in the fields of Energy, Environment and Technology, placing the institution at the forefront of science and technology. Its activities include the promotion, introduction and improvement of renewable energies on the energy market, as well as promotion of technology transfer, training and scientific outreach. With 1342 employees, 57% graduated, CIEMAT has a wide presence at international scientific and technical forums. In addition to the head offices and laboratories located in Madrid, CIEMAT owns several research centres in Spain. The Plataforma Solar de Almería, PSA, (www.psa.es) is one of these outlying centres located in Southern Spain, it is formally considered as European Large Scientific Installation and is also the largest R+D centre in the World devoted to solar thermal concentrating systems (research, development, and testing of concentrating solar thermal technologies). With a large and long-lasting international collaboration with many other R+D centres and industries, their main objectives are the contribution to the establishment of a sustainable and clean world energy supply, as well as the technical and scientific promotion of solar thermal technologies and derived solar chemical processes, in order to contribute to the development of a competitive solar thermal industry.

Main tasks attributed in the project

CIEMAT will lead WP 5, related to the evaluation of a water recovery system to be installed in a CSP plant. Also, CIEMAT will participate in WP 1, with a high participation in the training activities. In addition, CIEMAT will contribute to the cleaning activities with the durability testing of the anti-soiling coatings for receivers (WP 3) and will be involved in the standardization of testing for anti-soiling coatings (WP7). Finally, CIEMAT will lead the preparation of the experimental campaign and results analysis for the on-site testing (WP6).

List of relevant previous projects or activities (max. 5)

- **OPTS – OPtimization of a Thermal energy Storage system with integrated Steam Generator (FP7 Project)**
  Where CIEMAT gained valuable experience in integrating thermocline storage tanks in CSP simulation models and definition of efficient operation strategies for them.
- **STAGE-STE – Scientific and Technical Alliance for Guaranteeing the European Excellence in Concentrating Solar Thermal Energy (FP7 Project)**
  Comprising a WP about "Materials for Solar receivers and STE Components" is an opportunity to compare accelerated aging tests protocols between the involved partners. There is also a WP on "Storage", which task on "Innovative Storage Systems" is leading by Ciemat. WP10, which is about "STE plus Desalination", includes the development of detailed models of thermal desalination technologies and their coupling with solar thermal plants. This WP also includes a subtask in which the different cooling methods for a solar thermal plant are investigated.
- **HYSOL – Innovative Configuration for a Fully Renewable Hybrid CSP Plant (FP7 Project)**
  In this project, a new hybrid CSP system, fully renewable (solar + biomass), was developed at a pre-industrial scale by including a new configuration in a conventional CSP plant with storage system. CIEMAT was mainly involved in the implementation of an integrated operation and the development of control systems and tools.
- **RAISELIFE – Raising the Lifetime of Functional Materials for Concentrated Solar Power Technology (H2020 Project)**
  CIEMAT participated in several activities related to accelerated aging and outdoor testing of solar reflectors with different type of protective coatings, including anti-soiling coatings for reflectors.

Description of any significant infrastructure and/or any major items of technical equipment

Characterization of reflectors and glass tubes: 2 spectrophotometers to measure and calculate optical properties, 4 specular reflectometers to measure reflectance, 2 goniometers for static contact angles measurements and 2 microscopes. Accelerated aging of reflectors and glass tubes: 10 weathering chambers, 2 linear abrasers and 1 cleaning device. Outdoor test benches to study the effectiveness of special coatings, optimize the cleaning strategy, analyse the soiling rate and study the durability. A multi-effect distillation unit for water treatment made up of 14 stages, arranged vertically with direct feedwater supply to the first effect (forward feed configuration). At a nominal 8 m^3/h feedwater flow rates, the total water treated is 3 m^3/h, and the thermal consumption of the plant is 190 kWth, with a performance factor (kg of distillate produced per 2326 kJ of thermal energy consumed) over 9. Real scale facilities of all CSP technologies (including cooling and water recovery systems) for training.

Curriculum vitae of the key persons

Dr. Gema SAN VICENTE DOMINGO (F), with a PhD in Applied Physics-Chemistry, is a senior researcher in the field of coatings for solar energy applications with 17 years of experience in this area. Her research activity is mainly focused on the development and characterization of optical thin films by sol-gel method, specifically in antireflective coatings. She has participated in more than 13 R+D projects and more than 20 international Conferences. She is co- author of 19 papers in SCI journals and 1 patent.

Dr. Aranzazu FERNÁNDEZ GARCÍA (F), with a PhD in Environmental Engineering, is a researcher in the field of solar reflectors for concentrating solar systems. She has 15 years of experience in design and evaluation of solar thermal systems prototypes and optical characterization and durability testing of solar reflectors. She has participated in 16 R+D projects and more 32 contracts with industries. She is co-author of 17 papers in SCI journals and 46 communications to international Conferences.

Dr. Loreto VALENZUELA GUTIÉRREZ (F), with a PhD in Physics, is a senior researcher in the field of line-focus solar collectors and applications of concentrating solar thermal technologies. She has 20 years of experience in design, modelling, simulation and evaluation of solar thermal systems prototypes. She has been involved in more than 17 R+D projects and 20 contracts with industries or public bodies. She is co-author of 45 papers in SCI journals and 67 communications to international Conferences.

Dr. Patricia PALENZUELA ARDILA (F), with a PhD in Chemical Engineering is a researcher in the field of the integration of Multi-effect Distillation (MED) plants into Concentrating Solar Power (CSP) Plants. Her main activities are the development of software tools for modelling of CSP+MED systems, evaluation of cooling technologies in CSP plants, and on-site evaluations in solar stand-alone MED plants and coupled to heat pumps. She has been involved in 20 national and international R+D projects, has 26 papers in SCI journals and 28 contributions to different International Conferences.

Dr. Diego-César ALARCÓN PADILLA (M), with a PhD in Physics, is a senior researcher in the field of solar thermal concentrating technologies with special emphasis in solar thermal desalination and cogeneration processes. He has 20 years of experience in the design, modelling, simulation and experimental assessment of solar thermal desalination and absorption heat pump technologies. He has been involved in more than 20 R+D projects and several contracts with private companies. He is co-author of 48 publications in SCI journals and more than 75 contributions to International Conferences.

Dr. Lidia ROCA SOBRINO (F), with a PhD in Control System Engineering with an extraordinary doctorate award, is a researcher in the field of modeling, optimization and control theory and applications focusing on solar desalination and concentrating solar systems. He has contributed to 10 national and international R+D projects, authored 30 papers in SCI journals and contributed to more than 20 international conferences.

Dr. Javier BONILLA CRUZ (M), with a PhD in Computer Science with international mention and an extraordinary doctorate award, is a researcher in the field of object-oriented modeling, dynamic simulation, multi-objective optimization and automatic control of renewable energy systems. He has contributed to 5 national and international R+D projects, co-authored 12 papers in SCI journals and contributed to more than 10 international conferences.

Dr. Guillermo ZARAGOZA DEL ÁGUILA (M), PhD in Applied Physics, senior researcher in the field of solar desalination, especially thermal and including coupling MED with CSP. Has been involved in more than 40 R&D projects, published more than 70 papers in peer-reviewed international journals, presented more than 110 papers on international conferences, authored 8 book chapters and co-authored 3 books.

List of relevant publications and/or products, services, software (max. 5)

- **García-Segura A., Fernández-García A., Ariza M.J., Valenzuela L., Sutter F.:** Durability studies of solar reflectors: A review. Renewable and Sustainable Energy Reviews 62 (2016), 453-467.
- **Palenzuela P., Alarcón-Padilla D.C., Zaragoza G.:** Large-scale desalination by combination with CSP: Techno-economic analysis of different options for the Mediterranean Sea and the Arabian Gulf. Desalination 366 (2015), 130-138.
- **San Vicente G., Bayón R., Germán N., Morales A.:** Surface modification of porous antireflective coatings for solar glass covers. Solar Energy, 85 (2011), 676–680.

5. Cranfield University (CU), United Kingdom

Cranfield is an exclusively postgraduate research-intensive university that is a global leader for education and transformational research in technology and management. We are known for our excellence in research with a very strong industrial/engineering bias. Cranfield has targeted activity in strategic fields including: Energy, Aerospace, Automotive, Environment, Manufacturing, Healthcare, Security and Defence. Cranfield University is third in the UK for the impact of its mechanical, aeronautical and manufacturing research. Cranfield is also one of the UK's top five research intensive universities, based on research income as a percentage of its turnover.

Cranfield University is sole UK representative on the EERA (European Energy Research Alliance) Joint Programme on CSP. Cranfield University (through the Centre for Power Engineering) leads the Energy Materials area of the EU Technology Platform on Advanced Engineering Materials (EuMaT), which aims to contribute to setting the research agenda in Europe**.** The Global CSP Laboratory houses the only UK research team working exclusively on CSP technology and applications.

Main tasks attributed in the project

Cranfield University will contribute to **WP1-6** on this project. Cranfield will lead **WP1** on the Socio-economic, humanitarian, impact on livelihood, environmental, and life-cycle analysis of the key components of the market solutions developed during the project. In addition, Cranfield will contribute to the work packages on the Operation and Maintenance optimizer **(WP2)**, cleaning technologies through the installation of dust barriers **(WP3)**, innovative plant cooling technologies including thermal storage **(WP4)**, water recovery solutions **(WP5)** and its realisation in **WP6**.

List of relevant previous projects or activities (max. 5)

- **MATS – Multipurpose applications by Thermodynamic Solar (FP7 project)**
  The proposed MATS Project aims at promoting the exploitation of concentrated solar energy through small and middle scale facilities, suitable to fulfil local requirements of power and heat, and easily to back-up with the renewable fuels locally already available or that can be expressly produced.
- **FRESH NRG – Fresnel for Solar Heat with New Receiver and Geometry (FP7 project)**
  FRESH NRG produced a system able to provide efficient, low-temperature solar heating suitable for many industrial applications.
- **STAGE STE – Scientific and Technical Alliance for Guaranteeing the European Excellence in Concentrating Solar Thermal Energy (FP7 Project)**
  The main objective of the STAGE STE project was to increased real collaboration among EU research organizations in concentrating solar thermal energy.
- **WASCOP – Water Saving in CSP plants (H2020 project)**
  The project aims to develop a revolutionary innovation in water management of **Concentrating Solar Power** plants, a more flexible integrated solution comprising different innovative technologies and optimized strategies for the cooling of the power-block and the cleaning of the solar field optical surface. The project included the development of dust barriers and nocturnal thermal storage technologies to TRL5.
- **UK EPSRC Grant** Ref: EP/P031072/1 "Solar Steam: A novel application of Fresnel lenses as a solar thermal collector for industrial process heat and desalination". With Lark Energy (UK).

Description of any significant infrastructure and/or any major items of technical equipment

Cranfield University possesses industrial-scale facilities in the fields of renewable energy, large optics, and thermal power. The Global CSP Laboratory is housed within the Precision Engineering Institute, and includes the world's most accurate large CMM (circa 10 μm accuracy over a 1.4m travel). Within this Laboratory Cranfield is currently building a sol gel coating machine for the deposition of AR and absorber coatings on receiver tubes of up to 4m in length. The Laboratory also includes a Fanuc robot cleaning simulation system for assessing the robustness of CSP reflecting surfaces, and a unique wind tunnel built specifically to test CSP collectors and dust barriers.

Cranfield also has extensive optical analysis equipment (spectrophotometer for hemispherical and specular reflectance, photogrammetry, interferometry), an Abengoa Condor reflectometer for measurements in the solar field, a sand erosion rig for velocities >5m/s, materials structure analytical facilities (SEM, EDX, XPS, AES, AFM), and environmental chambers (70°C<T<180°C, 10%<RH<98%). In addition, we have facilities for high-temperature research, giving us the capability to assess new heat transfer fluids and thermal storage materials. For surface coatings, we have laboratories and cleanrooms for PVD, electron beam, and PECVD coating, plus dry (plasma) and wet chemical etching for surface patterning, with photolithography if required.

Within the Energy and Power department Cranfield also has built a pilot plant modular facility (400kWth) focused on low temperature heat storage (air-rock bed) for improving the efficiency of concentrated solar plants. Cranfield has also developed a whole plant annual performance model with conventional cooling towers, and testing these models for emerging cooling technologies in a cost/energy-effective manner. In addition, the team has developed a dynamic simulation analysis of the cooling and heating systems through absorption chillers under different climate conditions aimed to provide a cooling load of approximately 300 kW to local communities, such as building, hospitals and supermarkets etc.

Curriculum vitae of the key persons

Pr. John OAKEY (M) is Professor of Energy Technology and Head of Energy Research and Strategy. An expert in thermal power, heat transfer, and heating and cooling, he leads the UK side of a major collaboration programme with the US on 'Advanced Materials for Low Emission Power Plants' and is a Director of the industry-led cross EU 'Energy Materials Industrial Research Initiative'.

Assoc. Pr. Christopher SANSOM (M) is Leader in Concentrating Solar Power and Leader of the Global CSP Laboratory, the UK Centre for CSP manufacturing technology, based at Cranfield University. His expertise includes the design and assessment of solar collectors, cleaning processes, and sand erosion. His researches focus on concentrating solar power technology and applications, including power generation, industrial process heat, thermal storage, water purification and desalination. Cranfield's CSP group includes four permanent staff and eleven PhD students, plus project staff and visiting Fellows, plus MSc students.

Dr. Nazmiye OZKAN (F) is a senior lecturer in environmental/energy economics, her researches focus on econometric analysis, socio-economics and livelihood impact of energy policy.

Dr. Kumar PATCHIGOLLA (M) is a senior lecturer in Low Carbon Energy Systems. His research interests are in the science surrounding the wide range of application areas for cost-effective and reliable energy systems to balance renewables and other low carbon technologies, to address the carbon targets, and to help improve the energy efficiency of dispatchable power plants. He performs experimental, theoretical and thermodynamics research into many aspects of energy systems.. More recently he has been applying his knowledge in solar based renewables, in particularly developing an emerging technologies for the reduced use of the water needed to cool the power block for different operating conditions depending on geographical location, climate conditions and access to water

Dr. Peter TURNER (M) is a Visiting Fellow, and former Head of CSP at E. ON, his researches focus on CSP, Heat storage, cooling technologies.

List of relevant publications and/or products, services, software (max. 5)

- **Sansom C., Fernández-García A., Sutter F., Almond H., King P. and Martínez-Arcos L.:** Soiling and Cleaning of Polymer Film Solar Reflectors, Energies (2016), doi:10.3390/en9121006
- **Sansom C., Almond H., King P., Endaya E., and Bouaichaoui S.:** Airborne Sand and Dust Soiling of Solar Collecting Mirrors, AIP Conf. Proc (2017).
- **Sansom C., Fernández-García A., King P., Sutter F., and Garcia Segura A.:** Comparison of Reflectometry instruments to assess the soiling of solar collectors. Solar Energy 155, 496–505 (2017). doi.org/10.1016/j.solener.2017.06.053
- **Zhai R., Li, Y Chen C., Yang Y., Patchigolla K., Oakey J.E.:** Life cycle assessment of solar aided coal-fired power system with and without heat storage Energy Conversion and Management (2016).
- **Patchigolla K., Fatouh M., Oakey J.E., Elgendy E., Sansom C., Nawar M.A., Mostafa A.:** Performance of Li-Br absorption chiller for low-grade heat conversion in concentrated solar thermal power plants, Applied Thermal Engineering-under review (2017).

6. Fundacion Tekniker (TEK), Spain

IK4-TEKNIKER was created in 1981 as a non-profit Spanish technology centre and became legally a foundation in 1996 based on a statutory commitment aimed at upgrading the competitiveness of the industry and its services via technological support.

IK4-TEKNIKER defines itself as a centre of mechatronics, manufacturing technologies and microtechnologies, in areas such as energy, industrial products designing and consumer goods. IK4-TEKNIKER has been participating in European projects since 1988, under the 2nd Framework Program and nowadays it counts on over 250 experienced researchers.

Research related with Concentrating Solar Power have had and increasing importance during the last 10 years. This accounts for over 1M€/year for the last 8 years and includes not only industrial projects with main Spanish players in this sector, but also regional, national and international projects. We are an active member of the Joint Programme on CSP at the EERA (European Energy Research Alliance). Main Units within Tekniker involved in the project are:

- **Advanced Manufacturing Technologies Unit**, whose main research activity falls into: Machining technologies, Ultrasonic processes and Laser processes is involved in this project with the topic of Development of an Ultrasonic cleaning system.
- **Surface Chemistry Unit** has a large experience (more than 10 years) developing and applying new sol-gel coatings with different functionalities, such as self-cleaning, antireflective, low emission, anti-soiling and so on, deposited by dip-coating or spray-coating techniques.
- **Electronics and Communications Unit** has a wide experience in hardware/firmware platform development, ranging from standalone CPUs/MCUs, to hybrid systems based on DSPs, FPGAs and Wireless communication networks.

Main tasks attributed in the project

TEKNIKER will lead the work packages related with new novel cleaning approach (**WP3**)·. It will work on the definition, design and development of an Ultrasonic cleaning system to implement in a real plant. TEKNIKER will be also involved in the anti-soiling coating's development activities. Their main technical activity will be focused on the optimization and deposition of the anti-soiling coating by spray- coating in real mirrors. TEKNIKER will also participate in the crossed lab evaluation of the reflector coating's durability in climate chambers and will collaborate with other partners on the development of cleaning protocols derived because of the investigations. Moreover, TEKNIKER will be involved in the integration of low cost sensor in mirror.

List of relevant previous projects or activities (max. 5)

- **WASCOP – Water Saving for Concentrated Solar Power (H2020 project)**
  The project aims to develop a revolutionary innovation in water management of Concentrating Solar Power plants, a more flexible integrated solution comprising different innovative technologies and optimized strategies for the cooling of the power-block and the cleaning of the solar field optical surface.

- **MOSAIC – MOdular high concentration SolAr Configuration (H2020 project)**
  The project aims to develop a revolutionary plant concept based on fixed reflectors thus allowing for the design of automatic cleaning systems that could reduce significantly the water consumption. This novel concept also includes a modular approach for the plant that allows to work at the highest efficiencies and a more flexible management of the power block that enables additional water reductions.

- **STAGE-STE - Development of new first surface mirrors (FP7 project)**
  TEKNIKER is developing first surface reflectors by PVD and front protection layer by sol-gel. The new first surface mirrors must provide enough performance (reflectivity >96%), protection of the reflective surface, and resistance against abrasion or corrosion.

- **TC-GRAN - Development of ultrasonic cleaning techniques and dust sensors for heliostats (Basque Gob. finance)**
  Activity focused on the development of ultrasonic cleaning techniques with enhanced cleaning performances that could be implemented with none or minimal water consumption. Within the same project a first prototype for the dust sensor was developed and tested in lab conditions.

Description of any significant infrastructure and/or any major items of technical equipment

IK4-TEKNIKER operates laboratories with the modern equipment which is needed for the development of the innovative solutions. For the development of the ultrasonic cleaning system three high frequency sources as well as several transducers of different power and amplitude and frequency measurement devices can be used. Moreover, IK4-TEKNIKER has dip-coater and spray-coater robot for the deposition of the anti-soiling coating as well as climatic chamber allowing controlling of the temperature (-30ºC+150ºC) and relative humidity (10-98%).

Curriculum vitae of the key persons

Dr. Estibaliz ARANZABE (F) is Head of Surface Chemistry Unit in TEKNIKER. She has degree in Chemical Sciences in 1999 and Dr in 2016 by University of the Basque Country. She has a large experience, more than 15 years, in R&D projects, mainly involved in advanced fluids and sol-gel projects. She is continuously coordinating national and European projects in different calls related to sol-gel technology.

Itziar AZPITARTE (F) has degree in Chemical Engineering by the University of Basque Country with more than 10 years of experience in R&D and scale – up industrial related to sol-gel technology. In 2016 joins to Surface Chemistry in Tekniker where has participated in several European projects Wascop, Summed, Stage.

Cristóbal VILLASANTE (M) has MSc in Mechanical Engineering with more than 20 years of experience in R&D projects. In 1994 he started working in IK4-TEKNIKER involved in dynamic analysis for mechatronic design. During the following years participated and/or coordinated national and international projects (FP5, FP6 and FP7) for machine design on different sectors. From 2006 he acts as coordinator for solar thermal projects and at 2007 he was promoted to Head of Thermal Engineering Unit. From 1999 to 2008 he combined researching at IK4-TEKNIKER with teaching at Universidad de Deusto as teacher for "Machine Design". Nowadays he also coordinates activities for Solar Thermal Electricity Industry at IK4 Research Alliance and represents it at the corresponding JP at EERA.

Jon Ander SARASUA (M) has MSc in Mechanical Engineering with more than 6 years of experience in R&D projects. Project leader in machining field, process modelling/simulation and ultrasonic devices development and implementation. His expertise is focused on the development of systems for the application of ultrasonics in different manufacturing processes: Modelling, simulation and control of the resonant system.

Alex SANDÁ (M) has MSc in Mechanical Engineering with more than 9 years of experience in R&D projects and team leader in the field of machining and Ultrasonic processes. His expertise is focused on the development of systems for the application of ultrasonics in different manufacturing processes: Modelling, simulation and control of the resonant system.

Roberto CALVO (M) is Electronic Engineer with over 29 years of experience in the areas of industrial electronics and communications, scientific instrumentation and advanced metrology systems. He is an expert in the development of embedded systems based on advanced architectures, the development of mechatronic systems and especially the development of measurement systems based on optical techniques

David CANTERO BURGOS (M) obtained his degree in Electronic Engineering in 2002 and graduated in Physics in 2004. In 2008 joined Tekniker where he has participated in several projects related to machine tool magnetic levitation drives and kinetic flywheel energy storage devices. His present work is related to design and implementation of embedded software and hardware oriented to real time control applications, advanced sensor devices and digital signal processing.

List of relevant publications and/or products, services, software (max. 5)

- **Prado R., Beobide G., Marcaide A., Goikoetxea J., Aranzabe E.:** Development of multifunctional sol–gel coatings: Anti-reflection coatings with enhanced self-cleaning capacity. Solar Energy Materials & Solar Cells 94, 2010. 2.
- **Calvo R., Cantero D.:** A new high-sensitivity, low-cost solution for the measurement of reflectance loss due to dust deposition on solar collectors. SolarPACES 2013.
- **Patent applications PCT/ES2015/070308 and P201430605**, on dust sensor. "Sensor de Suciedad y Procedimiento para Detectar la Cantidad de Suciedad de una Superficie"
- **Aranzabe E., Azpitarte I., Fernandez A., Sutter F., Perez G., Ubach J.:** Hydrophilic anti-soiling coating for improved efficiency. SolarPaces2017.
- **Ander Sarasua J., Aranzabe E.**: Non-immersion ultrasonic cleaning for heliostats. SolarPaces 2017.

7. Rioglass Solar S.A.(RIO), Spain

Rioglass Solar S.A. (RIO), company founded in 2007, is a solar power and renewable energy technology manufacturer, specialized in developing key optical components for concentrated solar power (CSP) and concentrated photovoltaic (CPV) applications.

RIO has created the tempered high precision parabolic mirror, which has become the leading reference in the market, positioning the company as the solar technology leader with the largest installed base of parabolic mirrors in the industry.

RIO started to operate with a first factory in Asturias, Spain, having a production capacity of 1.600.000 m2 of mirrors per year, which is an equivalent to a thermoelectric generation capacity of 150 MW. The company belongs to the group Rioglass Solar Holding, that, after undergoing a rapid expansion in Spain with a second factory, Rioglass Solar II, in operation in 2009, developed a new plant in Surprise, Arizona in 2011, another in Upington, South Africa in 2013 and the most recent in Chile in 2015 and a new plant coming in 2017 in China. Today, RIO has circa 90 M sales in 2016 and 85 employees in its factory in Spain (Worldwide the total Rioglass Solar Holding has circa 400 employees). Rioglass Solar S.A. , concentrates the R&D activities in its facilities for Solar Mirrors in Spain, generating the knowhow for the whole Rioglass Solar Holding based, so far, on 6 patent families filed in 22 countries.

The international expansion continues in 2013 with the acquisition of the receiver tube facilities of Siemens in Israel, with the yet vivid Solel heritage known for shaping the CSP industry. More recently, in 2015, Rioglass Solar Holding has also acquired the tubes production site of Schott Solar in Sevilla with its complete know how. With six million mirrors delivered worldwide and 20 years of experience in supplying receiver tubes, Rioglass Solar Holding is the largest provider of CSP heat collector element (HCE) tubes and tempered glass mirrors in the world. Headquartered in Brussels, Rioglass Solar Holding has commercial offices in Spain, the U.S., South Africa, China, Germany, and Italy.

Main tasks attributed in the project

Rioglass will be involved in the soiling reduction in reflectors by integrating the process in a real production line using real processes available, redefining the process control parameters to improve reliability**,** and manufacturing and providing real size reflectors samples uncoated (TBD)/ AS coated (50 parts) with spray coating system and solutions developed during the WASCOP project.

In addition, RIO will optimise the cleaning strategy through the development of the procedure for attaching and assembling the sensor module to the glass panels and by manufacturing and providing real size reflectors (TBD) with sensor module. Some reflectors (TBD) including AS coatings and some of them without AS coating.

List of relevant previous projects or activities (max. 5)

- **WASCOP – Water Saving for Concentrated Solar Power (H2020 project)**
  The project is to develop a revolutionary innovation in water management of Concentrating Solar Power plants, a more flexible integrated solution comprising different innovative technologies and optimized strategies for the cooling of the power-block and the cleaning of the solar field optical surface. In in the frame of this projects, Rioglass develops and validates an AS coating until its preindustrial stage.
- **Development of the tempered glass reflector (2008)**
  RIO has developed the first reflector made with tempered glass. This product is protected under international patent.
- **Development of the bending technology for high precision dish reflectors (2011-2012)**
  RIO has successfully developed the bending and tempered technology for producing high optical performance mirrors for dish reflectors.
- **Development of a new fact of heliostat (2012-2014):**
  New heliostat facet, pre-bent, low weight and self-supported by means of a “sandwich” structure, and the method to achieve and accurate optical shape. This product is protected under international patent.

Description of any significant infrastructure and/or any major items of technical equipment

Rioglass possesses pilot equipment for coating application, this equipment will coat real size reflectors implemented in the real plant process.

Real production equipment's are available at Rioglass factory.

RIO has several laboratories (climatic chamber, humidity chamber, two corrosion chambers) that will be used for laboratory evaluations.

Curriculum vitae of the key persons

José UBACH CARTATEGUI. (M) holds a PhD in chemical, he worked as a researcher from 2002 to 2005 at the Texas University before to join Rioglass where he worked as process responsible. In 2007, he became Manager in technology and processes in Rioglass solar SA. He can speak Spanish as well as English.

Gema PÉREZ SÁNCHEZ (F) is an industrial engineer, she worked as a researcher in biomechanics at NADAR SL. She joined RIO in 2000 as a project manager. In 2008, she became IP manager and projects coordinator in Rioglass Solar SA. She speaks 4 languages: Spanish, English, French and German

List of relevant publications and/or products, services, software (max. 5)

RIO produces high reflectance mirrors for the different types of solar thermal systems.

- Parabolic Trough Tempered Mirrors
- Facet for Heliostats (Central Tower)
- Rioglass Solar MicroTrough (custom design mirrors)
- Dish Technology for Stirling and CPV application
- Lineal Fresnel Mirrors

8. Archimede Solar Energy S.r.l. (ASE), Italy

Archimede Solar Energy is an Italian company established in 2007. ASE is the world producer of high temperature solar receivers, suitable for linear focusing CSP system operating with molten salt or direct steam generation. Optimized receivers for medium temperatures, read diathermic oil technology, completes its portfolio.

In summer 2013 ASE has inaugurated a 1-loop demonstrative solar plant, aimed to be a feasibility example of the molten salt technology: the R&D investigations span from collector efficiency to plant optimisation to thermal storage system.

Main tasks attributed in the project

Industrialization of innovative antisoiling coatings deposition will be exploited on solar glass envelope and optically characterised.

Solar receiver tubes will be produced employing the innovative antisoiling glass coating and will be available for the installation.

The control strategy for the new storage system will be designed and implemented on the Solar Plant.

List of relevant previous projects or activities (max. 5)

- **MATS – Multipurpose applications by Thermodynamic Solar (FP7 project)**
  MATS project is focused on the CSP technology developed by ENEA as an improvement of its Solar Thermodynamic technology based on molten salts as heat transfer fluid. This technology, referred as TREBIOS, allows combined heat and power production from solar source integrated with renewable fuels, such as biomass, biogas, industrial residues etc.
- **STAGE-STE - Development of new first surface mirrors (FP7 project)**
  Integrated platform for researching purpose on Solar Thermal Electricity
- **WASCOP – Water Saving for Concentrated Solar Power (H2020 project)**
  WASCOP brings together leading EU and Moroccan Institutions, Universities, and commercial SMEs and industrials. They will join their forces to develop and validate a flexible and adaptive integrated solution encompassing different innovative technologies and optimized strategies for both the cooling of the power-block and the cleaning of the solar field optical surfaces.
- **MSLOOP – Molten Salt Loop 2.0: key element for the new solar thermal energy plants (H2020 Project)**
  MSLOOP aims to validate a business opportunity consisting of developing a cost effective solar field for CSP Parabolic Trough Power Plants using optimized ternary molten salts as HTF with an innovative hybridization system. The starting point of the project consists of the integration of two prototypes: 500 m loop representative of a solar field (LAZOSALES) connected to a hybridization system (HYSOL).

Description of any significant infrastructure and/or any major items of technical equipment

ASE manufactures solar receiver tubes for different CSP technologies in its production plant in Villa San Faustino – Massa Martana – Italy. The manufacturing plant and facilities occupy about 10.000 square meters of covered production area; additional 5.000 square meters of adjacent warehouse are available for logistic support. The current production capacity is around 75,000 HCE/year.

The R&D lab in ASE is equipped with several test benches for the different analysis the solar receiver tubes and their components.

The optical analysis of the coatings is performed by means of UV-VIS spectrophotometer equipped with 150mm integrated sphere (Lambda 950, PerkinElmer), a FTIR spectrophotometer equipped integrated sphere (Vertex 70, Bruker), a portable spectrophotometer (Optosol Alphameter) and a portable reflectometer for the analysis of solar collector's mirror. Additionally, the R&D lab is equipped with a KLA-Tencor Profiler, a Polarimeter for glass residual stress analysis, a Taber abraser tester.

Curriculum vitae of the key persons

Augusto MACCARI (M) has been working as R&D Manager in ASE since 2011. In his long-time employment within ENEA, he has followed the most important solar projects. Engineering experience within Techint completed his technical profile in the field of solar thermal plant. Also, he is coordinator of the Technical

Committee of ANEST (Italian Association of Solar Thermal Electricity Operators). During the project, he will be the project and technical manager.

Sandro DONNOLA (M) has been working as a Product Specialist in ASE since 2010. After having completed his engineering studies within the supervision of the Italian research institute ENEA, he directly followed and coordinated the design of the Demonstrative solar plant of ASE and since 2013 the R&D activities on that facility. In addition, he is involved in other European Project (MATS, MSLOOP)

Francesca MATINO (F) has been working as a R&D Specialist in ASE since 2011. Since her degree in Physics and Ph.D. in "Innovative Materials and Technologies", she carried out studies on the electronic characterization of functionalized surface's materials. As R&D specialist, she has been involved in the estimation of performance capabilities of solar receiver tubes, the development and evaluation of manufacturing and testing processes and procedures. She is also involved in STAGE-STE and WASCOP EU projects.

Francesca BIANCIFIORI (F) has been working as a Process & Technical Engineer in ASE since 2010. **S**ince her degree in Chemical Engineer, she has been working as Process Engineer dealing with the production of plastic material, controlled oxidation of metals through high temperature treatment, glass to metal and glass to glass sealing, antireflective coating process, hydrophobization treatment, ultrasonic washing processes. She is involved in WASCOP EU project as well.

List of relevant publications and/or products, services, software (max. 5)

- "Comparing Abrasion Testing Results on AR-coatings for Solar Receivers": Poster presented at the SolarPACES, 2014
- "Archimede Solar Energy Molten Salt Parabolic Trough Demo Plant: A Step Ahead Towards the New Frontiers of CSP": contribution to the SolarPACES, 2014
- "Molten Salt receivers operated on Parabolic Trough Demo Plant and in laboratory conditions": contribution to the SolarPACES, 2014

9. Ingenieria Para el Desarrollo Tecnologico S.l. (INDETEC), Spain

INDETEC, S.L. is a SME for engineering, R+D, and commercialization of technical solutions for different processes involved in the chemical and food industry such as: evaporation, distillation, drying, heat exchange, ion exchange, solvent extraction, etc INDETEC was born in 1998 to complete and consolidate VENTO S. Coop., which. Moreover, the R&D department, certified according the standard UNE 166.002, performs lab and pilot scale experiments that allow the development of industrial processes tailored to the customers' needs, aimed to obtain fast and profitable results. INDETEC is located in Spain but provides its services all over the world.

Main tasks attributed in the project

Within the project, the company will be actively involved in the designing, dimensioning, manufacture and commissioning of water recovery technology based on evaporation technology. INDETEC, will collect the information from different partners so the optimal water recovery technology is developed. Laboratory essays will also be carried out in the water to be recovered to know in advance its behaviour in the water treatment plant. The impact of INDETEC is aimed to prove a cost-effective technology that leads to a drastically reduction in wastewater and maximise its reuse from all available sources.

List of relevant previous projects or activities (max. 5)

- **ECOPROLIVE – ECOfriendly PROcessing system for the full exploitation of the OLIVE health potential in products of added value (H2020 project)**
  The EcoPROLIVE project aims at testing, demonstrating, validating, and prototyping an innovative processing system for olive oil production and at least one functional food ingredient. The integral system pursues the full exploitation of the nutritive and bioactive potential of the olive with no waste generation or loss of valuable components.
- **ZLD – EL SAUZ THERMOELECTRIC POWER PLANT – FELGUERA – Querétaro (México)**
  Engineering, design, construction and commissioning of a Zero Liquid Discharge plant for recovering wastewater from different sources of the thermoelectric power plant of El Sauz in México for a treatment capacity of 10.000 kg/h and a 96% of water recovery.
- **ZLD – TRADEMED LANDFILL – FELGUERA – Cartagena (Spain)**
  Engineering, design, construction and commissioning of a Zero Liquid Discharge plant for recovering wastewater from landfill leachates in Cartagena for a treatment capacity of 2.000 kg/h and a 99% of water recovery.
- **H2ALRECYCLING – Prototype for producing hydrogen by means of clean water, ammonia and recycled aluminium (LIFE project)**
  Design and construction a pilot plant to obtain hydrogen using a new process based on the reaction between waste aluminium and ammonium hydroxide to power a fuel cell.
- **ECOELECTRICITY – Valorisation of organic waste to produce hydrogen for use in generating electricity in a sustainable manner (LIFE project)**
  The overall objective of the project is to design and build a pilot plant based on catalytic reforming technologies that allow the valorisation of impure alcoholic fractions (purges) from the distilleries. It will lead to the design, construction and optimization of a process that will produce a H2-rich reformate gas stream to be fed on a SOFC to produce electricity.

Description of any significant infrastructure and/or any major items of technical equipment

INDETEC has all the necessary infrastructure to perform their tasks smoothly. It is equipped with technical resources, simulation systems of industrial processes and a team with great experience in the industry, providing advisory services and technical assistance to their customers. Our laboratories have the equipment to perform among other experiences; drying, distillation, evaporation, reaction, absorption, ion exchange, etc. with representative product samples provided by our clients. In this way, we may generate small quantities of product to be analysed by the customer or external laboratories, while allowing the adequate design of industrial equipment.

Furthermore, INDETEC counts with several pilot plants such as an evaporation-distillation-desulfitation plant, an absorption plant and an indirect drying equipment (STR type) where tests can be carried out with larger amounts of product than in lab scale.

Curriculum vitae of the key persons

Pedro José GARCÍA MORENO (M) graduated as a technical industrial engineer at the Universidad Politécnica de Valencia. He joined the company in 1977 where he worked as technical director until 1998. Then, he became sales manager before to be general manager since 2000. He has participated in many projects, from laboratory scale to the construction of equipment for industrialization of different products such as red pepper, caffeine, wine, olive and biodiesel. He contributes to this project as a project manager.

Álvaro CASAÑ PERPIÑÁ (M) graduated as an industrial engineer at the Universidad Politécnica de Valencia. He joined the company in 2000 as a technical director. He developed several projects from laboratory scale to the construction of equipment for industrialization in various field such as in biodiesel, biomass, environment (systems for industrial wastewater minimization). He worked also on R&D project, for instance he participated to the design and the construction of pilot plants for H2 production. He contributes to the current project as responsible for calculations, detailed and process engineering.

Antonio GONZÁLEZ HEREDIA (M) graduated as a Technical Chemical Engineer at the Universidad Politécnica de Valencia. He is working in the company as a draftsman since 2007. As draftsman, he develops process, instrumentation and construction drawings for the manufactured equipment. He is also responsible for processing the certifications of the equipment to the regulatory agencies. He contributes to the current project as CAD design responsible.

Pedro GARCÍA BELDA (M) graduated as Technical Chemical Engineer at the Universidad Politécnica de Valencia. He is working INDETEC as a draftsman since 2008. As a draftsman, he develops detailed, implementation 2D and 3D layout drawings for the manufactured equipment. He contributes to the current project as detailed engineering designer

Chema CARRILLO CAPEL (M) graduated as Chemical Engineer at the Universidad de Valencia. He works at INDETEC since 2011 as a Sales and R&D engineer. His tasks are to develop proposals, industrial processes and budgets relying on the company experience and R&D essays tailored to the customers. He contributes to the current project as process engineering researcher. He is also responsible for collecting and transmitting information among partners and the coordinator.

List of relevant publications and/or products, services, software (max. 5)

- **Patent ES2110912** (16-02-98). Procedimiento integral para la industrialización de alpechines y su depuración en almazaras y centros de repasado de alpeorujos". (Integral process for the industrial utilization of the olive wastewater and its purification in olive-mills and centres for purifying the olive-mill waste from two-phase processing)
- **Patent ES2277490** (29-11-2004). "Procedimiento para la industrialización de subproductos de almazara y productos obtenidos". (Process for the industrial utilization of the olive-mill products and by-products)

10. FENIKS Cleaning & Safety S.L. (FNK), SPAIN

Feniks was born in September 2014 in Seville. The company stems from the concern of professionals with over 10 years' experience in vehicle bodywork of urban cleaning, firefighting and cleaning & maintenance of solar thermal plants. It bases its strategy on two main lines:

- Personalized customer in search of solving their needs.
- The faithful compliance with committed manufacturing a product with a differential value in terms of performance and quality.

Feniks is specialist about O&M in CSP plants. The company offers an extensive portfolio of vehicles to clean parabolic trough collectors and heliostats, as well as the handling of thermal oil and firefighting. Constantly evolving towards the creation of increasingly more efficient products, as a result of its commitment to R&D, the vehicles developed by Feniks feature automation, increased reflectivity, reduced water consumption and higher speed cleaning and manoeuvring.

Currently, the firm has 10 engineers, 20 direct employees and subcontracted labour.

Main tasks attributed in the project

Feniks will participate in the research related with new novel cleaning system looking for reducing water consumption in solar thermal plants.

The company will bring its experience and equipment to work on the definition, design and development of an ultrasonic cleaning system to implement in a real plant.

One of the main tasks is to design a carrier of an ultrasonic cleaning device that allows a stable cleaning of the entire surface of the collector and at a suitable speed.

Finally, Feniks will participate in the development of the cleaning protocol with this new system and in the manufacturing of the prototype to prove its effectiveness.

List of relevant previous projects or activities (max. 5)

- **Development of cleaning vehicles for solar plants (FEDER Innterconecta 2015 – CDTI Spain)**
  Project of cooperation between three companies to research, develop and manufacture vehicles for cleaning solar fields, as well as an analysis of the benefits of these vehicles through different modes of use, in order to describe on optimal procedures. The owners of the Feniks were very present in the production of vehicles for the cleaning of CSP plants in their previous company and Feniks, since the beginning of the company, has participated in projects like this to evolve their products continually.

- **TOP-PLAN – Technologies for the Optimization of Photovoltaics PLANts (FEDER Innterconecta 2016 – CDTI Spain)**
  TOP-PLAN was a multidisciplinary R&D consortium created by four companies and supported by a reference research organization. The project's objective was to study how obtaining a novel robot system of automated positioning for the assembly of photovoltaic panels on solar structures (fixed or mobiles), as well as the definition of the algorithm for the optimal logistic process of operation with the vehicle and the panels (from the arrival to the site to the panels installation).

Description of any significant infrastructure and/or any major items of technical equipment

Feniks has the facilities, staff and equipment to ensure the development of its function in the project.

In addition, the firm has a technical office with 10 engineers that usually work about innovate projects. They count with the latest advances in computer software.

Finally, Feniks counts with 3.500 sqm of facilities for manufacturing its products. The area for testing outside has 5.500 sqm.

Curriculum vitae of the key persons

Manuel DE NOVALES JIMÉNEZ (M) studied Industrial engineering with production speciality (University of Seville), he has more than 10 years of experience in projects about cleaning in CSP projects. Nowadays, he is founding partner and production director of Feniks Cleaning & Safety S.L. He was production director, R&D director and product manager in his previous company (Albatros). He has participated in several conferences. For instance, he participated to a conference about Efficient cleaning management (Conferencias CSP Today Seville, 2011), and another on Optimization of solar plant performances through mirror cleaning (Ciclo

Intereconomía, 2011). Finally, he has participated in patented projects through cleaning containers truck with ultrasonic sensor in 2010 and the development of cleaning system for parabolic trough collectors in 2009.

Roberto SERRANO CABELLO (M) hold a degree in industrial technology engineering acquired at the University of Seville. He started to work in Feniks as an intern in the technical office in 2016. Nowadays, he is product manager in the CSP line (O&M vehicles), generating the technical documentation, controlling the production, calculating and optimizing costs and preparing offers. He participates actively in several research projects

Rosario INFANTES MONTIEL (F) is an industrial design & product development engineer at University of Malaga. She starts working in Feniks like intern in the technical office in January 2017. Nowadays, she is the responsible of I+D+i department. She is controlling the production, principally in the CSP line (O&M vehicles). She participates actively in several research projects.

Antonio PEREA PALMA (M) graduated at the University of Seville as an Industrial Engineer. He is working in Feniks as a technical director since 2016. He worked at Abengoa as site manager in South Africa at the Xina Solar One Plant. Previously, he was product manager of the manufacturing urban cleaning vehicles in Albatros.

List of relevant publications and/or products, services, software (max. 5)

- Feniks has developed the most automatic software that exists in solar thermal cleaning trucks. The operator's function is limited to moving the steering wheel and accelerating.
- Feniks has developed a web application that monitors all the vehicle's sensors and its position, creating a report at the end of the day with summary of the tasks undertaken. In addition, a software has been generated to control the truck through a computer. It allows repair damages in the main program and updating it remotely.

11. Barcelona Supercomputing Center – Centro Nacional de Supercomputación (BSC), Spain

- The Barcelona Supercomputing Center – Centro Nacional de Supercomputación (short named as BSC), created in 2005, is the leading supercomputing centre in Spain. It specialises in High Performance Computing and its mission is twofold: to offer supercomputing facilities and services to Spanish and European scientists, and to create knowledge and technology to be transferred to society. At the BSC, more than 500 people from 40 different countries perform and facilitate research into Computer Sciences, Life Sciences, Earth Sciences and Computational Applications in Science and Engineering. This multi-disciplinary approach and the combination of world-leading researchers and experts in HPC (High-Performing Computing) with state-of-the-art supercomputing resources make BSC unique. The BSC is one of the first eight Spanish 'Severo Ochoa Centre of Excellence" awarded by the Spanish Government, it is managing the Spanish Supercomputing Network, as well as one of the four hosting members of the European PRACE Research Infrastructure. The BSC hosts MareNostrum supercomputer, a Tier-0 PRACE system currently ranked as the #3 most powerful supercomputer in Europe (#13 in the world) with 13.7Pflop/s capacity. In addition, the BSC hosts other High-Performance Computing (HPC) resources, among which it is worth mentioning Minotauro, one of the most efficient supercomputers in the world (#35 in the last ranking of the top500 green list). The Earth Sciences Department at BSC (ES-BSC) has developed into a reference institution in Europe in the field of climate predictions, air quality and atmospheric composition modelling. The Atmospheric Composition group at ES-BSC aims at better understanding and predicting the spatiotemporal variations of atmospheric pollutants along with their effects on air quality, weather and climate and contributes to a variety of forecasting activities.

Main tasks attributed in the project

A core activity of the ES-BSC group is sand and dust storm modelling and forecasting from regional to global scales. BSC contribution in the SOWAT project will be in the development of a new dust forecasting product oriented to solar power activities. Firstly, the development of a soiling model forecasting tool which will be able to combine regional information with local information. The soiling forecasting system will be able to predict severe soiling events caused by regional dust movements, e.g. sandstorms or red rain events. Additionally, BSC will lead the development of a regional soiling risk map based on a regional dust reanalysis.

List of relevant previous projects or activities (max. 5)

- **ACTRIS-2 - Aerosols, Clouds, and Trace Gases Research InfraStructure (H2020 project)**
  BSC is participating in ACTRIS (Aerosols, Clouds, and Trace gases Research InfraStructure Network) which is a European Project aiming at integrating European ground-based stations equipped with advanced atmospheric probing instrumentation for aerosols, clouds, and short-lived gas-phase species. ACTRIS will have the essential role to support building of new knowledge as well as policy issues on climate change, air quality, and long-range transport of pollutants.

- **WMO Dust Centers**
  BSC (jointly to the Spanish Meteorological Agency, AEMET) is managing the Sand and Dust Warning Advisory and Assessment System (SDS-WAS; https://sds-was.aemet.es/) Regional Center for Northern Africa, Middle East and Europe and the first Regional Specialized Meteorological Center with activity specialization on Atmospheric Sand and Dust Forecast, known as the Barcelona Dust Forecast Center (BDFC, https://dust.aemet.es/forecast).

- **CAMS-84 - Copernicus Atmospheric Monitoring Service (Copernicus)**
  BSC is participating in the global and regional a posteriori validation Copernicus Atmospheric Monitoring Service (CAMS) products. Validation activities also provide a set of plots and quality monitoring statistics, which are integrated in the CAMS website and are easily accessible together with the products from the CAMS catalogue.

- **AXA Chair on Sand and Dust Storms (AXA Research Fund)**
  This 15-year research programme hosted by BSC that is not only intended to support the two WMO SDS Regional Centers based at BSC, but also to widen the scope and relevance of the mineral dust research at BSC.

- **ICAP - International Cooperative for Aerosol Prediction**
  BSC is part of the International Cooperative for Aerosol Prediction (ICAP) which is an international forum for aerosol forecast centers, remote sensing data providers, and lead systems developers to share best practices and discuss pressing issues facing the operational aerosol community.

Description of any significant infrastructure and/or any major items of technical equipment

The high-performance capabilities of BSC and the close collaboration with the HPC experts allow to increase the spatial and temporal resolution of atmospheric modelling systems, in order to improve our knowledge on dynamic patterns of air pollutants in complex terrains and interactions and feedbacks of physico-chemical processes occurring in the atmosphere. The dust forecast system used in this project will be based on the NMMB-MONARCH. This state-of-the-art model is designed to be efficient, flexible, and extendible. It contains advanced physics, chemistry and aerosol packages, and has the unique ability to be configured as a global model or as a very high-resolution regional model.

Curriculum vitae of the key persons

Dr. Carlos PEREZ GARCIA-PANDO (M) is AXA Professor, Ramón y Cajal Researcher and Head of the Atmospheric Composition Group at BSC. He holds an AXA Chair on Dust Storms at BSC. His research group is composed of ~12 people including senior researchers, postdocs, PhD students and technical support staff. His research focuses on understanding the physical and chemical processes controlling atmospheric aerosols, and evaluating their effects upon climate, ocean biogeochemistry, air quality and health. His core area of expertise is atmospheric mineral dust. He is also a model developer with a large experience in supercomputers. He is the main developer of the NMMB/BSC–Dust model used in this proposal. Previously he has held research positions at the NOAA/National Centers for Environmental Prediction, the International Research Institute for Climate and Society, the NASA Goddard Institute for Space Studies and Columbia University. He has participated in ~30 international and national projects (in 7 of them as PI or co-PI). In the US, he has been PI and co-PI of competitive projects funded by the Department of Energy, NASA and NOAA. His work has resulted in ~60 peer-reviewed publications, 20 chapters in books, proceedings and reports, more than 150 contributions to conferences/workshops/seminars (26 as invited speaker) and the edition of a book of proceedings (Google scholar; citations 2894; h-index 28).

Dr. Sara BASART (F) received a degree in Physics from the University of Barcelona (UB). She studied a Masters in Meteorology and Climatology at the University of Barcelona (UB). Dr Basart obtained her PhD degree in Engineering Environmental (Degree of European Doctor) at Technical University of Catalonia (UPC) in January 2012 while doing her research at different research centres (Centro de Investigación Atmosférica de Izaña, Spain, and Laboratoire des Sciences du Climat et de l'Environnement, France). Her main research background covers mineral dust modelling, air quality and aerosols. At present, Dr Basart is a researcher in the Barcelona Supercomputing Center (BSC). She is the scientist in charge of the WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS) Regional Center for Northern Africa, Middle East and Europe, and the Barcelona Dust Forecast Center (BDFC), hosted in BSC. She also participates in international projects like the International Cooperative on Aerosol Prediction (ICAP) initiative and ACTRIS (ACTRIS and ACTRIS-2). She is leading the BSC participation in Copernicus (CAMS-84). She has authored or co-authored more than 30 peer-reviewed publications in international journals and book chapters.

Dr. Albert SORET (M) holds a PhD in Environmental Engineering from the Polytechnic University of Catalonia (Barcelona). He is head of the Services group at BSC-ES. He is a postdoc researcher with ten years of experience in earth sciences. His research focuses on assessing the impact of climate on socio-economic sectors through the development of user-oriented services that ensure the transfer of the technology developed and the adaptation to a rapidly changing environment. He is Work Package leader within Clim4Energy (Copernicus), VISCA (H2020) and MAGIC (Copernicus) and he is also involved in EC-FP7 and H2020 projects: NEWA, EUPORIAS, SPECS, IMPREX and PRIMAVERA.

List of relevant publications and/or products, services, software (max. 5)

- **Basart, S., Vendrell L. and Baldasano J.M.**: High-resolution dust modelling over complex terrains in West Asia. Aeolian Research, 23, 37-50, doi:10.1016/j.aeolia.2016.09.005. - 2016
- **Gkikas, A., Basart S., Hatzianastassiou N., Marinou E., Amiridis V., Kazadzis S., Pey J., Querol X., Jorba O., Gassó S. and Baldasano J.M.** (2016): Mediterranean intense desert dust outbreaks and their vertical structure based on remote sensing data. Atmospheric Chemistry and Physics, 16, 8609-8642, doi:10.5194/acp-16-8609-2016.

- **Huneeus, N., Basart S., Fiedler S., Morcrette J.J., Benedetti A., Mulcahy J., Terradellas E., Pérez García-Pando C., Pejanovic G., Nickovic S., Arsenovic P., Schulz M., Cuevas E., Baldasano J.M., Pey J., Remy S. and Cvetkovic B.** (2016): Forecasting the northern African dust outbreak towards Europe in April 2011: a model intercomparison, Atmospheric Chemistry and Physics, 16, 4967-4986, doi:10.5194/acp-16-4967-2016.
- **Pérez García-Pando, C., Miller, R. L., Perlwitz, J. P., Rodríguez, S., and Prospero, J. M.** : Predicting the mineral composition of dust aerosols: Insights from elemental composition measured at the Izaña Observatory. Geophysical Research Letters, 43(19), 2016.
- **Soret, A., Piot M., Ortega D. and Basart S.:** 'Solar power forecasting: application of the NMMB/BSC-CTM on-line chemical weather prediction model in central Europe", 16th EMS Annual Meeting, Trieste, Italy, 12-16 September 2016.

13. BrightSource Industries Israel Ltd (BSII), Israel

BSII is a wholly-owned subsidiary of BrightSource Energy, Inc. (BSE), a US corporation registered in the state of Delaware and headquartered in California. BSII, a corporation registered and headquartered in Jerusalem, Israel, acts as the technology arm of the BSE group, performing design, engineering, R&D, project management and product supply functions. In addition to BSII, BSE has business development and project development subsidiaries in China, South Africa and the UK (from where worldwide business development activities are managed).

To date, BSII has provided the technology (design, engineering, product supply, etc.) for the three tower CSP plants comprising the 392 MW Ivanpah project in California, which has now been operating commercially since January 2014. BSII is currently implementing, through a company jointly owned with General Electric (a minority investor in BSE) and a private equity fund, a 126 MW tower CSP project in southwestern Israel that is under construction and expected to be completed in early 2018. The company is now developing CSP projects in China, together with joint venture partner Shanghai Electric Co.

BSII and its sister entities in Israel have over 120 employees (excluding temporary construction workers) at the company's facilities in Jerusalem and at its Solar Energy Development Center 150 km south of Jerusalem in the Negev Desert. Earlier, more than 20 of BSII's key employees were central to building the first commercial CSP plants in the 1980s – the 354 MW of parabolic trough plants built by Luz International (and its Israeli subsidiary) in California and still operating at full capacity after 25-30 years of operation.

Main tasks attributed in the project

Within the project the company will be mainly involved in two work packages. In **WP4** connected with cooling technologies BSII will act as a consulting partner, performing specific analysis for proposed technologies. Within **WP3,** BSII will perform a full development and upscaling of a dynamic integral dry cleaning device for the heliostats.

List of relevant previous projects or activities (max. 5)

- **RAISELIFE – Raising the Lifetime of Functional Materials for Concentrated Solar Power Technology (H2020 Project)**
  BSII is involved in the development and testing of coatings, thin-glass composite mirrors, and secondary reflectors, as well as participating in system modelling and techno-economic analysis relating to materials lifetime and degradation, all with respect to central tower CSP systems.
- **PEGASUS – Renewable Power Generation by Solar Particle Receiver Driven Sulphur Storage Cycle (H2020 project)**
  BSII is cooperating in the development of new CSP technologies including particle receivers and sulphur-based thermochemical energy storage.

Description of any significant infrastructure and/or any major items of technical equipment

BSII operates a Solar Energy Development Center (SEDC) in Dimona, Israel, as a technology testbed and proving ground for new generations of components and materials. SEDC was originally built by BSII in 2007/8 at a cost of US$15 million and currently boasts a solar field comprising some 13,000 m2 of heliostats of varied design and material application, all centrally controlled through a wireless network. From 2008 through 2014 the centrepiece of SEDC was a 6 MWt pilot-scale direct-steam receiver with evaporator, steam drum and superheater that produced utility-grade steam at temperatures of up to 540°C and pressures of up to 140 bar. At the end of 2014 that receiver was removed from atop the 60m tower in favour of a pilot-scale molten salt receiver built by Alstom. Following modifications to control system algorithms, the molten-salt receiver and associated steam generator have been operated and tested on a daily basis for two full years. The technologies tested at SEDC to date include: heliostat component materials, design and assembly; wired and wireless communications and autonomous power systems; mirrors, mirror coatings and sealants; waterless heliostat cleaning systems; receiver tube materials, receiver coatings and methods for application and testing of receiver coatings; and solar field and receiver control systems.

Curriculum vitae of the key persons

Yaniv BINYAMIN (M) is a Director of BSII. He is specialised in chemistry and materials engineering, coating, development and engineering Labs Manager. He holds a M.Sc. in materials engineering and has more than 10 years of experience in process engineering, materials and chemistry R&D in aerospace, medical devices and energy industries. He is leading BSII coating technologies since more than 5 years. Finally, he is currently a Doctoral candidate in applied chemistry.

ARNON TURNER (M) is a intended project manager for SOLWATT project. He is a mechanical engineer with more than 7 years of experience in project engineering, process and project management.

Rotem HAYUT (M) is a VP for Solar Field Modeling. He has more than 10 years of experience in CSP control systems, solar flux design, and tower CSP design and operation.

Yona MAGEN (M) is a VP of Receiver design. He is responsible for receiver development and integration from preliminary design to operation and performance.

Avishai CHALFON (M) is a Mechanical engineer. He has more than 25 years of experience in various industries. He is the BSII Test Group Manager.

Shmuel HUSS (M) is a Mechanical engineer, VP of Heliostat Design and Production Engineering with 35 years of experience in parabolic trough and heliostat design.

Susan WALZER (F) is a Senior Director. She is a Civil Engineer with 35 years of professional experience, specialised in solar power plant performance simulation models. She also has solar engineering experience dating back to Luz International.

List of relevant publications and/or products, services, software (max. 5)

- "Heliostats, and methods and apparatus for assembly thereof," PCT Patent Application WO/2013/128403
- "Systems, methods, and devices for operating a solar thermal electricity generating system," US Patent No. 9,255,569
- "Systems and methods for control and calibration of a solar power tower system," US Patent No. 9,222,702
- "Devices, methods and systems for control of heliostats," European Patent No. 2247974
- "Solar field layout and systems and methods for arranging, maintaining, and operating heliostats therein," PCT Patent Application WO/2011/158199

13. AMIRES (AMI), Czech Republic

AMIRES is a consulting and management company for research, development and innovation projects, which provides the necessary strategic and administrative support to high quality international teams to achieve their objectives and facilitates the research-industrial and research-policy making interface. AMIRES follows projects from their initiation and planning, through negotiation, execution and management to the final stage, where exploitation of new technologies, products or services is facilitated. Moreover, main mission of the company is to facilitate the access of European research to high-tech SMEs and improve exploitation of innovative ideas. AMIRES s. r. o. is based in the Czech Republic but provides its services all around Europe.

Main tasks attributed in the project

Within the project the company will be actively involved in the administrative and financial project management tasks and will be responsible for the dissemination activities. AMIRES will coordinate the External Advisory Board meetings. Company will support the coordinator and WP leaders with assistance needed for negotiation and seamless project execution, consortium agreement preparation, competitive call preparation (if needed), timely reporting and budget follow-up. Moreover, AMIRES will support coordination of project meetings, dissemination (e.g. webpages, press releases, leaflets) and exploitation (support to companies and provide liaison with other SMEs and industrials). AMIRES will be also responsible for support to the exploitation manager.

List of relevant previous projects or activities (max. 5)

- **WASCOP – Water Saving for Concentrated Solar Power (H2020 project)**
  The project aims to develop a revolutionary innovation in water management of Concentrating Solar Power plants, a more flexible integrated solution comprising different innovative technologies and optimized strategies for the cooling of the power-block and the cleaning of the solar field optical surface.
- **MOSAIC – MOdular high concentration SolAr Configuration (H2020 project)**
  The project aims to develop a revolutionary plant concept based on fixed reflectors thus allowing for the design of automatic cleaning systems that could reduce significantly the water consumption. This novel concept also includes a modular approach for the plant that allows to work at the highest efficiencies and a more flexible management of the power block that enables additional water reductions.
- **SABINA – SmArt BI-directional multi eNergy gAteway (H2020 project)**
  The project aims to develop new technology that will connect, control and actively manage thermal and electric networks using generation and storage assets to exploit synergies between electrical requirements and the thermal inertia of buildings, whilst allowing aggregators to provide flexibility and balancing services to the grid. Provision for aggregation at district level will be provided to maximise the effect of SABINA.
- **FLUIDGLASS - Solar Thermal Glass Facades with Adjustable Transparency (FP7 project)**
  Project develops a new and innovative concept for multifunctional solar thermal glass facades systems. The FLUIDGLASS approach turns passive glass facades into active transparent solar collectors while at the same time controlling the energy flow through the building envelope.
- **TRIBUTE - Take the energy bill back to the promised building performance (FP7 project)**
  The large-scale integrating project aimed at minimizing the gap between computed and measured energy performances through the improvement of the predictive capability of a state-of-the-art commercial BEPS.

Description of any significant infrastructure and/or any major items of technical equipment

AMIRES has all the necessary equipment to ensure smooth administrative and financial support to the whole consortium including the FTP server (backed up in another European country) that could be used as a repository tool within the project. AMIRES has a good developed platform for webpages, which could be also used as a management tool and document repository. AMIRES has direct access to meeting rooms in Prague and Brussels, which are offered for consortium meetings.

Curriculum vitae of the key persons

Rudolf FRYČEK, PhD. (M) is the CEO of AMIRES and he has more than 10 years' experience in the European project management and consultancy. He was a consultant to several SMEs in the field of production, innovation and company development, including preparation of project for governmental incentive and for several business oriented bank loans. In 2006 he was nominated as a Seconded National Expert to the European Commission, Directorate General for Industrial Technologies. Beside his technological expertise and daily project officer work (more than 13 projects under his responsibility) he has been active in the policy structuring for exploitation and commercialization of EU framework projects. He helped to analyze the overall nanotechnology unit project portfolio in terms of generated IPR and also co-organized the workshop with European Patent Office and US Patent and Trade Office on IPR in nanotechnology – lessons from experiences worldwide, held in Brussels. He was a Scientific Coordinator of the EuroNanoForum 2009, the bi-annual conference financed by the European Commission. Since 2011 he is an accredited coach of Innovation Platform – PLATINN, which provides hands-on coaching to SMEs. Rudolf is a cooperation coach, which helps companies to increase their innovation capacity. Rudolf is a founder of AMIRES company and within the project will be responsible especially for the technology scouting activities as he has quite deep experience within this domain.

Lenka BAJAROVÁ (F) is a managing director of AMIRES s. r. o. She graduated from the University of Economics, Faculty of International Relations in 2003. She gained her experience as a National Contact Point for several FP7 priorities especially in the Capacities programme and FP7 horizontal activities – technology platforms, JTIs, PPPs. She was working in this position for 5 years and was also a Deputy Head of the Department National Information Centre for European Research, co-leading team of Czech FP7 NCPs. Her portfolio covered monitoring of the activities in related areas, communication with researchers interested in FP7 / preparing FP7 proposals / running FP7 projects, organising dissemination events etc. During the Czech Presidency of the Council of the European Union she was actively involved in the preparation of two conferences – EUFORDIA 2009 (impact assessment of research and development) and EuroNanoForum 2009. Lenka runs the Czech branch of AMIRES and is responsible for H2020 project SABINA and supervises other projects (FLUIDGLASS, LASSIE-FP7, TRIBUTE).

Václav SMÍTKA, PhD. (M) is a Programme Manager for Energy & Energy Efficiency of AMIRES s. r. o. He graduated from the Czech Technical University in Prague, Faculty of Civil Engineering in 2009. At the same faculty, he finished his PhD. in 2013. During his studies, he took part in many research and development programmes and projects as a coordinator as well as a member of a research team. All these projects were mainly focused on the deformation measurement methods in the field of civil engineering. As an assistant professor at the Department of Special Geodesy at FCE, CTU in Prague he was also actively involved in teaching and publication activities. During his studies at the Institute of Property Valuation at the University of Economics in Prague he gained knowledge in the field of Real Estate Appraisal. Václav is responsible for FP7 projects FLUIDGLASS (Solar Thermal Glass Facades with Adjustable Transparency) and TRIBUTE (Take the energy bill back to the promised building performance) and supervises other projects (WASCOP, MOSAIC, SABINA).

List of relevant publications and/or products, services, software (max. 5)

- **Hullman A., Frycek R.**: Results from the international workshop „IPR in nanotechnology – lessons from experiences worldwide ", World Patent Information Vol.29, Issue 4, 2007, pp. 395-398.
- **Frycek R.**: Public Partner Partnership applied in the Research & Development. Ekonom Journal, 2005, p. 7, ISSN 1210-0714.
- **Havlickova L, Rakusanova K., Vlkova M.**: Coordination of research activities in FP7 – related programmes and initiatives. Technology Centre ASCR, ISBN 978-80-86794-33-4.

4.2. Third parties involved in the project (third party resources)

Partner 1: TSK

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	Yes
Installation of mirrors, HCEs and dust barrier. Mechanical and electrical installation of the WRS. Authorized Control Body for the installations of the plants.	
Does the participant envisage that part of its work is performed by linked third parties[27]	No
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	No

Partner 2: CEA

No third parties involved, no subcontracts introduced

Partner 3: DLR

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	Yes
Laboratory assistant for anti-soling coating sample investigation	
Does the participant envisage that part of its work is performed by linked third parties[28]	No
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	No

Partner 4: CIE

No third parties involved, no subcontracts introduced

Partner 5: CU

No third parties involved, no subcontracts introduced

Partner 6: TEK

No third parties involved, no subcontracts introduced

Partner 7: RIO

No third parties involved, no subcontracts introduced

Partner 8: ASE

No third parties involved, no subcontracts introduced

[27] *A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the Model Grant Agreement).*

[28] *A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the Model Grant Agreement).*

Partner 9: IND

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	No
Does the participant envisage that part of its work is performed by linked third parties[29]	Yes
VENTO MAQUINARIA INDUSTRIAL, S Coop. VENTO provides the workshops and construction and commissioning of the machinery that INDETEC designs and sells, under the trade mark of GRUPO VENTO sharing the majority of the stakeholders. In project, VENTO will provide industrialization for the Water Recovery System (WRS) based on a 6 effect Multiple Effect Evaporator (MEE) for a treatment capacity of 5670 kg/h and 90 % of water recovery	
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	No

Partner 10: FNK

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	Yes
Design of PLC for the truck and programming of the parameters of control system for the cleaning system	
Does the participant envisage that part of its work is performed by linked third parties[30]	No
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	No

Partner 11: BSC

No third party involved, no subcontracts introduced

Partner 12: BSII

No third party involved, no subcontracts introduced

Partner 13: AMI

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	Yes
Subcontracting for the development of the website	
Does the participant envisage that part of its work is performed by linked third parties[31]	No
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	No

[29] A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the Model Grant Agreement).

[30] A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the Model Grant Agreement).

[31] A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the Model Grant Agreement).

5. ETHICS AND SECURITY

5.1. Ethics

Ethical issues are raised in WP1, where Cranfield University academic staff intend to carry out interviews involving the local inhabitants at five locations near existing CSP plants or at locations that are potential CSP sites. All Cranfield University staff are bound by its "Research Ethics Policy" # CU-RIO-POL-2.0-V3. A copy of this Policy is available at https://www.cranfield.ac.uk/about/governance-and-policies/policies-and-regulations

5.2. Security

- Activities or results raising security issues: NO
- 'EU-classified information' as background or results: NO

6. ANNEX I – EXPLOITATION PLANS

INDETEC (GRUPO VENTO) exploitation strategy of SOLWATT results
Market description: constructional design and engineering

Exploitation plan: INDETEC, plans to exploit the know how generated during this project in the field of water recovery systems based on multiple effect evaporators in two different approaches; for CSP plants it is intended to develop the commercialization strategy altogether with TSK in an open innovation approach at their sites (the new ones and upgrading the already existing ones. For applications other than CSP, where the heat source is not steady over the day and year, INDETEC will exploit the results by adopting the strategy that proves to be more feasible during the SOLWATT project.

Expected revenues and market share: INDETEC (GRUPO VENTO) is a SME that designs and builds industrial machinery (evaporators, distillation columns, ionic exchange, heat exchangers, dryers, reactors, etc) for process industry. Last year's total turnover was of 5 M€ and the internal market share for MEE represented 43%. In a similar case scenario abovementioned, a 15% increase in the turnover is expected 5 years after the project implementation.

Year	2022	2023	2024	2025	2026	2027	TOTAL
Turnover (M€)	5	5,6	6	7	7,5	8,5	39,6
Turnover with SOLWATT (M€)	7	7	7	7	7,5	10	45,5
Difference (M€)	2	1,4	1	0	0	1,5	5,9
Market share MEE	43%	45%	48%	50%	52%	54%	50%

BRIGHTSOURCE exploitation strategy of SOLWATT results
Market description: cleaning and maintenance of solar thermal plants

Exploitation plan: The natural first customers for the cleaning solution are the CSP projects that will be developed and built with strategic partners, joint venture partners and project development companies that will use BSII solar field technologies – BSII generally does not own the projects but develops and in some cases supplies the technologies for the solar field. These are typically owned by special-purpose project companies which can include some minority ownership by BSII's parent company, BrightSource Energy, Inc., or by some other affiliated company. As a rule of thumb, each 100-130MW plant employs between 50,000 and 60,000 heliostats, and each heliostat will take one automated cleaning system. Thus, the expected market size in the initial years, notwithstanding our ability to adapt the design to other heliostat providers' offerings, is the number of heliostats in existing projects and in projects in the near-term development pipeline:

- Ashalim Solar Thermal Power Station (Israel) – 50,000 heliostats (2020)
- Delingha Solar Thermal Power Project (northwest China) – 60,000 heliostats (2021)
- Estimated one project of 60,000 heliostats per year going forward.

Calendar year	2020	2021	2022
Target market size for developed product (M€)	6	7.2	5.4
Estimated market share (%)	100%	100%	100%
Estimated sales quantity (units)	50000	60000	60000
Estimated representative unit price (€/unit)	120	120	90
Estimated sales revenue (K€)	6,000	7,200	5,400
Estimated cumulative sales revenue (K€)	6,000	13,200	18,600

DLR exploitation strategy of SOLWATT results
Market description: O&M Optimizer and Soiling Rate Forecast

Exploitation plan: In general, DLR will manage the commercialization of SOLWATT results within its technology marketing department. Patents will be filed, when possible. License agreements with one or more companies per product will be targeted. The soiling forecast and maps will be exploited like this together with BSC. Furthermore, DLR benefits in terms of new research project acquisition opportunities, insights into real plant data and high-quality journal publications.

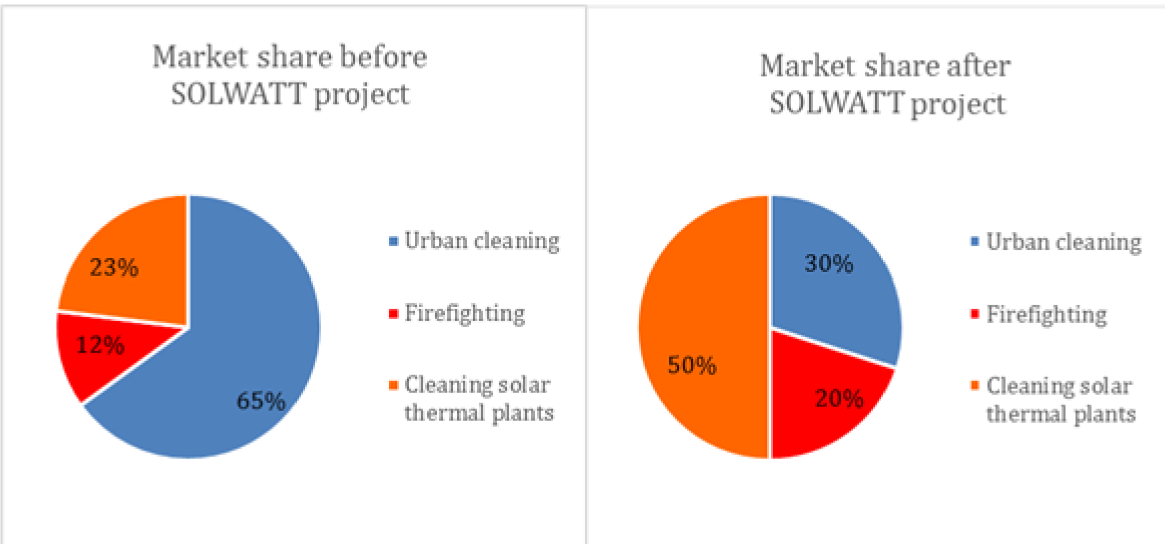
DLR sees a very high market opportunity for the O&M Optimizer, since it allows for high profit increase at very low CAPEX. Thus, DLR will try to exploit the gained know-how and O&M Optimizer by establishing a related spin-off company and actively promoting the tool in the CSP community. This commercialization strategy can lead to a fast spreading of the O&M Optimizer for both existing and future CSP plants.

Expected revenues and market share: The scheduling and optimization tool is applicable to all kinds of CSP plants under various market conditions. Thus, it is likely that significant benefit can be shown for about 90% of all CSP plants (existing and future ones). The O&M Optimizer Module could be installed either as stand-alone or, most likely, in combination with the corresponding plant operators' tools. A **market share of more than 50% in 2025** in the upcoming market for O&M Optimizers is envisaged for new CSP plants; and until then about 30% may upgrade existing plants with the O&M Optimizer. Especially, cooperation with SOLWATT partner TSK is desired for all plants. As a result, an annual **revenue of about 1.5 million €** is envisaged for 2025.

FENIKS exploitation strategy of SOLWATT results
Market description: cleaning and maintenance of solar thermal plants

Exploitation plan: Through the know-how generate during the SOLWATT project, Feniks will enrich its products portfolio in the field of cleaning devices by implementing of newly developed ultrasonic cleaning device. There are two different strategies for the implementation of this new technology expected. Firstly, traditional truck cleaning equipment will be replace by ultra-sonic device which will create a completely new product. Secondly, current trucks with conventional cleaning devices already sold to customers will be adapted in order to be able to carry the new ultrasonic device.

Moreover, we will invest in worker training and in demonstrations for customers. This will boost the company's growth at the national and international level while supporting more sustainable energy production.



Expected revenues and market share: Feniks has three lines of business: urban cleaning, firefighting and O&M trucks for the CSP plants. The company is mainly focusing on water works, cleaning or extinguishing.

During the years 2015 and 2016, our turnover was around 2.8 million €. In total, we are producing around 50 vehicles bodywork per year. In the CSP market, our production is around 6 trucks per year. With this new product, which consumes a small amount of water and is economically competitive, we expect to improve our performance and sell up to 10 units per year. After the development of this product and the adaptation of our trucks, we are expecting to increase our turnover on the CSP market from 1.5 million to 2.5 million.

Year	2022	2023	2024	2025	2026	2027	Total
New plants	2	2	2	2	3	3	
Market share (new plants)	3.2%	3%	4.3%	3%	4.4%	3.2%	
New plants with SOLWATT solutions	3	3	3	4	4	5	
Market share with SOLWATT solutions	6%	5.4%	5%	4.5%	6%	5.8%	
Turnover (M€)	1	1	2	1	2	1.5	
Turnover with SOLWATT solutions (M€)	3	2.5	2.5	2	3	3	
Difference (M€)	2	1.5	0.5	1	1	1.5	

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