

# CONCENTRATED SOLAR POWER IMPLEMENTATION PLAN STATUS & NEXT STEPS

*Inmaculada Figueroa*  
*Chair of the CSP Temporary Working Group*

STAGE-STE FINAL WORKSHOP  
23/01/2018

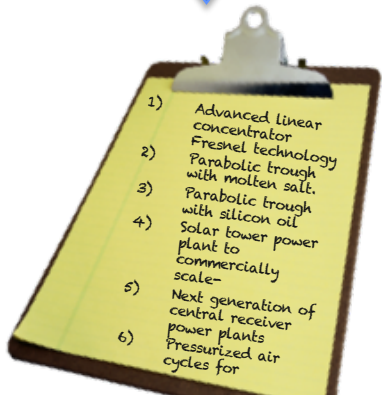


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**June 2014**



**CSP Issue Paper  
October 2015**



**Stakeholders Consultation**



EUROPEAN COMMISSION  
RTD - Energy  
ENER - Renewables, R&D, Energy Efficiency  
JTC - Institute for Energy and Transport  
SET Plan Secretariat



SET-Plan - Declaration  
on Strategic Targets in the context of an  
Initiative for Global Leadership in Solar Thermal Electricity (CSP/STE)

**Declaration of Intent**



**Declaration of Intent - CSP Targets:**

1. *> 40% cost reduction by 2020 (from 2013) translating into supply price\* < 10 c€/kWh for a radiation of 2050 kWh/m<sup>2</sup>/year (conditions in Southern Europe)*
2. *New cycles (including supercritical ones) with a first demonstrator by 2020, with the aim to achieve additional cost reductions & opening new business opportunities.*

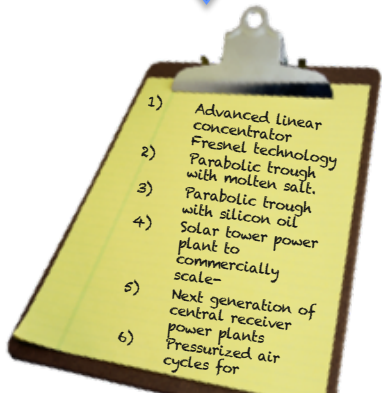


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EFRA STAGE



**SET-Plan Steering Group Approval DoI**



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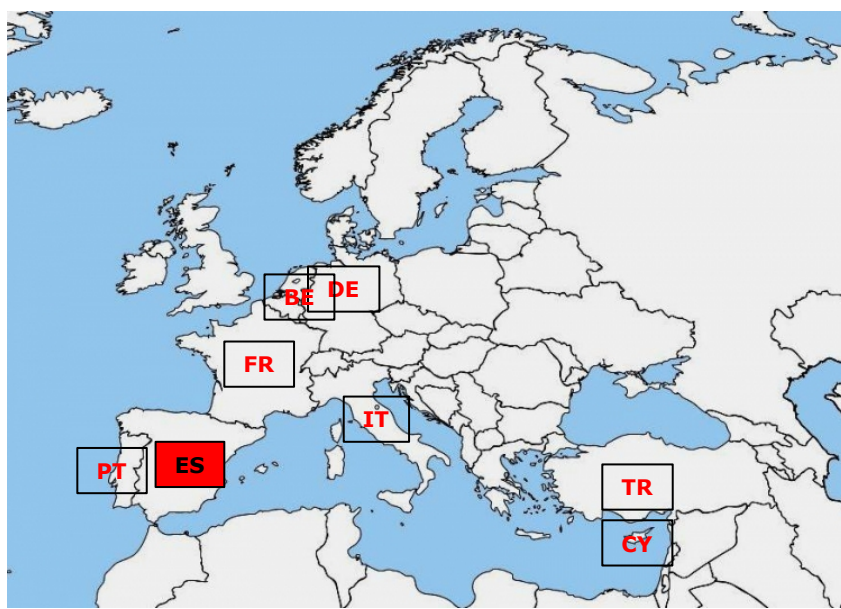
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# Temporary Working Group



❑ **Governments/Funding Agencies from: Spain, Portugal, France, Germany, Italy, Cyprus, Turkey, & Belgium. Leadership: Spain (MINECO)**

❑ **European Solar Thermal Electricity Association (ESTELA) representing more than 100 entities**



❑ **Joint Programme on CSP/STE of the EERA representing 29 organizations**



❑ **European Association of Gas and Steam Turbine Manufacturers (EUTurbines) representing 6 entities**



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# Outcome

**Initiative for  
Global  
Leadership in  
CSP**



Initiative for Global Leadership in Concentrated Solar Power

Implementation Plan

## Implementation Plan

27/09/2018

- **First-of-a-kind projects**
- **R&I Activities**
- **Framework conditions (access to finance & regulatory)**
- **Support to internationalisation**
- **Possible implementing frameworks**



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# First-of-a-kind projects

## Main requirements defined by TWG

- Demonstrate at commercial scale crucial technology solutions to reach the targets
- Include storage to provide fully dispatchable power, & to allow for more flexible generation
- Have high potential of replication in Europe & worldwide
- Make use of cooperation mechanisms of RES Directive to facilitate access to new markets in Europe
- Combine financial instruments (loans, guarantees) with grants, structural funds & promoters' equity
- Have business plan including PPA agreement with off-taker interested in value of CSP dispatchable power

**OVERALL COST ESTIMATED AT MINIMUM € 900 MILLION**

See ICF study on Innovative Financial Instruments for First-of-a-Kind, **commercial-scale demonstration projects in the field of Energy, funded by DG RTD**



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# SET Plan countries with companies holding references in CSP technology

	SET Plan country	GER	BEL	DNK	CZE	ESP	FRA	NLD	ITA	PT	NO	TUR	CY	GR	IRE	CH	
Activity	Developer	x				x	x		x				x				
	Civil works					x			x	x							
	Solar Field	x				x	x									x	
	Tower					x			x	x		x					
	Receiver	x		x		x		x									
	Storage	x				x						x					
	Control	x		x		x	x	x	x	x							
	Piping/Valves	x	x			x	x		x	x							
	Steam gener.	x		x		x		x	x								
	Turbine	x				x				x							x
	Cooling system					x				x	x					x	
	Electrical syst.	x		x	x	x	x	x	x	x	x						
	Auxiliary syst.					x				x	x						
Assembling						x			x	x							

(Non-exhaustive list)



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# R&I Activities

## 1 Portfolio analysis of actions of the Integrated Roadmap

### TWG analysed all actions in Integrated Roadmap

- From Y actions to 5 priority activity areas

Integrated Roadmap Action	Potential contribution to strategic target 1	Potential contribution to strategic target 2
<b>Advanced Research Programme</b>		
Action 1: More efficient components – HTF, receivers, reflecting surfaces	5	4
Action 2: Reliability of CSP plants	3	3
Action 3: Hybridization of CSP plants	4	4
Action 4: Storage systems	5	5
Action 5: Water consumption	1	1
Action 6: Weather forecasting	3	3
<b>Industrial Research and Demonstration Programme</b>		
Action 1: More efficient components – HTF, receivers, reflecting surfaces	5	4
Action 2: Reliability of CSP plants	3	3
Action 3: Hybridization of CSP plants	4	5
Action 4: Storage systems	5	5
Action 5: Water consumption	1	1
<b>Innovative and Market Uptake Programme</b>		
Action 1: Cooperation Mechanisms	5	3
Action 2: European Standards	2	2

## 2 Five priority activity areas identified by the TWG

### TWG agreed on 5 activity areas:

- storage systems
- Components
- integration and hybridization
- supercritical steam turbines
- advanced concepts for improved flexibility & efficiency in CSP applications

## 3 Twelve R&I activities in Implementation Plan (IP)

- Advanced linear concentrator Fresnel technology with direct molten salt circulation as heat transfer fluid and for high temperature thermal energy storage
- Parabolic trough with molten salt
- Parabolic trough with silicon oil
- Solar tower power plant to commercially scale-up and optimize the core components of the open volumetric air receiver technology
- Improved central receiver molten salt technology
- Next generation of central receiver power plants
- Pressurized air cycles for high efficiency solar thermal power plants
- Multi-tower central receiver beam down system
- Thermal energy storage
- Development of supercritical steam turbines optimised for the specifics of CSP applications
- Development of advanced concepts for improved flexibility in CSP applications
- Development and field test of CSP hybrid air Brayton turbine combined cycle sCO<sub>2</sub> systems





# CSP/STE IMPLEMENTATION PLAN (June 2016 – September 2017)

## List of R&D proposed activities ranked according defined relevance:

List of R&D proposal ranked according its defined relevance	Estimated budget (M€)
1) Proposal 5: Improved Central Receiver Molten Salt technology	20 – 22
2) Proposal 3: Parabolic Trough with Silicon Oil	6 - 8
3) Proposal 6: Next Generation of Central Receiver power plants	20 - 25
4) Proposal 1: Advanced Linear Fresnel technology	25 - 30
5) Proposal 2: Parabolic Trough with Molten Salt	10 - 14
6) Proposal 4: Open Volumetric Air Receiver	5 - 6
7) Proposal 8: Multi-Tower Beam Down System	7 – 8
8) Proposal 9: Advanced TES	8 – 10
9) Proposal 10: Supercritical Steam turbine	20 - 25
10) Proposal 11: Improved flexibility in CSP applications	4 - 5
11) Proposal 12: High Temp Brayton Sc. CO <sub>2</sub>	25 - 30
12) Proposal 7: Pressurized Air Receiver with Storage	4 – 6
<b>TOTALS</b>	<b>154 - 189</b>



# CSP/STE IMPLEMENTATION PLAN (September 2017 - .....

## Tentative mapping of Activities sharing (national level):

R&D Activities with more than one country interested	Number of countries interested	Total budget (M€)	Contrib. requested (M€)
Act. 1: Advanced Linear Fresnel technology	3	30	15
Act. 2: P. Trough with Molten Salt	3	11,5	5,75
Act. 3: Parab. Trough with Silicon Oil	3	8	4
Act. 4: Open Volumetric Air Receiver	4	5,5	2,75
Act. 5: Improved Central Receiver Molten Salt technology	5	22	11
Act. 6: Next Generation of Central Receiver power plants	5	25	12,5
Act. 7: Pressurized Air Receiver with Storage			
Act. 8: Multi-Tower Beam Down System	3	8	4
Act. 9: Advanced TES	5	10	5
Act. 10: Supercritical Steam Turbine			
Act. 11: Improved flexibility in CSP applications			
Act. 12: High Temp Brayton Sc. CO <sub>2</sub>			
<b>TOTALS</b>		<b>120</b>	<b>60</b>

# CSP/STE IMPLEMENTATION PLAN (proposed Mapping of Activities)

	Spain	Portugal	France	Italy	Germany	Cyprus	Turkey	Belgium	TOTAL
Act. 1: Advanced Linear Fresnel tech.		5,50	5,50	4,00					<b>15,00</b>
Act. 2: P. Trough with Molten Salt. (LC-CS3-RES-13-2018)		1,90		1,90	1,90				<b>5,70</b>
Act. 3: P. Trough with Silicon Oil (LC-CS3-RES-13-2018)	0,80			1,20	2,00				<b>4,00</b>
Act. 4: Open Volumetric Air Receiver				0,40	1,15		0,40	0,80	<b>2,75</b>
Act. 5: Improved Central Receiver Molten Salt tech.	3,00				3,00	1,00	2,00	2,00	<b>11,00</b>
Act. 6: Next Generation of Central Receiver plants	3,75		2,50			1,25	2,50	2,50	<b>12,50</b>
Act. 8: Multi-Tower Beam Down		1,20		2,40		0,40			<b>4,00</b>
Act. 9: Advanced TES (L-RES-17-2019)	1,00	0,50	1,50	1,00			1,00		<b>5,00</b>
	<b>8,55</b>	<b>9,10</b>	<b>9,50</b>	<b>10,90</b>	<b>8,05</b>	<b>2,65</b>	<b>5,90</b>	<b>5,30</b>	<b>59,95</b>

## Next steps:

- Final selection of projects to be executed based on the funding availability (NFOs/EC)
- Definition of procedure/tool to the implementation/execution of defined activities (public competitive calls required, ).

# How to fund the selected R&I Activities?

1. **Main source:** National level [e.g. from government, and/or from stakeholders (industry alone in some cases)]
2. **Joint R&I activities between SET Plan countries** (with or without EU funds) should be an important dimension of the Implementation Plans

Transnational R&I Funding Programmes/schemes established currently

- ERANET CO-fund – (ERANET- SOLAR COFUND 2 recently approved in 2017). (PV+CSP)
  - A new ERANET specific for CSP could be explored focused on some of the R&I included in the IP-CSP under the topic LC-SC3-JA1-2018 (Deadline Sept)
  - EUREKA Program (Cluster EUROGIA)
3. **In selected cases: EU resources**, provided that R&I activities are in line with relevant policies endorsed by the EU legislative bodies and with the mandate of the EC, and a strong EU added value is justified
    - H2020-FP9

In the medium term other new initiatives could be explored:

- EJPs – European Joint Programmes
- PPPs/JTIs with specific and enough budget assignments and an effective governance.

# New ERANET under the topic LC-SC3-JA1-2018.

## Estimates

- Gathering around 20M€ from national budgets + 1/5 EC top up = 4M€. TOTAL 24M€
- Budget enough for the Implementation of 2-3 R&I activities.

***organisation in the coming weeks of a meeting of the NFO to analyse the availability of financial resources and evaluate the possibility to prepare a proposal to***

***LC-SC3-JA1-2018.***



# Call: LC-SC3-JA-2-2018

## **LC-SC3-JA-2-2018: Support to the realisation of the Implementation Plans of the SET Plan (Coordination and Support Action)**

**Scope:** Support the execution/realisation of a SET Plan Implementation Plan prepared by the SET Plan Temporary Working Groups (TWGs), e.g. Solar thermal energy (CSP / STE);

- The actions financed under this topic will be coordinated with the SET Plan Steering Group through the SET Plan secretariat.
- Financial amount: 1 EUR million (total budget call: 6 EUR million)
- Indicative duration: 3 years
- Deadline: Tuesday 11 September 2018

***Under preparation***



**THANK YOU FOR YOUR ATTENTION**



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