

Development of thermal storage systems using phase change materials (PCM) in the temperature range from 230°C to 330°C for systems using steam between 30-100bar

Founded by the European Commission within the 6th framework

Solar thermal power plants using parabolic trough collectors represent today's most economic systems to generate electricity from solar insolation in the MW range. By demonstrating the feasibility of high temperature direct steam generation (DSG) in absorber pipes of parabolic trough collectors European industry and research institutions have gained a leading position in this technology area. A key element for a successful market penetration of this technology is the availability of storage systems to reduce the dependence on the course of solar insolation. The most important benefits of storage systems integrated into a solar thermal power plant are:

- Reduced internal costs of electricity production due to increase in plant efficiency and extended utilisation of power block
- Facilitating the integration of a solar power plant into an electrical grid, since fluctuations in electricity generation resulting from the actual insolation are reduced
- Adaptation of electricity production to the demand increases the revenues

Efficient storage systems for steam power plants demand transfer of energy during the charging/discharging process at constant temperatures. The DISTOR project focuses on the development of latent heat storage systems based on phase change materials (PCM) used as storage media. While this approach has often been proposed, no experiences are available for the temperature level and scale relevant for direct steam generation. In order to accelerate the development, the project structure of DISTOR is based on parallel research on three different storage concepts. The concepts include innovative technologies like encapsulated PCM, evaporation heat transfer and new design concepts. This parallel approach takes advantage of synergy effects and will enable the identification of the most promising storage concept. In order to achieve the aims of the project, the DISTOR consortium covering all required sectors has been formed: companies for design and manufacturing of thermal components and power plant supply, engineering companies, manufacturer of storage materials, electric utility and solar plant design company, and highly experienced research institutes for PCM storage development, modelling and testing. The project will result in the following benefits and main deliverables:

- Development of advanced storage materials based on PCM technology adapted to steam generation/condensation in the range 200 - 300 °C.
- Identification of adjusted design by lab scale testing.
- Material and design verification for DSG technology by on-sun testing of a 100 kW storage module with 200 kWh thermal capacity in the existing DISS loop at the PSA in Spain.
- Identification of a storage design with the potential for scale up and the capability to meet in the mid to long term the cost target of < 20 €/per kWh thermal capacity.

The storage system for DSG will complete the set of components needed to implement economic solar power plants in areas like the Mediterranean region. The knowledge about this technology helps Europe to advance the DSG concept and expand its strong position in solar thermal power systems.



Parabolic trough collectors of the DISS-test facility for direct steam generation at Almeria, Spain



Temperature distribution of energy demand in steam power cycle

Partners of the DISTOR project

The DISTOR consortium include 13 partners from Germany(DE), France(F), Spain(ES), Israel (IL) and Bulgaria:

Name (Nation)	Type	Relevant Expertise	Role in the Project
1. DLR - Deutsches Zentrum für Luft- und Raumfahrt (DE)	RES	Solar storage technology, DSG development, system technology and modelling	Coordination; macro-encapsulation of EG-PCM, 10kW module, PSA testing
2. CNRS - Centre National de la Recherche Scientifique (F)	RES	Application of expanded graphite, heat storage materials and modelling	EG-PCM development, characterisation, modelling EG-PCM design concepts
3. Epsilon Ingénierie (F)	IND	Design of thermic/fluidic and thermo-mechanical components thermal systems	Design of test module based on EG-PCM external arrangement concept
4. DEFI Systèmes (F)	IND SME	manufacturing of components based on innovative structure materials and designs	Manufacturing of test module based on EG-PCM external arrangement concept
5. SGL Technologies GmbH (DE)	IND	Manufacturing of expanded graphite and EG-PCM composite materials < 100 °C	Providing expanded graphite and manufacturing EG-PCM composite materials
6. FLAGSOL GmbH (DE)	IND SME	Developer of trough collector, solar plant design, performance analysis	Storage integration into solar power plants; risk analysis, economic analysis
7. CIEMAT -Centro de Investigaciones Energéticas, Medioamb. y Tecnológicas (ES)	RES	Solar power technology, DSG development, operation of DISS loop at the PSA	Operation of DISS facility, 100 kW module testing, control strategy
8. FUNDACIÓN INASMET (ES)	RES	Development of advanced processes, materials, and new manufacturing techniques	Manufacturing of macro-encapsulated EG-PCM, heat exchanger for RHTS module
Solucar Energica, S.A (ES)	IND	Design and manufacturing of solar components, receiver, trough and dish installation	Design and manufacturing of high pressure part of 100 kW module, storage scale up
10. Sistemas de Calor S.L. (ES)	IND SME	manufacturing of energy related equipment for cogeneration, and heating	Design and manufacturing of 100 kW module, integration in test loop, storage scale up
11. Iberdrola Ingeniería y Consultoria (ES)	IND	Utility, generation, transport and distribution of electrical energy	Design specification DSG storage, operation strategy and storage integration
12. Weizmann Institute of Science (IL)	HE	Solar tower research facility, PCM storage, high temperature processes	PCM material and design for RHTS approach, 10 kW module testing
13. Central Laboratory of Solar Energy and New Energy Sources, of Science (BG)	RES	Themophysical investigation of storage materials including PCM and PCM slurries	Determination of thermo-physical properties, PCM lab scale testing

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