



**Horizon 2020 Regional Seminar**

# **ORC – PLUS PROJECT**

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## ORC-PLUS PROJECT

- Short ENEA activities introduction
- Project concept
- Partners
- Initial results
- Expected specific impact
- Barriers
- Future developments: TES-PLUSS proposal
- Areas Open to Collaboration

## ENEA

<http://www.enea.it>

ENEA is the **Italian National Agency for New Technologies, Energy and Sustainable Economic Development**, a public body aimed at research, technological innovation and the provision of advanced services to enterprises, public administration and citizens in the sectors of energy, the environment and sustainable economic development.

Its focus sectors are **energy technologies (renewable sources, energy storage, smart grids), nuclear fusion and nuclear safety, energy efficiency, technologies for cultural heritage, seismic protection, food safety, pollution, life sciences, strategic raw materials, climate change.**

ENEA's scientific and technological development activities are carried out in **9 Research Centers**, in addition to the headquarters in Rome, a network of regional offices and the Brussels liaison office for participation in European and international research projects.

The ENEA's Human resources is composed by about 2500 fixed units, of which the 61% are holders of degree.



## DEPARTMENT OF ENERGY TECHNOLOGIES.

<http://energia.enea.it/>

The focus sectors of the Department of Energy Technologies are renewable energies, technologies for efficiency energy and in the final uses of energy (**low-carbon economy**).

The department is composed by following 6 division:

Smart Energy; PV and smart devices, Production, conversion and efficient use of energy, **Solar Thermal, Thermodynamic and Smart Network (STSN)**, Development of systems for information technology and ICT, Bioenergy, bio-refinery and green chemistry.

The STSN division's activities are mainly concentrated on the following research topics:

- Solar power systems and components for the production of heat for industrial / residential uses, and/or electricity;
- Thermal Energy storage systems;
- Generation distributed from renewable energy sources and their integration into the grid (Smart Grid);

Among the main experimental demonstration plants of the STSN Division, there is the PCS (Solar Collectors Test) system: the first in the world to use molten salts as a heat transfer fluid in a parabolic collector.



# ORC-PLUS Project concept

## Organic Rankine Cycle - Prototype Link to Unit Storage



**Call: LCE-03-2014** (Innovation Action); Total cost: 7,3M€;  
EU contribution : 6,4 M€; Duration: May 2015 to April 2019

**Topic areas:** small/medium CSP plant - Smart Grid - thermal energy storage system (TES) - Demand side flexibility - pre-commercial scale demonstrator (TR7);

### Challenges:

- 1) to develop TES systems for small CSP plants coupled to a power ORC unit;
- 2) to help the diffusion of new CSP technologies in Morocco;

### Main Project goals:

- 1) Decrease of the TES for small/medium size CSP plant cost from 50% of total system cost down to 20%;
- 2) Increase of daily operating hours by up to 4 Hours of an existing CSP plant coupled with a ORC turbine with a rated output of 1 MW<sub>e</sub>
- 3) Enhancement by up to +20% of the annual average efficiency of heat to electricity transformation;



Green Energy Park (GEP) of IRESEN

**Site reference:** the ORC-PLUS technology will be validate at the Green Energy Park (GEP) located in Benguerir (Morocco).

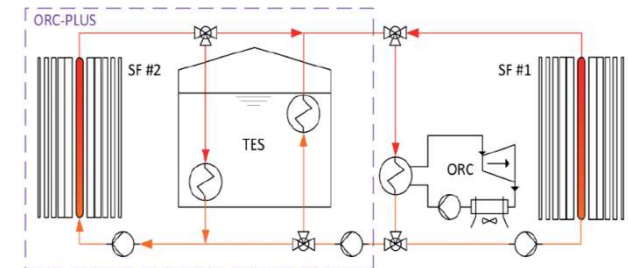
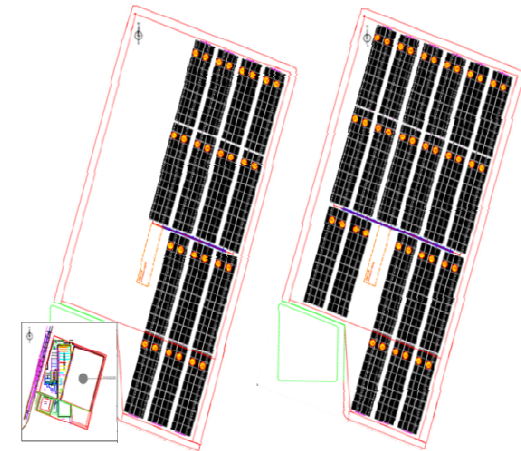
The ORC-PLUS plant will be an extension of existing CSP plant. This latter has been co-financed (6,2 M€) by IRESEN and OCP (the Moroccan phosphate industries).

The existing CSP plant consists of a linear Fresnel solar field (11,435 m<sup>2</sup> total net area of mirrors) with thermal oil as heat transfer fluid, a ORC turbine with a net capacity of 1 MW and an air condenser.

This plant offer a test bench for energy recovery technologies, multiple generation options and a large operation optimization.

The ORC-PLUS package includes:

- 4 hours thermal storage;
- Solar field extension from solar multiple 0,9 to 1,4;
- Final SF setting will be a two solar fields configuration.



Green Energy Park (GEP) of IRESEN



- ENEA: Coordinator & Research;
- F-ISE: Research;
- CIC: Research;
- IRESEN: Research & management pilot plant;
- SOLTIGUA srl: Solar collectors manufacturing & industrial case analysis;
- EURONOVIA: Dissemination & exploitation, Risk analysis (sub contract Fichter company);
- ENERRAY SpA: EPC Contractor;
  - Exergy ORC turbine manufacturing;
  - ENERRAY Morocco Ltd Local EPC;

## Third parties of Enerray SpA:





# Initial results



- Completion of the characterization activities of the TES materials;
- Realization & testing of 2 new TES experimental prototypes TRL5;
  - Thermocline magnetite pebbles + oil;
  - Single tank, low melting molten salt mixtures, thermocline system
- Selection of the better TES technology for the case under evaluation (thermocline magnetite pebbles + oil);
- Development of a customized dynamic model of the overall CSP plant - TES ( target: to maximize the energetic performance during the peak periods of the power grid);
- Completion of the final design of the ORC-PLUS plant & selection of local manufacturers / subcontractors;
- Manufacturing and installation on site of the ORC-PLUS solar field;
- Completion of the concrete basement of TES system;
- Completion of the risk analysis of the project;
- Manufacturing and installation on site TES tank



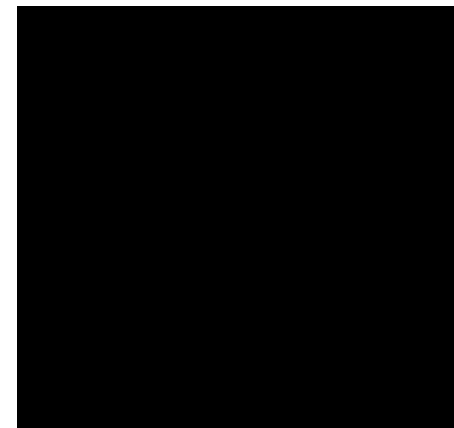
The project has benefited from its participation in the initiative "Support Service for the Exploitation of Research Results", promoted by DG RTD



# Initial results



The industrial pilot plant is going to be installed at GEP to validate the technology



video

## Expected specific impact

### *Market Transformation*

- The ORC-PLUS Project will contribute to overcome the present limitations to the expansion of small CSP plants.

### *Policy*

- The ORC-PLUS Project represents a new model of decentralized power production.

### *Socio-economics*

- a new opportunity for disadvantaged areas.
- The ORC-PLUS design was defined in such way to allow the activation of possible chains of domestic production of some CSP plant components, and the provision services.

### *Environment*

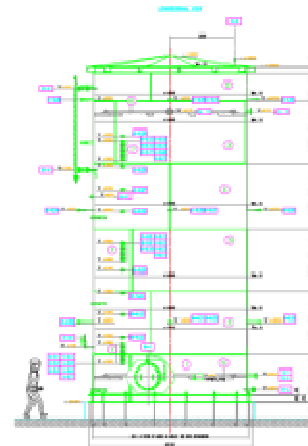
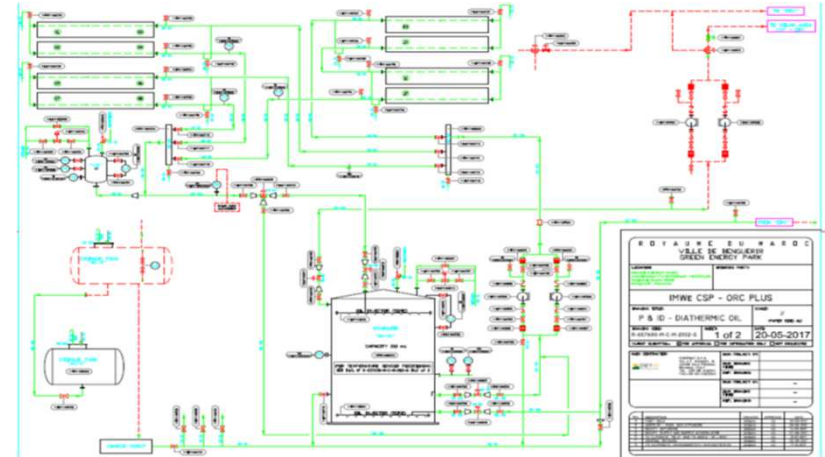
- The ORC-PLUS technology can represent a new opportunity of electric power production in remote areas respect to other solutions, such as diesel generators or PV-battery systems;
- The medium CSP plants (1-10 MWe) coupled with innovative TES systems can to employed with a new function of local renewable power grid stabilizer .





## Barriers

- Lack of standards;
- Lack regional policies;
- Technology risks;
- Competition with other existing renewable technologies;
- The regional Market supply is not sufficiently diversified/ developed;
- Difficulties in the procedures for the connection with local power grid.





# Future developments: TES-PLUSS proposal

## Project outline for a proposal in the call LC-SC3-RES-17-2019

Demonstration of solutions based on renewable sources that provide flexibility to the energy system Subtopic: Thermal energy storage in CSP plants

**TES-PLUSS** ( Thermal Energy Storage – Prototypes Link to Unit Solar System)

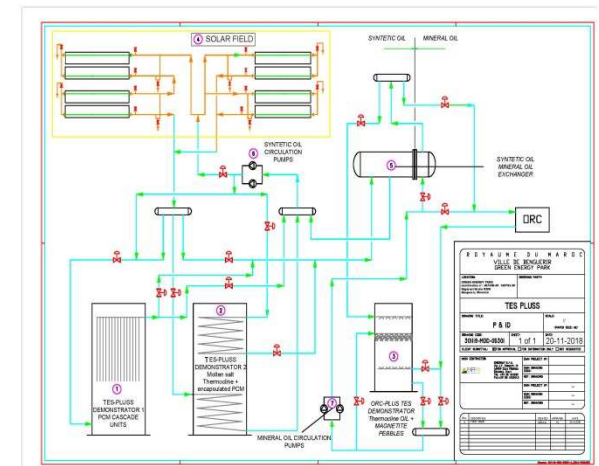
**Challenge:** demonstration of innovative storage systems for CSP plants with a much higher storage densities than current mainstream solutions with similar performance in terms of cycles.

to bring the TES technology proposed **from TRL 5 to TRL 7**

The method proposed consists in adding two advanced pre-engineered packaged solution of TES system in the plant layout of the ORC-PLUS plant.

- **Single tank, confined liquid, thermocline system** enhanced with **PCM** (evolution of the TES prototype developed in ORC-PLUS project by ENEA)
- **Cascade PCM system** (series of shell-and-tube solid-liquid PCM systems with different melting temperatures) **developed by DLR in the framework** of the DISTOR project (FP6).

During the first part of the project, the two TES technologies will be studied in parallel in TRL 5-6 pilot system.



Partners: **ENEA**, F-ISE, CIC, IRESEN, DLR, ENERRAY Morocco, ENI, EURONOVIA

Work Programme: *Secure, clean and efficient energy*

Call - BUILDING A LOW-CARBON, CLIMATE RESILIENT FUTURE: SECURE, CLEAN AND EFFICIENT ENERGY

Thematic round table: Bioclimatic approaches for improving energy performance in building in Africa and Europe (group 3)

Possible topics of interest

- Energy efficiency
- Global leadership in renewables
- Smart and clean energy for consumers
- TES systems;
- Smart Cities and Communities

**Thanks you very much for  
your attention**

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