

Media Press Pack

September 2019



Foreword

«The deregulation of the electric power generation market and the currently evolution of the environmental regulations inspire the next development of distributed utilities close to local power loads. This trend will allow to reduce the oversizing of the power grid and the costs of the transmission and distribution of the electric power.

In this frame the Concentrating Solar Power (CSP) plants of few Megawatts, coupled with advanced Thermal Energy Storage (TES) systems, will play an important role since they have all the characteristics to closely track both demand and potential growth in local electrical power loads. In addition, respect at other systems, they can be easily integrated in local district heating.

In this frame, the H2020 ORC-Plus project aimed to develop at pilot level an innovative TES system able to extend the power production of an existing solar thermal power plant, already existing in Benguerir (Morocco), by using the linear Fresnel collectors technology as solar field and an ORC turbine with a rated output of 1 MWel as power unit. The Heat Transfer Fluid (HTF) used by the existing CSP plant is an environmentally friendly mineral oil working in the range 180°C - 300°C.

After more than 4 years of collaboration between 7 partners from 4 different EU countries and Morocco, ORC-Plus will come to an end in October 2019. In this publication, you will find a glimpse of the project's objectives, key achievements, results and impacts, that we could achieve thanks to international cooperation and the support of the European Union.»

Walter Gaggioli (INEA)
ORC-Plus coordinator



Table of contents

● Concentrated Solar Power: Challenges and solutions	4
● ORC-Plus: Dispatchable small scale solar thermal electricity	5
● A collaborative research project funded by the EU	6
● Timeline of the project: our key achievements	7
● ORC-Plus results and key figures	8
● Visit the ORC-Plus plant: our final Info Day	9
● ORC-Plus impacts	10
● Communication and dissemination: ORC-Plus in the media	11



List of acronyms

CSP: *Concentrated Solar Power*
CST: *Concentrated Solar Thermal*
HSM: *Heat Storage Materials*
HTF: *Heat Transfer Fluid*
LCOE: *Levelized Cost of Energy*
ORC: *Organic Rankine Cycle*
PV: *Photovoltaics*
TES: *Thermal Energy Storage*
TRL: *Technology Readiness Level*

Concentrated Solar Power: Challenges and solutions

Fighting climate change: a global challenge

As **climate change** and **global warming** threaten our societies, the **European Union** committed to **reducing greenhouse gas emissions** by at least **40%** by 2030. Among the **objectives**: improving energy efficiency by 27% and increasing the share of **renewable and greener energy sources** to 27% of final consumption, such as **solar energy**.

What is Concentrated Solar Power (CSP)?

Concentrated Solar Power (CSP) plants use **mirrors** to concentrate **sunlight** onto **receivers** where it is converted into **heat**. A **heat transfer fluid** transports the thermal energy to a **storage system** or a power block where it is used to produce **steam** that drives a steam turbine to **generate electricity**. The integration of a storage system enables **power production** during cloudy periods and **after sunset**.

The four main CSP technologies



Parabolic dish



Parabolic Trough



Linear Fresnel



Solar Tower

Storage, dispatchability and costs: 3 challenges for CSP development

Nowadays, R&D efforts mostly focus on **thermal energy storage (TES)** for **large-scale plants**, even though **small/medium-scale CSP installations** have a **large potential**. This limitation is due to the **lack of technical solutions** of TES specialised for this size of plants and validated in a relevant industrial environment.

In this range of **size**, in order to make the **CSP systems more competitive** than the **Photovoltaic (PV)** systems, the TES has to

allow the operators of the solar power plant to adjust the electricity production for **matching consumer demand**, so enabling the sale of electricity during peak demand periods for boosting plant revenues.

In the same time, there is a need to **lower the TES weight** in the **capital costs** of the overall system: in fact, one of the **limits** in the use of a TES system in a mid-size power plant is due to its **high capital costs**.

ORC-Plus: Dispatchable small scale solar thermal electricity

ORC-Plus in a nutshell

ORC-Plus stands for “**Organic Rankine Cycle - Prototype Link to Unit Storage**”.

This **EU-funded project** aims at developing an innovative Thermal Energy Storage system (TES) which is optimised for **middle-scale CSP plants** (1-5 MWe).

The technology proposed is based on a **solar field**, using a thermal oil as **Heat Transfer Fluid** and a “Organic Rankine Cycle”¹ power

unit coupled with an **innovative TES**.

The experimental demonstration of **different industrial prototypes** of TES systems have been performed in **relevant environment**.

The **validation process** also included an analysis of the **techno-economic viability**, of the **environmental impact** and of the **replicability** of the final design of the pilot plant.

The final result of the project:

The **validation** of this **key storage technology** in a real industrial environment: an **existing CSP plant** located in the **Green Energy Park of Ben Guerir**, in the Moroccan desert. This pre-commercial solution will be **commissioned** during the course of **Autumn 2019**. For more information about our final Info Day and visit of the plant, see page 9!



ORC-Plus objectives

- Increasing the **technological performance** of renewable energy systems
- Extending the **number of hours** of **energy production** in CSP plants, **even after dark**
- Improving **dispatchability**, i.e. the production of **electricity on demand**, according to **market needs**
- Accelerating the development of **renewable smart grid networks**
- **Reducing costs** of CSP technologies, including **maintenance** and **energy production**
- Developing engineering **pre-packaged solutions**
- Minimising the use of **fossil fuels** in the process and **decreasing carbon emissions**
- **Socioeconomic growth** in a remote desert area.

¹ The Organic Rankine Cycle (ORC) is based on the principle whereby a liquid is heated, causing it to evaporate, and the resulting gas is used to turn an engine, which is then connected to a generator, and thus creates power.

A collaborative research project funded by the EU

The ORC-Plus project is supported by **Horizon 2020**, the European Union's Framework Programme for **Research and Innovation**. It was funded by the "**Secure, clean and efficient energy**" programme, under the specific topic "Demonstration of renewable electricity and heating/cooling technologies" (LCE-03-2014). **Launched in 2015**, the project will **end in October 2019**.

The **consortium** is coordinated by **ENEA** (Italian National Agency for New Technologies, Energy and Sustainable Economic Development).

It is made by a total of **6 partners** from **4 different European countries**, plus 1 international partner from **Morocco** (IRESEN), one of the main stakeholders related to Concentrated Solar Power (CSP) in that country.



Total cost
€7,29M



EU contribution
€6,25M



Duration
54 months

ORC-Plus Consortium

Italy				Project coordinator, Design and realisation of the trial TES systems
				Solar field construction and industrial case
				Pre-industrial scale pilot demonstrator
France				Communication, dissemination and exploitation, Risk identification and Management plan
Germany				Integration of the TES systems in the CSP Plant
Morocco				Monitoring pre-industrial scale pilot demonstrator
Spain				TES materials characterization

Timeline of the project: our key achievements



April 2016

Analysis and experimental characterisation of Heat Storage Materials (HSM)



March 2017

Thermal Energy Storage (TES) technology chosen with oil and filler storage materials: magnetite pebbles



December 2017

Solar field installed: Completion of mechanical erection of solar collectors



November 2018

Experimental Tests of TES prototypes completed



June 2019

Solar field commissioning: Cold commissioning of the solar field with the rest of the system

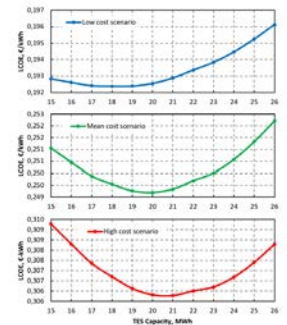
May 2015

Start of the project



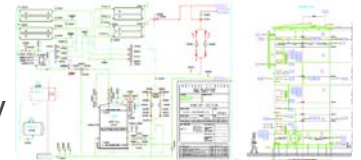
January 2017

Economic pilot analysis and Assessment



October 2017

Final design of the TES pilot system completed by ENERRAY SpA



April 2018

Risk analysis completed



March 2019

TES system installed and filled with magnetite pebbles



September 2019

Hot commissioning of the plant



October 2019

End of the project

ORC-Plus results and key figures

Results

Heat Storage Materials (HSM)

After analysis and experimental characterisation among the HSM materials, **Magnetite** is the material that presents the best thermo-mechanical and durability properties.

Economic pilot analysis and Assessment

The evaluation analysis has shown that **plant configurations are possible**, which allows **high peak coverage values** and require only **little investment**. If lower Levelized Costs of Energy are desired, a higher total investment is required.

Thermal Energy Storage (TES) technologies

Performance analysis of **2 new TES systems**:

- One based on with **thermocline oil** and **magnetite pebbles**;
 - One based on a **thermocline system** with **molten salt**.
- TES chosen: Oil and magnetite pebbles** (lower costs and better efficiency)

TES prototypes

TES prototypes have been realised and experimented, focusing the tests on the **characterisation** of the various **technical aspects** of the TES technologies under evaluation in the project itself.

Key figures: the technical figures of the ORC-Plus plant

Solar field

Collector Manufacturer	Soltigua
Type solar Collector	Fresnel collector type FLT10v
Receiver tube	HCEOI-receiver 12 ASE type
Mirror surface	4.900 m2
Parallel hydraulic solar collector loop	3
Heat-Transfer Fluid Type	DelcoTerm®Solar E 15
Min Solar-Field Inlet Temp/ Max Solar-Field Outlet Temp	180°C/300°C

Power Block

Turbine Capacity (Gross)	1.0 MWe
Output Type	Organic Rankine
Cooling Method	Dry cooling
Cooling Method Description	Direct

Thermal Storage Pilot plant

Storage Type	Sensible heat
Time Storage Capacity	4 hours
Thermal energy Storage	20 MWh
Thermal Storage Description	Back up

Visit the ORC-Plus plant!

ORC-Plus final event

Save the date! On **24 September 2019**, the ORC-Plus consortium will organise its **final event**: an **Info Day** which features a **special visit** of the **ORC-Plus plant** in the **Green Energy Park of Ben Guerir, Morocco**.

After more than **4 years of design**, tests and demonstrations, the ORC-Plus plant will finally

be **commissioned** in Autumn 2019.

This special event will take place at the same time as **Solar Decathlon Africa 2019**, an international competition that challenges collegiate teams to design and build houses powered exclusively by the sun.

Info Day preliminary programme

- 09:00** Registration
- 09:30** Opening and Welcome speech
- 09:45** **Session 1: ORC-Plus project: context and strategic opportunities**
- Introduction to ORC-PLUS project
 - Presentation of the ORC-Plus plant concept
 - Filling materials and potential application for thermal storage
- 11:15** *Coffee break*
- 11:30** **Session 2 round table: Materials and design considerations for thermal storage systems**
- 13:00** *Lunch break*
- 14:30** **Side visits**
- **14:30** - Visit to the Solar Decathlon competition
 - **15:30** - Visit to the GEP, ORC-Plus plant and ORC-PLUS pilot system
- 17:30** Closure of the Info Day

Practical information



24 September 2019
09:00-17:30



Route Régionale Kelaa, Km 3
R206 - Ben Guerir, Morocco



Register > click [here](#)



What is the Green Energy Park?



Inaugurated in **January 2017**, the Green Energy Park is a **unique platform** for tests, research and training in the field of **solar energy**, located in the **Green City of Ben Guerir**. This unique initiative in **Africa** fosters **synergies** between research **infrastructures**, **partner universities and industries**. It was developed by **IRESEN**, with the support of the Moroccan Ministry of Energy and the OCP Group.

ORC-Plus impacts

Beyond scientific achievements, the ORC-Plus project contributes to a **wide range of impacts in various areas**, for example:

Renewable energy costs and performance

- Decrease of the **Levelized Cost of Energy** between 30 and 40%
- **Increase** of the energy production of at least **4 hours**, during night time

Socioeconomic growth and jobs

- More than **5000 working hours** generated during the construction of the facility
- Revitalisation of **local industries**: carpentry, boiler making, pipes, light equipment...

Environment

- Use of mineral oils as a heat transfer fluid with almost **no polluting effect** on the soil
- Use of a dry cooled ORC system: **zero water consumption** for cooling the power block
- Reduction of **greenhouse gas emissions**:
 - 600t per year
 - Total reduction of GHG emissions for the CSP-ORC-Plus facility: 1750t
- **Substitute solution** for expensive **electro-diesel** groups in rural on/off-grid applications

Market transformation and CSP attractiveness

- **Increased dispatchability** as compared to other renewable energy technologies, such as photovoltaics or wind
- **Lower investment required** for small and medium scale CSP plants that could raise more interest from **market investors**



Communication and dissemination: ORC-Plus in the media

For all our communication material, check out our website:
<https://www.orc-plus.eu/>

ORC-Plus in the press

Radio 24 Interview of the coordinator Walter Gaggioli (29 August 2015) > [Link](#)

 MarketScreener: EU-funded project develops solar power storage technology (13 November 2016): > [Link](#)

SolarPV.TV ORC-PLUS: Innovative CSP & Storage Projects in Morocco – Interview of Michele Scandellari, CEO of Enerray at World Future Energy Summit (January 2017) > [Link](#)


 CSP Solar for Smart Grids (March 2017) > [Link](#)


 Presentation of the Green Energy Park and the ORC-PLUS project (19 May 2019) > [Link](#)

pV magazine Enerray's expanding business in MENA (9 January 2019) > [Link](#)

Communication material

 ORC-Plus video > [watch online](#)

 ORC-Plus brochure > [download in PDF](#)

 ORC-Plus logo > [download in PDF](#)

ORC-Plus public workshops

- **20 May 2016:** Solar Thermal Storage and ORC systems : ambitions, challenges and horizons - **Casablanca, Morocco** > [Find out more](#)
- **27 October 2017:** A one day focus on Solar Thermal Energy Storage - **Freiburg, Germany** > [Find out more](#)
- **03 October 2018:** TES Systems Optimized for Mid-Size CSP Plant Coupled with an ORC Turbine of 1MWe - **Casablanca, Morocco** > [Find out more](#)

Upcoming events

- **24 September 2019:** ORC-Plus final event - **Ben Guerir, Morocco** > [Register](#)
- **1-4 October 2019:** SolarPACES 2019 - **Daegu, South Korea** > [More information](#)
- **30 October 2019:** Internal ORC-PLUS closing event - **Ben Guerir, Morocco**



Our contact details



Walter Gaggioli
Project Coordinator
+39 06 30481



Marie Prouteau
Project & Communication manager
+ 33 6 48 86 70 85

<https://www.orc-plus.eu/>
orcplus.contact@enea.it

Follow us on Social Media!



ORC-PLUS - Dispatchable small scale solar thermal electricity
<https://www.linkedin.com/groups/8419883/>



H2020 CSP projects | @H2020CSP