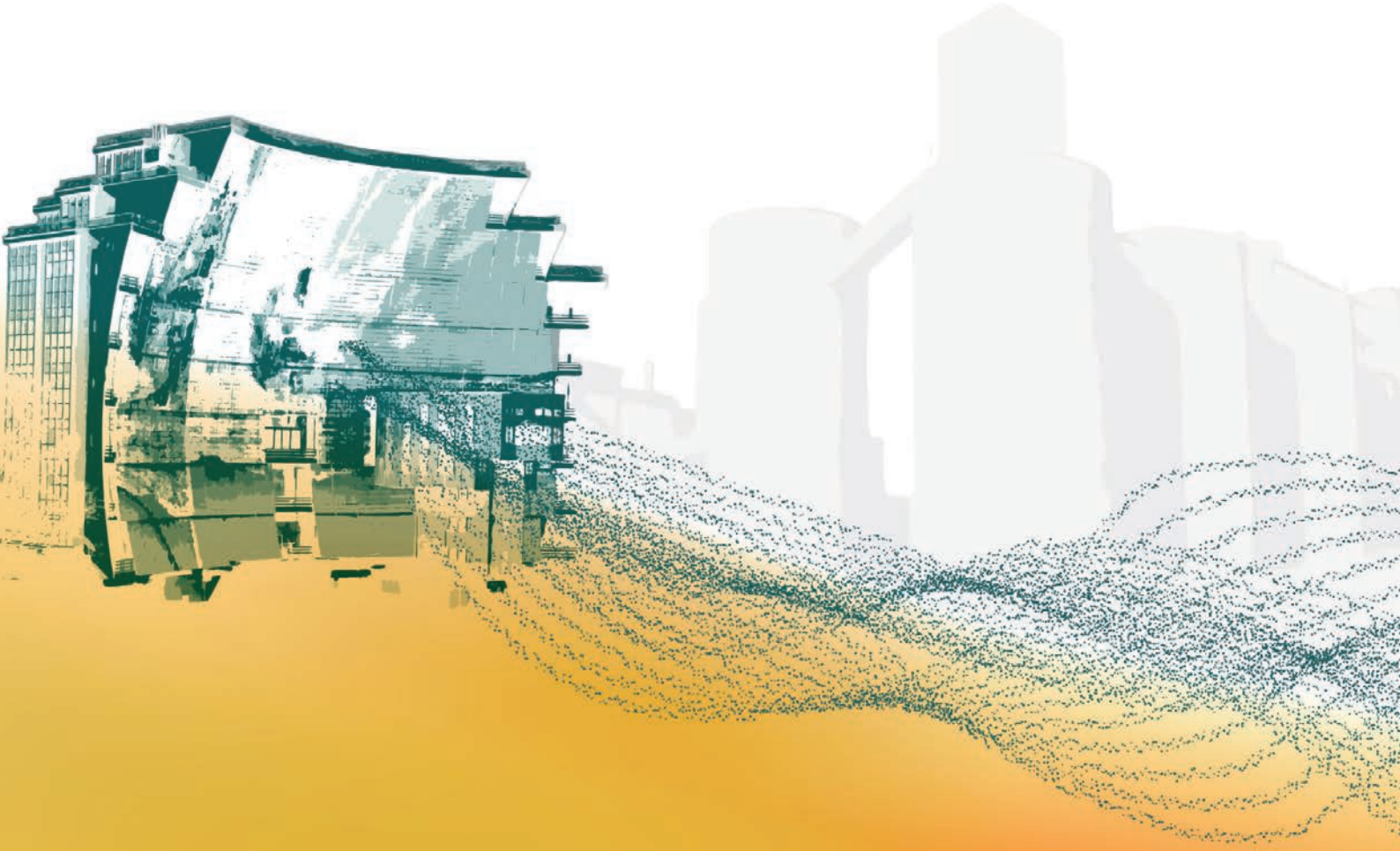
SOLPART

Harnessing the sun to clean up industrial processes

Press Pack for the Media

November 2019



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Foreword by Gilles Flamant,
CNRS-PROMES,
SOLPART coordinator

"Calcination can be presented as one of the paradigms of solar thermochemistry as hydrogen production. It is involved in the production of commodities and in thermochemical energy storage using decarbonation – carbonation cycles. Research on this topic has started about forty years ago at lab-scale and the proof of concept of many reactors has been demonstrated.

However, time to address the issues related to solar reactor scaling up is coming. In chemical engineering, reactor scaling up is always a challenge and for gas-solid reactor the challenge is even harder. In solar thermochemistry applied to particles processing one additional question is added to the standard ones: how to heat the particles up to about 900°C with concentrated solar energy and control the reaction?

For a first step of scaling up, the objectives were numerous:

- *to process particles continuously at a significant mass flow rate (typically larger than 10 kg/h),*
- *to convert the carbonate at the same level as industrial reactor,*
- *to run the reactor for long duration periods (full days),*
- *to control the reaction temperature and the residence time of the particles,*
- *to treat the flue gas (fine particles filtering, CO_2 separation if necessary),*
- *to define recommendations and specifications for the second scaling up step (1 ton/day).*

The SOLPART project addressed successfully all the previous objectives and the consortium proved that scaling up particle solar reactor for reactive solid processing is possible.

This success was possible only at European level because the skills and field of expertise of such a project can be found only by joining European scientists and researchers, and industry engineers in a collaborative project. Moreover, collaboration with Morocco open the route to new development and demonstration in a country with high solar resources and an important mineral industry.

After 4 years of collaborative research between 10 partners from 7 countries, SOLPART will come to an end in December 2019. Therefore, we will organise the project's final event: an Info Day showcasing SOLPART's key results and scientific achievements as well as side visits to the CNRS-PROMES solar facilities. In this publication, you will find more information about this special event, as well as all the key features about SOLPART."

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DLR Solar Simulator

List of Acronyms

CSP: *Concentrated Solar Power*

CST: *Concentrating Solar Thermal*

LCIA: *Life Cycle Impact Assessment*

Formula

$CaCO_3$: *Calcium carbonate*

CO_2: *Carbon dioxide*

MgO: *Magnesium oxide*

INTRODUCTION: CONCENTRATED SOLAR POWER APPLIED TO INDUSTRIAL PROCESSES

THE CHALLENGE OF ENERGY INTENSIVE INDUSTRIES

Calcination industries, such as the **lime** and **cement industries**, are some of the **biggest CO_2 emitters in the world**. The cement, lime and clay sectors represent more than 10% of anthropogenic CO_2 emissions. For example, for every 10 tonnes of cement produced, 9t of CO_2 are released from calcite decomposition (calcination) and fossil fuels combustion. Therefore, **decarbonisation** of these sectors is a key requirement for reducing industrial CO_2 emissions.

WHAT IS CONCENTRATED SOLAR TECHNOLOGY?

Concentrated Solar Technology uses **mirrors** to concentrate sunlight onto **receivers** where it is converted into **heat**. This heat can be used for either producing power with a turbine or industrial process heat. In the latter case, the solar heat can generate a **chemical reaction**. In this domain, one of the possible concepts is processing this reaction inside the solar receiver that becomes a **solar receiver-reactor**.

HOW SOLPART ADDRESSES THIS CHALLENGE?

By using concentrated solar energy at high temperatures of about 900˚C, the SOLPART project aims to **integrate** a **solar receiver-reactor** into the **processes** of **mineral industries**, enabling the reduction of fossil fuel use and CO_2 emissions.

Our objective: substituting fossil fuels with solar heat by 60 to 100% and cutting the greenhouse gas emissions by 40-60%.

CNRS-PROMES solar furnace

SOLPART: HARNESSING THE SUN TO CLEAN UP INDUSTRIAL PROCESSES

SOLPART IN A NUTSHELL

SOLPART is a EU-funded project which stands for "*High temperature Solar-Heated Reactors for Industrials Production of Reactive Particulates*". The project's main objective is to develop - at a pilot scale - a high temperature (800-1000°C) **continuous solar process** suitable for particle treatment in energy intensive industries.

The pilot-scale reactor with about **50kW of heating power** is currently **being tested** for limestone, dolomite, phosphate and cement raw meal calcination in the solar furnace of the CNRS-PROMES laboratory in Font-Romeu, France.

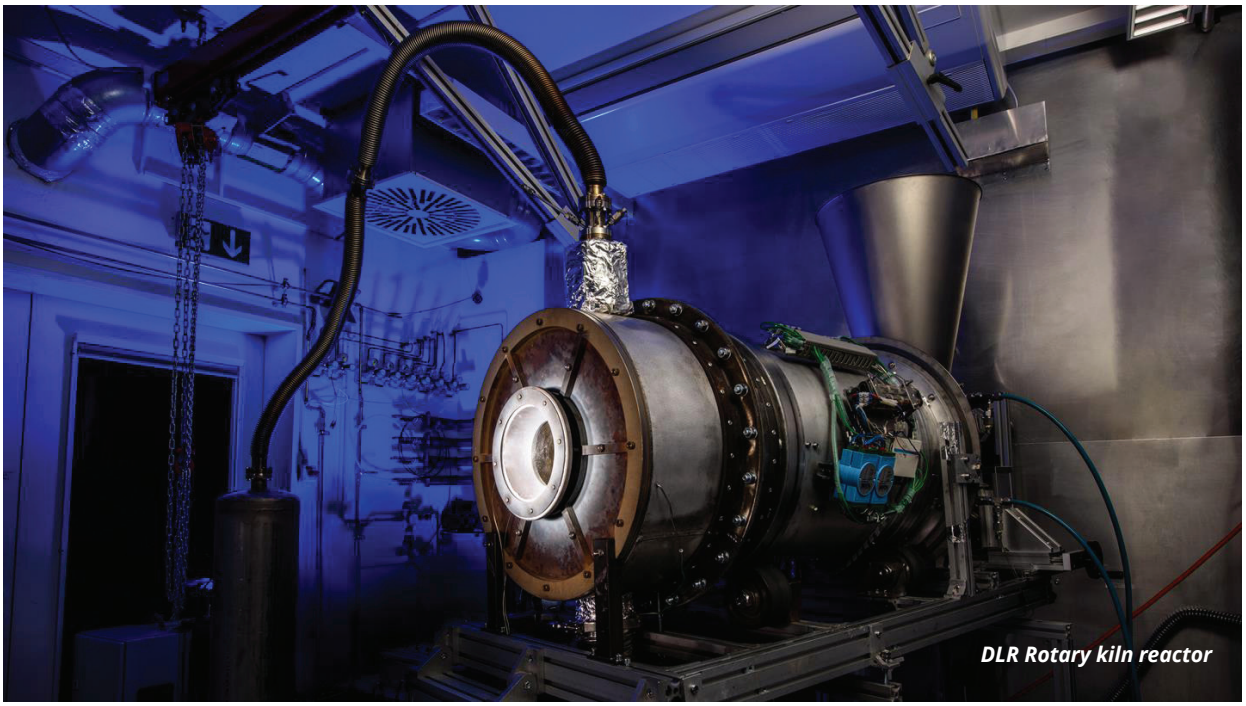
UNIQUENESS OF THE PROJECT

The project merges **three advanced technologies**:

- a high-temperature solar reactor
- transport of high-temperature solid materials
- a storage tank of high temperature solid materials/intermediate products.

SOLPART'S OBJECTIVES

- Demonstrate ways of totally or partially supplying the thermal energy requirement for $CaCO_3$ calcination with high-temperature solar heat
- Reducing the lifecycle environmental impacts of the process
- Increasing the attractiveness of renewable heating technologies in process industries.



DLR Rotary kiln reactor

The development of a such an innovative technology for continuous particle processing by concentrated solar energy is **unique in the world**. Thanks to the solar unit integration in the industrial process rather than fossil fuels, this could result in the considerable **reduction of the carbon footprint** of the CO_2 emitter industries **by 60%**.

A COLLABORATIVE EU-FUNDED PROJECT

The SOLPART project has been 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 "Developing the next generation technologies of renewable electricity and heating/cooling" (LCE-02-2015).

Duration 48 months
Jan. 2016 – Dec. 2019

Overall budget
€ 4 558 687,50

EU contribution
€ 4 366 562,50

COORDINATOR
CNRS-PROMES, France
(Centre national de la recherche scientifique - Processes, Materials and Solar Energy)

CONSORTIUM
10 partners
7 countries

SOLPART FINAL INFO DAY
28-29 NOVEMBER 2019

On behalf of the H2020 SOLPART project team, we are pleased to announce the **organisation of the SOLPART Final Info Day**. This **two-day final event** will take place on:

- **Thursday 28 November 2019**: Conference sessions in Toulouse, France
- **Friday 29 November 2019**: Site visits in Font-Romeu, France.

The SOLPART Info Day will present a **panorama** of the project's **main activities** over the last 4 years, such as:

- an introduction on **concentrated solar technologies applications** to particle processing for the general public,
- the project's mains results and achievements in the field of **solar calcination**, such as: solar heat in industry, environmental benefits, scaling-up...

AGENDA

Thursday 28 November 2019: Conference sessions on CSP and SOLPART
Toulouse, ENSACIET, France

- 09:00 - 09:30 – Registration
- **09:30 – 12:30 - Morning session – Solar Concentrating Technologies and Particle Processing**
    - Introduction to solar concentrating technologies and applications
    - Solar reactors for particle processing: Particle properties and their impact on developing solar particle processing | Options for particle solar receiver-reactors | The solar-heated rotary kiln | The solar-heated fluidized bed
- 12:30 – 14:00 – Lunch break
- **14:00 - 17:00 – Afternoon session – Challenges in Solar Calcination, the SOLPART H2020 EU Project**
    - Solar heat in industry
    - Lime, dolomitic lime and phosphates
    - Solar receiver-reactors, options for solar calcination
    - Solar CaO or MgO, from pilot to commercial processes
    - What are the environmental benefits of solar calcination processes?
    - Design of a high temperature industrial pilot plant, method and materials issues
    - Scaling up the solar calcination process at industrial scales
- 17:00 – Closure of the Info Day
- 17:30 – 20:30 – Transfer to Font-Romeu-Odeillo, France

Friday 29 November 2019: Side visits of SOLPART Solar Facilities
CNRS-PROMES, Font-Romeu-Odeillo, France

- 9:00 – Site visits – CNRS-PROMES solar installations (solar tower and solar furnace)
- 12:30 – 13:30 – Lunch break
- 13:45 – 16h45 – Transfer to Toulouse

Download the full detailed programme here: shorturl.at/fmtyT

This event is free and open to the public and all interested stakeholders
Registration mandatory here: shorturl.at/mFTY4

RESULTS OF THE PROJECT

The main results of the SOLPART project address **four main domains**: the solar reactor technology, the storage and handling of high temperature particles, the environmental impact of the solar process and the integration of the solar calcination reactors in industry (scaling-up).

SOLAR REACTOR TECHNOLOGY

The key issues of the SOLPART project in the domain of solar reactor technology are **twofold**: to design solutions that can be applied to a **wide range of particle diameter** and that can be **scaled-up**. Consequently, **two new solar receivers-reactors** have been developed and tested at lab-scale:

- a **rotary kiln reactor**,
- a **fluidized bed reactor**.

The **fluidized bed technology** was chosen for the pilot scale solar reactor (about 50 kW and able to treat 50 kg/h particles) because of its ability to be scaled up and to integrate a dust treatment and a CO_2 capture unit.

An innovative concept was designed, constructed and tested: the shallow **cross-flow compartmented fluidized bed**.

This solar reactor was operated successfully at the focus of the 1 MW CNRS solar furnace and the test campaign will continue until the end of year 2019.

The improvement of the starting procedure leads to a **reduction** of the **heating time** from 2 hours to **45 minutes** that corresponds to an **increase** of the **daily production capacity by about 15-20%**.

STORAGE AND HANDLING OF HIGH TEMPERATURE PARTICLES

The addition of a **hot particles storage capacity** in the solar thermal treatment loop is essential when a postprocessing of the solid product is part of the industrial process such as in cement industry. Key issues of **hot store design**, **construction material**, **solid clogging** and **heat losses** have been addressed.

ENVIRONMENTAL IMPACT OF THE SOLAR PROCESS

SOLPART developed a cradle to grave LCIA (**Life Cycle Impact Assessment**) by comparison to the standard process. The results show the **main advantages** of the **solar solution** with respect to the **combustion solution** (existing processes) as shown in the **Impacts section** (see on page 10).

INTEGRATION OF THE SOLAR CALCINATION REACTORS IN INDUSTRY

Two cases have been examined:

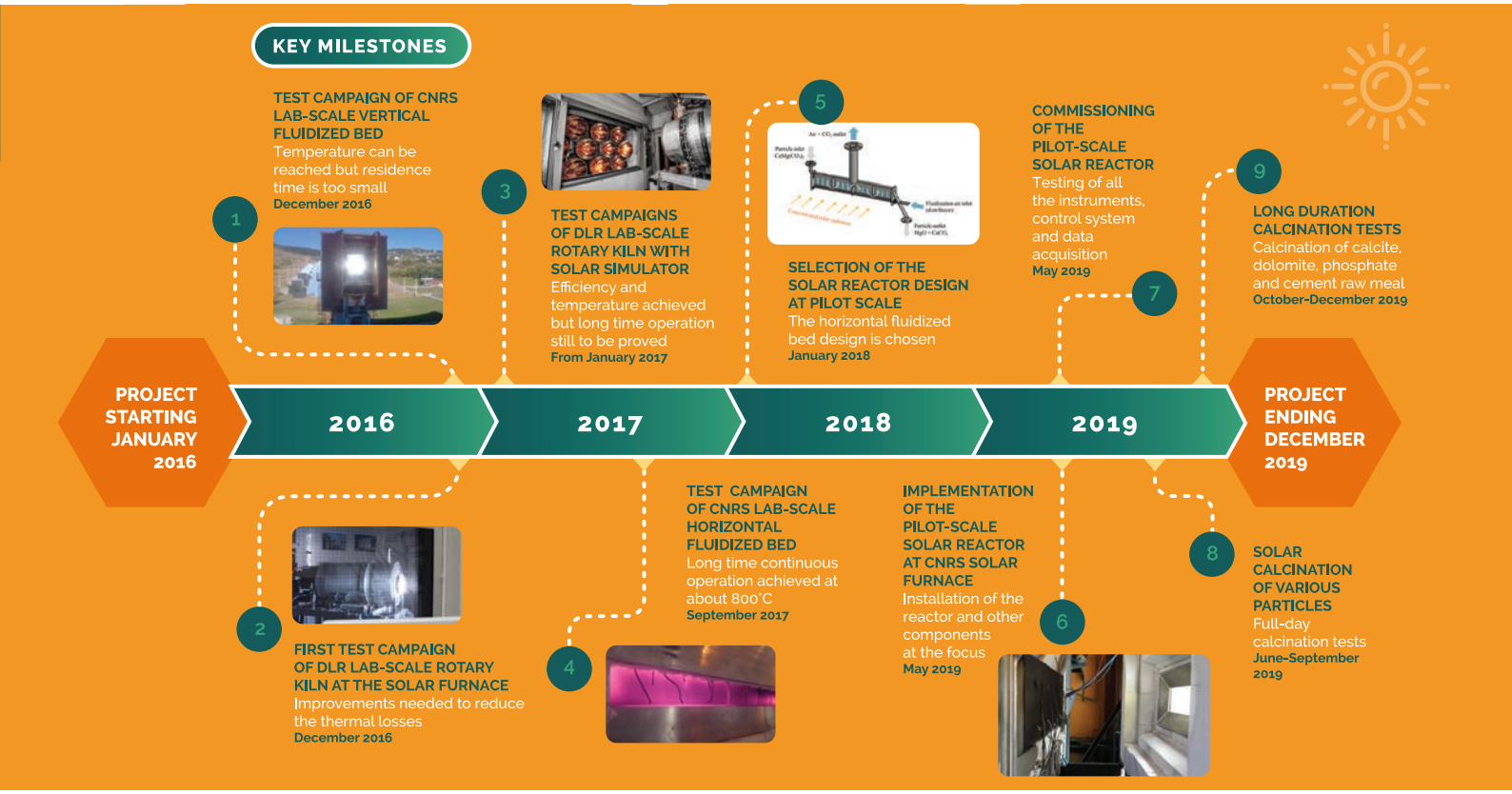
- applications to **one-step thermochemical industrial processes** such as calcite, dolomite and natural phosphate thermal treatments,

- applications to **two-step processes** such as cement in which the calcination step is followed by the clinkering at about 1400°C.

In the latter case, a **storage of hot particles** produced by the solar loop is **necessary** for carrying out a 24h production of the plant. In the former case the storage unit is **not compulsory**. The flow sheeting of the commercial processes have been established for a production of solid in the range 100-3500 tons/day. It is estimated that a **10 MWth solar tower** is suitable to process about **100 tons/day calcium carbonate**.

CNRS Fluidized Bed Reactor

TIMELINE OF THE PROJECT



WHAT'S COMING **NEXT?**

The results of the project open the route to a demo-scale solar calcination unit with a capacity of about **1-5 ton per day**.

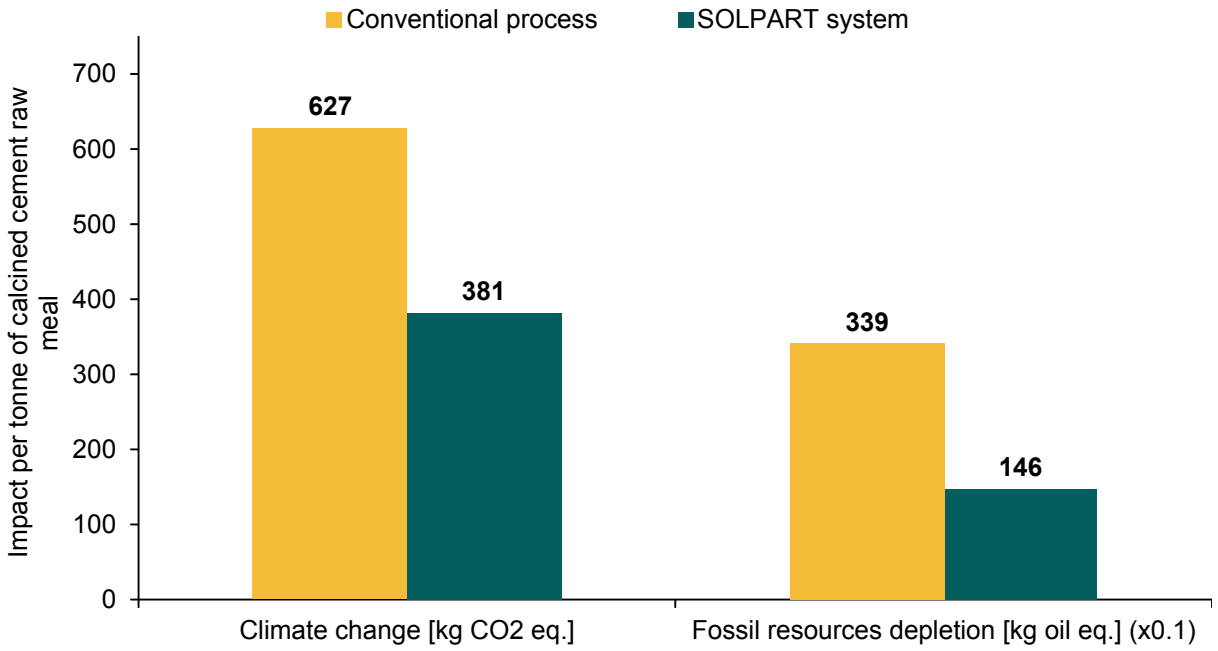
The developed solar reactor technologies demonstrated their capacity to **calcine particles in the range 800-900°C**. They can be used in **other thermal processes** of mineral industries involving particles in a wide range of solid diameter.


ABENGOA Solar Tower

IMPACTS

ENVIRONMENTAL IMPACTS

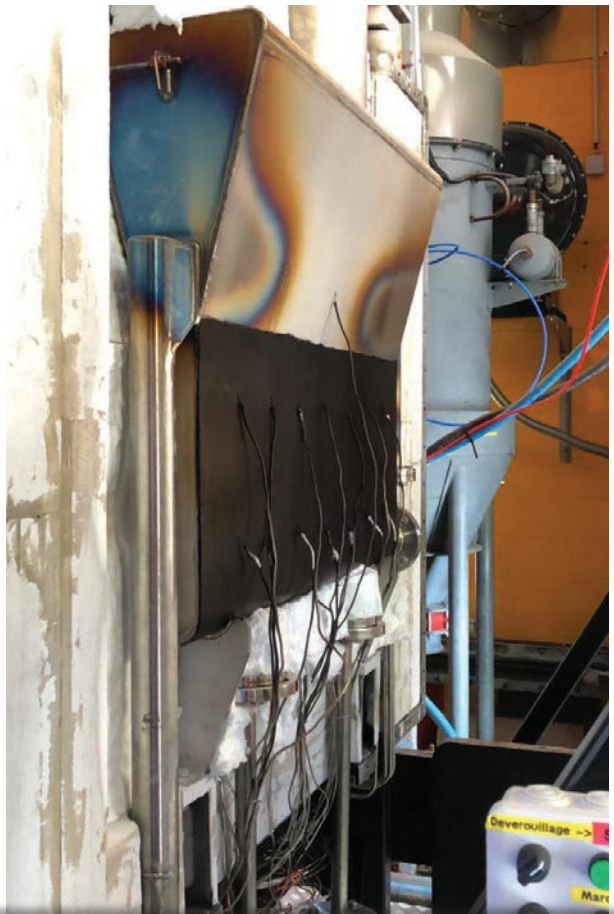
The environmental impacts of the solar-driven (SOLPART) calcination process have been compared with the conventional calcination process via life cycle assessment. The **results** estimated by the University of Manchester show that, compared to the conventional process, the **SOLPART calcination system** has the potential to **reduce greenhouse gas emissions by nearly 40%** and the **fossil energy use by 57%**. This is due to the SOLPART system utilising **solar thermal power** as a **substitute** for **fossil fuels**.



SCIENTIFIC AND TECHNOLOGICAL IMPACTS

The SOLPART project results in the development of **two new solar reactor technologies,** namely the **rotary kiln** and the **fluidized bed** that enable **continuous solar calcination of particles** in a wide range of particle diameter from about 5 microns to 500 microns.

The **possible integration** of these solar technologies for **lime, dolomite, phosphate** and **cement industries** was studied for **calcination capacity** ranging from 100 tons per day to 3500 tons/day. **Scaling-up issues** have been identified and evaluated accounting for the needed sizes of the **solar field,** the **solar reactor** and the **storage**.



CNRS Fluidized bed reactor

COMMUNICATION & DISSEMINATION

SOLPART IN THE MEDIA

European Commission - 17 April 2017:
H2020 Success Stories: Harnessing the sun to clean up industrial processes

Solarthermalworld.org - 23 September 2017:
Concentrating Solar Thermal for High-Temperature Solar Process Heat

Abengoa (The energy of change) - 8 August 2018:
Solpart Project: the solarization of industrial processes

SolarPACES news - 10 January 2019:
Researchers Test Solar to Cut CO2 in Cement Processing

CEMNET: International Cement Review - 11 January 2019:
First 50kW solar cement kiln will be tested throughout 2019

Global Cement - 11 January 2019:
SOLPART to test pilot project from February 2019

Scientific American - 19 April 2019:
Solar Energy Isn't Just for Electricity

CEMNET: International Cement Review - September 2019:
Harnessing the sun to clean up industrial processes

SCIENTIFIC PUBLICATIONS & CONFERENCE PROCEEDINGS

SolarPACES 2017 > downloadable on https://aip.scitation.org/

- Solar Processing of Reactive Particles up to 900°C, the SOLPART Project - CNRS
- Fluidized particle-in-tube solar receiver and reactor: A versatile concept for particulate calcination and high efficiency thermodynamic cycles - CNRS
- Experimental and numerical analysis of a solar rotary kiln for continuous treatment of particle material - DLR
- Some details about the third rejuvenation of the 1000 kWth solar furnace in Odeillo: Extreme performance heliostats - CNRS

SolarPACES 2018 > downloadable on https://aip.scitation.org/

- Solar thermal treatment of non-metallic minerals: The potential application of the SOLPART technology - EPPT
- On Sun Test of a Single Tube Dense Particle Suspension Solar Receiver: Cristobalite Powder as Heat Transfer Fluid - CNRS

Scientific publications

- Solids mixing in a shallow cross-flow bubbling fluidized bed - EPPT
  Published in: **Chemical Engineering Science**, Avril 2018
- The use of ultrasound probes to monitor multi-phase behavior in opaque systems - EPPT
  Published in **Particulology**, May 2018
- Solar treatment of cohesive particles in a directly irradiated rotary kiln - DLR
  Published in **Solar Energy**, March 2019

COMMUNICATION MATERIAL & EVENTS

Logo, brochures, factsheets, presentations... Download all our communication material on our website **> https://www.solpart-project.eu/dissemination/#documentation**

All the information about our past events, such as project meetings and participation to international conferences, can also be found on SOLPART's website **> https://www.solpart-project.eu/dissemination/#events**

CONTACT

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