SOCRATCES

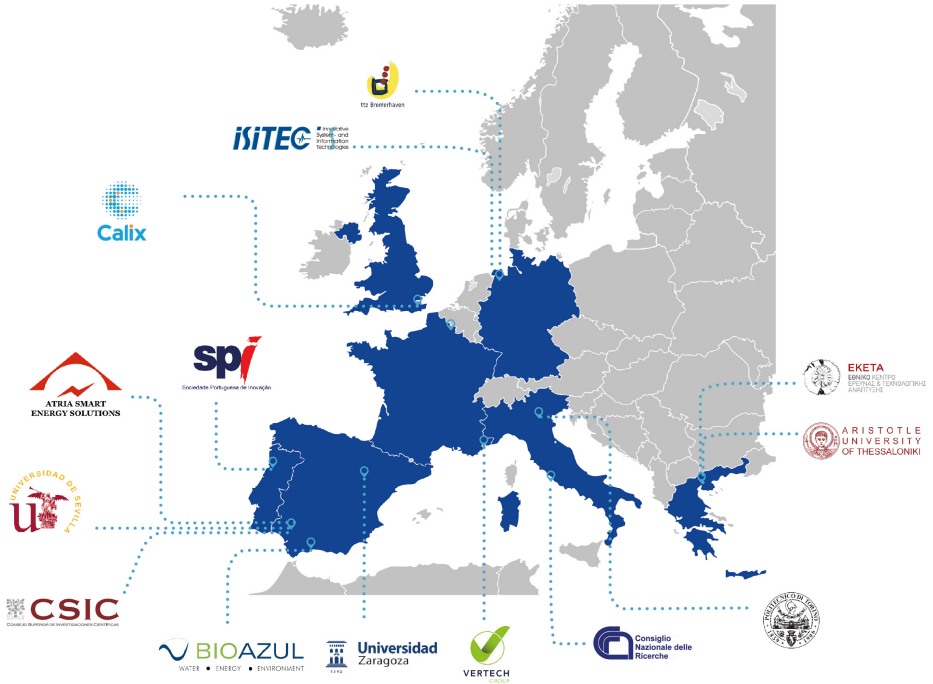
Solar Calcium looping integRAtion for Thermo-Chemical Energy Storage

DEVELOPING THE NEXT GENERATION TECHNOLOGIES OF RENEWABLE ELECTRICITY

https://socratces.eu/

SOCRATCES Consortium

SOCRATCES is an **integral** and **multidisciplinary** approach where different knowledge areas are involved

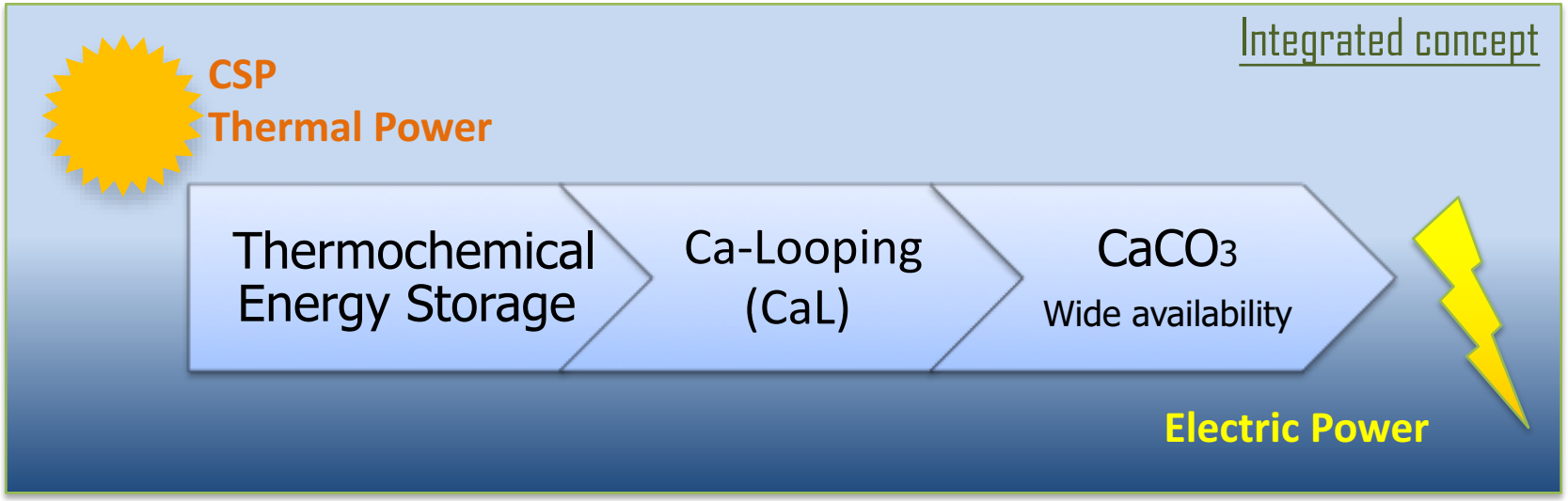


- ✓ Multidisciplinary R&D groups
- ✓ SMEs
- ✓ Companies

Associations and Stakeholders *offer the opportunity for* ***wide dissemination*** *of the project and will link the consortia with the relevant industries in Europe*

Project Scope And Goals

Energy storage is one of the greatest challenges for a short-term deeper penetration of **renewable** energy sources



SOCRATCES is aimed at demonstrating the feasibility of the **integration** by erecting a **pilot scale plant**

SOCRATCES Technical Approach

The Ca-Looping (CaL) process based upon the reversible carbonation/calcination of CaO is one of the most promising technologies for thermochemical energy storage (TCES).

calcination

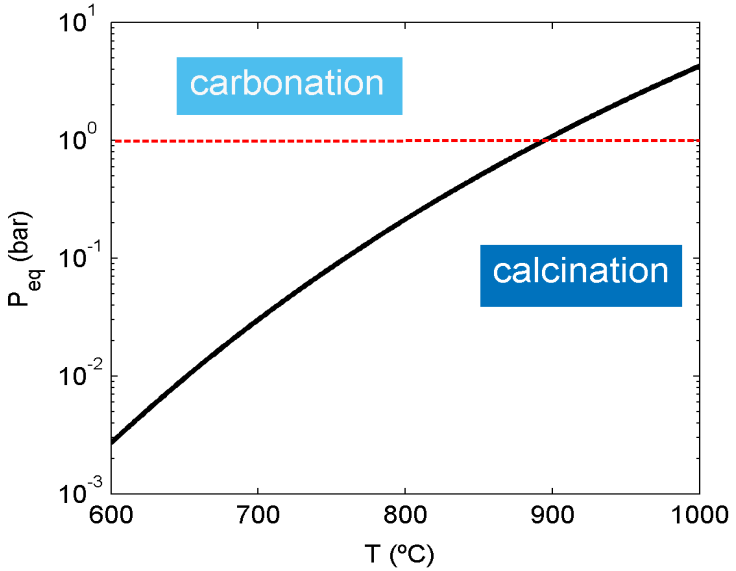
$$CaCO_{3\,(s)} \longrightarrow CaO_{(s)} + CO_{2\,(g)}$$

ΔH_r=+178 kJ/mol

carbonation

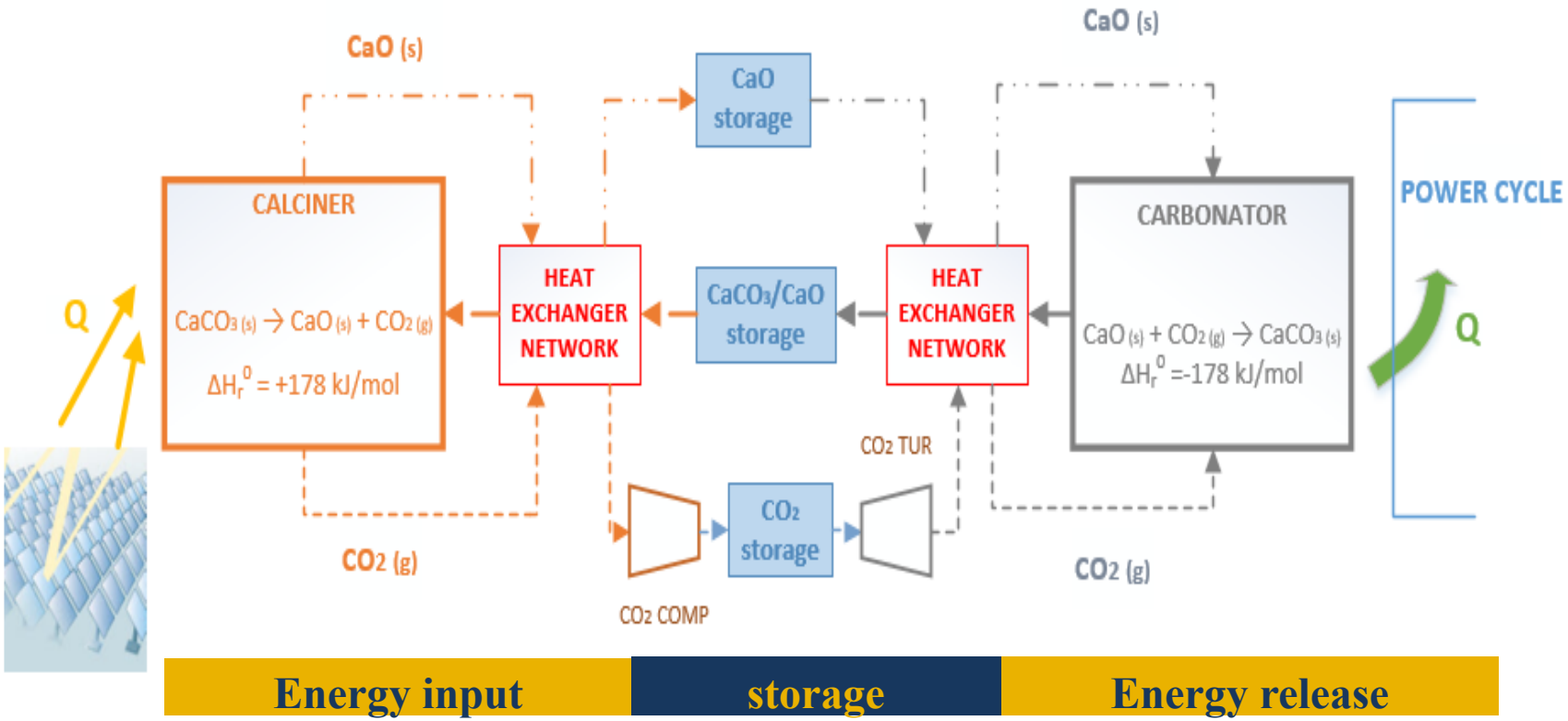
$$CaO_{(s)} + CO_{2\,(g)} \longrightarrow CaCO_{3\,(s)}$$

ΔH_r=-178 kJ/mol



C. Ortiz, J.M. Valverde, R. Chacartegui, L. A. Perez-Maqueda, P. Giménez. **The Calcium-Looping (CaCO3/CaO) Process for Thermochemical Energy Storage in Concentrating Solar Power Plants.** Renew Sustain Energy Rev 2019

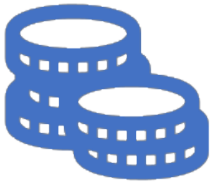
SOCRATCES Technical Approach



Chacartegui R, Alovisio A, Ortiz C, Valverde JM, Verda V, Becerra JA. **Thermochemical energy storage of concentrated solar power by integration of the calcium looping process and a CO2 power cycle.** Appl Energy 2016

Main benefits of SOCRATCES concept

1 CaO precursors:

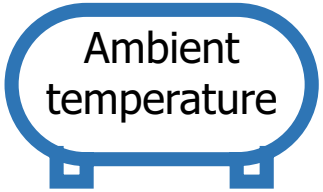


- ✓ Low price
- ✓ wide availability
- ✓ harmlessness

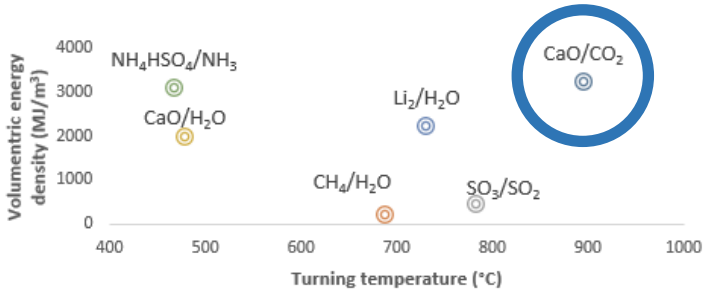
2 Carbonation for generating heat ~650-1000ºC

- ✓ High efficient generation of electricity

3 Reactants and products can be stored at ambient temperature



4 High energy density to maximize storage capacity



5 Materials and process equipment

- ✓ Well-known in the cement industry

Main challenges for the CSP-CaL concept

1 High temperature solar receiver

i) Enough residence time to calcination occurs

ii) Adequate particles size for proper handling

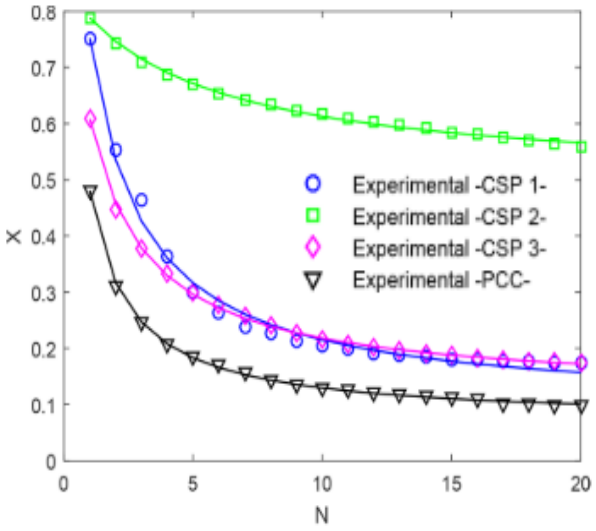
iii) The system has to be closed to avoid CO_2 losses

iv) Thermal gradient over the particles must be avoided

v) Continuous operation

Limestone calcination only occurs fast under high CO2 partial pressure for reaction temperatures around **930-950ºC**.
Technological challenge

2 Multicyclic CaO deactivation



CaO deactivation is highly dependent on the reactor conditions, CaO precursors and particles size

SOCRATCES Technical Approach

Global Objective

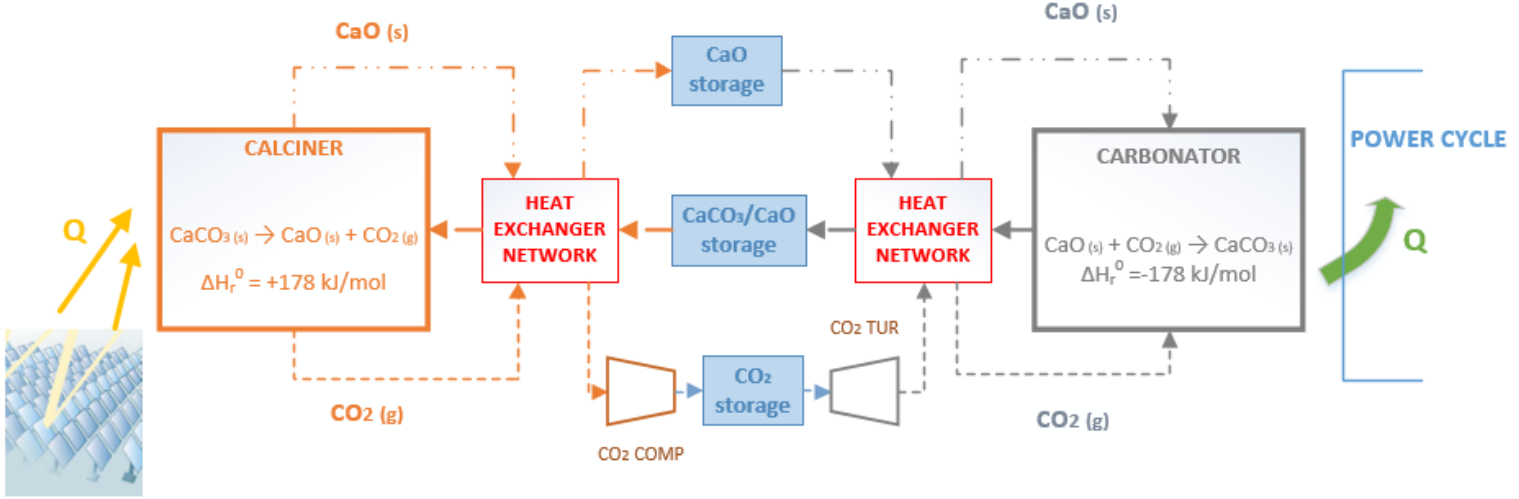
Develop a prototype that will reduce the core risks of scaling up the technology and solve challenge

SOCRATCES Technical Approach

WP1: *Project Management*

Research and design laboratory

WP3 | **WP2** | **WP4**



WP5: *System Integration and Control*

WP6: *Engineering and prototype construction*

WP7: *Validation and test*

WP8: *LCA, Risk analysis…*

WP9: *Dissemination & Exploitation*

Expected results

- Prototype demonstration of capacity for energy storage. System tested at TRL5.
- Validated kinetics models for both calcination and carbonation.
- Successful calcination at prototype scale by means of flash calcination technology.
- Successful carbonator design with possibility to scale-up.
- Particles attrition, agglomeration and fouling analysis.
- Successful solids conveying and control system management.
- At commercial scale design, high CaL-power cycle efficiencies are expected (>45%)

SOCRATCES

Thanks for your attention

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