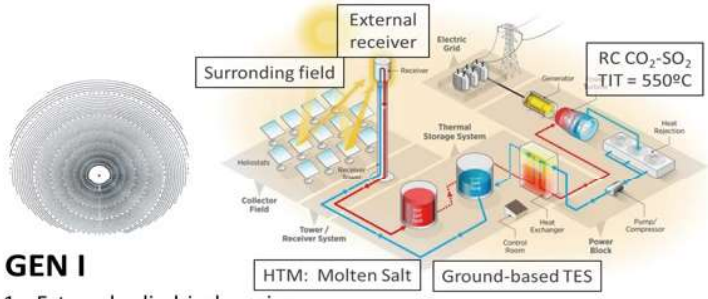
Project Information

Under the EU's Horizon 2020 R&I Programme

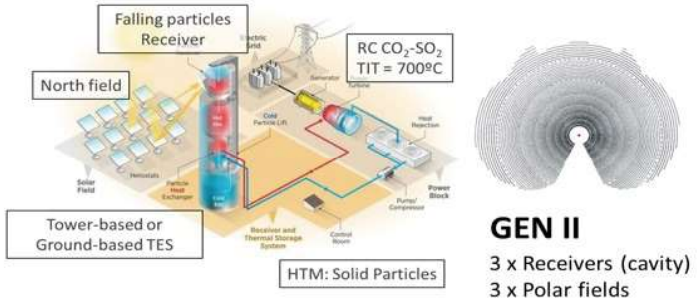
Acronym: SCARABEUS
Grant Agreement ID: 814985
Duration: 4 years & 10 months (1 April 2019 - 31 February 2024)
Programme: H2020-EU.3.3.2.
(Low-cost, low-carbon energy supply)
Topic: LC-SC3-RES-11-2018
(Developing solutions to reduce the cost and increase performance of renewable technologies)
Call for Proposal: H2020-LC-SC3-2018-RES-TwoStages
Funding Scheme: RIA - Research and Innovation action
Budget: 4 950 266,25 € (100% EU funding)

Technology For The Short (GEN I) And Mid (GEN II) Terms

Gen I: Molten Salt Technology
Gen II: Particle Technology



GEN I
1 x External cylindrical receiver
1 x Circular field



GEN II
3 x Receivers (cavity)
3 x Polar fields

SCARABEUS Contact

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SCARABEUS

Supercritical CARbon dioxide/Alternative fluids Blends for Efficiency Upgrade of Solar power plants

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 814985

Technical Objectives

- Specific to hot environments (>40°C)
- Demonstrate feasibility of breakthrough working fluids
- Higher than 50% power block efficiency

Economic Objectives

- 30% lower CapEx
- 35% lower OpEx
- 30% lower Levelised Cost of Electricity

Environmental Objectives

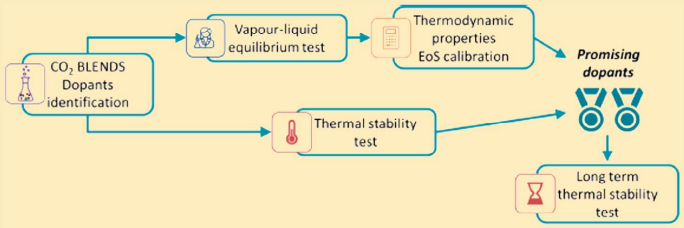
- 34% lower Carbon Footprint than IPCC* standard

** International Panel for Climate Change*

SCARABEUS

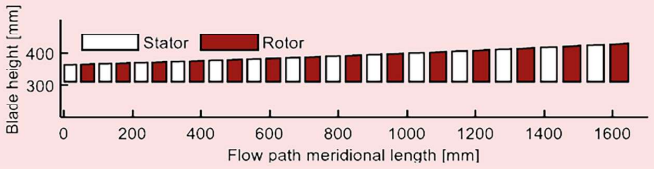
WP2: New Working Fluid - CO_2 Mixtures

- Over fifty potential dopants screened.
- Five dopants identified: C_6F_6, $TiCl_4$, SO_2,$SiCl_4$, C_4F_{10}.
- Full theoretical and experimental characterisation.
- Tests to verify material compatibility.
- L-V equilibrium curves produced experimentally.



WP3: Turbomachinery Design

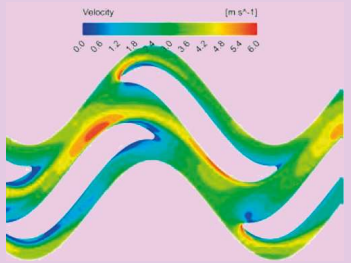
- 135 MWe gross turbine output at generator termianls (100 MWe Net).
- Complete CO_2/SO_2 turbine design (aero/mechanical).
- 14 axial stages achieve 92.9% flow path total-to-total efficiency.
- Rotordynamic design acceptable: safe stability margin.
- Mechanical design shows resistance lof last rotor to High Cyclw Fatigue (Ni-based alloy).
- Cooling system successfully satisfied requirements of Dry Gas Seals and stainless-steel casing.



WP4: ACC and HX development

- Two Printed Circuit Heat Exchangers supplied.
- Recuperator No. 1: SS316 with zigzag channels.
- Recuperator No. 2: SS316 / Inconel 625 (headers and flanges) with S-shape channels (12% thickness reduction).
- Prototype ACC (Kelvion) tested at TUW: groovy fins on air side, and DIESTA inner fins on CO_2 side.

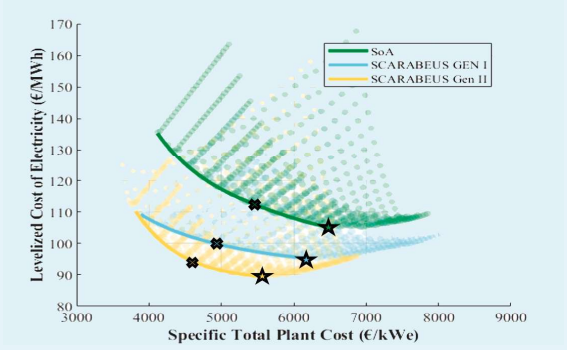
PCHE No. 2



CFD analysis of S-shape channels

WP5: Technoeconomics, social and environmental assessment

- Over 40 cycl layouts screened.
- Two storage/receiver technologies assessed: molten salt and particles.
- IA-based techno-economic optimisation.
- Optimum performance for transcritical recompression cycle running on 80% CO_2 - 20% SO_2 (Gen I and Gen II).
- >50% thermal efficiency (TIT=700°C) at 50°C ambient temperature.
- Large reduction of capital cost enabled.
- 30% lower Levelised Cot of Electricity (LCoE).
- Lower carbon footprint than IPCC standard.



LCoE as a function of specific CapEX

WP6: Test rig and experimental validation

- First of its kind test rig for high temperature testing of CO_2 mixtures.
- Three innovative heat exchangers tested: PCHE No. 1, No. 2 and ACC.
- High pressure and temperature testing completed at industrially-relevant scale: TRL 5/6.
- SCARABEUS concept for high temperature condensation demonstrated.

Deatil of the Test Rig

Prototype ACC