



Research in sCO₂ Technologies at KTH

Dr. Rafael Guédez – KTH Energy Department

Panel Session III: International Panel Session

8th International sCO₂ Power Cycles Symposium

San Antonio – February 27, 2024

KTH: Sweden's largest tech university

1 (15 EU)

17k students

4k staff

In Engineering



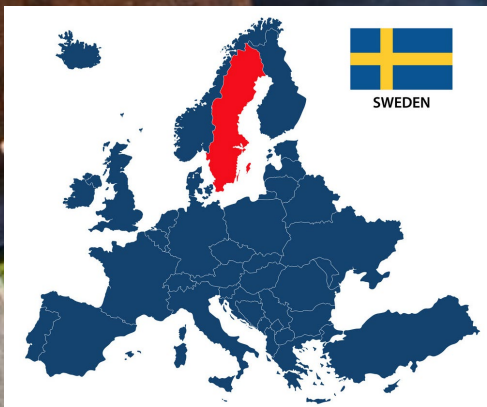
School of Industrial Engineering & Management

Department of Energy Technology

Division of Heat and Power



22 Faculty and 20 PhDs



KTH-HPT: Research & Infrastructure

Distributed Resources & Energy Networks



Energy Systems and Industrial Processes



System Analysis and Validation

- Time-dependent Process Simulation
- Control and Dynamic Modeling / Optimization
- Techno-economic Modeling / Optimization
- Life Cycle Analysis

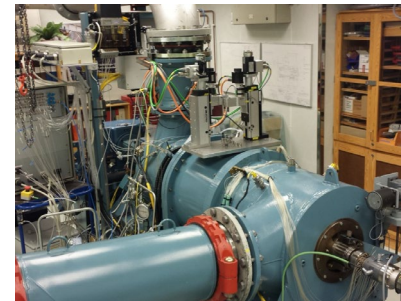
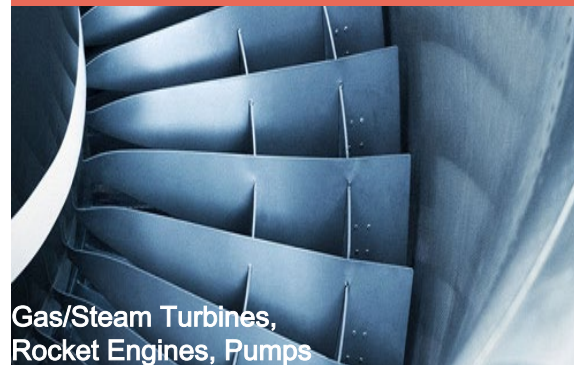
Component Design, Optimization and Testing

- Applied heat transfer and thermodynamics
- Material development and testing
- Aerodynamics and aero-mechanics
- Rotating equipment and heat exchangers



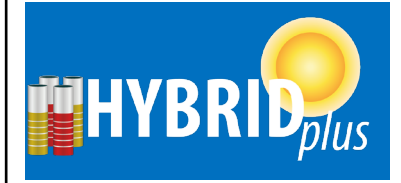


Thermal Technologies for Decarbonization



Turbomachinery & Propulsion



Supercritical CO₂ research at KTH-HPT

 2020–2025	 2022–2025	 2022–2026	 2023–2027	 2024–2028
Coordinator	Coordinator	WP leader	Task leader	WP leader
Demo TRL7 (MW)	Pilot TRL5 (kW)	Pilot TRL5 (kW)	Demo TRL7 (MW)	Pilot TRL5 (kW)
Solar + sCO ₂	Solar + sCO ₂	Solar + sCO ₂	Solar + sCO ₂	sCO ₂ P-TES
Molten Salts ($< 600\text{ C}$)	Air + solids ($< 900\text{ C}$)	MS + PCMs ($< 600\text{ C}$)	Particles ($< 800\text{ C}$)	MS + solids ($< 450\text{ C}$)
CSP-PV hybrids	CSP-PV hybrids	CSP-PV hybrids	CSP-PV hybrids	Heat Pumps Solar + WHR
10 M€ (0.6 M€)	3 M€ (0.5 M€)	3 M€ (0.5 M€)	5.5 M€ (0.4 M€)	5 M€ (0.3 M€)



Project Overview

Objectives:

1. 2 MW scale sCO₂ cycle DEMO (FOAK in EU, operating from molten salts)
2. Demo of MW molten salt electric heaters
3. Techno-economics of Hybrid PV -CSP sCO₂

Time-plan and budget :

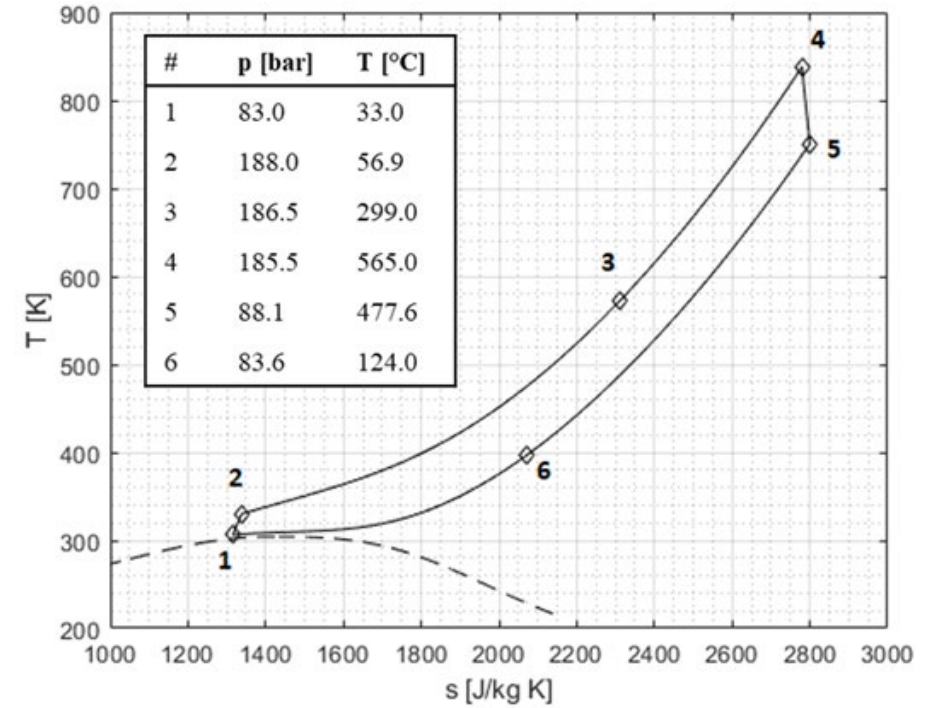
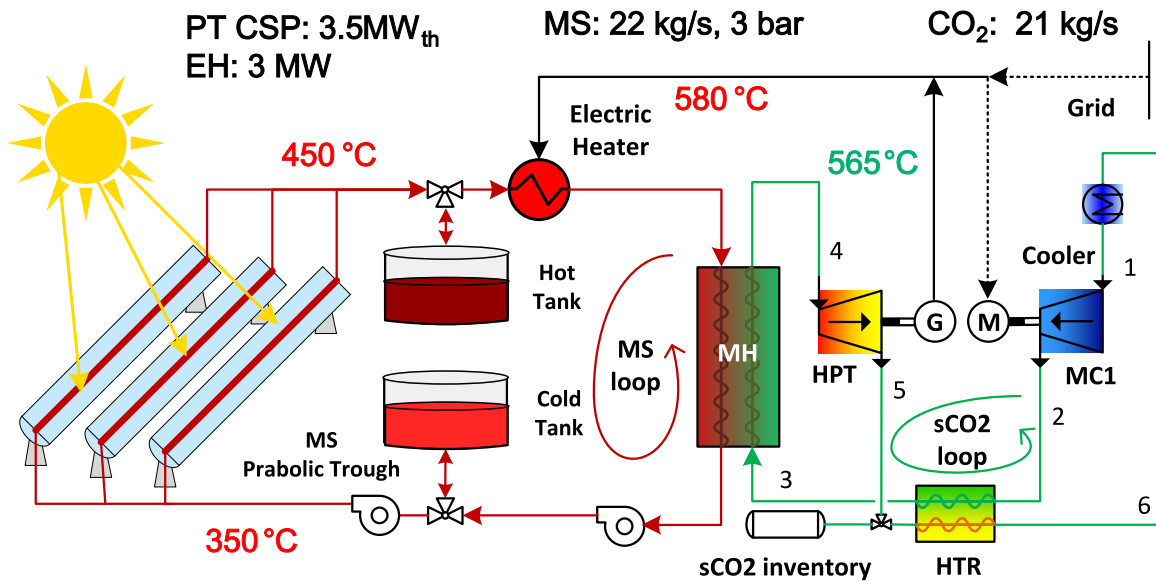
October 2020 – September 2025.

DEMO campaign expected in summer 2025.

17 partners Coordinated by KTH and RINA Consulting
 Approx. 16 M€ total budget (10M€ EU funding)



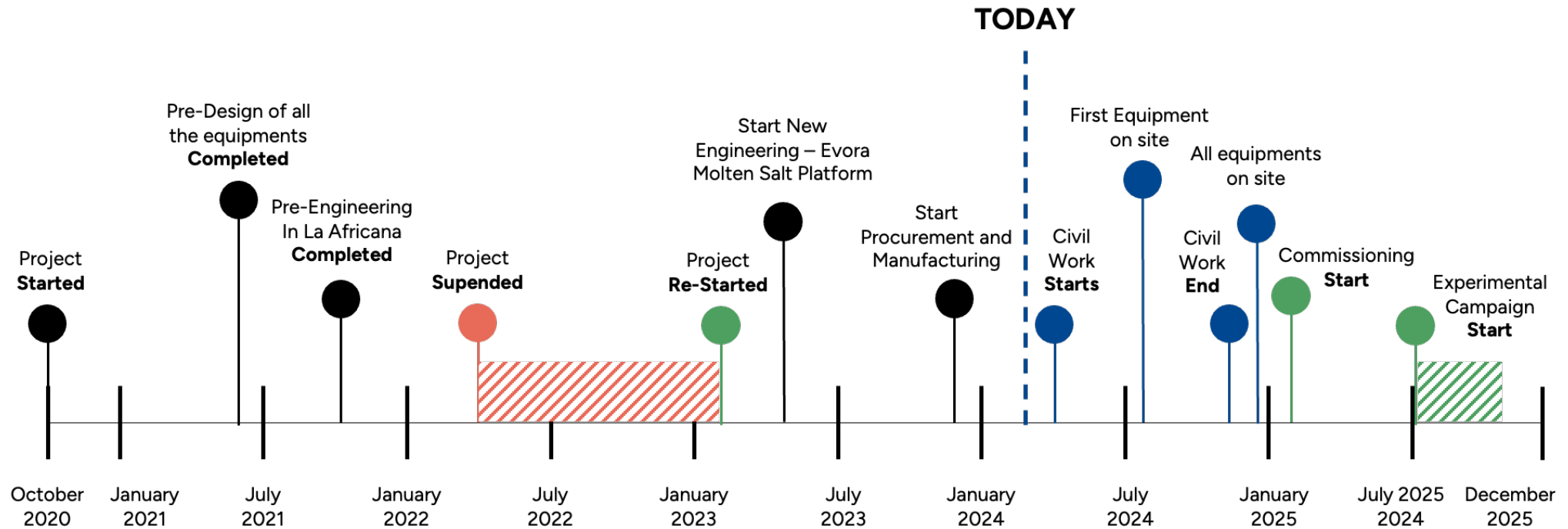
Demo at EMSP in Portugal



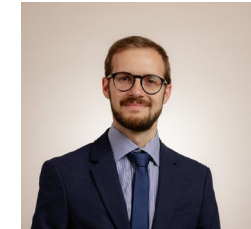
Cycle Efficiency	22.1%
Total Efficiency	20.3%
Recuperator Effectiveness	80%
Turbine Efficiency	83%
Compressor Efficiency	67%
Mechanical Efficiency	96%
Electrical Efficiency	96%

Heater – Q	6.8 MW _{th}
Cooler – Q	5.3 MW _{th}
Recuperator – Q	8.7 MW _{th}
Turbine – P	1.96 MW _{th}
Compressor – P	0.47 Mw _e
Net Power	1.38 MW _e

Project Timeline & on-going activities



#85 SOLARSCO2OL Updates
 S. Guccione - KTH
 Wed Feb 28, 1:30– 2:30 PM
 Paper Track 2– “Systems” (Salon B)



Project Overview

Objective:

Enable a new generation of high efficient and flexible hybrid PV -CSP plants

New components to TRL5 (Pilot):

- Air receiver + MV Air Electric Heaters
- Packed bed thermal storage using waste media
- Compact/modular Air -to-sCO₂ Heat exchangers

Time-plan and budget :

October 2022 – September 2025.

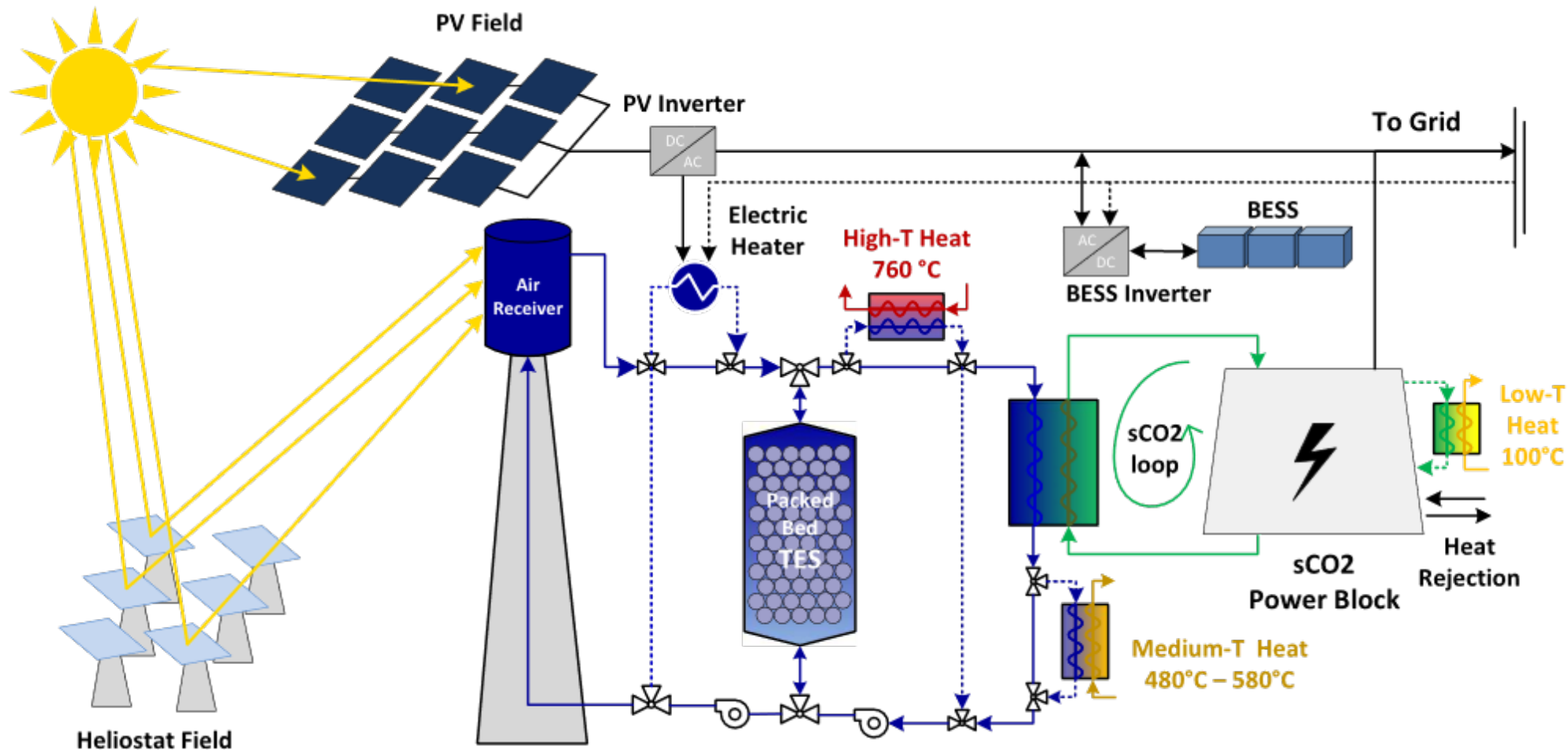
TRL5 campaign expected Q2-Q3 2025.

10 partners Coordinated by KTH

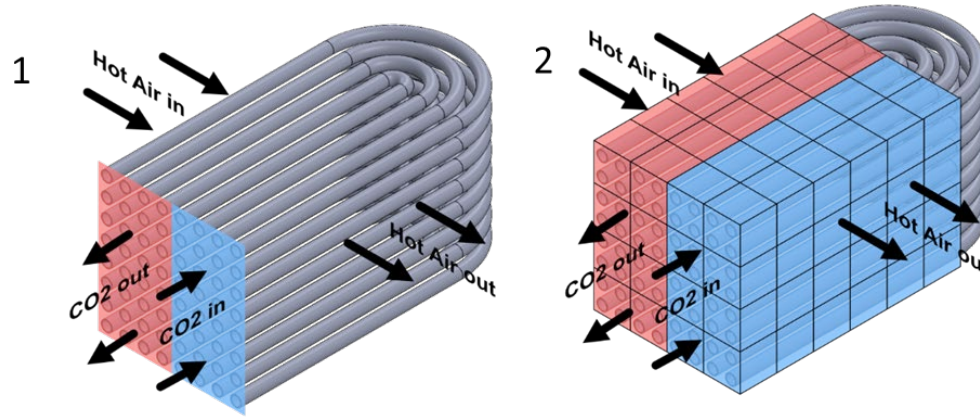
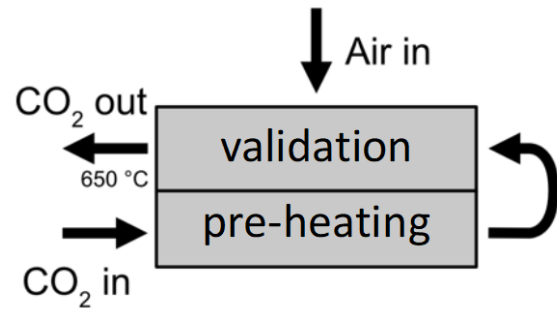
Approx. 3 M€ total budget (2.3M€ EU funding)



Project Vision



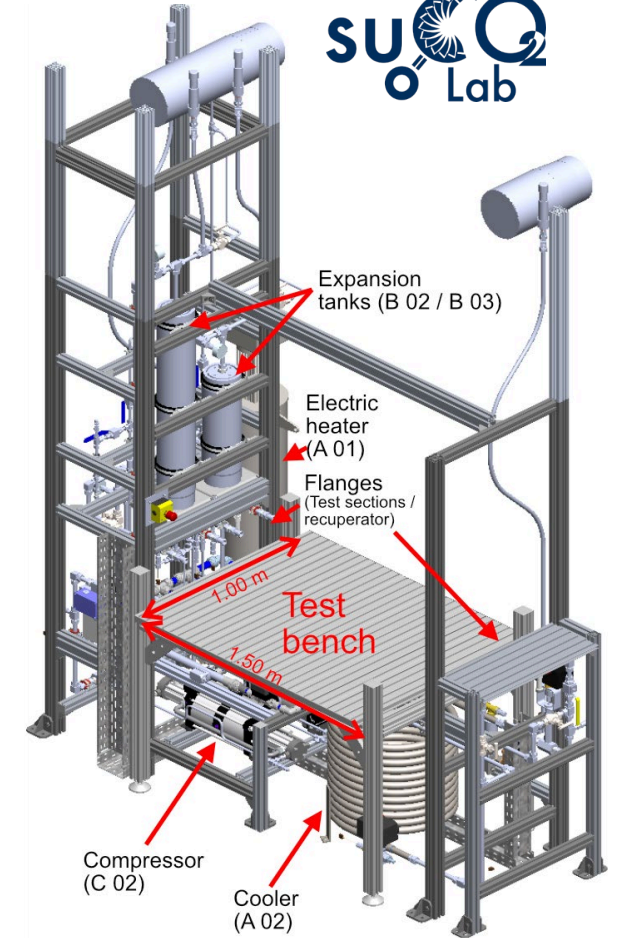
Air-to-sCO₂ Heat Exchanger



2 Parts modular heat -exchanger (tested at 100 kW scales)

- Testing one part (half mass flow) at full target temperatures (≈ 700 °C)
- Using the second partition to pre-heat the CO₂ to ensure, $\Delta T=200$ K

Shell and (micro) tube designs , involving bare or finned tube
 Microchannel flow plates combined with several fin-geometries



SCO2OP-TES

Project Overview



Main Objective:

To validate a 100 kW sCO₂ based P2H2P pilot

New components to TRL5 (Pilot):

- TES (molten salt + slags thermocline)
- Turbomachinery
- Balance of plant components and interfaces incl. Molten Salt to sCO₂ Heat Exchangers

Time-plan and budget :

December 2023 – November 2027.

TRL5 campaign expected Q2-Q4 2027.

16 partners Coordinated by UNIGE

Approx. 5 M€ total budget (4.7M€ EU funding)



SCO2OP-TES

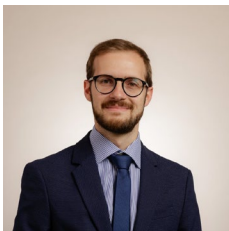
Pilot Plant at Tirreno CCGT



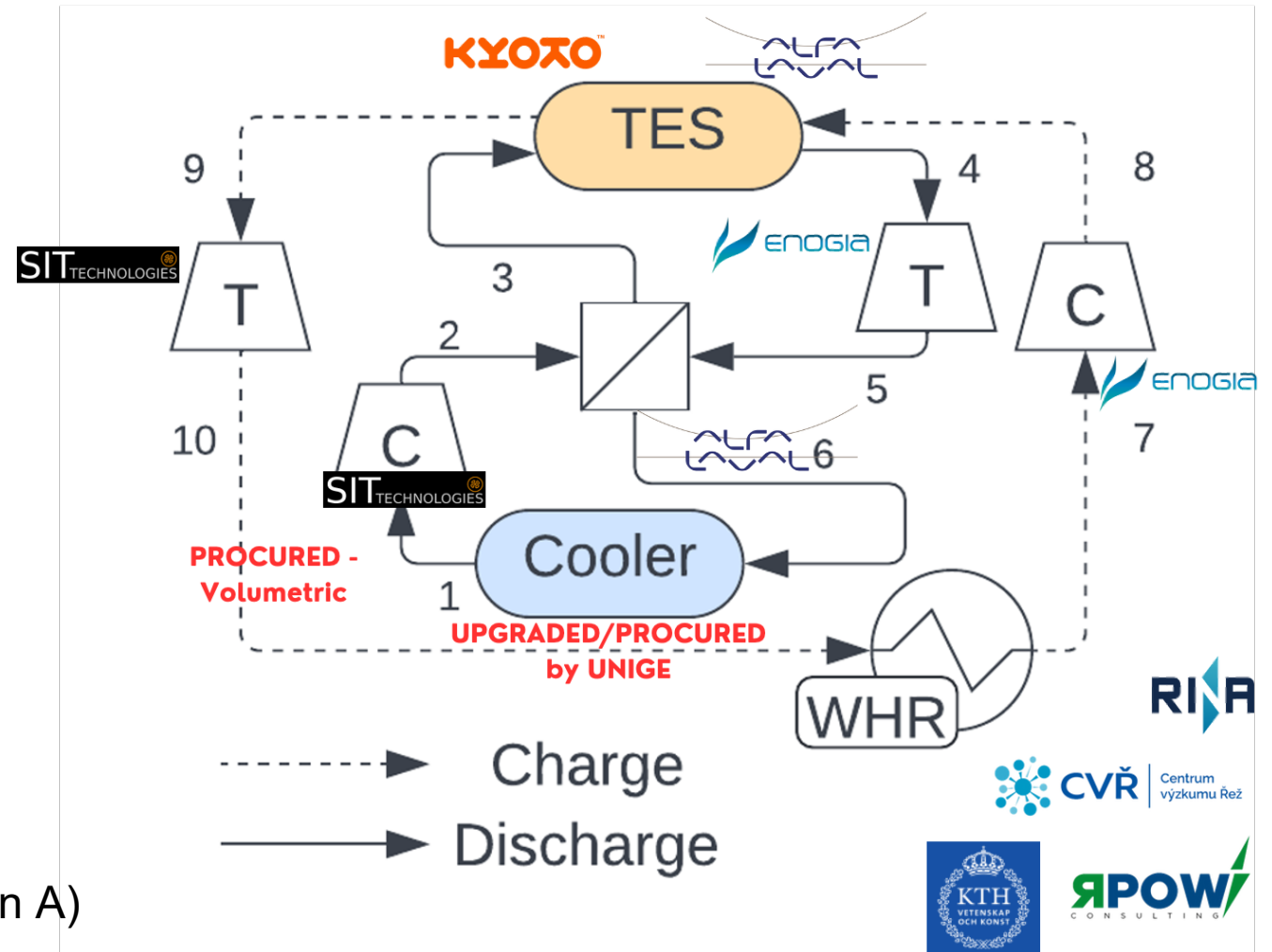
SCO2OP-TES








Horizon EU Project GA # 101136000



#8 SCO2OP-TES
 S. Maccarini - UNIGE
 Tue Feb 27, 2:45 PM
 Paper Track 1– “Testing” (Salon A)



Supercritical CO₂ research at KTH-HPT

				
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Solar + sCO2	Solar + sCO2	Solar + sCO2	Solar + sCO2	sCO2 P-TES
10 M€	3 M€	3 M€	5.5 M€	5 M€



Key takeaways:

- Multiple projects studying CSP and TES interfaces with sCO₂ (molten salts, particles, air).
- Demos have limited grant funding + complex project structures (large commitment from industry)
- 2025 we aim to have a FOAK 2 MW CSP + sCO₂ cycle in operation. EPC work in progress.
- Open for collaboration to demonstrate the viability of sCO₂.



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