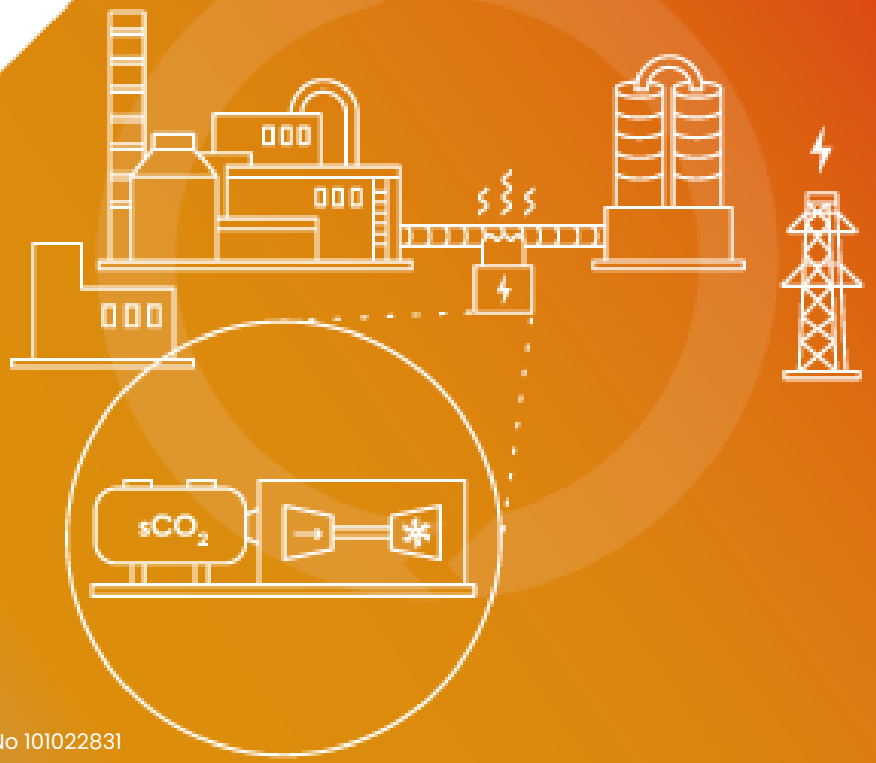
CO2OLHEAT

Supercritical **CO2** power cycles demonstration in **O**perational environment **L**ocally valorising industrial Waste **HEAT**



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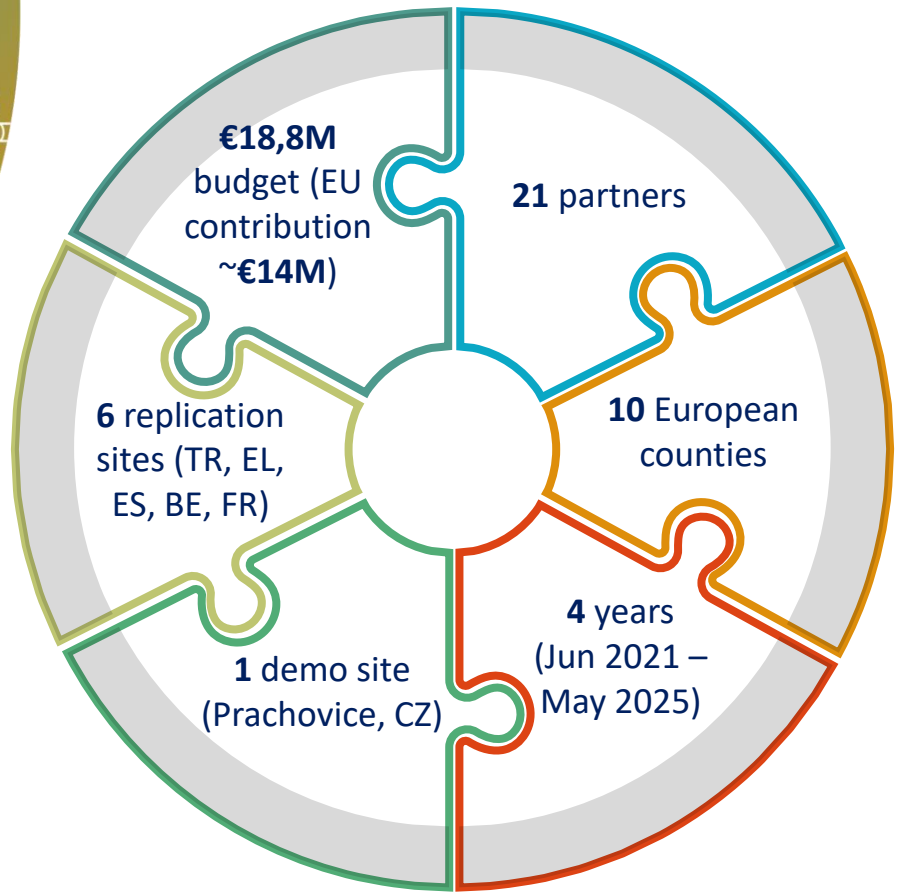
CO2OLHEAT in a nutshell



- **CO2OLHEAT** aims to unlock the potential of industrial **waste heat** and **transform it into power** (WH2P) via **supercritical CO_2 cycles** (sCO_2)
- **CO2OLHEAT** will develop and demonstrate a 2 MW **sCO_2 power block able to valorise** the unused **waste heat**
- **CO2OLHEAT** targets WH2P as a key enabler in fostering
  - Resource **efficiency** and the **competitiveness** of the EU's Energy Intensive Industries
  - EU industrial sector **decarbonisation**
- **CO2OLHEAT** is the **first-of-its-kind** EU MW scale WH2P sCO_2 plant
- This **CO2OLHEAT** plant will be installed in the **real industrial environment** of CEMEX cement plant in Prachovice (CZ)

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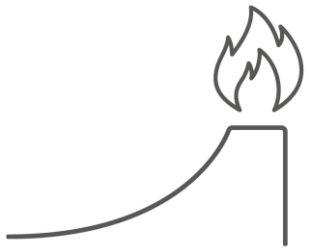
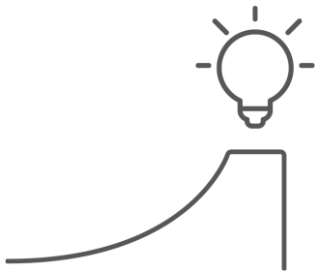
Main goals



1

Design of a novel integrated **waste-heat-to-power (WH2P)** plant layout to untap industrial waste heat valorisation at T>400ºC in an efficient and cost effective way



2

Development of an innovative, economically viable and easily replicable **sCO_2 power block** via an integrate easy to install skid

3

Increase the energy and resource utilisation efficiency of **Resources and Energy Intensive Industries (REIIs)** while enabling grid flexibility targeting a LCOE of: 0,05-0,06 €/kWh in the 5-20 MW scale

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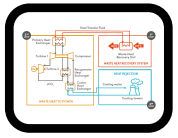
Project timeline

1 Jun 2021

Start of the project

1 Jun 2022



Plant layout definition

1 June 2023

sCO_2 power block design

1 June 2024

DEMO

Demonstration in operational environment: Prachovice - CEMEX

31 May 2025

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Project objectives

Technical

- Development and demonstration of a **2MW highly flexible** sCO_2 WH2P power block with a heat source T>400ºC and efficiency η_{NOM}>23%
- **Development** of sCO2 power cycle components: **turbomachinery, heat exchangers**
- Development of **control systems enabling flexibility enhancements** (related to part load, lower WH temperatures) and **power grid interoperability**

Replication

- **Replication** of CO2OLHEAT concept in **6 applications**: aluminium, steel, glass, CSP, waste incinerator, CCGT
- Wide **dissemination** and creation of a **pan-European sCO_2 WG**

Ec./ env/ soc

- Demonstrate **economic** and **replication** feasibility, **environmental** impact and **social** acceptance

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Technological development

- Shorter **ramp-up** time
- Good accommodation of **load changes**

Flexible

- Unparalleled WH2P **technology**
- No GHG **emissions**

Innovative

- Competitive **LCOE**
- **Payback** period of max. **6 years**

Economic. viable

- **Smaller size**
- **Modular**
- **Material savings**

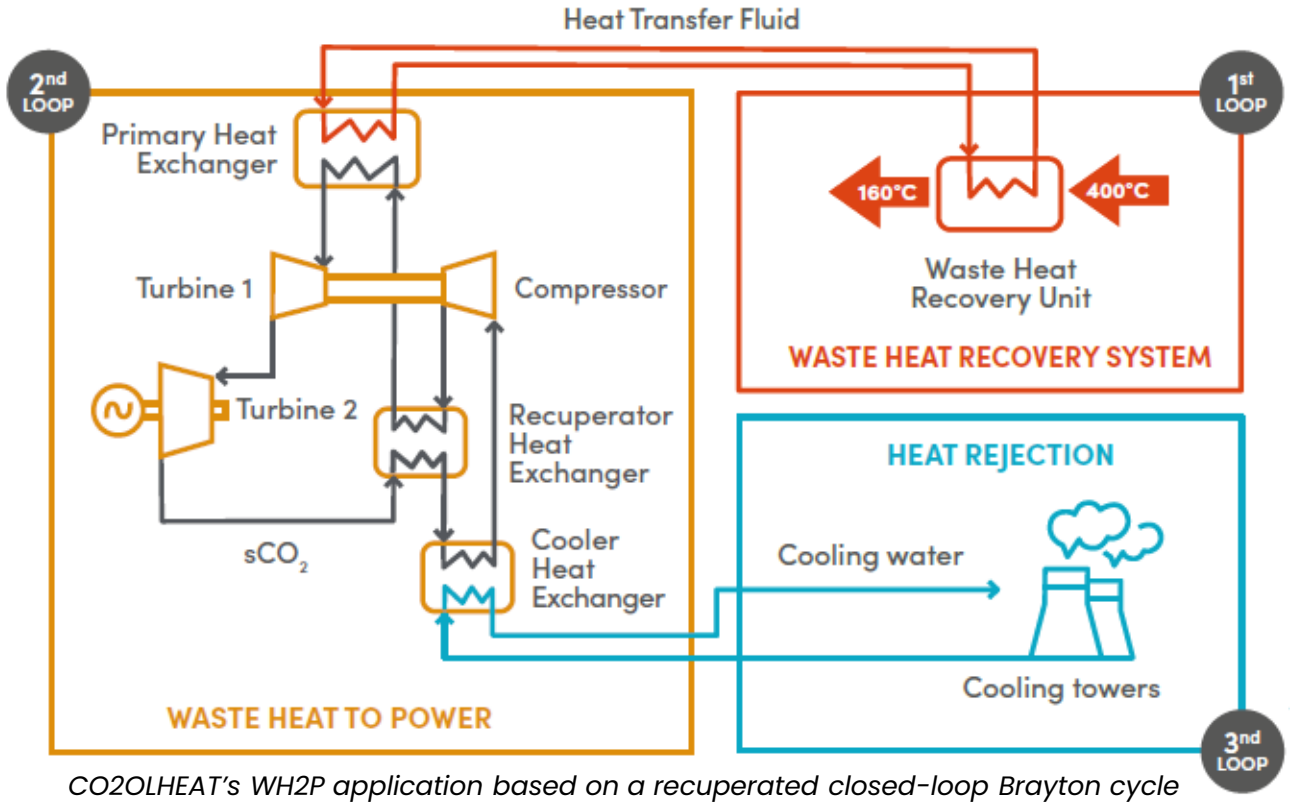
Compact

- Comparable or even **higher efficiency** than steam cycles/ORC

Efficient

- **6 replications sites** already part of the project
- Others are **ready to follow**

Replicable



CO2OLHEAT's WH2P application based on a recuperated closed-loop Brayton cycle with sCO2 as a working fluid

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The demo site – CEMEX Prachovice (CZ)

- The demo site – **the CEMEX cement plant** – is located in the municipality of **Prachovice (Czech Republic)**
- **The WH potential** in CEMEX plant is **~16 MW**
- CO2OLHEAT will valorise the WH in the cooling tower

CEMEX Plant – Characteristics	
Kiln Preheater	170.000 - 250.000 Nm^3/h
	300ºC < T < 500ºC
Bypass	45.000 - 80.000 Nm^3/h
	T >1100ºC
Cooling tower	170.000 - 250.000 Nm^3/h
	100ºC < T < 400ºC

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Replication sites 1/3

Şişecam – Glass industry
Ankara (Turkey)

SISECAM Plant – Characteristics	
Waste Heat	20 - 25 MW_{th}
Flow rate	90.000-120.000 Nm^3/h
Temperature	450-580ºC

MYTILINEOS – Aluminium industry
Viotia (Greece)

MYTILINEOS Plant – Characteristics	
Waste Heat	>11 MW_{th}
Flow rate	>100.000 Nm^3/h
Temperature	>440ºC

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Replication sites 2/3

CELSA – Steel production
Barcelona (Spain)

CELSA Plant – Characteristics	
Waste Heat	52 MWh
Flow rate	200.000 Nm^3/h
Temperature	1.150ºC

ENGIE Laborelec – Waste incineration
Beringen (Belgium)

ENGIE Laborelec Plant – Characteristics	
Steam capacity	102.5 ton/hour
Pressure	43.5 bara
Temperature	410ºC

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Replication sites 3/3

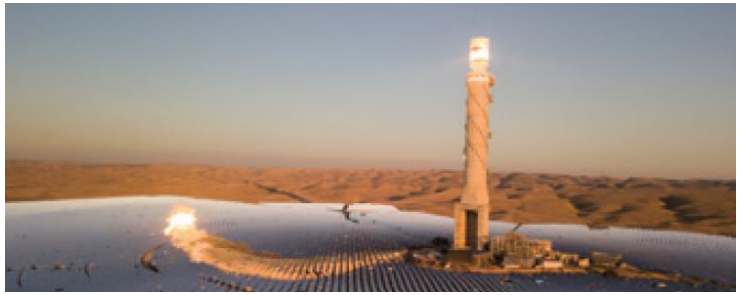
EDT – Power generation (CCGT)

Montereau (FR)

EDF Plant – Characteristics	
Waste Heat	250 - 260 MW_{th}
Pressure	Atmospheric pressure
Temperature	515ºC

RINA-Consulting – Power Generation (CSP)

Cordoba, La Africana (Spain)



La Africana Plant – Characteristics	
Thermal input for CSP plant	160 – 200 MW_{th}
Temperature	360 – 400ºC

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Project methodology

6/2021

6/2022

6/2023

6/2024

5/2025

A. ASSESSMENT PHASE I.
CO2OLHEAT layouts, Prachovice Pilot layout definition, thermo-economic model development, dynamic analysis
(M1-M18)

C. DEMONSTRATION PHASE
Commissioning and installation of CO2OLHEAT skid for integration in Prachovice demonstration site TRL 7. Demonstration, monitoring and evaluation through specific KPIs
(M24-M48)

B. ENABLING TECHNOLOGIES DEVELOPMENT AND PREDEMONSTRATION PHASE
Design of components and realisation of sCO_2 turbomachinery, BoP/HEXs, control development
(M1-M36)

D. ASSESSMENT PHASE II.
Business and environmental analysis, roadmap towards TRL 9, replication feasibility studies and policy promotion, sCO_2 EU WG animation
(M1-M48)

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Consortium

CO2OLHEAT brought together a consortium composed of **21 stakeholders** with complementary expertise from 10 European countries

- **Companies**: 13 Enterprises
- **Academia**: 3 research and technology organisations, 4 universities
- **Other**: 1 association

ETN Global · RINA · SIEMENS energy · University Duisburg Essen Open-Minded · Baker Hughes · Politecnico Milano 1863 · SiMeROM

CEMEX · Brunel University London · mas Intelligent Energy Technologies · Roma Tre Università degli Studi Dipartimento di Ingegneria · CERTH · LEITAT managing technologies · Heatric

ENEA · ENGIE Laborelec · EDF · MYTILINEOS Aluminium of Greece | Metallurgy Business Unit · ŞİŞECAM · bosal · celsa barcelona

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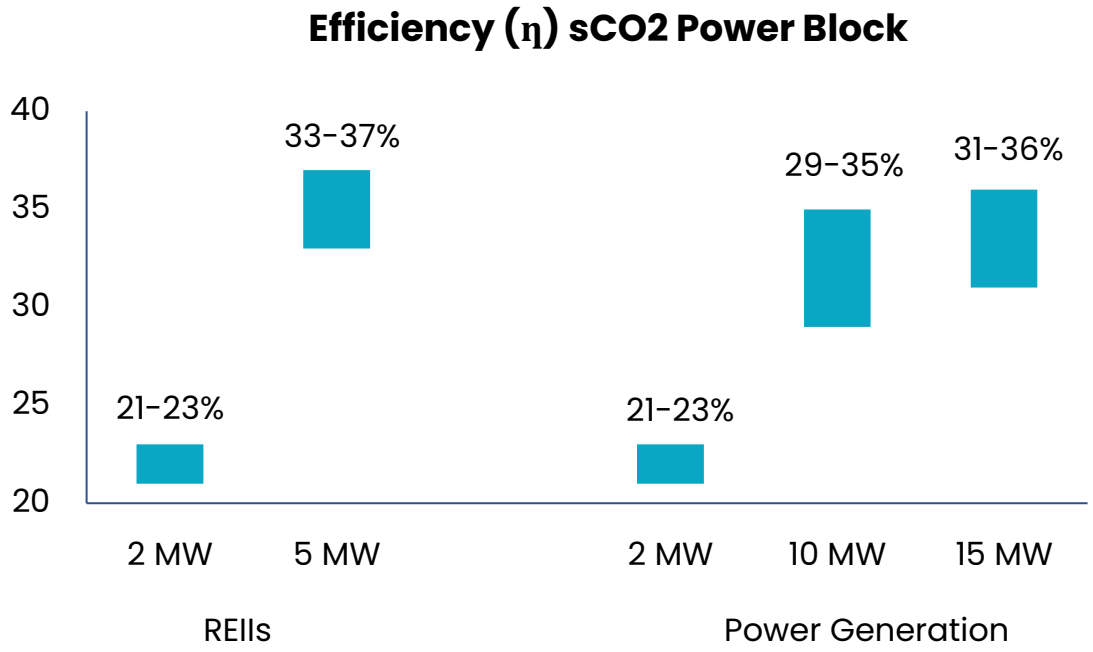
Expected impacts – Technology

The **REIIs** will become flexibility actors in the electricity grids, changing their role from **consumers to prosumers**, thanks to the following characteristics of the sCO2 power block **Waste Heat to Power solution**:

- Higher flexibility
- Higher efficiency
- Easier installation/integration
- Higher safety
- Significantly reduced size
- Wider input temperature ranges
- Scalability to higher power levels



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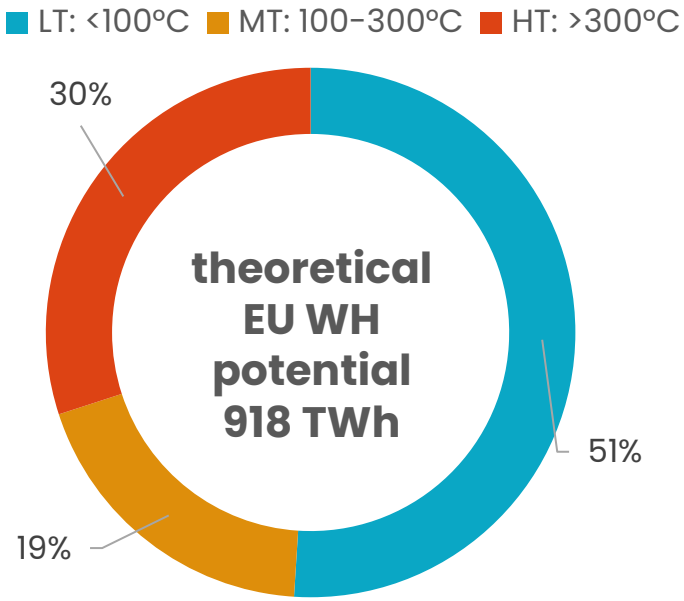
Expected impacts – Environment

CO2OLHEAT will be a game-changer in the WH use offsetting the disadvantages of available technologies and being able to:

- Increase the REIIs Primary Energy Savings *>40.000 MWh/year for CEMEX plant*
- Reduce the GHG emissions *6.496 tCO_2/year for CEMEX plant*
- Reduce up to 100% of water consumption
- Reduce up to 30-40% of raw material in components (compact size)



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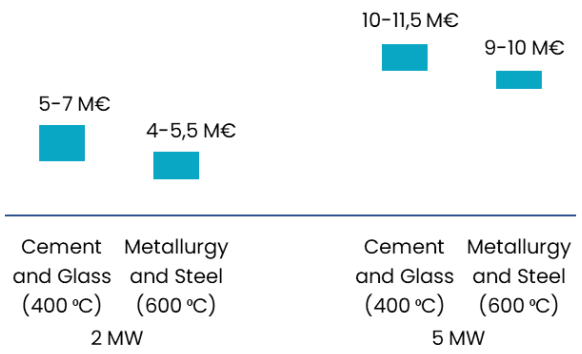
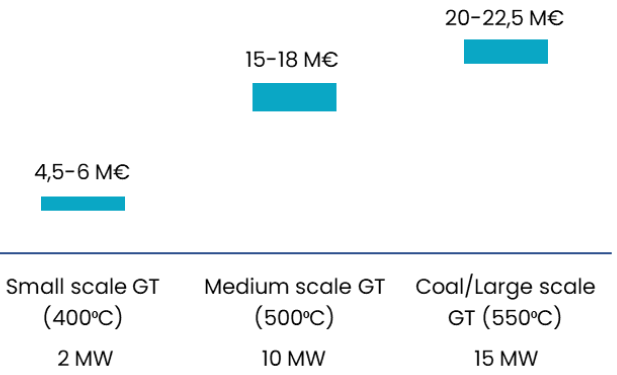
Expected impacts – Economy

CAPEX sCO2 Power Block – *REIIS*
(EOH = 8.000 h/yr)



CAPEX sCO2 Power Block – *Power Generation*
(EOH = 5.000 h/yr)



Estimated **LCOE 4c€/kWh**

Shift from **consumer to prosumer**

CEMEX: Avoided **cost** of electricity **750k€**

Costs savings and economic benefits

Global **market** potential **60B€** by 2030

Payback period **4,3-7,8 years**

Rate of **Return** of the sCO_2 System **18%**

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Project structure

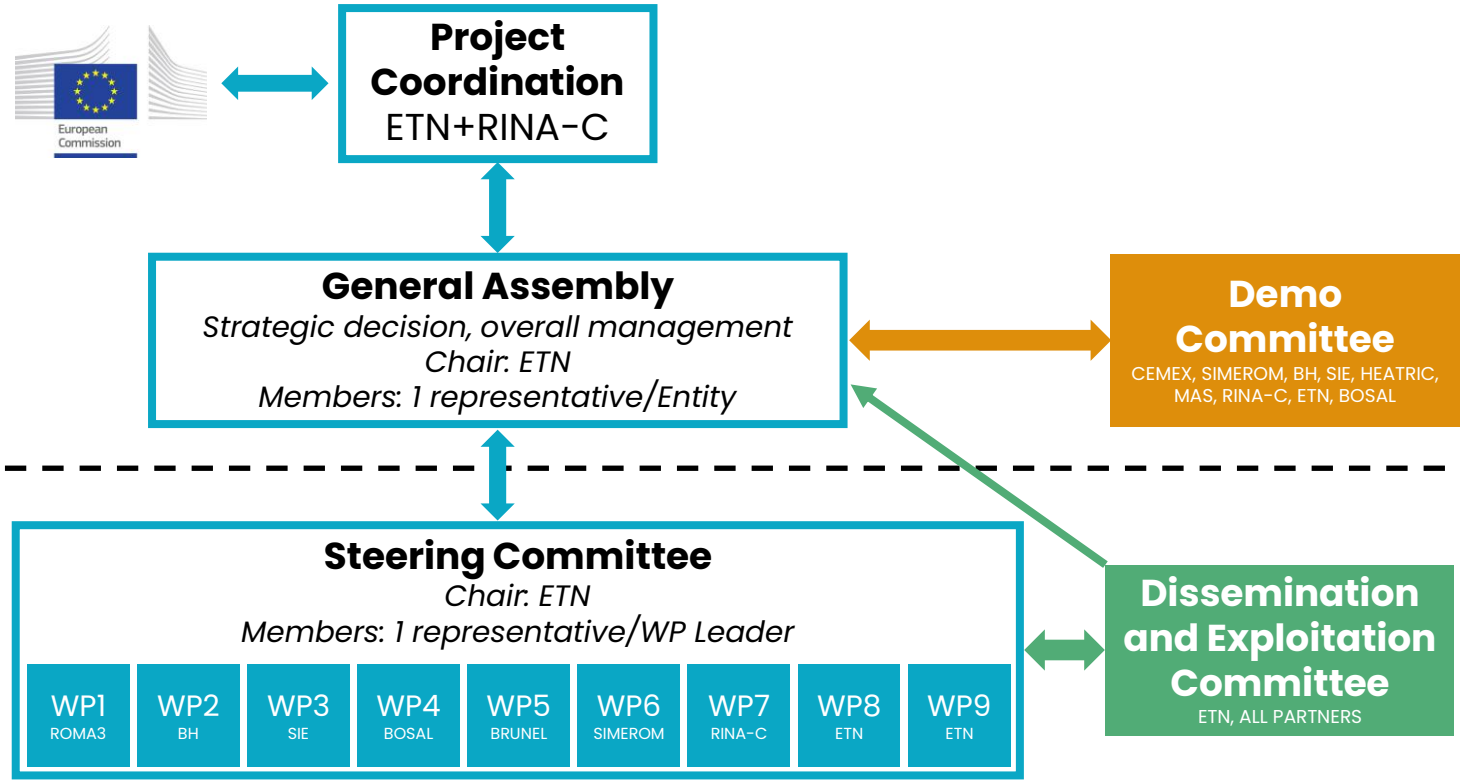
Two levels of project management:

Strategic Level

where the main project decisions are taken

Operational Level

where tasks are performed



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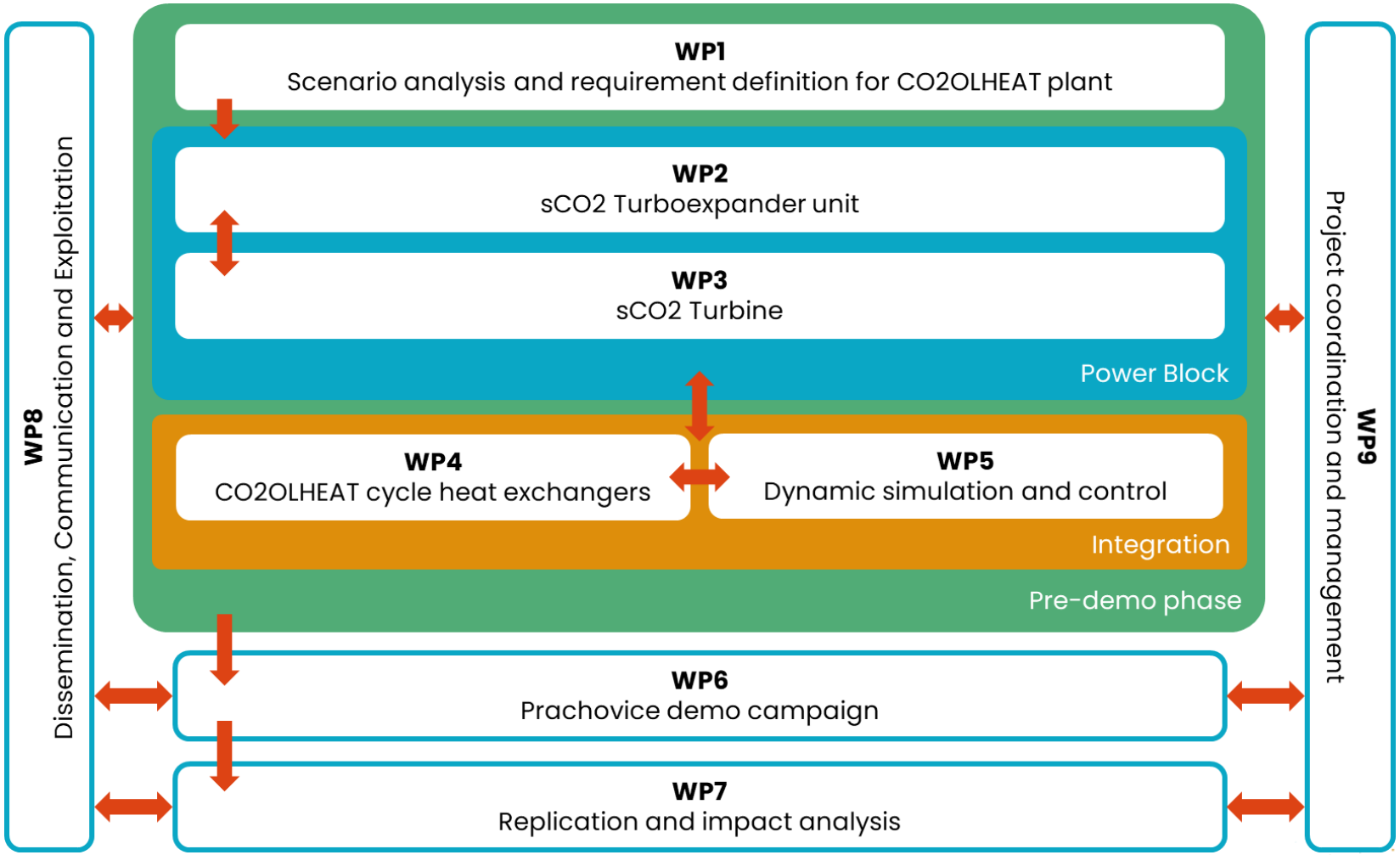
Work packages



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Thank you

Get in touch with us

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