



HERCCULES

full CCUS chain demonstration



HERCCULES aims to accelerate the **application of the CCUS in Southern Europe**, demonstrating the techno-economic feasibility of **two full-scale CCUS chains**, each serving an industrial cluster with a capture potential of 10 Mt_{CO2}/y by 2030: (i) in Greece, driven by the **cement sector**; (ii) in Northern Italy, driven by the synergic integration of **cement and Energy from Waste (EfW)** industries. The project will leverage on the two most advanced geological CO₂ storage sites in southern Europe (Prinos in Greece and Ravenna in Italy) involving the **main industrial actors** of the CCUS field, will realize three TRL7-8 capture pilots and three CO₂ mineralization pilots

1 - FLEXIBLE AND OPTIMIZED CAPTURE IN CEMENT

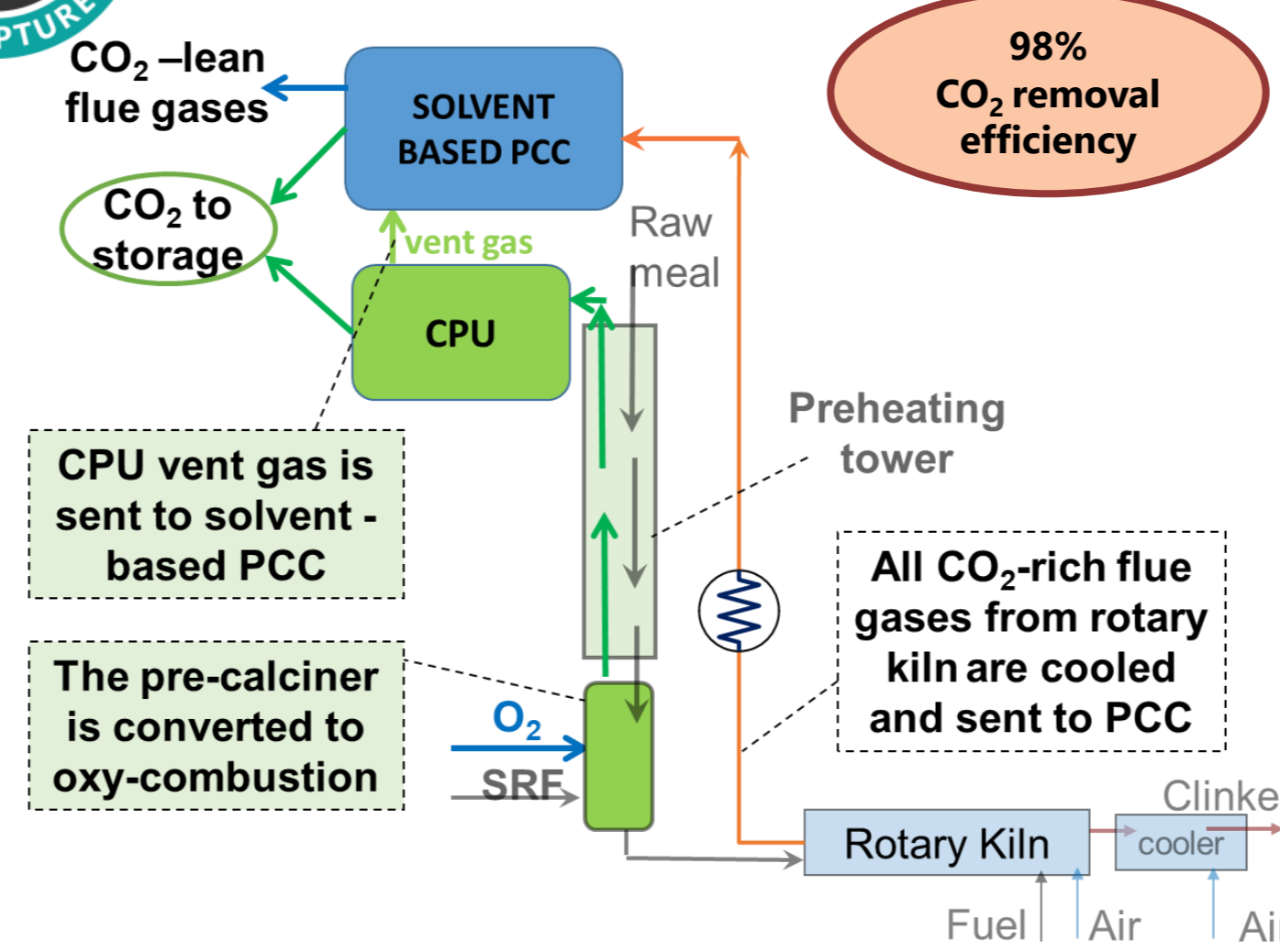
One pilot plant will be realized integrating: **(1) oxy-fuel calcination** with CO₂ processing unit (CPU); **(2) new generation solvent-based, Post-Combustion Capture (PCC)**. Retrofitability and step-by-step implementation will be demonstrated testing the technology at first in a BUZZI cement plant (Italy) and then, moving the equipment, in a TITAN cement plant (Greece)

- **7-8** TRL
- **>2'000** test hours
- **7-8** t_{CO2}/day captured
- **>99%** CO₂ purity
- **98%** CO₂ removal efficiency
- **-150** t_{CO2}/t_{clinker} negative emissions when firing biomass (SRF)
- **-50%*** reduction of Energy penalty due to CO₂ capture

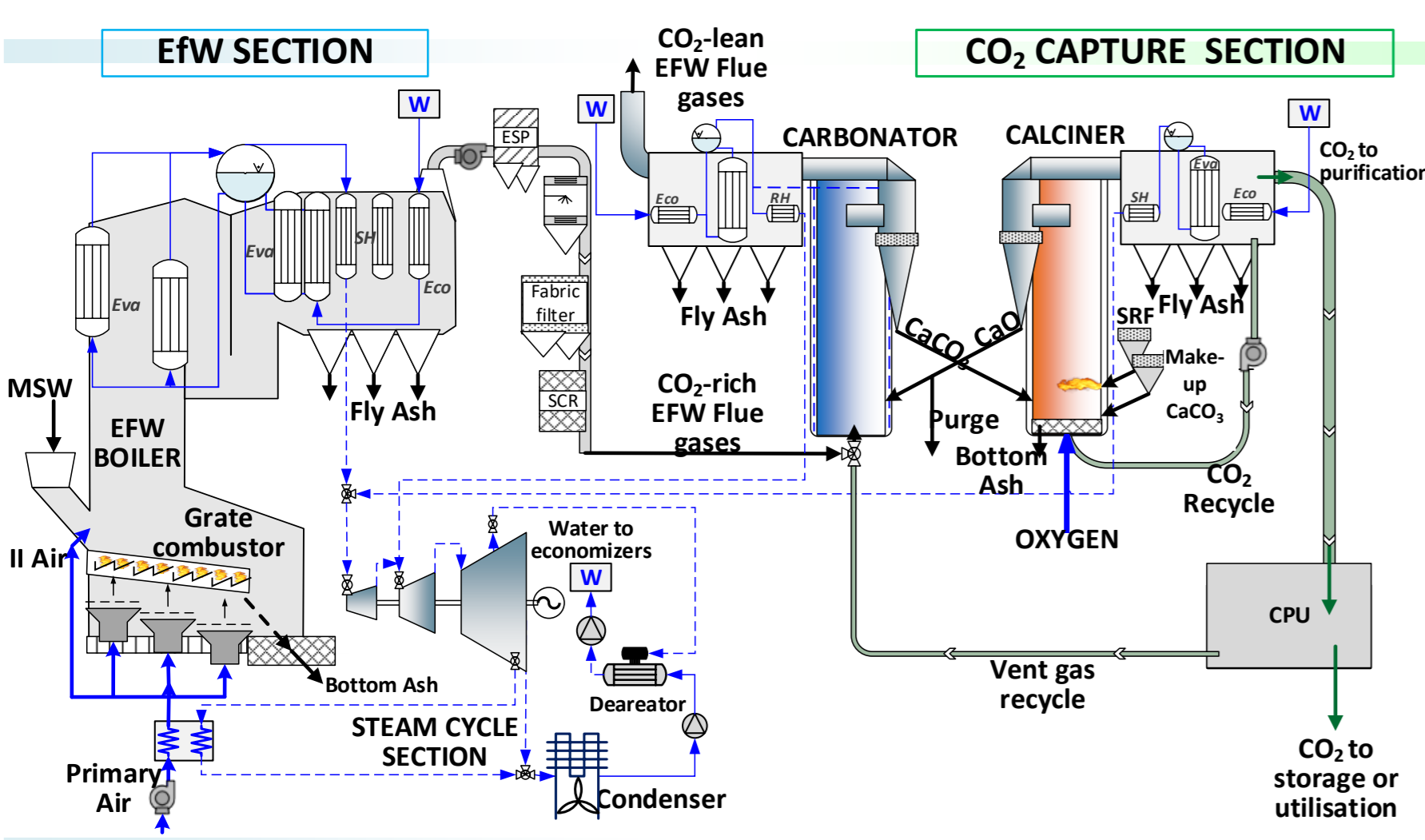
*with respect to the conventional technology: MEA-based absorption



Hybrid concept



Calcium Looping in EfW



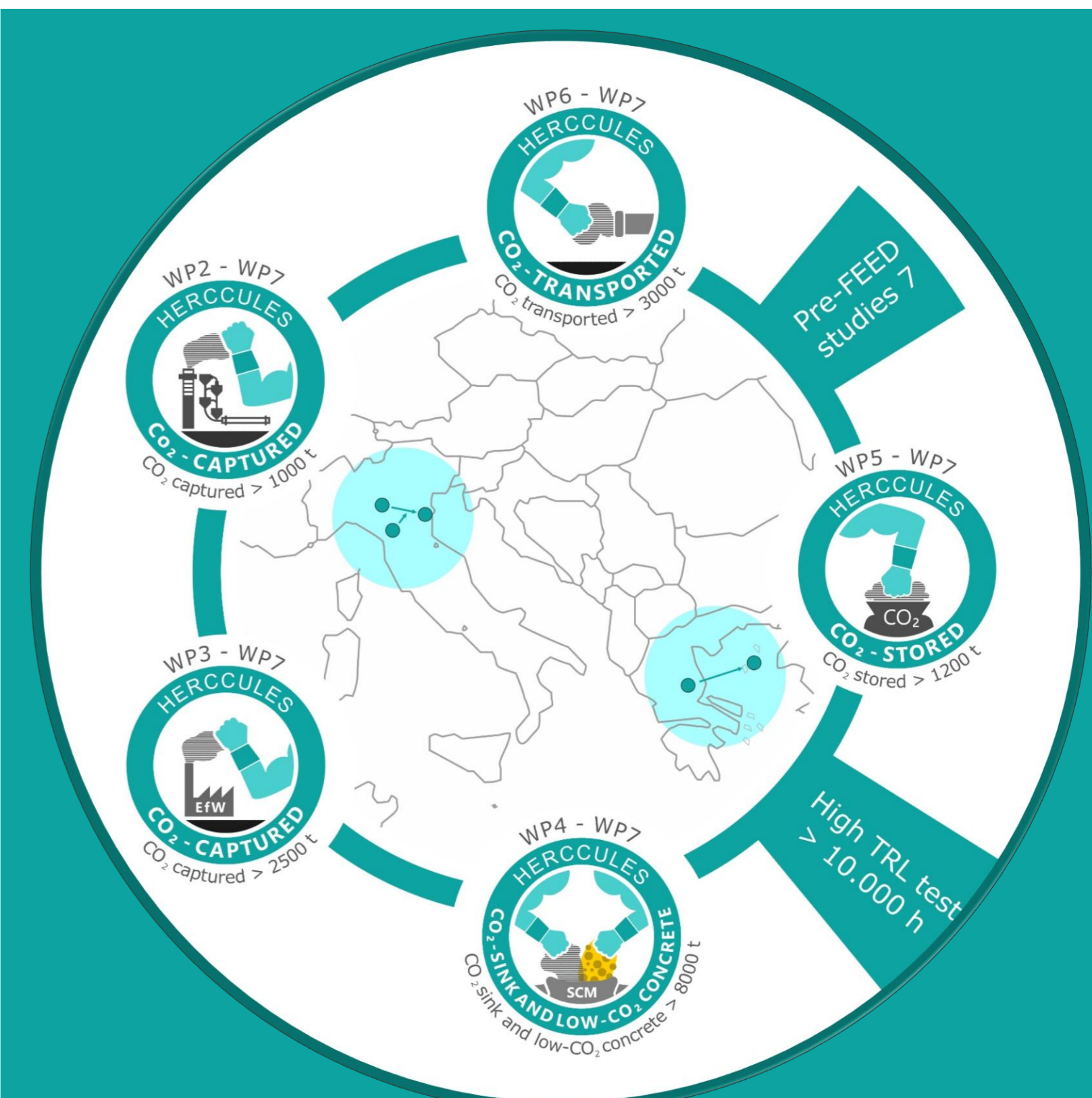
2 - OPTIMIZED CAPTURE IN EfW

A first-of-a-kind carbon capture pilot plant will be realized in the A2A "Silla2" Energy-from-waste (EfW) power plant (in Milan), based on the **Calcium Looping technology (CaL)** with Circulating Fluidized Bed (CFB). CaL is based on a CaO-based solid sorbent, which absorbs CO₂ in the carbonator and is regenerated in the calciner:



- **7-8** TRL
- **>4'000** test hours
- **15** t_{CO2}/day captured
- **>99.9%** CO₂ purity
- **95%** CO₂ removal efficiency
- **-400** t_{CO2}/t_{waste} negative emissions co-firing biofuel
- **-30%*** reduction of Energy penalty due to CO₂ capture

*with respect to the conventional technology: MEA-based absorption



CEMENT AND EfW: hard-to-abate sectors

In Europe, Cement and Energy from Waste (EfW) emit 120 Mt_{CO2}/y and ~96 Mt_{CO2}/y, respectively, but unlike other industrial sectors which could expand their reliance on renewable sources or bio-based intermediates, their process-related CO₂ emissions can be curtailed only by capture. Therefore, the attainment of Europe carbon neutrality by 2050 calls for urgent actions to applicate CCUS in these sectors.

3 - CO₂ AND BY PRODUCTS UTILIZATION, enabling synergies between cement and EfW

HERCCULES will prove the reduction of cement and concrete carbon footprint through two **TRL7-8 pilot plants**:

- two promising **mineralization technologies for direct CO₂ sequestration** (exploiting zeolites and demolished concrete) will be integrated with CO₂ capture pilot plants, producing **8'000 tons of low carbon concrete**. These technologies will demonstrate the superior quality of the carbonated concrete
- the **exhaust CaO-based sorbent** (purged from the CaL-EfW pilot plant in Milan) will be **recycled** as decarbonized raw meal for the production of an alternative hydraulic binder (by means of the **TRL8 CELITEMENT pilot plant**) and low carbon clinker in an operational BUZZI cement plant

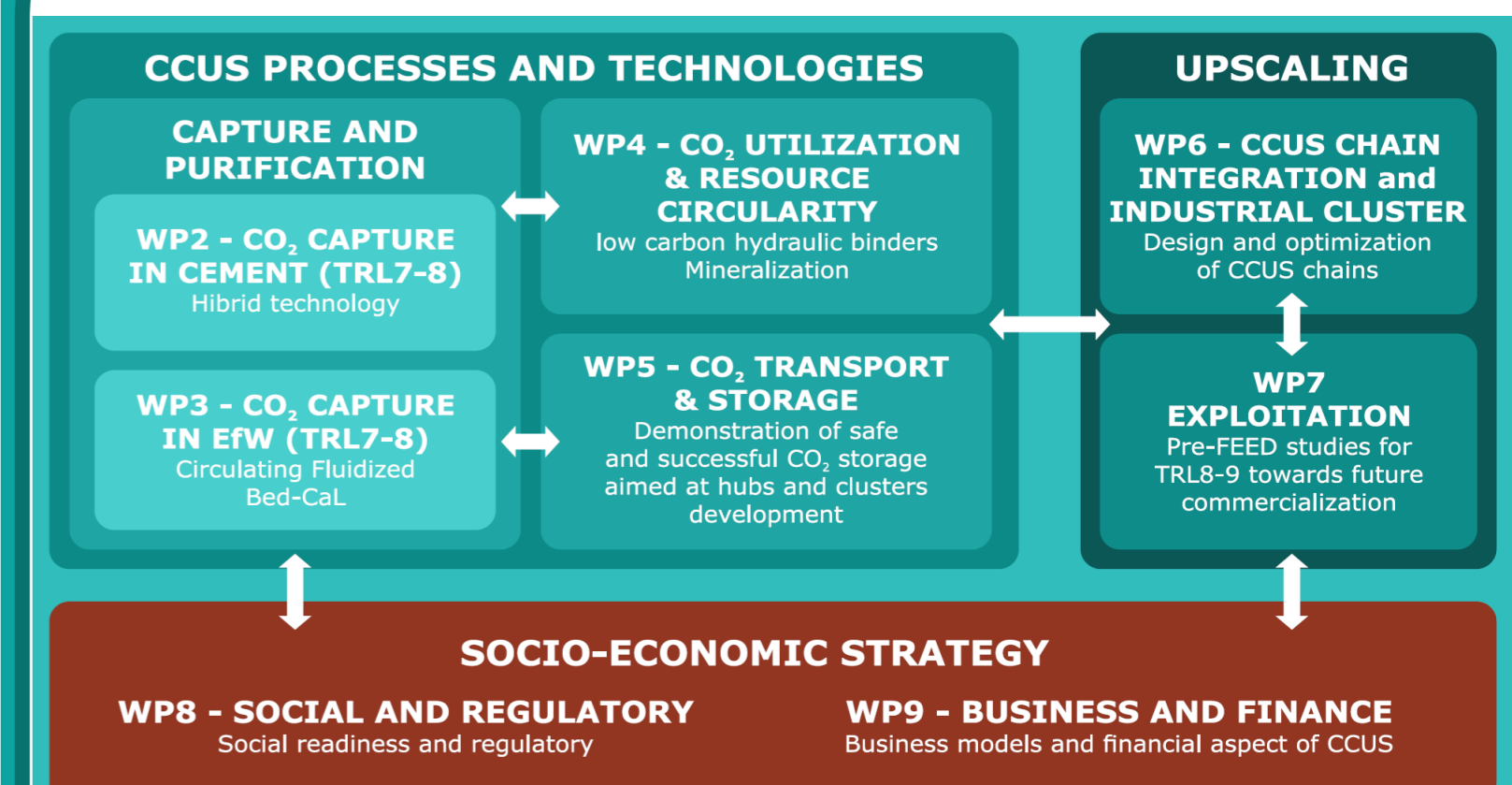
4 - To accelerate CO₂ storage implementation in two strategic areas of the Mediterranean basin

HERCCULES will store more than **1'000 t of CO₂** in the most **advanced CO₂ storage sites** in Southern Europe: Prinos (Greece) and Ravenna (Italy). These sites are featured by **high capacity, cost-effective storage** potential, **good connection** with emitters, possibility to repurpose **existing infrastructure** for transport and storage. The **assessment of permitting**, CO₂ transport and logistics, **safety**, injection and monitoring plan in these two sites will be a turn-key to enable first-of-a-kind industrial projects covering the full CCUS chain in Southern Europe.

5 - To enable the CCUS in Southern Europe, by laying the groundwork for societal acceptance, providing effective business models and generating regulatory experience and political awareness

- **Societally relevant issues** will be investigated (regulatory framework, safety, sites availability, awareness, citizens involvement, social license).
- **The upscaling of the whole CCUS chain** will be studied, covering aspects such as **business models**, CO₂ industrial logistics and safety, permitting iter and regulatory aspects as well as the **financial mechanisms** in order to reduce the perceived financial risk and identify and remove the barriers limiting CCUS deployment in northern Italy and Greece.

WP1 - Project Management and Coordination



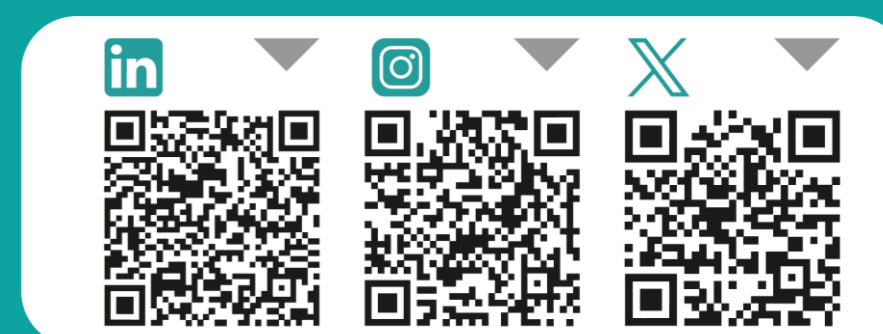
WP10 - Communication, Dissemination, knowledge sharing and exploitation

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Number of partners: 25
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Website



Social



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