

15 aprile 2021

EVENTO DI PRESENTAZIONE

dell'infrastruttura CO₂ Circle Lab – CCL

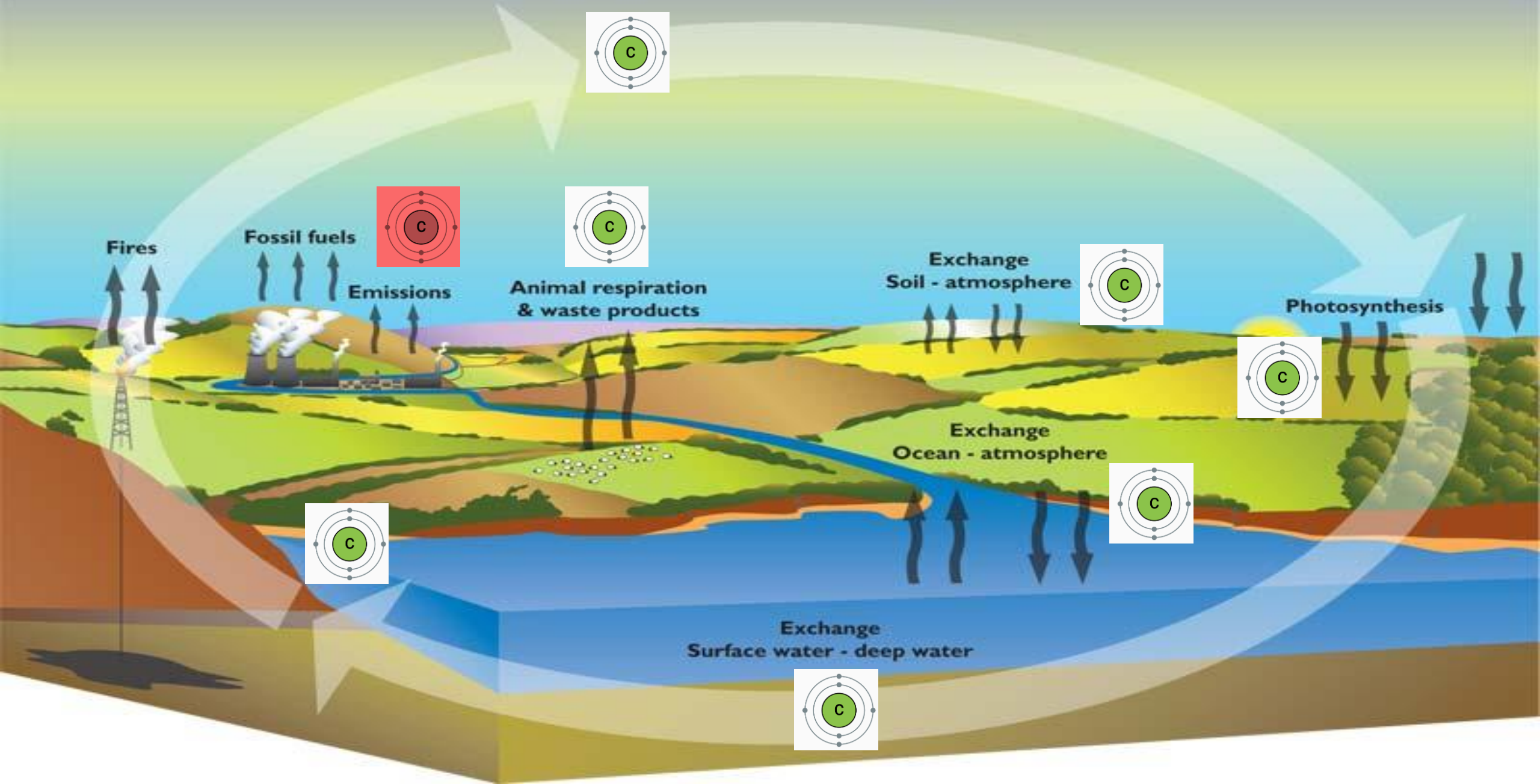
**“CO₂ da problema a risorsa:
processi e tecnologie per le imprese”**

Prof. Massimo Santarelli

Politecnico di Torino



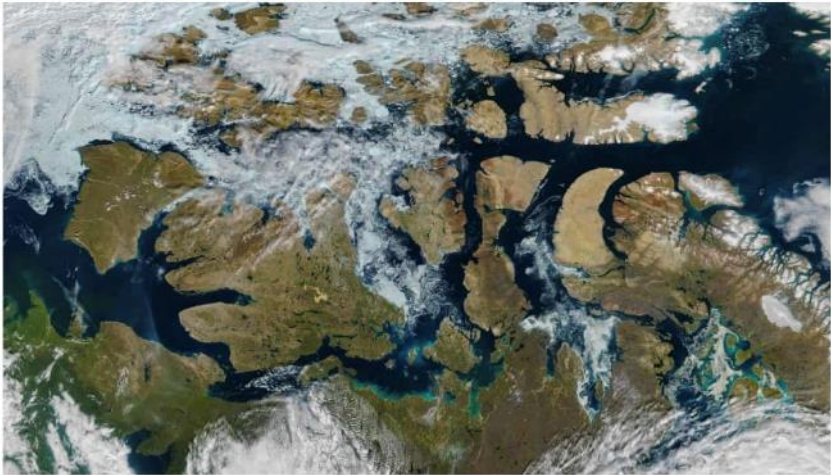
THE CARBON CYCLE



II problema: Global Warming



▲ A firefighter battles a fire in California. The world is currently 1C warmer than preindustrial levels. P Rinquo HW Chiu/AP



Source: The Guardian, July 30th - Oct 8th, 2018

UN: 'Life-and-Death' Action Needed on Climate Change

Rapid transformation within 12 years could limit worst effects

▶ Hurricane Michael: footage shows devastation in Florida's Mexico Beach - video



Aerial footage shows the extent of the damage along Florida's coastline after the devastating impact of Hurricane Michael, the strongest US storm in more than 25 years. It made landfall near Mexico Beach - as seen in this video - with winds of up to 155 mph

Elections have consequences. Denying science has consequences. And we are reaping what we sow.

● Hurricane Michael - live updates



The Swedish town on the frontline of the Arctic wildfires

A sleepy Lapland fire station is calling in help from all corners to fight the unprecedented wildfires sweeping the region



▲ Burnt forest: two hot, dry months in Sweden have turned the region into a tinderbox. Photograph: Maja Suslin/TT News Agency/AFP/Getty Images



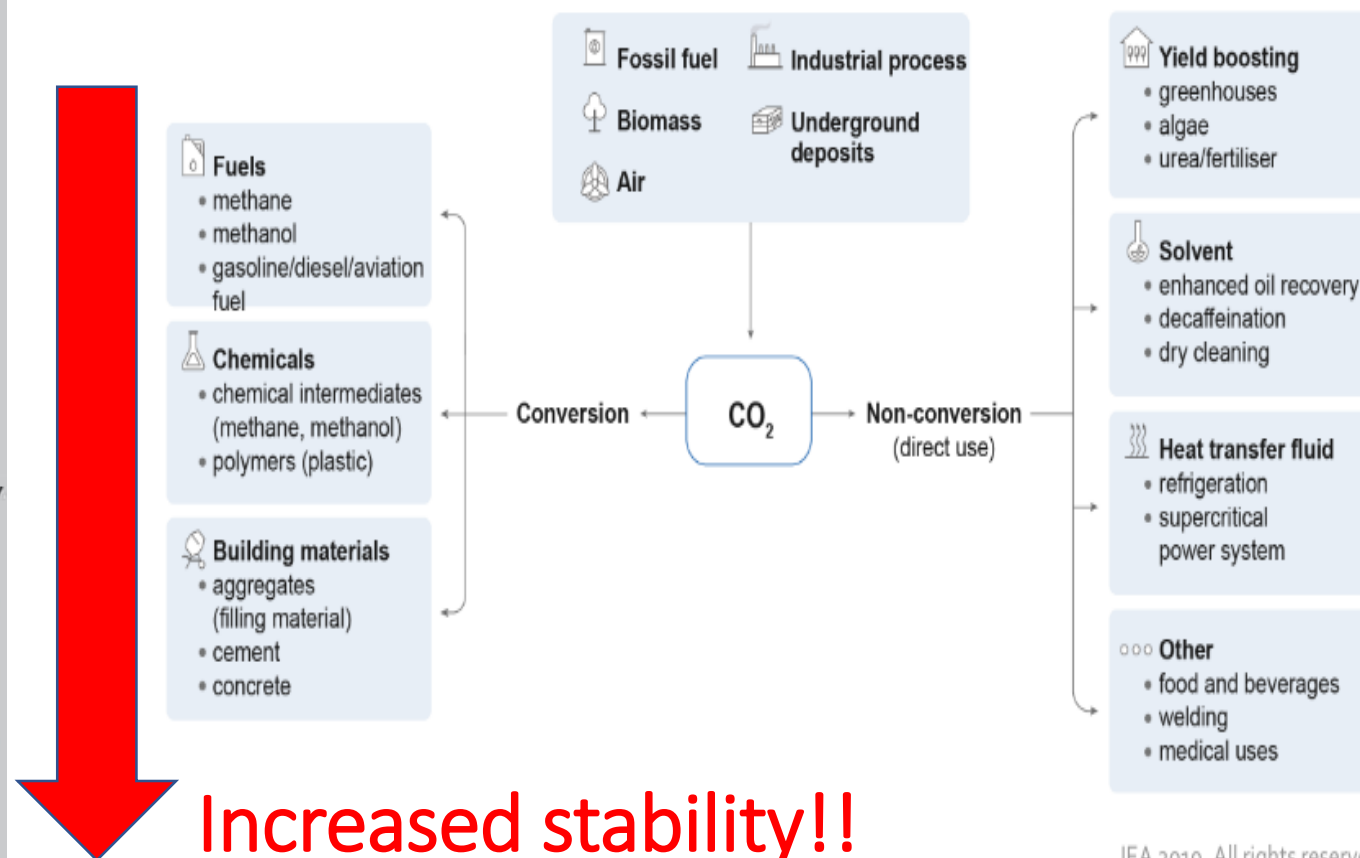
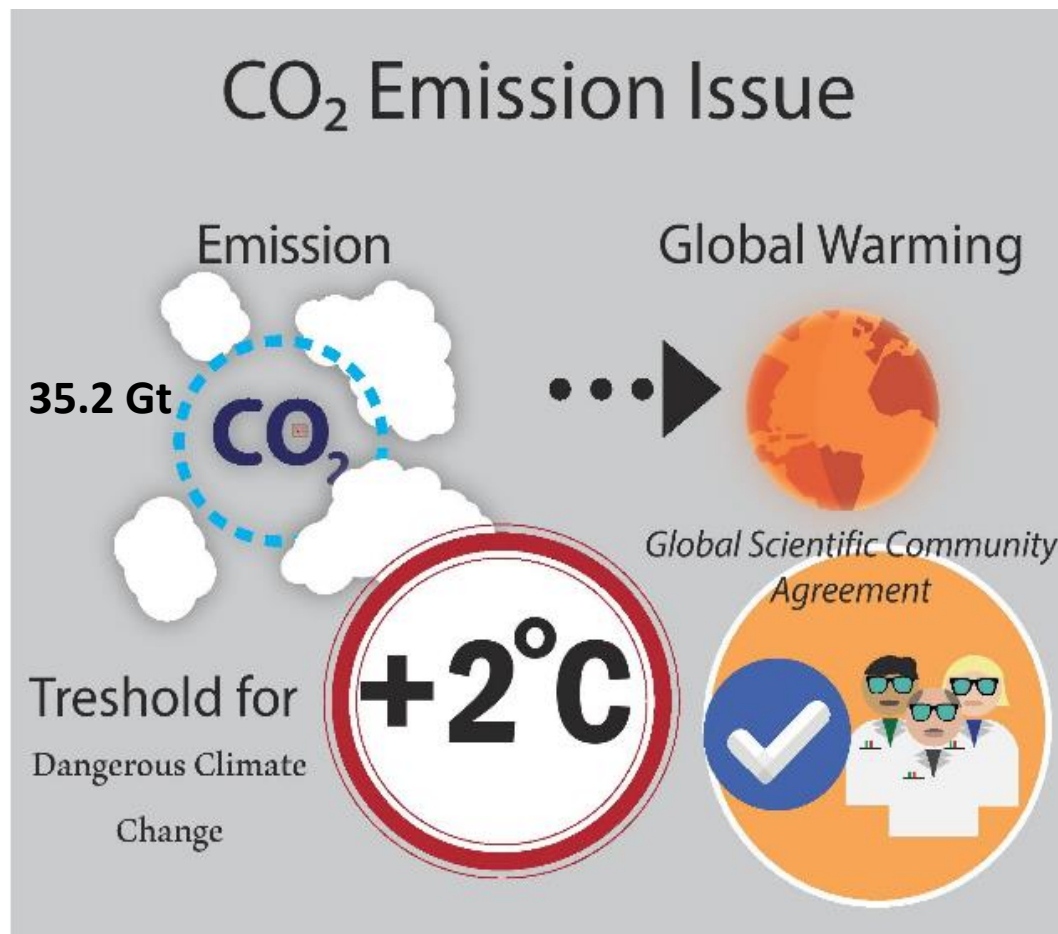
▲ Sweden has been hit by more than 60 forest fires this month. Photograph: Mats Andersson/AFP/Getty Images



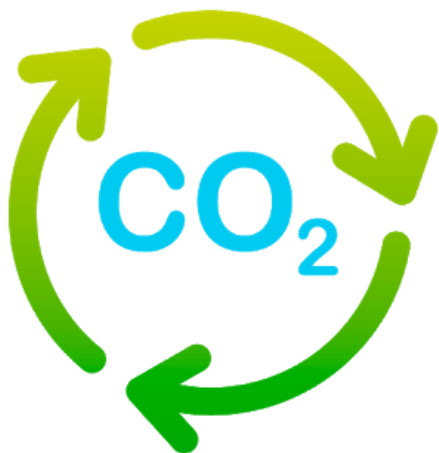
CO₂: from problem ...



... to commodity



Increased stability!!
to deal with climate change



Electrochemical
conversion



Termochemical
conversion

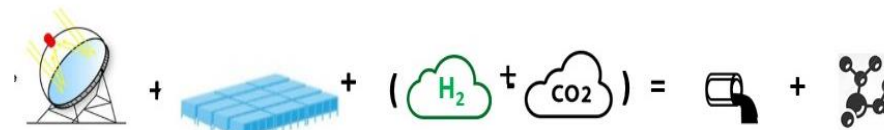


Photo-catalytic
conversion



Biological conversion





Test area at Environment Park

Test area at departments labs

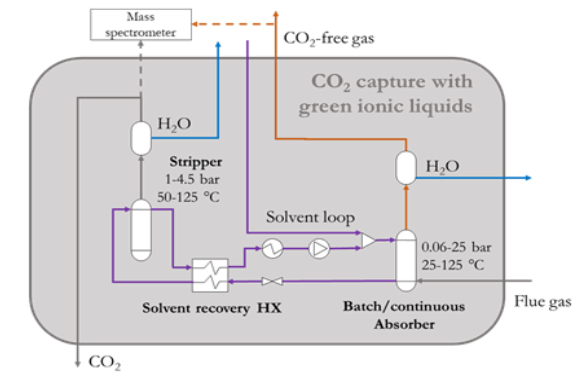
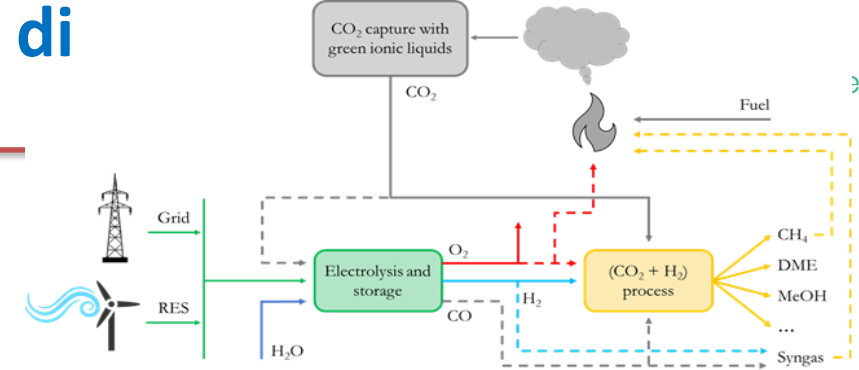
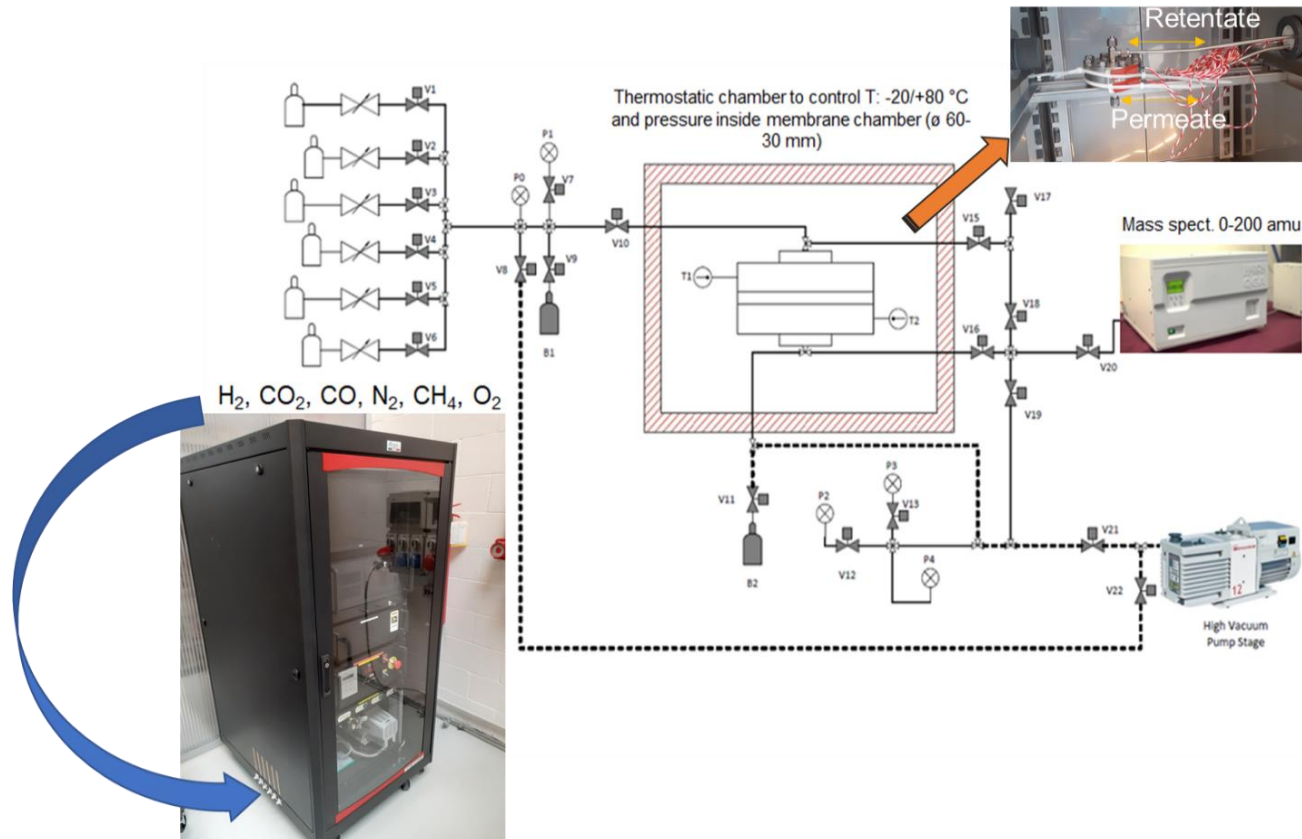
Test area at Energy Center Lab

- ✓ Test benches for processes CO₂ / H₂
 - CO₂ capture
 - CO₂ conversion
 - CO₂ and H₂
- ✓ Test benches for several CO₂ / H₂ activities
 - Electrolyzers (LT and HT)
 - Alternative processes (chemical looping, photocatalysis, biochemical processes)
 - Balance-of-Plant components
 - Renewable sources of energy (VRE)
 - VRE storage and management
 - Energy models and strategies

CO₂ Circle Lab (Politecnico di Torino, Istituto Italiano di Tecnologia)

CO₂ Capture

- CO₂ recovery test bench for absorption in liquid solutions (e.g. ionic liquids, including synthesis and characterization)
- Test bench for gas permeation (in particular CO₂) in membranes



CO₂ Circle Lab (Politecnico di Torino, Istituto Italiano di Tecnologia)

CO₂ conversion to chemicals thermo-catalytic processes

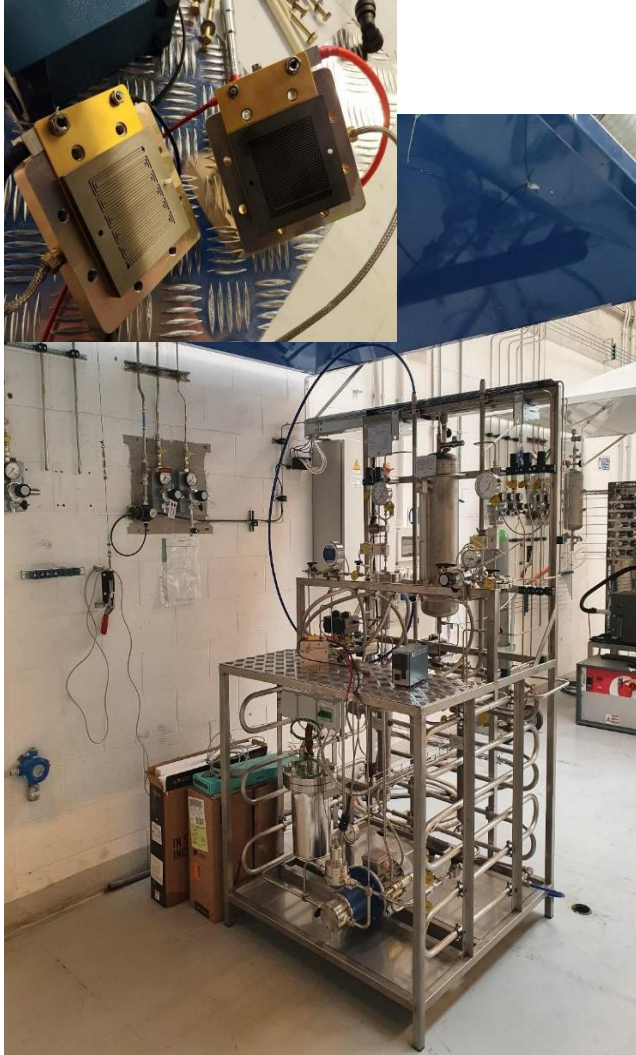


Reactor system for thermo-catalytic tests



Production of synthetic chemicals through CO₂ hydrogenation tests

Hydrogen, the partner of CO₂ VRE-fed electrochemical pathway: electrolysis section



Alkaline and PEM single cells and stacks

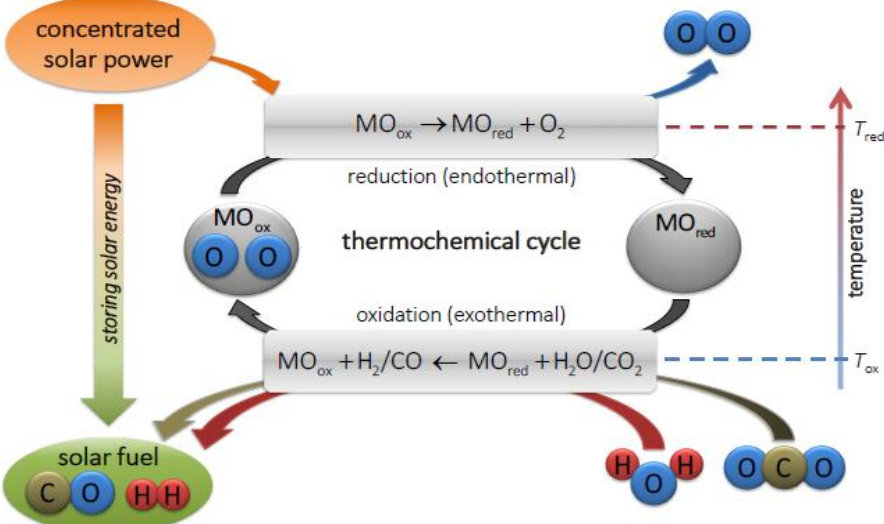


High pressure PEM stacks

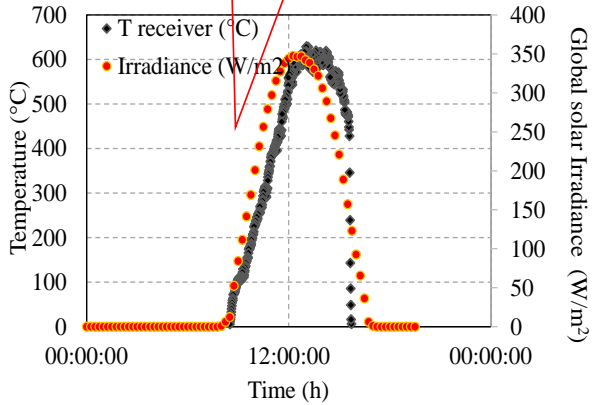
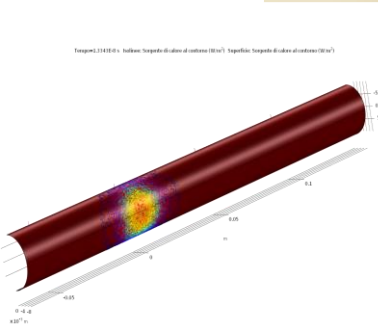
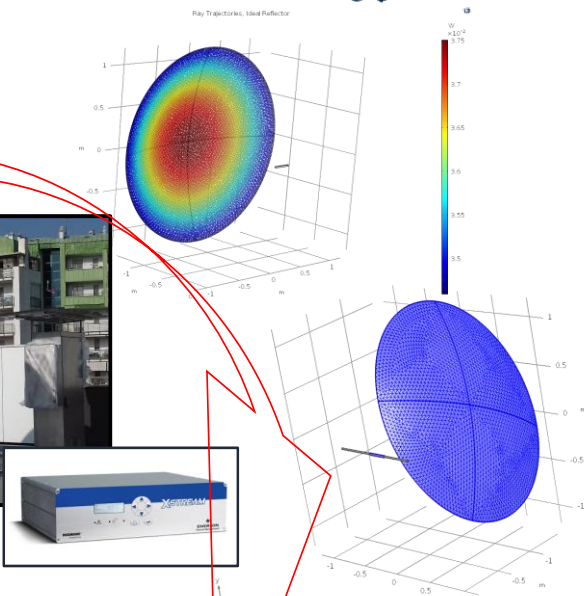


SOEC (ceramic) single cells and stacks

CO₂ / H₂O capture + conversion to CO/H₂ solar-fed chemical looping processes



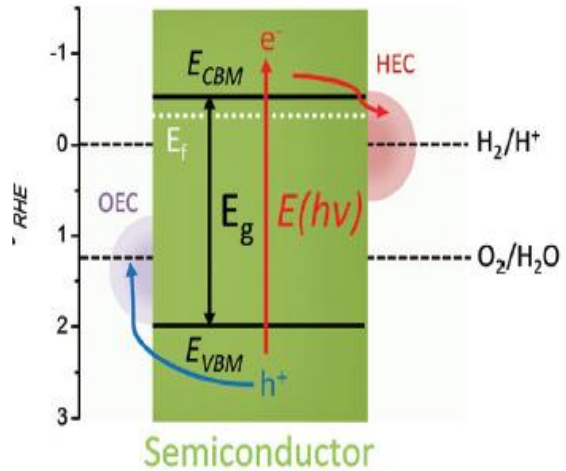
Assembly phase



CO₂ / H₂O conversion to chemicals

photo-electrochemical cells
photo-catalysis

Photon driven-water electrolysis



$$E(h\nu) \geq E_g + \eta_{\text{loss}} > 1.23 \text{ V}$$

$$\eta_{\text{loss}} = \eta_{\text{resistance}} + \eta_{\text{OER}} + \eta_{\text{HER}}$$



Test-bench for photo-electrochemical tests

CO₂/biomass conversion to chemicals bio-chemical processes



Organic matrices pre-treatment pilot plants



Membranes filtration plant

The sustainable energy input: renewable energy

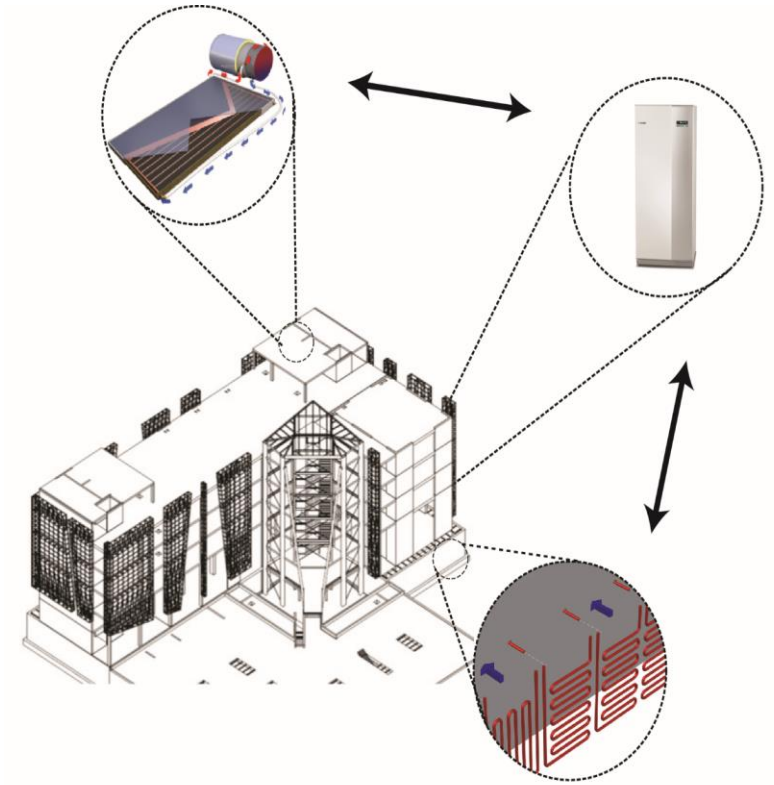
solar, wind, geothermal



Solar concentration

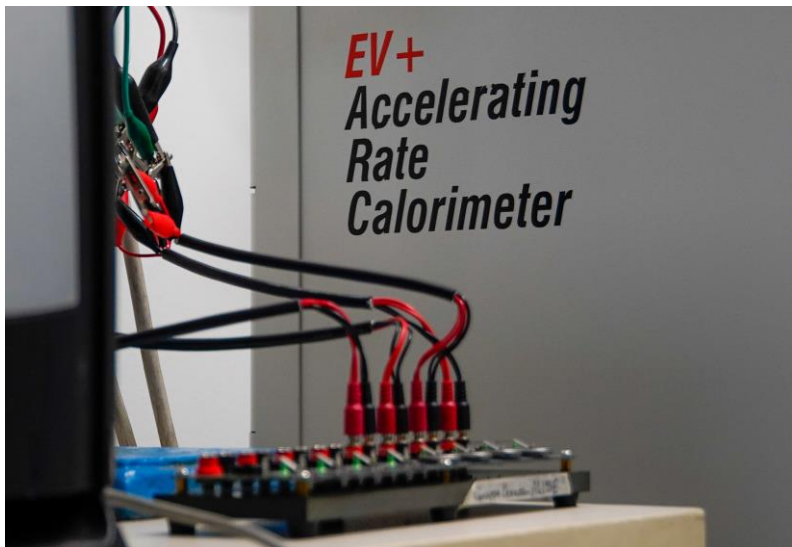


Wind energy



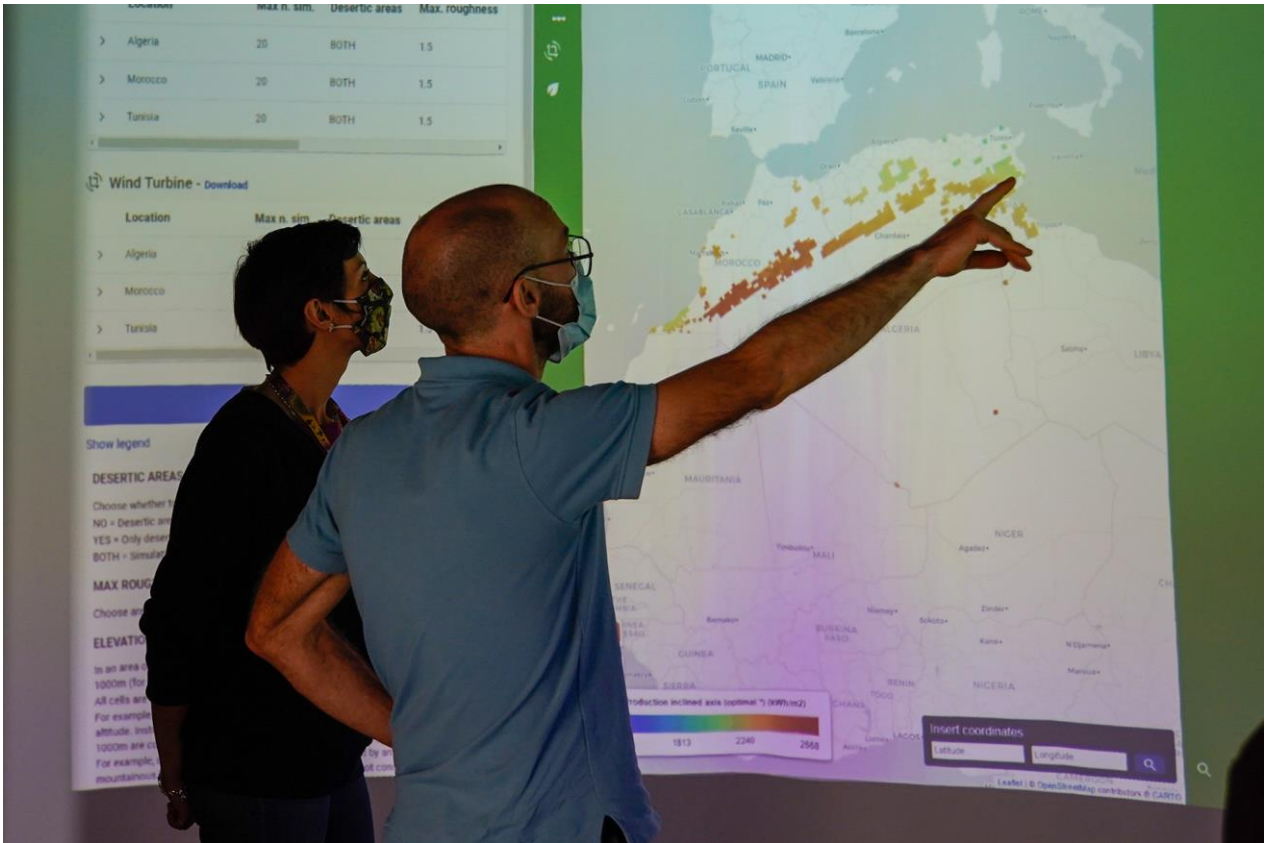
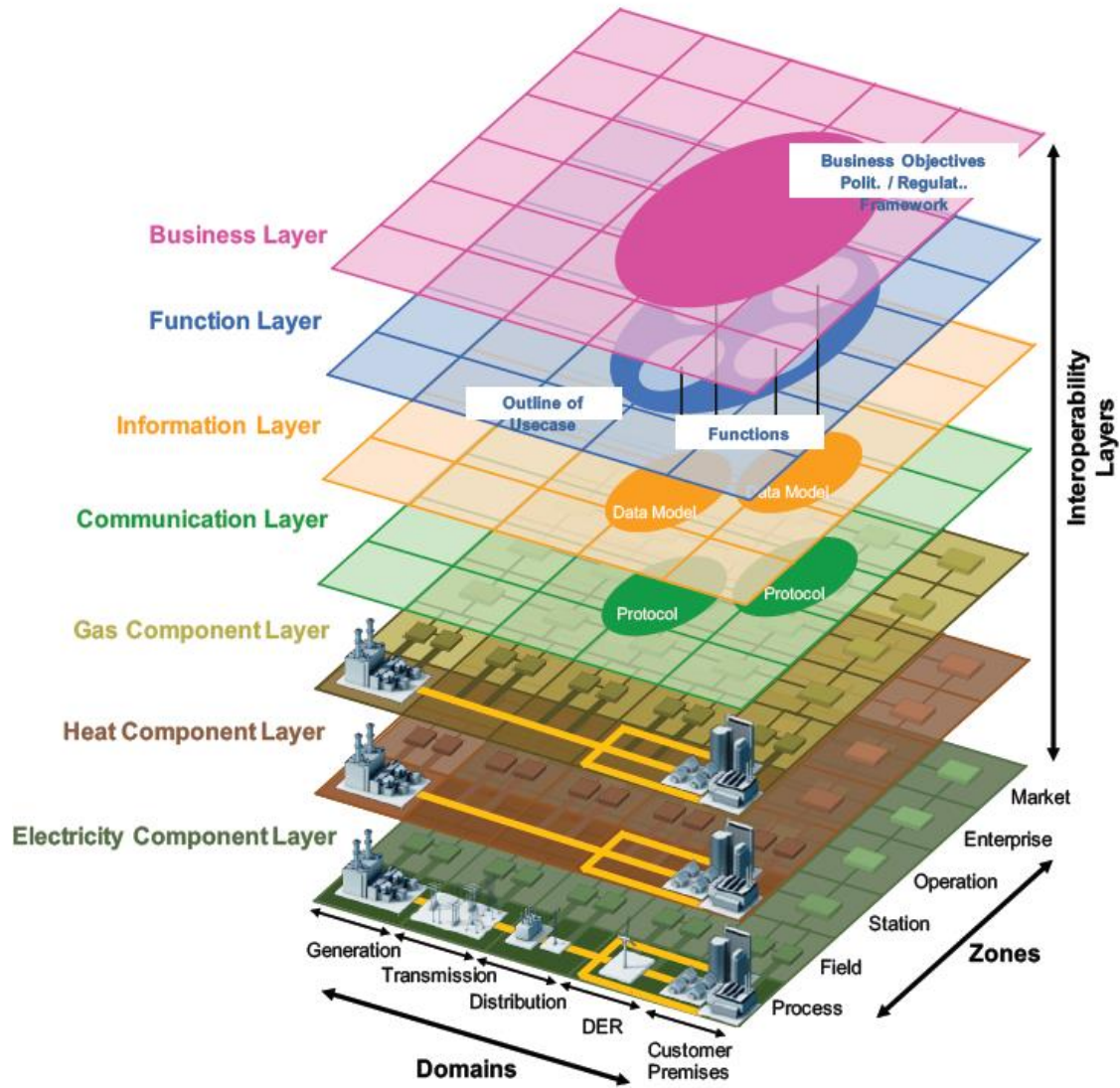
Low-enthalpy geothermal energy

The storage and management of the VRE sustainable input: batteries, power electronics, grid emulators



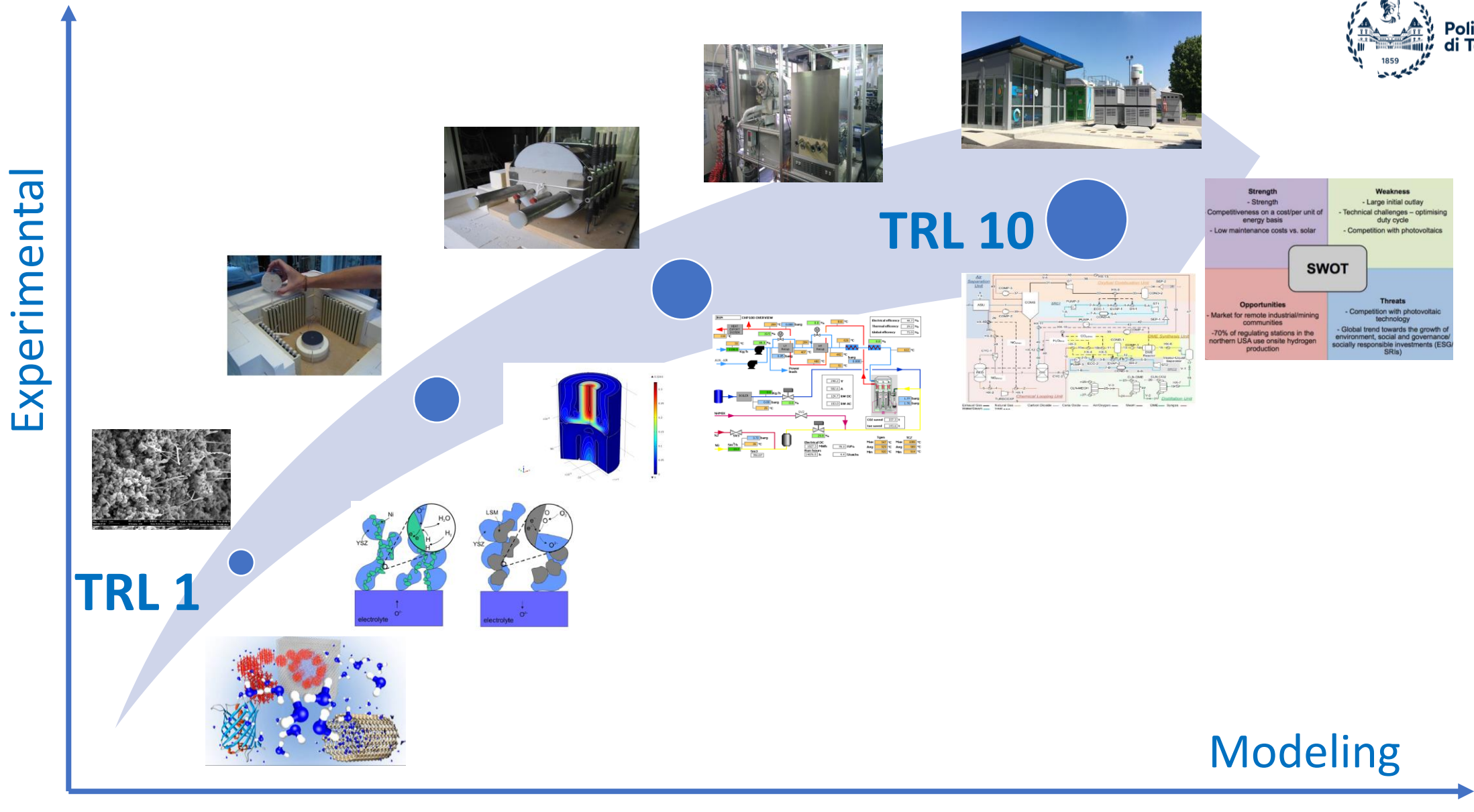
Emulators of grid-elements

Finally: the global energy and environmental management (Energy Center) modeling and analysis of global energy and environmental scenarios: decision theater



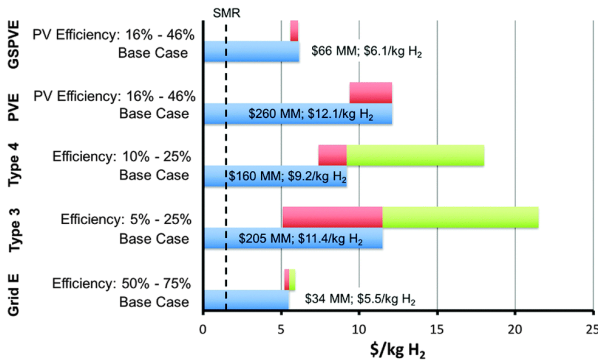
Decision Theater @ Energy Center Lab

R&D at several TRLs: from concept to market

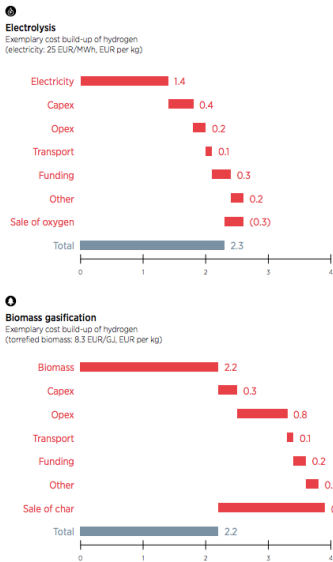




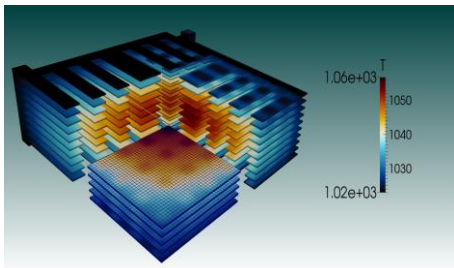
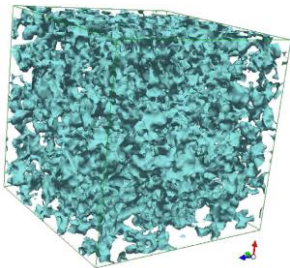
Test and experimental services



Feasibility studies, strategic consultancy, scenario analysis



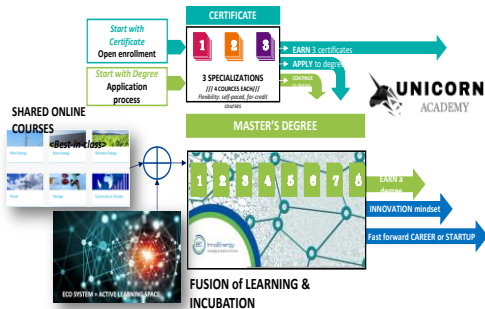
Modeling



Prototyping



Training



Per informazioni

CO2 Circle Lab

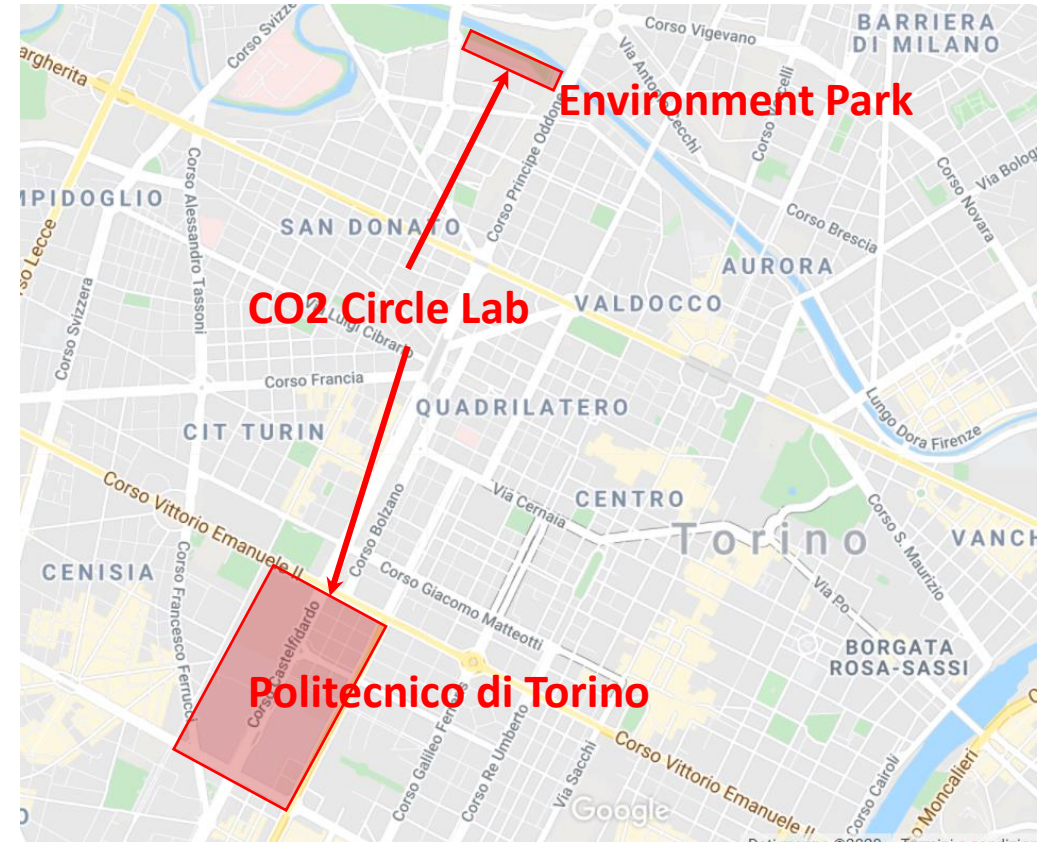
www.polito.it/ricerca/infrastrutture/ccl/

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GRAZIE PER L'ATTENZIONE

<http://co2circlelab.eu>

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