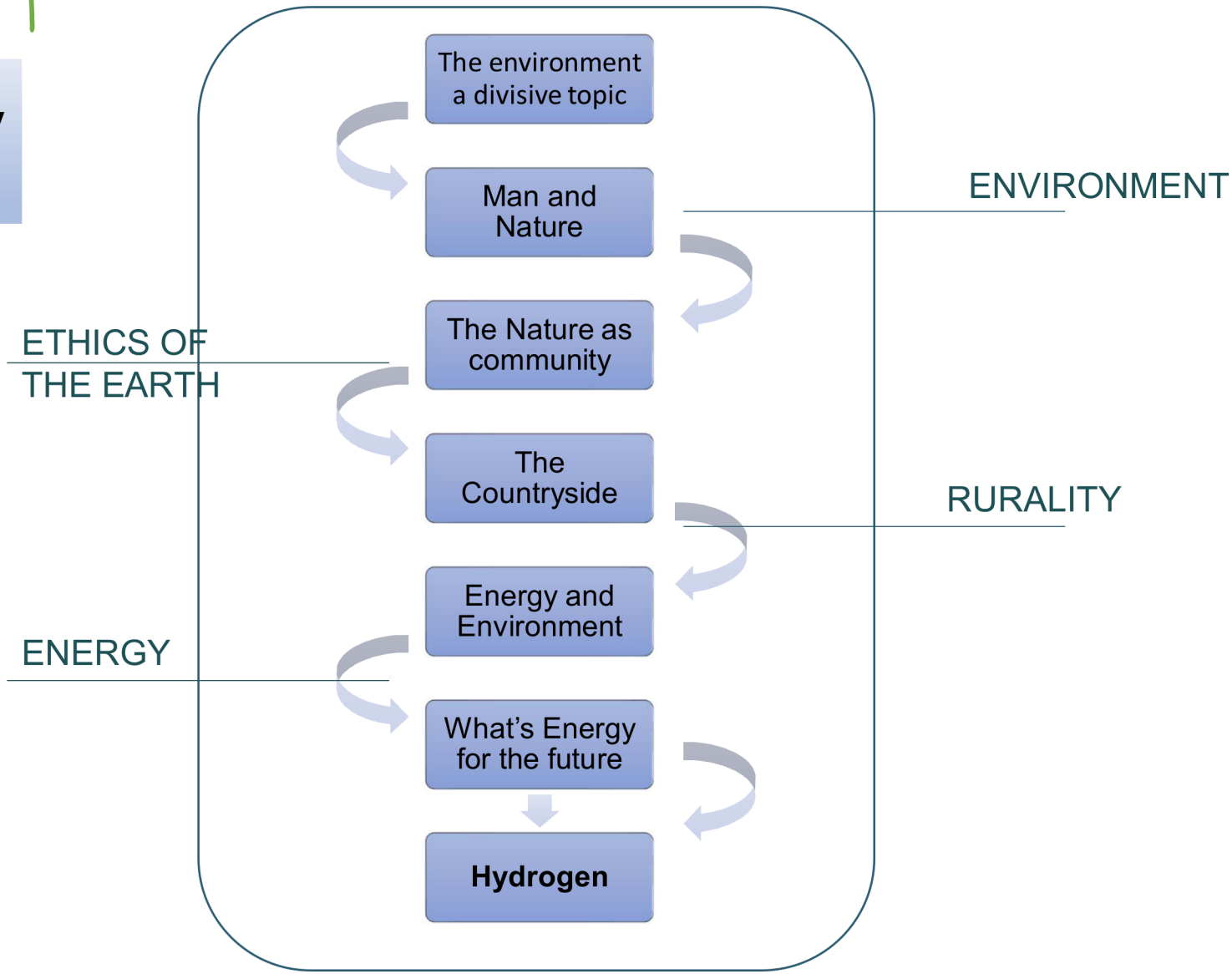
NEW PERSPECTIVES FOR ENVIRONMENT

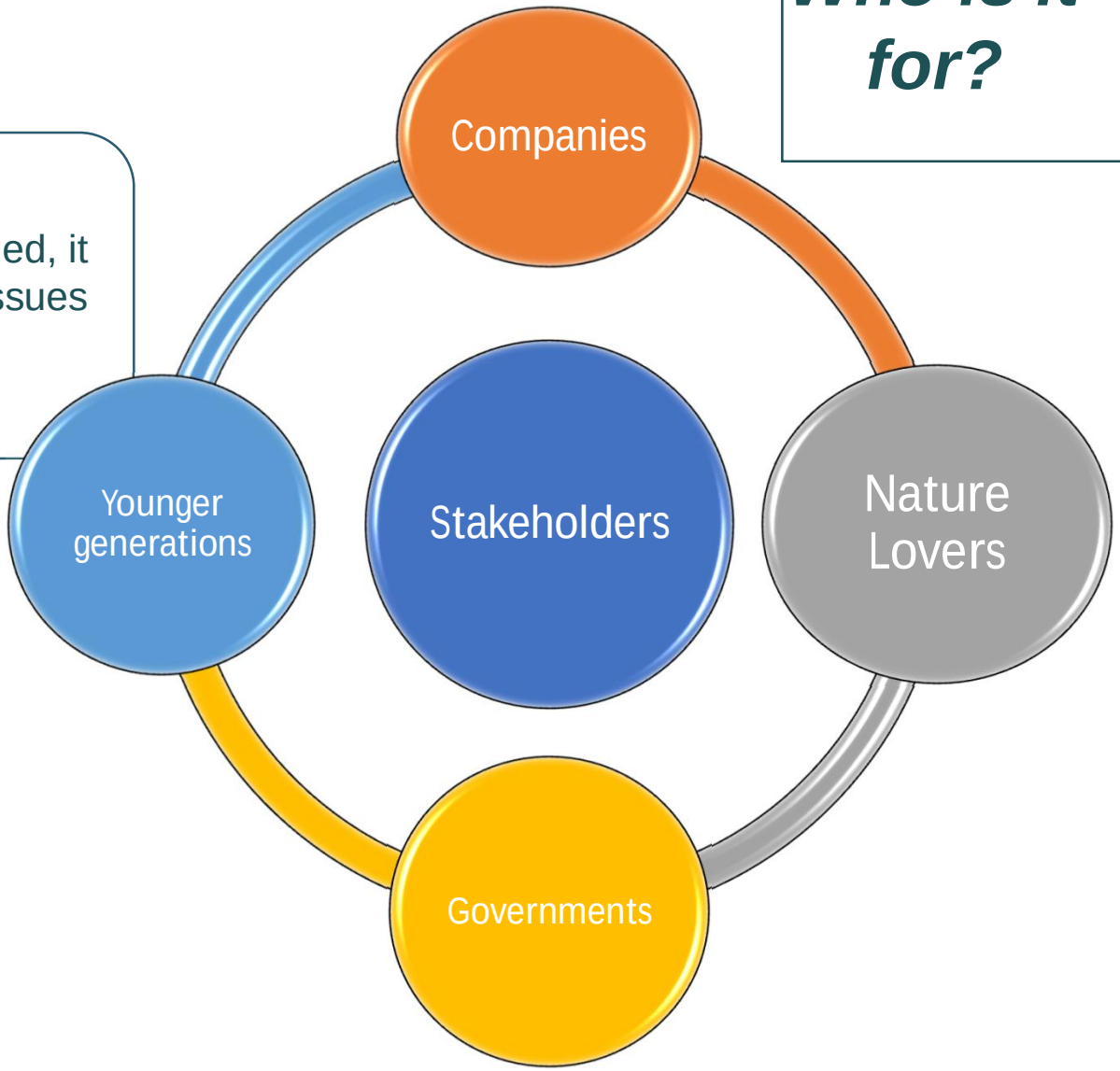
Environmetal & Enegy Challenges in E.U.

Summary



Who is it for?

Once the stakeholders have been identified, it will be necessary to map the critical issues and indicate the priority



The environment a divisive topic

When it comes to nature, there should be no doubt which side to take, on the side of the defense of our common home, instead we are increasingly witnessing fierce disputes between environmentalists and rulers, between the supporters of a catastrophic theory and those which denounce a climate of fear and false alarmism, and the even more amazing thing is that in both groups there can be several of scientists, who with different and sometimes conflicting arguments support their theses.

"Men argue. Nature acts"
Voltaire

Some data….

Water Quality

Dati @2020

- 25% of bathing water in EU are in Italy
- 90% excellent quality
- 98% meets the European standards

Forestes

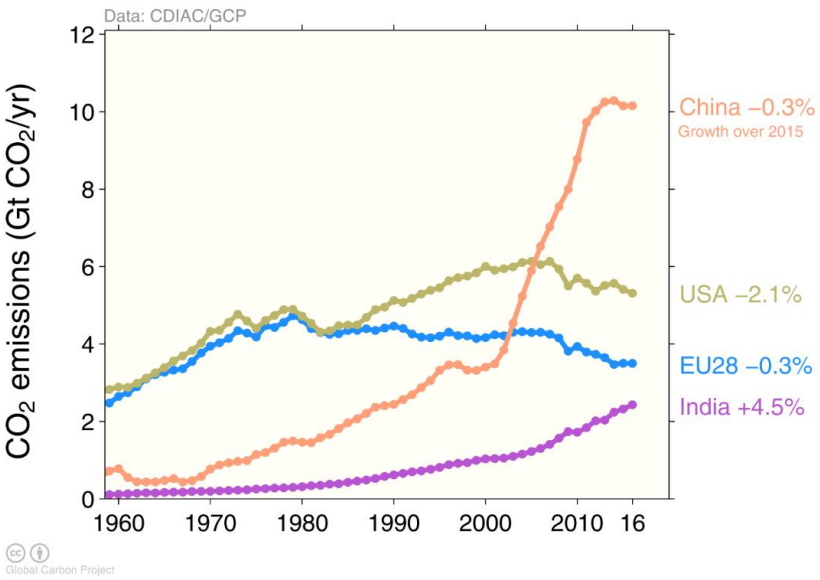
In the last 30 years in Italy;

o The forests increase from 26% to 32%;

↓

<u>The depopulation of mountain areas increases</u>

Global warming ….



- The levels of greenhouse gases reached in last years, in particular CO2, are the highest in the human history.
- It should also be noted that in Europe and in the most industrialized countries there is a significant reduction of these emissions, even China marks a promising negative trend;
- but the question remains because this reduction would seem not to be sufficient to compensate for what has been produced during the last century.

Men and Nature

Today there is the need to recover a healthy and balanced relationship between man and nature, and not, as happens more and more often, to accuse man for natural disasters and identify anthropocentrism as the focus of the ecological and environmental problem.

Photo by F. De Benedictis – Tanzania @2018

The Nature as community

Today nature, apparently deified, finish to be considered as a thing, an object and not a community to which one belongs, forgetting that the environment cannot be saved without saving man, his territory and his historical and cultural community.

A serious environmentalist battle, it would be better to say naturalist, has the obligation to reconsider the centrality of man, *man as guardian* and at the same time an integral part of the great community called Earth

"When we see land as a community to which we belong, we may begin to use it with love and respect." (A. Leopold)

Photo by F. De Benedictis – Tanzania @2018

The Community….

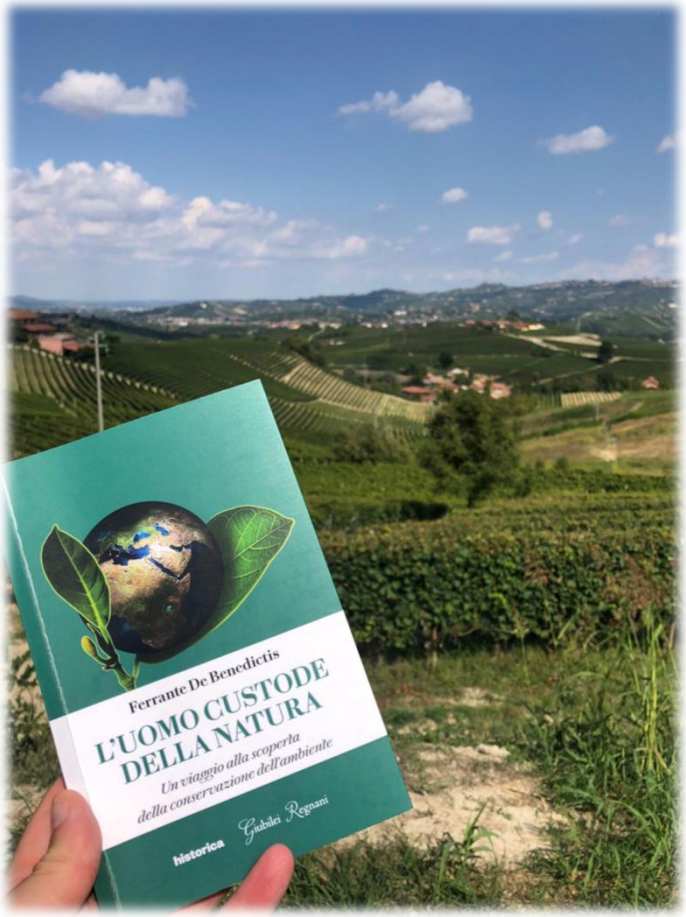
Place of formation of the future generations → Where the concept of ETHICS was born → ***Land Ethic***

Photo by F. De Benedictis – USA @2019

To extend the concept of ethics and community to the earth

The countryside and the rurality

Rural culture, the last witness of that healthy relationship between man and nature, made up of attention to the landscape, places and their beauty that are now in danger forever, for this reason any environmental policy cannot ignore its defense / protection



"the term "countryside" implies a sense of land transformed by work." (G. Tomasi di Lampedusa)

Local economy

- Territorial Economy;
- Short Supply Chain;
- Less resources consumption;
- Care of territory

Countryside & rurality

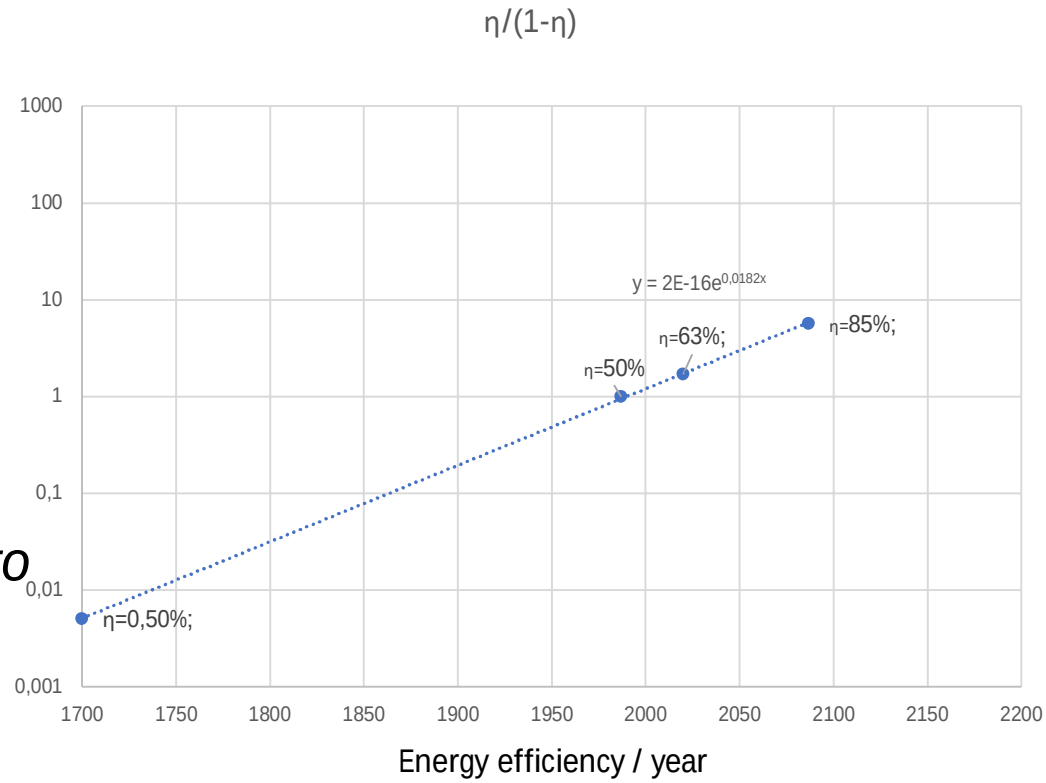
Global economy

- Intensive farming;
- Intensive agricolture;
- Greater consumption of resources;

If the trend of homologation to Western diets by Asian countries and more generally by developing countries is confirmed, in 2050 we will not have enough food to feed intensive farms for meat production

ENERGY and ENVIRONMENT

Speaking of the environment, it is impossible not to mention Energy, in fact not only the economic and social future of our planet will depend on energy choices, but also and above all the direction of sustainable development and environmental protection that we intend to undertake.



The term Energy is a Greek term << ἐνέργεια >> which only appeared in the English language in the 17th century.

ENERGY

During the twentieth century, the energy consumption grew to reach 3.7 toe per year in 1990 and then drop below 3 in 2017.

2,5-2,6 milion years ago

- 0.11 toe/year

500 thousand years ago

- 0.22 toe/year

1000 al 3550 b. C. (Neolithic)

- 0.45 toe/year

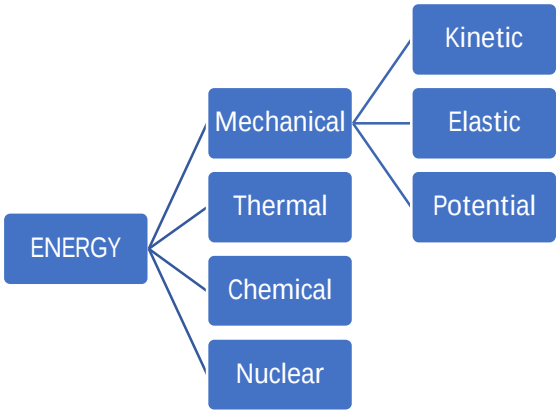
I century a. C. (Roman times)

- 0.50 toe/year

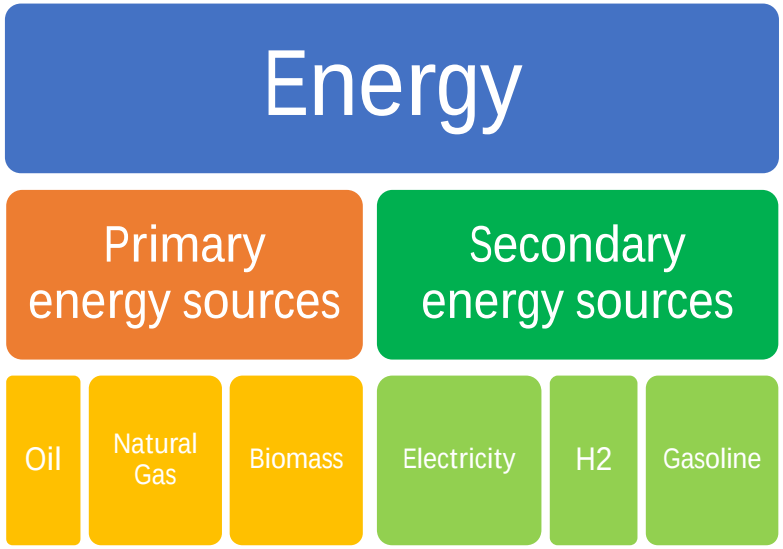
1800 - 1900

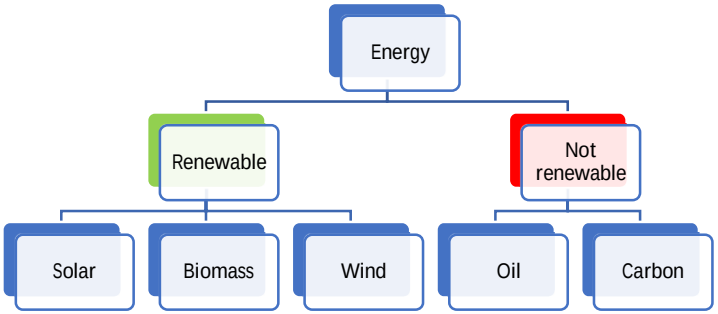
- 0.5 toe → 2.8 toe / year

ENERGY FORMS & CHANGES



Energy Forms

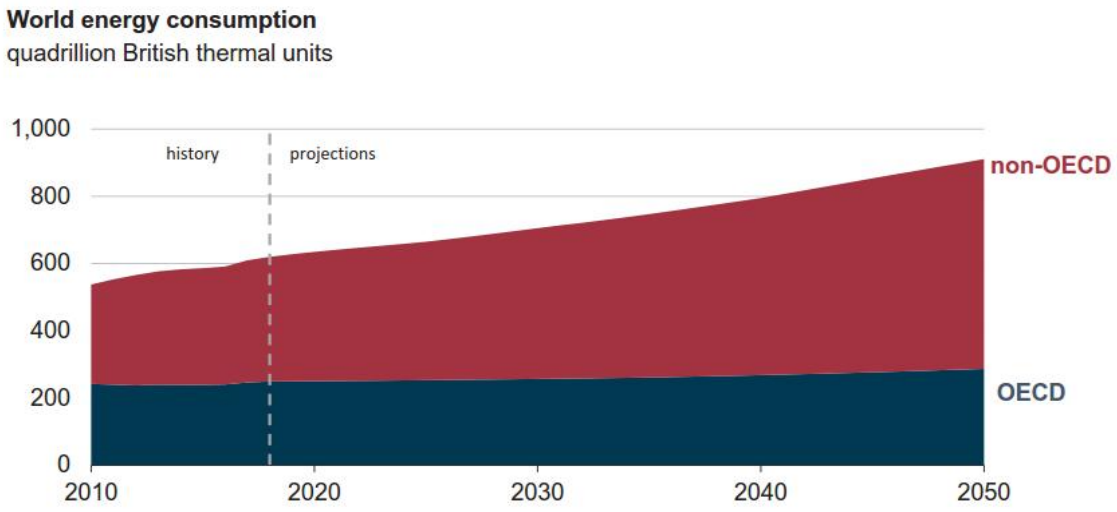




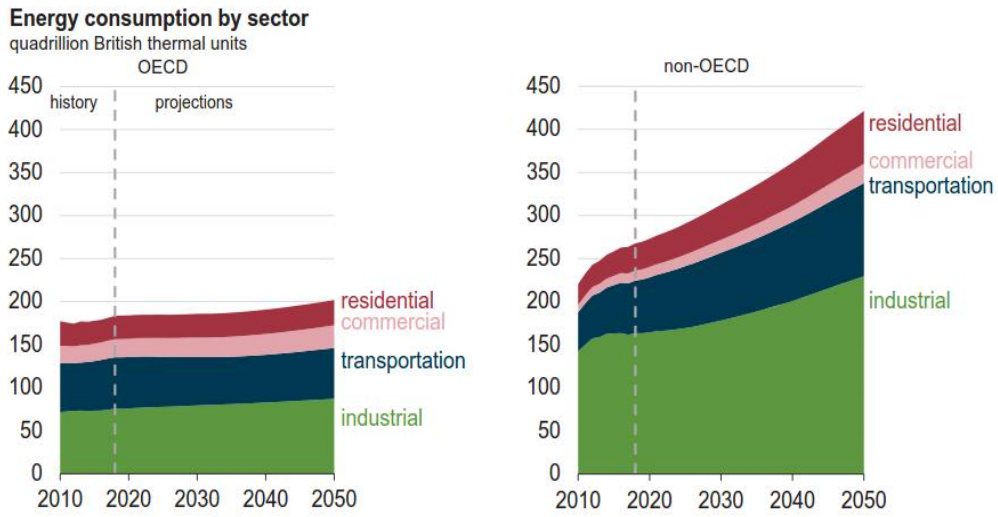
Energy Sources

ENERGY CONSUMPTION @2020-2050

World energy consumption



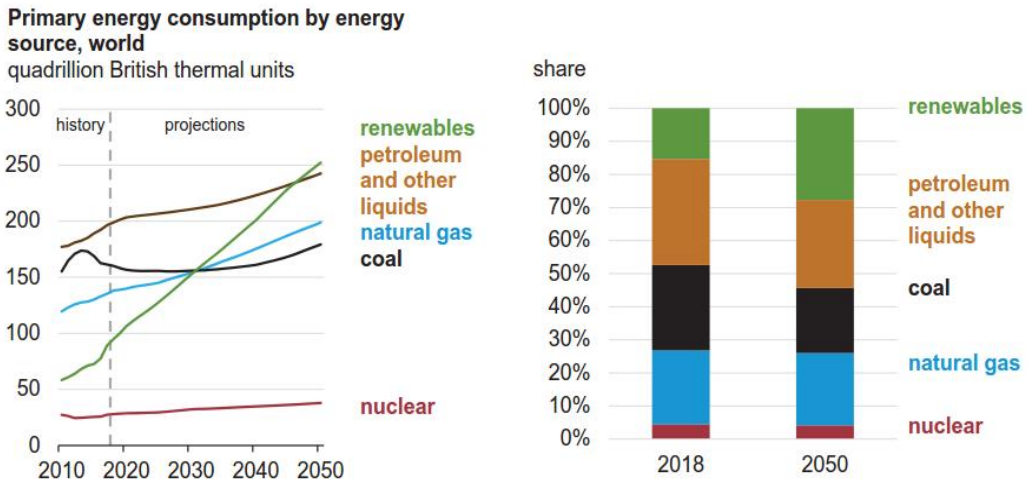
Energy Consumption by sector

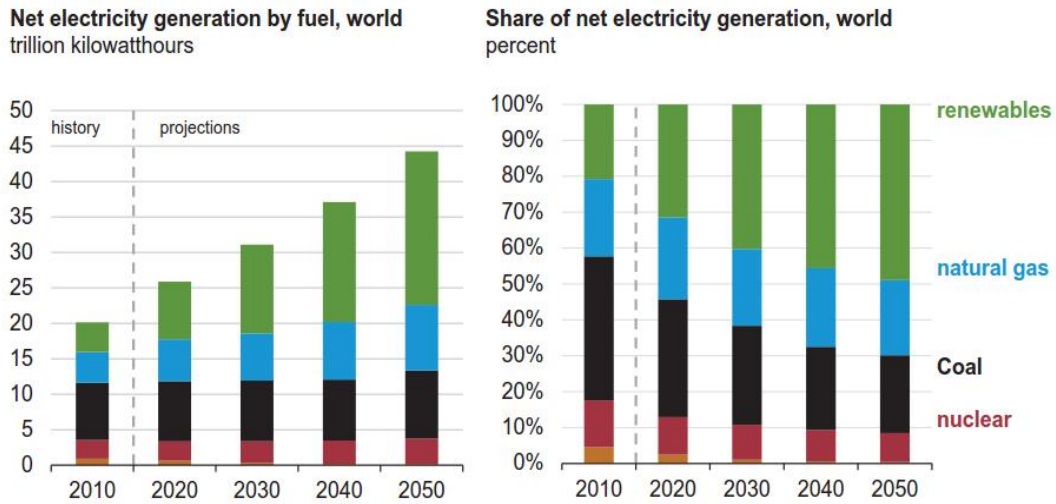


PRIMARY ENERGY CONSUMPTION @2020-2050

Primary Energy consumption by energy source

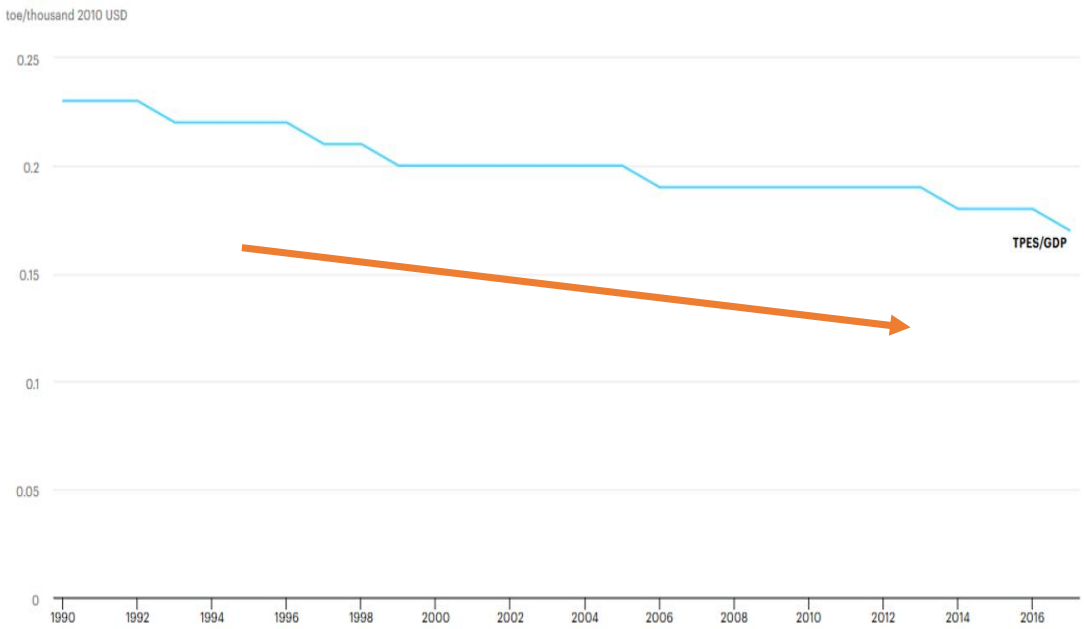
Net electricity generation



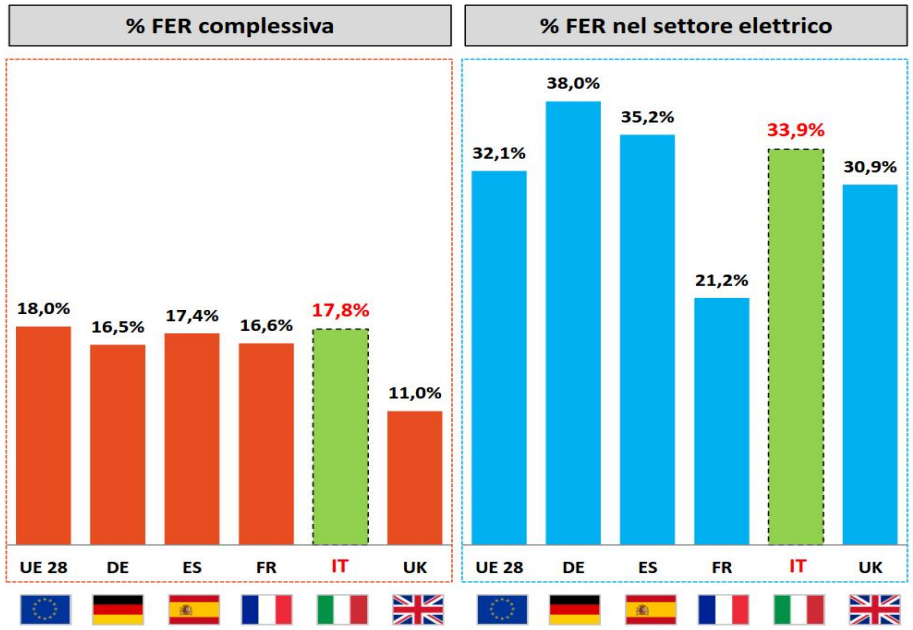


Efficiency and Renawable Energy

Energy dematerialization



Renawable Energy in EU



European Union on Hydrogen

Phase 1
2020-2024

- the objective is to decarbonise existing hydrogen production for current uses. This phase relies on the installation of at least 6 Gigawatt of renewable hydrogen electrolysers in the EU by 2024 and aims at producing up to one million tonne of renewable hydrogen. In comparison to the current situation, approximately 1 Gigawatt of electrolysers are installed in the EU today.

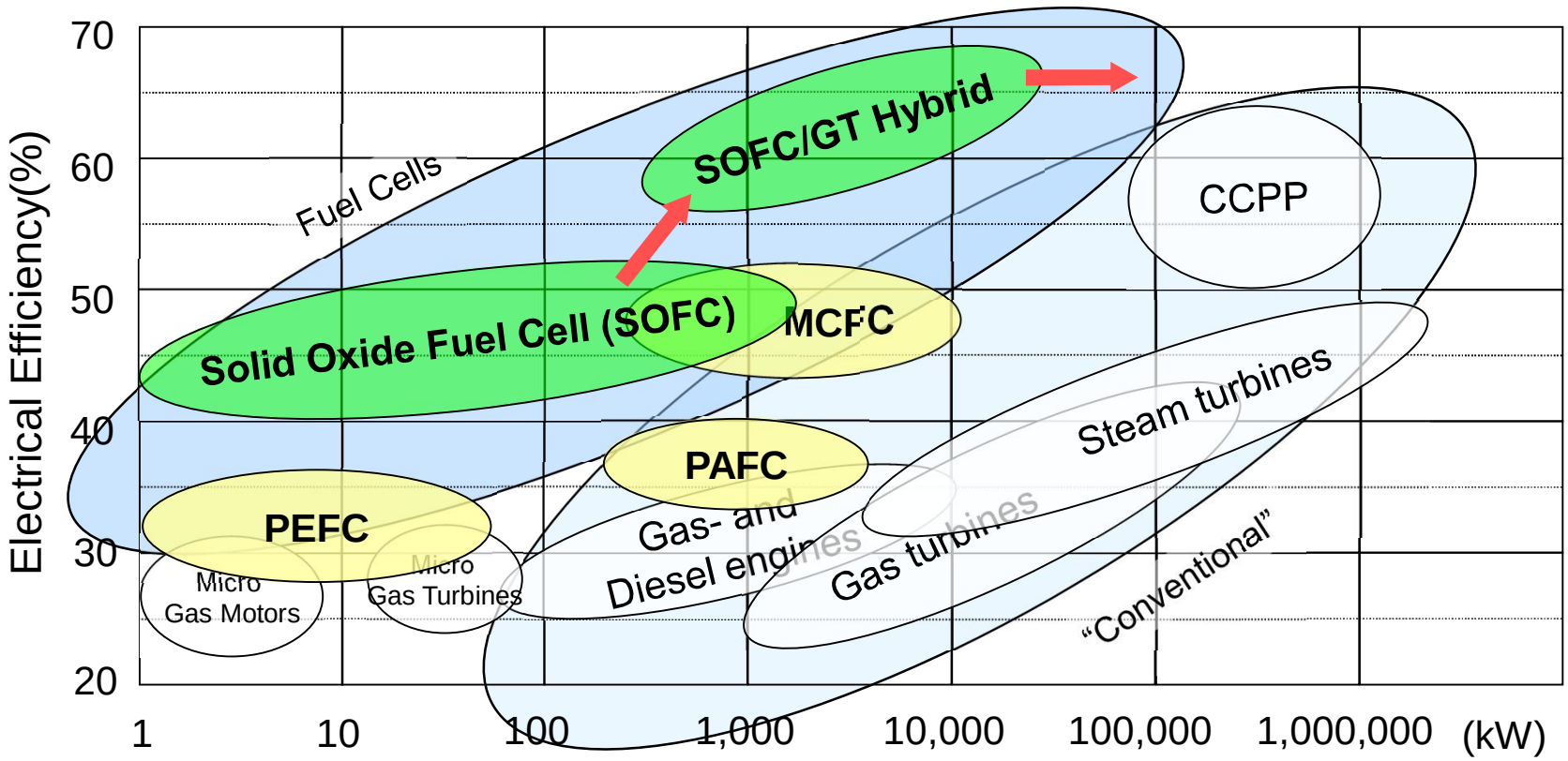
Phase 2
2024-2030

- hydrogen needs to become part of an integrated energy system with a strategic objective to install at least 40 Gigawatt of renewable hydrogen electrolysers by 2030 and the production of up to ten million tonnes of renewable hydrogen in the EU. It will still mainly be produced close to the user or close the renewable energy sources, in local ecosystems.

Phase 3
2030-2050

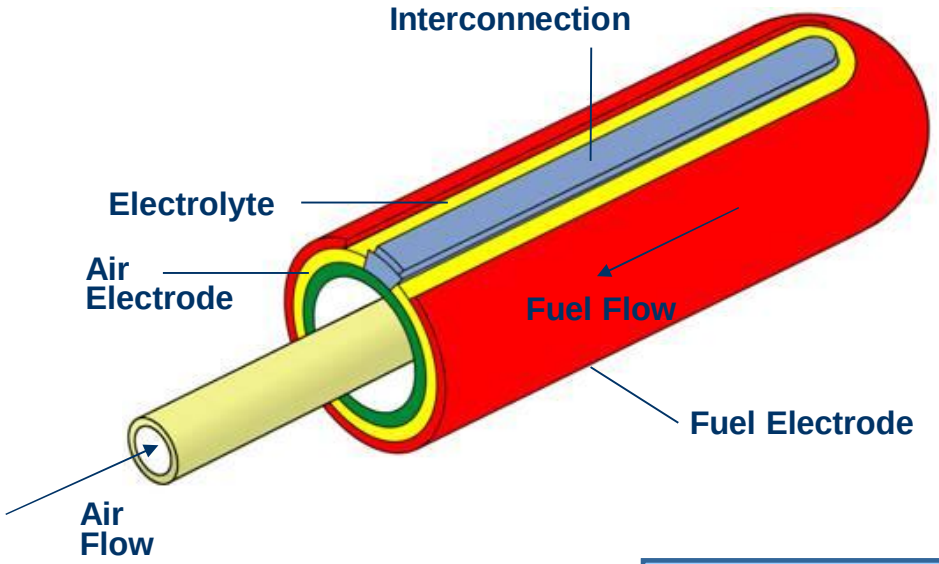
- renewable hydrogen technologies should reach maturity and be deployed at large scale to reach all hard-to-decarbonise sectors where other alternatives might not be feasible or have higher costs.

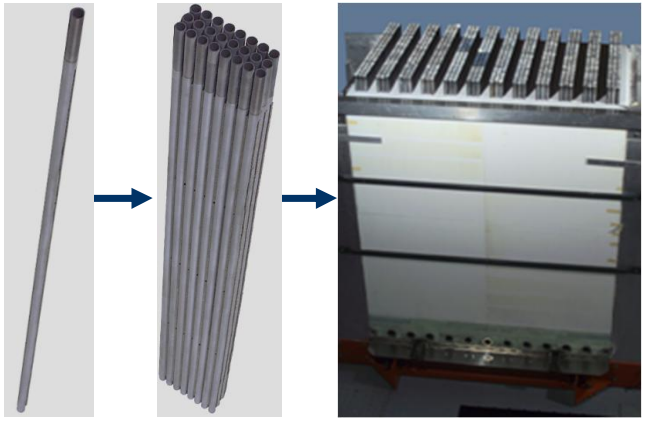
Efficiency potential of various PG techniques



Today SOFC Technology already achieves highest electrical efficiencies in the mid to lower power rating range and has the potential to be advantageous versus central power generation in the future.

SOFC Tubular Technology





Cell *110 W* → Bundle *3 kW* → Stack *125 kW*

Performance of SOFC technology proven by:

- **Single cell tests over 69,000 hrs**
- **Voltage degradation < 0.1% per 1000 hours**
- **Thermal cycle capability of > 100 cycles**
- **Complete system operating hours > 50,590 and counting**

Hydrogen in standard applications

- Hydrogen-fueled turbines using concentrations ranging from 5% to 95% (by volume)
- This includes synthesis gas (syngas), a variety of steel mill gases (i.e. coke oven), and refinery off-gases
- The use of hydrogen as a gas turbine fuel has been demonstrated commercially, but its use in a gas turbine has challenges with regards to combustion and safety
- Differences in the combustion properties of high hydrogen content fuels and their impact to all gas turbine systems as well as the overall balance of plant, must be considered
- Changes may be needed to the fuel accessories, bottoming cycle components and plant safety systems

- Gas turbines can be configured to operate on high hydrogen content mixtures:
  - As a new unit,
  - Or be upgraded even after extended service on traditional fuels

- The scope of the required modifications to configure a gas turbine to operate on hydrogen depends:
  - On the initial configuration of the gas turbine
  - On the overall balance of plant
  - On the desired hydrogen concentration in the fuel

Hydrogen: combustion challenges

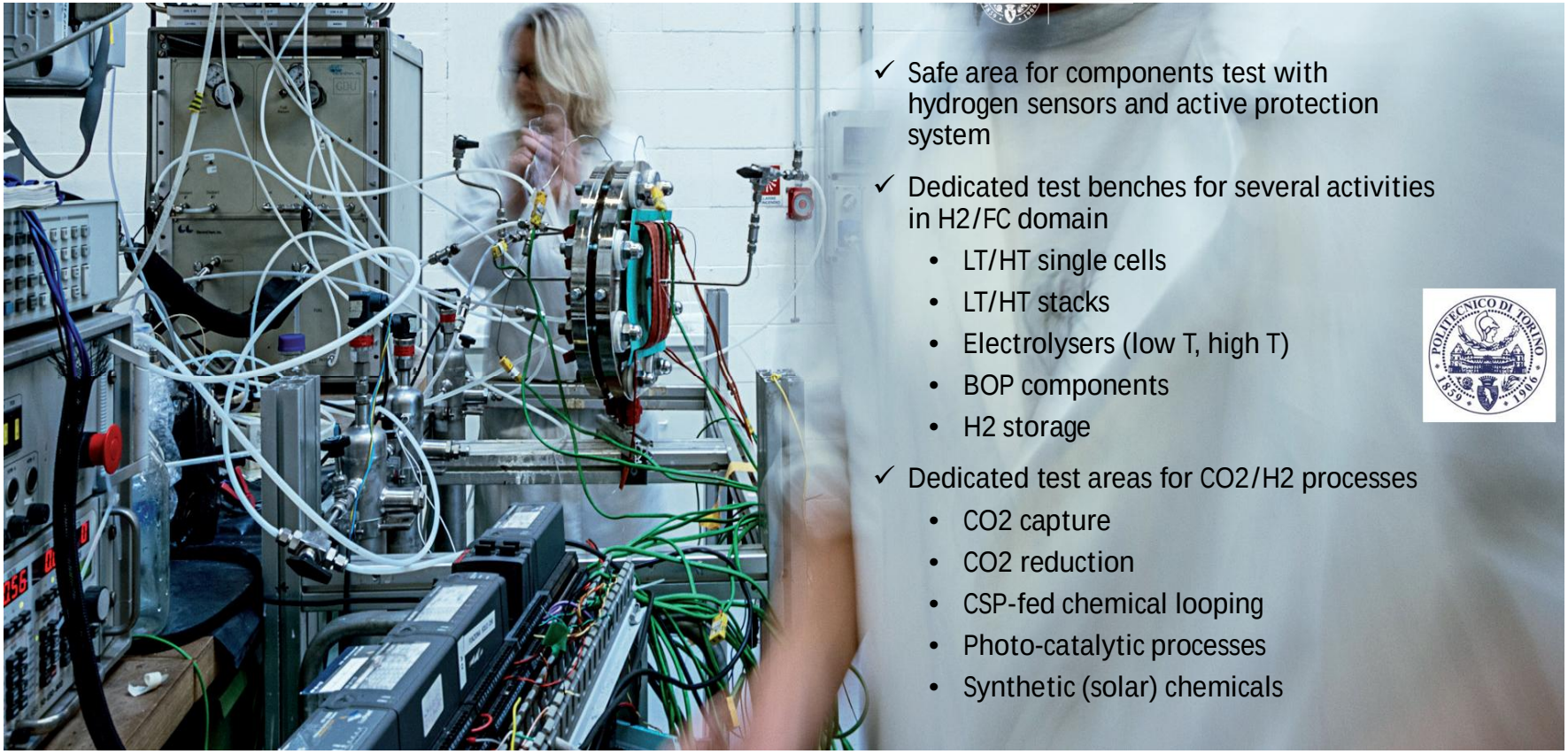
H2 high flammability and very low density; it especially affects DLN systems where flow velocities in the primary area of the combustion section are lower

Safe production, handling and use of hydrogen. The main concern in working with hydrogen is flammability due to low-energy ignition, wide range of combustible fuel-air mixtures

H2 leaking as a gaseous fuel and its ability to embrittle metals must be accounted for to ensure safe operation

NOx emissions

Hydrogen: research programs

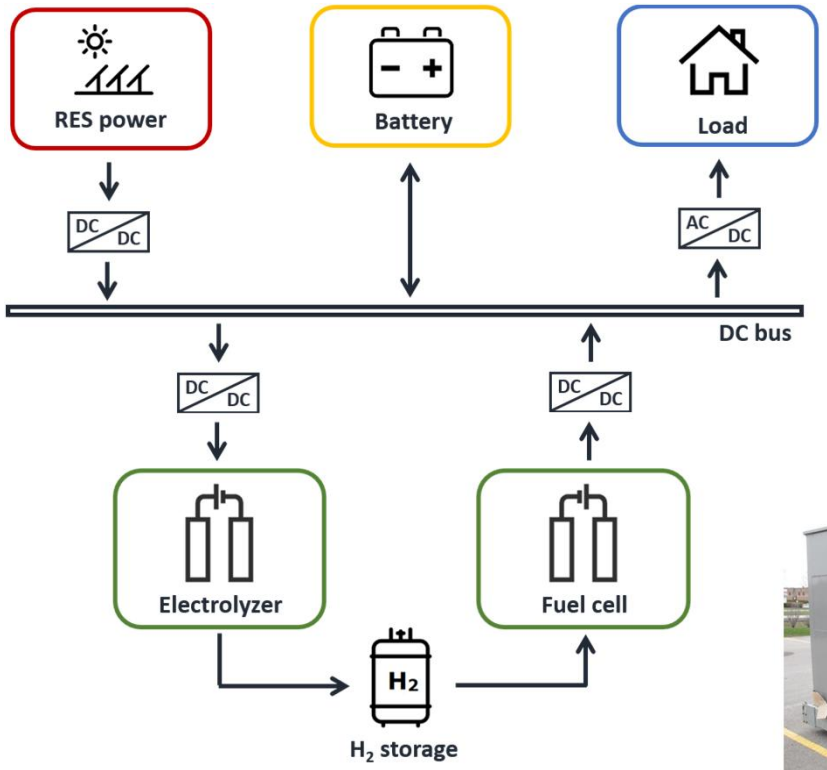


- ✓ Safe area for components test with hydrogen sensors and active protection system
- ✓ Dedicated test benches for several activities in H2/FC domain
  - LT/HT single cells
  - LT/HT stacks
  - Electrolysers (low T, high T)
  - BOP components
  - H2 storage
- ✓ Dedicated test areas for CO2/H2 processes
  - CO2 capture
  - CO2 reduction
  - CSP-fed chemical looping
  - Photo-catalytic processes
  - Synthetic (solar) chemicals

OPEN RESEARCH LABORATORIES, also in cooperation with IIT and Environment Park

H2 based power to power system

General configuration of a hybrid stand-alone P2P system:

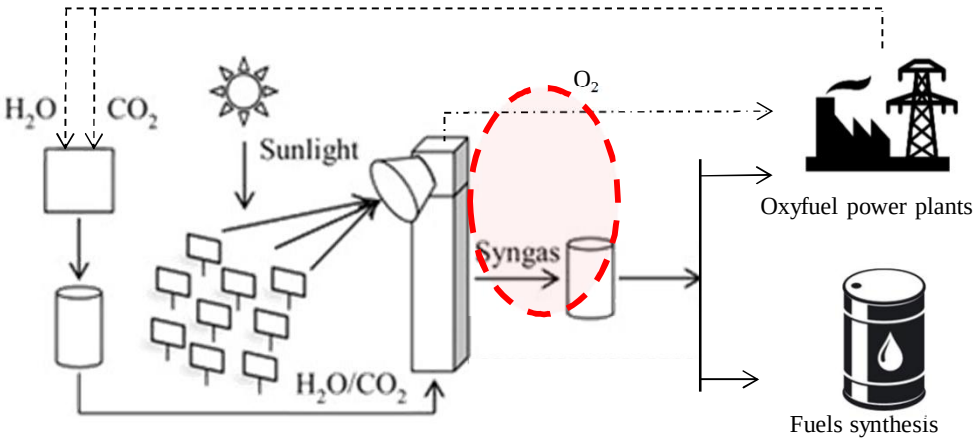


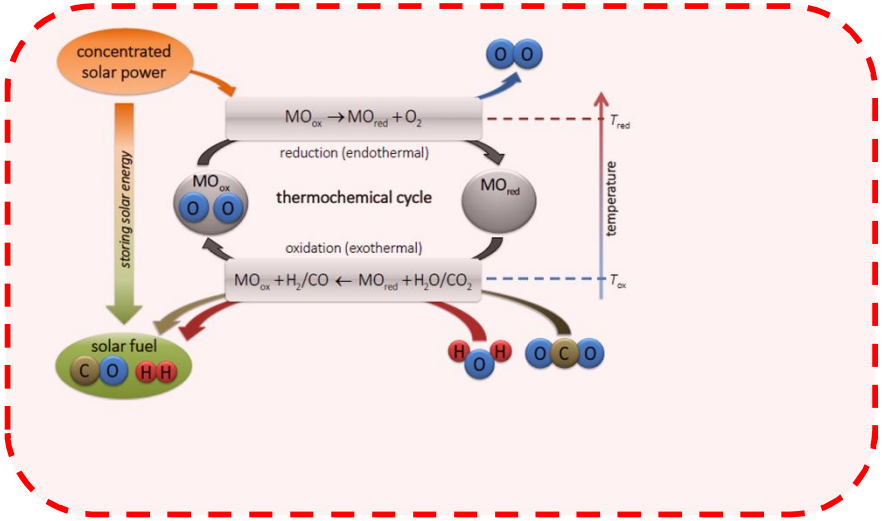
- **Electrolyzer**: converting the excess of RES power into H_2
- **Fuel cell**: re-converting the stored H_2 into electricity when a RES power deficit occurs
- **Battery**: support for the system operation and daily energy buffer
- **Converters**: to make the different sub-systems to exchange the correct amount of energy

CSP-fed chemical looping for H2O/CO2 splitting

Converting emissions (CO_2/H_2O) into fuels through solar energy. Solar thermo-chemical looping (STC) cycles of redox materials (metal oxides so far) that can act as oxygen carriers for the thermochemical cycle.

The process is enhanced by biomethane injection

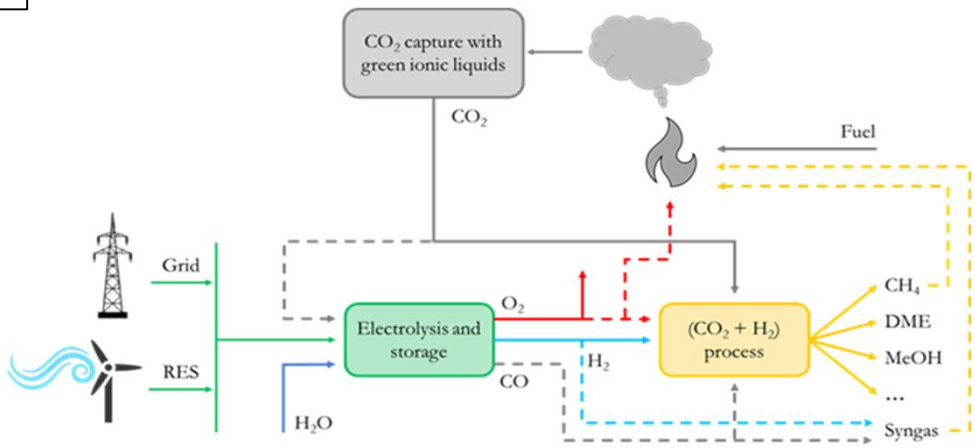


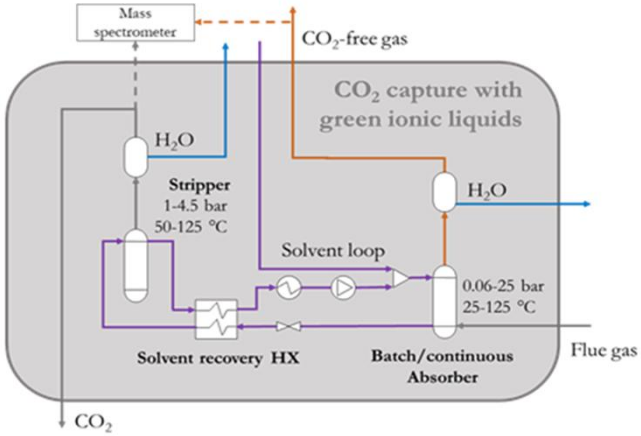


CO2 recovery

CO_2 Capture

- Bench for the study of CO2 absorption and release in liquid systems (HEL)
- Measurement bench for gas permeation (in particular CO2) in membranes
- CO2 recovery test bench for absorption in ionic liquids (synthesis and characterization)
- CO2 recovery test bench for absorption in ionic liquids (test)
- Benches for ultrafiltration and centrifugation of materials deriving from biomass treatment processes, for recovery of useful materials and CO2 recovery

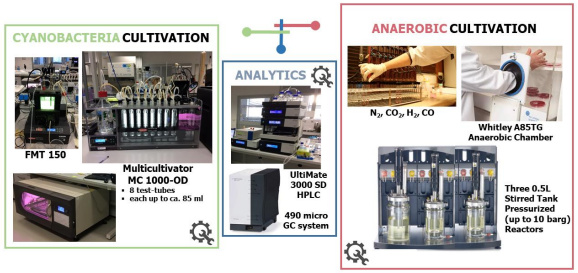


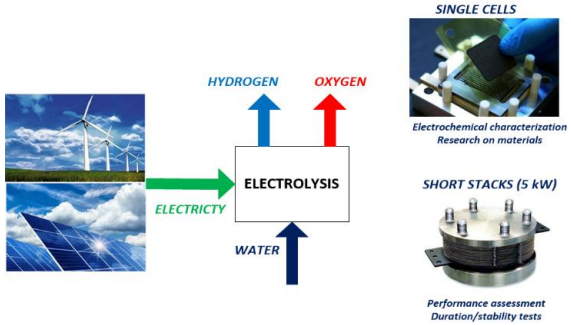


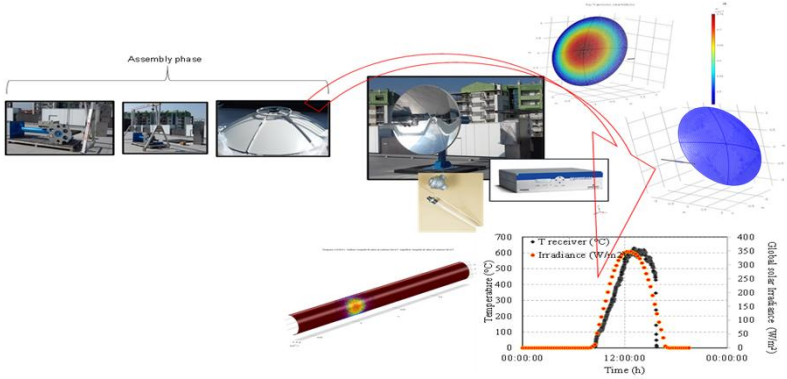
H2 for CO2 re-utilization

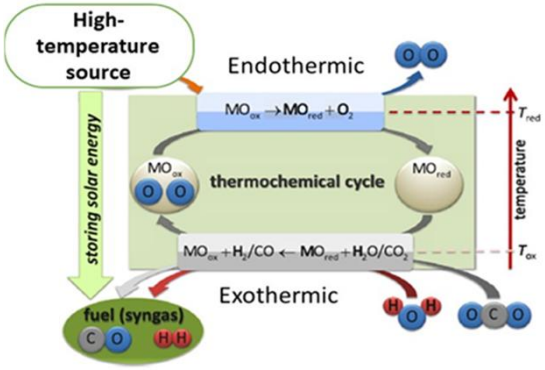
Hydrogen for CO2 re-utilization

- Modular and high precision anaerobic cultivation of bacteria
- Test benches for photo / electro, thermo activated CO2 reduction and chemical composition analysis
- CO2 and H2O reduction benches for thermo-catalytic hydrogenation
- Benches for H2 production by electrochemical way (high and low temperature) for CO2 hydrogenation
- Benches for thermo-catalytic processes for power-to-fuels processes and power-to-chemicals processes from CO2
- Benches for direct H2O / CO2 reduction in syngas by chemical looping









CONCLUSIONS

In order to be effective, future energy policy choices, must first of all guarantee: economy, safety and sustainability;