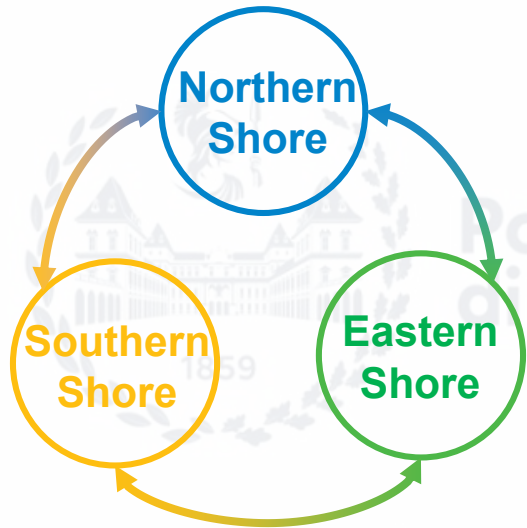


# The three triangles for energy in the Mediterranean

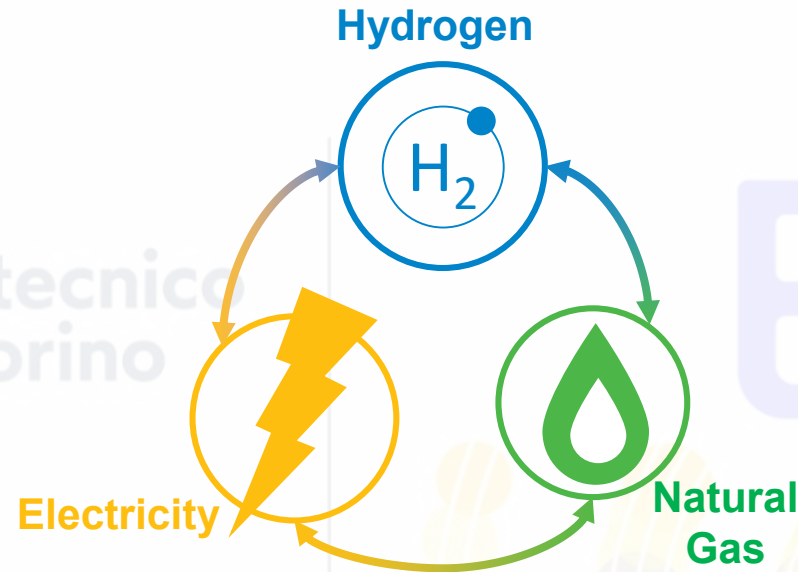
E. Bompard

14 October 2022

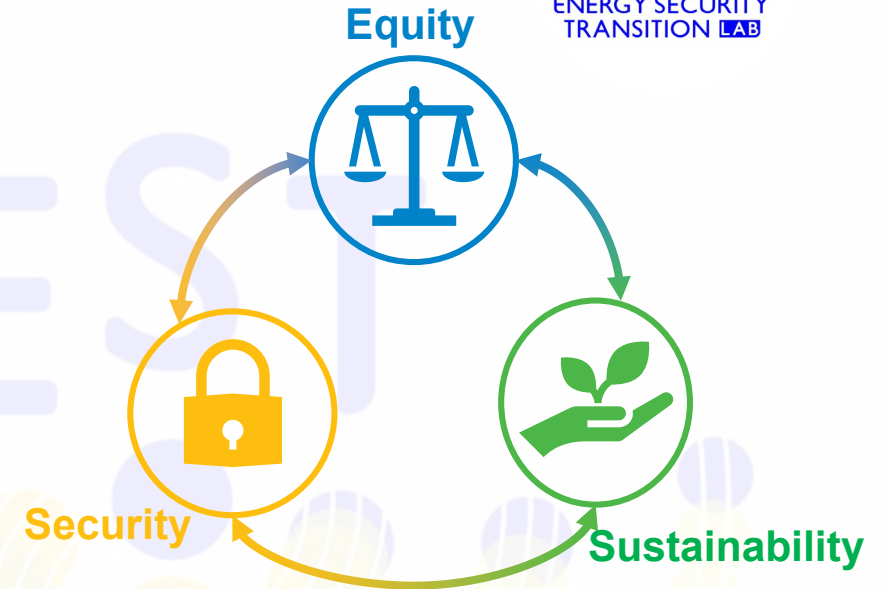
# The triplet of triangles



**The Geographical Triangle**



**The Commodity Triangle**



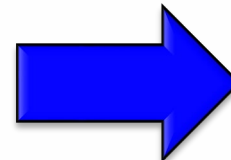
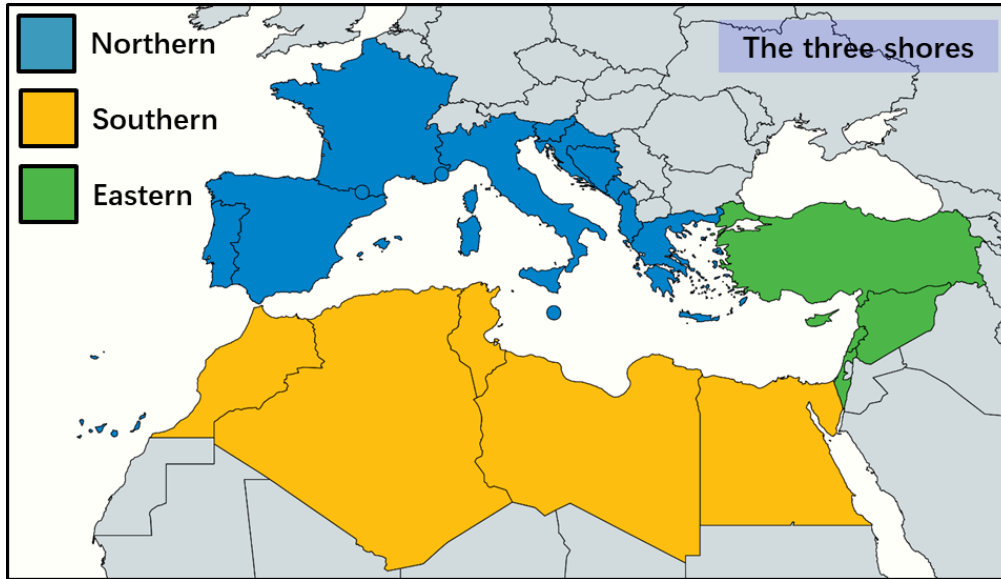
**The Energy trilemma from the World Energy Council**

- The need for the **decarbonisation** of the energy system implies an energy transition towards renewables → a radical **change** of the current **energy dialogue** (based on fossils) in the Mediterranean region
- This **transition**, however, **cannot be conflicting with** the **social** and **economic development** of the region



- **Interaction** among a **triplet** of **triangles**: **geography**, **attributes** and **commodities**

# The geographical triangle



Different **socio-economic conditions**. Northern shore has:

- high economic development and welfare
- higher per capita energy consumption
- lower energy intensity (→ higher efficiency and better use of energy)
- higher promotion of RES exploitation, despite a lower potential

N: 40.8%			S: 36.2%			E: 23.0%			Population: 512 M pers.																																				
									EU 209 NA 185 ME 118																																				
<table border="1"> <tr> <td colspan="3">N: 75.5%</td> <td colspan="3">S: 7.4%</td> <td colspan="3">E: 17.1%</td> </tr> <tr> <td colspan="3">GDP p.c.: 34,856 \$/pers.</td> <td colspan="3">GDP p.c.: 3,865 \$/pers.</td> <td colspan="3">GDP p.c.: 13,949 \$/pers.</td> </tr> <tr> <td colspan="3">WGI Index: 67.6</td> <td colspan="3">WGI Index: 26.7</td> <td colspan="3">WGI Index: 41.6</td> </tr> </table>									N: 75.5%			S: 7.4%			E: 17.1%			GDP p.c.: 34,856 \$/pers.			GDP p.c.: 3,865 \$/pers.			GDP p.c.: 13,949 \$/pers.			WGI Index: 67.6			WGI Index: 26.7			WGI Index: 41.6			GDP: 9,646 billion \$									
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# The triangle of attributes



- The dimension of **energy security** is the ability to ensure the availability of energy - in its various forms and for its various uses - in the needed quantities and where it is required, in the short, medium and long term



- The dimension of **environmental sustainability** concerns the capability to meet current energy needs and ensure future ones without compromising primary goods



- The **equity** dimension measures the capability of a country to guarantee market-based access to energy commodities for the population and the industrial sector

The 3 attributes can be **consistent** or **conflicting** with each other





Relevance of


- simultaneously considering their **interdependencies** when possible scenarios are analysed
- **quantitatively assessing** them and **track** their time **evolution** through specific metrics and indicators
- **political strategic choices** for finding the **right balancing** among them, given the extreme difficulty of maximising them simultaneously

# The triangle of attributes – Figures for the Mediterranean

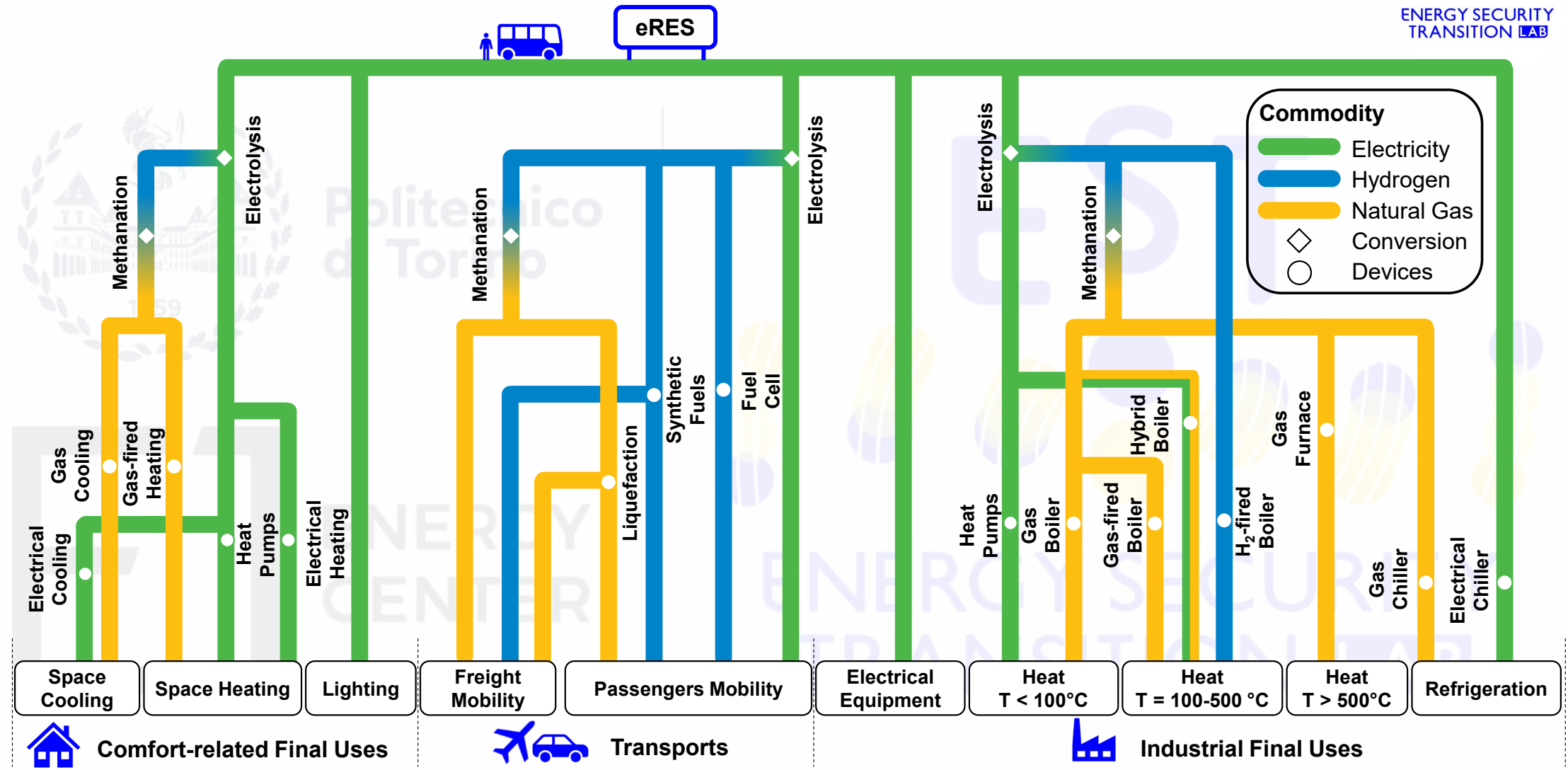


- 
- Majority of **fossil fuel production concentrated in** limited (often **unstable**) **areas**, while a large part of the most **developed countries** has a **high energy import dependence**
  - In the **Mediterranean: net exporters** of fossil fuels in the Southern shore (in particular, **Algeria** and **Libya**); **high dependent countries** in the Northern shore (import dependency in 2018: 73.8% for **Spain** and 77.6% for **Italy**, while 47.0% for France, due to the relevance of nuclear energy)

- 
- Greenhouse Gases (**GHG**) and air **pollutant emissions** widely **due** to the **energy sector**
  - In the **Mediterranean**, in 2018 **CO2 emissions** = 2021.4 Mt (**6%** of **world** total)
  - Wide **variability** among countries, between 1.50 ton/(person·y) for Albania and 6.83 ton/(person·y) for Libya
  - Average CO2 emissions p.c. in the Mediterranean: 3.89 ton/(person·y) (global value: 4.41 ton/(person·y))

- 
- Allocation of **finite resources**, with a distribution directly related to **willingness** (and **capability**) **to pay**  
→ possible social tensions and **energy poverty**
  - In the **Mediterranean**, the **TPES per capita varies** from 23.9 GJ/(person·y) (**Morocco**) and 25.6 GJ/(person·y) (Syria) to 153.7 GJ/(person·y) for **France**
  - **Access to electricity**: 100% in the majority of Mediterranean countries, but **lower values** in **Syria** (89.3% in 2019) and **Libya** (68.5%)

# The commodity triangle – «RES Energy underground»



**Commodity**

- Electricity
- Hydrogen
- Natural Gas
- Conversion
- Devices

**Comfort-related Final Uses**

**Transports**

**Industrial Final Uses**

# The commodity triangle – Gas



## THE PRESENT: NATURAL GAS

- Mediterranean proved natural gas **reserves** (2021): **6.75 Tcm** (2.28 Tcm in Algeria, 2.14 Tcm in Egypt, 1.43 Tcm in Libya and 0.59 in Israel)
- Gas from relevant offshore reserves in the “**Levantine basin**” (between Israel, Egypt and Cyprus) could be delivered to the Northern shore if the **Eastmed** pipeline, passing through Cyprus and Greece to Italy, will be built
- **3 gas pipelines** (capacity: 51.5 bcm/y) from Southern shore (Algeria and Libya) to the Northern coast: Medgaz (Algeria→Spain); Transmed (Algeria→Italy); GreenStream (Libya→Italy) + **1 pipeline crossing the Mediterranean**: TAP (Azerbaijan→Italy; capacity: 10 bcm/y)
- **21 LNG terminals** in the Mediterranean basin (5 liquefaction plants on the Southern shore, capacity: 55.6 bcm/y; 16 regasification plants, capacity: 116.4 bcm/y)
- **Key role of Algerian** natural gas in facing supply issues related to the crisis between Russia and Ukraine for **Italy** (+9 bcm/y) → Algeria is currently the main gas supplier of Italy



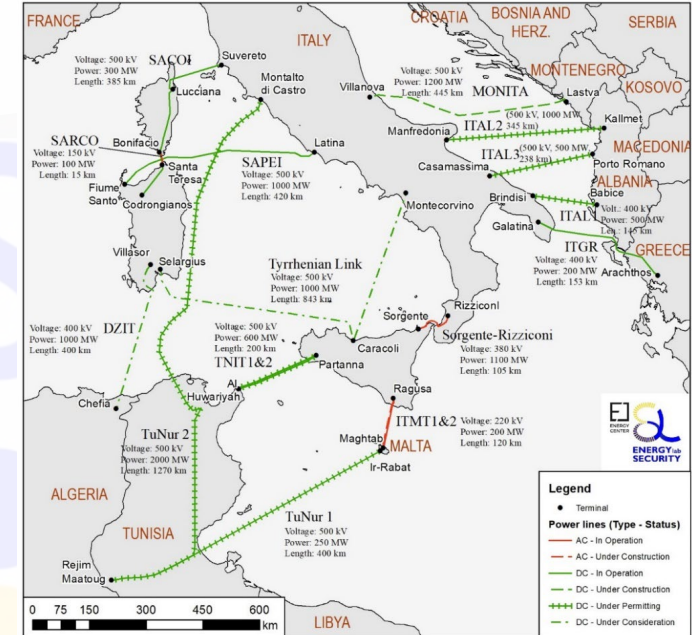
## THE FUTURE: BIO/SYNGAS?

- In the future, **natural gas** could be partially **substituted** by:
  - **biogas** produced through methanation processes, from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, food waste, ...
  - **synthetic** natural gas (SNG) obtained by power-to-gas process from hydrogen. Another emerging application is the so-called “windgas”, in which green hydrogen or methane are locally produced by the coupling between wind farms and power-to-gas systems

# The commodity triangle – Electricity



- **North Africa** has **low electrification** rates (12.3% Algeria, 14.0% Libya in 2019); only Egypt (22.1%) is comparable with Southern Europe (21.3% Italy, 24.7% France, 23.6% Spain)
- The **penetration of RES in electricity generation is low** on the **Southern shore** almost zero in Libya, 1% in Algeria, 4% in Tunisia, 9% in Egypt, 19% in Morocco, while in Europe (except France) it is generally > 25% (in Italy about 35%)
- Thanks to the **high potential of Southern shore**, electricity from RES could play a role in building a **new energy dialogue** between across the Mediterranean, but **investments in new infrastructures** are needed:



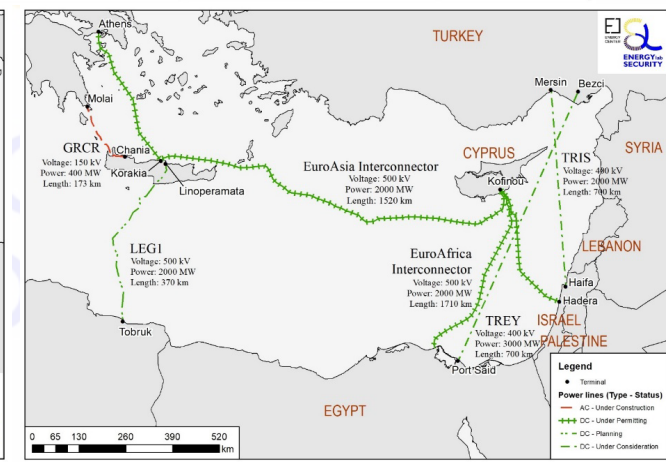
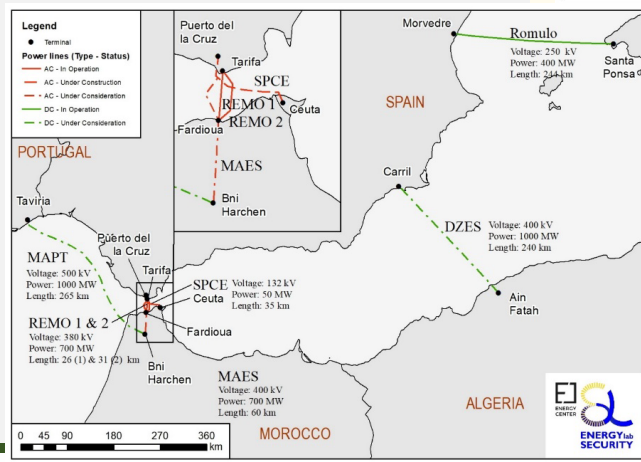
## Current Lines:

- 10 in operation; total capacity = 5 GW

## Future Lines:

- 3 under construction
- 9 under licensing
- 1 planned
- 7 under discussion

Total Capacity = 20.8 GW  
Investments = 21 G€





# The commodity triangle – Hydrogen



- Green hydrogen produced through electrolysis using electricity from RES can **support** the **decarbonization** of **hard-to-abate sectors**
- The adoption of a **cooperative approach** in supporting hydrogen penetration can **enhance** the **socio-economic development** of the Eastern and Southern countries, by creating a **new industrial chain** and new **job positions** → improvement of living conditions, reduction in migration flows, possible stabilization of the area
- This could **counteract** the negative **economic effects** related to the transition from fossils to RES, particularly in **countries** that **strongly rely on oil** and **gas** industry (like Algeria and Libya)
- The role of **Critical Raw Materials** in hydrogen technologies, however, require **careful analyses** on the possible critical **geopolitical dependencies** that can arise
- **Existing** natural **gas interconnections** may **support hydrogen penetration** and the creation of a Mediterranean hydrogen market. Hydrogen-natural gas blends up to 20% are recognized as feasible, but a European-wide consensus between gas sector stakeholders needs to be reached in order to change technical regulations and standards
- Already at **5% hydrogen blending**, the overall power transfer in form of hydrogen is **comparable** to the capacity of about **2 HVDC connections**
- Regarding **Italy**, the **maximum** potential **import** of **hydrogen through** gas **pipelines** could be of 33.7 TWh/y (about **2.5%** of the **total final** energy **consumption** of Italy in 2019)

- The energy transition in the Mediterranean area requires a **new energy dialogue**, based on RES
- **Electricity from RES** could not ensure the complete decarbonisation of the energy system by itself, but an **interplay with other hydrogen and gas** (both natural gas and synthetic gas) will be probably needed
- The **composition** of the **mix** in each country is however **influenced** by **several factors**: it should reflect the **needs** of the **industrial players** and it has to consider the **socio-economic peculiarities** → need for **ad hoc policies** on the 3 shores
- **Each country**, has to **identify** its **priorities** w.r.t. the **3 attributes** (security, equity and sustainability), **difficult to be maximised** at the same time, since they can be **consistent** or **conflicting** each other → **possible barriers** and need for **strategical** political and investment **choices**
- In this **multi-commodity framework**, the possibility to transport large amount of energy through different energy vectors allows for **exploiting existing infrastructures** and to **diversify** the **energy flows** among the three areas → possible benefits in terms of **energy security**
- From the **industrial perspective**, the presence of a well-established (even though young) industrial sector related to **RES exploitation** and **hydrogen** production in **the Northern shore** could represent a **flywheel** for the whole **Mediterranean** region, and the **installation** of **production** sites in **Eastern** and **Southern countries** and the knowledge transfer process could help in improving the economic and development conditions of these areas
- However, a **collaborative industrial dialogue** among the 3 shores , **based on an overarching political one**, may help the Mediterranean industries to find a strong **positioning** in the **global market** and to enhance their competitiveness

# ENEMED – MED & Italian Energy Report



## MED & Italian Energy Report

Energy sources, flows and strategies of Italy between Europe and the Mediterranean

1<sup>st</sup> Annual Report



Natural Gas



## MED & Italian Energy Report

Fostering renewables for new Euro Mediterranean cooperation  
A look to a post-pandemic green future: electricity and the emergence of gas and hydrogen synergies  
The map of existing and potential open-sea energy flows

2<sup>nd</sup> Annual Report



Electricity



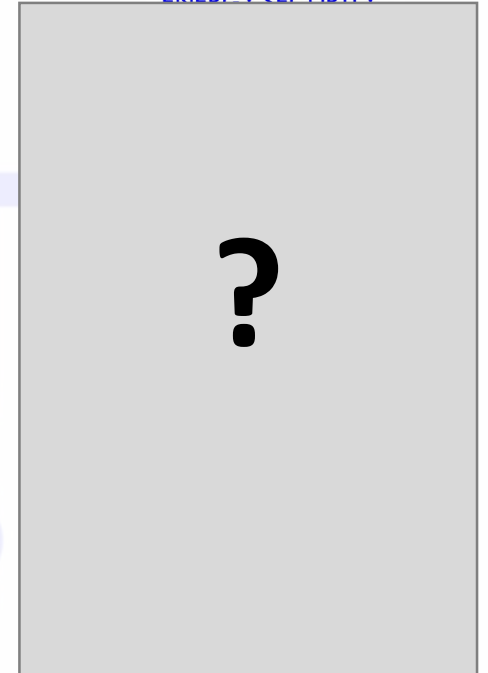
## MED & Italian Energy Report

The new game of hydrogen in the Euro Mediterranean region

3<sup>rd</sup> Annual Report



Hydrogen



Alternative fuels

Cooperation among:

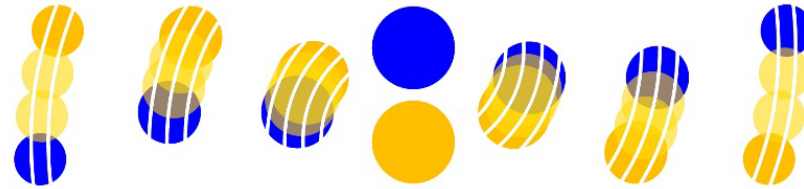


# ENEMED – MED & Italian Energy Report



Politecnico  
di Torino

# EST



## ENERGY SECURITY TRANSITION LAB

[EST@ENERGYCENTER.POLITO.IT](mailto:EST@ENERGYCENTER.POLITO.IT)



ENERGY  
CENTER

Scientific Coordinator:

Ettore F. Bompard ([ettore.bompard@polito.it](mailto:ettore.bompard@polito.it))

Scientific Executive Manager:

Daniele Grosso ([daniele.grosso@polito.it](mailto:daniele.grosso@polito.it))