Presentazione del

MED & Italian Energy Report 2023

Geopolitica dell'Energia nel Mediterraneo tra crisi internazionali e nuove commodity energetiche

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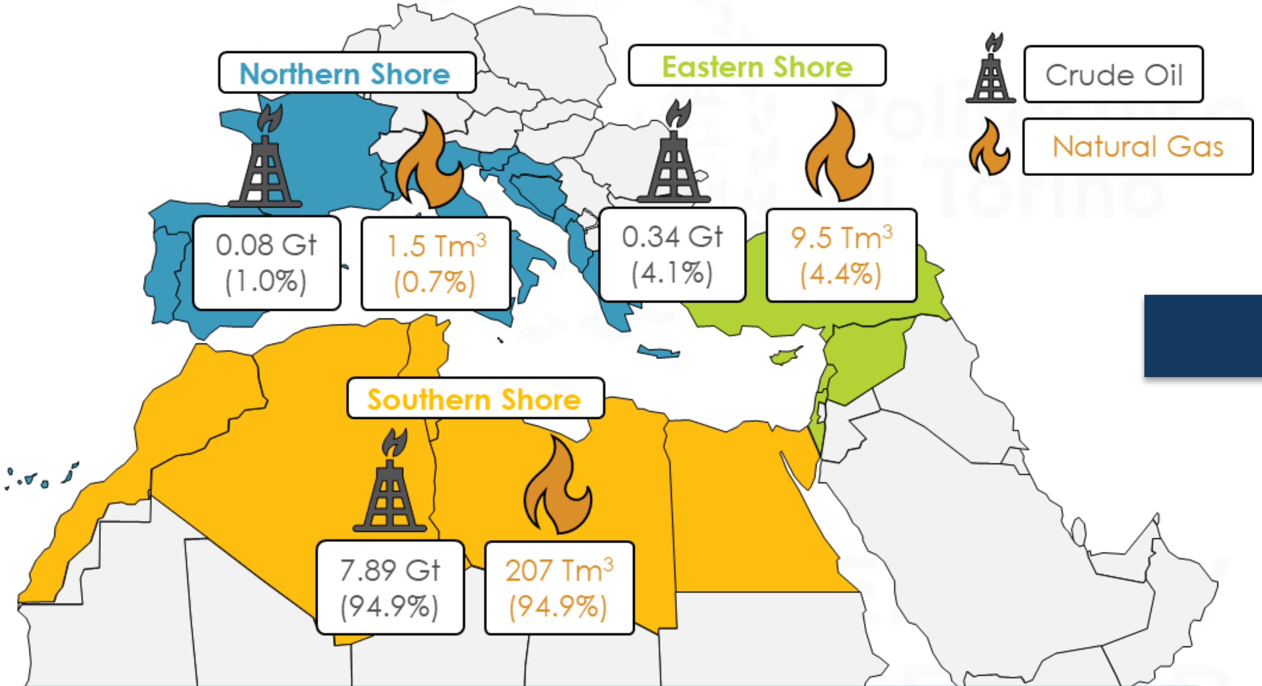
The uneven allocation of fossil resources and flows

ENERGY lab SECURITY

Proved crude oil and gas reserves (2021)

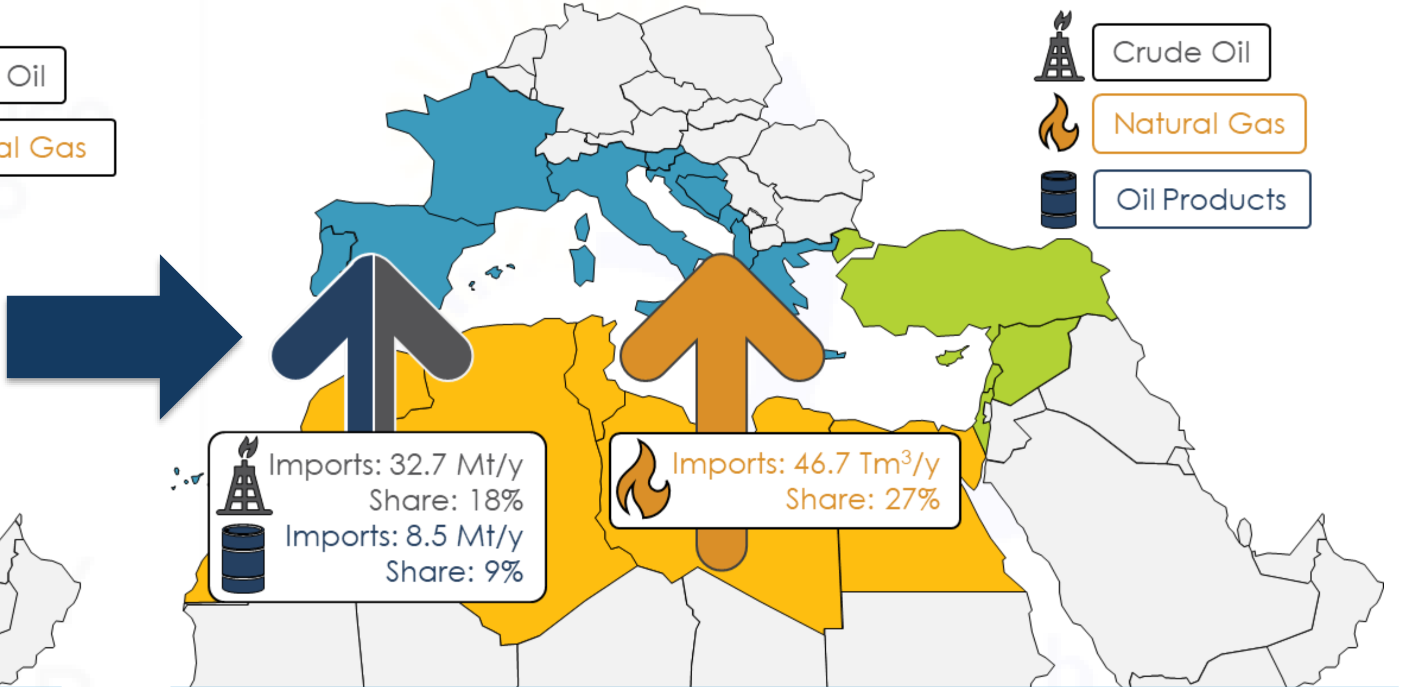


Almost 95% of both oil and gas proved reserves of Mediterranean area are located in the Southern shore

Northern Shore · Southern Shore · Eastern Shore

Source: BP Stats Review 2023

Crude oil and gas flows from Southern to Northern Shore (2021)



Northern and Eastern shores rely on Southern one for **18% and 27% of their** crude oil and gas **imports**, respectively

Northern Shore · Southern Shore · Eastern Shore

Source: Eurostat (2021 data)

Energy commodities from and across the Mediterranean

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The Mediterranean region is **both** an **energy supplier for non-Mediterranean European countries** and a **landing basin for commodities** coming **from non-Mediterranean countries**

Imports of the Mediterranean region from non-Mediterranean countries (2021)

Total Imports (LNG): 59 Tm^3/y
From Non-Mediterranean: 47.5 Tm^3/y (82%)
Main Suppliers:

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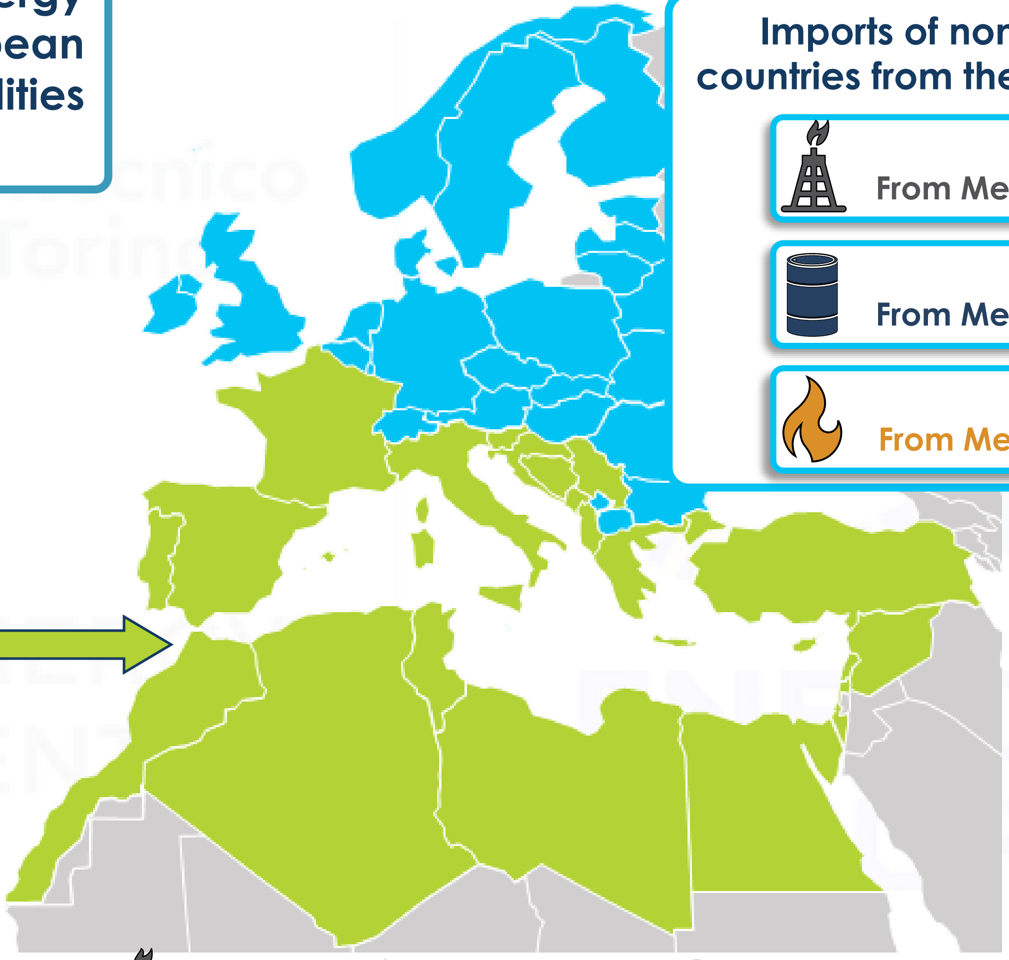


Imports of non-Mediterranean European countries from the Mediterranean region (2021)

Total Imports: 216 Mt/y
From Mediterranean: 17.5 Mt/y (8.1%)

Total Imports: 218 Mt/y
From Mediterranean: 18.9 Mt/y (8.7%)

Total Imports: 62.7 Tm^3/y
From Mediterranean: 1.7 Tm^3/y (2.7%)

Main Suppliers

USA | Qatar
Nigeria | Saudi Arabia
Russia | Iraq

Crude Oil | Natural Gas | Oil Products

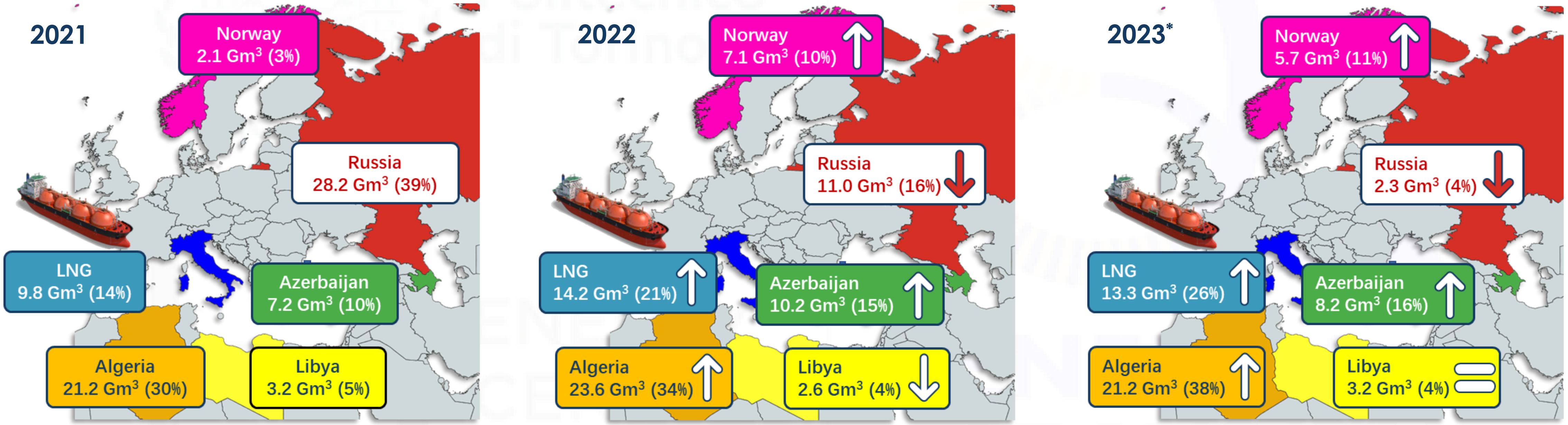
Source: Eurostat , AXSMarine-Alphatanker (2021 data)

Politecnico di Torino | ENERGY CENTER

Strengthening the «black dialogue»: the Italian case

Algeria replaced Russia as the **main gas supplier** to Italy: in October 2022, Algerian imports through the **Transmed pipeline >40%** of the total, while Russian ones from **TAG less than 1%**

The **crisis** further **strengthened** the "**black dialogue**" across the Mediterranean



Source: SNAM – dati operativi business

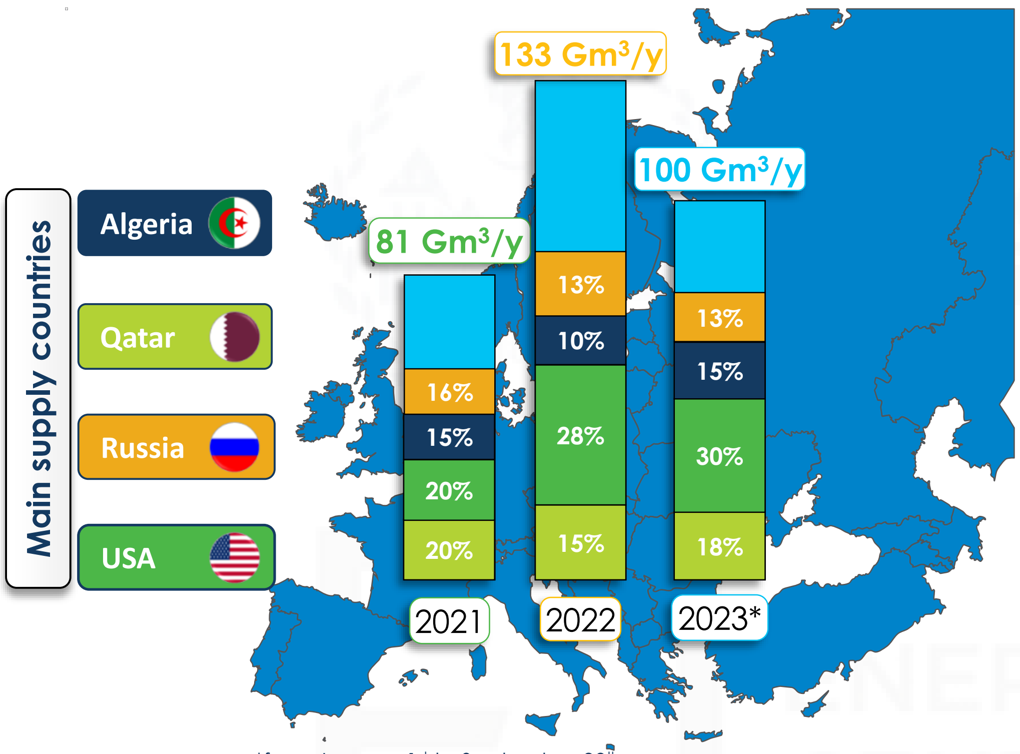
*from January 1st to October 31st

From 2021 to 2023:

- **Increase** in the weight of **Algeria** (+8%), **Norway** (+8%), **Azerbaijan** (+6%) and **LNG** (+12%)
- **Reduction** in the weight of **Russia** (-35%)

The role of LNG as «game changer»

Imports of LNG to the EU



*from January 1st to September 30th

PROS:
High **flexibility**, **diversification** and the possibility of **increasing quickly the overall import capacity** → positive for **energy security**

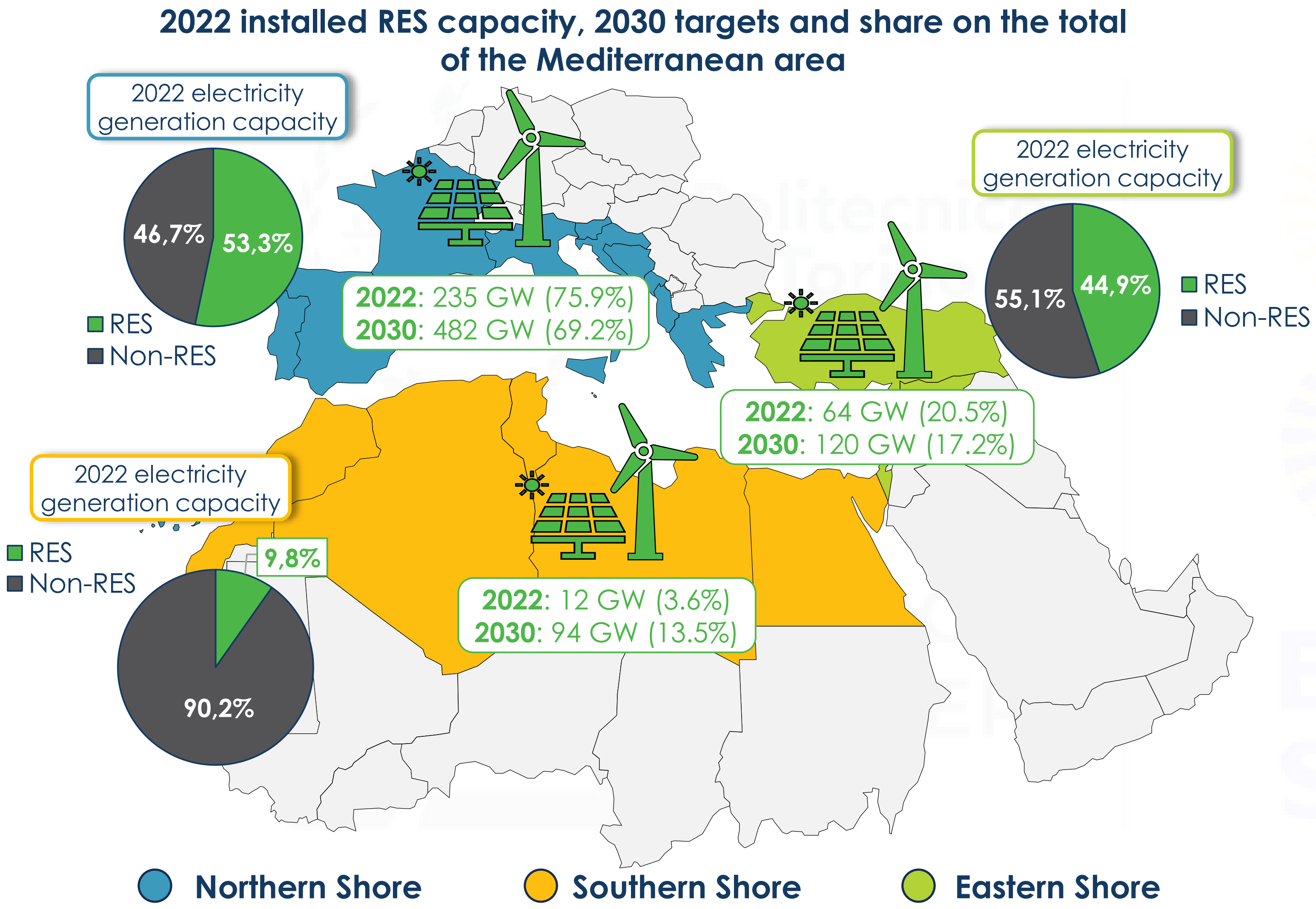
CONS:
lower **affordability** w.r.t. natural gas, due to its **higher costs** and **market competition** phenomena, especially with Asian markets

Possible **evolution** towards a **balance** between **long-term** (to reduce exposure to price volatilities) and **short-term** spot (to allow for supply flexibility) LNG **contracts**

- In the **EU**, the **import of LNG** increased from 81 Gm³/y in 2021 to **133 Gm³/y in 2022 (+64%)**
- Increasing **role of U.S.** in EU supply: 30 Gm³ (30%) in 2023, followed by Qatar (18 Gm³) and Algeria (16 Gm³)
- **EU import of Russian LNG** (mainly by **Belgium**, **Spain** and **France**) = 13 Gm³ (13%), with stable/slightly growing trend

Source: AXSMarine - Alphatanker

The needed transition towards renewables



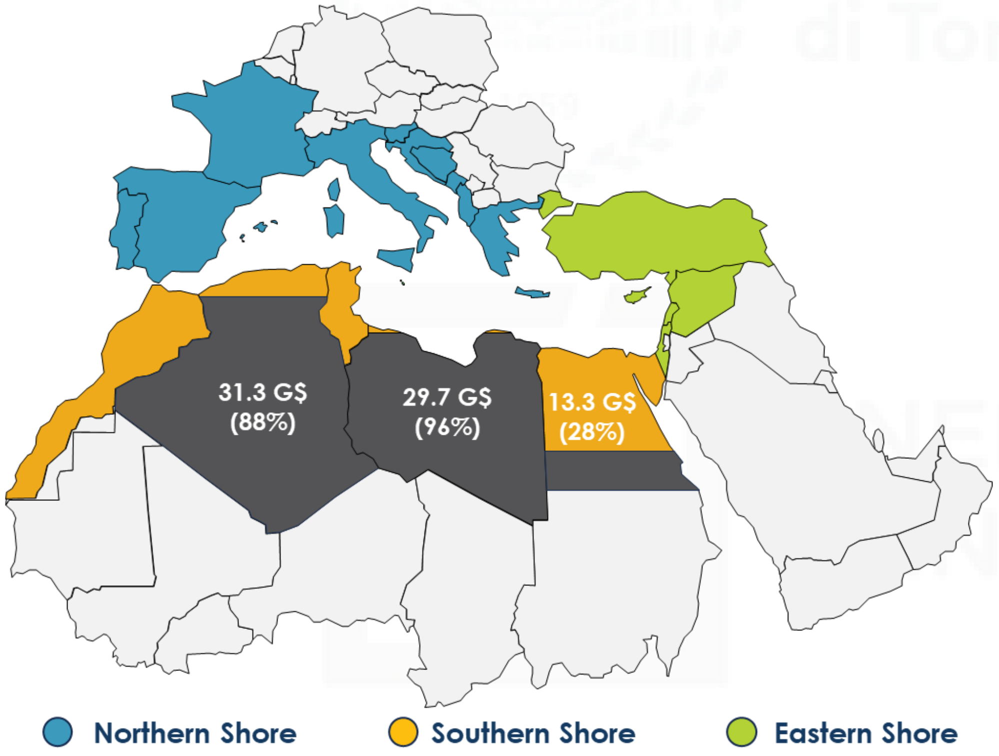
- **RES development** in the 3 Mediterranean shores show **large differences**
- In 2022, out of **309 GW of RES installed capacity**, **76% was** in the Northern shore, **18% in Türkiye**, and **only 3.6%** in the Southern shore
- To match their national targets, Mediterranean countries must sharply increase the **rate of RES penetration**
- While EU countries can benefit from **consolidated regulatory frameworks and technical knowledge**, for the other Mediterranean countries is still difficult to prioritize **sustainability**, also due to internal **political instability** and/or ongoing **conflicts**

Sources: IRENA, National Energy Climate Plans (NECPs), country-specific national plans

Energy & Economics: some open issues in the Mediterranean

The transition is heavily tackled by the presence of 2 **rentier states** (**Algeria** and **Libya**), whose economies are almost completely relying on hydrocarbons export

Economic value of hydrocarbons export from Algeria, Libya and Egypt in 2021, and share on the total value of exports



Source: CEPII, (2022), BACI database

- **Energy transition** requires **large investments** in infrastructures, especially in **Southern shore** (to exploit the large renewable potential), BUT **avoiding** a sort of “ **energy neo-colonialism”**
- In **2021**, **84.5%** of the overall **public investments** in RES in the Mediterranean region (3.5 G$/y) was concentrated in **3 countries** of **Northern shore**: Spain (38.7%), France (36.0%) and Italy (9.9%)
- These **investments** are **affected** by **several factors**:
  - **National**: Difficulty in defining coherent and solid policies and in balancing sustainability, security and equity priorities (e.g. a central aspect affecting energy investment policies is the impact of energy prices on inflation)
  - **Regional**: lack of convergence among policies of the various countries; misalignment of standards and technological choices → long term barriers to joint developments.
  - **International**: negative influences on prices due to turbulences on global markets; unavoidable incidence on prices, costs, financial decisions, access to technologies, etc. due to global conflicts (e.g. Russia-Ukraine war)

Source: IRENA, Public investment database 2023

Technologies for the energy transition: some comparative example

MAIN ELECTRICITY TECHNOLOGIES FOR THE TRANSITION

Input	Technology	TRL	Cost [$/kW]	Efficiency
Generation				
Solar irradiance	PV: crystalline silicon	10	810 - 1120	0.17 - 0.23
	PV: multi-junction	9	4850 - 8240	0.39 - 0.47
	Floating PV	8	~ 860	0.17 - 0.23
Water	Hydro Power Plants	11	2650 - 3900	0.40 - 0.50
	Tidal stream & tidal range	9	150 - 800	~ 0.80
Wind	Onshore Wind Turbine	10	1590 – 1950	0.29 - 0.35
	Seabed fixed offshore Wind Turbine	9	2600 - 3721	0.45 - 0.51
	Floating offshore Wind Turbine	8	2936 - 3289	0.45 - 0.51
Geoth. heat	Thermal power plant	11	3851 - 10959	0.12 - 0.18
Storage				
Type	**Technology**	**TRL**	**Cost [$/kWh]**	**Efficiency**
Mechanical	Pumped Hydro Storage	11	10 – 100	0.70 - 0.84
	Flywheel Energy Storage	9	1500 - 6000	0.70 - 0.95
	Compressed Air Energy Storage	8	50 - 80	0.70 - 0.80
Electro-chemical	Li-ion batteries	10	245 - 620	0.92 - 0.96
	Redox Flow Batteries	9	315 - 1680	~ 0.75
Conversion				
Commodity	**Technology**	**TRL**	**Cost [$/kW]**	**Efficiency**
Hydrogen	Solid Oxide Fuel Cells	9	3000 - 4000	0.45 - 0.50
	Molten Carbonate Fuel Cell	9	4000 - 6000	0.45 - 0.52
Transmission & Distribution				
Type	**Technology**	**TRL**	**Cost [M€/km]**	**Efficiency**
Transmission	High-voltage Direct Current	11	~3.5	~0.97
	Ultra High-voltage Alternate Current	11	~3.1	0.93 - 0.94

TRL scale (ref. IEA): **11**: Proof of stability reached;**10**: Integration needed at scale; **9**: Commercial operation in relevant environment; **8:** First of a kind commercial

MAIN HYDROGEN TECHNOLOGIES FOR THE TRANSITION

Input	Technology	TRL	Cost [$/kW]	Efficiency
Generation				
Electricity	Alkaline electrolyser	9	500 - 1400	0.58 - 0.70
	Proton Exchange Membrane electrol.	9	1100 - 1800	0.50 - 0.83
	Solid Oxide electrolyser	8	2800 - 5600	up to 0.84
Storage				
Type	**Technology**	**TRL**	**Cost [$/kg$_{H2}$]**	**Efficiency**
Physical	Pressure vessel	11	712 - 998	0.91
	Liquid hydrogen tank	9	1905	0.71
	Salt cavern	10	0.6	0.98
Transmission & Distribution				
Type	**Technology**	**TRL**	**Cost[$/kg$_{H2}$]**	**Efficiency**
Open-sea	Ammonia tanker ships	11	1.2	0.90
Captive	Hydrogen pipeline	9	1.5	~1.00

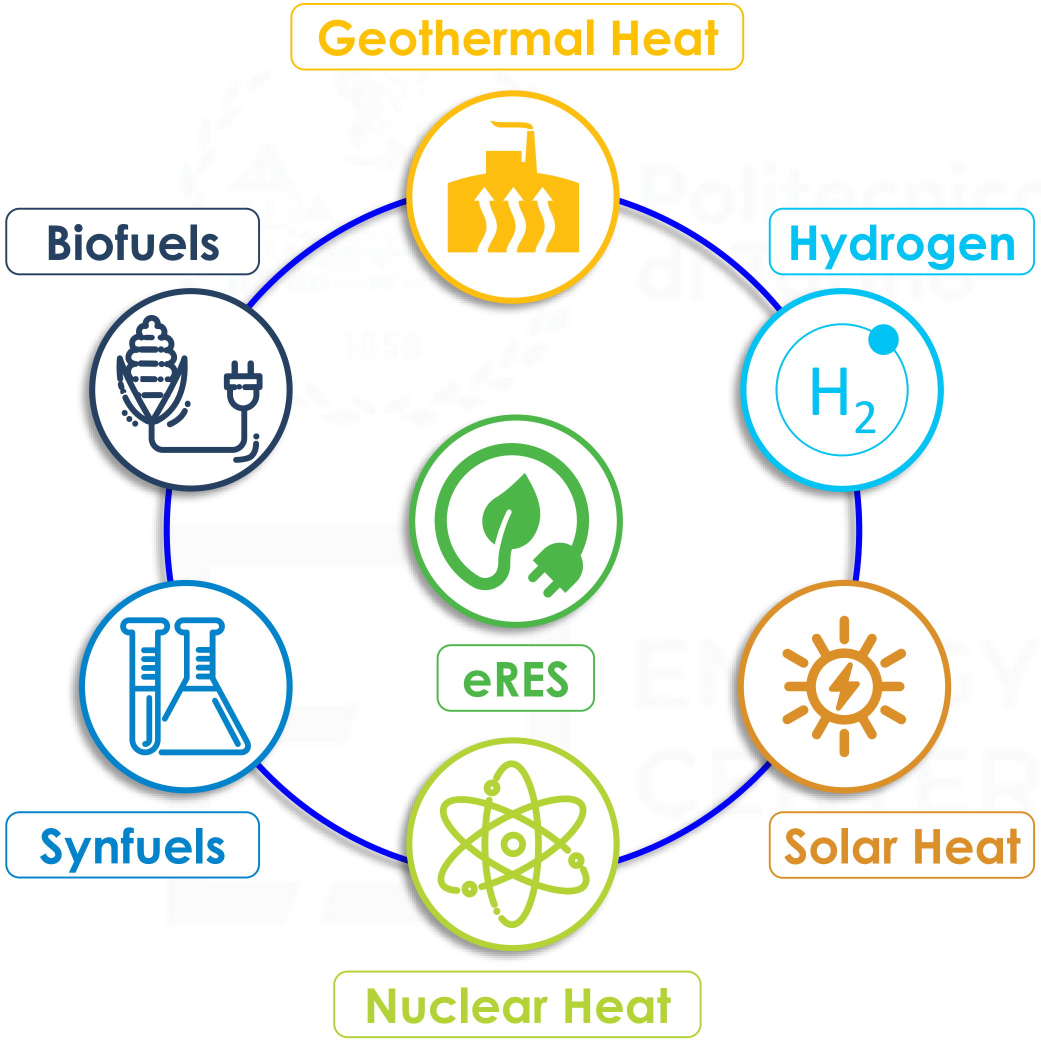
Currently multi-junctions PV cells have an efficiency double w.r.t. crystalline silicon ones, but the needed investment cost can be up to 8 times

The conversion of hydrogen in electricity through fuel cells hydrogen has relatively low efficiency (~50%) with associated relevant investment costs

The Solid Oxide electrolysers have higher efficiency w.r.t. the traditional ones (ALK, PEM), but a still low level of maturity and an investment cost up to 4 times

Source: ESL@energycenter elaboration based on IEA and IRENA data

The need for a Multicommodity energy system



- **Electricity from renewables** is expected to assume the **central role** in the future energy mix and in building a new "**green**" **dialogue**
- However, electricity **cannot completely decarbonise** by itself the Mediterranean energy systems, due to "**hard-to-abate**" final uses (e.g., production of high temperature process heat in industry and long-distance maritime and aviation transport)

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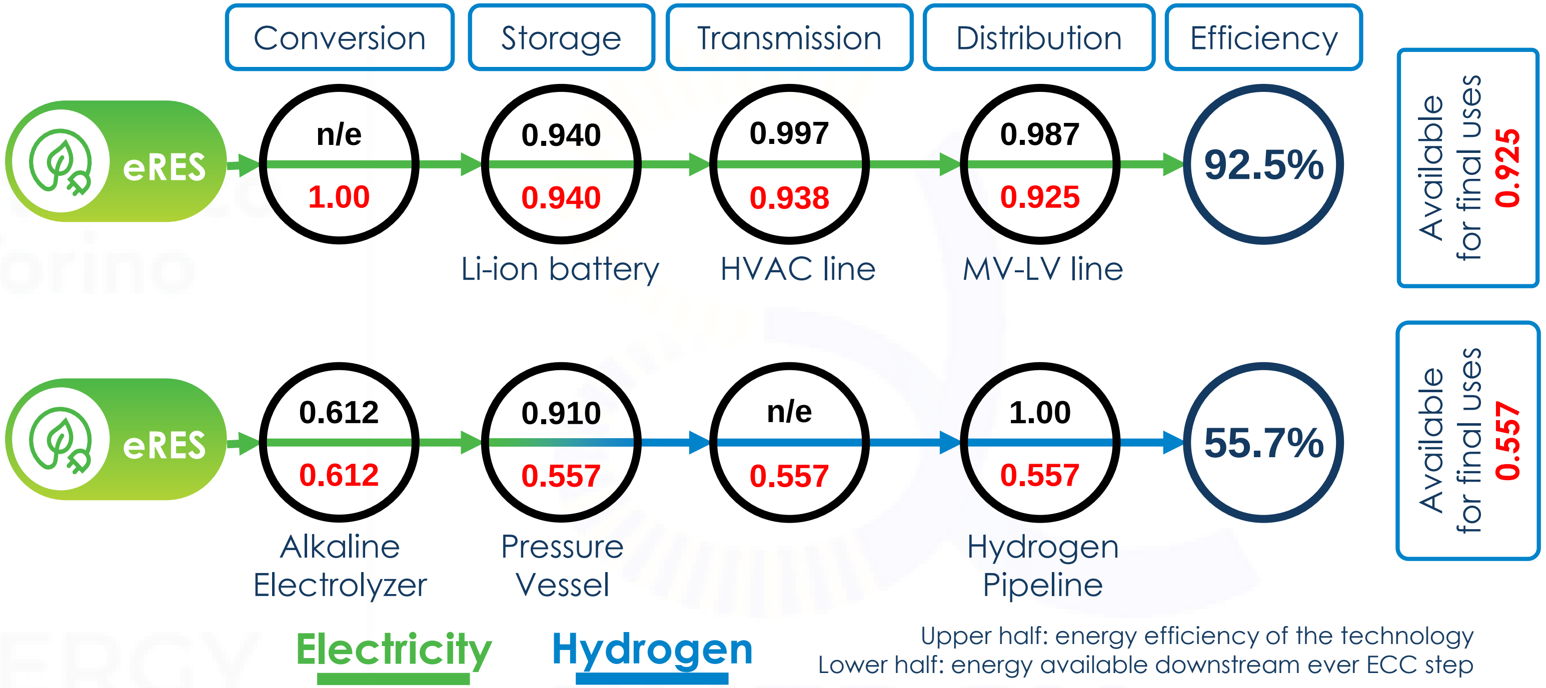
- Need for a **synergy** between electricity and **other commodities**, like green **hydrogen** (produced through water electrolysis by means of electricity from RES), **alternative fuels**, **geothermal**, **solar thermal** and **nuclear** heat

Energy Commodity Chains (ECCs) as a tool to compare alternative pathways

- ECCs are defined as the set of processes that **energy commodities** undergo along their path to final uses, from being harnessed from primary energy sources
- The **same final use** can be fed by more than one commodity, as well as being provided by different technologies
- ECCs are a tool to **quantitatively evaluate** equivalent but alternative energy pathways, and **rank** them basing on a set of **numerical metrics**



- **Electricity** is by far the most energy-efficient choice, with **overall energy efficiencies even above 90%**
- Hydrogen suffers from the relatively **low conversion efficiency** of **electrolysis process** (**40% less available energy**)
- The need to decarbonize must inevitably take into account the massive infrastructural and financial effort required to deploy commodities alternative to electricity, but energy-inefficient

Grazie per l’attenzione