MED & Italian Energy Report 2023

Presentation of the 5th Annual Report

ETTORE BOMPARD, Director of ESL@ Energy Center, Politecnico di Torino

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Outline

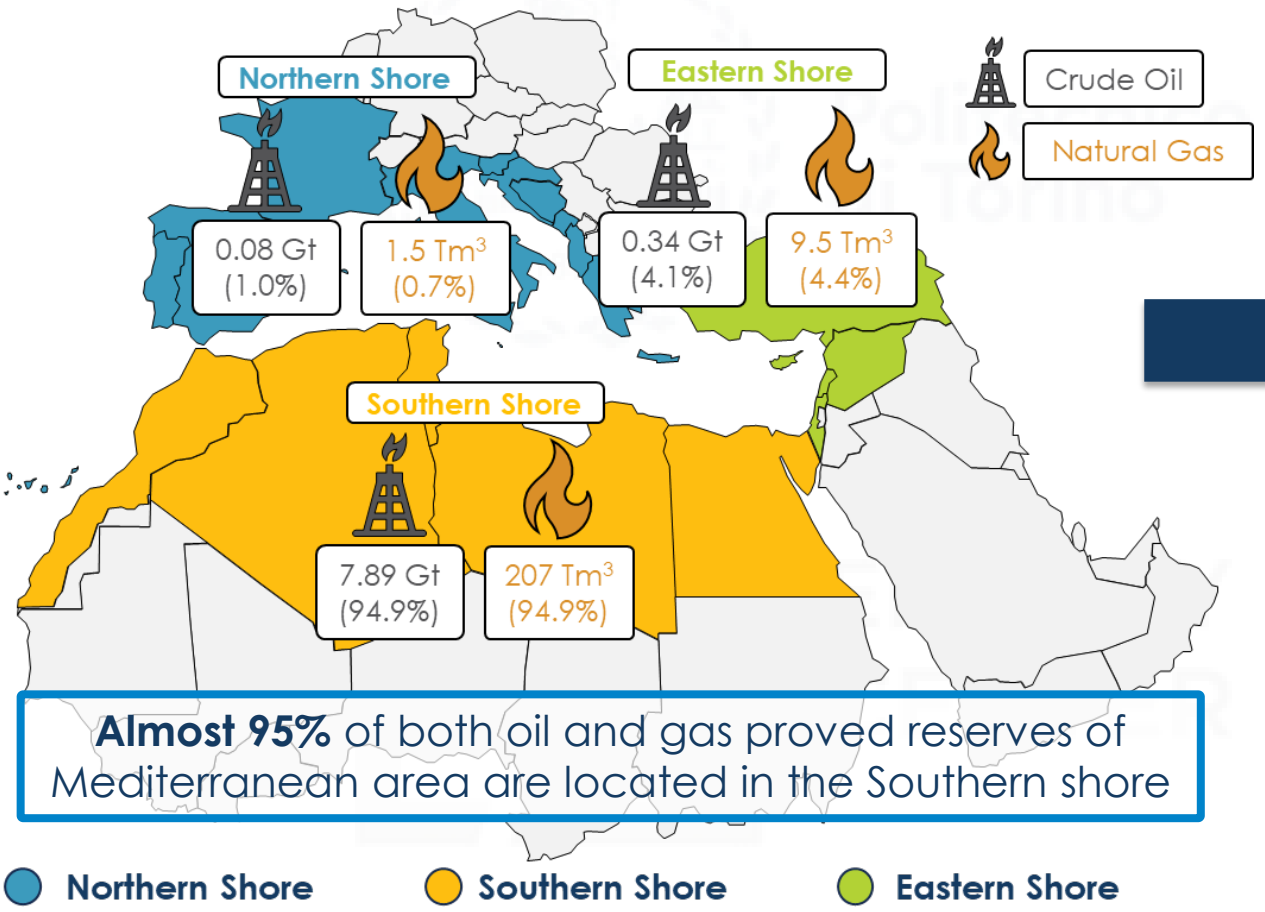
- The present «black dialogue» …
  - The uneven allocation of fossil resources and flows
  - Energy commodities from and across the Mediterranean
  - The energy consequences of the Russo-Ukranian war
  - Strengthening the «black dialogue»: the Italian case
  - The role of LNG as «game changer»
  - Estimating the geopolitical stability of a country: the WGI index
- … and the transition for a future «green dialogue»
  - The change of priorities in the energy attributes
  - The needed transition towards renewables
  - A new dependency: the Critical Raw Materials
  - Counteracting the new dependencies: the EU CRM Act
  - Energy & Economics: some open issues in the Mediterranean
  - The need for a Multicommodity energy system
  - Energy Commodity Chains (ECCs) as a tool to compare alternative pathways
  - Technologies for the energy transition
  - A glance at the future ENEMED web-integrated platform
- Conclusions

The present “black dialogue”

The uneven allocation of fossil resources and flows

ENERGY lab SECURITY

Proved crude oil and gas reserves (2021)

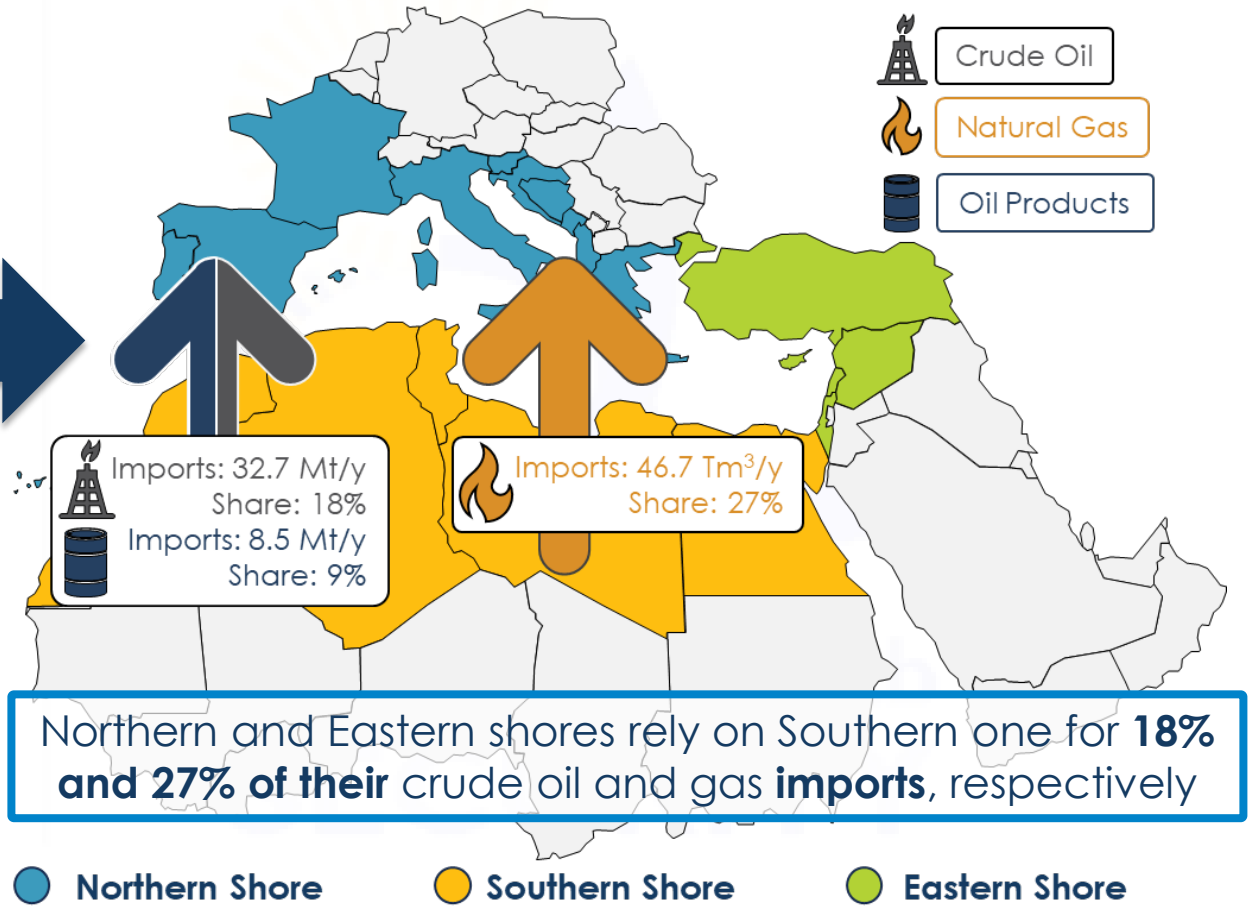


Almost 95% of both oil and gas proved reserves of Mediterranean area are located in the Southern shore

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

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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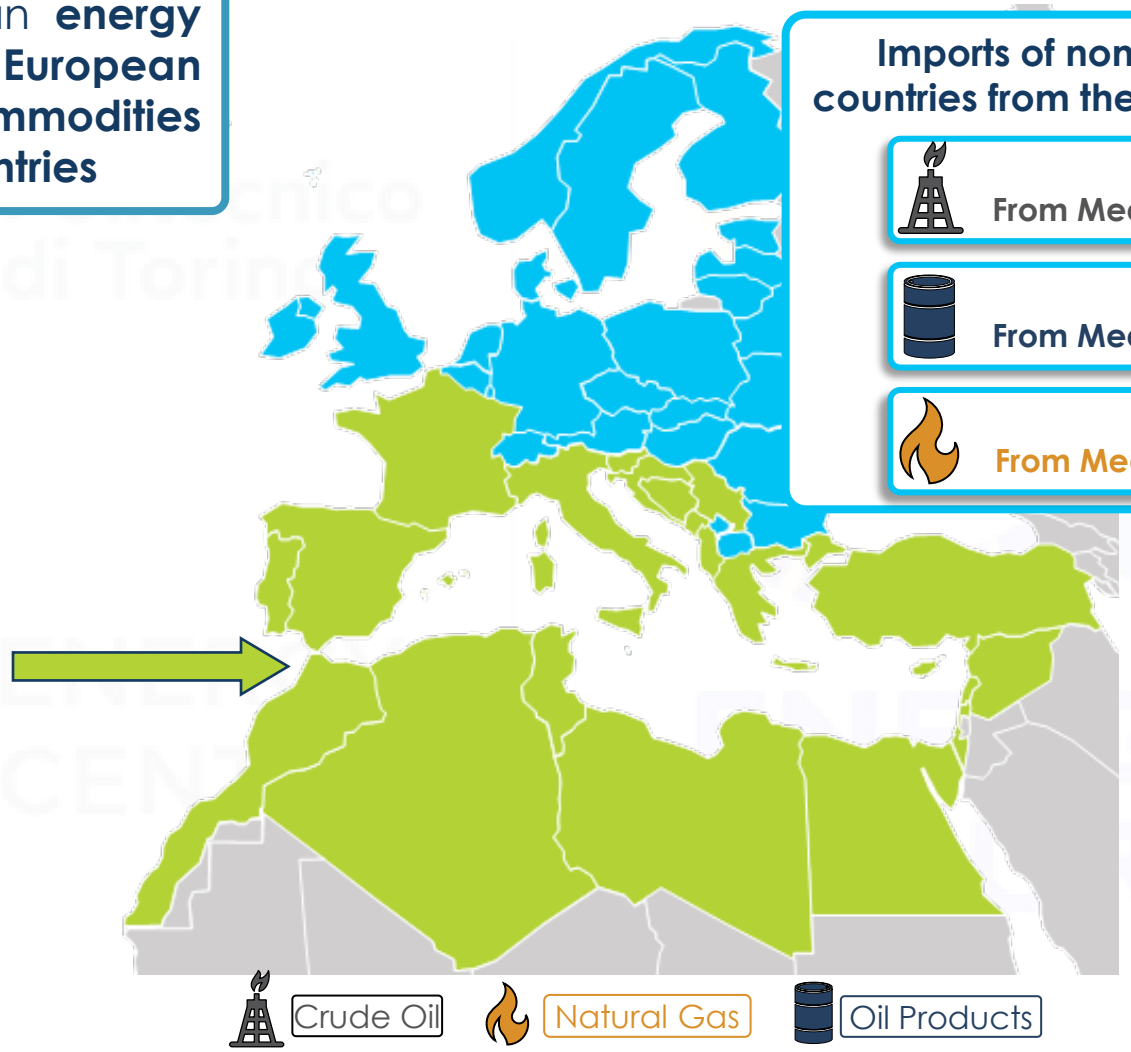


Imports of non-Mediterranean European countries from the Mediterranean region (2021)

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%)

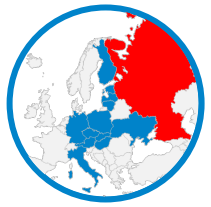
Total Imports: 62.7 Tm^3/y
From Mediterranean: 1.7 Tm^3/y (2.7%)

Main Suppliers

USA | Qatar
Nigeria | Saudi Arabia
Russia | Iraq

Source: Eurostat , AXSMarine-Alphatanker (2021 data)

The energy consequences of the Russo-Ukranian war



Highlight the **critical dependence on gas pipelines**

In May 2022, **Gazprom stopped** the gas supply to Europe via the **Yamal-Europe** pipeline, while on September 26, 2022, the **NordStream 1 and 2** pipelines (from Russia to Germany through the Baltic Sea) were **damaged by explosions**

Increase the **energy prices** in 2022

The gas price on the **Dutch hub TTF** grew from **70 €/MWh** on February 21st to a **peak of 350 €/MWh on August 26th**, followed by a decrease (due to achievement of **storage** targets, **diversification** of supply and reduction of **demand)** up to the current value of **50 €/MWh**, however almost double w.r.t. 2021 one

Source: ICE Dutch TTF Natural Gas Futures

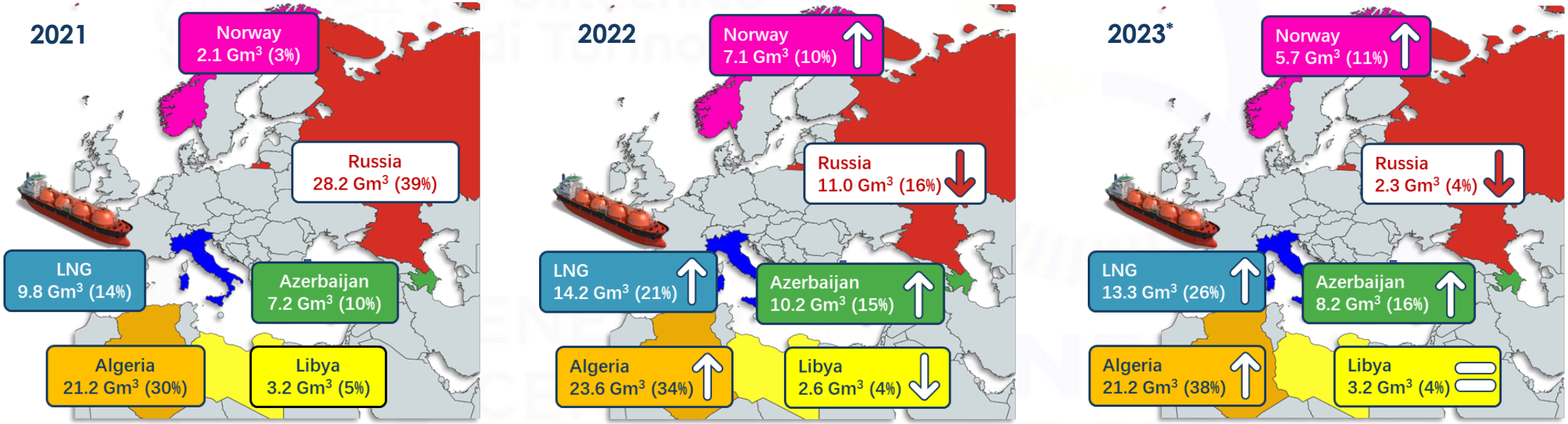
Introduce the **REPowerEU plan**

Goal: quickly **reducing** the **energy dependency from Russia** and speeding up the ecological transition, based on **three pillars**: **diversification** of energy supply, **energy saving**, and increase in **penetration of renewables**. **Value** of the plan: **300 G€**

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

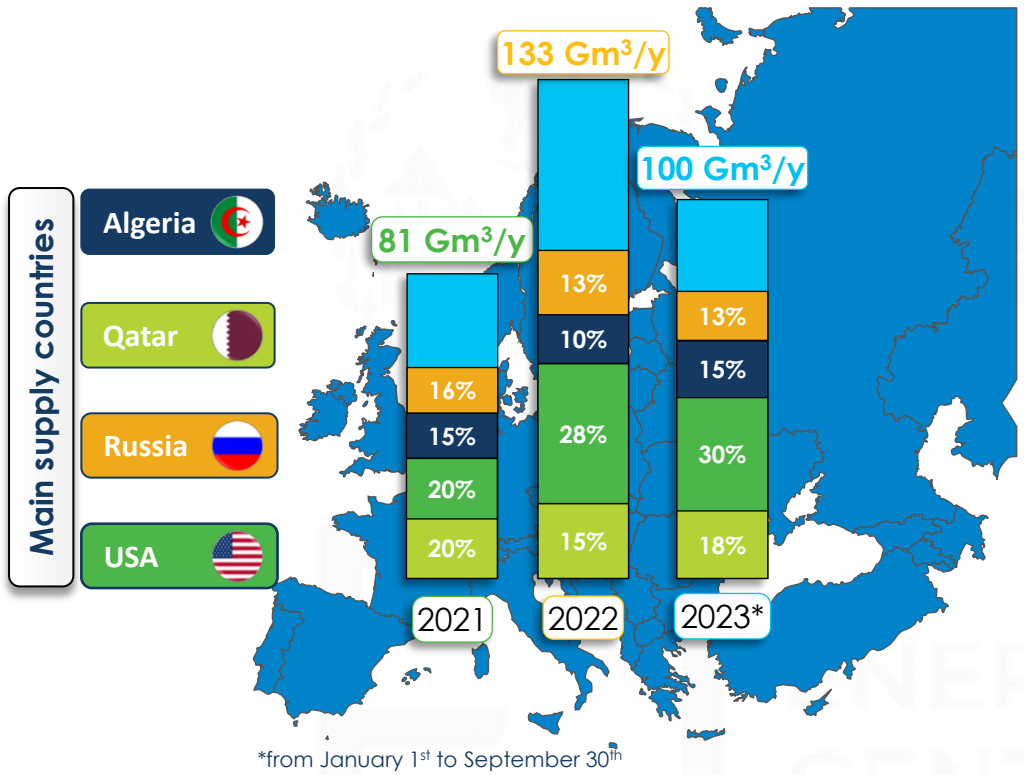
*from January 1st to October 31st

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 Gm^3/y in 2021 to **133 Gm^3/y in 2022 (+64%)**
- Increasing **role of U.S.** in EU supply: 30 Gm^3 (30%) in 2023, followed by Qatar (18 Gm^3) and Algeria (16 Gm^3)
- **EU import of Russian LNG** (mainly by **Belgium**, **Spain** and **France**) = 13 Gm^3 (13%), with stable/slightly growing trend

Source: AXSMarine - Alphatanker

Estimating the geopolitical stability of a country: the WGI index

Historical trend of the WGI index of Mediterranean countries

Country	2019	2020	2021	2022
Italy	32.77	33.79 ↑	32.36 ↓	32.62 ↑
France	16.87	20.05 ↑	18.46 ↓	19.79 ↑
Spain	24.27	26.17 ↑	25.62 ↓	26.81 ↑
Portugal	16.99	18.25 ↑	19.04 ↑	19.85 ↑
Malta	23.59	20.88 ↓	24.69 ↓	24.59 ↓

Country	2019	2020	2021	2022
Slovenia	20.49	21.59 ↑	22.71 ↑	22.73 ↑
Croatia	34.73	36.46 ↑	36.06 ↓	34.49 ↓
Bosnia	63.69	67.42 ↑	67.42 ↑	67.78 ↑
Montenegro	45.36	47.42 ↑	46.53 ↓	46.48 ↓
Albania	52.50	53.45 ↑	52.19 ↓	49.56 ↓
Greece	37.37	35.77 ↓	36.32 ↑	37.28 ↑

Country	2019	2020	2021	2022
Algeria	79.74	78.71 ↓	78.86 ↑	76.88 ↓
Morocco	60.62	58.79 ↓	60.05 ↑	58.36 ↓
Tunisia	55.21	54.11 ↓	57.36 ↑	59.67 ↑
Libya	96.73	96.24 ↓	95.78 ↓	95.87 ↑
Egypt	74.21	74.60 ↑	72.94 ↓	74.89 ↑

Country	2019	2020	2021	2022
Türkiye	63.13	64.33 ↑	65.44 ↑	67.36 ↑
Cyprus	24.99	29.83 ↑	30.47 ↑	30.21 ↓
Syria	98.09	98.49 ↑	98.33 ↓	98.42 ↑
Lebanon	79.14	82.24 ↑	84.46 ↑	85.18 ↑
Israel	29.79	33.04 ↓	31.05 ↓	31.50 ↑

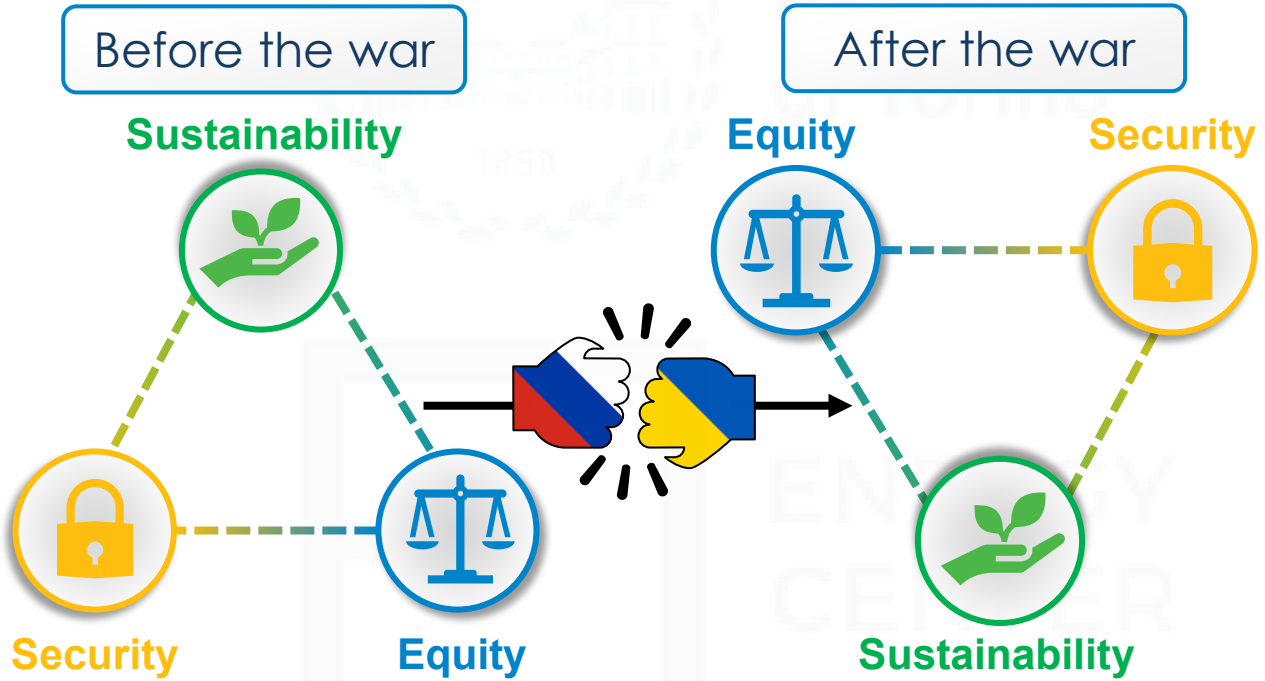
Northern Shore Southern Shore Eastern Shore

- **The WGI** (Worldwide Governance Indicators) **Index** quantifies the **geopolitical stability** of a country, ranging from 1 to 100 (100 = maximum risk)
- It is the average value of 6 categories:
  - *Voice and accountability*
  - *Political Stability and Absence of Violence/Terrorism*
  - *Government Effectiveness*
  - *Regulatory Quality*
  - *Rule of Law*
  - *Control of Corruption*
- The **Russian WGI index** constantly increased from 70.40 in 2019, to 83.13 in 2022 (the last value is supposedly influenced by the beginning of the Russia-Ukriane war)

Source: The World Bank (2022)

The transition for a future «green dialogue»

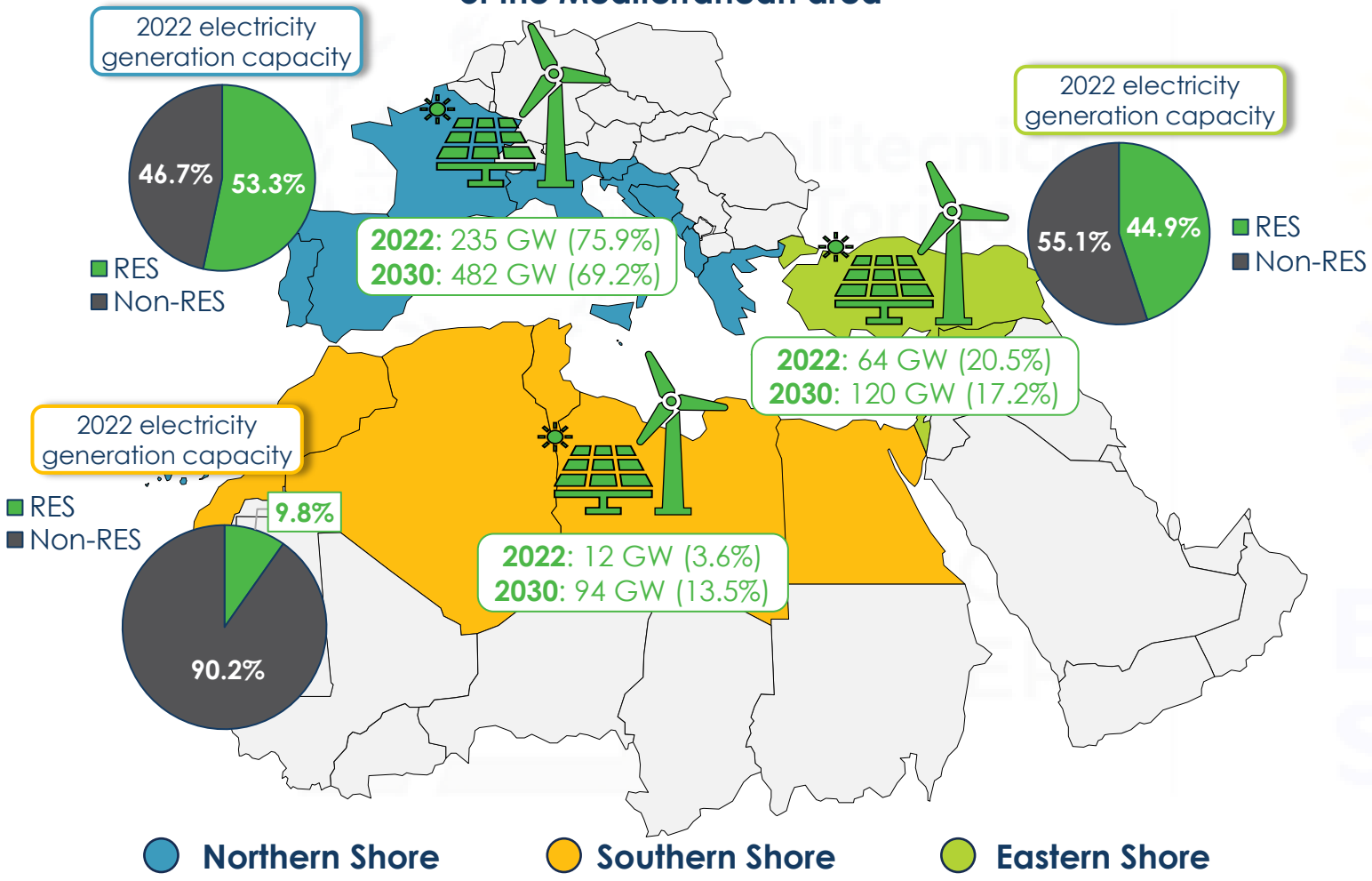
The change of priorities in the energy attributes



- Energy systems are characterized by **3** possible **desirable attributes** (→ "**energy trilemma**"): environmental **sustainability**, energy **security**, **equity** (i.e., economic affordability)
- In the last decade, **sustainability** played the role of **main attribute**, especially in Northern shore (e.g. the EU "Green Deal")
- The Russo-Ukranian conflict changed the order of priority, with **security** and **equity** overcoming the **sustainability**, at least in the short-term

The needed transition towards renewables

2022 installed RES capacity, 2030 targets and share on the total of the Mediterranean area



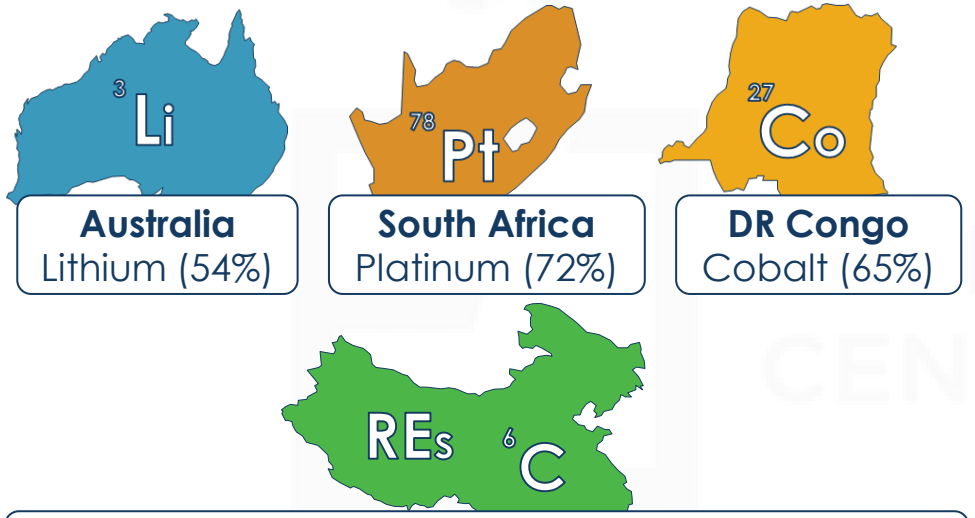
- **RES development** in the 3 Mediterranean shores show **large differences**
- In 2022, out of **309 GW of RES installed capacity**, **76% was** in the Northern shore, **18% in Türkiye**, and **only 3.6%** in the Southern shore
- To match their national targets, Mediterranean countries must sharply 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

A new dependency: the Critical Raw Materials

- **Green technologies** for the energy transition require significant amount of **critical raw materials**. E.g.:
  - **solar PV**: copper
  - **wind turbines**: copper, rare earths (REs), manganese and nickel
  - **Li-ion batteries**: all CRMs except for platinum and rare earths
  - **electric motors**: copper and rare earths
- CRMs are **concentrated** in a **small number of countries**. **Mediterranean resources are very limited**. In the case of **rare earths,** Mediterranean countries are **completely reliant on third countries**

Shares of CRMs annual production



Australia
Lithium (54%)

South Africa
Platinum (72%)

DR Congo
Cobalt (65%)

China
Graphite (65%) REs (65%)

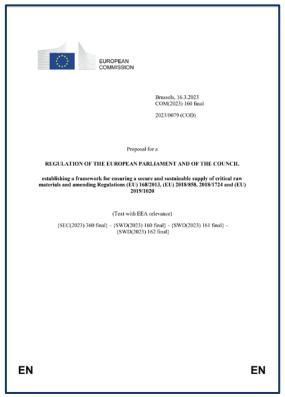
The energy transition can lead from a dependency on fossil commodities to one on CRMs

→ **critical role** of **China**: e.g. 50% of Li mines that China controls outside since 2018 are located in Australia and Canada, and 90% of Li extracted in Australia is exported to China for the refining phase.
In Australia, Chinese companies co-operate the Greenbush mine (the largest Li mine of the world), producing in 2022 the 61.5% of the total Australian Li, and the Mt. Marion mine, producing the 15.4%

Sources: Austrian Federal Ministry of Finance, World Mining Data; Mining.com, World's top 10 biggest lithium operations; Statista, Major countries in worldwide lithium mine production in 2022

Counteracting the new dependencies: the EU CRM Act

- In 2023, the EU **issued** the **Critical Raw Materials Act**, outlining **measures** to ensure a secure and **sustainable supply of** CRMs
- Goals: To meet
  - at least **10%** of the EU's annual consumptions by **domestic extraction**,
  - **40%** by **domestic processing**
  - **15%** by **domestic recycling**
  - **no more than 65%** of import covered by a **single third countries**


EUROPEAN COMMISSION

Brussels, 16.3.2023
COM(2023) 160 final
2023/0079 (COD)

Proposal for a

REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) 168/2013, (EU) 2018/858, 2018/1724 and (EU) 2019/1020

(Text with EEA relevance)

{SEC(2023) 160 final} - {SWD(2023) 160 final} - {SWD(2023) 161 final} - {SWD(2023) 162 final}

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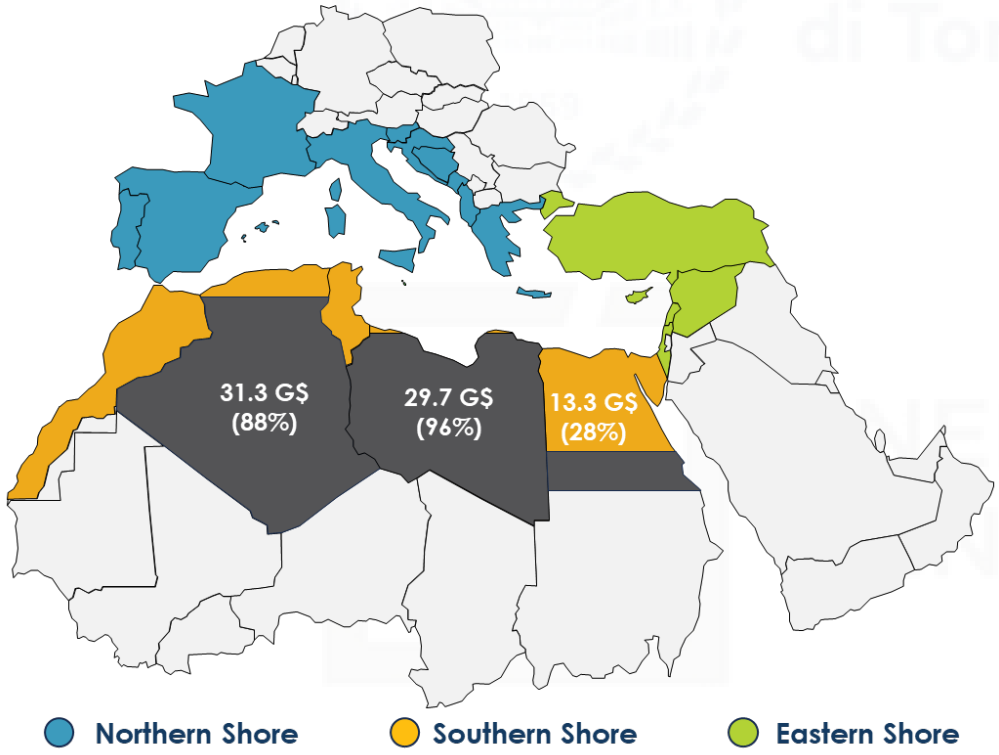
Remaining Issues

- The **ENEMED 2023 scenario** analysis (assessing the amount of raw materials needed for reaching the national RES targets by 2030 in the Mediterranean area) **shows** that the **2030 demand largely exceeds** the **current Mediterranean production** for most of CRMs, especially cobalt, lithium, graphite, nickel and rare earths
- In the **EU** there could be a **social opposition** to **investments** and interventions needed for **exploiting** the **domestic CRMs resources**, due to their strong **impact** on the **environment** and local **communities**

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

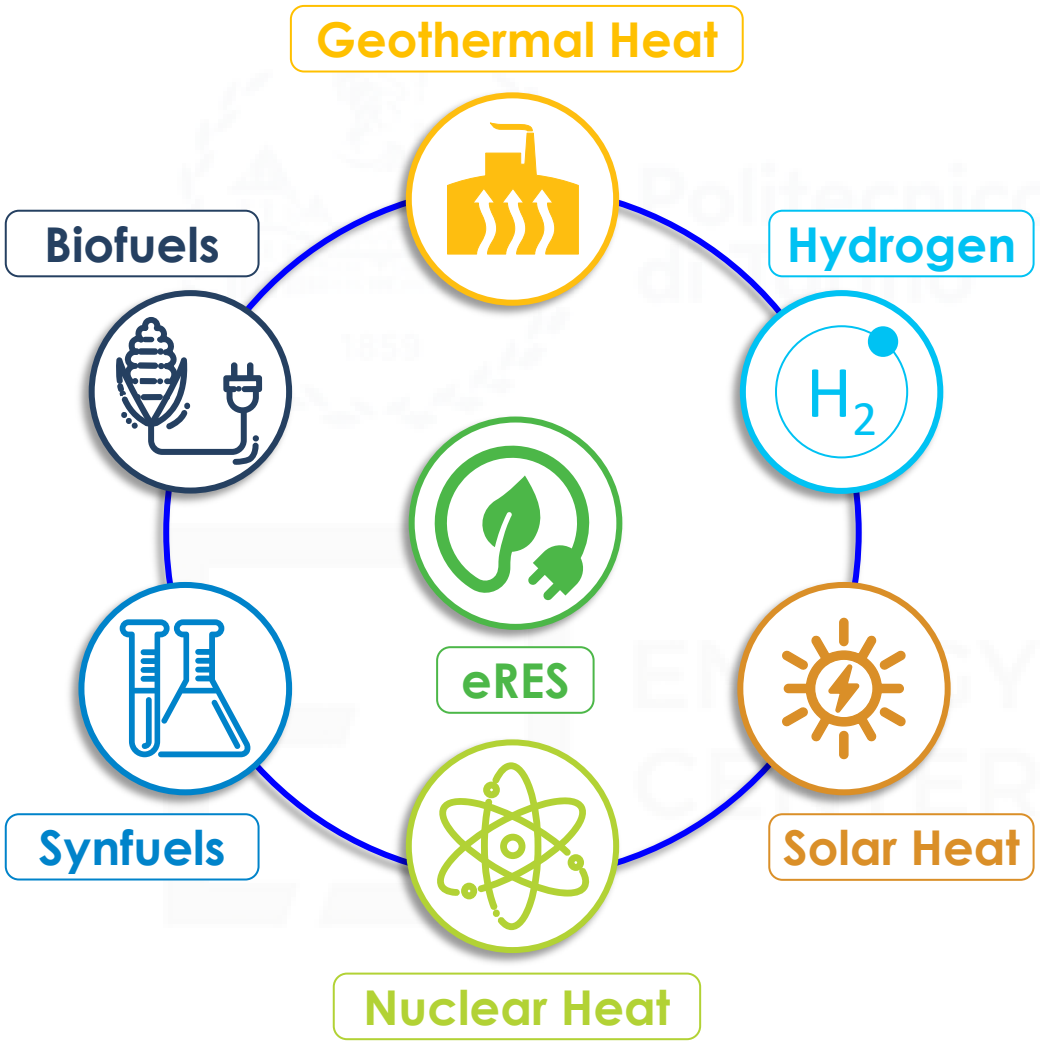


Source: CEPII, (2022), BACI database

- **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

The need for a Multicommodity energy system

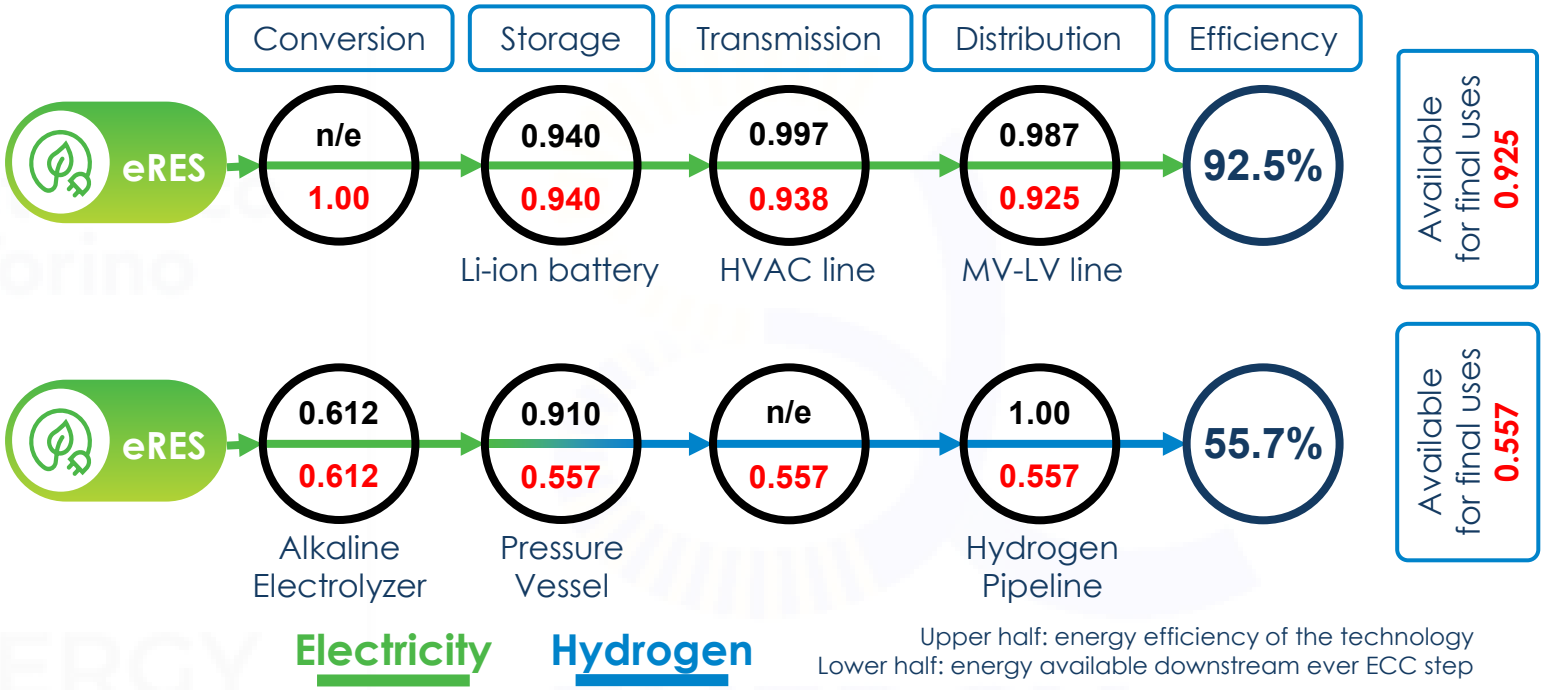


- **Electricity from renewables** is expected to assume the **central role** in the future energy mix and in building a new "**green**" **dialogue**
- However, electricity **cannot completely decarbonise** by itself the Mediterranean energy systems, due to "**hard-to-abate**" final uses (e.g., production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

- 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

Technologies for the energy transition

MAIN ELECTRICITY TECHNOLOGIES FOR THE TRANSITION

Generation

Input	Technology	TRL	Cost [$/kW]	Efficiency
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

Generation

Input	Technology	TRL	Cost [$/kW]	Efficiency
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

- Technologies for the transition are characterized by different **efficiencies**, **costs** and Technology Readiness Level (**TRL**)
- The **combination** of these **factors** can **promote or hinder** the **penetration** of a given technology
- **Commercial scale diffusion** of new technologies with an **adequate TRL** and a good **trade-off between performances and costs** is needed, making still **not easy** to **identify dominant solutions** in the long run

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

Technologies for the energy transition: some comparative example

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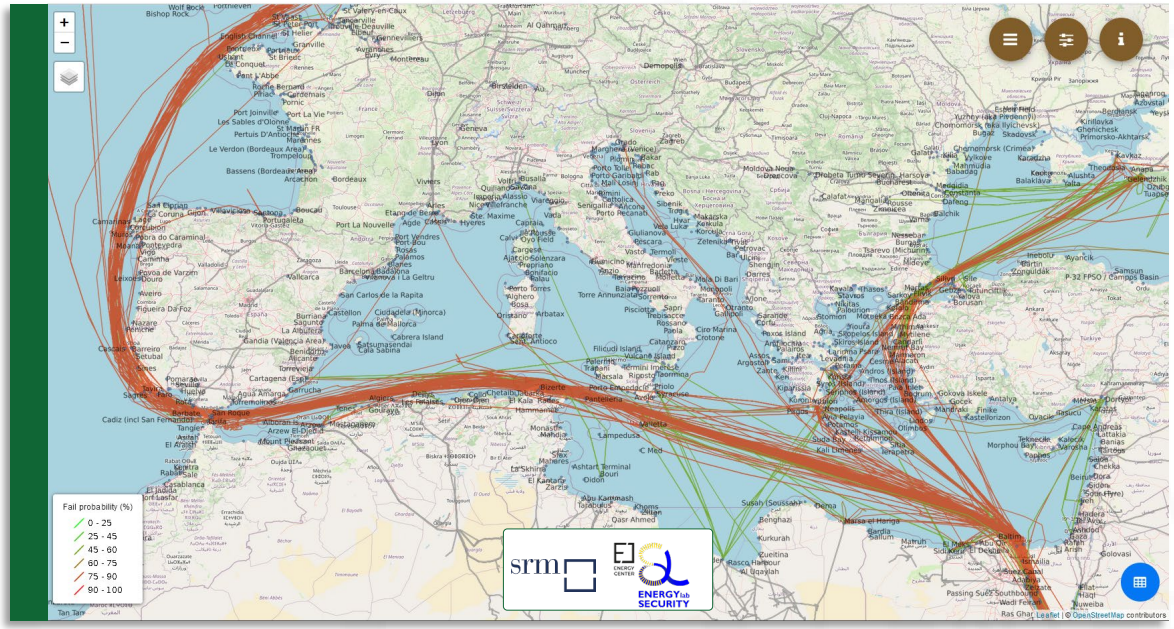
Currently multi-junctions PV cells have an efficiency double w.r.t. crystalline silicon ones, but the needed investment cost can be up to 8 times

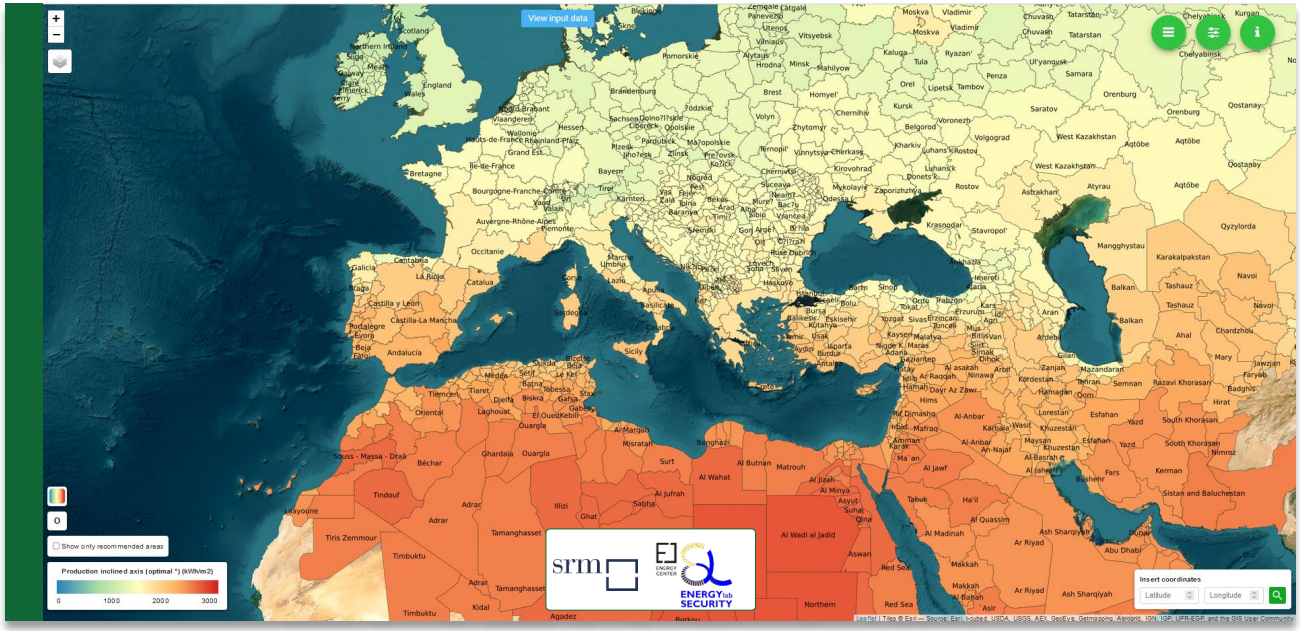
The conversion of hydrogen in electricity through fuel cells hydrogen has relatively low efficiency (~50%) with associated relevant investment costs

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

A glance at the future ENEMED web-integrated platform





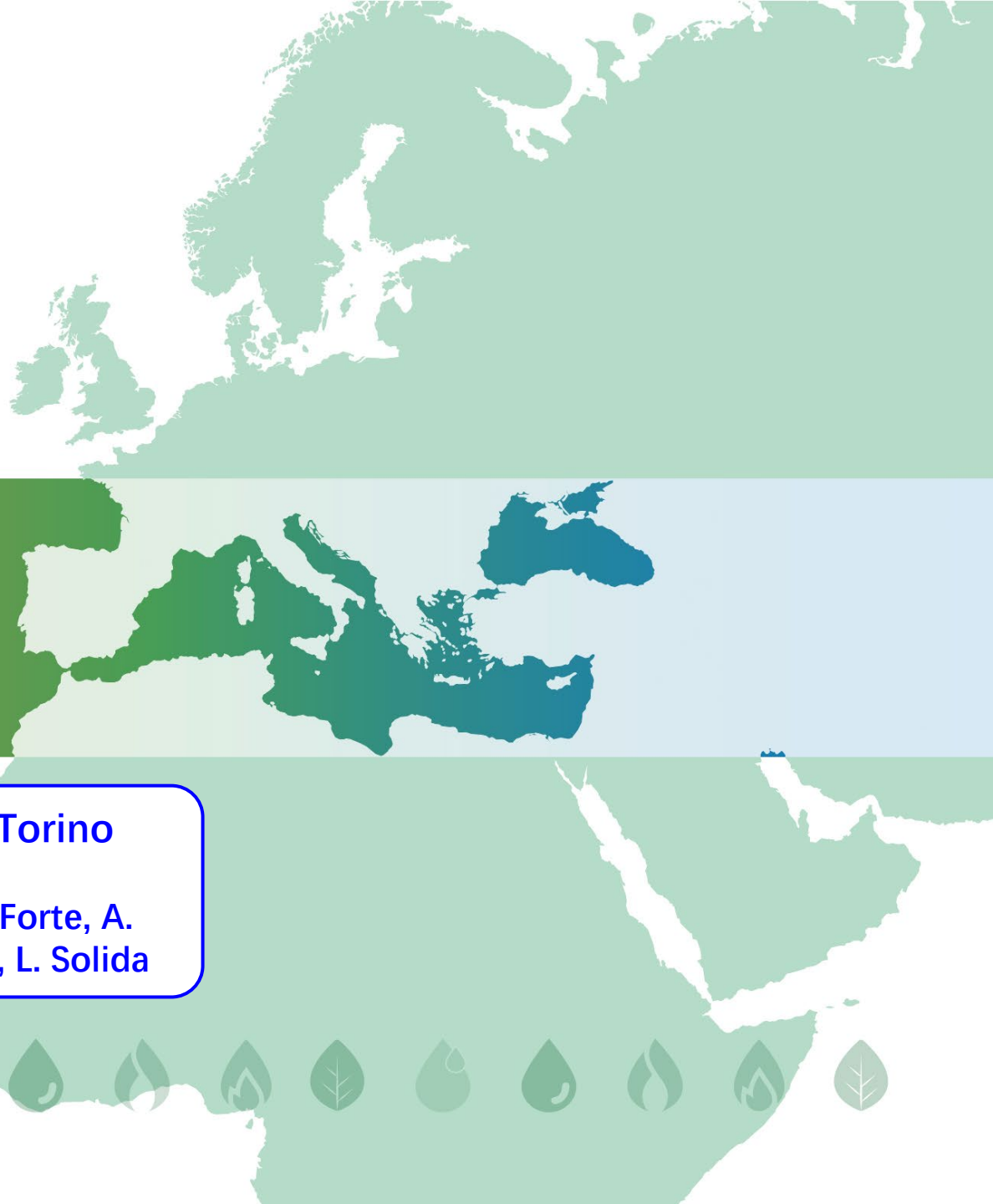
Daily tracking of oil trade routes

Multicommodity Assessment

Assessment of RES producibility potential

Conclusions

- The **geopolitical events** and **relations** widely **affect** the **Mediterranean energy system**, w.r.t. both the current configuration based on a "**black dialogue**" and the possible (desirable) evolution towards a "**green dialogue**", **shifting dependencies** from **fossil** commodities to **critical raw materials**
- Mediterranean countries will have to choose whether to firmly steer towards a **cooperative and cross-shore approach** to energy transition or not. The efforts conducted in the last decades are **insufficient**, and different economic interests and policy priorities still cause a strong inhomogeneous level of renewables penetration across the three shores
- A cooperative transformation of the energy sector in the Mediterranean will have to be based on **two main factors**: a **convergence** of **policies** and **regulations** and the need to **mobilize private actors**.
- Such transformation implies profound **geopolitical changes**: some **beneficial** (new opportunities to industrial ventures, trade and advanced services), some others potentially resulting in **criticalities** (geopolitical tensions due to the change of the economic power of different countries, new dependencies, conflicts for the control of resources)
- Though hydrocarbons are central to the economies of some Mediterranean countries, the transition could be achievable through the production of renewable fuels like **green gases** (biomethane and hydrogen) and **liquid biofuels**, which will mainly be justified by their access to regional markets
- However, there are still **marked differences** between the regulation in the European Union and the Southern and Eastern shores, where the situation is still maturing
- The long-term vision and the implemented actions have to consider the **inescapable policy goals**: **diversification** of sources for increasing the supply security, **decarbonization** of the energy sector, and **alignment with the climate action** while considering social, economic and political objectives



Thank you for your attention

Research Team ESL/EST@energycenter - Politecnico di Torino

M. Alberici, E. Bompard (Coordinator), S. Cellura, S. Corgnati, A. Forte, A. Gallucci, D. Grosso, S. Lo Russo, M. Masera, A. Mazza, F. Profumo, L. Solida