SETTING THE SCENE FOR AN INTERCONNECTED, RENEWABLE MEDITERRANEAN ENERGY SYSTEM

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EXECUTIVE SUMMARY

Today, the Mediterranean region's capacity is 90 GW for solar PV and 82 GW for wind[1]. However, the solar and wind potential is estimated at more than 3 TW, meaning that the development of renewables falls short of realising their full potential.

Far beyond contributing to climate change mitigation, the deployment of renewable energy can enormously benefit local populations and economies, creating added value for societies. Renewables offer an opportunity to tackle the diverse but common challenges faced by countries across the region and relaunch trust in international cooperation. An inclusive energy transition pathway for the region is critical to future-proofing the region against the worst impacts of climate change, creating economic resilience and shielding fossil fuels-producing countries from the volatility of international fossil fuels' markets, providing a stable energy supply to power a competitive industrial regional ecosystem while mitigating geopolitical tensions.

Currently, Spain has the highest installed capacity of PV power (27 GW, adding more than 10 GW only in 2021-2022), followed by Italy and France (25 GW and 18 GW, respectively). Spain also has the highest installed capacity of wind power (30 GW, adding 3 GW in 2021-2022), followed by France (21 GW) and Italy (11.8 GW). Up to today, despite an encouraging annual growth rate in the last years, North African countries have much lower installed capacity, contributing with less than 12 GW of total renewable capacity.

The uneven development of renewables across the two shores of the Mediterranean has largely resulted from supporting mechanisms on the northern shore. Over the last two decades, renewables in Europe have been supported by comprehensive policies. Financial incentives evolved progressively, from initial feed-in tariffs to auction systems to enhance competition and limit consumer costs. The European Green Deal has provided further leverage for the expansion of renewables in Southern European countries and has raised national climate and energy targets.
The expansion of renewable energy in Southern Mediterranean countries has been slower. From a market structure point of view, although the power sectors in many countries were traditionally characterized by a high degree of vertical integration and state control, a gradual but slow transition towards competitive power market status is observed through unbundling vertically integrated power utilities. Even in the Southern shore, the current trends in renewable energy policies witness a shift from feed-in-tariff towards auctions and tender mechanisms.

Therefore, as renewables are nowadays competitive without supporting mechanisms on both shores of the Mediterranean Basin, opportunities for energy market integration between the two shores open.

Energy market integration has long been recognised for offering numerous benefits to energy systems and economies of participating countries: enhanced energy security and power system reliability, supply mix diversification, lower power system costs, and, therefore, lower consumer prices. With increasingly ambitious climate mitigation objectives at the global level, the climate benefits become the key rationale for market integration at the regional level, as it accelerates the scale up of renewable energy through regional collaboration.

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[1] See section 1.1

Energy market integration should be based on the understanding of:

- The scale of the security threat posed by climate inaction in the Mediterranean region.
- The *transition away* from fossil fuels as a matter of mutual energy security and just transition.
- The economic opportunities offered by the clean energy transition to regional economies.
- The shared advantages of integrating the region's energy systems.

This research paper aims to set the scene for an interconnected, renewable Mediterranean energy system by providing the region's current energy picture.

An ambitious scenario to underpin future regional stability declines the COP28 Pledge, committing to triple the world's installed renewable energy generation, at the regional level and describes the possible benefits of installing 1 TW of renewable energy capacity by 2030.

According to this scenario, the potential investments are ~120 billion $ per year, in light of the recent decline in solar and wind technology costs, especially in North Africa, and the opportunities for new jobs around 3 million in the sole supply chain for solar and wind industries.

An interconnected, renewable Mediterranean region can also unlock opportunities for industry electrification, substitution of fossil fuels in electricity production, electrification of household and service energy consumption, and transport electrification.

According to the International Energy Agency, the energy transition also provides an opportunity for North African countries to establish or expand manufacturing of clean technologies and near-zero emissions materials, by already offering favorable business enabling factors for solar PV manufacturing, EV and battery, green iron and steel and ammonia.

However, a comprehensive regional vision is needed to increase economic resilience and boost competitiveness in a low carbon world. A failed, incomplete or uncoordinated energy transition in the Mediterranean region bears, firstly and foremost, social and economic costs for Mediterranean countries and the resilience of their societies. In an ever-increasingly competitive global economy that sees rising protectionism policies and the segmentation of traditional fossil fuels markets, the future of decarbonisation for countries in the Mediterranean region is anchored in both their geographical proximity and the history of Mediterranean relations. Moreover, the structural and progressive decline in European gas demand forecasts jeopardises the stability of traditional North African producer countries, affecting their revenues. On the other side, delaying the needed investments and policy reforms to implement more far-sighted industrialisation policies in the framework of global decarbonisation might lead to the loss of the comparative advantage that North African countries might have by leveraging regional decarbonisation.

Endorsing the target of tripling renewable capacity in the region to reach 1 TW would provide the political framing for current market and energy trends. The upcoming NDC update cycle towards COP30 provides a window of opportunity for countries across the Mediterranean region to set higher ambitions and kickstart the needed policy changes.

A new renewable-based, region-wide approach towards the transformation to a clean, flexible, reliable and secure Mediterranean energy system should promote renewable energy production, electrification of end-use consumption, storage technologies and cross-border electricity exchanges rather than a 360° technological neutrality approach that risks further delaying the energy transition.

The region must have a clear and cohesive financial strategy to unlock investments, combining long-term government policy commitments with strong governance frameworks. Public institutions must take the lead, creating the right incentives for private investment while ensuring financial flows align with the Paris Agreement goals.
The role of National and Regional Development Banks, Multilateral Development Banks, and Export Credit Agencies will be pivotal in this process. Close collaboration between domestic and regional financial actors can provide the necessary financial tools, from public-private partnerships to concessional loans or risk mitigation mechanisms to innovative instruments for foreign exchange risks, to incentivize private investments in renewable energy projects.

Ultimately, achieving a net-zero transition in the Mediterranean depends on effective collaboration between the public and private sectors. Public investment will need to be structured to reduce risks for private investors, leveraging public resources to catalyze the vast amounts of private capital required to meet the region's decarbonization goals. By creating an enabling environment where both can work together, the region can unlock the climate finance needed to transform its energy landscape, meeting both regional needs and global climate targets.

If successfully undertaken, the creation of an interconnected Mediterranean system across the two shores of the Mediterranean Basin could play an essential role in bridging the world's largest market economy – the European Union - to the world's fastest growing population – Africa – linking the Mediterranean region to the sub-Saharan power pools in West Africa (West African Power Pool) and East Africa (East African Power Pool), accelerating Sub-Saharan Africa's decarbonisation.

However, despite scientific evidence for an acceleration of climate action and notwithstanding the positive effects of the energy transition, the European energy diplomacy in response to the Russian invasion of Ukraine in February 2022 risks clashing with European climate targets. Such pursuit of energy security in the exclusive terms of security of gas supplies sends contradicting signals that are not conducive to building the political conditions for a fossil-to-clean shift in the Mediterranean region. Accelerating the clean energy transition represents, first and foremost, an existential matter of regional security and the condition for future prosperity. Only the diversification of renewable energy supply chains can minimise geopolitical risks.

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1 INTRODUCTION

1.1 RATIONALE AND GEOGRAPHICAL SCOPE

The Mediterranean region has always played an important role in global energy dynamics mostly through fossil fuels exploitation (production and transport). Today, the decarbonisation imperative requires a rapid and just fossil-to-clean shift. This analysis aims to assess opportunities and barriers to a regional clean energy transition with the view of building a fully decarbonised, renewable-based, integrated Mediterranean energy and power market in the next two decades.

In this work, the "Mediterranean region" refers to the geographical area including:

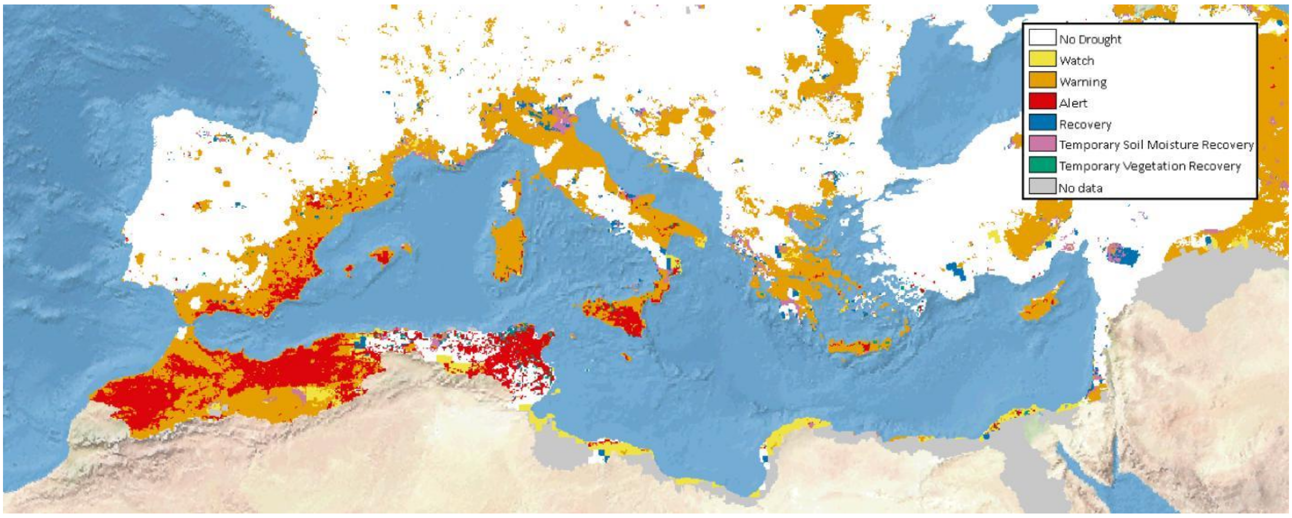
- 4 countries in the Northern shore of the Mediterranean Sea or the Southern European countries of Spain, France, Italy and Greece
- 5 countries in the Southern shore of the Mediterranean Sea or the Northern African countries, ie Morocco, Algeria, Libya, Tunisia and Egypt
- Turkey

1.2 A CLIMATE HOTSPOT

According to Sixth Assessment report of the Intergovernmental Panel on Climate Change (IPCC), the Mediterranean region is a climate change hotspot. Despite relatively low levels of greenhouse gases (GHGs) emission, the Mediterranean climate is warming faster than the global average, with temperatures expected to rise 20% higher than the global average, an increase in temperatures of around 2°C between 2021 and 2040, and an increase of 2.5 °C during summer and fall. More heat waves, dust storms, and extreme weather events are expected in the coming years and decades, affecting biodiversity, livelihoods, and public health.

Cascading climate impacts act as a threat multiplier and exacerbate pre-existing conditions, affecting the social, economic, political, and human security dimensions. These concerns revolve around decreasing availability of natural resources, particularly water, primarily because of the region's heavy reliance on agriculture and pre-existing water scarcity conditions. The altering climate also threatens rural livelihoods and food security, heightening the risk of increased social inequalities. The agriculture and livestock sectors, vital for the economies of countries like Algeria, Morocco, and Tunisia, are especially vulnerable to climate variations. While rising average temperatures pose challenges for all the countries in the Mediterranean Basin, the level of vulnerability of individual countries and communities is not uniform across the region but is determined by the interaction of climatic and non-climatic factors, such as the effectiveness of crisis response, population growth, the resilience of economic systems, and access to finance. All these elements determine the level of resilience of communities and individual countries.

__Figure 1 –__ Drought Indicator for the 10-day period of January 2024



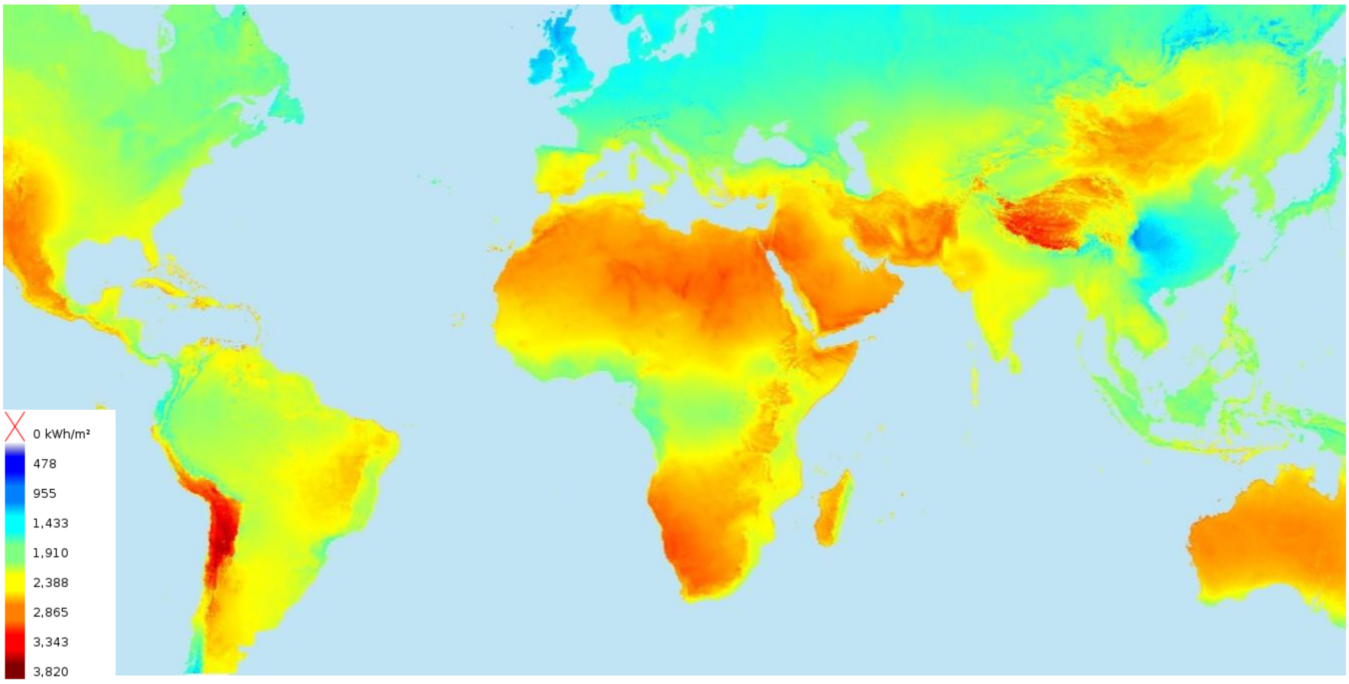
These cascading risks demand more attention from the international climate community, and in particular stakeholders and policymakers, due to the profound security, trade, social, and financial ties among Mediterranean countries. They also underscore the need to prioritise the clean energy transition as well as adaptation and resilience measures across the region, enhancing cooperation among the two shores. Failing to do so, climate impacts will compound local vulnerabilities and have severe consequences for socio-economic stability, human livelihood, economies, and security. An inclusive energy transition pathway is critical to underpin the region's future stability, achieve sustainable development goals, reduce reliance on fossil fuels, mitigate geopolitical tension, and adapt to worsening climate impacts.

2 RENEWABLE ENERGY IN THE REGION

2.1 THE POTENTIAL OF RENEWABLES

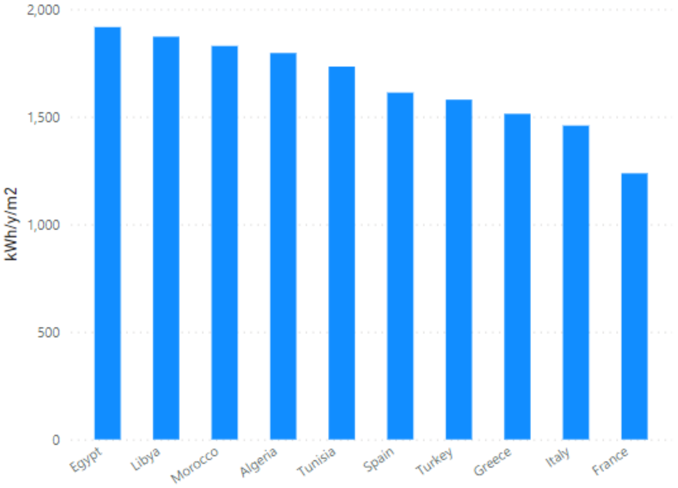
The region's annual average irradiation is 1700 kWh/m2, which ranks it among the most promising for solar power development.

Figure 2 *– [Global solar irradiation (Global Solar Atlas)]*



North African countries have higher average irradiation (1830 kWh/m2) than the Southern European ones (1480 kWh/m2), as shown in Figure 3. Egypt shows the highest figure, with 1915 kWh/m2.

Figure 3 *– Average irradiation by country*



To assess the utility-scale plant potential (and excluding off-grid plants), it is necessary to consider the extension of the electricity infrastructure, as new plants should be connected to the grids.

Figure 4 *– Electricity transmission grid extension by country. ECCO elaboration based on [ESMAP](#) data.*

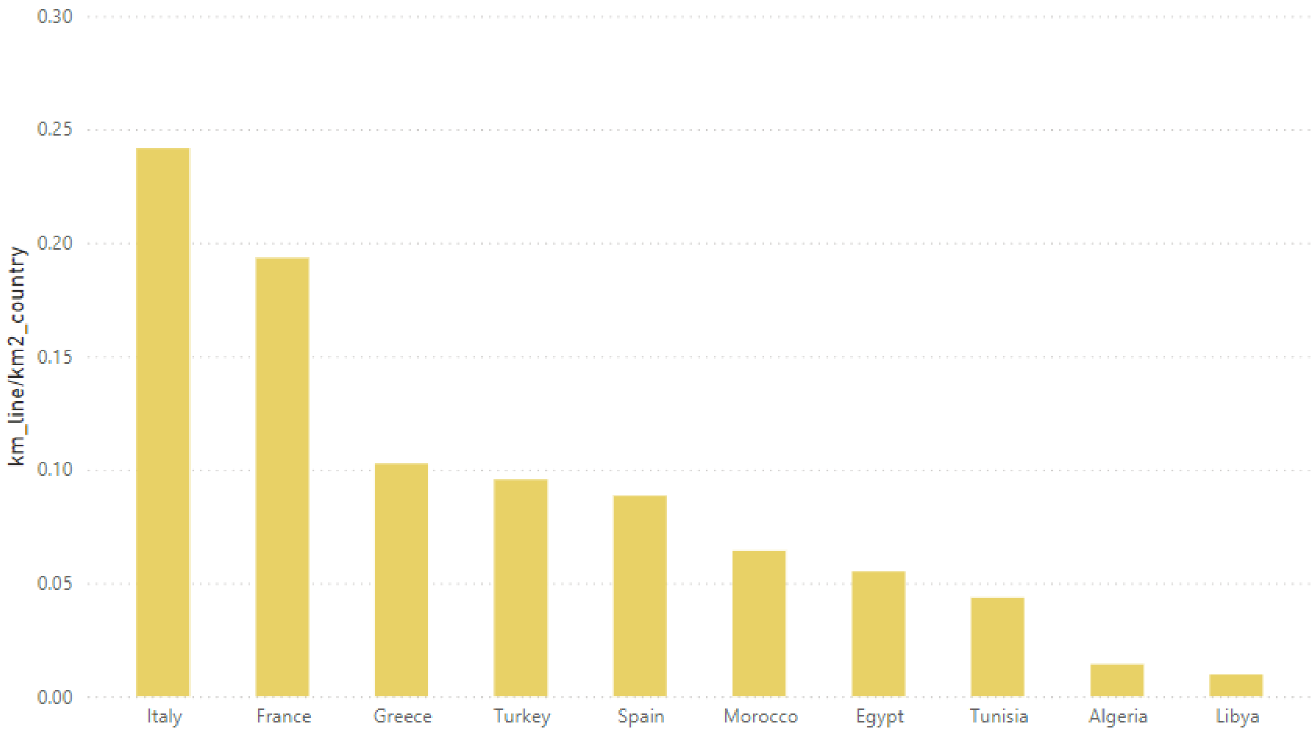


Figure 4 shows the electricity transmission grid and country area ratio, ranging from more than 0.2 km/km^2 in Italy to less than 0.2 km/km^2 in Algeria and Libya. Combining the grid layout with the open-source software QGIS with the areas that exclude land with physical obstacles and possibly under land use regulations due to environmental and cropland protection, the following figure indicates the practical areas for large scale PV plant installation.

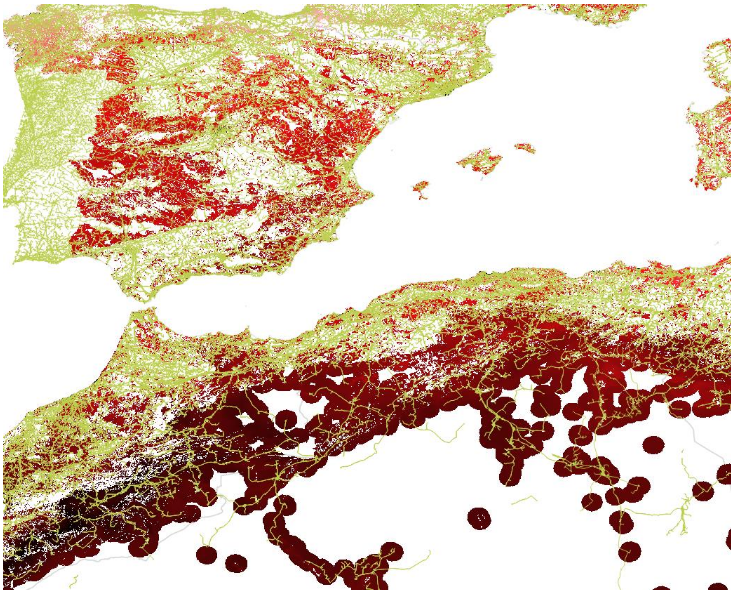
Figure 5 *– Practical areas for large scale PV installation*

The map of the large scale PV's practical potential[2] based on the Global Solar Atlas database is then derived (Figure 6).

Figure 6 – *Large scale PV potential map. ECCO elaboration based on Global Solar Atlas data*[3]

Figure 7 emphasizes that PV potential is closely related to the available infrastructure and stresses its key role in developing renewable energy.

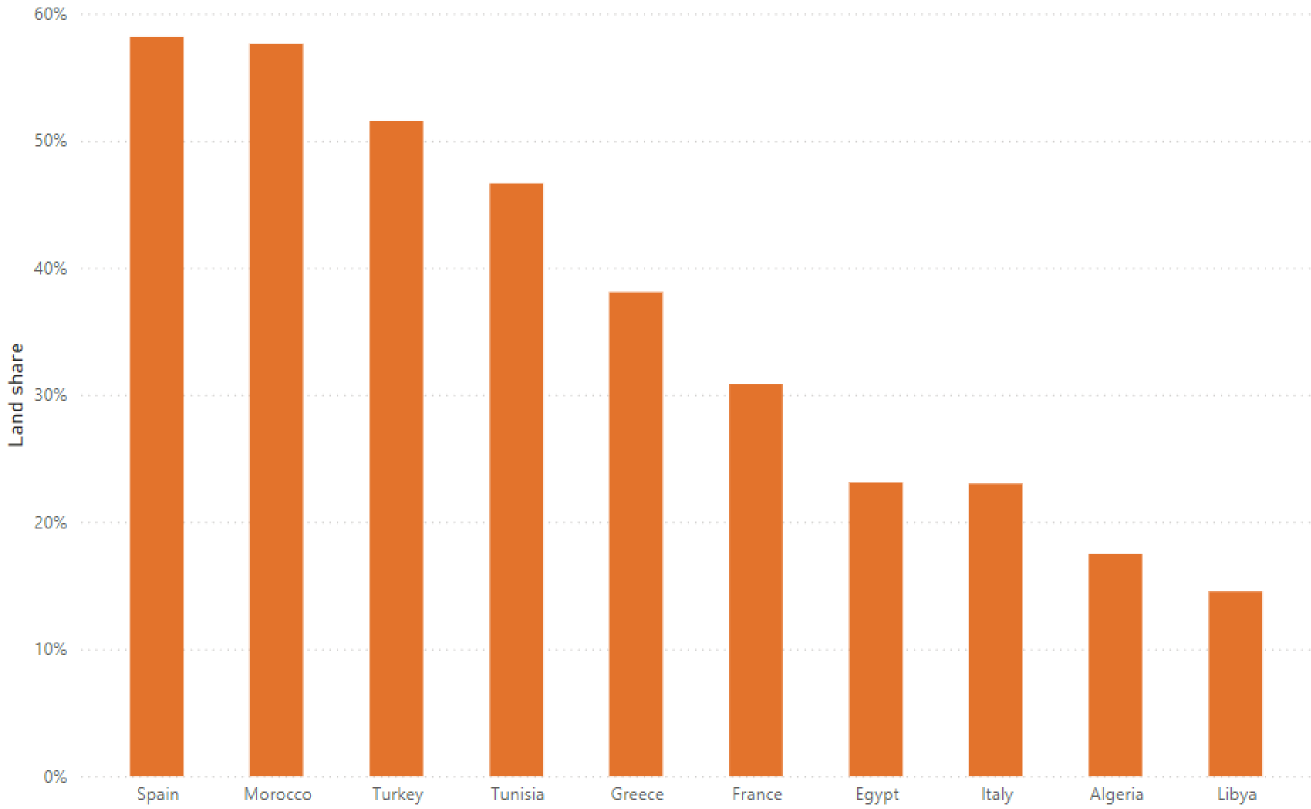
Figure 7 – *Detail of large scale solar PV potential map with current electricity infrastructure. ECCO elaboration based on Global Solar Atlas data.*



[2] i.e., the most suitable areas for utility-scale PV plants

[3] This map is provided for illustration purposes only. The boundaries and names shown on the map do not imply the expression of any opinion on the part of ECCO concerning the status of any region, country, territory, city or area, or its authorities, or concerning the delimitation of frontiers or boundaries.

Figure 8 *– Practical areas land share by country. ECCO elaboration based on [ESMAP](#) data.*



In Figure 8, the share of practical land for PV installation is assessed, showing values ranging from 15% to more than 55%. However, considering the theoretical limit of 1% of the country area for PV installation, as used also by IRENA, it is possible to determine the potential solar capacity that can be installed. Algeria and Libya, thanks to their land extension, present the highest values, followed by Egypt (Figure 9). The whole Southern shore can theoretically host up to 2.5 TW of solar capacity, while the Northern shore 0.7 TW.

At the same time, the current region's solar PV capacity amounts to 90 GW. Spain has the highest installed capacity (27 GW, adding more than 10 GW only in 2021-2022), followed by Italy and France (25 GW and 18 GW, respectively) (Table 1).

***Figure 9** – Large scale PV theoretical capacity by country. ECCO elaboration.*

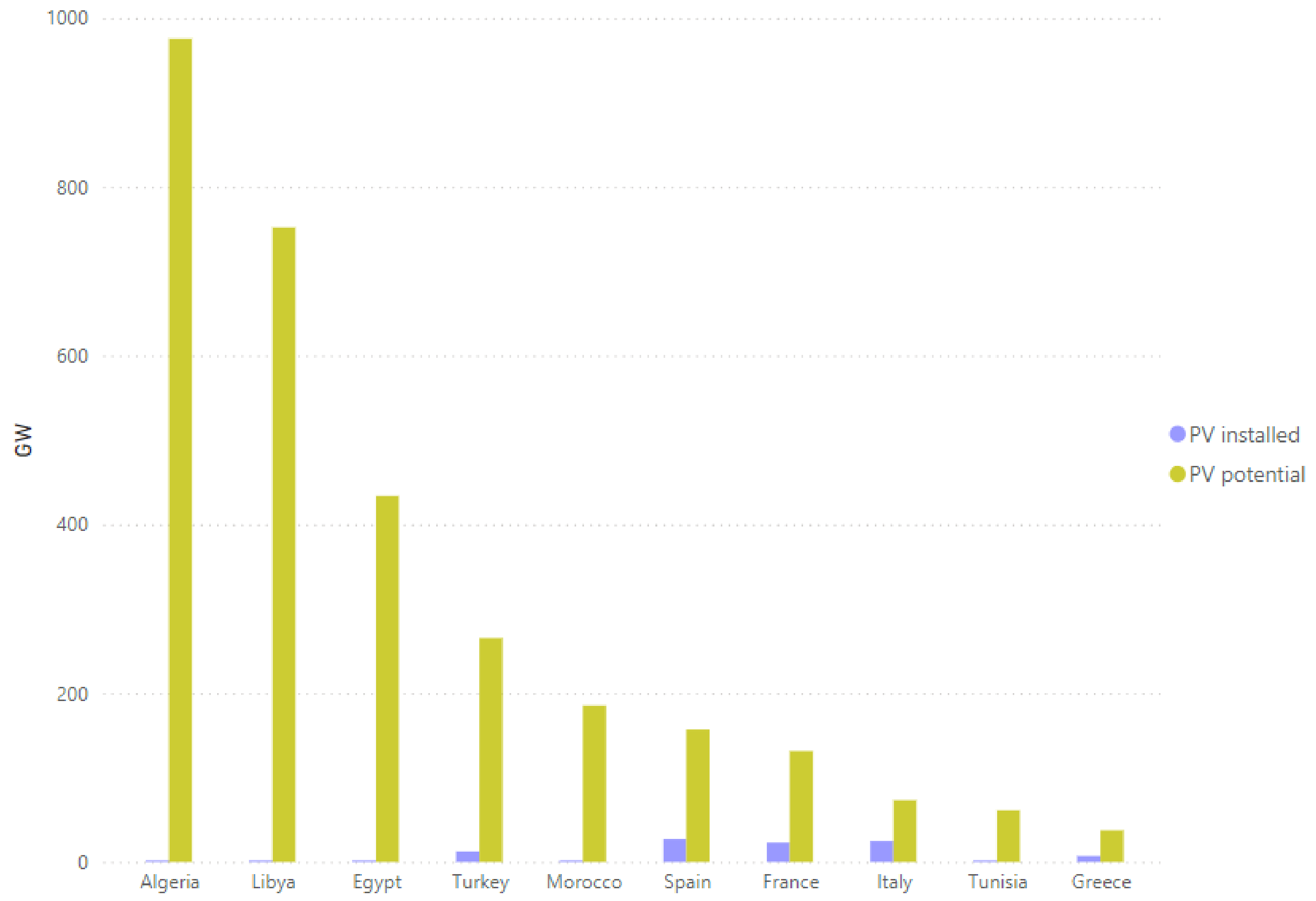


***Table 1** – Large scale solar PV installed capacity by country (IEA, RCREEE)[4]*

Country	Solar PV installed capacity large scale[5]
Spain	27.80
Italy	25.00
France	17.30
Turkey	11.10
Greece	5.40
Morocco	0.83
Egypt	1.67
Algeria	0.50
Libya	0.40
Tunisia	0.02

[4] 2022 data for Algeria, Egypt, Libya and Tunisia, 2023 data for Italy, Spain, France and Greece
[5] On grid. Small scale and off-grid systems are excluded

Similarly to solar potential, the wind potential map has been elaborated based on the Global Wind Atlas database.

Figure 10 *– Global wind power density*

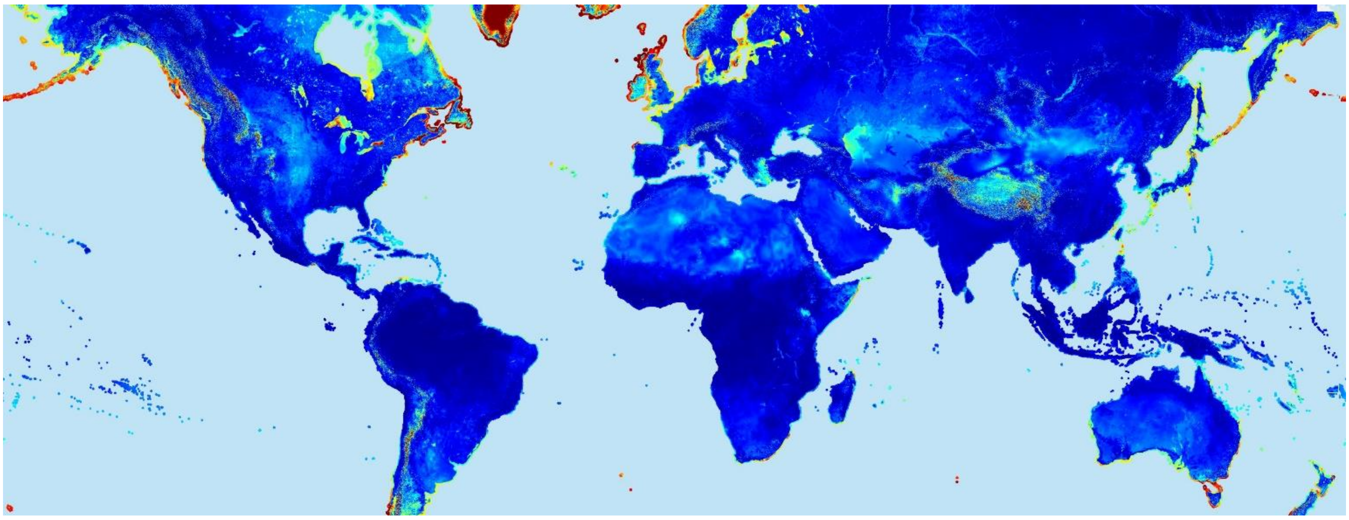
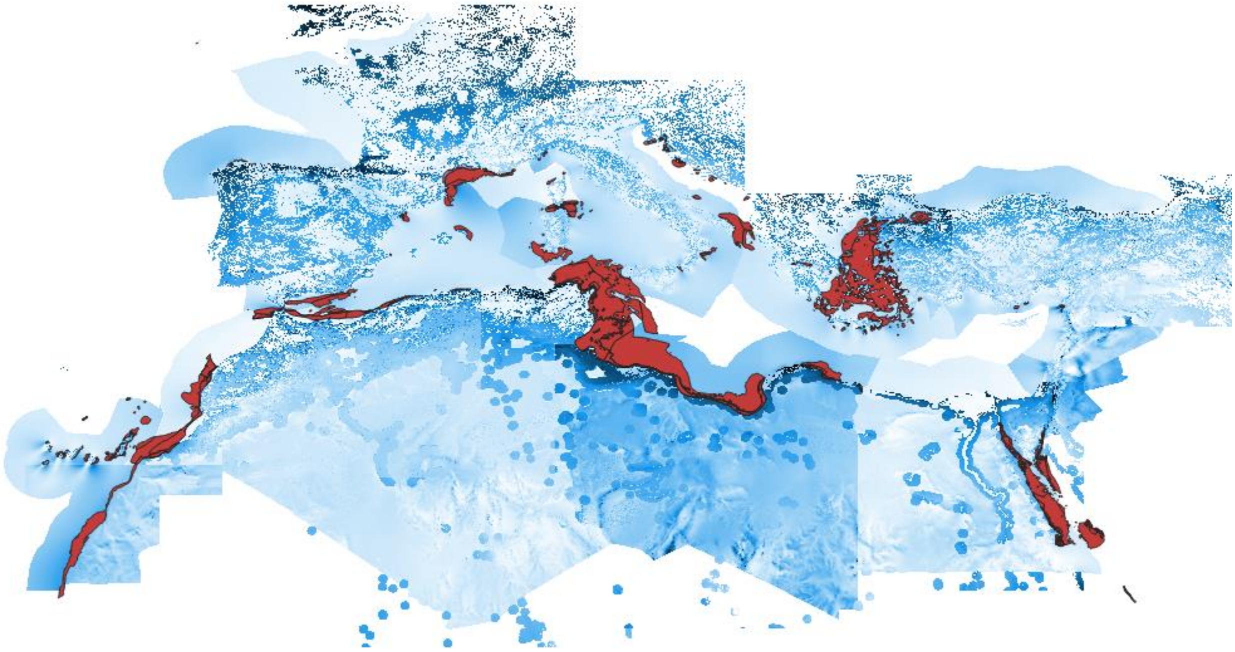


Figure 11 shows the practical areas for onshore and offshore utility-scale wind power plants. Offshore includes both floating, identified with the red colour, and fixed foundation, in purple.

Figure 11 *– Wind potential map. ECCO elaboration based on Global Wind Atlas data*[6,7]

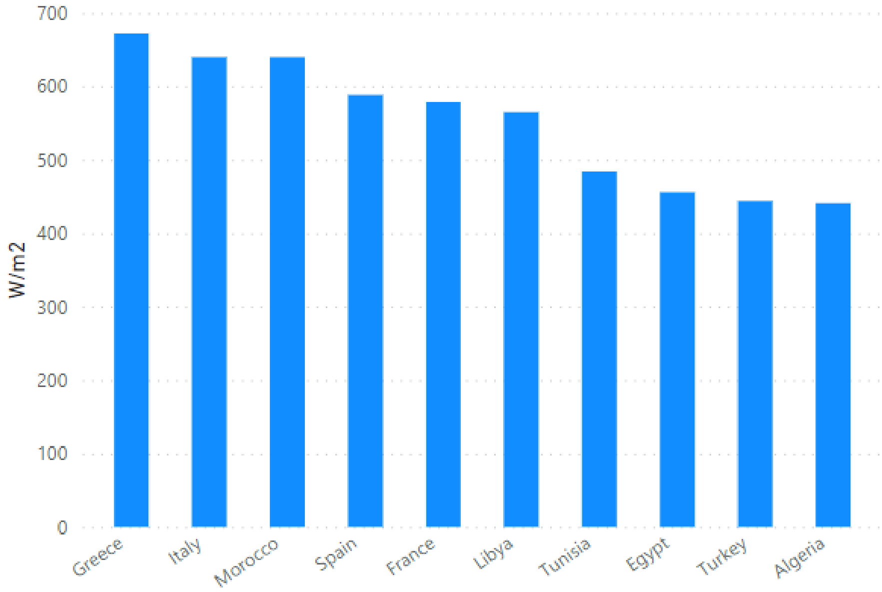


In the case of onshore wind, the difference between Southern European countries and Northern African ones is less evident than in solar. Greece has the highest power density (672 W/m2 at 50m height), followed by Italy and Morocco (both at 640 W/m2).

[6] This map is provided for illustration purposes only. The boundaries and names shown on the map do not imply the expression of any opinion on the part of ECCO concerning the status of any region, country, territory, city or area, or its authorities, or concerning the delimitation of frontiers or boundaries.

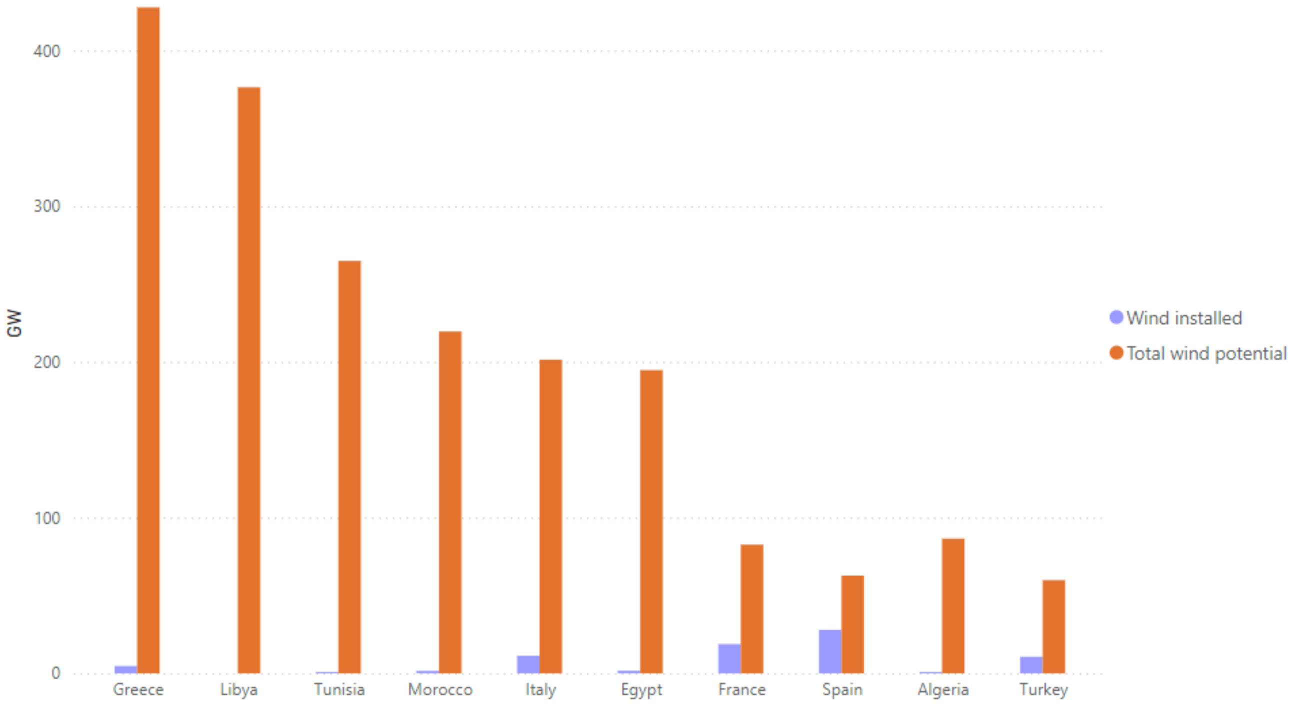
[7] The map does not include the French, Spanish and Turkish suitable areas not located in the Mediterranean Sea

__Figure 12__ – Wind average power density by country.



Once again, Algeria and Libya come out on top (Figure 13) in terms of wind potential capacity [8,9]. The total regional potential could reach 1.8 TW, including 1 TW in the South and 0.8 in the North.

Figure 13 – Wind onshore theoretical capacity by country. ECCO elaboration.



Regarding the current wind installed capacity, the regional total is 82 GW. Spain still has the highest installed capacity (30 GW, adding 3 GW in 2021-2022), followed by France (21 GW) and Italy (11.8 GW). Northern African countries have much lower installed capacity. Morocco and Egypt have 1.3 GW and 1.6 GW of capacity, respectively, accounting for 65% and 29.7% of the southern shore's wind capacity.

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[8] The offshore wind potential capacity by country can be directly derived from the Global Wind Atlas database

[9] Figures do not include French, Spanish and Turkish potential located outside the Mediterranean sea

Table 2 – Wind installed capacity by country (IEA, RCREEE)[10]

Country	Wind installed capacity
Spain	30.3
France	20.8
Italy	11.8
Turkey	11.3
Greece	4.7
Egypt	1.63
Morocco	1.55
Tunisia	0.2
Algeria	0.01
Libya	0

2.2 EXISTING RENEWABLES AND NDCS

The development of renewables in the region, however, falls short of realising the full regional potential.

The development of renewables in Europe over the last two decades has been supported by comprehensive policies, such as the Renewable Energy Directives. Financial incentives also evolved progressively, from initial feed-in tariffs to auction systems to enhance competition and limit consumer costs. Grid modernisation and regional cooperation through the Trans-European Network for Energy (TEN-E) regulation have been critical in ensuring the integration of increasing amounts of renewable energy into the system.

The European Green Deal[11] has provided further leverage for the expansion of renewables on the Northern shore of the Mediterranean and has raised national ambitions:

- **France**'s announcement of a 100GW solar target by 2050 underscored a significant leap in the country's renewable energy ambitions. This target aligns with a broader strategy to accelerate the development of renewable energy, alongside nuclear energy, to meet future energy demands and sustainability goals. These developments highlight France's strategic direction towards reducing reliance on nuclear power and increasing the share of renewables in its energy mix. In 2030, the country NECP foresees 100 GW of total installed renewable capacity.
- **Italy** has experienced significant growth in its renewable energy sector, particularly in wind and solar power, setting records and laying out ambitious plans for future expansion. Italy

[10] 2022 data for Algeria, Egypt, Libya and Tunisia, 2023 data for Italy, Spain, France and Greece
[11] The EU committed to cutting its net greenhouse gas emissions by at least 55 per cent by 2050 compared to 1990 levels, with the final goal of reaching carbon neutrality by 2050. The European Climate Law, adopted in 2021, set both 2030 and 2050 climate goals into legislation. The Fit for 55 package is the first economy-wide decarbonisation project, with provisions including renewable energy deployment, energy efficiency, increased carbon removals, and emissions trading systems. In February of this year, the EU Commission presented intermediate decarbonisation assessment.

aims to generate nearly two-thirds of its electricity from renewable sources by 2030, nearly 120 GW in terms of installed capacity, according to its National Energy and Climate Plan (NECP). Italy is expected to install 12 GW of solar in the 2023-24 period, driven mainly by the industrial segment and supported by ground-mount solar installations. This growth is anticipated due to a combination of more permits being issued for PV projects and increasing installations, potentially reaching 8 GW in 2024.

- **Spain** has set an ambitious target to deploy 76 GW of cumulative PV capacity and 22 GW of storage by the end of this decade, a substantial increase from the previous target of 39 GW set in the older version of the national energy strategy. This update is part of Spain's NECP, which seeks to reduce greenhouse gas emissions by 32% compared to 1990 levels, surpassing the previous goal of 23%. The plan also anticipates a total installed capacity of 214 GW in the electricity sector by 2030, with 160 GW from renewable generation.
- Under **Greece**'s revised NECP, the government aims for 13.4 GW of installed PV capacity by 2030, nearly doubling the previous target. However, IEA suggests that Greece could reach 30 GW of renewable capacity by the end of the decade, indicating a robust momentum in the Greek solar photovoltaic market.

In addition, **Turkey** aims to increase wind capacity to 17 GW and solar capacity to 16 GW by 2027, alongside a goal to reduce greenhouse gas emissions by 41%, raise the share of nuclear energy in electricity generation to 10% by 2030 and aim to reach net zero emissions by 2053.

Figure 14 – *Renewable installed capacity in Northern shore - current vs 2030 NECP*

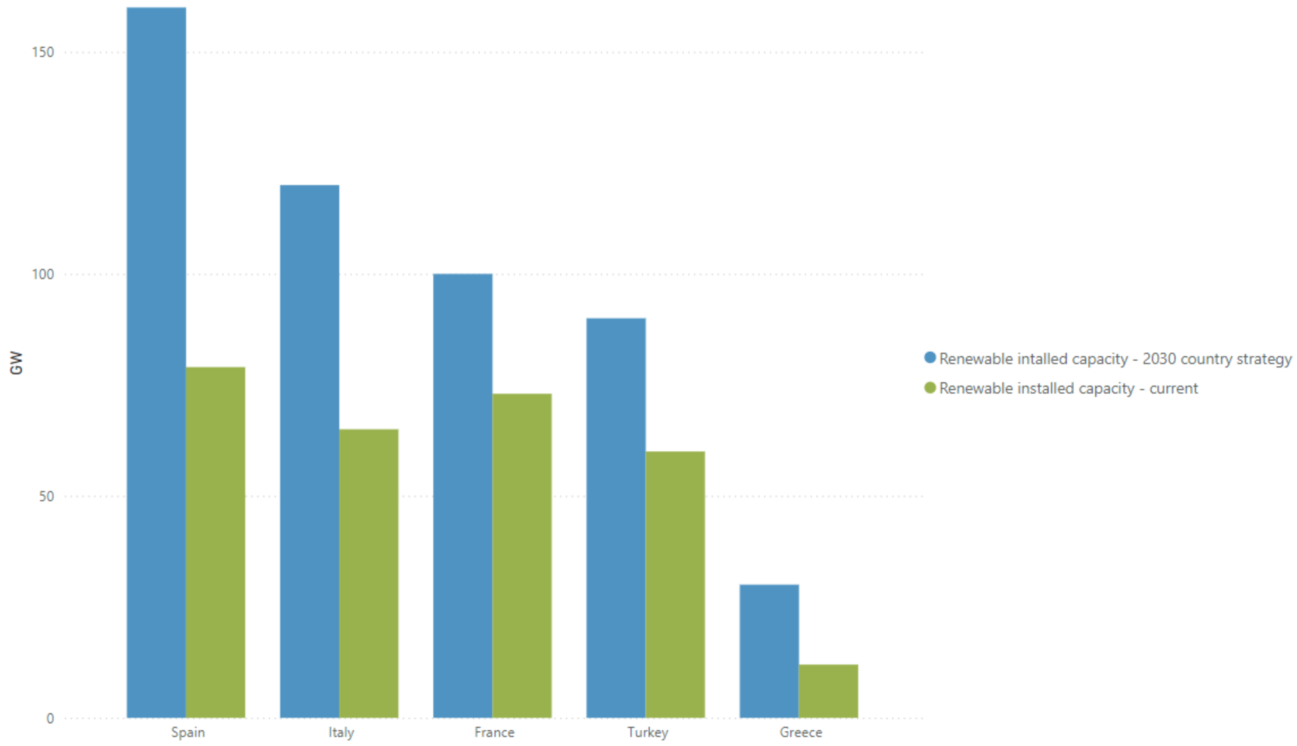


Figure 14 shows the comparison between the current and the 2030 renewable capacity in northern shore countries.

The expansion of renewable energy in North Africa has been slower than in the EU for several reasons. Until 2010s, North African countries have often lacked clear, long-term renewable energy strategies. However, today a gradual but slow transition towards competitive power market status is observed through unbundling vertically integrated power utilities. Reliable and stable regulatory frameworks are essential for attracting long-term investment and the current trends in renewable energy policies witness a shift from feed-in-tariff towards auctions and tender mechanisms. From a financial point of view, still many North African countries face challenges in accessing affordable financing. Higher interest rates and economic instability increase the cost of capital, hampering the capacity of governments and private companies to fund large-scale renewable energy projects. Finally, regional political tensions have hindered deeper collaboration in cross-border energy infrastructure projects, which could otherwise boost the deployment of renewable energy.

In the last years, Egypt, Morocco, and Algeria have contributed to initiating a positive trend in renewable energy generation capacity, with an encouraging annual growth rate of 6%. Egypt and Algeria have invested significantly in photovoltaic power plants in recent years, with most of the installed solar power capacity currently grid-connected. Off-grid capacity is mostly found in the remote regions of southern Algeria.

Except for Libya, all those countries have signed the Paris Agreement and ratified it in their national legislation and submitted their Nationally Determined Contributions (NDCs) describing the mitigation and adaptation actions that they pledge to take to comply with the objectives of the agreement. Table 3 summarises the status of NDCs and renewable energy targets.

***Table** 3 – National renewable energy targets in South Med countries.*

Country	NDC Submission Date	National Renewable energy target
Algeria	20/10/2016	The NDC aims for a 7% (unconditional) to 22% (conditional) reduction in greenhouse gas emissions by 2030 compared with the business-as-usual scenario. The Renewable Energy and Energy Efficiency Development Plan 2016-2030 and the NDC set a conditional target of reaching 27% of electricity generation from renewables by 2030, or 20 GW in terms of installed capacity. Key sectoral targets include: • 9% reduction in energy consumption by 2030 • 27% of electricity from renewable sources 1% reduction in gas flaring by 2030 • 1 million vehicles converted to LPG • 20,000 buses converted to LPG
Morocco	Submitted and updated in 2021	The NDC, updated in June 2021, aims for an 18.3% (unconditional) to 27.2% (conditional) reduction in greenhouse gas emissions by 2030 compared with the business-as-usual scenario. The renewable energy targets in the NDC include reaching a 52% renewables share in installed power generation capacity by 2030 (or 8 GW of installed capacity), of which 20% is from solar, 20% is from wind, and 12% is from hydropower. Morocco also revised downwards the BAU scenario, to which the reduction targets are applied. For the unconditional target, this leads to 21% lower emissions in 2030 compared to the first NDC submission, and 29% for the conditional target.

Egypt	Submitted in 2017 and updated in July 2022	The NDC defines "increased use of renewable energy as an alternative to non-renewable energy sources" as one of the five pillars of mitigation policies. Egypt's updated NDC reiterates the target mentioned in the Integrated Sustainable Energy Strategy 2035 to increase renewables' share in the electricity mix to 42% by 2030. In 2030, the installed capacity forecast is 40 GW. Key sectoral targets include 10% decrease in thermal energy consumption by the iron, steel, fertilizers, and ceramic tiles industries. GHG emissions reduction targets include: • 37% GHG emission reduction by 2030 from electricity generation transmission and distribution • 65% GHG emission reduction by 2030 from oil and gas activities • 7% GHG emission reduction by 2030 from transport sector
Tunisia	Submitted and updated in 2021	The NDC, updated in October 2021, aims for a 27% (unconditional) to 18% (conditional) reduction in carbon intensity by 2030 compared with 2010 as the base year. The NDC includes reaching 30% renewable electricity by 2030 (up from 4% in 2015). The National Renewable Energy Action Plan 2018 targets 3.8 GW of renewable capacity by 2030.
Libya	n/a	The National Strategy of Renewable Energy and Energy Efficiency (2023-2035) targets 17% in 2025, 19% by 2030 and 20% by 2030.

All the NDCs include renewable energy capacity expansion targets for 2030, both unconditional and conditional. Morocco's most ambitious and detailed NDC in the region calls for renewable power plants to make up 52% of installed capacity by 2030, while other NDCs present targets primarily conditional on international financing. Egypt submitted an updated NDC in July 2022 (ahead of COP27 in Sharm el-Sheikh), being so far the only country using quantitative benchmarks divided by sectorial, however conditional, reduction commitments in the electricity production, oil & gas and transportation sector in compliance with the Article 4.4 of the Paris Agreement.

Figure 15 – *Renewable installed capacity in Southern shore - current vs 2030 NECP*

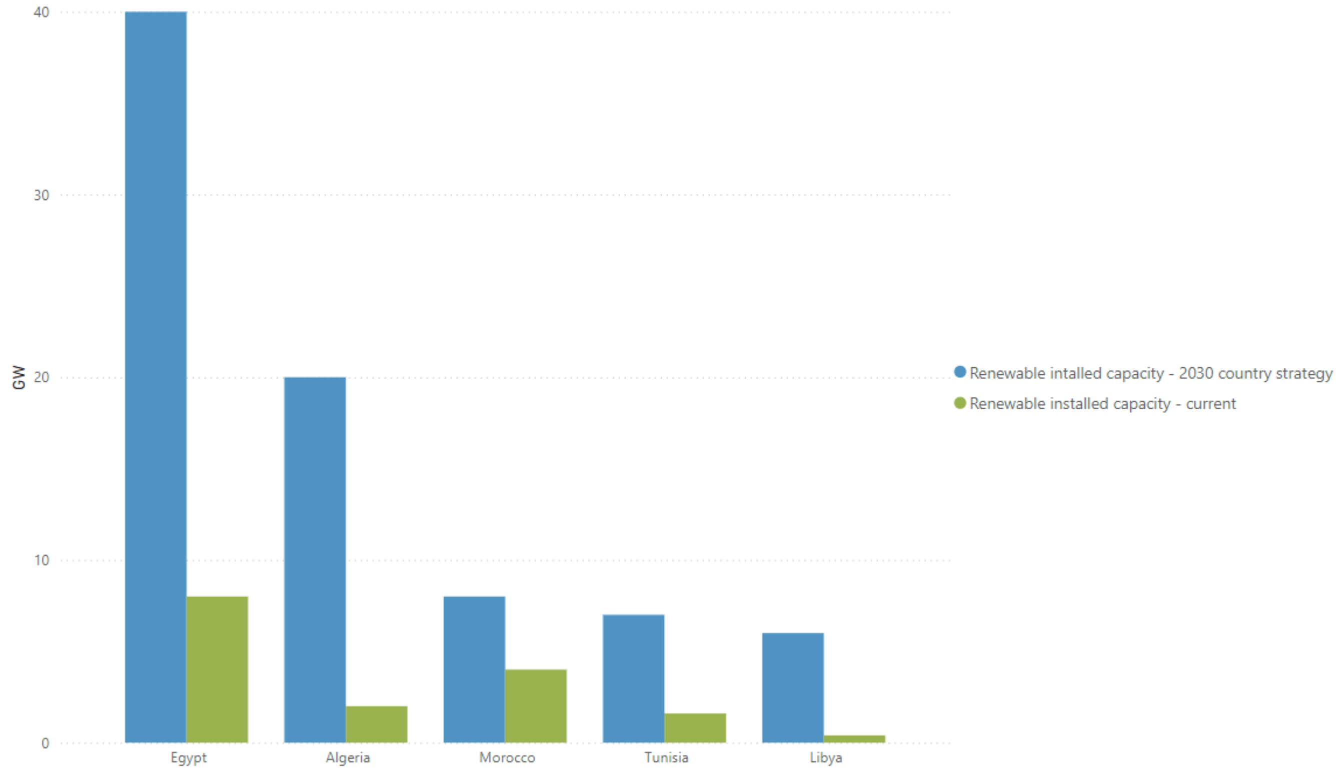


Figure 15 shows the comparison between the current and the 2030 renewable capacity in southern shore countries. The figure indicates higher gaps between the current capacity and ambition in Southern countries compared to Northern countries.

Tunisia and Morocco signed the Global Renewables and Energy Efficiency Pledge[12], while, critically, the two largest O&G-producing countries, Algeria and Libya, as well as Turkey and Egypt, haven't yet signed.

However, Southern Mediterranean countries have supported the Pan-Arab Strategy for the Development of Renewable Energy 2010-2030, which was expanded in 2018 to become the Pan-Arab Sustainable Energy Strategy 2030 and includes energy efficiency and energy access. The strategy aims to reach a 12.4% renewable share in the Arab region's electricity mix and includes a commitment to fostering public and private investment, mitigating the risks associated with grid planning, expansion, and operation, and integrating smart services and quality assurance schemes.

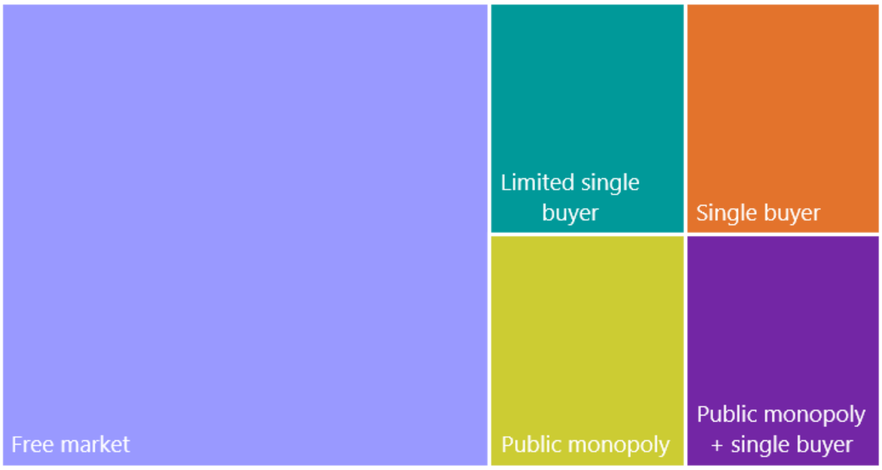
[12] Committing to triple the world's installed renewable energy generation capacity to at least 11,000 GW by 2030, considering different starting points and national circumstances.

3 ENERGY MARKET INTEGRATION

3.1 ADVANTAGES OF ELECTRICITY MARKET INTEGRATION

Today, the region's electricity markets are characterised by different models.

***Figure 16** – Market models in the MED*



In EU countries, contracts are part of a liberalised market, where unbundling, third-party network access, and competition rules are applied at all levels. Interconnections' operations are associated with price differentials between national markets. Cross-border transmission capacity allocation and power exchanges are assigned and concluded on spot markets. Interconnections allow the complementarities between national systems to be exploited, with surpluses from one country offsetting deficits from another.

In North African countries, the internal market structure is completely different. In Algeria, a limited single buyer establishes bilateral contracts between producers and large consumers, while competition is introduced in the wholesale and retail trades. Moroccan regulatory framework establishes a public monopoly at both wholesale and retail levels. In Tunisia, the electricity market is based on the combination of monopoly and the limited single-buyer model. A total single-buyer model can be found in Egypt. The single buyer model guarantees a decision role for the public sector in investments in generation capacity and the control of the electricity company in financial affairs.

Higher harmonisation in terms of legislation and regulation framework in the region is certainly needed to facilitate the efficient exploitation of complementarities between national systems and for the development of interconnections. Currently, electricity trades between the northern and southern shores, limited to the Morocco-Spain interconnection, are concluded on the spot market, although bilateral commercial agreements have been studied.

The competitiveness of renewables, however, offers energy market integration opportunities.

Energy market integration has always been known to offer numerous benefits to the energy systems and the economies of participating countries: enhanced energy security and power system reliability, reduced need for back-up capacity thanks to reserve sharing, supply mix diversification, more efficient use of power plants, lower power system costs (both investment and operating), and therefore lower consumer prices. With increasingly ambitious climate mitigation objectives, the climate benefits become the major justification for market integration, as regional integration facilitates renewable energy scale-up.

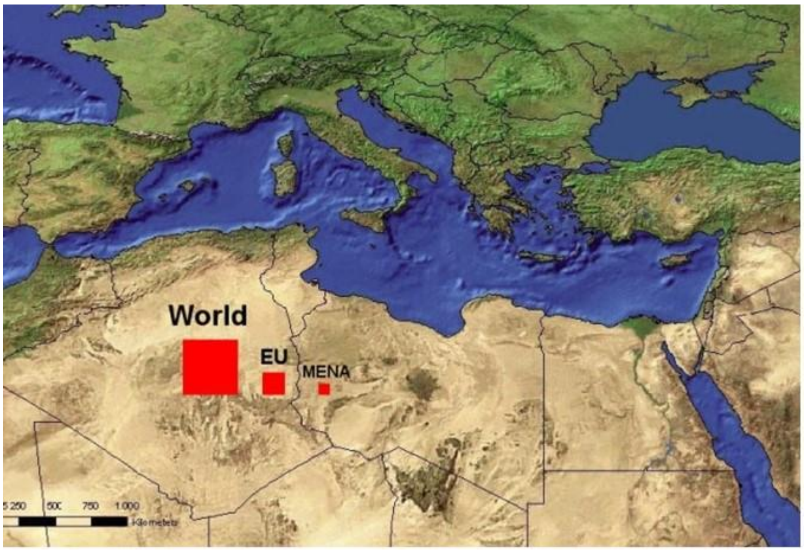
Power systems need flexibility to cope with a high penetration of intermittent and variable renewables. According to the International Energy Agency, flexibility is "the ability of a power system to reliably and cost-effectively cope with the variability and uncertainty of demand and supply across all relevant timescales, from ensuring instantaneous stability of the power system to supporting long-term security of supply". Two key solutions to increase flexibility are storage (batteries, thermal storage, pumped hydro) and regional market integration through interconnections. Whereas storage addresses the time dimension of flexibility, regional market integration is directed at the spatial dimension and makes it easier to balance in real time a large power system with vast quantities of intermittent renewables, as the wind is always blowing and the sun is shining somewhere.

3.2 PAST ATTEMPTS AT INTEGRATION

The narrative for a new energy market integration to fully benefit from the shared advantages must also build on the lessons learned from past projects and attempts to integrate the Mediterranean region.

The most famous is probably the Desertec project. Desertec was developed by the Trans-Mediterranean Renewable Energy Cooperation (TREC), a non-profit organization created in 2003 by the Club of Rome and the National Energy Research Center Jordan, made up of scientists and experts from across Europe, the Middle East and North Africa. The project was based on the concept that the world's deserts receive more energy from the sun than humankind consumes in a year and that an area of 110 km x 110 km in the Sahara desert covered by concentrated solar panels (CSP) could produce the amount of electricity needed by the EU (Figure 17).

***Figure 17** – Map at the base of the Desertec project*



In 2009, to help accelerate the implementation of the Desertec concept, the Desertec Foundation and a group of 12 European companies led by Munich Re, created an industrial initiative called Dii GmbH, with the aim of establishing a positive investment climate for renewable energy sources and interconnected power grids in EU-MENA. The study Desert Power 2050, published in June 2012, demonstrates that the abundance of sun and wind in the EU-MENA region could enable the creation of a joint power network that would allow the MENA countries to meet their expanding needs for power with renewable energy, while developing an export industry from their excess power which could reach an annual volume worth more than 60 billion Euros. By importing up to 20 percent of its power from the deserts, Europe could save up to 30 euros/MWh.

The CSP technology was at the heart of the Desertec concept. Siemens, one of the key members of the Dii consortium, announced, in October 2012, its exit from the CSP business and its withdrawal from Dii. The Consortium thus lost an important anchor company, which may have been a turning point in the history of Desertec. At the end of 2014, most German Consortium members left Dii, which has been deemed both a "failure" and a reorientation in project objectives. At no point over its existence was Desertec, or its successor Dii, able to secure significant funding for specific infrastructure projects, and its contribution was limited to studies. RWE, State Grid of China, ACWA Power and a number of partner companies stayed on board to fulfil the new Dii mission. The initiative was revived in 2020, as Desertec 3.0 with a focus on green hydrogen, covering both domestic markets and exports to Europe, and launched the MENA Hydrogen Alliance.

Building on the hype around Desertec, the period 2008-2013 saw a flurry of initiatives to interconnect the Southern and Northern shores of the Mediterranean, when it seemed that many EU countries would face difficulties in meeting their commitments under the first EU Renewable Energy Directive (RED). A particularly noteworthy one is the Mediterranean Solar Plan (MSP), launched under the auspices of the Union for the Mediterranean (UfM) in July 2008, which had strong political support both from the EU governments and some countries of the Southern shore. The purpose of the MSP was to set up 20 GW of renewable power generation capacity by 2020, using a mix of technology: PV, CSP and wind power. It also aimed to contribute to the convergence of national energy policies and to the emergence of a regulatory environment enabling the massive scaling up of renewable energy in the region. However, the MSP Master Plan failed to receive the political endorsement of the UfM Energy Ministers in 2014 and thus never materialized into concrete projects, leading to its dissolution.

Created in December 2010, based on the EU MED-EMIP MEDRING studies, MEDGRID was a consortium of companies from the electricity production, transmission and distribution sectors and from the financial sector whose objectives was to promote and facilitate the development of a Mediterranean interconnection system to enable the electricity exchanges foreseen in the MSP. On 24 November 2011, MEDGRID and Dii signed a Memorandum of Understanding to cooperate on the design and implementation of the Euro-Mediterranean super-grid, but no developments have been made public since 2013.

The only initiative specifically supported by a country of the South was the Sustainable Electricity Trade (SET) Roadmap. The SET Roadmap was launched during COP22 in Marrakech at the initiative of the Moroccan government, with MASEN (the Moroccan Agency for Sustainable Energy) acting as Secretariat, to establish the technical, market and regulatory conditions for unimpeded trade of renewable electricity between Morocco and four European countries (France, Germany, Portugal and Spain). After preparatory studies confirmed the potential benefits of electricity market integration between the five countries and identified the requirements in terms of regulatory convergence, trade agreements, interconnection investments and interconnection management, the five countries signed an MoU during COP27 to take all necessary actions to enable renewable electricity trade, focusing in the short term on cross-border renewable power purchase agreements (CPPA).

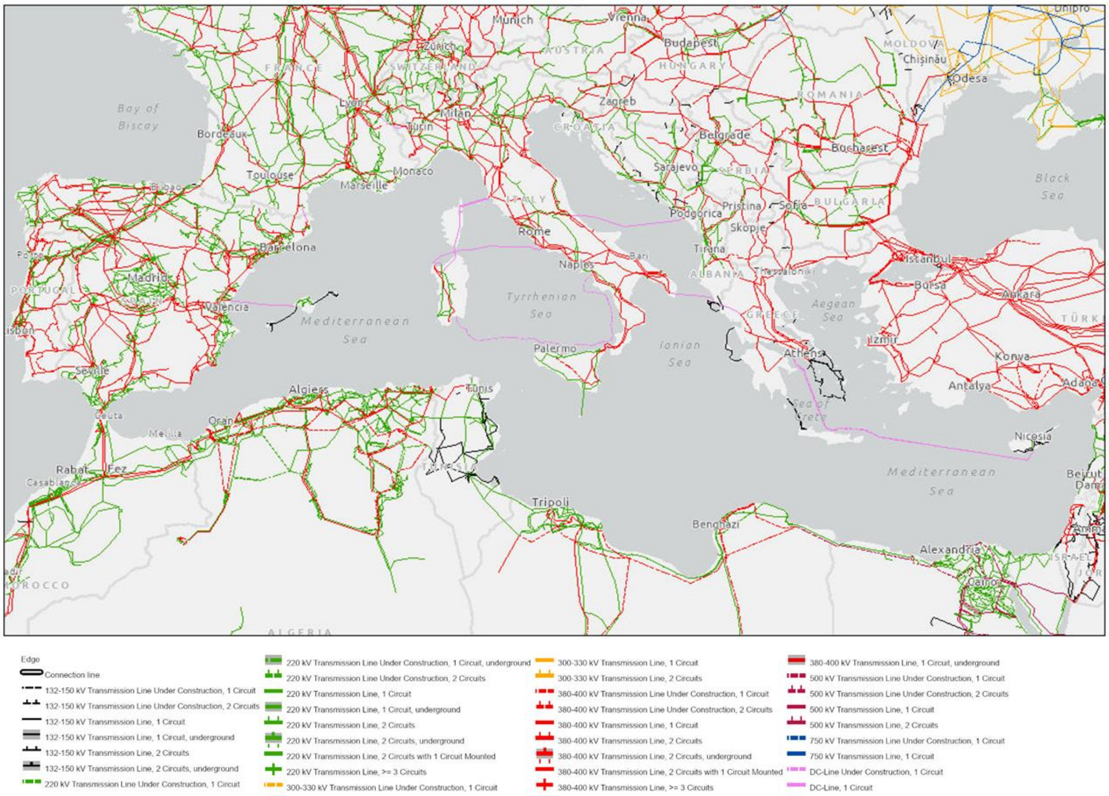
Today, successful initiatives aiming at energy cooperation between the Mediterranean shores are MEDREG, MED-TSO and MEDENER. These are technical platforms that include national regulators, system operators and energy agencies, respectively. Co-funded by the EU and following a bottom-up approach, they promote best practices and provide knowledge and training using multilateral cooperation as a strategy for regional development.

4 PRESENT AND FUTURE INTERCONNECTIONS IN THE MED

Today, Europe's national transmission networks consist of approximately 500,000 km of lines between voltages of 110-400 kV, and over 25,000 km of new lines are planned between now and 2026 (5195 of which in Spain, 2067 in Greece, 770 in France, 560 in Italy)[13]. Adding the distribution lines, the total length of the European electricity grid is 11 million km. The transmission and distribution grid length across the Maghreb region is ~1 million km, and the electricity access reaches almost 100% in every country.

The only interconnection between the two Mediterranean shores currently existing is represented by two high-voltage cables connecting Spain and Morocco. The current Net Transfer Capability (NTC) is 900 MW from Spain to Morocco and 600 MW from Morocco to Spain and is an important factor in stabilizing supplies. An additional 700 MW expansion is expected by 2026.

***Figure 18 –** Entso-e grid map*



Today three interconnected zones exist in the region:

- The synchronous region of continental Europe (CESA), that ensures the balance of the entire European grid. It is coordinated by ENTSO-E under the mandate of the European Union.
- The synchronous region of the Maghreb, including Morocco, Algeria, Tunisia, and Libya, grouped under the COMELEC (the Maghreb Electricity Committee) in the western Mediterranean.

[13] The EU Grid Action Plan for Grids includes €584bn of new investments required by 2030 to upgrade Europe's grids.

- Turkey is connected to CESA through a cable with Greece (400kV) and Bulgaria (400kV) in the Eastern Mediterranean.

European countries share reliability standards of electricity systems, and the market model allows high levels of exchange through interconnections. **Italy** has 26 interconnection lines with neighbours, including connections with France and Greece. The average winter capacity is around 9700 MW, and, in the summer, around 8200 MW. The exchange capacity of the interconnections in **France** achieves an estimated export capacity of 17 GW and an estimated import capacity of 11 GW (including 2.8 GW of interconnection capacity with Spain). **Greece** has seven high-voltage lines (Bulgaria, Albania, North Macedonia, Italy, and Turkey) with a total theoretical capacity of 7400 MW operating only at a total capacity of 2500 MW.

Turkey has 11 cross-border interconnection lines with its neighbours, with a capacity of around 9600 MW. Four lines are not in operation (2100 MW), and three lines operate in synchronous modes with Bulgaria and Greece (4000 MW); the remaining interconnections are either in isolated island mode or for emergencies.

In North Africa, the organization is not comparable. Cross-border interconnections are not well developed, and the existing ones are not operating at their full potential. **Egypt** has only two interconnection lines with Libya and Jordan and three more under construction or in the negotiation phase with Sudan, Saudi Arabia, Cyprus and a reinforcement of the interconnection with Jordan. **Algeria** has five interconnections with Tunisia and four with Morocco. The capacities of these lines are limited to 600 MW exportation and 300 MW importation with Morocco and 275 MW with Tunisia for security purposes.

In developing cross-border interconnections, the cooperation between the National Regulatory Authorities (NRAs) and TSOs is crucial.

One of the challenges for Mediterranean cross-border interconnections is the assessment mechanism of the Cross-Border Cost Allocation (CBCA), i.e., the costs incurred when electricity is transmitted across the networks of different TSOs. These charges compensate the TSOs for the use of their grid infrastructure during cross-border electricity transactions and should ensure fair compensation across borders. In that regard, the role of platforms such as MEDREG and MED-TSO is crucial in coordinating the knowledge transfer. Reflection on this issue is already underway, and progress has been made on the northern shore of the Mediterranean, while it is relatively new in the countries of the southern shore.

In Italy, the national TSO (TERNA) is responsible for designing and building interconnection infrastructures. TERNA plans and builds interconnections based on a long-term plan that has to be approved by the regulator (ARERA) and is consistent with the ENTSO-E long-term EU plan. In Greece, the TSO (IPTO) participates in the South East Europe Coordinated Auction Office (SEECAO), where Control Areas allocate cross-border transmission capacity, and in the Joint Allocation Office (JAO), which performs transmission capacity long- and short-term auctions for the Greece–Bulgaria and Greece–Italy lines.

On the Southern shore, the Algerian System Operator (APRUE) monitors and operates the interconnections, exchanging information on energy exchange planning and compensation for involuntary exchanges with neighbouring TSOs. In Egypt, EETC builds interconnectors once approved by the ministry and monitors commercial operations and electricity transactions.

It is MED-TSO that can help envision the future of interconnections in the Mediterranean region. The Med-TSO Masterplan includes the assessment of 19 interconnection projects that have been grouped into five corridors:

- Western Mediterranean Corridor (Algeria, Morocco, Portugal, Spain)
- Central Mediterranean corridor & North Africa Backbone (Algeria, Egypt, Italy, Libya, Tunisia)
- East Mediterranean interconnectors (Cyprus, Egypt, Greece, Israel, Türkiye)
- Eastern Balkan corridor (Bulgaria, Italy, Greece, Türkiye)
- Middle East Mediterranean Integration (Egypt, Jordan, Palestine, Syria, Türkiye)

Collectively, these new interconnections can provide around 19 GW of interconnection capacity in the region. The most advanced is the Tunisia-Italy interconnection (ELMED), which will connect the two shores of the central Mediterranean, strengthening the integration of the Euro-Mediterranean market when commissioned in 2028. The project has been granted the status of Project of Common Interest (PCI) under the Connecting Europe Facility (CEF), thus being awarded a 307 million Euros CEF grant, and has reached financial close.

In addition, the ENTSO-E 10-year network development plan (TYNDP2024) includes four merchant projects not included in the MED-TSO Master Plan: the Greece-Africa Power (GAP) project interconnecting Egypt and Greece at the island of Crete, the XLink project linking Morocco to the United Kingdom or/and Germany (the project also includes dedicated production facilities in Morocco, using PV, wind and batteries), the MEDLink Interconnector from Algeria and Tunisia to Italy and the TuNur project linking Tunisia to Italy and possibly Malta.

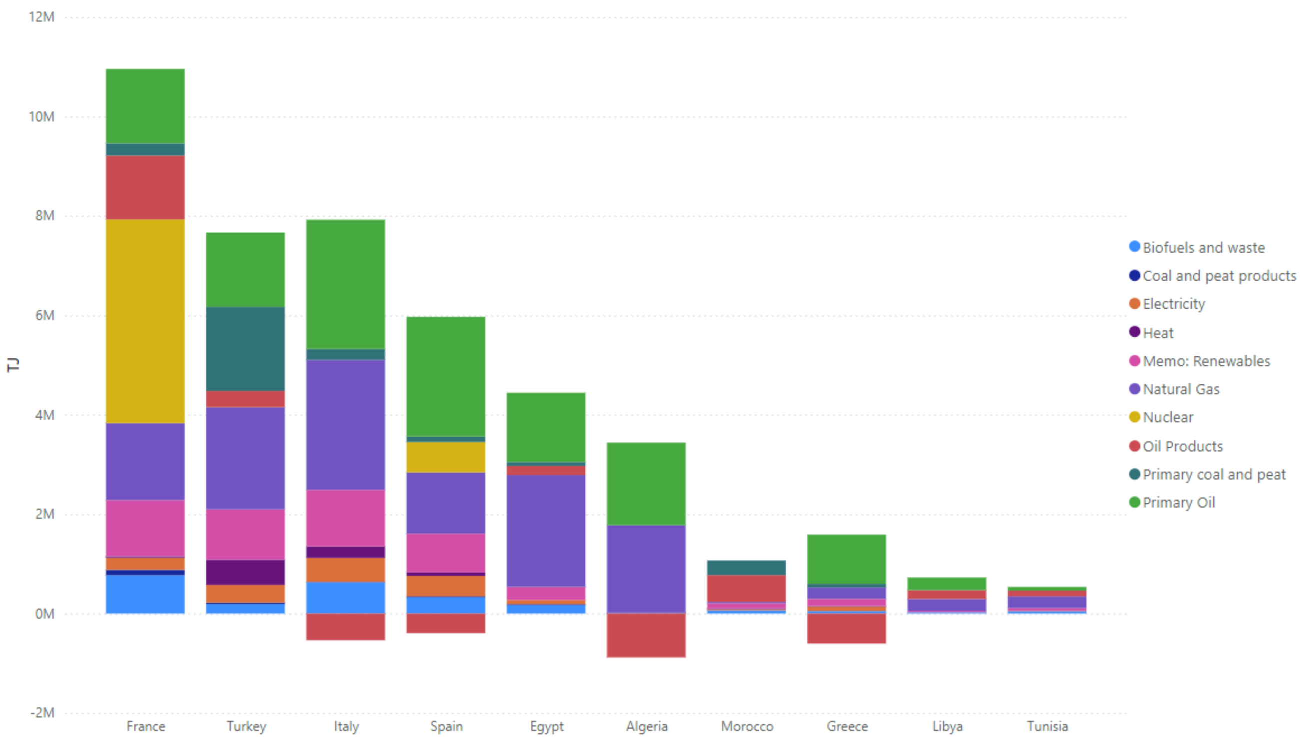
Besides connecting the North and South shores of the Mediterranean, the creation of an integrated Mediterranean market to facilitate large-scale renewables development also requires strengthening the networks between countries on the Southern and Eastern shores of the Mediterranean. Such projects are included in the Med-TSO Master Plan under the "North African Backbone", part of the Central Corridor, and the Middle East Mediterranean Integration Corridor.

Interconnection of the eight-country block (Egypt, Iraq, Jordan, Lebanon, Libya, Palestine, Syria, and Turkey - EIJLLPST) was initiated in 1998 by Egypt, Iraq, Jordan, Syria, and Turkey as part of an effort to upgrade their electricity systems to a regional standard. With Turkey now fully synchronized with the European grid, the EIJLLPST electricity network could potentially become more integrated with the grids in Turkey and Europe. When the 3000 MW Egyptian-Saudi interconnection is commissioned in 2025, the Gulf Cooperation Council (CCG) market will be connected to the EIJLLPST and Mediterranean markets, creating a large area where power systems can be optimised.

5 AN AMBITIOUS SCENARIO FOR THE REGION

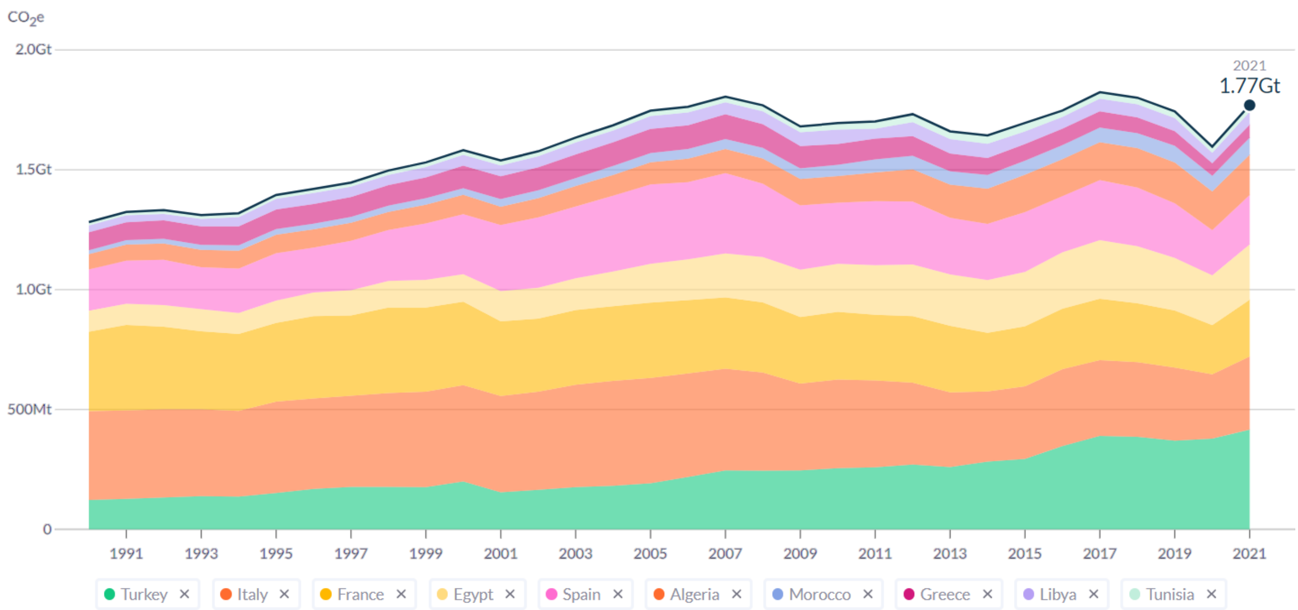
Today, the region's energy supply is dominated by fossil fuels and is characterised by enormous differences.

***Figure 19** – Total energy supply by country (UN, 2021)*



Looking at Figure 19, the strong difference in energy supply among countries in the region is evident. There is an x10 ratio between France, the country with the highest supply, and Tunisia, the lowest.

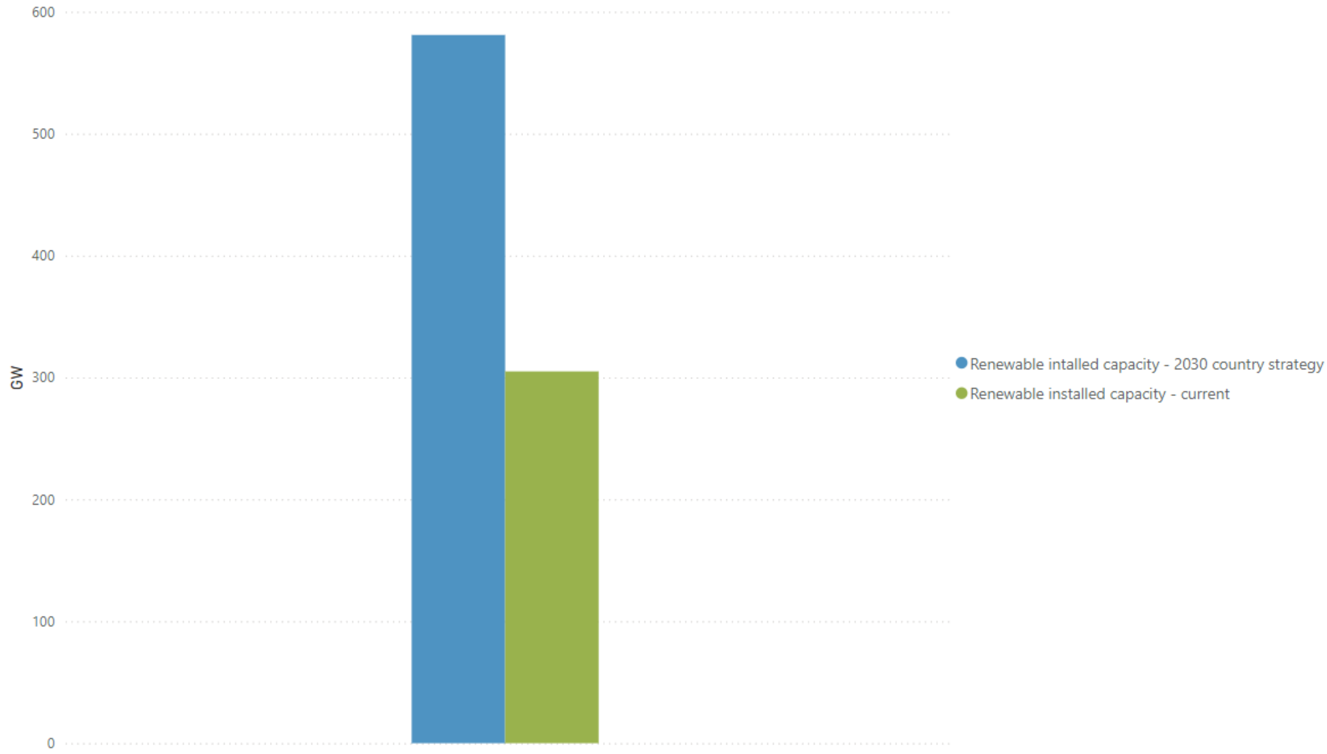
***Figure 20** – Total CO2 emissions by country (Climatewatch, 2024)*



According to Climatewatch, in 2021 the CO_2 emissions reached 1.8 Gt (2.4 considering all greenhouse gas emissions), with Turkey being the major emitter (416 $MtCO_2$), followed by Italy (304 $MtCO_2$), and France (236 $MtCO_2$). Egypt was the major emitter in the Southern shore (230 $MtCO_2$), higher than Spain.

Today, the total capacity of renewables (including hydro and other renewables) is ~310 GW. Existing national targets are estimated to add other ~260 GW (including both conditional and unconditional), achieving ~560 GW of installed renewable capacity in the MED by 2030. However, declining the global target of tripling renewable installed capacity by 2030, the NDCs fall short.

Figure 21 *– Countries' strategy vs current renewable installed capacity in 2030.*

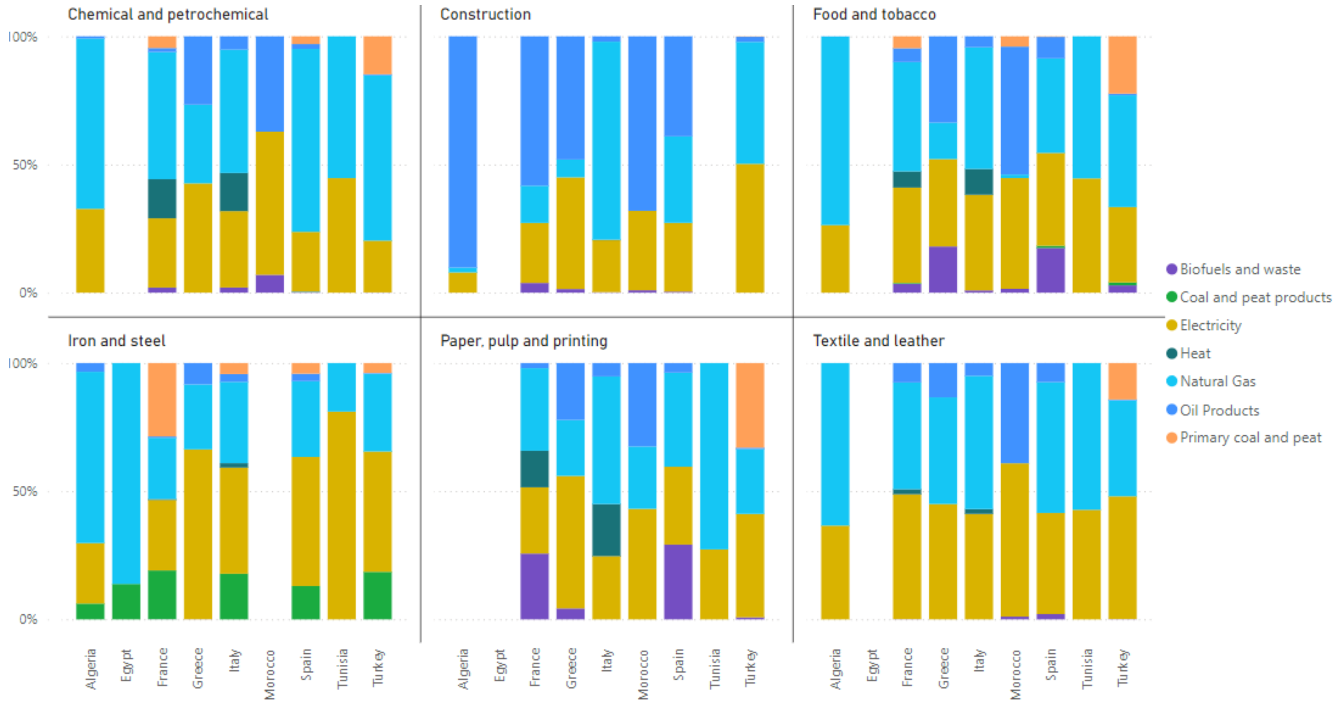


Below, a simple exercise assuming an ambitious x3 increase of renewable installed capacity, therefore reaching 1 TW, shows possible impacts on the final energy consumption sectors:

1. **Electrification of industry heat demand:**

Today, the final consumption of industry sectors in the Med is ~10EJ. Except for the construction sector, where oil plays a relevant role, gas and electricity are the primary fuels, as Figure 22 shows.

Figure 22 *– Industry final consumption share by source and country ([UN, 2021](#))*



While electricity is generally used for running machinery, gas is used primarily for process heat. 1 TW can serve the electrification of such process heat and accelerate the sector's decarbonisation. ~300 GW would allow 50% of low-temperature heat, equivalent to 290 TWh_{TH}, to be produced by heat pumps (assuming 20% of solar thermal penetration), 50% of high-temperature heat, equivalent to 340 TWh_{TH}, produced by electric boilers. The 1 TW therefore would allow the industry sector to undertake an electrification pathway more ambitious than the [International Energy Agency Announced Pledge Scenario](#) and pave the way to achieve net zero emissions. It would also allow the decarbonisation of 3% non-electrifiable heat demand in chemical and non-ferrous metal through the production of green hydrogen (see **[Box 2: Hydrogen in the Med](#)**).

Figure 23 *– Electrifiable share of low-temperature heat in the industry by ~30% of 1 TW [TJth]*

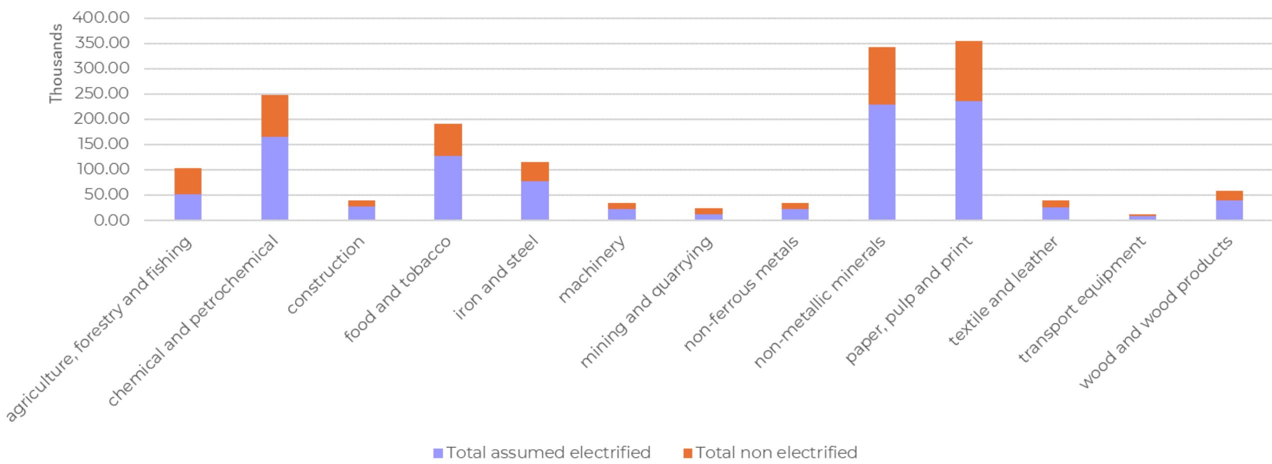
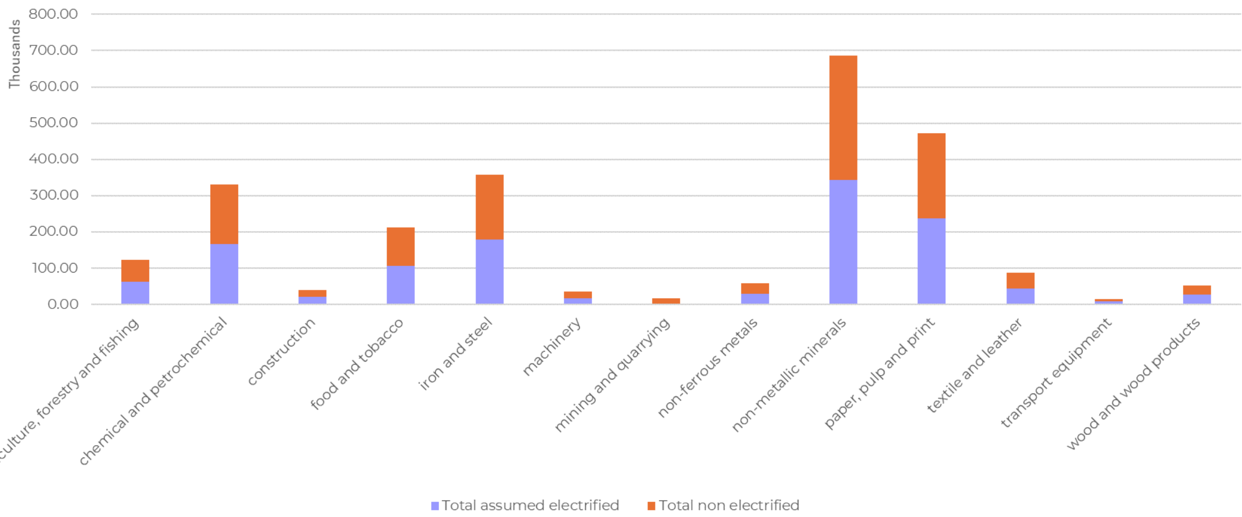


Figure 24 *– Electrifiable share of high-temperature heat in the industry by ~30% of 1 TW [TJth]*



BOX 1: REGIONAL TRADES AND THE EU CBAM

France, Italy, and Spain are among the first destinations (the actual first destinations in some cases) of trade for North African countries. Major trades include, of course, oil and gas products from Egypt, Algeria, and Libya to the EU. In 2022, these six countries traded oil and gas products for ~50 billion $[14]. Italy has re-exported refined products for ~3 billion $ to North African countries, and Spain for 1.8 B$.

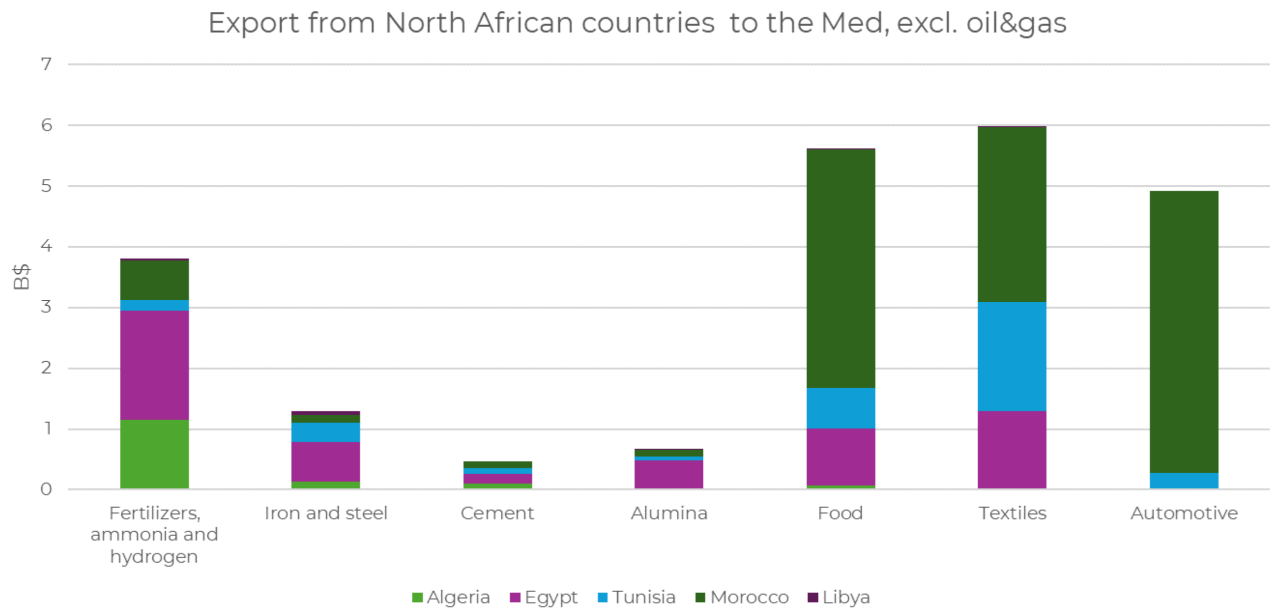
Other sectors have much lower figures for exports from North African countries to the rest of the region (Figure 25):

- Textiles reached ~6 billion $, and sees a significant share of Morocco (48%), followed by Tunisia (30%) and Egypt (21%)
- Food export reached 5.6 billion $, with Morocco exporting 70% of the total value
- Fertilizers and inorganic chemicals trades, including ammonia and hydrogen, achieved 3.8 billion $. In this sector, Egypt exported 47% of the value, followed by Algeria 30%.
- Automotive (Cars, tractors, trucks and parts) reached ~5 billion $, having in Morocco almost the only supplier (94%).
- Iron and steel achieved ~1.3 billion $, with Egypt exporting the 50%, and Tunisia the 25%
- Alumina and cement, ~0.7 billion $ and ~0.5 billion $, respectively, saw a share from Egypt of 74% and 34%.

Primary exports from France, Italy and Spain to North Africa include cereals (France traded ~2.5 billion $ to Morocco and Algeria), and machinery and mechanical appliances and parts.

[14] Based on ECCO elaboration of OEC data

Figure 25 – Exports from North African countries to the Med, excl. oil&gas



Morocco and Tunisia represent two examples of economies that are not dependent on the oil and gas industry. The two countries have specialised in different sectors, such as automotive, food and beverage and textiles. These sectors are easy to electrify and decarbonise with already commercially viable technologies (i.e., heat pumps and electric boilers can produce the heat required, especially in food and textile, where it is almost 100% low temperature). Egypt has a diversified and integrated economy, exporting multiple products to the Mediterranean region. It counts 9 main firms in the iron and steel sector, more than 9000 chemical companies, and more than 17.000 firms in the non-ferrous metal sector. Algeria's primary exports, after gas, are fertilisers, ammonia, and hydrogen, in which more than 140 companies are operative. This sector is expected to grow due to the increasing demand for hydrogen and related products (see **Box 2: Hydrogen in the MED**), therefore, it represents a key sector for the energy transition. However, hydrogen imports will fall under the European Union's Carbon Border Adjustment Mechanism (CBAM), together with iron and steel (where Algeria counts 7 main companies employing more than 3000 workers, Morocco 2000), cement (in which Morocco employs 28000 workers, Algeria 12000, Libya 1800) and alumina. This represents an opportunity for decarbonising these sectors in North African countries, but, at the same time, a potential economic threat. The CBAM will apply a carbon price on these products, making them more expensive for EU importers and possibly less competitive than lower-carbon alternatives (Figure 26). The CBAM essentially incentivises exporting countries to reduce emissions or face higher tariffs. North African countries may have less access to the technologies and investments needed for decarbonisation.

***Figure 26** – Products included in the EU CBAM*

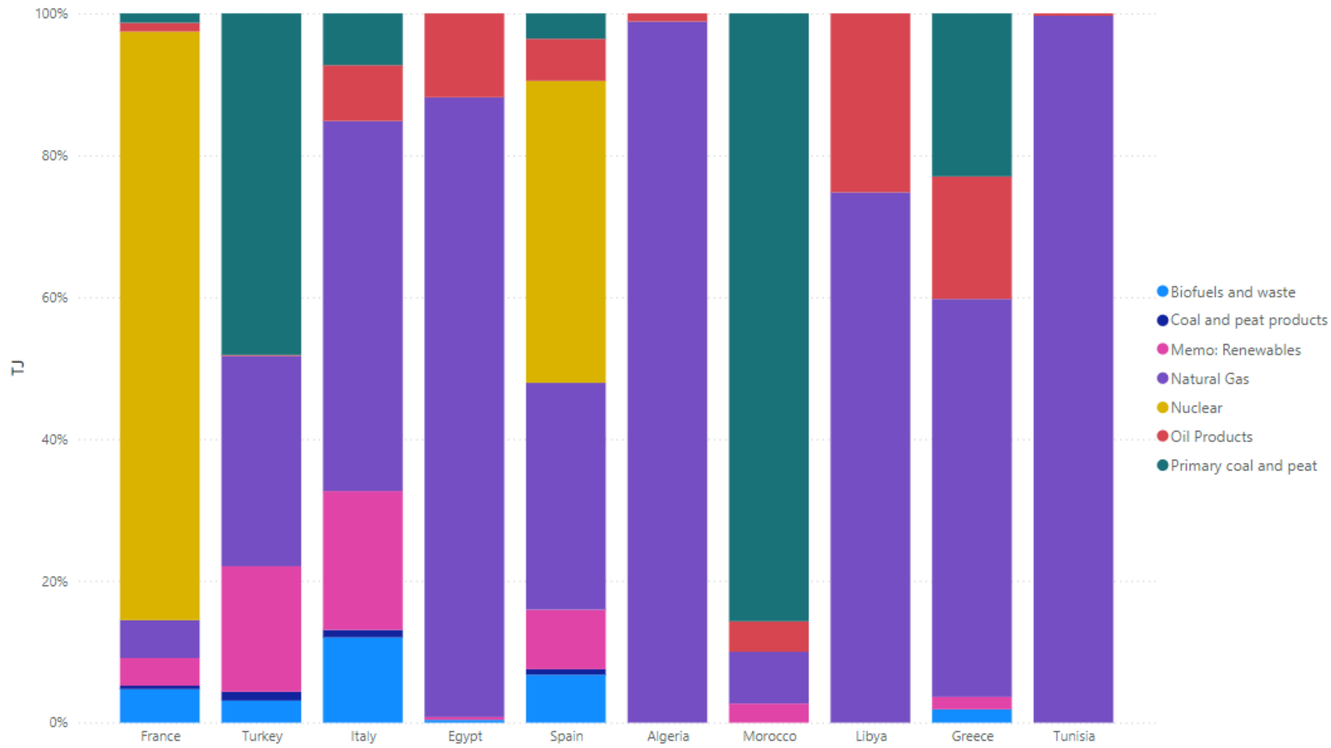
Product category	Products
Aluminium	Unwrought aluminium, aluminium powders and flakes, and all kinds of aluminium products (including bars, rods, wires, plates, sheets, foils, tubes and pipes, tube and pipe fittings, structures, reservoirs, tanks, casks, drums, cans, boxes, other containers, and cables)
Chemicals	Hydrogen
Cement	Cement clinkers, white Portland cements, other Portland cements, aluminous cements, other hydraulic cements, other kaolinic clays
Electricity	Electrical energy
Fertilisers	Nitric acid, sulphonitric acids, urea, ammonia (anhydrous or in aqueous solutions), nitrates of potassium, mixed fertilisers (nitrogenous mineral and chemical fertilisers, and other fertilisers containing nitrogen, phosphorus and/or potassium)
Iron and Steel	Agglomerated iron ores and concentrates (other than roasted iron pyrites), pig iron, ferrous products obtained by DRI and other spongy ferrous products, crude steel, and all kinds of iron and steel products* (including bars, rods, rails, wires, tubes, pipes, sheets and other flat-rolled products, reservoirs, tanks, casks, drums, cans, boxes, containers, screws, bolts, nuts, hooks, and rivets) – *except certain ferro-alloys (only ferro-manganese, ferro-chromium, and ferro-nickel are covered), and ferrous waste and scrap (including remelting scrap ingots and steel)

Source: Adapted from Annex I of Regulation (EU) 2023/956

2. **Decarbonization of electricity production:**

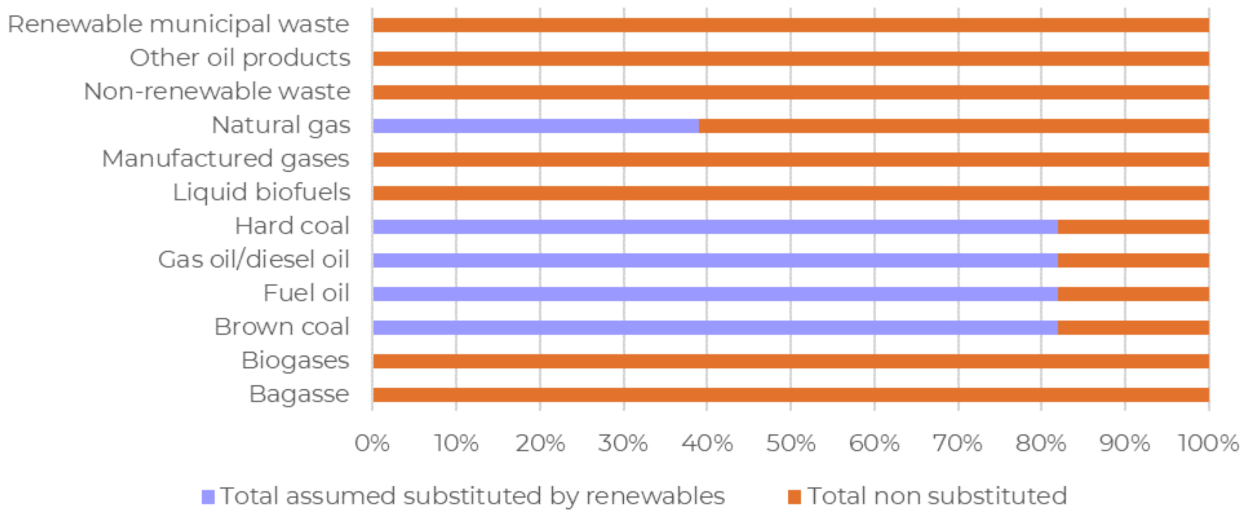
Figure 27 shows the fuel consumption share of electricity and heat production in the region. Natural gas has the leading role in many countries, with the exception of nuclear in France, and partially Spain, and coal in Turkey and Morocco.

Figure 27 – Electricity production share by source and country (UN, 2021)



190 GW can realise the phase out of coal, fuel oil and diesel in electricity generation in EU countries, phase them down to 30% in Northern African countries and Turkey (equivalent to 170 TWh) and reduce gas share in the whole region (260 TWh).

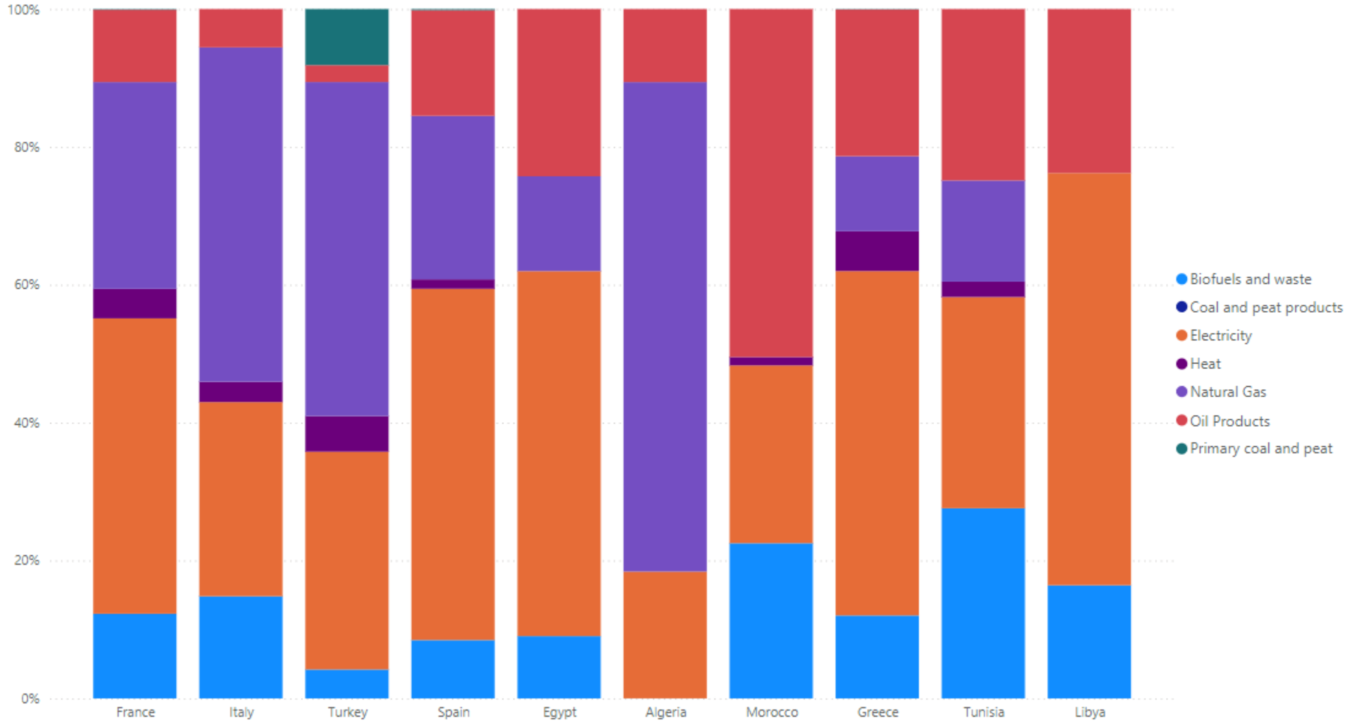
Figure 28 – Fossil fuel reduction share in electricity production by ~19% of 1 TW



3. **Electrification of buildings:**

A mix of sources characterises buildings' final consumption. Electricity is generally used for lighting and all electric devices; gas for thermal uses and cooking.

__Figure 29__ – Buildings' final consumption share by fuel and country ([UN, 2021](#))



130 GW can serve heat electrification in buildings. With 20% of solar thermal share, it can phase out coal, oil and traditional biomass and reduce the gas share (~630 TWh_{TH}).

__Figure 30__ – Electrifiable share of useful heat in buildings the industry by ~13% of 1 TW [TJth]

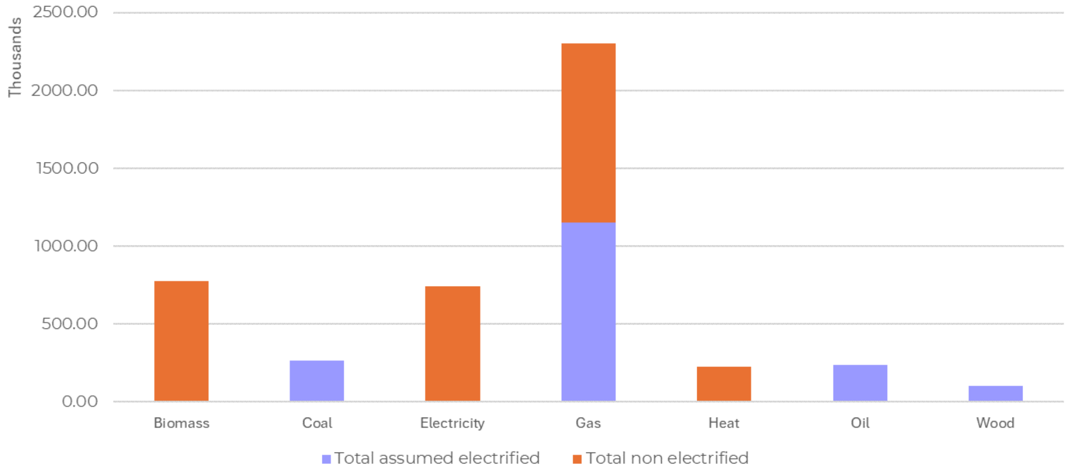
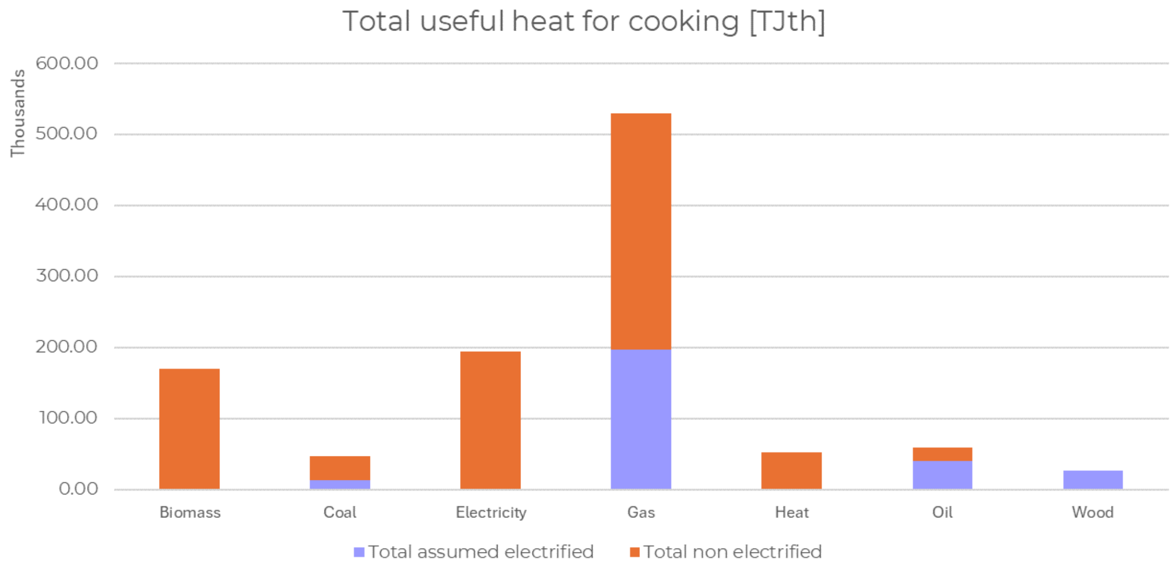


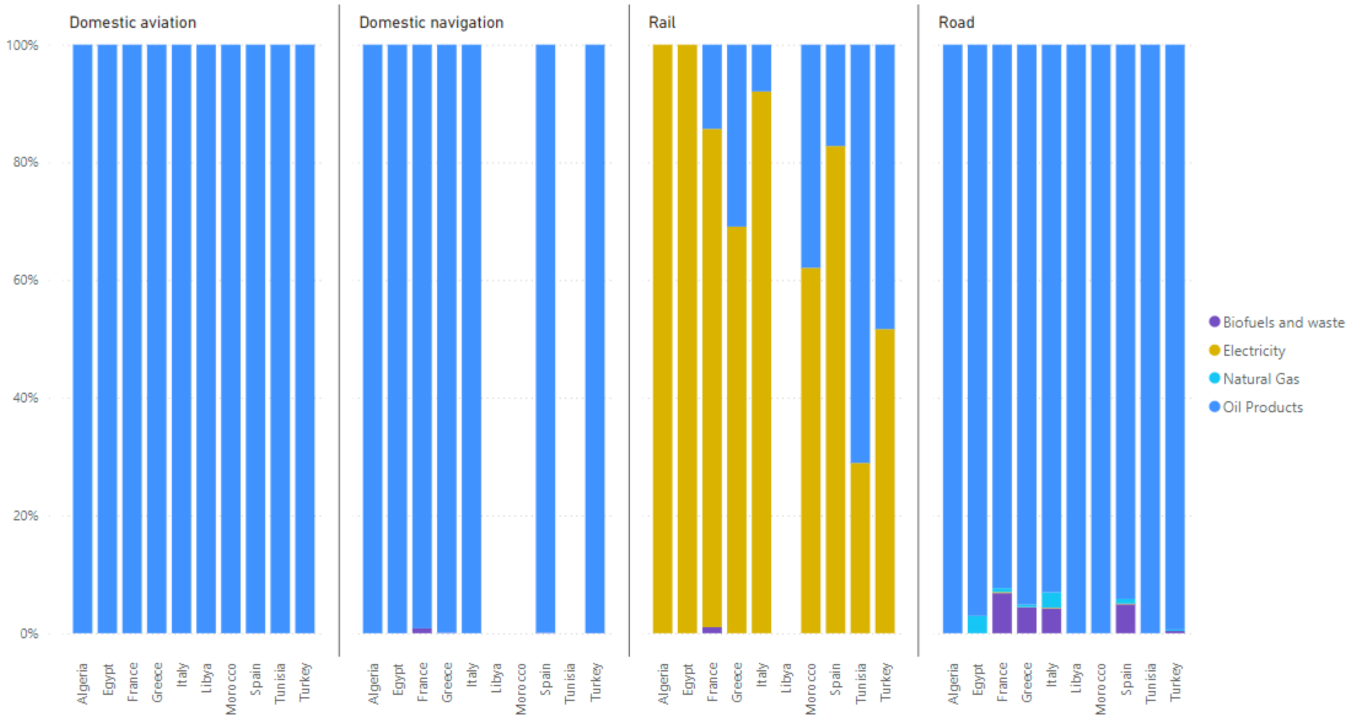
***Figure 31** – Electrifiable share of useful heat for cooking by ~13% of 1 TW [TJth]*



4. **Electrification of road transport:**

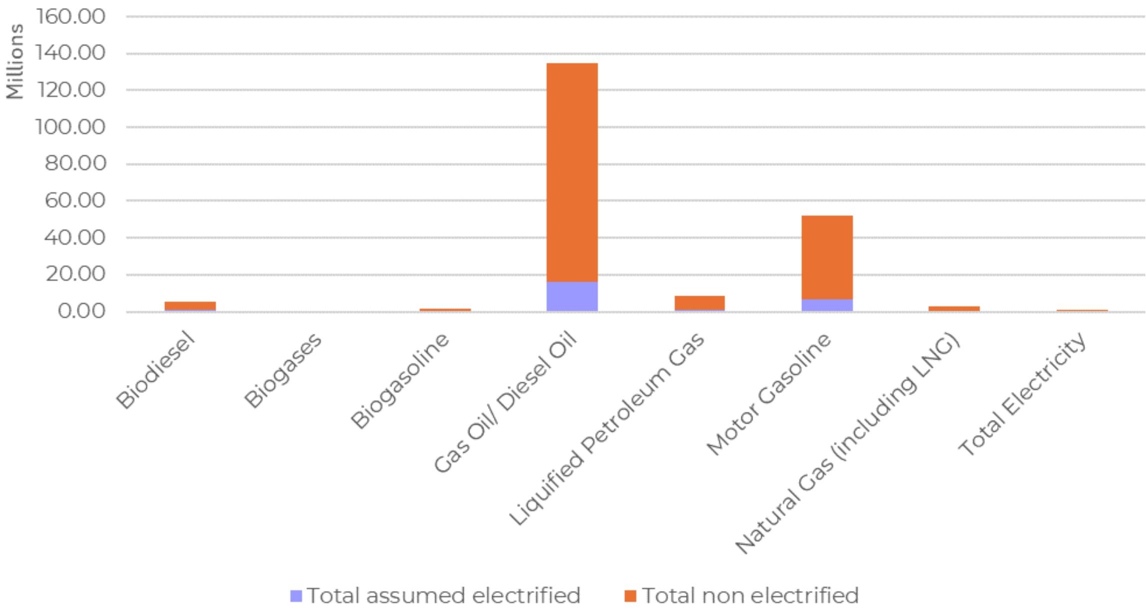
Transport is dominated by oil, with the exception of rail. Road transport sees a slight consumption of biofuels (in EU countries) and natural gas (in Egypt, Italy and Spain primarily).

***Figure 32** – Transport consumption share by mode and country ([UN, 2021](#))*



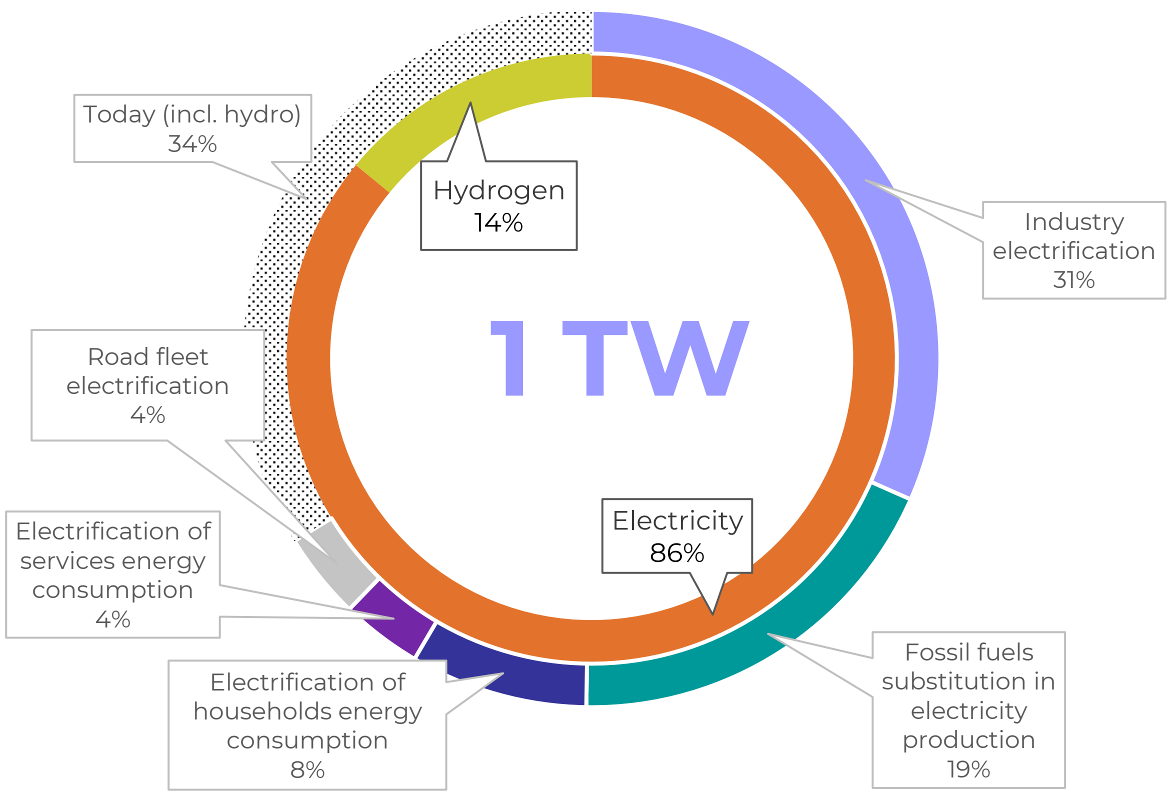
5 GW can accommodate 5-10% of the electrification of the road transport fleet in North African countries and Turkey and 20% in EU countries (~28 million vehicles).

Figure 33 – *Electrifiable share of road transport by ~4% of 1 TW [vehicles]*



Finally, Figure 34 synthesises the impact that 1 TW of renewables can trigger in the Mediterranean energy system.

Figure 34 – *Impact of 1 TW of renewables in the Mediterranean energy system*



This fossil fuel consumption decrease generated would lead to a reduction of more than 20 bcm of gas, ~30 million tons of oil and ~200 million tons of coal. The CO2 emissions potentially avoided are ~600 million tons**,** around the double of France emissions in 2023.

Figure 35 *– CO2 emissions avoided by 1 TW of renewables*

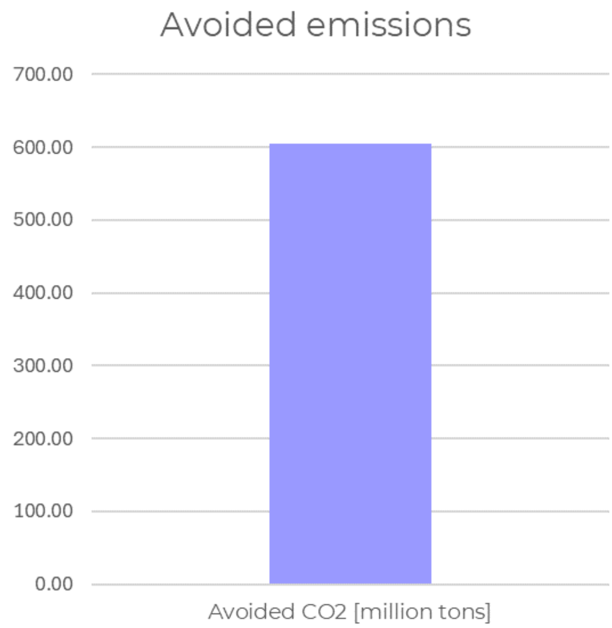
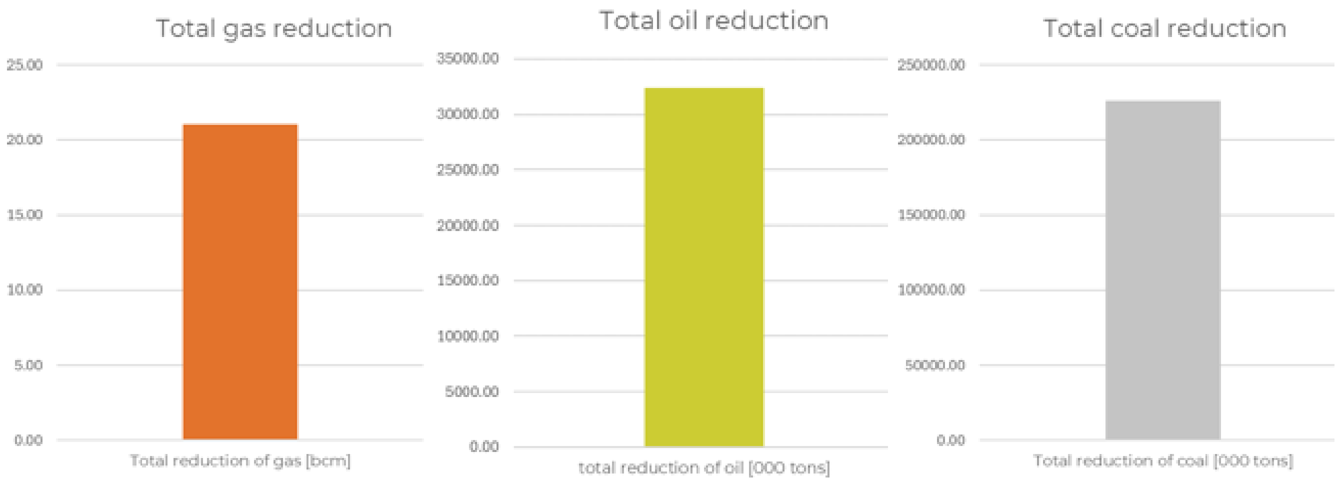


Figure 36 *– Fossil fuels decrease generated by 1 TW of renewables*



BOX 2: HYDROGEN IN THE MED

Hydrogen is currently used in refineries, chemical and iron processes as feedstock or as reducing agent for the direct reduction of iron (DRI). In the next future, hydrogen (even transformed in ammonia or other fuels) is expected to be used in more sectors and reduce emissions where electrification processes can't be implemented:

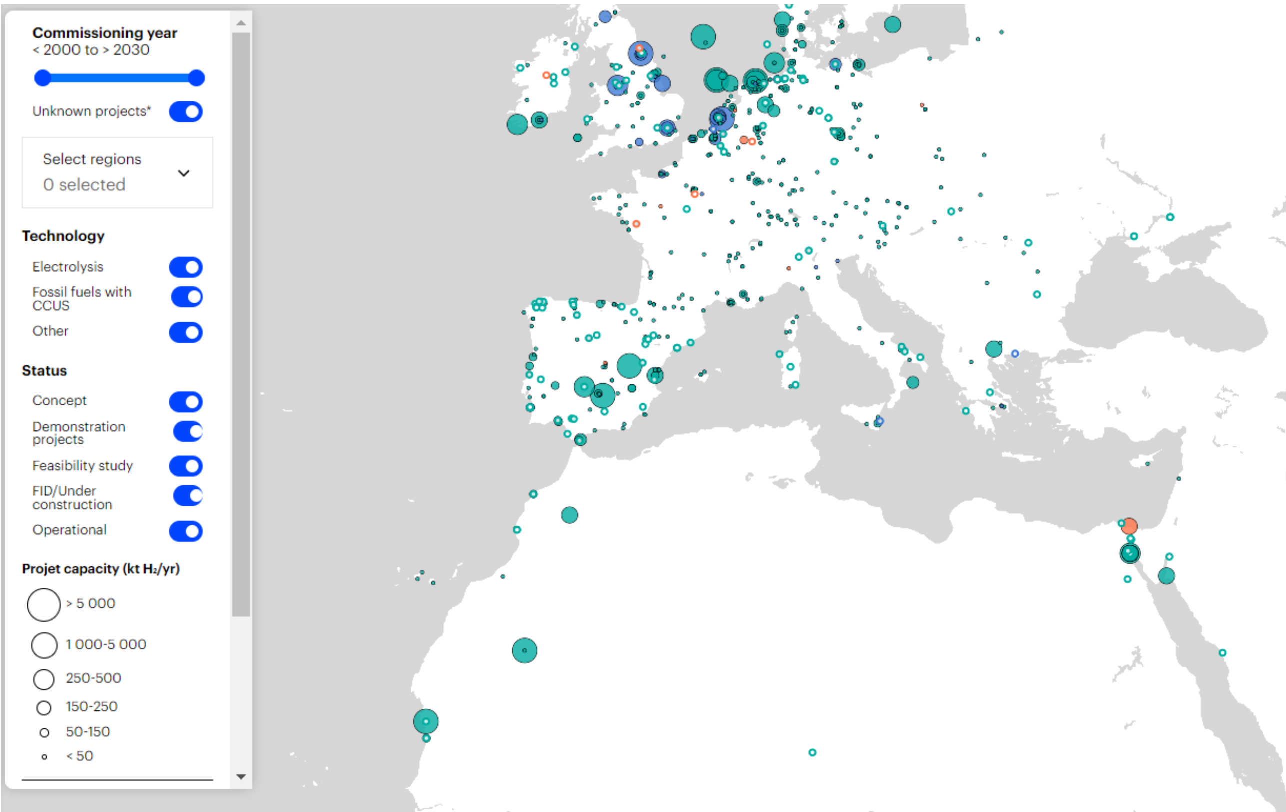
- High temperature heat production in industry and 100% H2-DRI
- As a fuel for heavy road transport and shipping
- Low emission synthetic fuels production, e.g. for aviation

- Storage and production of energy

Hydrogen, therefore, is set to have a relevant role in the energy transition. For this reason, all countries in the region have defined their own hydrogen strategy.

Currently, there are 54 operational projects in the region, all located in EU countries, for a total production of low carbon hydrogen in 2030 of 50 ktonH2/y (40 kton of blue hydrogen, 10 kton from electrolysis). Including projects under construction and demonstration projects, the number of projects increased to 120 today (50% blue hydrogen, 50% electrolysis). Two feasibility studies are located in Egypt (the Ain Sokhna ammonia project and East Port Said waste to hydrogen) for a total production of 645 ktonH2/y (300 of which produced from 2GW of electrolysers). Other two feasibility projects are located in Morocco, the HEVO-Morocco and Masen KfW, all based on electrolysers to produce 120 ktonH2/y.

Figure 37 – *Hydrogen production projects (IEA)*



The EU has set ambitious goals, aiming at producing 10 million tonnes domestically in addition to 10 million tonnes from imports by 2030 as part of the REPowerEU plan. The European Hydrogen Backbone (EHB), envisions 40 infrastructural projects representing 31.500 kilometres of hydrogen projects with expected commissioning prior 2030. (Figure 38). Within this integrated pan-European hydrogen network, the South H2 Corridor aims to connect Algeria to Germany through Austria and Italy. The project combines gas repurposed and new H2 pipelines and is composed by four backbones:

- The "Italian H2 Backbone" promoted by Snam Rete Gas
- The "H2 Readiness of the TAG pipeline system" promoted by Trans Austria Gasleitung GmbH
- The "H2 Backbone WAG + Penta-West" promoted by Gas Connect Austria GmbH
- The "HyPipe Bavaria – The Hydrogen Hub" promoted by Bayernets GmbH

Although many investments are planned in the hydrogen sector, many challenges remain for an integrated Mediterranean H2 market, including:

- High production technology cost (4.18 - 9.60€/kg greenH2 in EU, TRL 8 to 9)
- High electricity and water consumption of electrolyzes (60 kWh/kgH2)
- Uncertainties in the transport and storage technology
- Current lack of a horizon for an "Economy of hydrogen", i.e., an integrated market from suppliers to consumers

***Figure 38 –** EU Hydrogen Backbone Initiative*

6 CHALLENGES

6.1 THE ROLE OF GAS

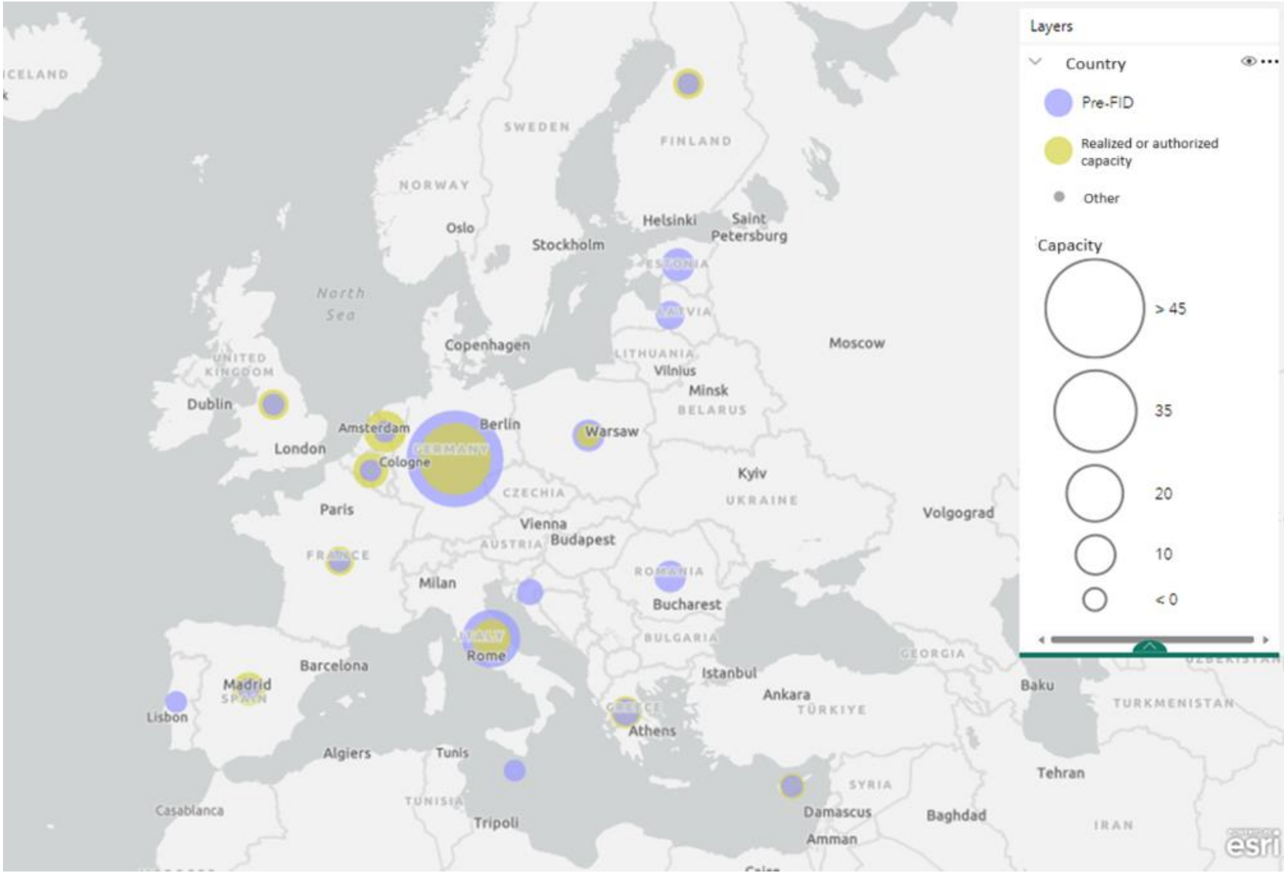
Despite the evidence of the need for climate action and the opportunities of the energy transition, the challenges have been increasing further in the last few years. Algeria, Libya and Egypt emerged as key alternative gas suppliers for Europe after the Russian invasion of Ukraine in February 2022. The consequent changes in the European internal energy market shook the supply-demand balance, causing unprecedented price spikes and driving a dash for new gas and import infrastructure.

The European Commission, with the REPowerEU plan, established a full phase-out of Russian gas by 2027 by supporting new gas infrastructures alongside the acceleration of efficiency and renewable energies. As a response, Europe's market strongly focused on new LNG infrastructures, leading to a transformation in global LNG supply dynamics and the centrality of sea-transported LNG. In the first year of the war, the EU and its member states concluded around 100 energy cooperation agreements. Most of these were with countries that feature among the EU's largest and most longstanding suppliers of fossil fuels: 17 agreements with the United States, 9 with Azerbaijan, 9 with Norway, 8 with Qatar, and 7 with Algeria.

The conflict in the Middle East has further complicated the geopolitical landscape, leading to additional repercussions on the security of energy supplies and infrastructure and leaving significant uncertainty in the energy markets. This uncertainty could persist given the extension of the Middle Eastern crisis to the Red Sea area. These crises risk slowing down energy supplies to the region.

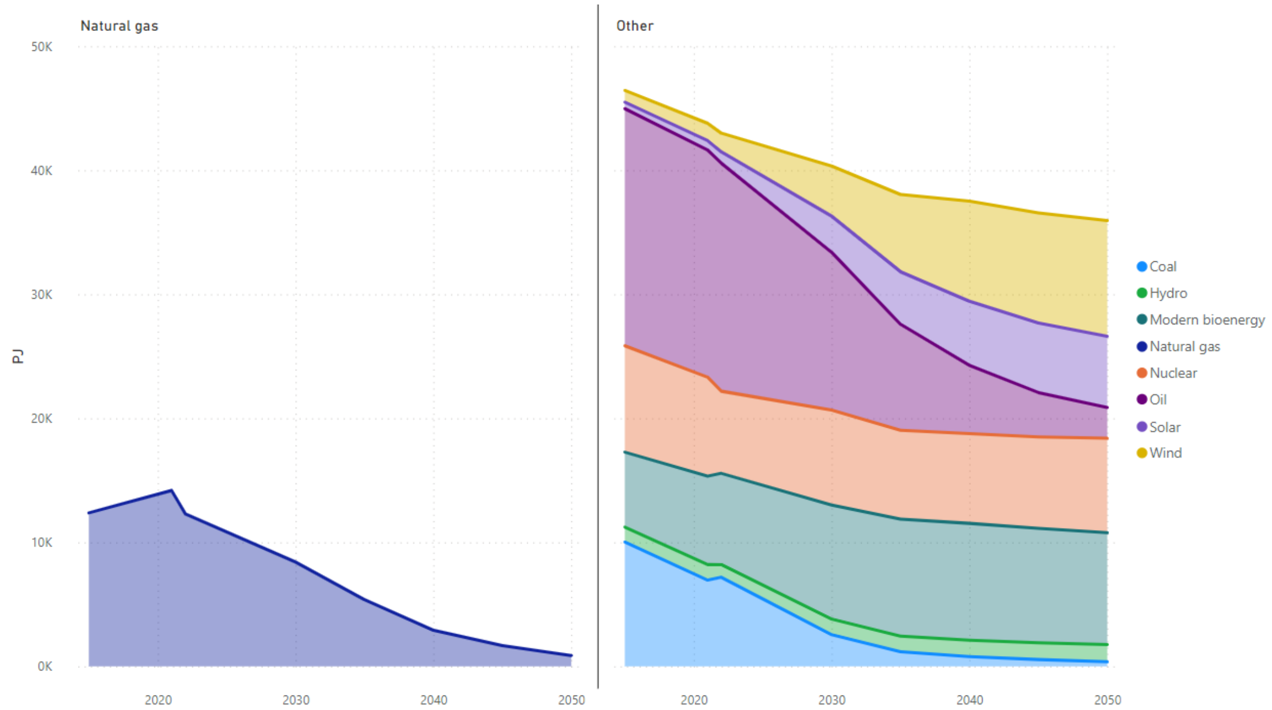
In this context, new investments in gas infrastructure capacity, mainly regasification terminals across Europe, have been justified through an all-hazards approach to supply security. This new capacity is financed through European public sources. In fact, the suspension of the "Do No Significant Harm" principle to access REPowerEU funds allows for the financing of gas infrastructures deemed necessary for the goal of independence from Russian gas supplies, theoretically ensuring consistency with climate objectives.

__Figure 39 –__ Realised or authorised LNG regasification capacity (yellow) and pre-authorized capacity (purple). ECCO elaboration.



However, according to the [International Energy Agency](), to achieve climate neutrality in 2050, European demand for natural gas should decrease by ¼ by 2030 and fall below 30 bcm by 2050 through the acceleration in the electrification of end uses, the increase in efficiency, and the expansion of renewable energies. Investments in new gas infrastructure are clearly not coherent with this pathway.

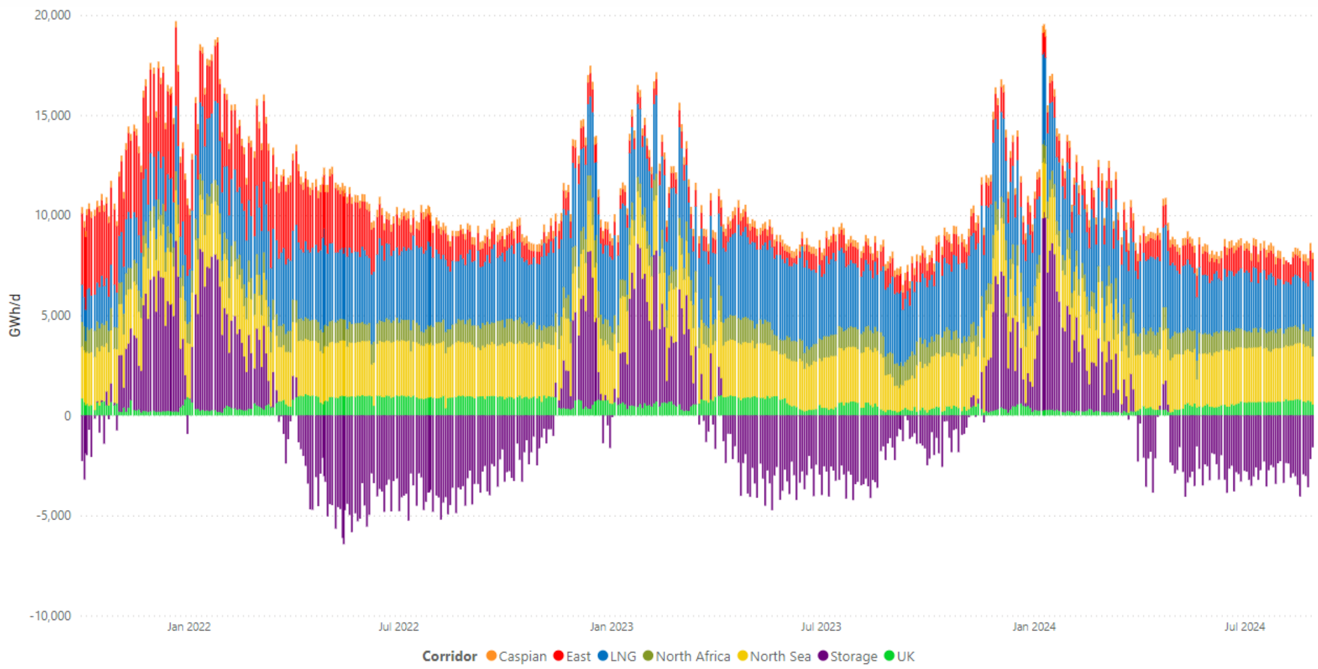
__Figure 40 –__ Role of gas in the total primary energy supply according to the Announced Pledge Scenario of the International Energy Agency



In fact, the EU's demand for natural gas has been declining for two consecutive years. After a 13.3% yearly decrease in 2022, demand fell by another 7.4% in 2023, totalling 12.72 million TJ in 2023.

Figure 41 shows the amount of gas imported by EU from the different corridors: it is clearly visible that the reduced flow imported by Russia (included in the East corridor) since January 2022 has not been replaced by other flows, neither by national production.

__Figure 41 –__ Gas supply corridors and flows to the EU (ENTSOG, 2024)



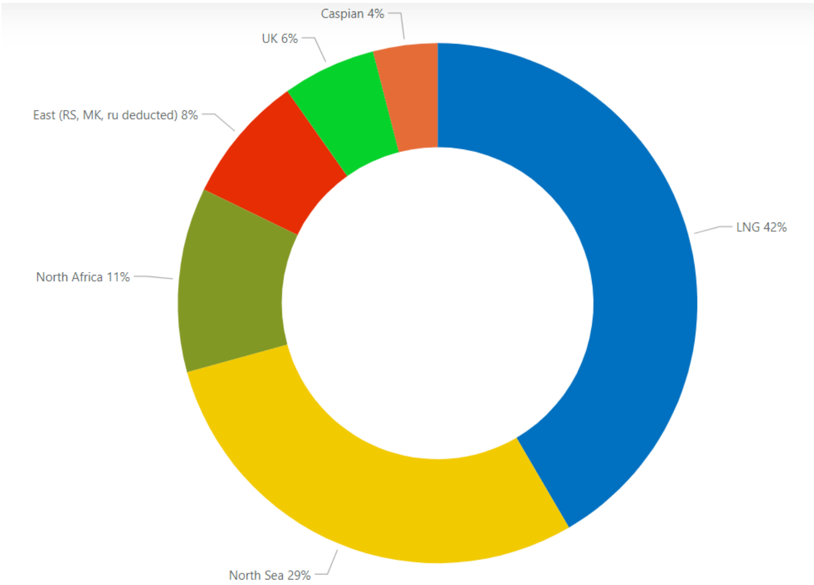
BOX 3: THE CURRENT GAS PIPELINES AND THE EAST MED PROJECT

The two shores of the Mediterranean sea are currently connected by 4 pipelines:

- EMPL (European Maghreb Pipeline), connecting Morocco and Spain, with a capacity of 442,9 GWh/d
- MEDGAZ, from Algeria to Spain, with a capacity of 337,1 GWh/d
- TRANSMED, from Algeria to Italy, with a capacity of 1154,5 GWh/d
- GREEN STREAM, from Libya to Italy, with a capacity of 493,7 GWh/d

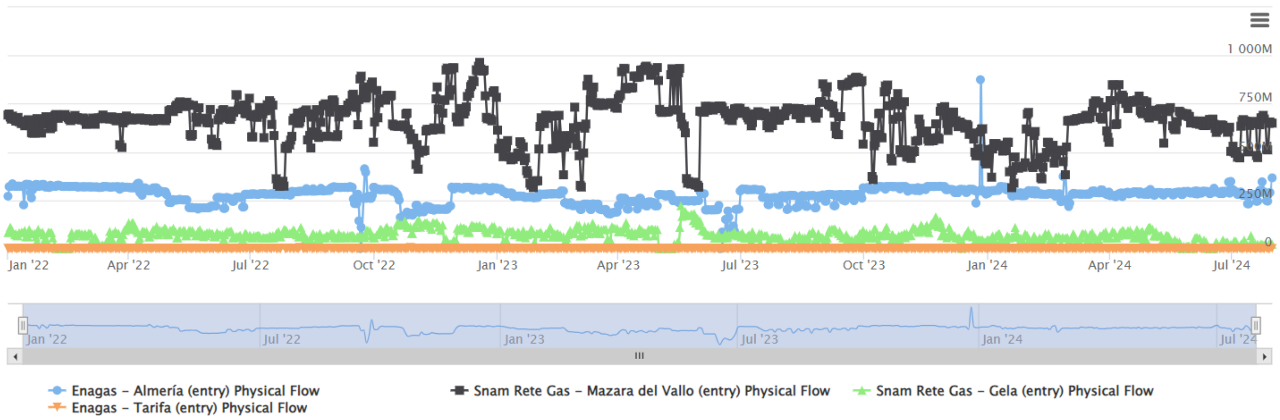
In 2023, these connections provided for the 11% of the gas supply to EU, positioning as the third corridor of supply, after LNG and North Sea (Figure 42).

***Figure 42** – Gas supply corridors distribution to EU (ENTSOG, 2024)*



However, 2 connections have regularly supplied gas (TRANSMED average flow is below 750 GWh/d, around 60-65% of the capacity, MEDGAZ average flow is around 250 GWh/d, 75% of the capacity), while 2 (GREEN STREAM from Libya and EMPL from Morocco) have almost supplied almost zero due to political instability and regional tensions, as Figure 43 shows.

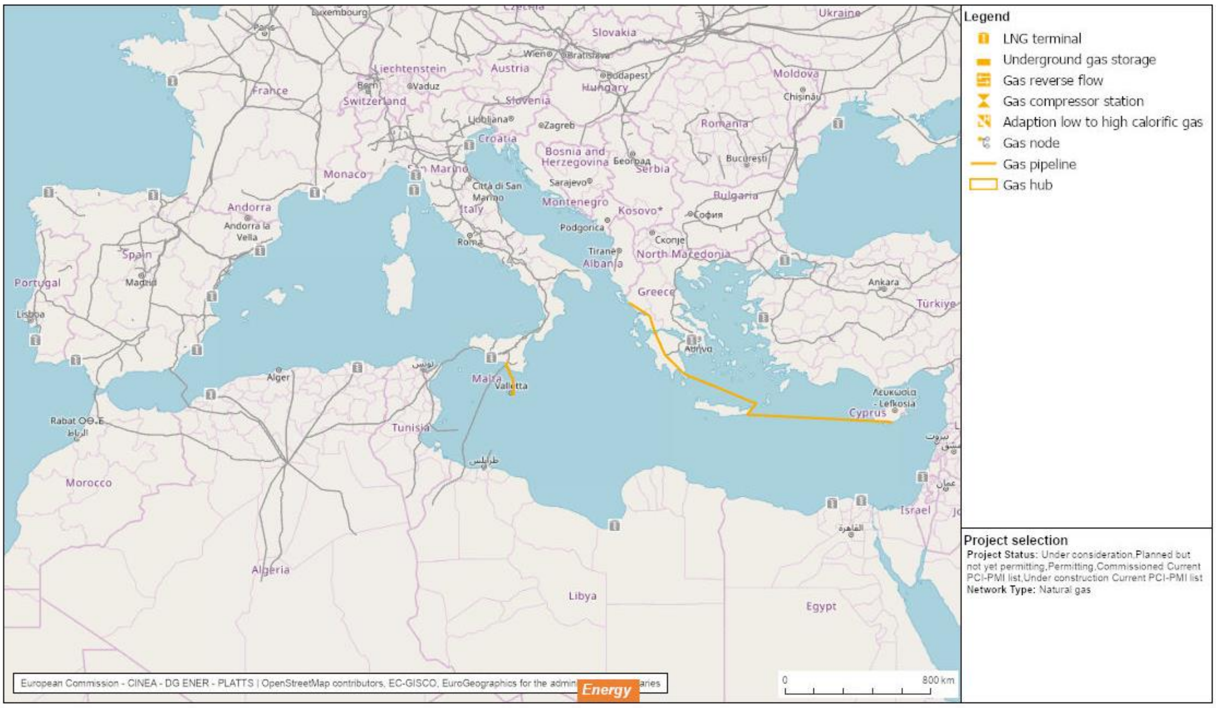
***Figure 43** – Physical gas flow from North African pipelines to EU*



EU has also included the East Med project in the list of the projects of common interest (PCI) for further diversifying the supply corridors. The pipeline should connect the EU to the

Eastern Mediterranean gas fields through Cyprus and Greece. It has been designed with a transportation capacity up to 12 bcm/y (320 GWh/d). Figure 44 shows the gas pipelines connecting the two Mediterranean shores, including the East Med project. The connection between Greece and Italy is not displayed because not included in the PCIs, however, the project is combined with the East Med and it is named Poseidon.

***Figure 44** – EU-MED gas pipelines*



7 CONCLUSIONS

Renewables offer an opportunity to tackle the diverse but common challenges faced by countries across the region and relaunch trust in international cooperation. An inclusive energy transition pathway for the region is critical to underpinning its future stability, increasing economic resilience and reducing the reliance on fossil fuels, providing a stable energy supply to power competitive industry while mitigating geopolitical tensions.

Deploying renewable energy can be of enormous benefit to local populations and economies, creating value for society. Far beyond their potential to mitigate climate change, research on the impacts of renewables emphasises their multiple socio-economic benefits, including direct macroeconomic effects, such as new investments and jobs in construction and O&M; indirect effects, such as investments in upstream industry production; and induced effects, such as GDP growth and minimisation of technical, financial and geopolitical risks.

In 2021, the renewable energy sector in Spain contributed 1.6% of gross domestic product (GDP). An estimated 111.409 workers were employed, and solar PV installations witnessed a 59% increase in employment opportunities. Wind, solar thermal and marine, also positively contributed to job creation. This resulted in an overall net gain in employment opportunities of almost 20% compared with the previous year. In France, the number of jobs in solar PV rose dramatically, from 3600 to 23300 in 2020-2021, reflecting a fast pace of installations, which continued into 2022. 25460 direct and indirect wind-related jobs were generated at the end of 2021, up 12.8% over the 22600 jobs in 2020. Of the total jobs, 33% were in planning and development, 28% in engineering and construction, 22% in component manufacturing, and 17% in O&M. In Southern Mediterranean countries, more than 200,000 direct jobs are expected to be created in the solar industry by 2030, and more than 50,000 direct jobs in the wind industry. For both industries, 54% of jobs are expected in the Egyptian economy, Algeria (22%) and Morocco (10%).

According to the International Energy Agency, the energy transition also provides an opportunity for North African countries to establish or expand manufacturing of clean technologies and near-zero emissions materials, by already offering favorable business enabling factors for solar PV manufacturing, EV and battery, green iron and steel and ammonia. North Africa has the potential to become a strategic supplier of batteries and cathodes for Europe, with exports accounting for 5% of European batteries demand and nearly 20% of cathode demand in 2050, satisfying 85% of its demand domestically.

At COP28 in Dubai, countries have signed the Dubai Consensus to triple renewable energy capacity globally. Declining this target in the Mediterranean region would lead to 1TW of renewable capacity installed by 2030. Such a target could represent a first milestone for future regional stability and sustainable development and present the region as a global frontrunner in tackling climate change. In addition, thanks to the decline in solar and wind technology costs, especially in North Africa, it would open to investments for ~**120 billion $**[15,16] per year and opportunities for around **3 million new jobs** only in the supply chains of the solar and wind industries [17,18].

The region must have a clear and cohesive financial strategy to unlock these investments, combining long-term government policy commitments with strong governance frameworks. Public institutions must take the lead, creating the right incentives for private investment while ensuring financial flows align with the Paris Agreement goals.

The role of National and Regional Development Banks, Multilateral Development Banks, and Export Credit Agencies will be pivotal in this process. Close collaboration between domestic and regional financial actors can provide the necessary financial tools, from public-private partnerships to concessional loans or risk mitigation mechanisms to innovative instruments for foreign exchange risks, to incentivize private investments in renewable energy projects.

Ultimately, achieving a net-zero transition in the Mediterranean depends on effective collaboration between the public and private sectors. Public investment will need to be structured to reduce risks for private investors, leveraging public resources to catalyze the vast amounts of private capital required to meet the region's decarbonization goals. By creating an enabling environment where both can work together, the region can unlock the climate finance needed to transform its energy landscape, meeting both regional needs and global climate targets.

If successfully developed, however, an interconnected, renewable system between the northern and southern shores of the Mediterranean region would have a multiplier effect, guaranteeing access to sub-Saharan Africa through the power pools in West Africa (West African Power Pool) and East Africa (East African Power Pool) and accelerating Sub-Saharan Africa's decarbonisation.

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[15] Including NDC targets.

[16] Assumptions: PV capital cost EU 330 $/kW, North Africa 1000$/kW; wind capital cost EU 770$/kW, North Africa 1500$/kW. Ratio of new installed capacity: 4/5 EU, 1/5 North Africa. Ratio investment cost renewable capacity/grid: 1:1.

[17] According to SolarPower Europe, in 2022, the solar industry in Italy, France, Greece and Spain showed an average employment factor, including direct and indirect jobs, of 17 FTE (full-time equivalent jobs) per MW installed (in North African countries the employment factor is expected to be lower), while the workforce in the wind industry is expected to be an average of 1.8 technicians per MW for new additions in 2024-2027.

[18] Assuming a decreasing employment factor due to sector innovation, the final averages used are for solar 8.4 FTE/MW in EU countries and 4.2 FTE/MW in North African countries, for wind, 2.5 FTE/MW in EU countries and 0.65 FTE/MW in North African countries. These averages consider an exponential smoothing method.

THE ITALIAN CLIMATE CHANGE THINK TANK

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