MEDREG

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Mediterranean Electricity Markets Observatory – MEMO+

National electricity systems and regional overview

–2021 data–

Empowering Mediterranean regulators for a common energy future

Co-funded by the European Union

Electricity Working Group (ELE WG)

Abstract

Since 2007, the Mediterranean Electricity Market Observatory (MEMO) has aimed to monitor the evolution of national, sub-regional, and regional electricity markets. The MEMO conducts a periodic assessment of two years and mainly relies on the responses and clarifications received from the MEDREG members.
This edition focuses on updating the national data, exploring the RES integration challenges, and understanding data exchange and information. It includes indicators aimed at assessing the national priorities in Mediterranean countries and their potential to be a part of the integrated sub-regional and regional electricity markets.

ACKNOWLEDGEMENTS

This report is the result of the work of the MEDREG Electricity Working Group (ELE WG) and is based on the MEDREG members' responses to the benchmark prepared by the chairs of the ELE WG and the MEDREG Secretariat.

ABOUT MEDREG

MEDREG is the association of Mediterranean energy regulators, bringing together 27 regulators from 22 countries across the European Union (EU), the Balkans, and MENA region.

MEDREG acts as a platform for facilitating information exchange and assisting its members, in addition to fostering capacity development activities through webinars, training sessions, and workshops. Mediterranean regulators work together to improve the harmonisation of regional energy markets and legislations, seeking a progressive market integration in the Euro-Mediterranean Basin.

Through constant cooperation and information exchange among members, MEDREG aims at fostering consumer rights, energy efficiency, infrastructure investment, and development by employing safe, secure, cost-effective, and environmentally sustainable energy systems.

The MEDREG Secretariat is in Milan, Italy.
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TABLE OF CONTENT

LIST OF FIGURES

1. INTRODUCTION AND METHODOLOGY

1.1. Report Objective

This report aims to provide an update on the recent developments in the electricity markets and structures within the Mediterranean region. This benchmarking will also identify the most important challenges that the National Regulatory Authorities (NRAs) are facing and serve as a starting point for knowledge sharing among the MEDREG members.

This edition will follow the same methodology as the previous versions, with additional important topics that require discussions among the energy regulators in the Mediterranean region. The new features in this edition are related to the integration challenges of renewable energy sources (RES), which will shed light on the gaps and obstacles that slow down the development of RES in the Mediterranean region and open opportunities for further cooperation and knowledge sharing among the MEDREG members.

In addition, the report will analyse the data and information exchange between the NRAs and the electricity market actors. This section was included in the benchmarking upon the request of the MEDREG members and will help them to either develop an information system based on the experiences of other members or improve the existing information system.

Globally, the objective of the report is to analyse and open discussion among the MEDREG members regarding the following aspects:

- The internal structure of the electricity market
- The regional electricity market
- Information systems and data monitoring and exchanges
- Energy transition challenges

In parallel, MEDREG will develop complementary reports and studies to facilitate cooperation and information sharing among its members and move a step forward towards a fair, functioning and integrated Euro-Mediterranean energy market.

1.2. Methodology

The report is based on the replies of the MEDREG members to a benchmarking prepared by the ELE WG chairs in collaboration with the MEDREG Secretariat.

This survey contains six parts as follows:

1. Electricity system main data
2. Governance and unbundling regime
3. Internal structure of the electricity market
4. Regional electricity market system: purpose, status, and role of cross-border interconnections
5. Information systems and data monitoring and exchanges
6. Energy transition challenges

The MEDREG Secretariat collected the data and information from the members and elaborated the following report jointly with the ELE WG chairs.

To analyse the evolution of the electricity market and identify the challenges and priorities of the Mediterranean region, a sub-regional approach has been applied to the study.

The MEDREG members have been grouped into four zones. This grouping is for information purposes only and does not imply any political or economic bias on the part of MEDREG. The four areas are as follows:

- **Maghreb member countries – Algeria, Libya, Morocco, Tunisia.**
- **Middle East member countries – Egypt, Israel, Jordan, Lebanon, Palestinian Authority.**
- **Balkans and Türkiye – Albania, Bosnia-Herzegovina, Croatia, Montenegro, Slovenia, Türkiye.**
- **EU member countries – Cyprus, France, Greece, Italy, Malta, Portugal, Spain.**

Out of 22 member countries, the Secretariat received 15 replies, as represented in the next figure.
To complete the statistical overview of the electricity market in the Mediterranean region, the missing data and information were collected either from the NRAs' annual report or external sources.

Figure 1. Replies to the ELE WG Benchmarking and Data Source

2. OVERVIEW OF ELECTRICITY SYSTEMS

Electricity systems represent the heart of any country's economy and improve the quality of life of its citizens. Therefore, ensuring continuity of supply with a certain level of quality and affordability is the objective of every government and energy regulator.

Basically, the development of electricity system infrastructure aims to maintain a balance between the increasing demand and electricity generation (either in-land production or imports). However, designing a market that satisfies all the needs and expectations of the market operators and consumers is problematic and complex; moreover, the characteristics and inputs of the design (level of demand, number of consumers, primary energy source prices, etc.) are continuously changing. Nevertheless, the NRAs is the organization that best knows the machinery of the electricity system and its evolution through time. In addition, it has a global view of the energy market and can identify the impact of any measure at all levels of the energy supply chain value.

It's important to highlight that no successful market model can be duplicated from one country to another. The electricity market is strongly influenced by the available primary resources and geographical characteristics, consumer behaviours, and national priorities. Moreover, designing a well-functioning electricity market requires a lot of knowledge and time. The last two years have demonstrated that most of the energy systems and markets are and will always be vulnerable to sudden changes in demand, consumer behaviours (the COVID-19 outbreak), and sudden economic crises (energy price surge).

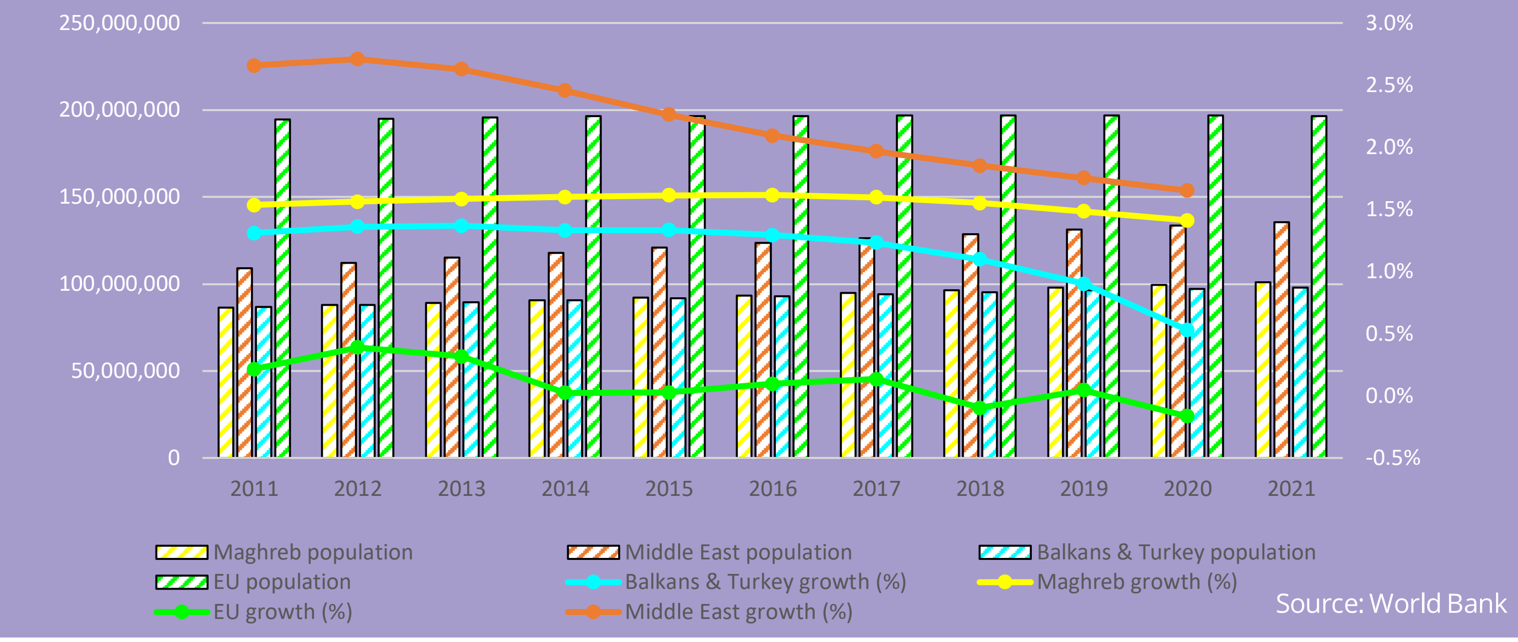
As an association of energy regulators, we must monitor the evolution of the electricity market in our region and collaborate with and support each other to overcome the current energy sector issues and prevent future market dysfunction. Furthermore, the main role of NRAs is to protect consumers from any threat to continued access to affordable energy with good-quality supply, protect their data privacy, and provide them with the most relevant information about their roles and rights.

The first chapter of the report provides a statistical overview of the electricity market in Mediterranean countries, with a focus on each sub-region. This chapter aims to offer an update on the evolution of the electricity systems in the MEDREG member countries without comparing them.

2.1. Macro-Economic Context

The population growth in the Mediterranean region is known for its wide demographic disparities, with a few large countries, such as Egypt, Türkiye, France, and Italy, representing almost 60% of the total region's population and smaller countries, such as Montenegro and Malta, with a population of less than 1 million. Within the subregions, the total population is growing at different paces. Since 2015, the total population of the Maghreb region has exceeded the Balkans and Tukey region. In addition, the Middle East region's rapid growth has reduced the gap between the total population of the EU MEDREG member countries and the Middle East region by 25% since 2011. The next figure represents the evolution of the population in each sub-region in terms of the total population and annual growth in percentage.

Figure 2. Evolution of the total population and annual growth by sub-region



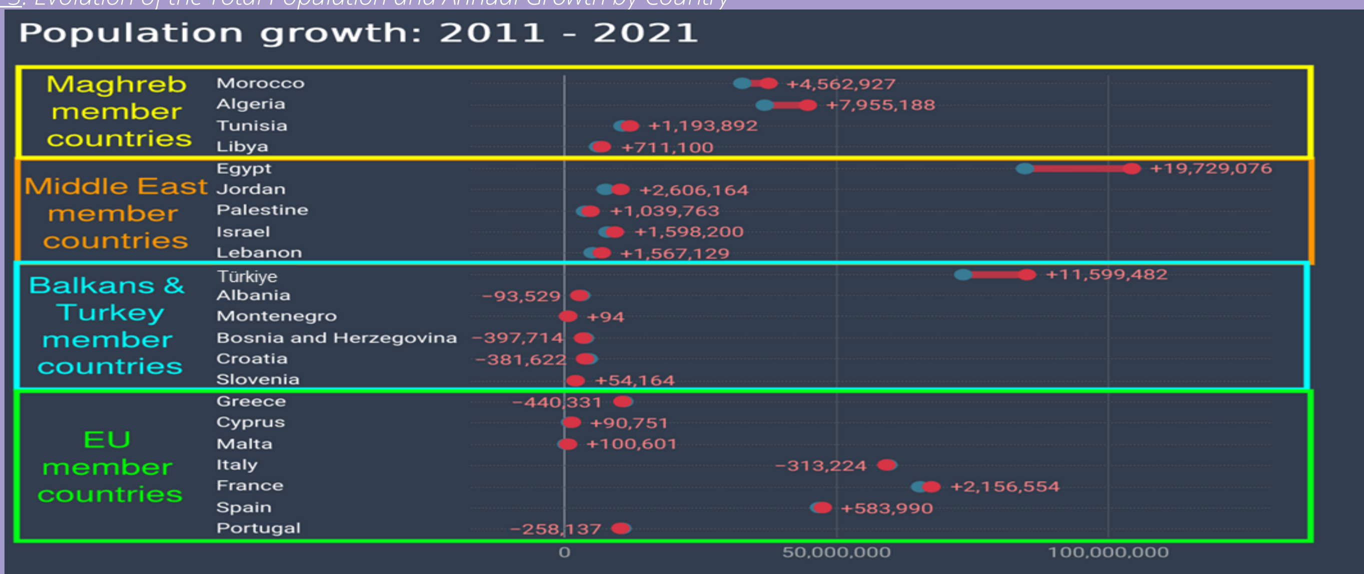
Source: World Bank

In addition, in terms of annual growth, the Maghreb and Middle East sub-regions have the highest rates, with a respective average of 1,6% and 2,7% per year. On the north shore, the demographic evolution is much slower and even negative is Balkans and the EU countries.

The growth in population directly impacts the electricity demand and will require more investments in electricity system infrastructure to maintain the balance between supply and demand. For instance, in Egypt, it was necessary to strengthen the electricity system by adding production units and developing the transmission and distribution network to meet the needs of 19 million more inhabitants since 2011 (equivalent to today's combined population of Greece and Portugal).

The next figure depicts the evolution of the MEDREG member countries' population since 2011, and it's clear that for a few countries, the growing population is a challenge to consider and analyse.

Figure 3. Evolution of the Total Population and Annual Growth by Country



Source: World Bank

The growth in the gross domestic product (GDP) reflects the economic performance of the country and can be used as an approximate indicator of the development of industries and important electricity consumers in the market.

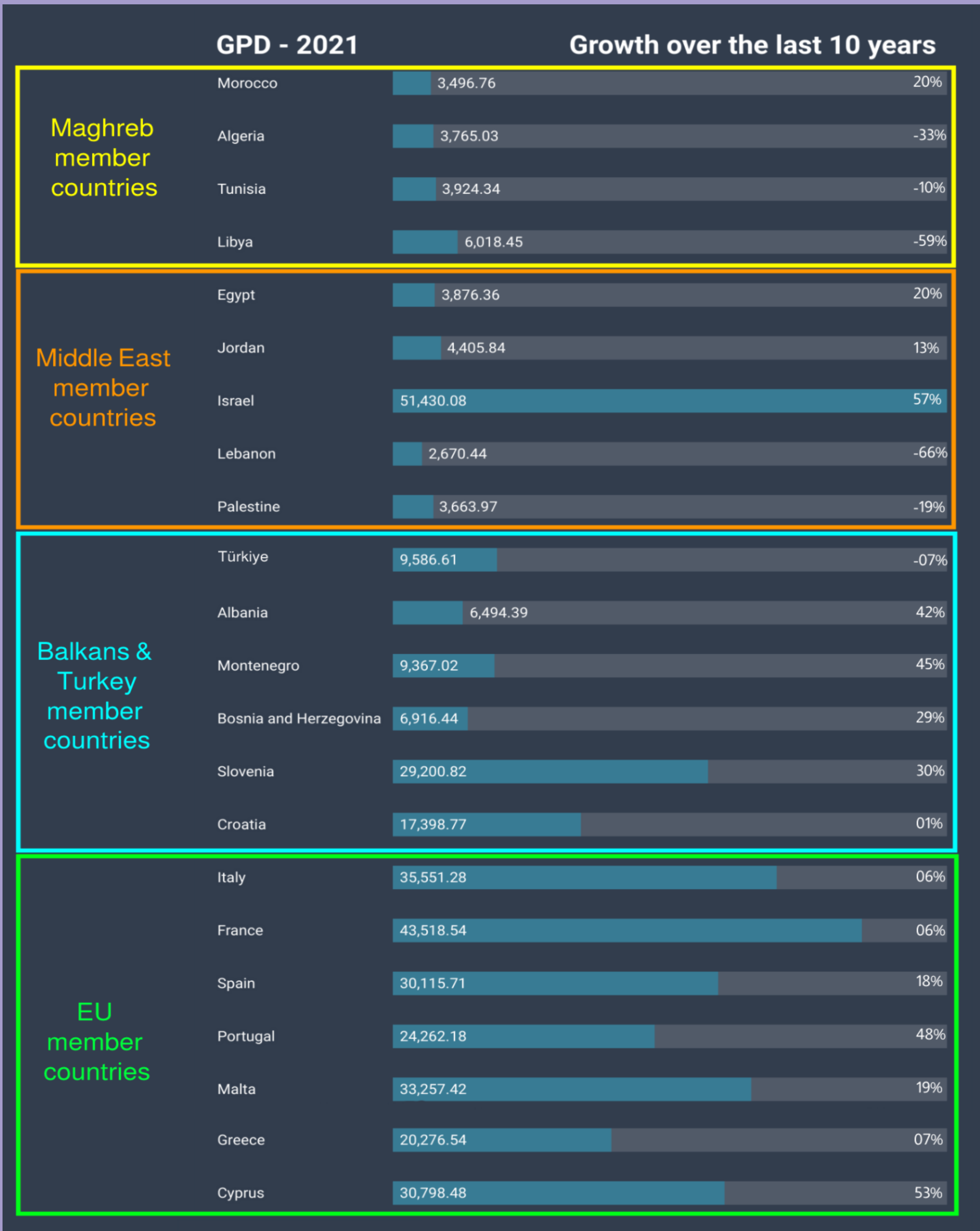
Most of the countries have had an increase in GDP during the last few years. However, some countries have below 5000 dollars per capita, especially in the Maghreb region (except Libya).

Among the 22 MEDREG member countries, a decline in GDP was observed in only six countries compared to the 2011 data.

Nonetheless, the last two years, in particular, significantly impacted the economic development of most of the countries, which adds uncertainty to the economic growth forecast. The World Bank expected that the growth in the Middle East and North Africa regions would reach 5,2% in 2022, mainly because the oil price would benefit the oil-exporting countries.

The next figure provides the GDP per country for 2021 and the growth over the last 10 years.

Figure 4. Evolution of GDP Over the Last 10 Years.



Source: World Bank

From a macro-economic point of view, the Mediterranean region presents a variety of trends depending on the sub-region. Globally, the electricity demand in the region will continue increasing, mainly due to the growing population in the south shore countries and the economic growth in most of the countries. In this report, the MEDREG provides a clear picture of the evolution of the electricity market in the Mediterranean region and identifies the main issues that the NRAs are facing.

2.2. Impact of the COVID-19 Pandemic and Energy Price Surge on the Electricity Demand

As energy regulators, the NRAs' role is to protect the end consumers from any risks or interference that may disturb the security and quality of supply. 2019–2020 was a challenging period for not only the NRAs but for all the electricity market actors.

MEDREG drafted an informative note that outlined the regulatory measures taken by the regulators and governments in the MEDREG region during the COVID-19 outbreak to support the energy markets and protect the end consumers at the same time.

The note shows that despite the differences in the specific regulatory measures taken in each country to support the energy sector during the COVID-19 outbreak, the regulators and the governments in the Mediterranean region took action to support the energy actors and protect the end consumers.

It also shows that the role of the regulator is crucial to maintain continued energy supply while preserving the rights of end consumers during emergency periods. Therefore, it is important to constantly monitor the market operators and energy markets to ensure they react quickly when needed.

The detailed actions taken by each can be found in the information note available on the MEDREG website.

Besides the impact of the COVID-19 pandemic, the MEDREG ELE WG chairs were tasked with analysing the energy price surge that affected the region from 2021 onwards.

In that year, a sharp rise in commodity and energy prices began, which is largely responsible for the resumption of global inflation. Regarding gas and electricity, this rise was observed from the summer of 2021, particularly in Europe, due to a drop in gas exports from Russia and because Gazprom did not fill the storage facilities it controls in the European market. This price increase was seen in the electricity sector as well, which was affected by the unavailability of production facilities. This situation continued throughout the winter and was amplified by the conflict in Ukraine in February 2022. The EU countries were hit hard by this crisis, which spread to all the hydrocarbon-importing countries. Today, inflation is a global problem with all the difficulties it causes for consumers, especially in the Mediterranean.

The purpose of this task force report is to analyse the impact of the energy price surge, for both gas and electricity, on the MEDREG members, considering the different characteristics of the Mediterranean countries. It is divided into three parts: a description of the recent energy price dynamics, an analysis of the impact on the gas and electricity markets of Mediterranean countries, and reflections on the challenges posed by the crisis for both the EU and developing counties in the Mediterranean. The analysis is complemented with recommendations for the region.

The full report can be found on MEDREG's website, which is available here.

2.3. Electricity Market Trends

The Mediterranean region was significantly impacted by the COVID-19 pandemic, which affected the electricity demand, which decreased in most countries in 2020. With the energy price surge, the situation worsened in most of the countries, except the hydrocarbon-producing countries. In 2021, the electricity demand started to recover in most countries and increased to the levels of 2019.

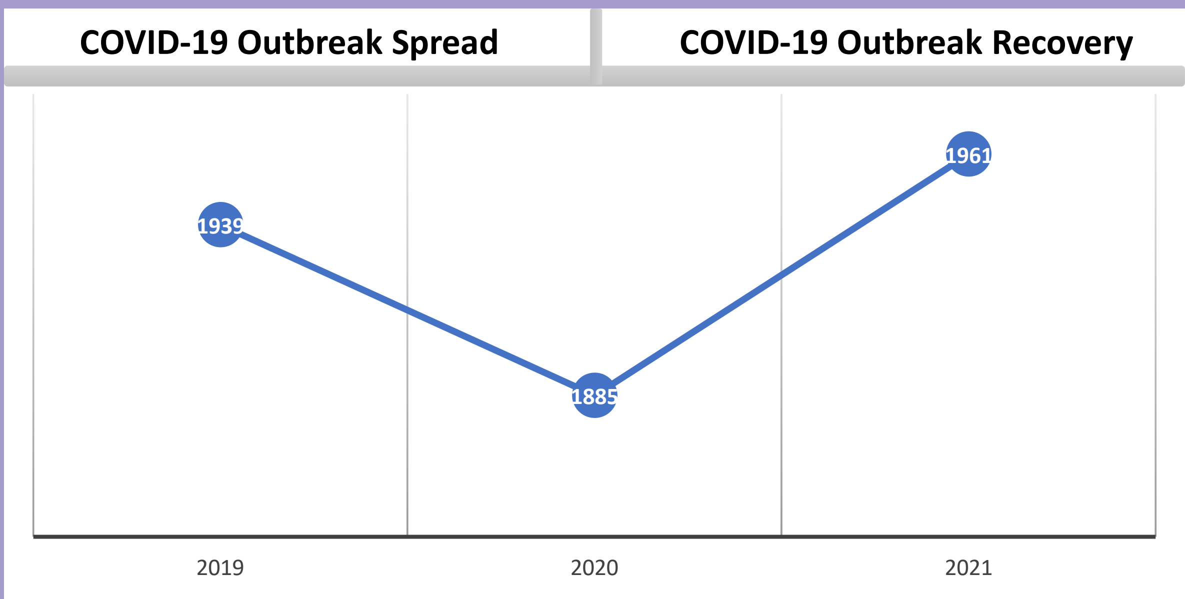
These events expedited the dialogue on accelerating the energy transition and increasing the share of RES in production.

Most of the countries cover their electricity needs using different approaches and measures. The countries on the south shore of the Mediterranean Sea[1] rely on their national production to maintain the balance of the electricity system. The use of cross-border interconnection ensures the security of supply in case the national network fails. On the opposite side of the Mediterranean Sea, the balance of the electricity system depends on the functioning of the regional market, where some countries, such as France and Bosnia and Herzegovina, are net exporters and some, such as Italy and Croatia, are net importers.

Technical and non-technical losses remain an important issue in several countries, and more efforts and collaboration among the market actors are required to develop and implement the proper measures and mechanisms to reduce the losses. MEDREG's consumer working group analysed the technical and non-technical losses in its report, which is available here.

The figure below represents the evolution of the total electricity demand and generation in the Mediterranean region.

Figure 5. Evolution of the Total Electricity Demand in the Mediterranean Region.



[1] With the exception of Morocco, who has commercial exchange with the MIBEL market.

2.4. Interconnections

The development of interconnections will have economic, environmental, and security impacts on the countries, sub-regions, and regions. Most of the impacts are positive and would facilitate the development of a better energy system, which offers, among others,

- Lower electricity prices for importer countries, thus facilitating economic growth.
- More integration of RES and reduced fossil fuel usage and CO_2 emissions in the electricity mix.
- Better security of supply and quality of service to the end consumers.

An integrated energy market in the Mediterranean basin would open doors for many opportunities to develop a well-functioning and sustainable energy market in the region. The complementary nature of the north and south shores of the basin presents enormous potential in terms of the development of RES at the least cost due to the availability of abundant sunlight and wind as well as the land to build the necessary power plants.

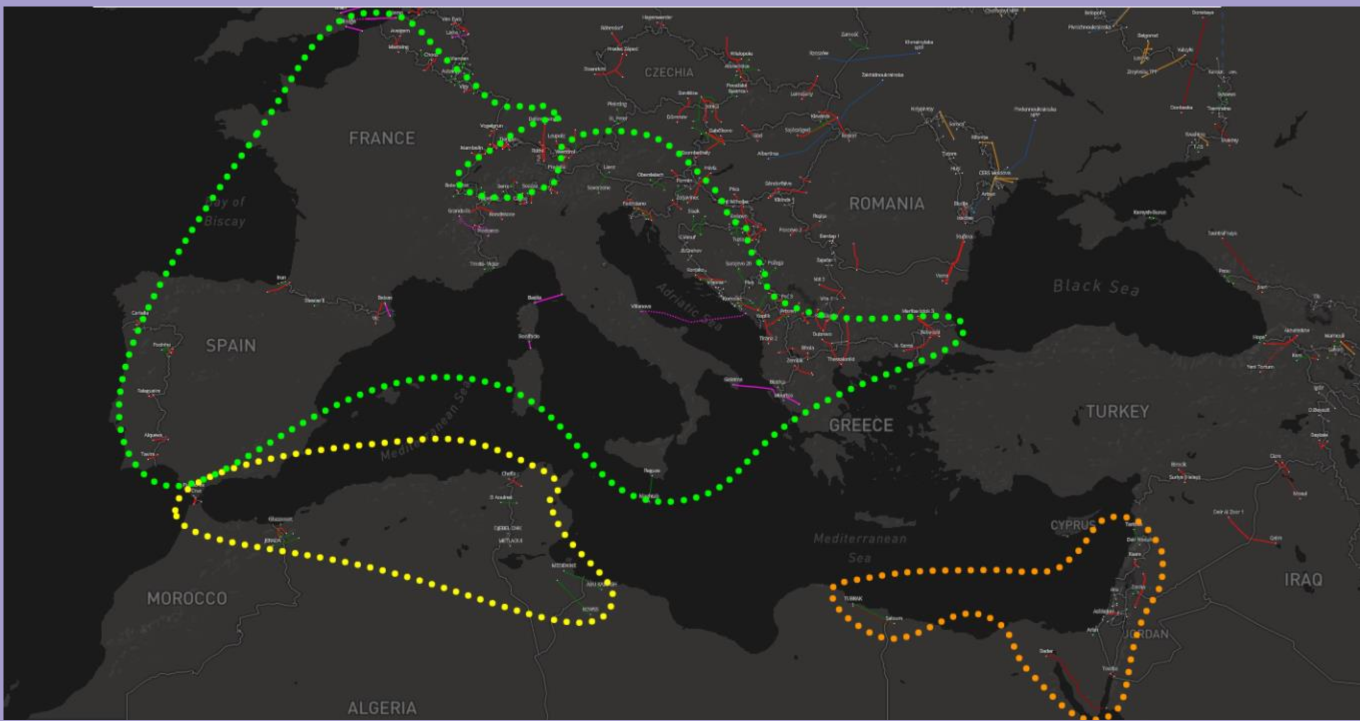
On the other hand, the north shore countries have accumulated vast knowledge in terms of designing mechanisms and support schemes for the development of an integrated market and the necessary administrative and technical requirements. Moreover, they have acquired know-how in terms of developing measures to facilitate the integration of RES in the power systems.

However, the development of interconnections requires long-term visibility, huge investments, and harmonisation of the technical and administrative procedures among the countries. Today, the level of interconnection between Mediterranean countries is highly uneven. We can identify three interconnection zones (see Figure 6) as follows:

- In the EU region, there is a well-developed, integrated market with a high exchange capacity between countries and a high level of interconnection usage. In the Balkans, Türkiye belongs to the European synchronous zone. For the countries belonging to the Energy Community, the market is well developed and functions well, with the possibility of expanding the network and improving the market functioning.
- In the Maghreb region, the interconnections are well developed in terms of exchange capacity. However, the regional market is not established, and the interconnection is only used for security reasons.
- In the Middle East region, most of the countries focus on the development of national infrastructure; therefore, this sub-region can create a well-functioning market by taking advantage of the lessons learnt from the other sub-regions.

The interconnection between the identified zones (north-south and south-south) is a key element for unlocking the potential of the Mediterranean region. Only one trans-Mediterranean interconnection between the two shores is operational between Spain and Morocco. In terms of energy exchange, it's one of the most used interconnections in the Mediterranean region, which demonstrates the benefits such interconnections can offer in the future.

Figure 6. Interconnections in the Mediterranean Region.



Source: ENTSO-E

2.5. Governance, unbundling, and institutional organization

The organization of electricity systems differ from one country to another (see figure 7 below). All the MEDREG member countries expressed their willingness to transit towards a liberalized market with transparent rules and fair competitiveness. However, the elaboration of such a market may be complicated and involve political aspects that are out of the NRAs' control, such as electricity price subsidies. Moreover, liberalizing a market with a powerful historical operator requires time and strong cooperation with the historical operator. In most countries with a public monopoly, the historical operator masters and knows all the characteristics of the electrical system perfectly well. Therefore, collaborating with the historical operator is a key element to ensure a smooth transition from a vertically integrated market to a liberalized market.

Furthermore, the process takes a long time and will require drastic changes in the regulatory framework and market procedures, technical rules, and administrative measures.

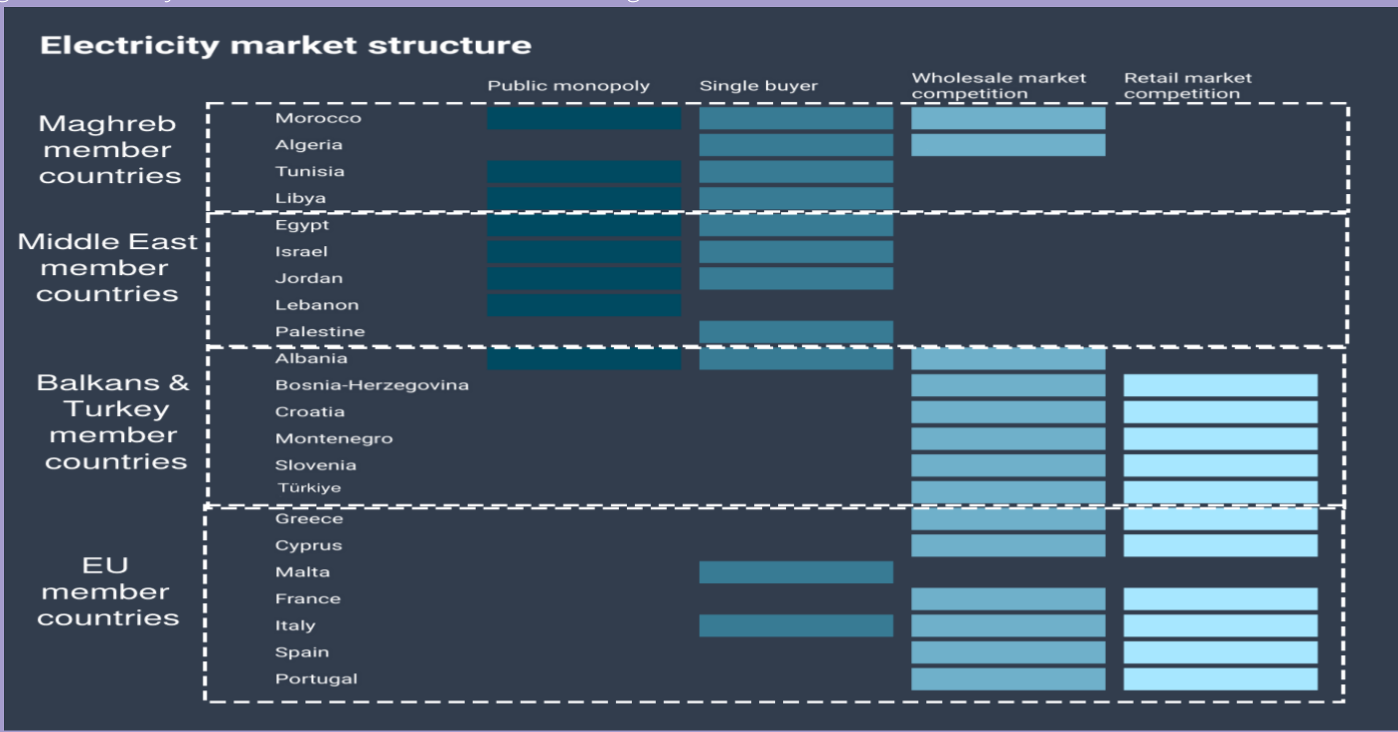
In the Mediterranean region, most of the countries already operate under wholesale and retail market competition. On the south shore, the process is slow and will require further support from the north shore to finalize the liberalization of the market. The figure below depicts the state of the electricity market of each country.

Several reforms are underway to cope with the changes in the electricity market on both shores of the Mediterranean Sea. On the upper side of the sea, the reforms aim to improve the security of supply and affordability of energy prices, as explained in the MEDREG ELE WG task force report on the energy price surge.

On the south shore, the development aims to move towards unbundling rules to improve transparency, allowing also for the integration of new producers without going through the independent power producer (IPP) model and developing rules for third-party access.

It also offers opportunities for the development of cross-border transactions via interconnections.

Figure 7. Electricity Market Structure in the Mediterranean Region



3. ELECTRICITY MARKET STATISTICS

3.1. Maghreb Member Countries

3.1.1. Market structure and organization

Historically, public monopoly is the structure of the electricity market in the Maghreb region, mostly due to the strategy of nationalization of the energy companies. Following the changes in the electricity market worldwide and the successful unbundling of the EU electricity markets, the Maghreb region countries expressed their willingness to change the structure of the electricity market. However, with a historical operator that owns most of the electricity infrastructure and a lack of regional integration, such as in the EU, the unbundling of the market is facing many challenges and obstacles.

As a first step, an independent NRA was created in Algeria – Electricity and Gas Regulatory Commission (CREG) in (2002) – and recently in Morocco – National Electricity Regulatory Authority (ANRE) in 2016.[2] Tunisia and Libya don't have a regulatory authority yet. The NRAs have dictated a roadmap to help achieve the unbundling of the electricity sector, starting with electricity generation; in all the countries except Libya, IPPs and PPA are used in electricity generation (more details are given in the energy mix paragraph).

In Algeria, the transmission system operation (TSO) is legally unbundled and performed by two companies: the system operator (OS) and the grid owner (GRTE, Gestionnaire du Réseau de Transport de l'Electricité). The distribution is operated by only one Distribution System Operator (DSO) called Sonelgaz distribution, which is a part of the historical operator group. The market is based on a limited single buyer and an Over The Counter "OTC" wholesale market; the consumers are eligible to choose their supply if their annual consumption is equal to or more than 4 GWh.

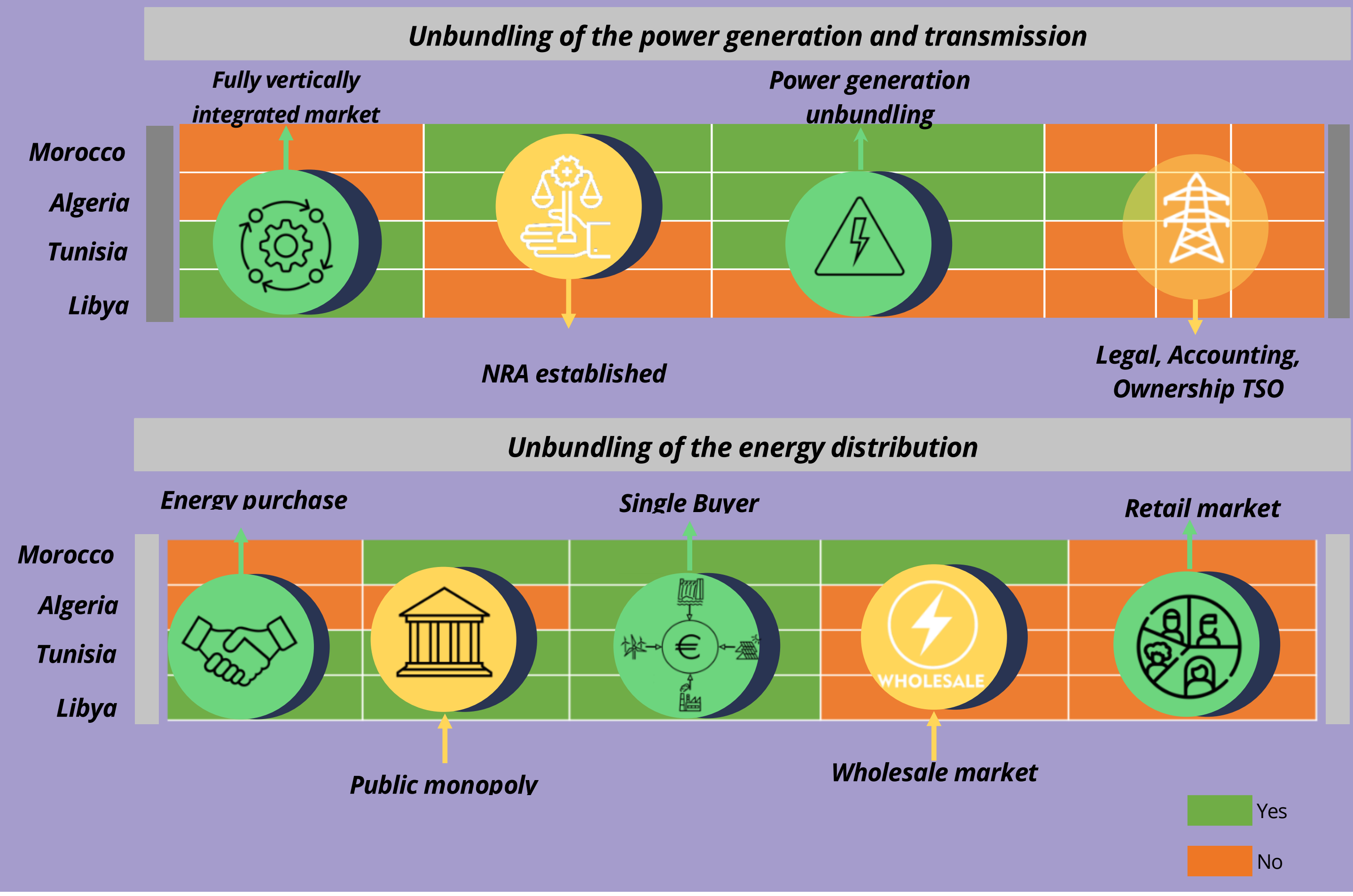
In Morocco, the transmission network is operated by the historical utility Office National de l'Electricité et de l'Eau Potable (ONEE), and the distribution is dominated by the historical operator ONEE and seven distribution regions 'Régies' + 4 private concessions (in Casablanca, Rabat, Tangier, and Tetouan).

In the market, a single buyer coexists with access to a third-party, wholesale OTC, mostly through bilateral contracts that allow private producers (RES) to sell to eligible consumers, and Morocco participates in the power exchange in the Liberian market as ONEE is an operator in the market.

On the other hand, Tunisia and Libya's transmission and distribution networks are still operated by the historical utility.

[2] Fully operational in 2021

Figure 8. Internal Market Structure in the Maghreb Countries



3.1.2. Electricity demand and generation

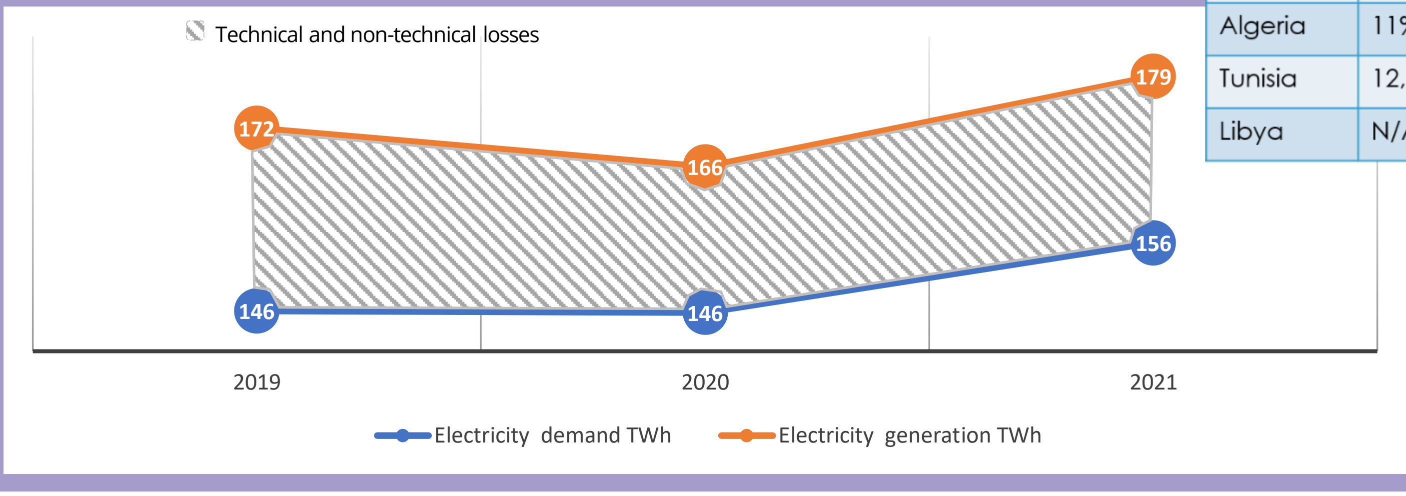
The electricity demand in the Mediterranean south shore countries continues to increase, mainly due to the rise in population and economic growth. In the Maghreb member countries (Morocco, Algeria, Tunisia, and Libya) the total demand reached 156 TWh in 2021, while the electricity generation reached 179 TWh, corresponding to a growth of 18% in 2016.

However, the weather conditions strongly affect the electricity demand in this region, which makes the planning and demand forecast even harder. Furthermore, the Maghreb region faces an additional challenge while maintaining the balance between demand and supply; the technical and non-technical losses represent an important share of the total generation.[3]

[3] The MEDREG Consumer WG published a report on the technical and non-technical losses, available here.

The next figure presents the evolution of global electricity demand and generation in the Maghreb member countries from 2016 to 2021. The gap between supply and demand is mainly due to losses as the rates of exports are low.

Figure 9. Electricity Demand vs Generation in the Maghreb Sub-Region



Total losses

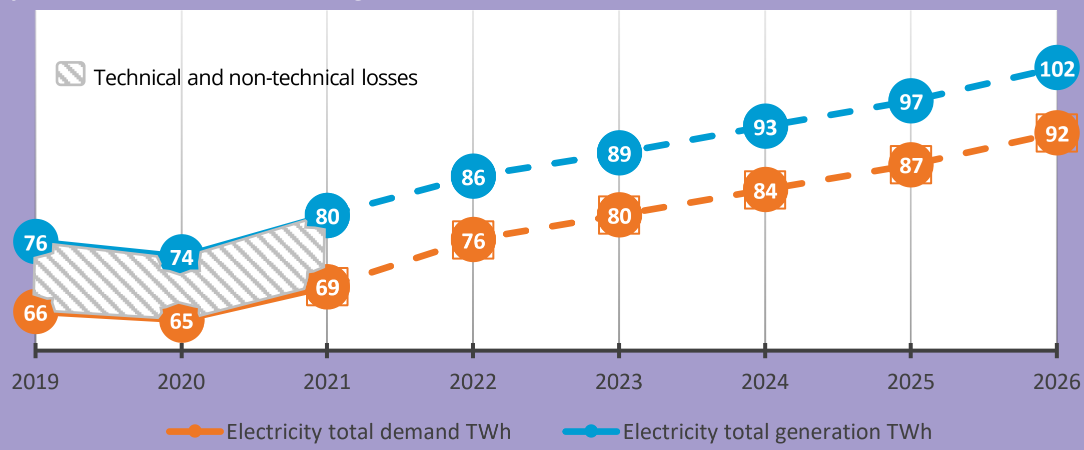
Morocco	12%
Algeria	11%
Tunisia	12,5%
Libya	N/A

The volume of demand in the Maghreb countries grows in each country, and the growth is expected to continue during the next five years. The demand is increasing in different proportions in each country depending on their characteristics.

- ***Algeria***

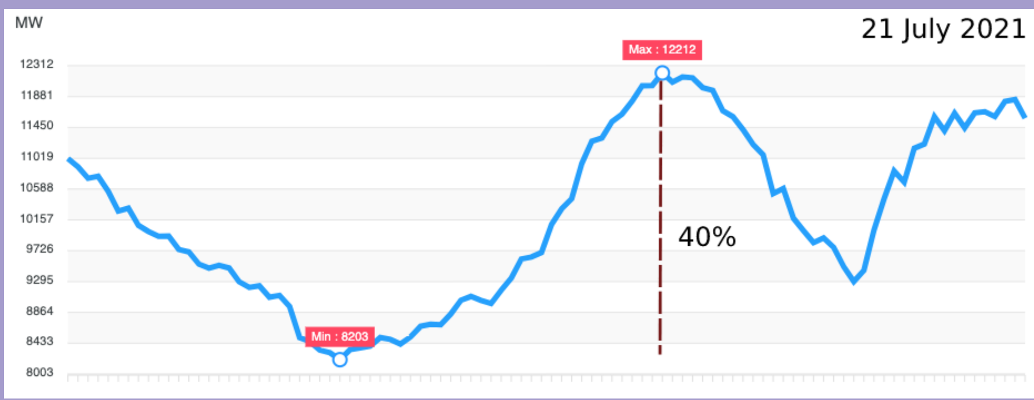
The demand in Algeria (Figure 10) is strongly linked to population growth and socio-economic development. In fact, the Algerian population has increased by 19% (7 million) since 2012, and economic development and social welfare were the reasons for the rise in electricity consumption. However, it's worth mentioning that during the COVID-19 pandemic, the electricity demand decreased by 1 TWh, mainly due to the impact of the pandemic on economic and social activities. Transmission and distribution losses are important issues in the Algerian system. During the last three years, 15% of the total generation was lost on the electrical grid (technical and non-technical losses). The NRA monitors the performance of the distributors through indicators; however, more measures and schemes are required to decrease the share of losses.

Figure 10. Electricity Demand and Generation in Algeria



The forecast up to 2026 predicts continuity in the demand and generation growth, which will reach a need of 92 TWh by 2026 and a total electricity generation of 102 TWh to cover it.
In terms of the load curve, the peak load in Algeria occurs during the day in summer, with a load of 16,2 GW in 2021, compared to 14,7 GW in 2020.
To maintain the security of supply and the balance between demand and generation, the development plan is based on the summer period, concentrating on all the challenges and system constraints.
However, the night drop peak is considerably low compared to the day (around 40%) as shown in the next figure, which also presents a challenge in terms of capacity allocation and maintaining the highest factor load of the power plants. After summer, the daily average load is around 8,7 GW, which is also considerably low compared to the annual peak load.

Figure 11. Load Curve of the Algerian Main Grid – 21 July 2021

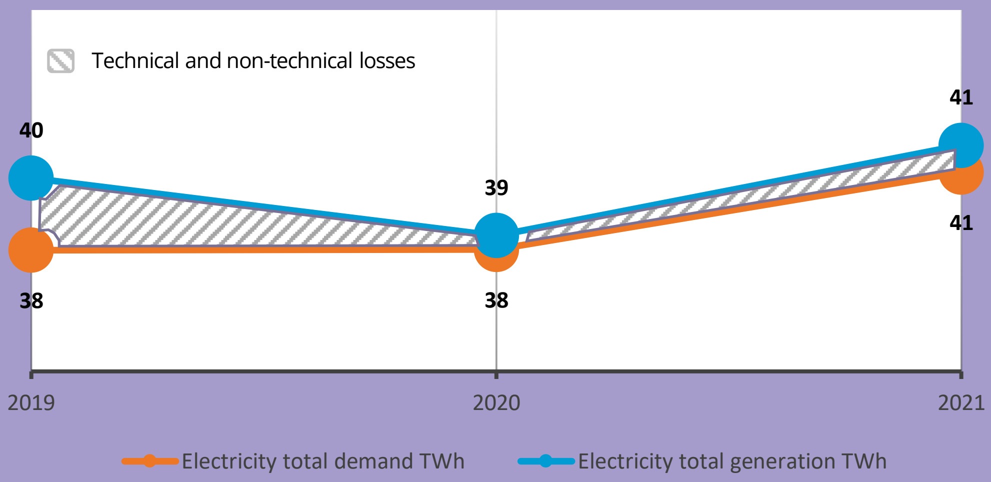


Source: Algerian TSO website

- ***Morocco***

Similar to its neighbouring country, the electricity demand in Morocco is driven by high population growth, with an increase of 12% (4 million) since 2012, which is reflected in the rise in electricity demand in 2021 to 41 TWh, as shown in the figure below.

Figure 12. Electricity Demand and Generation in Morocco

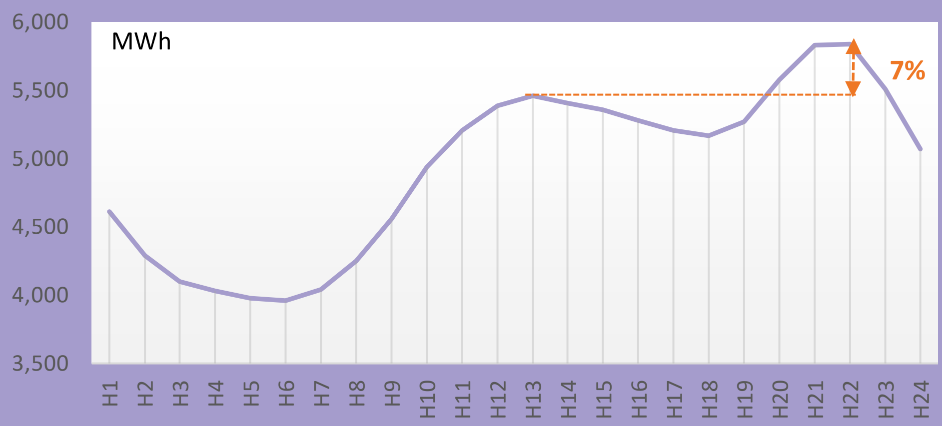


This rise in electricity demand is foreseen to continue with an average of 4% per year for the next five years. The COVID-19 outbreak also impacted the demand in Morocco, with a decrease in demand by 1 TWh, mainly due to a reduction of 5% in the industrial sector consumption.

The technical and non-technical losses are also high in Morocco. In 2021, the technical losses reached 7% and the non-technical losses around 12%.[4] Reducing the losses will considerably improve the security and quality of the supply.

About the load curve, the evening peak record reached 6,71 GW, which is an increase of 0,27 GW compared to 2020. However, the gap between the daytime and evening loads is much lower compared to Algeria. As shown in the figure below, the average gap is 7%, which is easier to manage. The figure below depicts the average curve during the 365 days of 2021.

Figure 13 Average Load Curve of the 365 Days of 2021



It's also worth mentioning that since the early 2000s, Morocco has focused on increasing the rural electrification rates to reach 99,78% by the end of 2020 compared to 55% in 2002.

- ***Tunisia***[5]

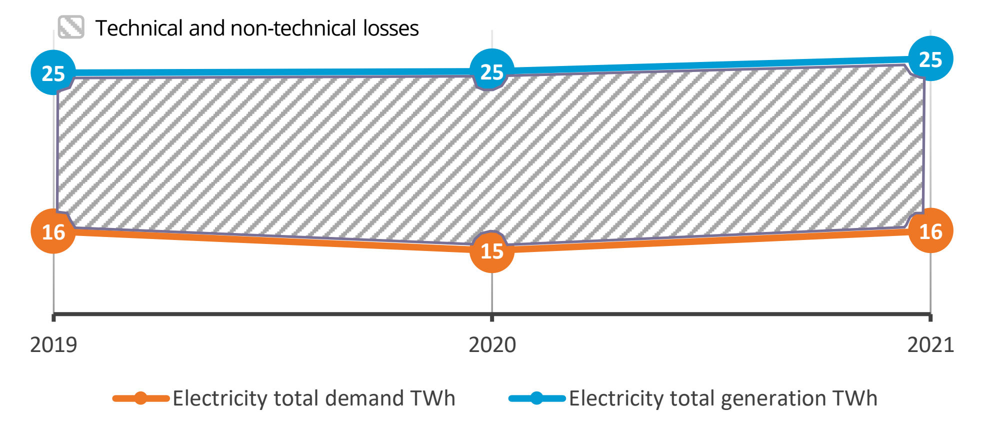
In contrast to Algeria and Morocco, the electricity demand in Tunisia remained at the same level, with a reduction during the COVID-19 outbreak in 2020, as shown below. However, the electricity demand in the last three years till 2021 has increased by 9% compared to 2016.

Electricity demand is impacted by weather conditions and the significant use of air conditioning.

[4] For transmission and distribution

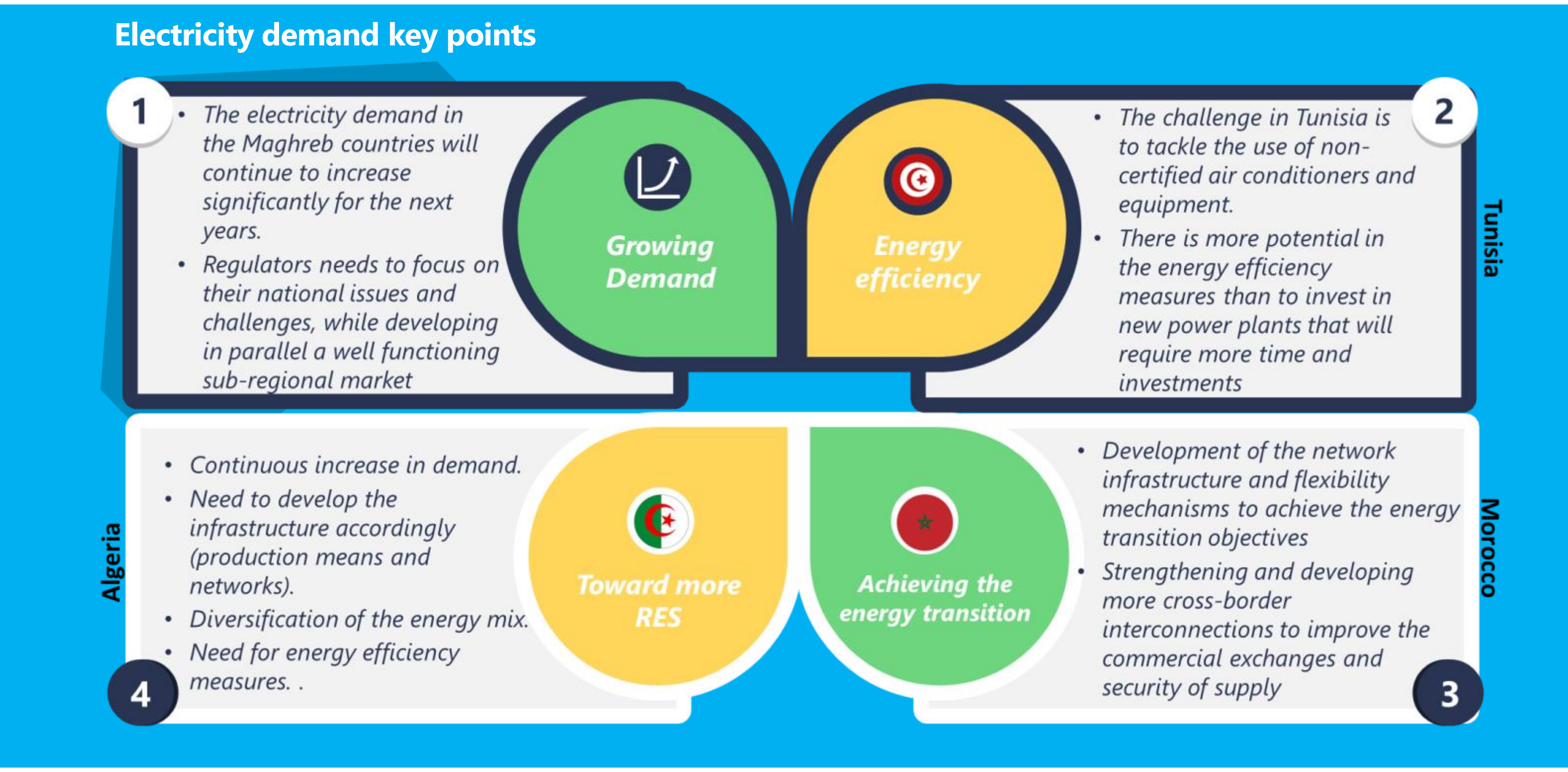
[5] All the data was collected from the Ministry of Interior's open data and the annual report of STEG.

Figure 14. Electricity demand and generation in Tunisia



The peak load reached 4,4 GW, with an increase of 11% compared to the previous year. Also, 44% of the peak load resulted from the use of air-conditioning. Most of the challenges and constraints to maintaining the security of supply are related to the use of non-certified equipment. Many efforts have been focused on implementing energy efficiency measures and raising consumer awareness to reduce the impact of energy-intensive equipment.

In addition, the technical and non-technical losses represent 18% of the total electricity generation in 2020. The historical operator Tunisian Company of Electricity and Gas (STEG) is planning to implement the smart grid to reduce the share of non-technical losses.



3.1.3. Energy mix

The energy mix in the Maghreb region is dominated by conventional production based on the available primary energy source in the country.

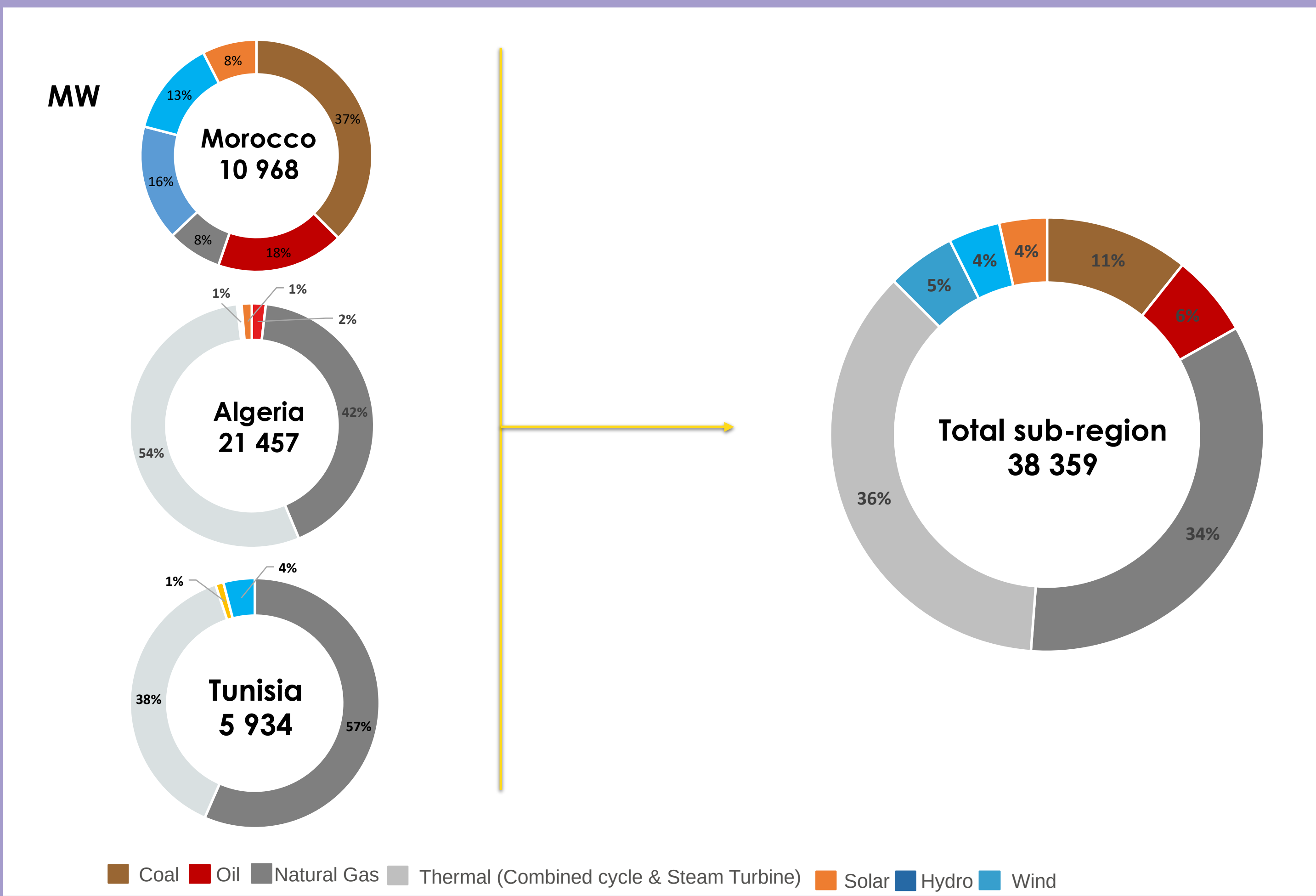
In Algeria, Tunisia, and Libya, electricity is mainly produced from natural gas. However, Morocco has a diverse energy mix, ranging from coal and gas to hydro and RES.

In terms of installed capacity, almost 80% is natural gas (gas turbine, steam turbine, and combined cycles), followed by 8% of coal and 6% of RES (hydro, wind, solar photovoltaic (PV) and concentrated solar power (CSP).

In Algeria, Tunisia, and Libya, at least 94% of the installed capacity is based on natural gas. On the other hand, coal represents 37% of the total installed capacity of Morocco.

Finally, most of the RES capacity installed in the Maghreb region comes from Morocco at 85% of the total capacity. The figure below depicts the proportion of each type comprising the installed capacity in the Maghreb region.

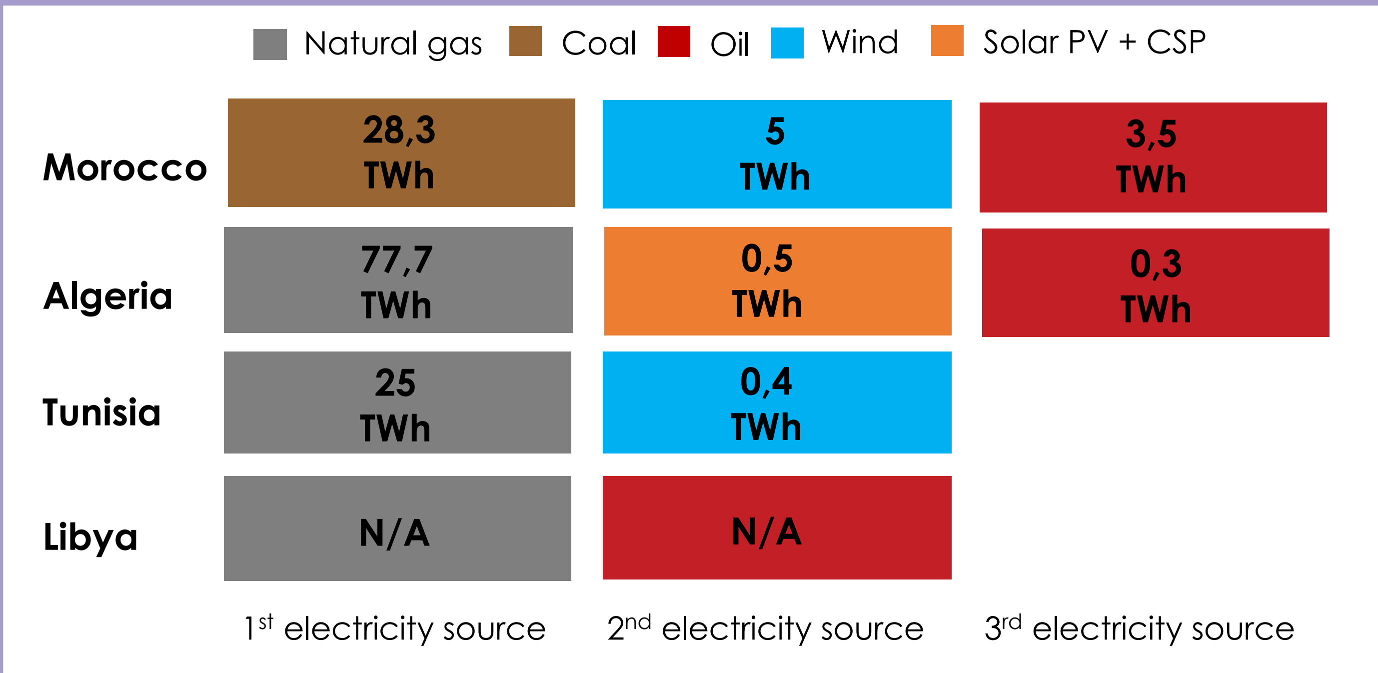
Figure 15. Installed Capacity in Maghreb Region by Country



During the last few years, many efforts have been taken in the region to increase the share of RES and reduce fossil fuel usage. Still, the integration of RES is slow and facing many challenges. The details of the electricity generation of each country are given below.

In addition, due to the structure of the electricity market in the Maghreb region, the production of electricity is dominated by the public operator, except in Morocco.

Figure 16. Energy Mix in the Maghreb Region – 2021



In most of the Maghreb countries, power generation is open for competition and private producers. However, the share of private producers is still low in Algeria and Tunisia, where the share of IPPs/PPA has reached almost 19,4% of the total production in each country. On the other hand, Morocco started the concession of electricity production earlier in the 90s. In 2021, the share of the historical operator ONEE reached only 21% of the total production.[6]

In Libya, most of the production is from the public producer.

3.1.4. Transmission and distribution infrastructure

The transport and distribution infrastructure is well developed in the Maghreb region. The electrification rates are almost 100% in Algeria, Morocco, and Tunisia. The rate is lower in Libya at 70% due to its past pollical situation.

The total length of the transmission and distribution network in the Maghreb region, excluding Libya where the data is not available has reached almost 1 million km. In addition, the development of infrastructure is continuously increasing to connect new consumers, improve the quality of supply, and increase the security of supply. In the last two years, the total length has increased by 3%.

[6] Source: ONEE website.

The figure below provides the transmission and distribution infrastructure by country and by the level of voltage. It also shows the share of consumption by the level of voltage.

Figure 17. Transmission and Distribution Infrastructure in the Maghreb Countries (2021)

Country		High voltage (≥ 60 kV)	Medium voltage (10 kV ≤ V ≤ 30 kV)	Low voltage (< 10 kV)
Morocco	Length (km)	28 352	95 567	256 305*
	Consumption (TWh)	15,6	8	8,4
Algeria	Length (km)	32 537	168 196	199 377
	Consumption (TWh)	13,4	17,6	38,4
Tunisia**	Length (km)	6 793	62 115	121 074
	Consumption (TWh)	1,2	6,3	7,8
Libya	Length (km)	N/A	N/A	N/A
	Consumption (TWh)	N/A	N/A	N/A

* Cover only ONEE distribution that represent nearly half of the total distribution network.

* * 2020 Data

The consumption per level of voltage shows the nature of the country's consumption, whether it is for residential or industrial needs and large consumers (commercial). It is also an indicator of the country's economic level. In addition, as shown in the figure below, the residential part is important, which suggests the potential to reduce consumption through energy efficiency measures.

3.1.5. Cross-border interconnections and exchanges

In terms of cross-border interconnections, the Maghreb region is connected to the European network through the interconnection between Morocco and Spain. However, the exchanges among the countries in the sub-region are considerably low compared to the existing capacities, as shown in the next figure.

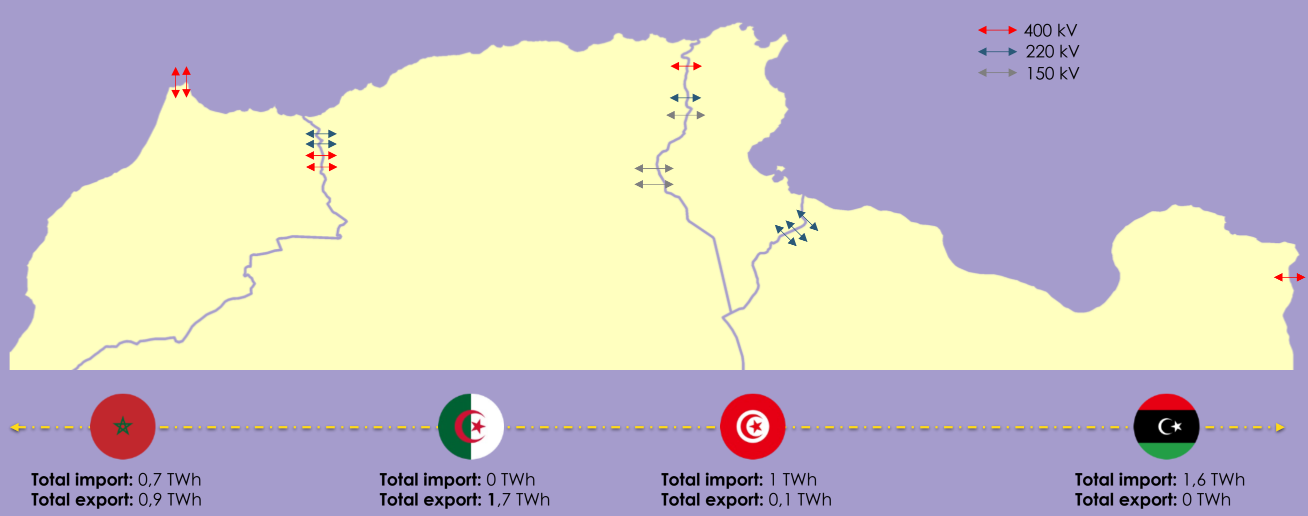
The first step was initiated in the 1950s to create a regional market and increase the security of supply in the region. In the second step, the Maghreb region, excluding Libya, was synchronized to the European network through the interconnection between Morocco and Spain in the late 90s, following which the interconnections between Tunisia, Algeria, and Morocco were reinforced in the 2000s, reaching a total of 15 transmission lines ranging from 130 kV to 400 kV.

However, the development of the market has not followed the same rhythm as the development of interconnections. The imports/exports between the countries remain low compared to the existing capacity and infrastructure. To date, the interconnections are mainly used for the security of supply. Tunisia imports a part of its consumption from Algeria (6% in 2021) and sells its electricity to Libya, even though in small quantities. Lastly, Libya imports its electricity from Tunisia and Egypt to ensure its security of supply.[7]

[7] Data on imports/exports from the Tunisian and Egyptian TSO annual reports.

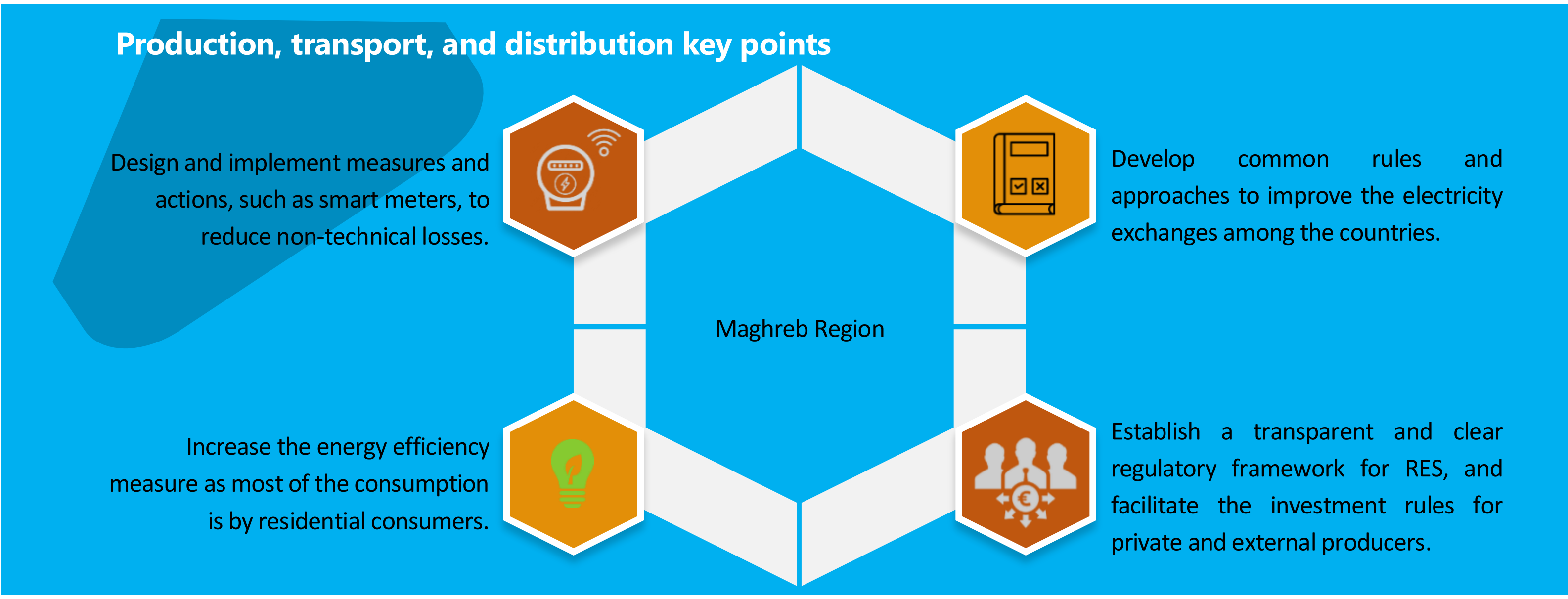
However, with the countries' recent events and energy transition objectives, the concretization of a regional market in the Maghreb is essential. Not only will this strengthen the security of supply and facilitate the integration of renewable energies but it will also be an active operator in the European market and export renewable energy to the EU market. But, for this, significant efforts and close cooperation between the countries are required to work together towards the same objective.

Figure 18. Cross border interconnections in the Maghreb member countries



The development of further interconnections is being planned from the West side between Morocco and Portugal as well as reinforcements with Spain to increase the exchange capacity on the east side between Tunisia and Italy and between Algeria and Italy. However, at this stage, only feasibility and financing studies have been undertaken.

The figure below provides the main key points related to production, transport, and distribution in the Maghreb sub-region.



3.2. Middle East Member Countries

3.2.1. Market structure and organization

The unbundling of the electricity market in the Middle East MEDREG member countries is similar to the Maghreb region. Power generation unbundling has been achieved in all the countries except Palestine, where they don't have power generation. On the other hand, the unbundling of the TSO and the distribution are facing many challenges and require more time to be achieved.

In Egypt, the TSO is legally and financially separated from the historical operator, the Egyptian Electricity Holding Company (EEHC), and the distribution is ensured by nine public and 69 private DSOs (very small companies with very limited territories). The market is still under a regulated regime that's foreseen to be removed in the future.

The Israeli electricity system has evolved considerably in the last few years, changing the country from one that was completely dependent on energy imports to one that meets all its energy needs and exports energy to its neighbouring countries, thanks to the recent discovery of large reservoirs of natural gas.

The government decided to reform the electricity market by creating an NRA, and as a part of the reform, most of the electricity production will be transferred to private ownership, the electricity supply will be open to competition, and the management of the electricity system will move from the Israel Electric Corporation (IEC) to a new government company – the system administrator. In addition, as a part of the reform, six power plants would be sold by the IEC to private producers in the coming years.

In Jordan, a public monopoly still exists as in Egypt, and since the creation of the Energy and Minerals Regulatory Commission (EMRC), the reform of the market was initiated by transferring a part of the owned state company, Central Electricity Generation Company (CEGCO), in 2007 by selling 60% of its shares to private companies. In addition, other IPPs have entered the electricity generation sector with Amman East Power Company, the first IPP project in Jordan in 2008 with 370 MW in a combined cycle power plant. In 2010, a second IPP project was established with an addition of 373MW in the combined cycle unit.

The transmission (TSO) is completely done by a state-owned company, but the distribution has been divided between three private companies: Jordan Electric Power Company (JEPCO), Irbid District Distribution Company (IDECO), and Electricity Distribution Company (EDCO).

In Lebanon, Electricité du Liban (EDL), a vertically integrated utility, owns and operates the electricity generation,[8] transmission, and distribution in the country. However, the Lebanese government plans to reform the electricity to address the sector's current and historical challenges.

The ministry of energy of water's (MoEW) policy statement aims to present the MoEW's comprehensive five-year plan (2022–2026). Given the increasing urgency for immediate action, the plan includes short-term action plans to increase the electricity supply in the country within the context of a long-term vision to tackle entrenched structural, operational, institutional, and financial deficiencies in the sector. This plan presents a comprehensive and interconnected framework to address sector challenges and increase the sector's

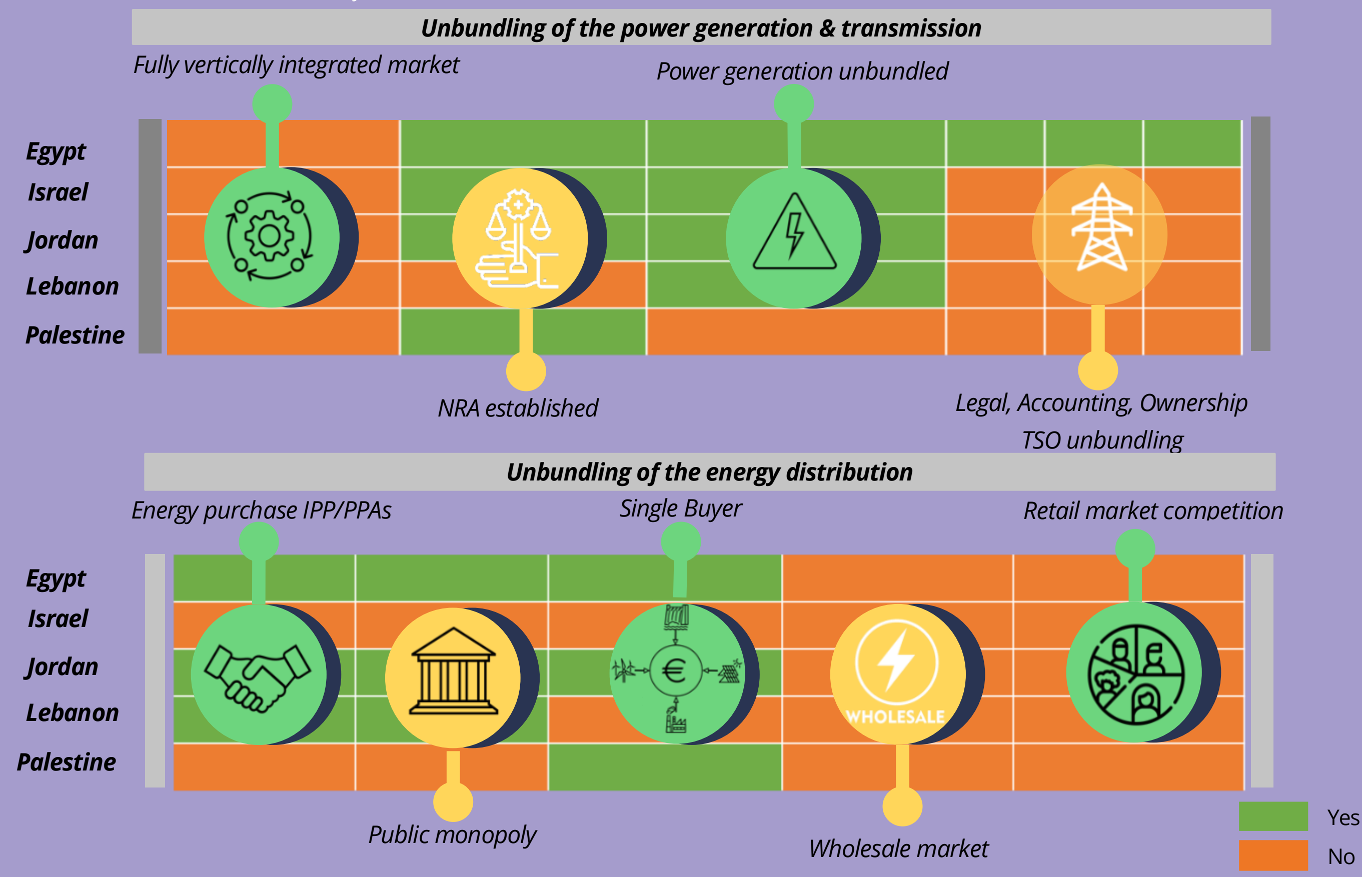
[8] Except for hydroelectric concessions

transparency, operational efficiency, and financial sustainability to a level on par with regional and international best practices.[9]

In Palestine, most of the energy supply comes from Israel. The TSO and DSO are public companies, and to meet the growing demand, continuous investments are being planned for electricity generation and diversifying the energy import.

The figure below describes the internal market structure and organization of the Middle East MEDREG member countries.

Figure 19. Internal Market Structure of the Middle East MEDREG Member Countries

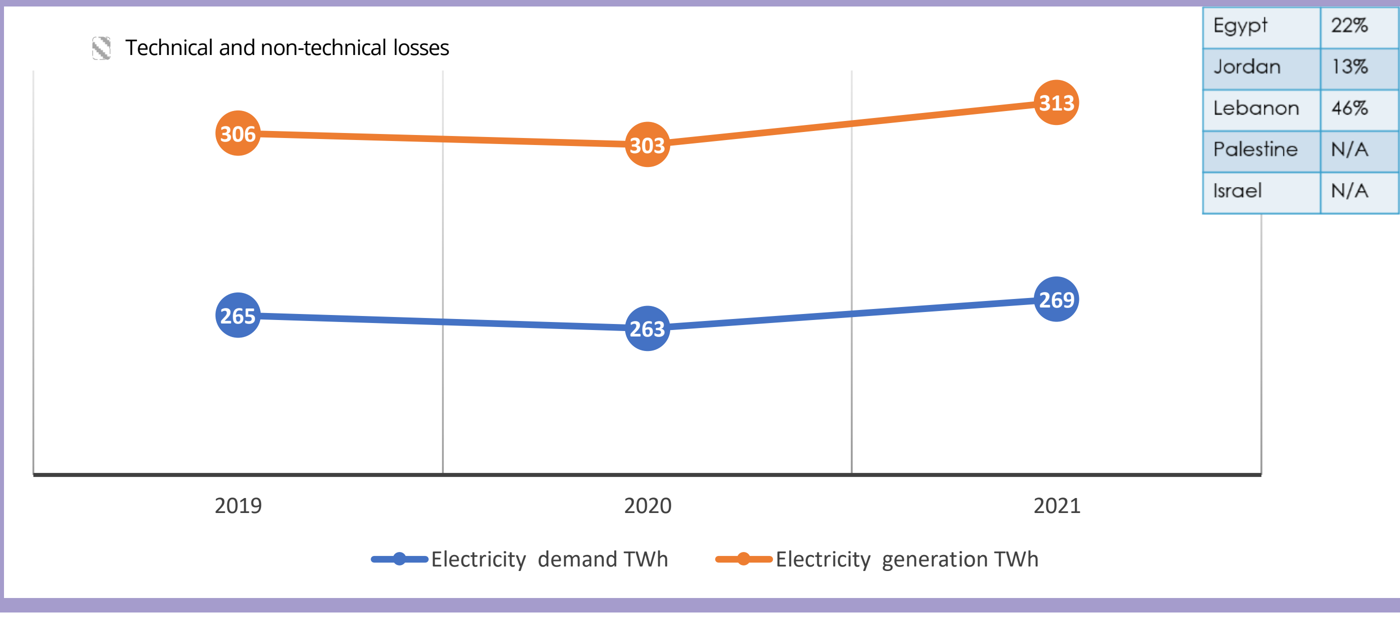


3.2.2. Electricity demand and generation

The Middle East region is continuously developing and evolving in terms of population and economic growth as shown in the first chapter. This growth is the main reason for the rise in electricity demand, and since most of the countries are self-sufficient in terms of electricity supply (except for Palestine and Lebanon), their electricity generation meets the increase in electricity demand. However, the technical and non-technical losses are significant and represent an issue in the region. The evolution of electricity demand and generation from 2016 is given in the figure 20.

[9] The policy statement of the Ministry of Energy and Water of Lebanon, March 2022, Link.

Figure 20. Electricity Demand vs Generation in Middle East Sub-Region



Total losses

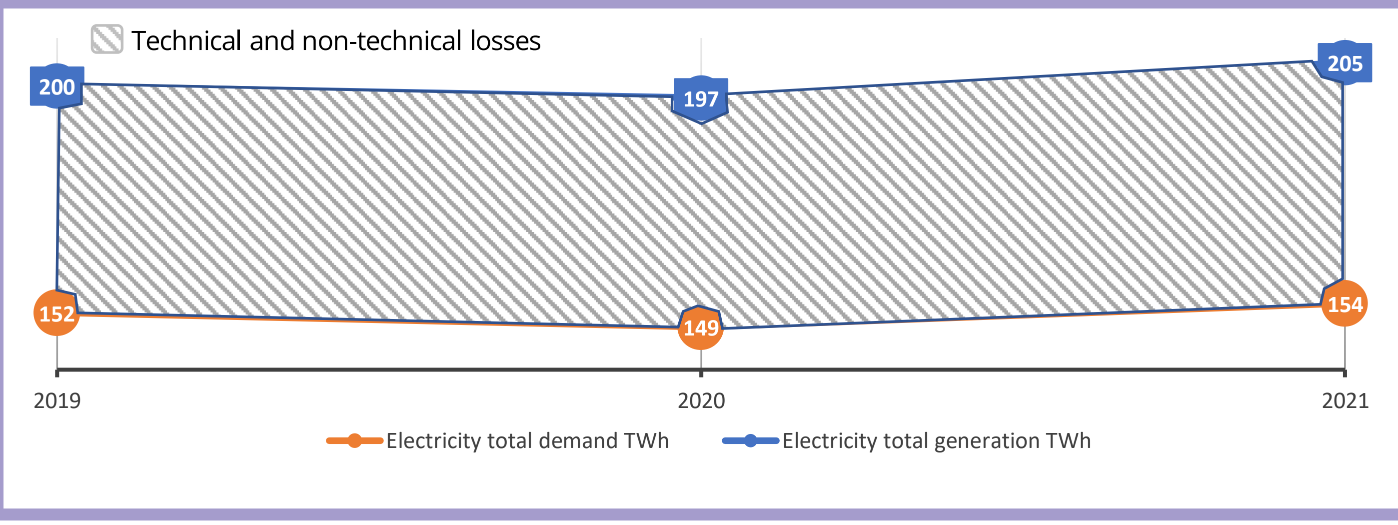
Egypt	22%
Jordan	13%
Lebanon	46%
Palestine	N/A
Israel	N/A

The electricity demand and generation have increased by almost 27 TWh since 2016 – a growth of 20% in the last five years – and it's expected to continue increasing in the next year. The technical and non-technical losses comprised around 13% of the total generation in 2021.

- ***Egypt***

The population growth in Egypt is the highest in the Mediterranean region, with an increase of 19 million since 2011, reaching 104,26 million in 2021. Population growth is the main driver of electricity demand and generation. In 2021, the total electricity demand reached 154 TWh, an increase of 1,4% since 2019. However, in the last two years, the pandemic and the energy price surge affected the electricity demand. In 2020, the electricity demand decreased by 3 TWh, mainly due to the COVID-19 outbreak, as depicted in the figure 21 below.

Figure 21. Electricity Demand and Generation in Egypt



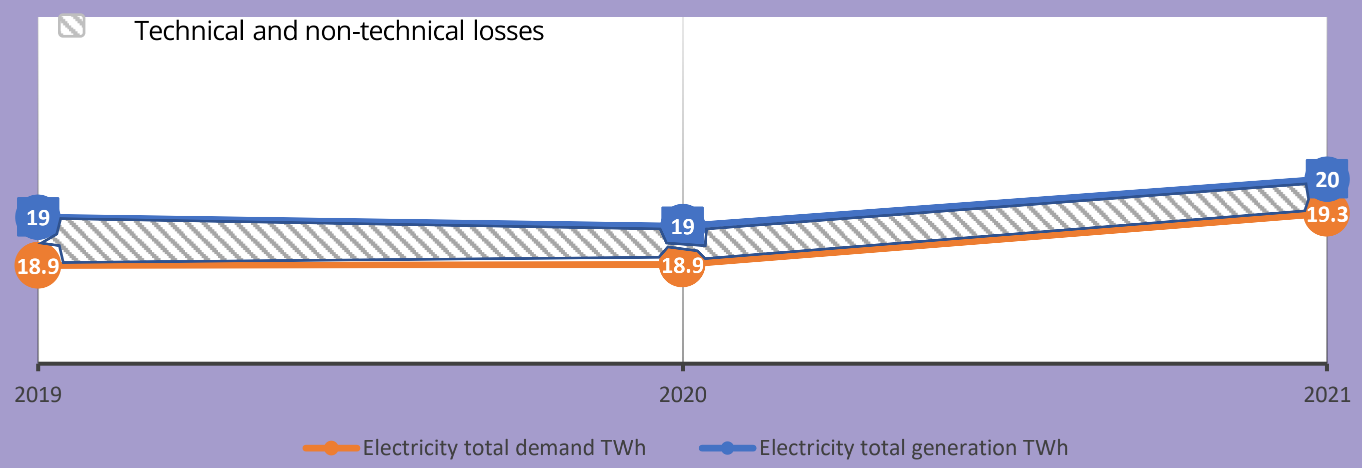
In the same way, electricity generation increased in the past few years and reached 205 TWh in 2021. However, the share of losses is significant. In one year, the Egyptian electricity market loses almost 50 TWh (22% of electricity generation) through technical and non-technical losses as their share of exports is very small (1,5 TWh in 2021).

- ***Jordan (Data of 2021 from the National Electric Power Company, NEPCO)***

The electricity demand has slightly increased in Jordan in the last three years, reaching 19,3 TWh in 2021. The electricity generation increased accordingly to meet the growing demand, and in 2021, the total generation was 20 TWh.

In terms of losses, the recorded rates are moderate, but more efforts are required to reduce the share of non-technical losses that accounted for 22% in 2020 as shown in the figure below.

Figure 22. Electricity Demand and Generation in Jordan



The demand is expected to continue to grow, and the Jordanian government has devised a strategy to maintain the security of supply, improve the quality of supply, increase the share of RES in the energy mix, and reinforce its cross-border interconnections.

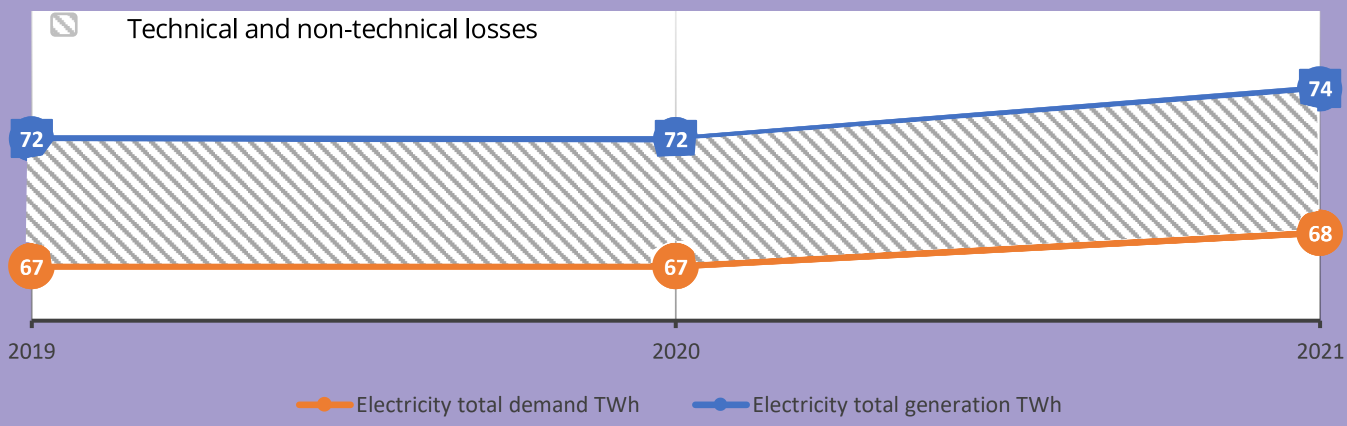
- ***Israel***

During the last three years, the electricity demand has increased, reaching a growth of 2% in 2021, and the electricity generation reached 74 TWh in the same year.

The electricity sector in Israel is expected to evolve considerably as the government promotes a competitive and efficient economy while implementing the main cornerstones of the reform in the electricity sector.

The technical and non-technical losses have remained in the same range over the past few years, with a total loss of approximately 5,5 TWh per year (see the figure below).

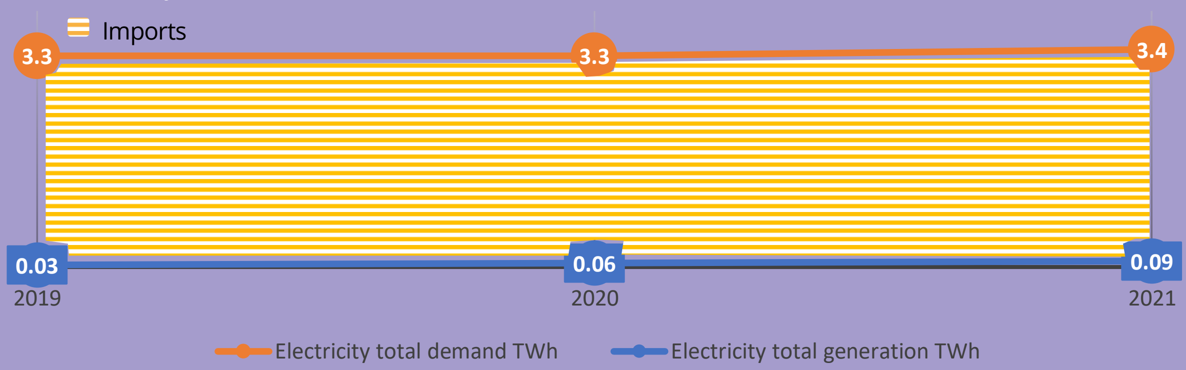
Figure 23. Electricity Demand and Generation in Israel



- ***Palestine***

In Palestine, electricity demand has remained at the same level for the past three years. On the other hand, electricity generation has increased slightly. However, Palestine's electricity supply depends on imports from its neighbouring countries, as shown in the next figure.

Figure 24. Electricity Demand and Generation in Palestine

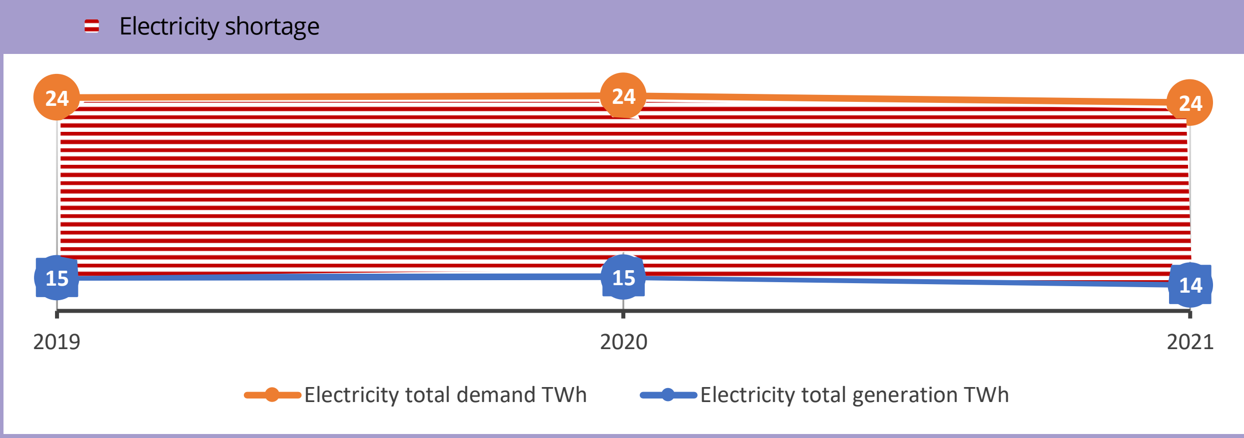


- ***Lebanon***

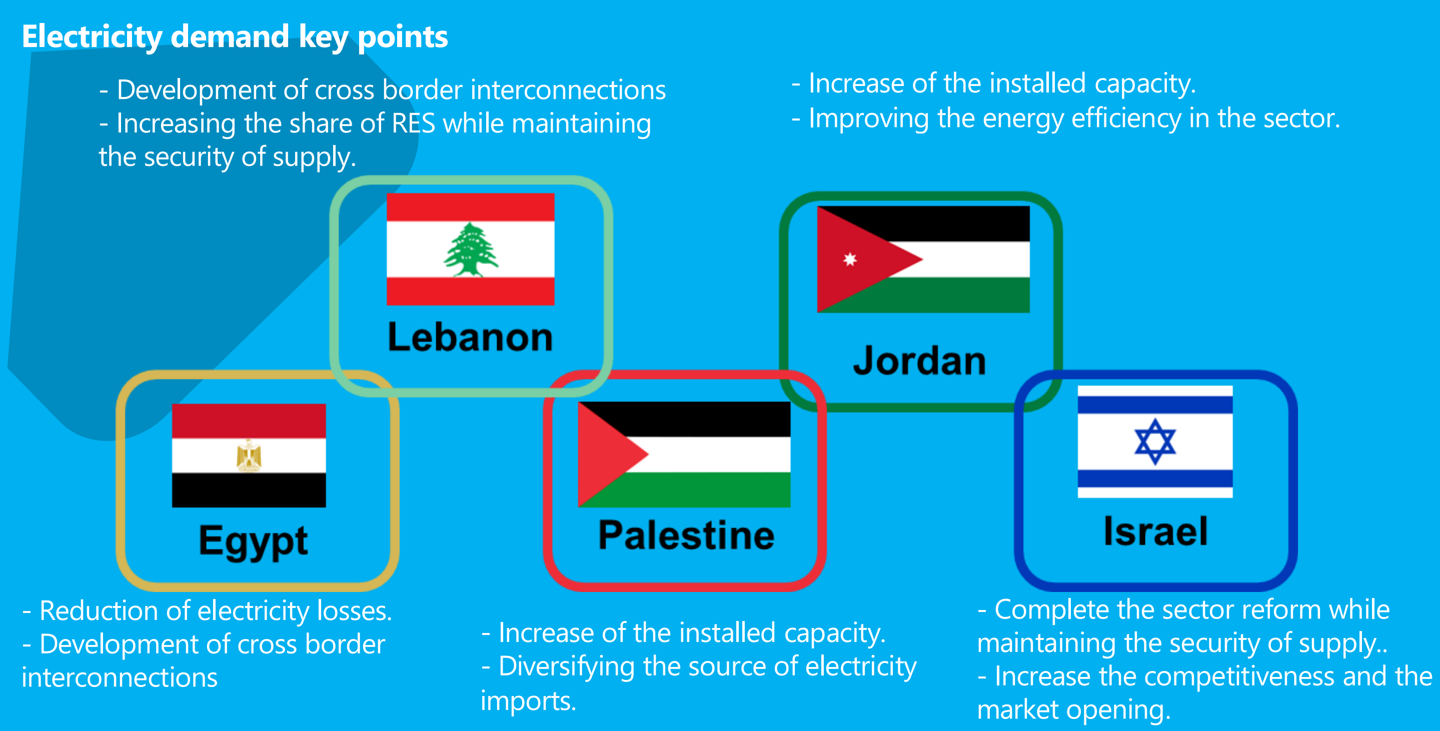
During the past three years, the electricity demand in Lebanon has remained at the same level (24 TWh). As for electricity generation, in 2021, the total generation reduced slightly.

The main challenge in Lebanon is increasing the national electricity production to reduce the electricity shortage. The installed capacity is insufficient to secure the supply, and the government has put in place a strategy to increase the capacity by opening a call for investors and promoting energy efficiency.

Figure 25. Electricity Demand and Generation in Lebanon



In general, the electricity demand in the Middle East MEDREG member countries is increasing, mainly due to population growth and improvement in the countries' economies. However, many future challenges have been identified in each country, and the concerned governments and NRAs have developed strategies to overcome those challenges. In addition, MEDREG, as a platform that gathers NRAs around the Mediterranean basin, will support its members to reach their objectives through cooperation among the members, knowledge sharing, and tailor-made training. The next figure depicts the main challenges of each country.



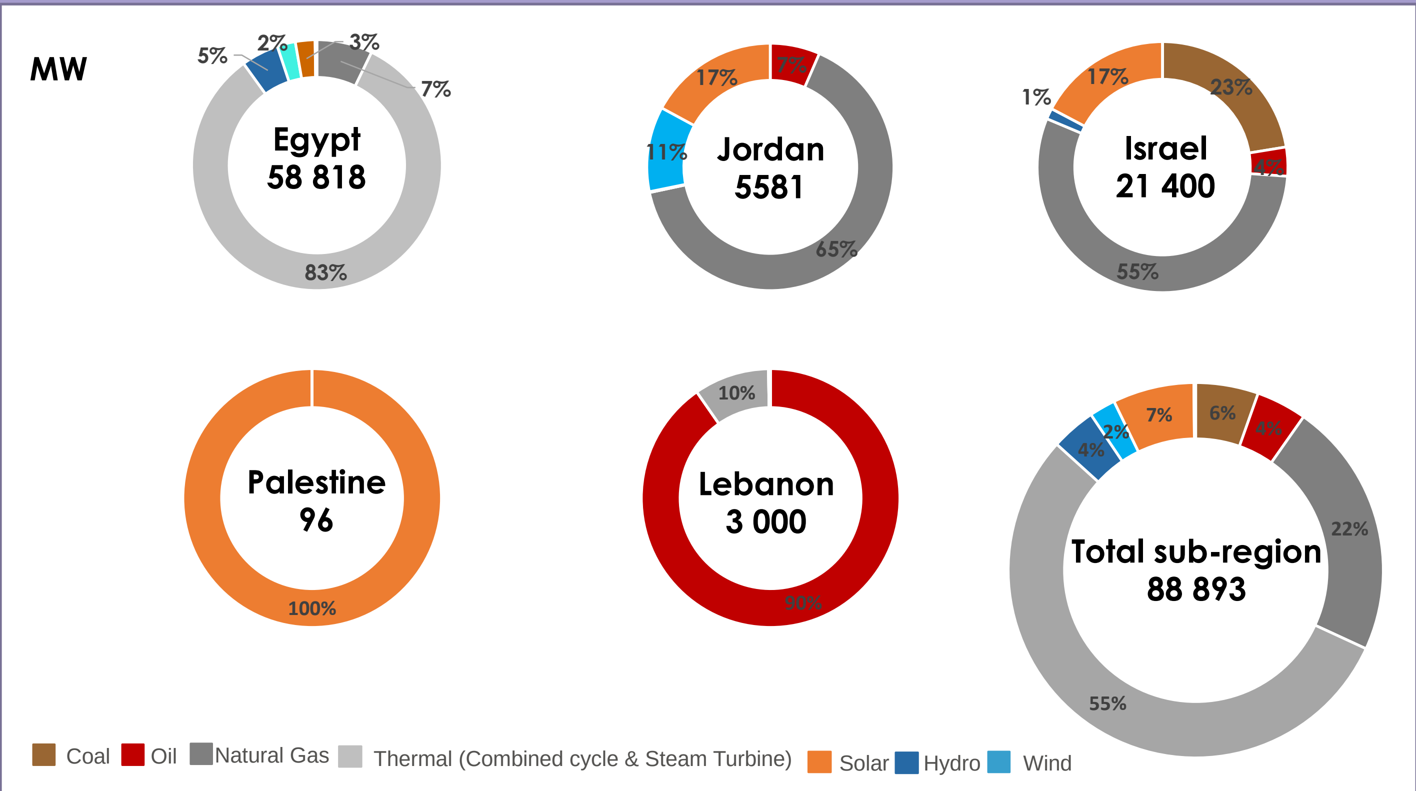
3.2.3. Energy mix

Natural gas is mostly used in the Middle East MEDREG member countries, where 77% of the installed capacity is based on natural gas (gas turbines, steam turbines, or combined cycles). However, it's worth mentioning that the energy mix includes a considerable share of RES such as wind, PV, and hydro, representing 13% of the total installed capacity.

Also, the combined cycle and steam turbines represent 55% of the installed capacity. These are the most optimal conventional power plants to support the integration of RES, as they are less polluting and have a better reaction time to tackle the intermittence of the RES.

The figure below depicts the installed capacity of the Middle East MEDREG member countries.

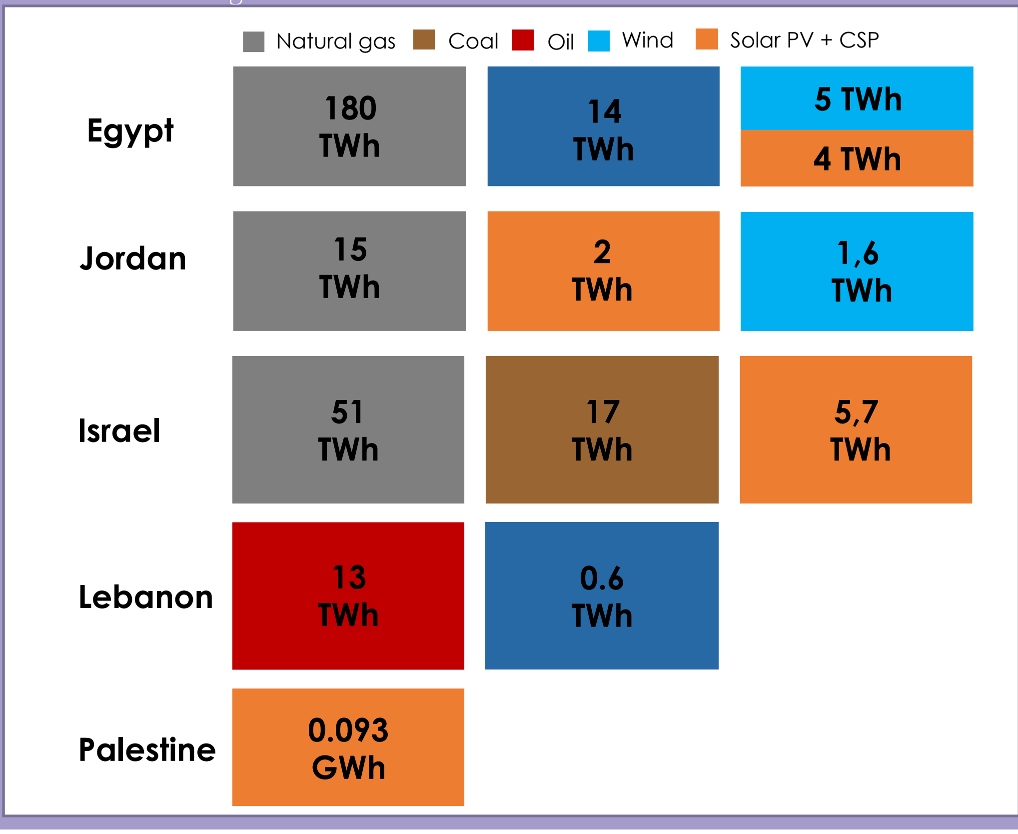
Figure 26. Installed Capacity in the Middle East Region by Country



In terms of energy production, natural gas dominates the mix with 246 TWh in 2021 (79%). However, the development of RES in the region has reduced the share of conventional energy sources by 2% since 2019, which is a substantial reduction, taking into consideration that the last three years were affected by the COVID-19 outbreak and energy price crisis. The RES are expected to increase during the next year as the country has adopted new strategies to facilitate the integration of RES in their national production. For example, Israel has reduced the share of coal in its energy mix by 23% compared to 2019 and substituted it with natural gas and solar PV.

In Egypt, the RES increased by 40% compared to 2019; in Jordan, the same trend can be noticed, with an increase of 79% compared to 2019, reaching almost 4 TWh in 2021. Even though the amount of RES production is still moderate compared to the conventional energy sources, the improvements observed in the last three years are a good sign for the region. The details of the electricity generation of each country are given below.

Figure 27. Energy Mix in the Middle East Region – 2021



The electricity market is not totally unbundled in the Middle East sub-region, and the power generation is already open for competition and private investors.

Almost 10% of the energy purchased in Egypt is from IPPs/PPA. The share is even more important in Jordan, where 43% of the conventional power generation comes from IPPs/PPA agreements, and all the RES are purchased through IPPs/PPA.

In Lebanon, only the energy purchased from hydropower plants is from IPPs/PPA. Details about Palestine and Israel are not available.

3.2.4. Transmission and distribution infrastructure

The total length of the transmission and distribution network in the Middle East sub-region reached 795 000 km by 2021, with 67 000 km in high voltage, 294 000 km in medium voltage, and 435 000 in low voltage. Most of the countries have reached an electrification rate of 100%. However, in some cases, such as Lebanon and Palestine, more development is required to tackle the security of supply issues.

To maintain and improve the quality of supply, the transmission and distribution infrastructure should be continuously developed. In Egypt, Jordan, and Israel the total length increased by around 2% in the last year (2020–2021)

The figure below depicts the transmission and distribution infrastructure of each country by the level of voltage and shows the share of consumption by the level of voltage.

Figure 28. Transmission and Distribution Infrastructure in the Middle East Countries

Country		High voltage (≥ 60 kV)	Medium voltage (10 kV ≤ V ≤ 30 kV)	Low voltage (< 10 kV)
Egypt	Length (km)	53 584	225 000	326 000
	Consumption (TWh)	24.6	31.9	95.7
Jordan	Length (km)	5 464	23 037	48 066
	Consumption (TWh)	0.44	18.4	
Israel	Length (km)	5 767	29 718	39 925
	Consumption (TWh)	5.7	24	36.7
Lebanon	Length (km)	1 539	15 506	19 846
	Consumption (TWh)	N/A	N/A	N/A
Palestine	Length (km)	0	3.5	14.8
	Consumption (TWh)	0	4.39	

In most of the countries, there is potential for reducing consumption by improving the energy efficiency measures and reducing the non-technical losses, which are considerable. However, more detailed studies are required to identify the expected saving from energy efficiency measures and at which level to apply them.

3.2.5. Cross-border interconnections and exchanges

The Middle East countries focused on developing the national infrastructure to ensure the security of supply and generate enough power to meet the growing demand. However, the cross-border interconnections didn't follow the same development as the national infrastructure, so there is a lack of interconnections between the countries, as shown in the figure below.

Figure 29. Cross-Border Interconnections in the Middle East Member Countries

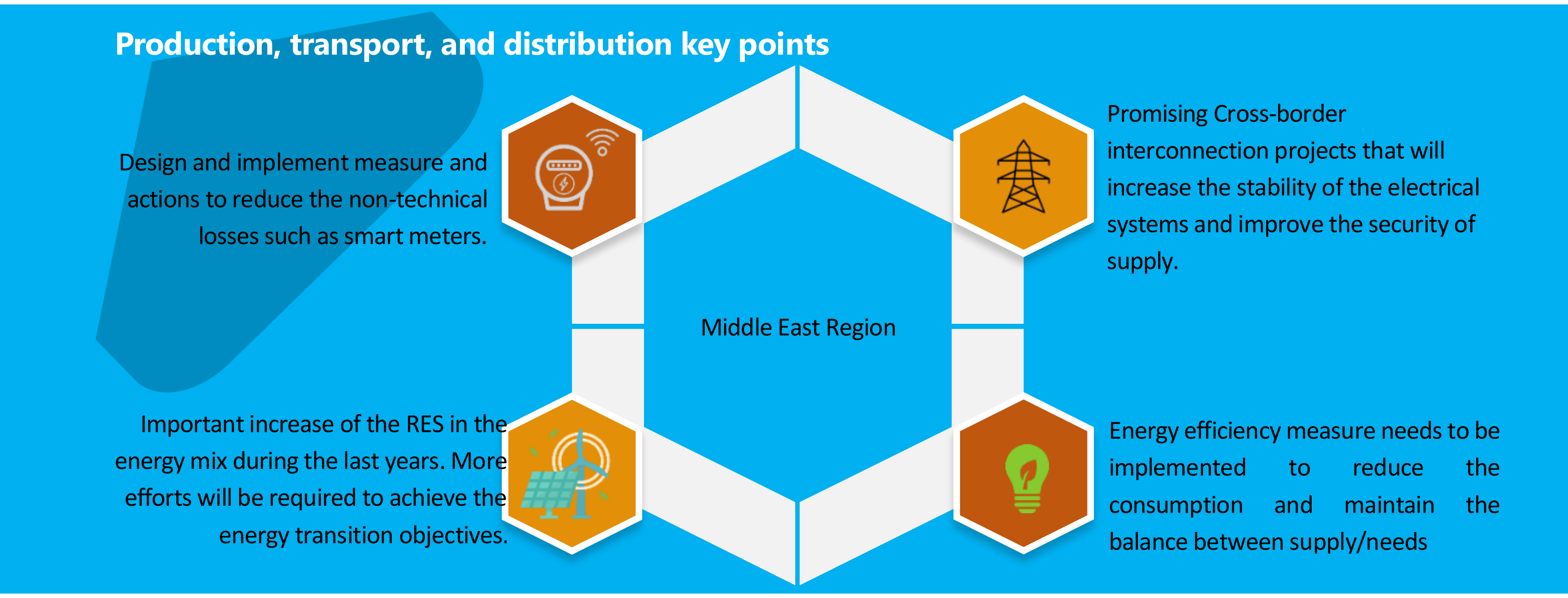
However, in 2021, multiple projects were announced to reinforce the cross-border interconnections, especially between Egypt and Jordan.

Now, Egypt is a part of the East Africa Power Pool, and it's connected to Jordan, Libya, and Sudan. The interconnection between Egypt and Saudi Arabia is under development, and there are also plans for interconnection with Cyprus.

Jordan is connected to Egypt, Palestine, and Syria (not operational) and is willing to develop more interconnections to establish a common Arab energy market and promote economic integration by 2030. Indeed, several agreements were signed in 2021, such as the supply of a part of Lebanon's needs through Syria by providing 150 MW from midnight to 6 AM and 250 MW from 6 AM to Midnight[10]. In addition, Jordan will also supply Iraq with electric power. The necessary bidding procedures have been started by the National Electric Power Company (NEPCO) to construct the new Al-Risha transfer station in Jordan and establish a new line to connect the new Risha station to the Al-Qaim transfer station in Iraq. Lastly, Jordan signed a memorandum of understanding for electrical interconnection projects with the Kingdom of Saudi Arabia, which constitutes a key element in the development of the regional market.

[10] NEPCO annual report 2021

Palestine imports its total needs from Israel using more than 300 connection points on MV and 4 substations on HV. Israel, on the other hand, doesn't have any cross-border interconnections, expect with Palestine. However, there is a proposal to establish a Euro Asia interconnector that connects Greece, Cyprus, and Israel via a submarine cable HVDC of 1 208 km and 2 000 MW capacity. The first stage of the project is expected to develop an initial transmission capacity of 1000 MW. The commissioning is foreseen for December 2025, and the financial cost is estimated at 2,5 billion euros.
The figure below illustrates the main key points related to production, transport, and distribution in the Middle East sub-region.



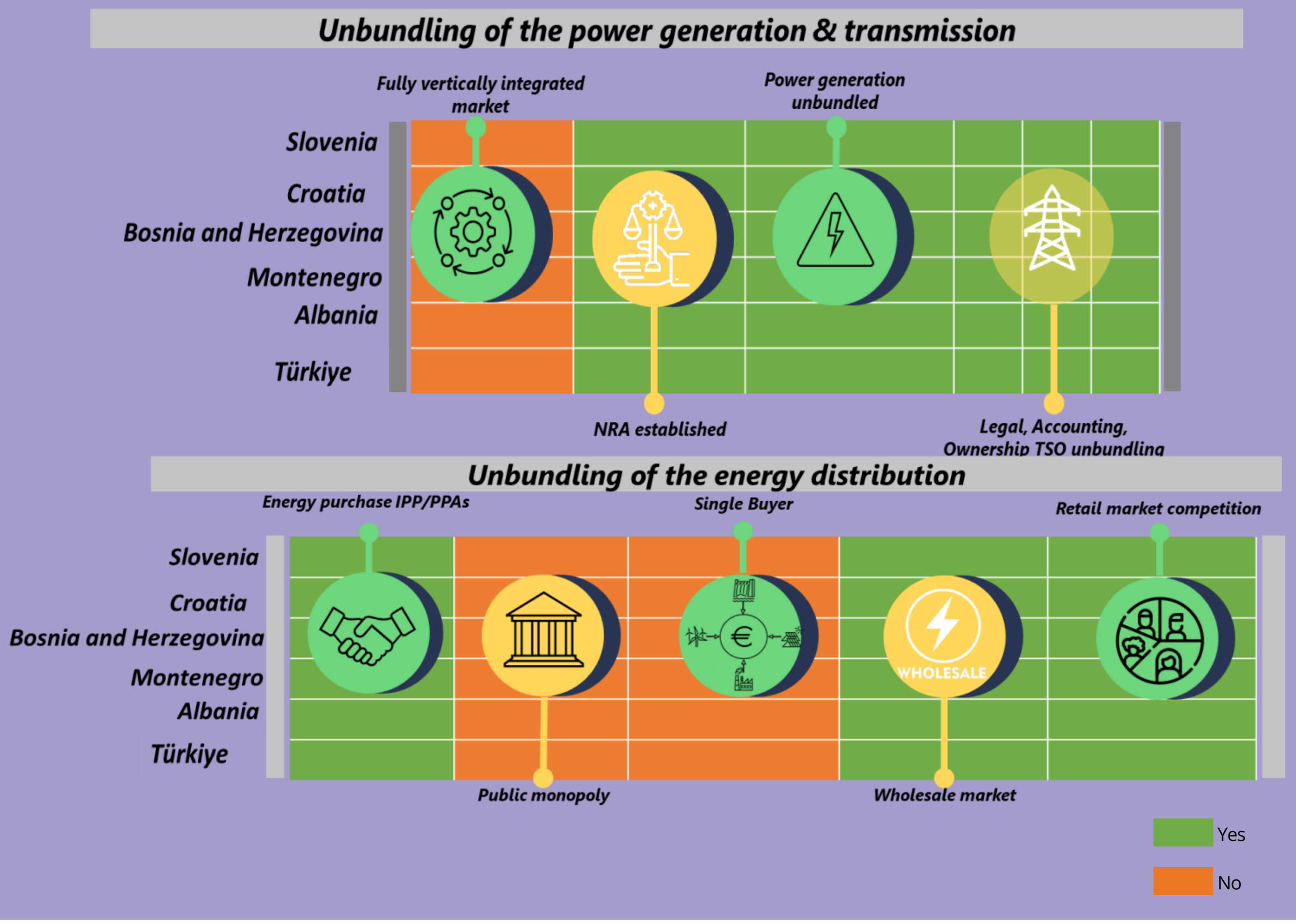
3.3. Türkiye and Balkans Member Countries

3.3.1. Market structure and organization

The electricity market structure in Türkiye and the Balkans is fully unbundled in power generation and energy distribution. At the TSO level, all the TSO in the region have achieved legal, accounting, and ownership unbundling. The figure below provides a preview of the state of unbundling in the sub-region at the generation, transmission, and distribution levels.

In Slovenia, all or most of the power generation companies, TSO, distribution, and suppliers are state owned, and there are no foreign investments at any level. Despite the unbundling of the sector, the Slovenian electricity structure is more like a fully vertically integrated market.

Figure 30. Internal Market Structure in Türkiye and the Balkans MEDREG Member Countries



The same case can be identified in Croatia, where the market is fully open. However, the state-owned company dominates the electricity market either on the power generation side or the supply side.

As a part of the Energy Community, Bosnia and Herzegovina must comply with the European Commission legislation. The power generation is mostly operated by state-owned companies, and private companies hold a small share of hydropower plants and PV power generation. However, more private investments are foreseen in the future.

In Montenegro, the electricity market has been open since the signature of the Agreement of the Electro-Energetic Community for South-eastern Europe in 2015. As it recently opened, most of the electricity generation is produced by state-owned companies (the Pljevlja Power Plant and the Perucica and Piva Hydropower Plants).

Albania signed the Energy Community Treaty, which establishes several pillars regarding the security of supply, renewable energy efficiency and statistics, and the resemblance of the regulatory framework of the countries of the region with those of the EU. In that respect, Albania has been putting efforts to improve its regulatory framework and increase the competitiveness, transparency, and consumer protection of its electricity market. In 2021, following the recommendations of the EU, the functional separation of public companies was completed, and the legal obstacles concerning the right of consumers to change their electricity supplier were removed, ensuring full access to market-free electricity for all consumers connected to the 20 kV voltage.

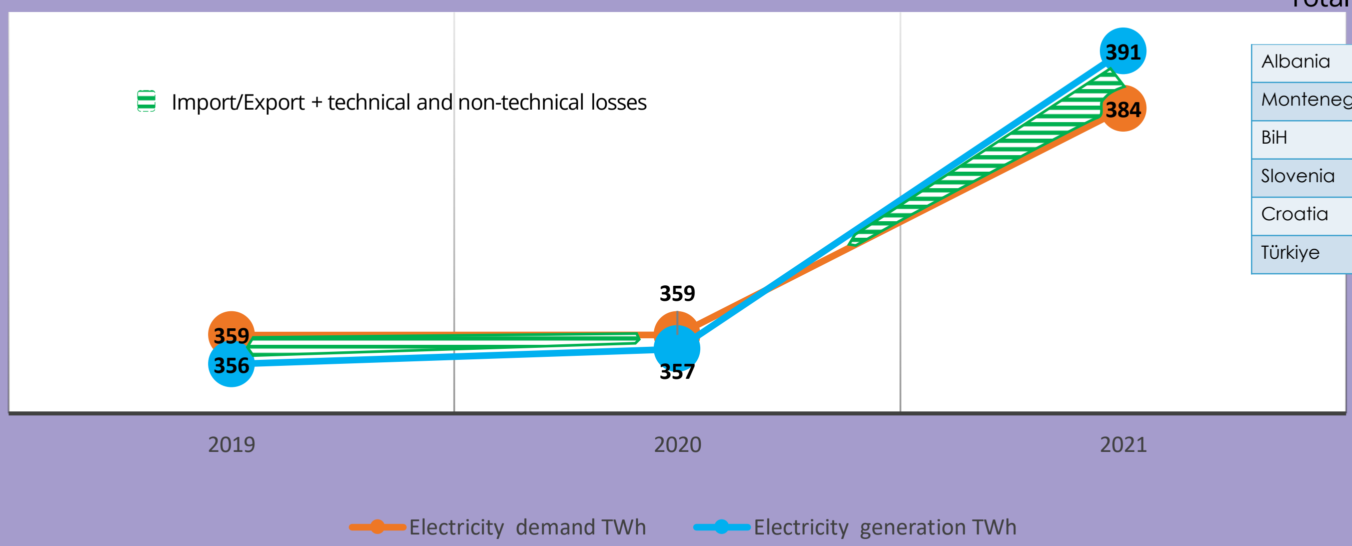
In Türkiye, after shifting from a public monopoly structure to a fully unbundled structure, the electricity market has become more competitive, and it has an environment-friendly energy mix. Türkiye achieved the unbundling of its electricity generation, and the share of the dominant producer was 16% in 2021. On the distribution level, the privatization process was completed in 2013. Also, Türkiye has 21 private DSOs.

3.3.2. Electricity demand and generation

From 2019 to 2020, the total electricity demand in the Türkiye and the Balkans country remained at the same level of 359 TWh, mainly due to the COVID-19 pandemic. However, with the recovery from the pandemic, the total demand increased considerably by 7% to reach 384 TWh at the end of 2021, as shown in the figure below.

The evolution of electricity demand and generation differs from one country to another. As in this sub-region, the security of supply is achieved through the benefits of the regional market and international exchanges, particularly in countries that depend on hydropower plants, such as Albania and Croatia.

Figure 31. Electricity Demand vs Generation in Türkiye and the Balkans Sub-Region



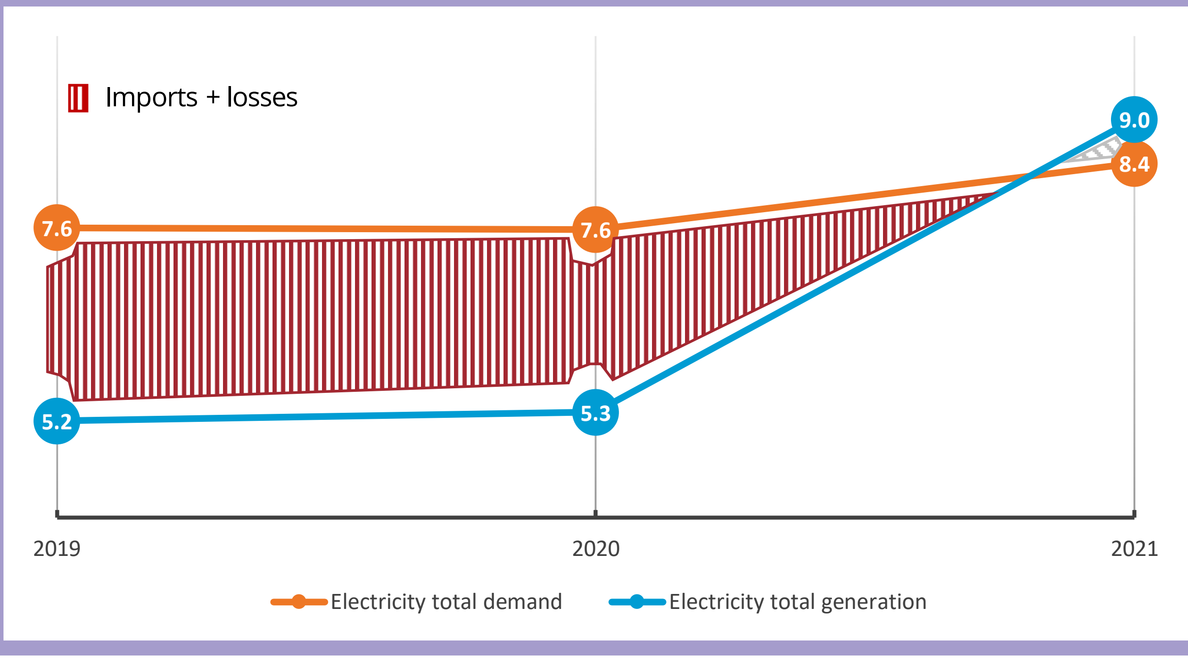
Total losses

Albania	23%
Montenegro	14%
BiH	11%
Slovenia	N/A
Croatia	N/A
Türkiye	12%

- ***Albania***

The next figure illustrates that the electricity generation in Albania fluctuated from one year to another, depending on the hydro production. The gaps between demand and generation in 2019 and 2020 were covered by imports from the neighbouring countries. On the other hand, 2021 was a good hydrological year, and the electricity produced in this year was 2,9 TWh more than the average production of electricity from 2009 to 2021.

Figure 32. Electricity Demand and Generation in Albania



Even though the technical and non-technical losses were lower in 2021, the level remained significantly high at 20,6%.

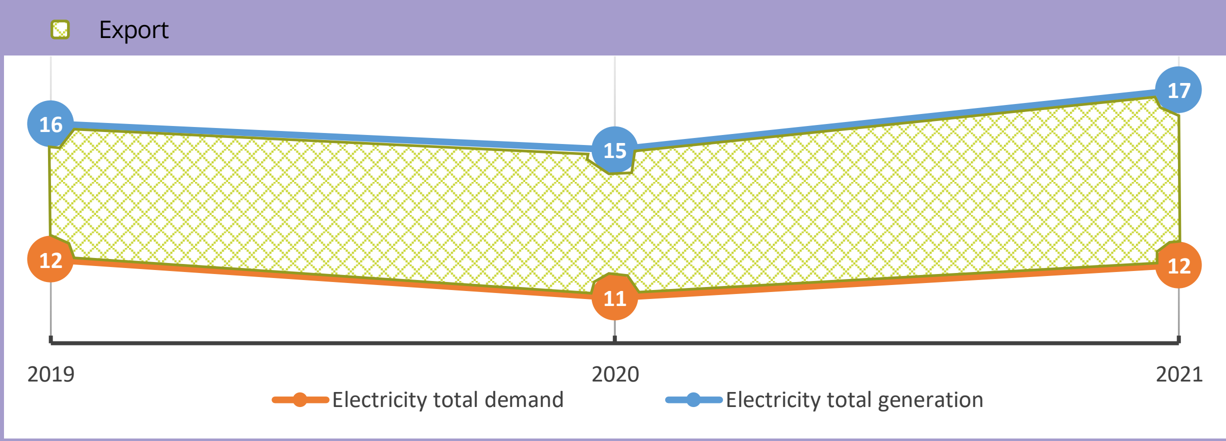
In terms of peak load, there was an increase of 142 MW compared to 2020, reaching 1 540 MW on 12 December 2021. On the other hand, the minimum load registered on 2 January 2021 was only 460 MW, representing 30% of the peak load.

- ***Bosnia and Herzegovina***

The electricity demand in Bosnia and Herzegovina is mostly covered by hydro and thermal power plants. In 2021, which was a good hydrological year, the hydro production increased by 2 TWh compared to the last year.

The excess in electricity production is mostly exported to the neighbouring country. In 2021, the exports amounted to 6,2 TWh (11% more than the previous years). On the other hand, the imports decreased by 7%, amounting to 1,4 TWh.

Figure 33. Electricity Demand and Generation in Bosnia and Herzegovina



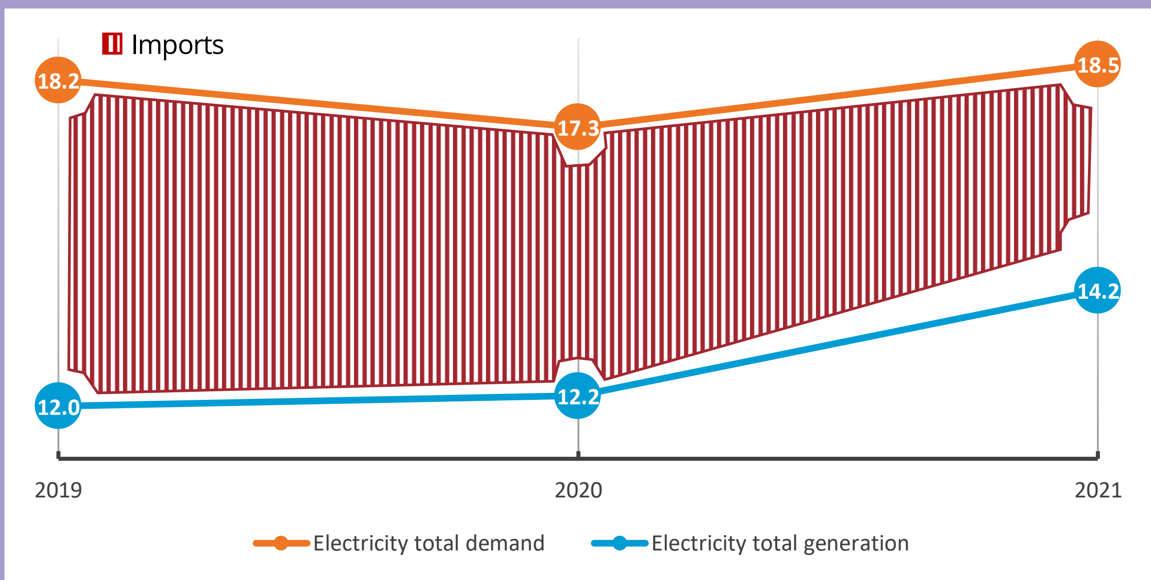
The above figure illustrates the evolution of electricity demand and generation in Bosnia and Herzegovina from 2019 to 2021.

In terms of peak load, in 2021, the maximum load reached 1 909 MW on 23 December 2021, while the minimum load amounted to 685 MW on 7 June.

- ***Croatia***

In 2021, the total electricity consumption in Croatia amounted to 18,5 GWh after two years of continuous decrease in consumption (2019 and 2020). At least 70% of the total consumption is covered by Croatian power plants, while the gap is covered by imports, as shown in the figure below.

Figure 34. Electricity Demand and Generation in Croatia

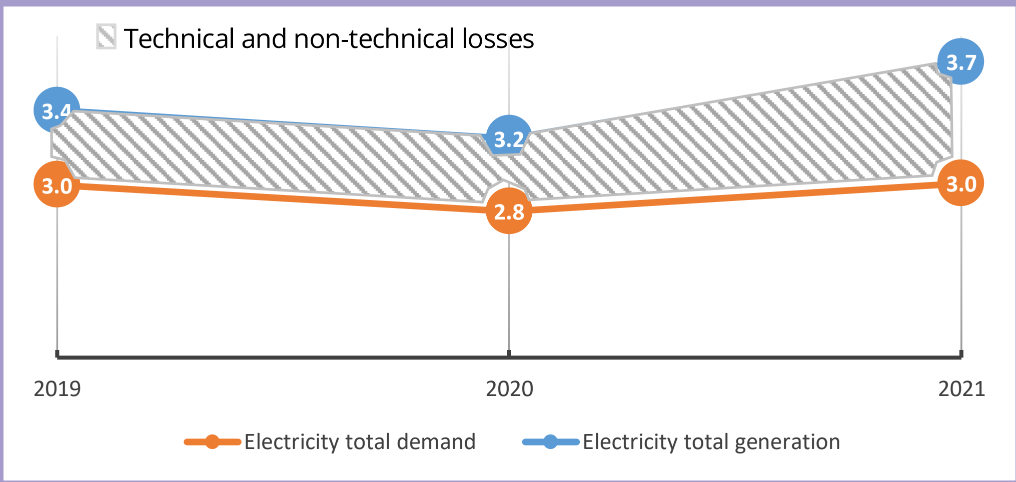


In terms of the peak load, the maximum load is usually recorded in the summer months due to relatively mild winters and increased consumption of air-conditioning. In 2021, the maximum load reached 2872 MW in July, while the minimum load was recorded at 1067 MW in April.

- ***Montenegro***

The total electricity consumption in Montenegro in 2021 remained at the same level as in 2019, with a slight decrease in 2020, mainly due to the COVID-19 outbreak.
The gap between the generation and electricity demand is mostly due to technical and non-technical losses. In 2021, the technical losses at the distribution level accounted for 12,4% of the total generation, while the non-technical losses accounted for 4%.

Figure 35. Electricity Demand and Generation in Montenegro

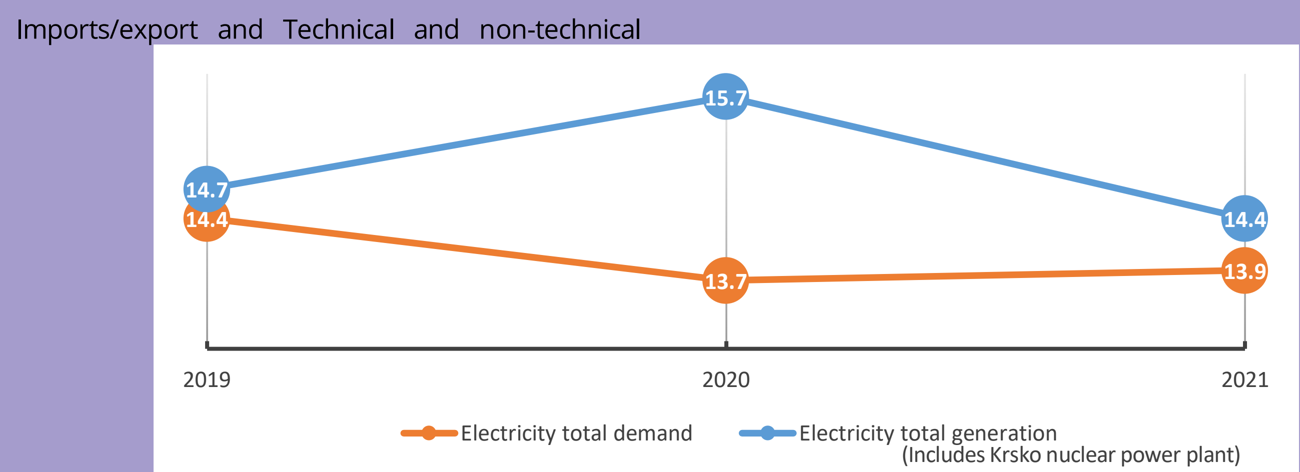


The 2021 annual peak load (0,58 GW) was slightly higher compared to the previous year but remained lower than the peak load in 2019 (0,6 GW).

- ***Slovenia***

The electricity demand decreased since the beginning of the COVID-19 outbreak; however, in 2021, the electricity demand started to recover from the pandemic and recorded a slight increase compared to 2020, as shown in the figure below.

Figure 36. Electricity Demand and Generation in Slovenia



The total generation in Slovenia includes the generation of the Krško nuclear power plant, which is co-owned by the Slovenian state-owned company Gen Energija and the Croatian state-owned company

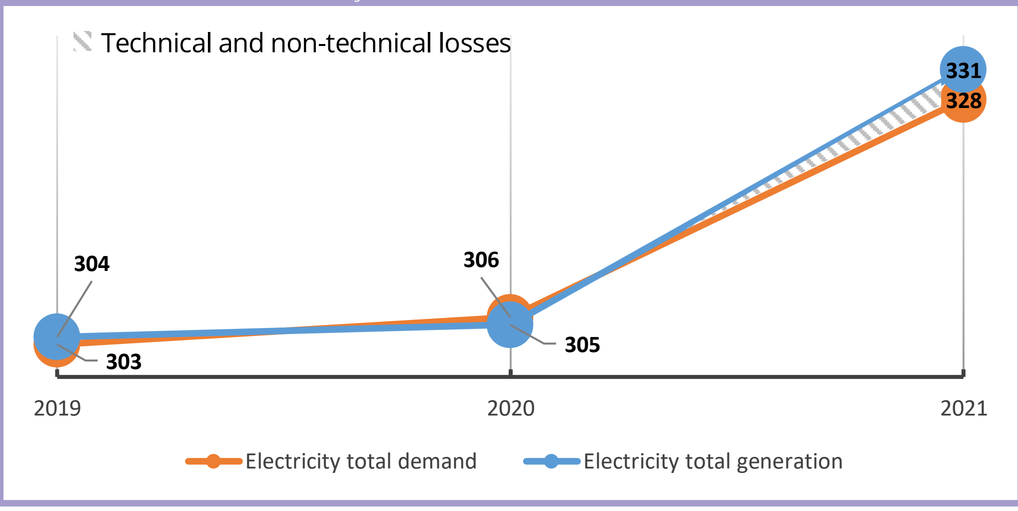
Hrvatska elektroprivreda (HEP). Without taking it into consideration, Slovenia ensures its security of supply through domestic production, which covered at least 80% of the demand during the last three years and international exchanges with its neighbouring countries. In 2021, Slovenia was a net exporter compared to 2020 and 2019, when Slovenia was a net importer.

In terms of the peak load, the maximum load usually occurs in the winter months and more often in the midday hours. The actual available power for the Slovenian market is equal to the difference between the installed power of production sources and half the power of the Krško nuclear power plant, which belongs to Croatia. The ratio between the available power and peak power on the transmission system in 2021 worsened compared to the previous year (approximately 2 125 MW). The ratio fell by approximately 2,1% compared to 2020, namely due to the increased peak consumption load.

- ***Türkiye***

Like the rest of the world, Türkiye was impacted by the Covid-19 pandemic, which impacted the level of consumption and generation. However, in 2021, the total electricity consumption and generation increased by 7% in only one year, mainly due to the recovery from the pandemic. But according to the TSO's 10-year demand forecast report (2022–2031), for the base scenario, the expected demand figures for the next five years will record a decrease in 2022 and then an average increase of 4% per year.

Figure 37. Electricity Demand and Generation in Türkiye



In 2021, the non-technical losses in the system were 10,8%.

Contrary to electricity generation, the maximum load has been increasing over the last three years, with a growth of 8% in 2020 and 13% in 2021, reaching 56,3 GW.

Türkiye and the Balkans represent a particular region which demonstrates the benefits of regional integration and cooperation among the neighbouring countries. Even though the national production doesn't cover the countries' needs, apart from Türkiye, the imports/exports keep the balance and ensure the security of supply in the region. The next figure summarizes the key elements related to electricity demand and generation in this sub-region.

Electricity demand and generation key points – 2021

Albania's generation depends on the hydrological conditions. Therefore, ERE works to facilitate the diversification of energy sources and improve the regional market integration

Electricity demand & generation greatly increased in Türkiye with 7% in 2021. However, the increase for the next years is foreseen to be around 4%
The peak load also increased during the last three years to reach 56,3GW in 2021

The good hydrological conditions allowed BiH to increase the hydro production and export it to its neighbouring countries and reduce its imports.

The electricity demand & generation slightly increased in 2021. However, the level of technical and non-technical losses remains moderate in 2021.

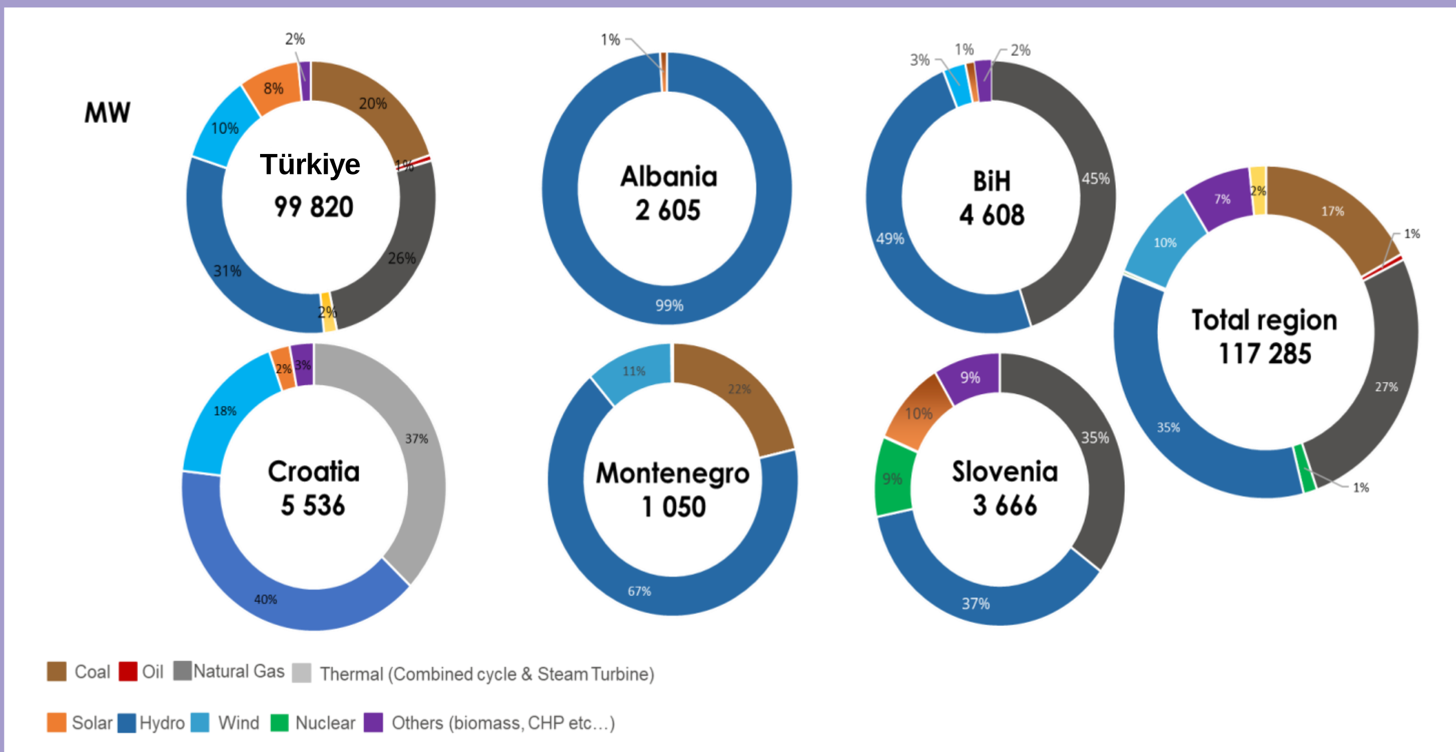
Croatia depends on its imports to ensure its security of supply as the national production power plants covers around 70% of the demand. The peak load occurs in summer due to the use of air conditioning.

To keep the electricity system balance, electricity exchanges with Austria, Italy and Croatia is important.
Contrarily to the last two years, in 2021 Slovenia was a net exporter.

3.3.3. Energy mix

Due to the availability of hydraulic resources in the region, the installed capacity is well diversified. The fossil fuel-based technologies represent 45% of the installed capacity, while the rest is shared between multiple RES. However, the installed capacity in each country is disparate; in some countries, one technology

Figure 38. Installed capacity Türkiye & Balkan countries

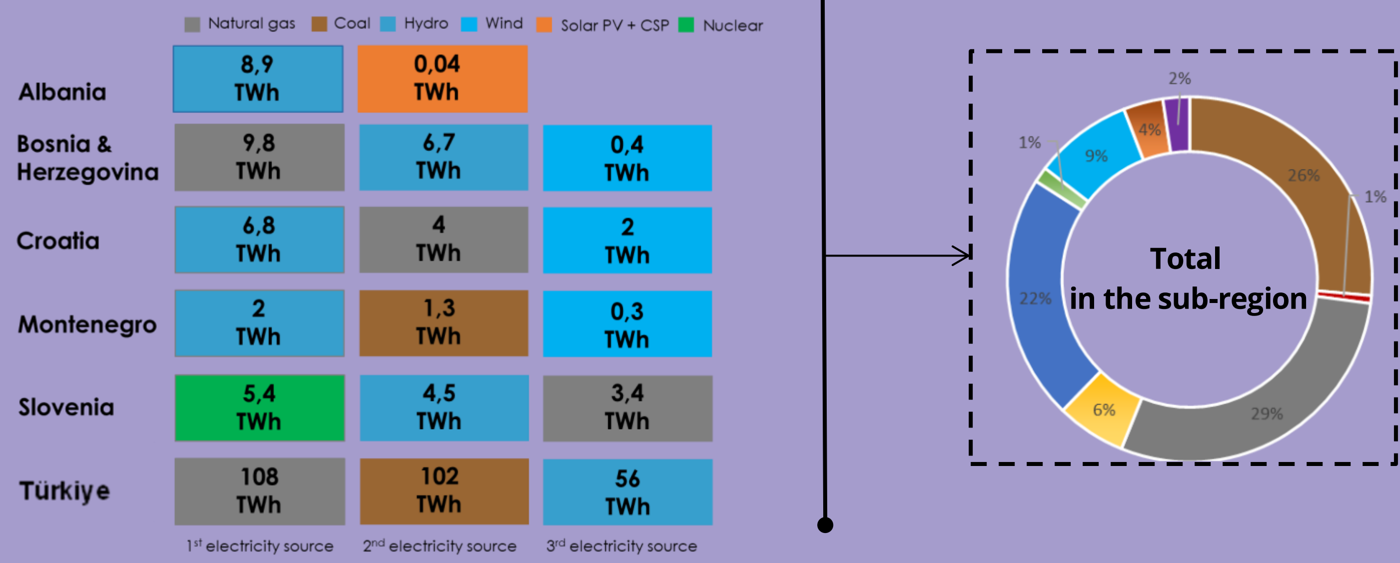


dominates, such as in Albania with only hydraulic power plants, while in others, there is a mix of several technologies, such as in Türkiye. The figure below depicts the installed capacity according to technology and the country.

In terms of the energy mix, the core energy source is hydraulic, which is the first main source of electricity production in three countries out of six. Natural gas is the main source in two countries. However, as a whole, hydropower takes the third place after natural gas and coal.

The figure below depicts the three main energy sources that produce electricity in each country.

Figure 39. Energy Mix in Türkiye and the Balkans – 2021



3.3.4. Transmission and distribution infrastructure

The infrastructure is well developed in Türkiye and the Balkans, both in terms of national and international cross-border infrastructure.

The total length of the transmission and distribution network is around 1,7 million km, delivering 304 TWh to the final consumers. Still, in 2021, the level of technical and non-technical losses remains moderate to high in most of the countries, ranging from 6% in Slovenia to 20,6% in Albania.

Most of these losses were at the distribution level, which suggests that the NRAs should focus more on consumer empowerment by raising awareness, providing more information and transparency, and in some cases, upgrading and improving the network and implementing energy efficiency measures.

The figure below illustrates the transmission and distribution infrastructure of each country and the level of voltage. It also shows the share of consumption according to the level of voltage.

Figure 40. Transmission and Distribution Infrastructure in Türkiye and the Balkans

Country		High voltage (≥ 60 kV)	Medium voltage (10 kV ≤ V ≤ 30 kV)	Low voltage (< 10 kV)
Türkiye	Length (km)	72 272	1 363 320	
	Consumption (TWh)	64	189	
Croatia	Length (km)	7 779	42 863	142 363
	Consumption (TWh)	5	10	
Slovenia	Length (km)	2 925	19 120	45 141
	Consumption (TWh)	0,094	1,4	11,3
Albania	Length (km)	3 360	16 682	56 566
	Consumption (TWh)	5,3	3,1	
Bosnia & Herzegovina	Length (km)	6 458	N/A	N/A
	Consumption (TWh)	1,17	10,4	
Montenegro	Length (km)	1 423	6 277	13 720
	Consumption (TWh)	0,604	0,463	1,909

3.3.5. Cross-border interconnections and exchanges

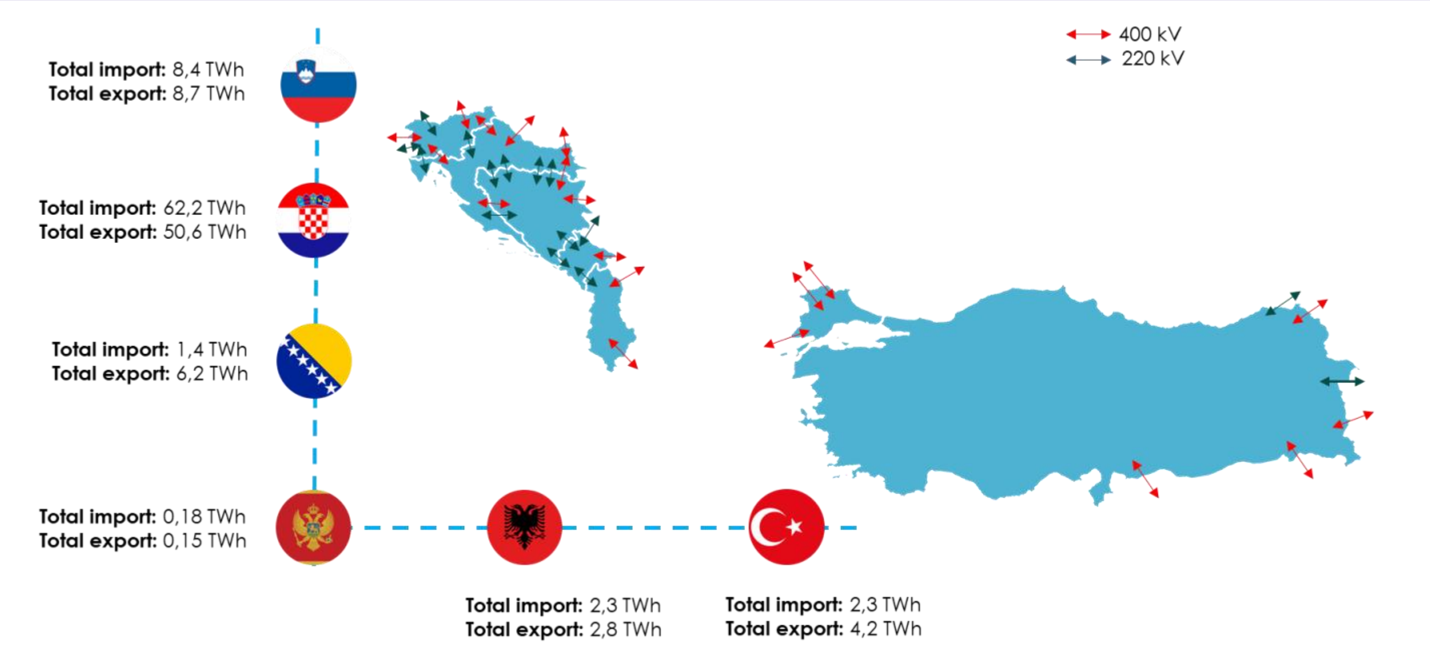
The regional market and international exchange are key elements for ensuring the balance of the electric system in the Türkiye and Balkans region. The cross-border interconnections have been distinctively developed, and further development is being planned for the future.

In total, at least 19 lines in 400 kV and 15 in 220 kV can be identified. However, in Türkiye, some of those lines are not operational, such as the interconnections with Armenia, Azerbaijan, Iraq, Iran, and Syria.

Concerning energy exchanges, most of the countries rely on it to cover the electricity demand, including Slovenia, Croatia, and Albania. In contrast, Bosnia and Herzegovina and Türkiye use the power exchanges for commercial purposes and are net exporters.

The figure below depicts the cross-border interconnections and the total import/export of each country. The geographic location of the interconnection is only for demonstration purposes and doesn't reflect the reality.

Figure 41. Cross-Border Interconnections in the Türkiye the Balkans



The Türkiye and Balkans region is a good example of a well-functioning regional market with a developed structure to ensure the security of supply in each country and the region.

Production, transport, and distribution key points

The energy mix is well diversified in the region with only 56% of its generation from fossil fuel energy sources.

The technical and non-technical losses remain an issue in the region and the NRA should develop measure and mechanisms to reduce them.

International electricity exchanges is a key element to maintain the electricity system balance in the Balkan countries.

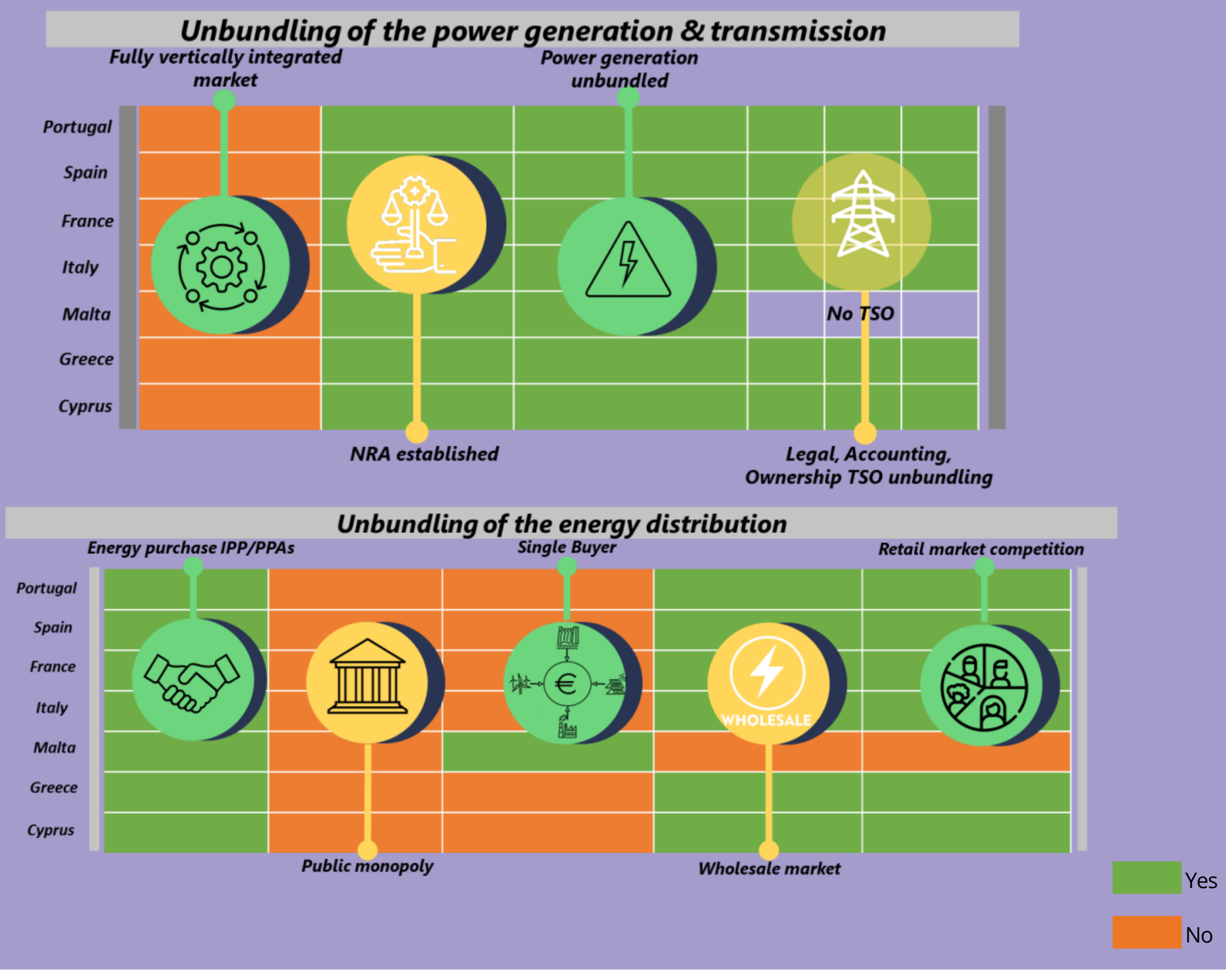
3.4. EU MEDREG Member Countries

3.4.1. Market structure and organization

The European electricity market structure has evolved from a fully vertical integrated market to a liberalized market based on cost-effectiveness to ensure the security of supply and affordability for its consumers. Since 2009, with the changes in the level of market integration and technology, the EU commission progressively updated the common market rules to match the current situation. The last update of the 'clean energy for all Europeans package' expects an increase in the share of RES in electricity production to 50% by 2030.

The market should also maintain continuity of supply in case of RES intermittency. The system should also integrate mechanisms and solutions to increase the investments in RES, such as energy storage. Lastly, the market needs to include a well-designed incentive to empower the consumers and increase their role in the electricity system's stability and balance.

Figure 42. Internal Market Structure in the EU MEDREG Member Countries



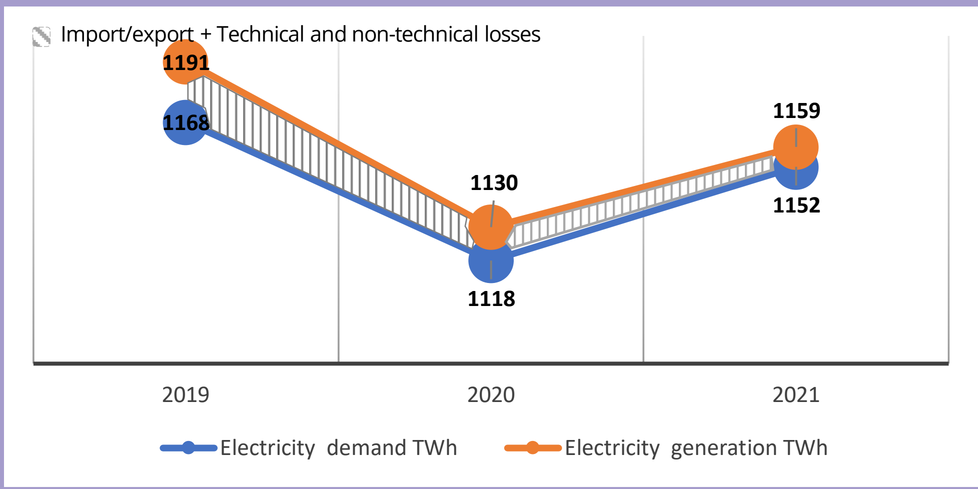
The figure above shows that the unbundling of the electricity market has been achieved in all the EU countries. However, Malta is a particular case, as there is no TSO in the market, the retail market is not open to competition, and all the generators must sell to a single buyer (Enemalta plc, who is the only supplier of electricity to the final customers) except for self-consumption.

3.4.2. Electricity demand and generation

After a drop in electricity demand in the EU MEDREG member countries in 2020 due to the COVID-19 outbreak, the electricity market is recovering, and electricity demand and generation are increasing again. However, the level of demand is still below that of 2019.

The next figure presents the evolution of global electricity demand and generation of the EU MEDREG member countries from 2019 to 2021. The gap between supply and demand was mainly due to the import/export to other MEDREG countries and technical and non-technical losses.

Figure 43. Electricity Demand vs Generation in MEDREG's EU Member Countries



Total losses

Cyprus	5%
Greece	12%
Italy*	6,7%
Malta	7%
Portugal	9,7%
Spain	10%
France	8,6%

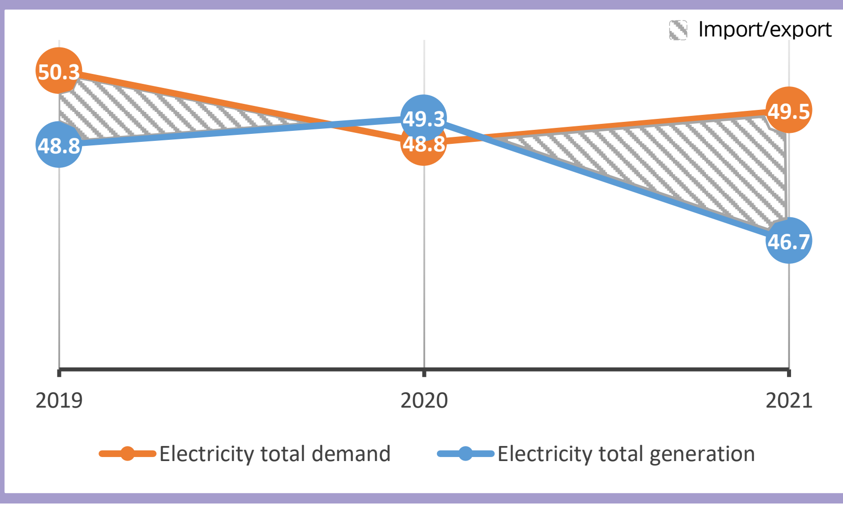
*No unpaid bill considered

In each country, the balance between electricity demand and generation was mostly maintained with national electricity generation and imports from neighbouring countries, except in the case of France and Spain. In the absence of cross-border interconnections, Malta and Cyprus had several power outages in 2020 and 2021.

- ***Portugal***

The COVID-19 pandemic decreased the level of demand in Portugal in 2020 (see the figure below). However, the electricity market in Portugal is recovering from it, and a slight increase was recorded in 2021, but it is

Figure 44. Electricity Demand and Generation in Portugal



still lower than the figures from 2019. In terms of the load curve, the peak load in Portugal reached 9 888 MW in January 2021.

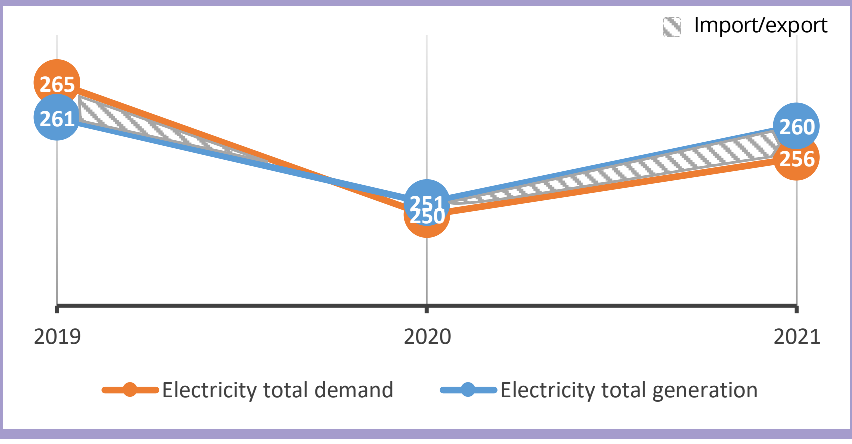
The electricity system's balance has been ensured by importing the missing energy from Spain. In 2021, the total imports reached 8,9 TWh.

- ***Spain***

The national power generation in Spain was sufficient to cover the electricity demand in 2020 and 2021. The electricity demand recovered progressively after the impact of the pandemic and increased by 2.5% compared to 2020, as shown in the figure below.

The peak load on the Spanish Peninsula was recorded in January, reaching 42 225 MW, which is 4.5% higher than the previous year's maximum, but still far from the all-time high of 45 450 MW from December 2007.

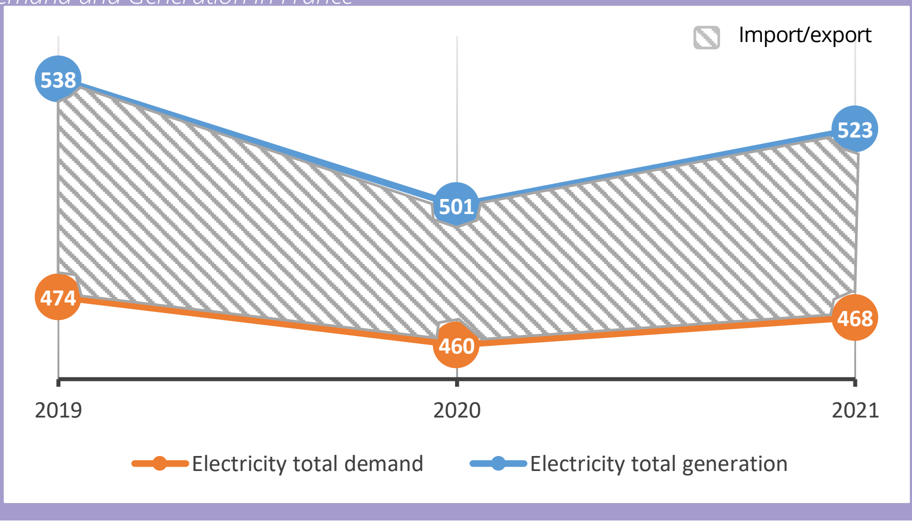
Figure 45. Electricity demand and generation in Spain



- ***France***

The economic recovery resulted in a jump back in electricity consumption (+ 1,7%) and production (+ 4,5%) in 2021, but it was still below the 2019 level. However, France remains the leading European exporter of electricity, with exchanges on the rise (87 TWh of exports and 44 TWh of imports) in 2021, as shown in the next figure. Electricity consumption peaked in January and amounted to 88,4 GW, a peak that remains within the average of the past 20 years of electricity consumption in France.

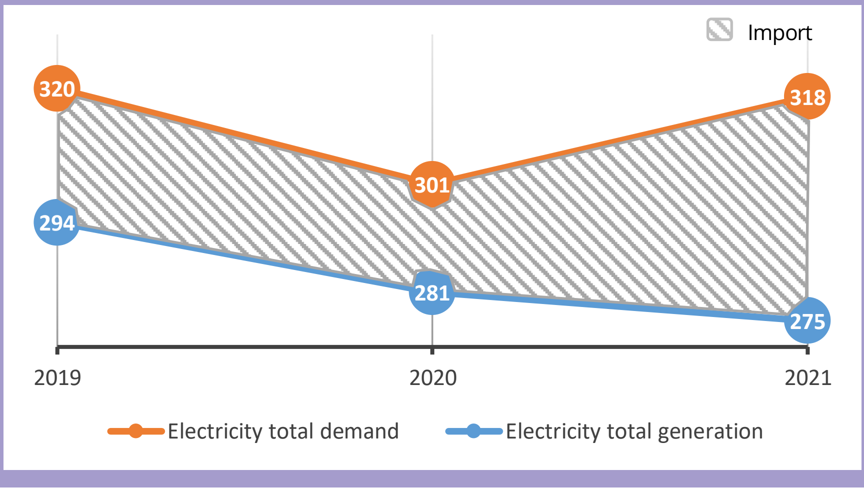
Figure 46. Electricity Demand and Generation in France



- ***Italy***[11]

The electricity demand in Italy in 2021 was 318 TWh, up 6,2% higher than the previous year. The electricity demand of 86,6% of the domestic production was met with a total of 277,1 TWh (+3%), while the remaining 42,8 TWh (13,4%) was met with net imports of up to 32,9% in 2020. On the other hand, the total generation has decreased in the last three years, as shown in the figure below.
The peak load continued to decrease from 59 GW in 2019 to 52 GW in 2022.

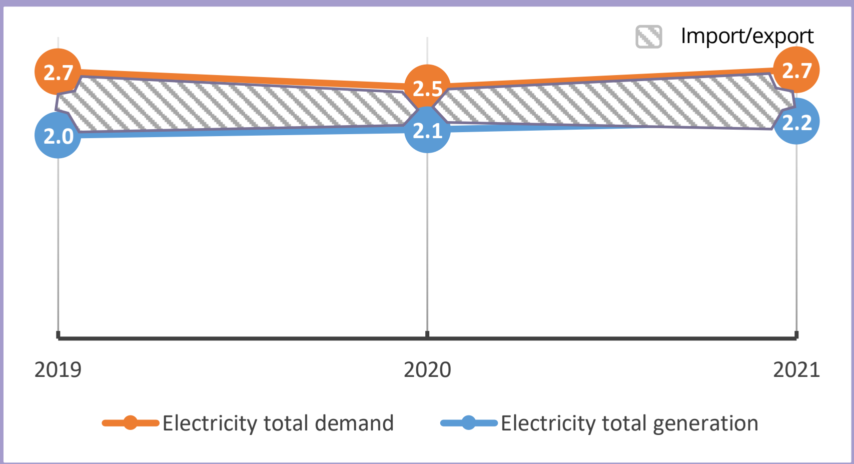
Figure 47. Electricity demand and generation in Italy



- ***Malta***

At the end of 2021, the electricity demand increased by 6.4% compared to 2020, reaching 2,66 TWh. The peak load also increased from 477 MW to 565 MW.
The total electricity generated in Malta amounted to 2,2 TWh, whilst the imports from Italy helped maintain the balance of the electricity market. The next figure depicts the electricity demand and generation in Malta in the last three years.

Figure 48. Electricity Demand and Generation in Malta



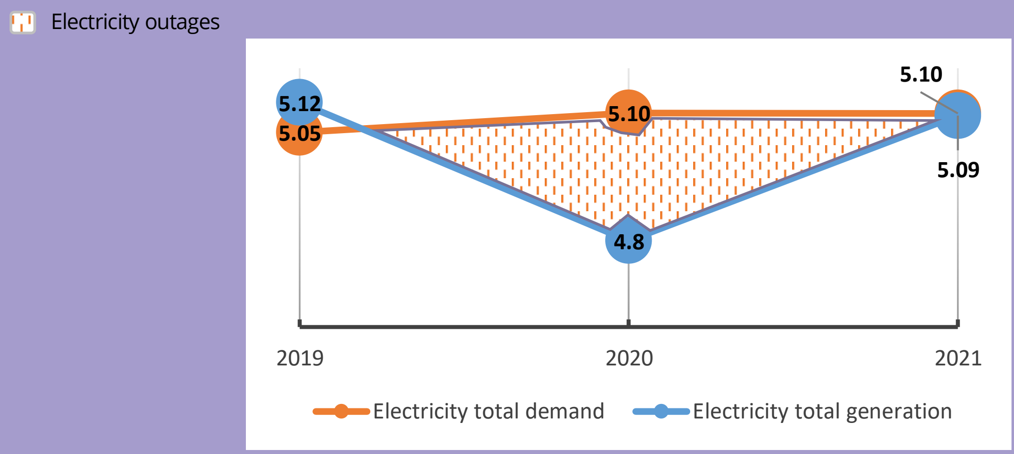
[11] The 2021 data were extracted from the TSO website.

- ***Cyprus***

Maintaining the stability of the electricity system in Cyprus was more challenging than the other countries. With no cross-border interconnections, Cyprus relies only on its own production, which may not be enough in certain periods. In 2020, with the COVID-19 pandemic, sustaining the electricity balance was even more difficult. The situation was worsened by the energy price surge, as Cyprus's electricity generation is based on imports of fossil fuel. The figure below presents the evolution of electricity demand and generation from 2019 to 2021.

The peak load remained at the same level of 1075 MW during the last few years, and the electricity demand remained at 5,1 TWh per year.

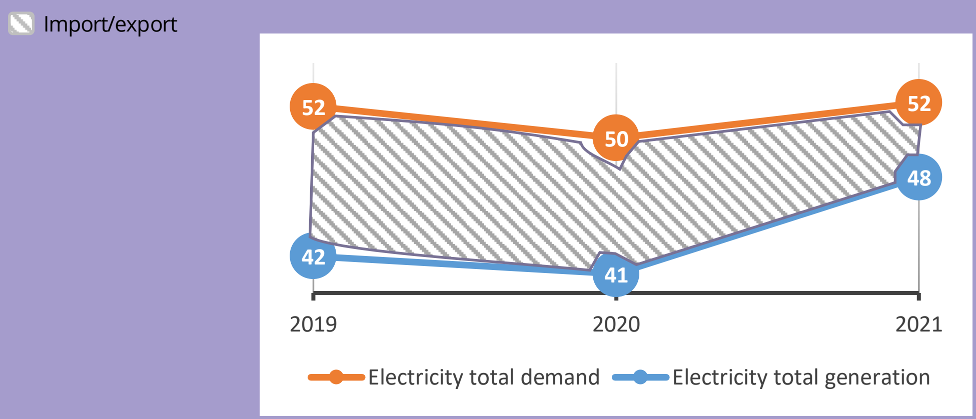
Figure 49. Electricity Demand and Generation in Cyprus



- ***Greece***

In 2021, the electricity demand jumped back to the same value as in 2019, mainly due to the recovery from the pandemic. The electricity generation also increased considerably in 2021 compared to the previous two years and reached 48 TWh (7% increase). Nevertheless, to meet the needs of the consumers, 16% was

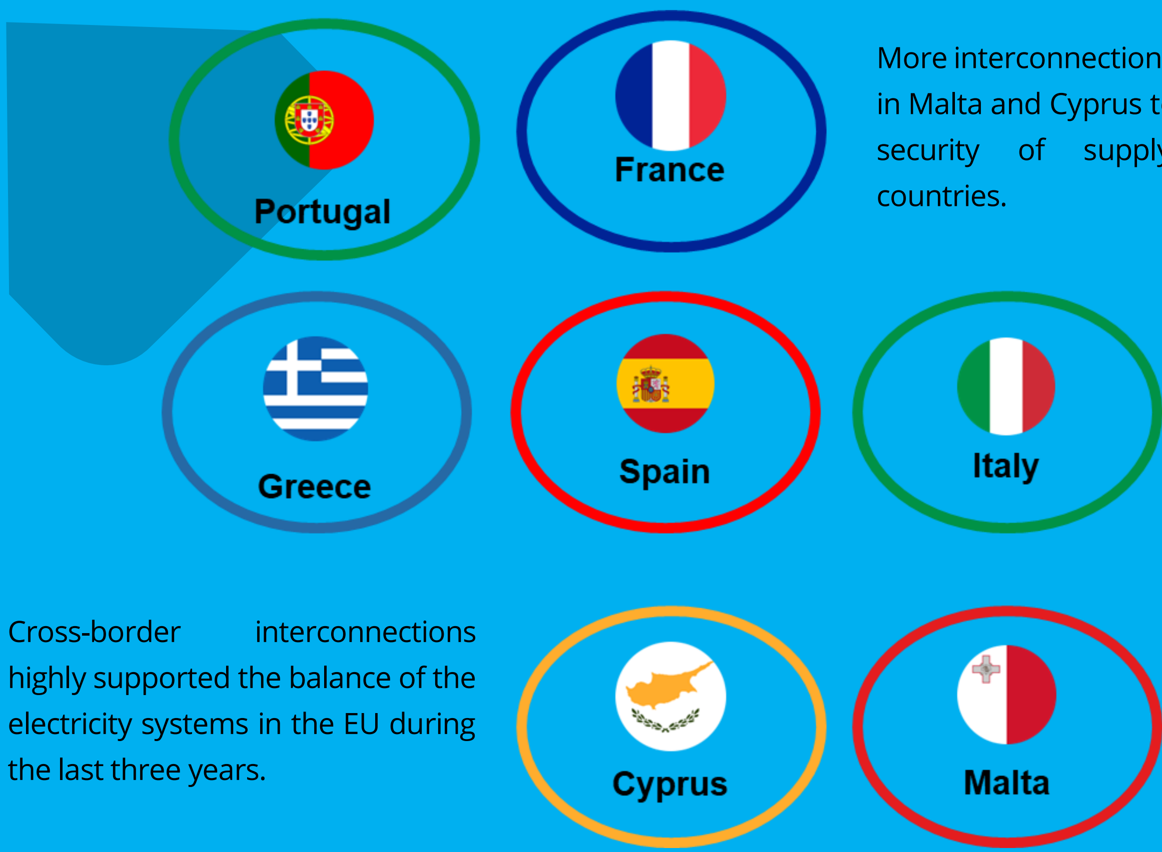
Figure 50. Electricity Demand and Generation in Greece



imported from the neighbouring countries. The figure above summarizes the evolution of electricity demand and generation in the past three years.

The COVID-19 outbreak significantly impacted the electricity market in the EU countries in 2020. The situation worsened with the price surge of energy and led to changes in the EU market rules to cope with the state of the electricity system. More actions and mechanisms are needed for both the demand and generation sides to meet the 2030 and 2050 objectives. However, the last three years have shown that no market structure is perfect, and from the regulation point of view, dynamic and flexible regulation is key to ensuring the security of supply in the future.

Electricity demand key points



More interconnections are required in Malta and Cyprus to improve the security of supply in these countries.

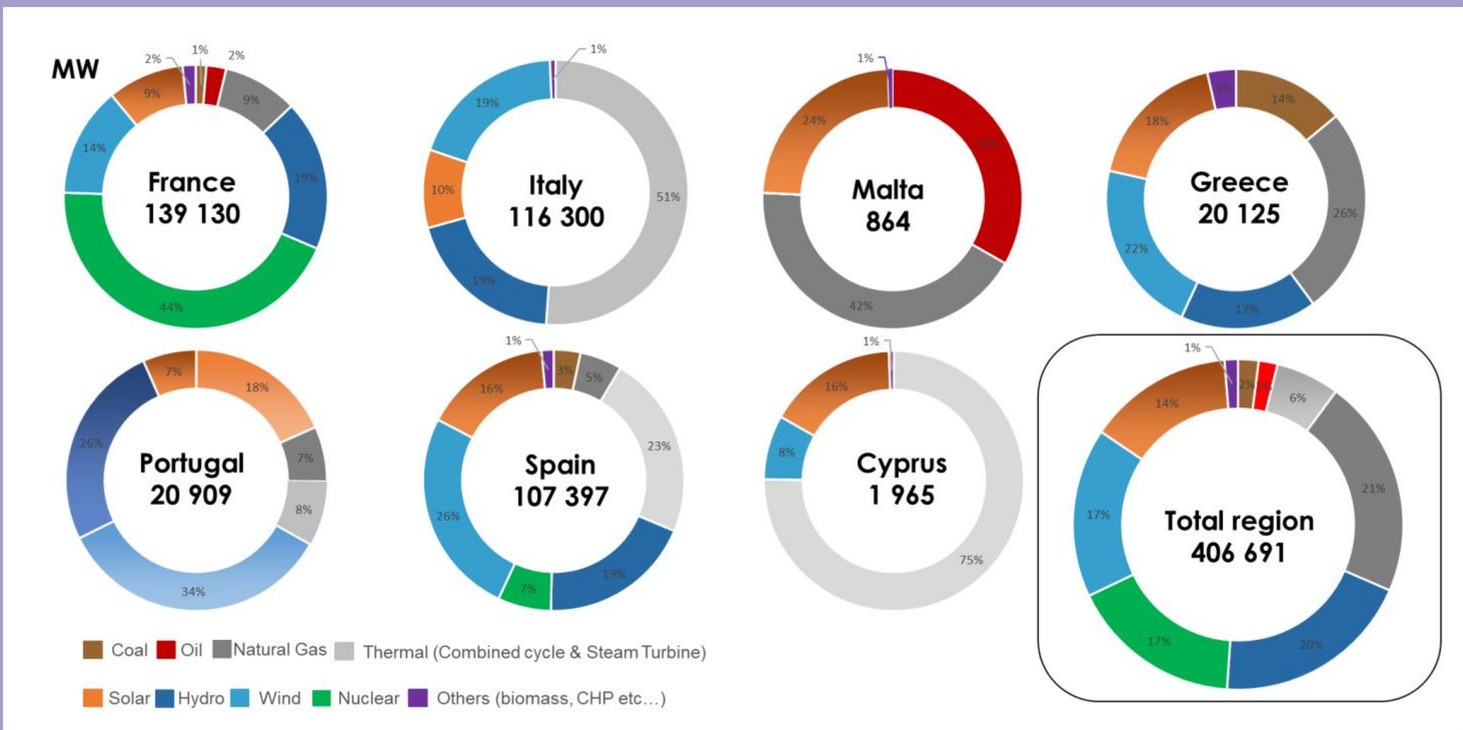
Cross-border interconnections highly supported the balance of the electricity systems in the EU during the last three years.

3.4.3. Energy mix

The installed capacity in the EU MEDREG member countries reached 406 TW in 2021. This capacity has been distributed almost evenly among several technologies. Renewable energies represent more than 50% of the installed capacity against 28% of natural gas as a source and 4% of oil and coal.

Nuclear power plants represent 17% of the installed capacity. However, the policy towards this technology remains ambiguous and differs from one country to another. In France, the energy strategy includes the commissioning of 14 reactors by 2050. On the other hand, in Spain, the energy policy provides for the decommissioning of nuclear power plants from 2027 until finalizing the phasing out in 2035. To date, the debate is still open on whether nuclear power should stay to support the energy transition or be phased out by 2035. The figure below illustrates the installed capacity in each country by the end of 2021.

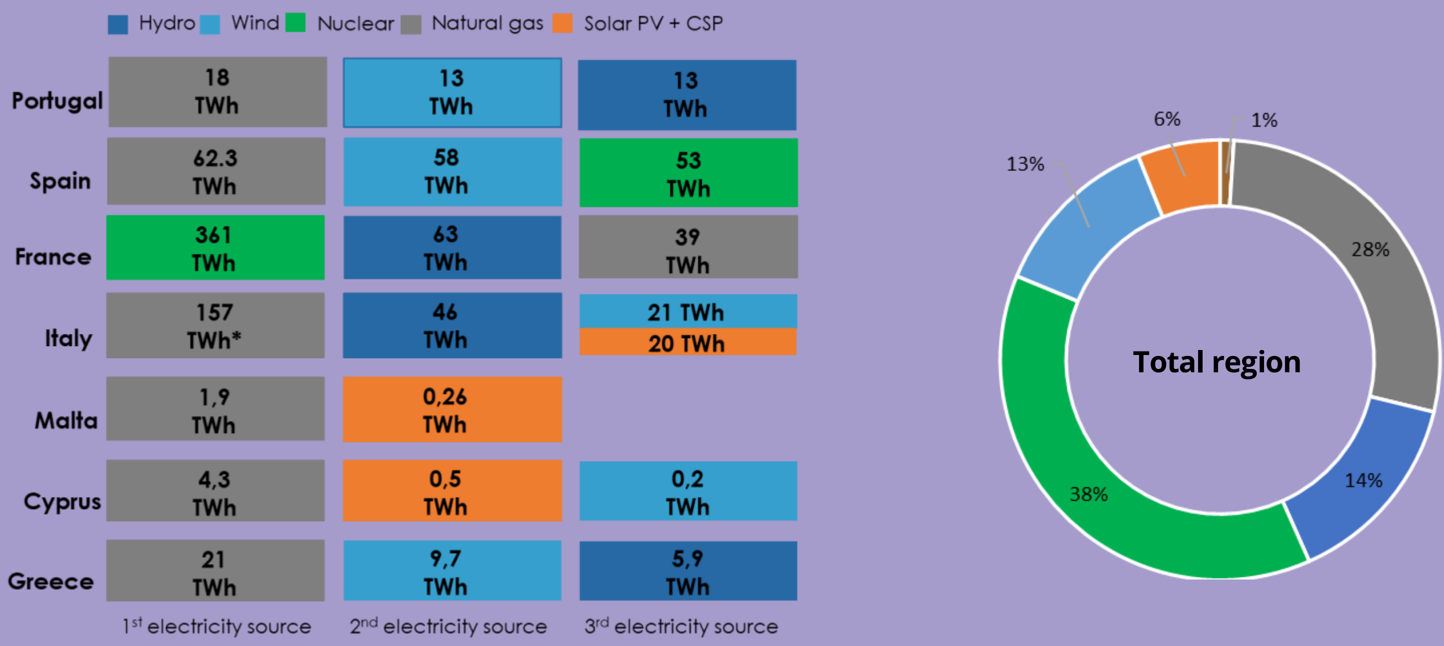
Figure 51. Installed Capacity in the EU MEDREG Member Countries – End of 2021.



In terms of the energy mix, the renewable energies represent at least 33% of the total production of 2021 and are in second place after nuclear power, which represents 38% of the production; natural gas takes the third place with 28%.

Except for France, the other six countries depend on natural gas to meet their electricity needs. On the other hand, we can identify countries with an equitable mix, such as Portugal and Spain, where the three main energy sources are at the same level as follows: (1) natural gas, (2) wind, and (3) hydro for Portugal and nuclear for Spain. The details according to the country and total sub-region are given in the next figure.

Figure 52. Energy Mix in EU MEDREG Member Countries – 2021



* includes all the fossil fuels, but mostly from natural gas.

3.4.4. Transmission and distribution infrastructure

The electricity infrastructure is well developed in each country, and the total length in the sub-region is more than 2 million km. However, in some countries, such as Italy, the infrastructure is saturated and slightly developing over the years. The figure below provides details on each country's transmission and distribution infrastructure based on the level of voltage.

Figure 53. Transmission and Distribution Infrastructure in the EU MEDREG Member Countries – 2021

Country		High voltage (≥ 60 kV)	Medium voltage (10 kV ≤ V ≤ 30 kV)	Low voltage (< 10 kV)
Portugal	Length (km)	9 607	74 380	146 689
	Consumption (TWh)	6,8	14,4	21,2
Spain	Length (km)	44 769	600 000	
	Consumption (TWh)	N/A	N/A	
France	Length (km)	105 970	658 835**	732 938**
	Consumption (TWh)	66,4	386,9	
Italy*	Length (km)	963	394 070	873 303
	Consumption (TWh)	24,8	91,8	123,1
Malta	Length (km)	110,65	1621	3 528
	Consumption (TWh)	N/A	N/A	
Cyprus	Length (km)	1 372	10 213	17 411
	Consumption (TWh)	0,025	1,16	3,243
Greece	Length (km)	12 236	113 358	128 211
	Consumption (TWh)	6,74	11,82	31,67

* 2020 data ** The data only concern the lines operated by Enedis (95% of the lines in France)

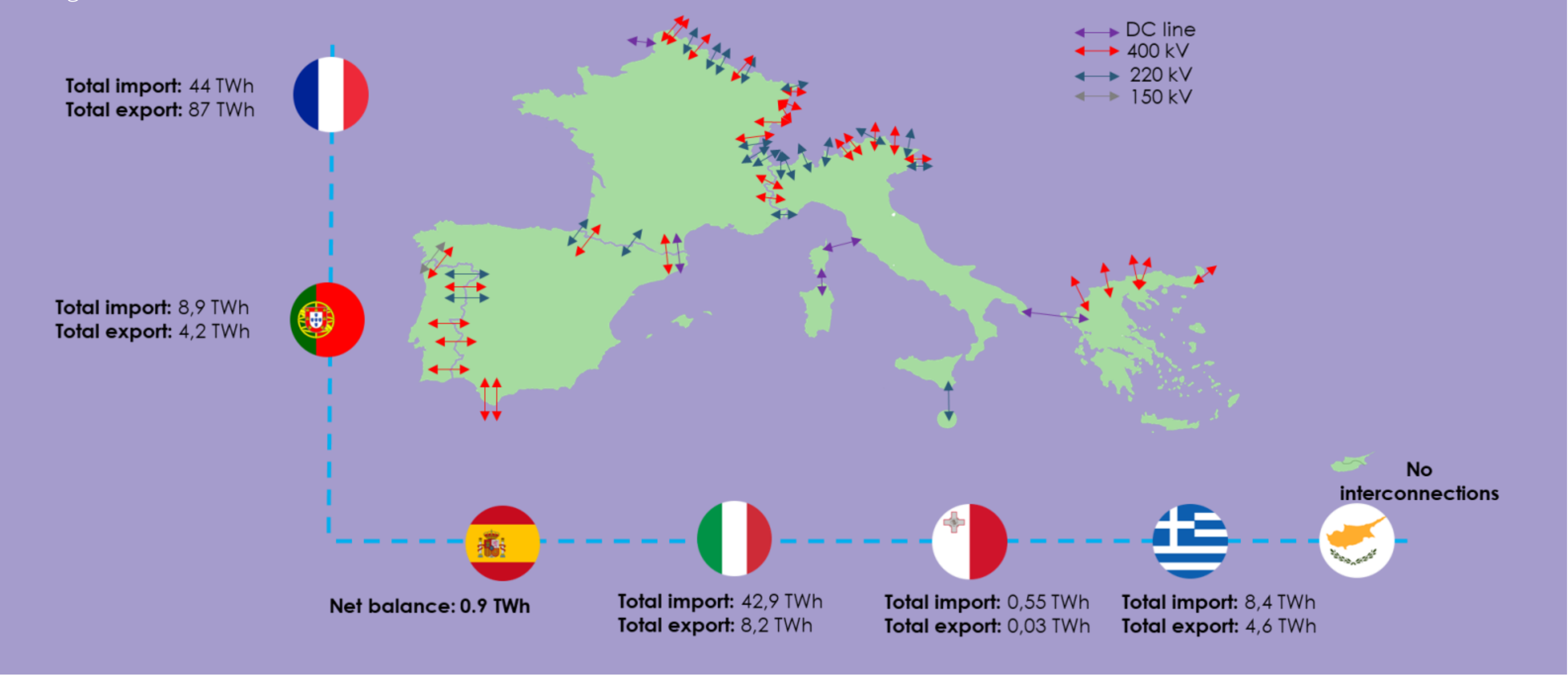
3.4.5. Cross-border interconnections and exchanges

The regional market in the EU MEDREG member countries is well developed and supports the countries in ensuring their security of supply by importing from the neighbouring countries.

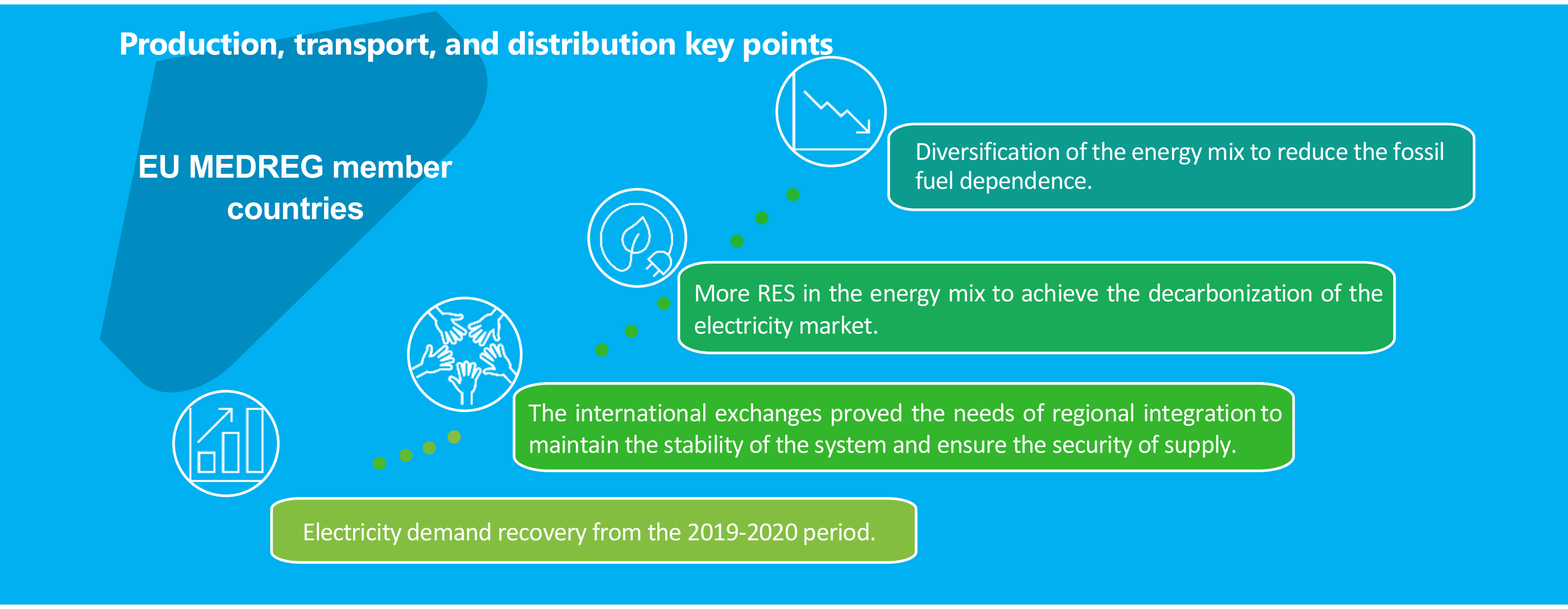
Two categories of countries can be identified in the market: the net exporter and net importer of electricity. For example, France is a key member in the region who supports the security of supply of many countries thanks to its nuclear production. On the other hand, Italy imported an important share of its required energy from the neighbouring countries in 2021. The cross-border interconnections and import/export of each country are given in the figure below.

Tunisia imports a part of its consumption from Algeria (6% in 2021) and sells its electricity to Libya, even though in small quantities. Lastly, Libya imports its electricity from Tunisia and Egypt to ensure its security of supply.

Figure 54. Cross-Border Interconnections in the EU MEDREG Member Countries



The EU MEDREG member countries have been significantly impacted by the COVID-19 pandemic and energy price surge. In 2021, the electricity market started to recover from past events, and the regional integration proved once again the need for cross-border interconnections to ensure and maintain the security of supply. The share of the RES has increased in the past few years. However, there is a need to facilitate the integration of additional capacities and use alternative mechanisms and technologies to achieve the objectives of the energy transition and reduce the dependence on fossil fuels. The key points of this chapter are given below.



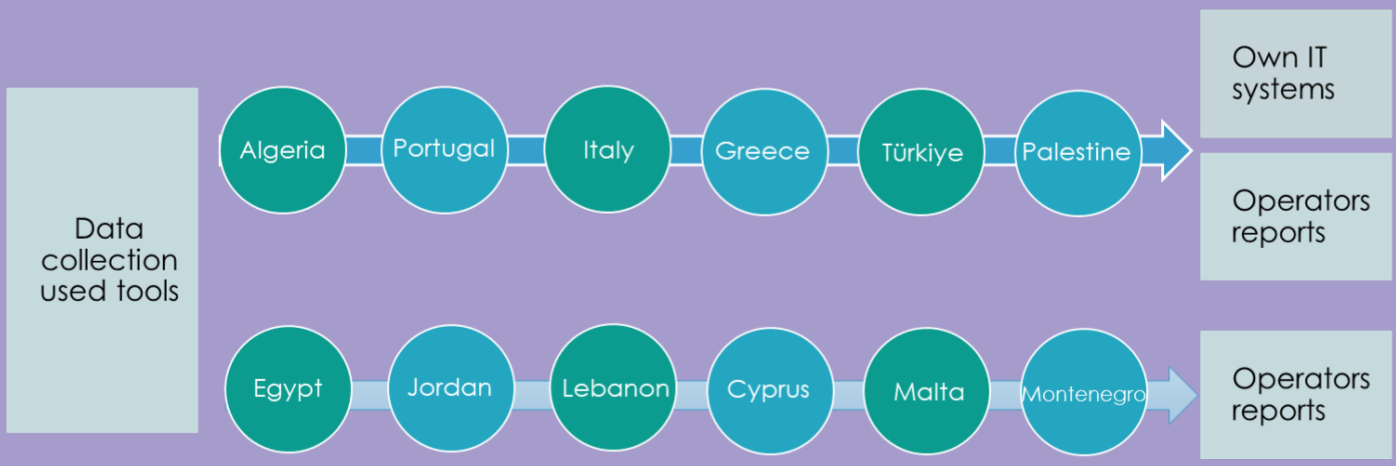
4. INFORMATION SYSTEMS AND DATA MONITORING AND EXCHANGES

Data Tools Used

The NRAs oversee a sensitive sector that highly and directly affects the revenues and costs of regulated entities and consumers. Therefore, to know all the features that are useful for analysing the evolution of energy markets and infrastructures, regulators need to have access to any information available to market or system operators. This requires access to a wide range of information from sector participants, such as financial, technical, and commercial data.

The tools used to collect the necessary data differ from one regulator to another. It can range from the market actors' reports to the NRA's own IT systems. 12 NRAs specified the used tools at their level to collect the needed data to complete their role; the tools are shown in the figure below.

Figure 55. Data Collection on Used Tools by Country.



In terms of data exchanges, the most commonly requested data concerns were as follows: 1) the electricity data flow (demand, peak load, generation, etc.); 2) quality of service at the transmission, distribution, and consumer levels; 3) wholesale market price; and 4) infrastructure development (in case it's under the NRA's scope). Additional data are also requested by several NRAs regarding specific segments of the electricity market depending on the NRA's role and competencies.

Commonly, the data is received every year unless the indicators require an increased frequency, such as wholesale prices, which is better to be monitored daily.

The choice of the data to be collected and its frequency should reflect the needs of the NRA in terms of performance monitoring of the electricity market actors. For example, the distribution data should be monitored monthly and yearly to observe the performance of the DSO, such as SAIDI and SAIFI.

The list of information and data needed by the NRAs extends to more than the list in the table below. For instance, the EMRA in Türkiye requests the number of complaints from users (monthly), the progress reports of generation plants under construction (every six months) and meter removal/installation (yearly). In Cyprus, the CERA also collects the residual mix energy exchange between the transmission and distribution networks. Further, the ARERA also monitors the data on the commercial quality of sales and distribution services.

In any case, the data collected, and its frequency, differ from one NRA to another. But the NRAs' establishment law should give the NRA the power to access any data needed to achieve its role in the market. The figure below provides the details of each country.

Figure 56. Details of the Information Received and its Frequency.

	Hourly	Daily	Monthly	Yearly
Data on electricity flow		Algeria Jordan Türkiye	Algeria / Jordan Palestine / Lebanon Cyprus / Montenegro Croatia	Algeria/ Egypt /Jordan Palestine/ Montenegro Italy /Portugal / Croatia
Data on cross border interconnections	Greece	Algeria Jordan Türkiye	Algeria Jordan Lebanon Montenegro	Algeria / Egypt Jordan / Palestine Montenegro / Italy Portugal / Croatia
Data on quality of service at transmission level	None	Algeria	Algeria Lebanon Montenegro	Algeria / Egypt Jordan / Palestine Montenegro / Cyprus Greece / Italy Portugal / Croatia
Data on quality of service at distribution level	None	Algeria	Cyprus Lebanon Montenegro Türkiye	Algeria / Egypt Jordan / Palestine Montenegro / Greece / Italy / Portugal / Croatia
Data on quality of service at consumers level	None	Algeria Greece	Lebanon Türkiye	Algeria / Egypt Jordan / Palestine Cyprus / Italy Croatia
Data on electricity wholesale price	Türkiye Greece Portugal	None	Jordan / Palestine Cyprus / Croatia	Jordan / Palestine Cyprus / Italy
Data on infrastructure development	None	Algeria Jordan Türkiye	None	Algeria / Egypt Jordan / Palestine Montenegro / Cyprus Greece / Italy Türkiye / Portugal

Over the past few decades, many countries started to unbundle these market activities to improve the economic efficiency of their electricity systems and open them to competition.

Unbundling brings economic efficiency but increases the cost of regulation. Unbundling also brings about information asymmetry between the regulatory body and the regulated companies.

For an independent regulatory authority to make cost-based tariffs and protect consumers, it is necessary to obtain accurate, real, and complete data promptly.

Utilizing the appropriate information technologies available today to obtain accurate, real, and complete data of the specified quality is the most effective way to minimize the information asymmetry between regulatory agencies and distribution operators.

5. ENERGY TRANSITION CHALLENGES

5.1. Renewable Energy Challenges

The progress of the deployment of renewable energies differs from one country to another due to the characteristics of each market and the obstacles to overcome. This section lists the challenges identified by the NRA in terms of the development of RES.

The Mediterranean region set ambitious targets in terms of RES integration. The EU countries that are a part of the MEDREG are committed to achieving the objectives set in the EU renewable energy directive,[12] which was revised in July 2021 and has set a common target – currently set at 32% – for renewable energy consumption in the EU by 2030.

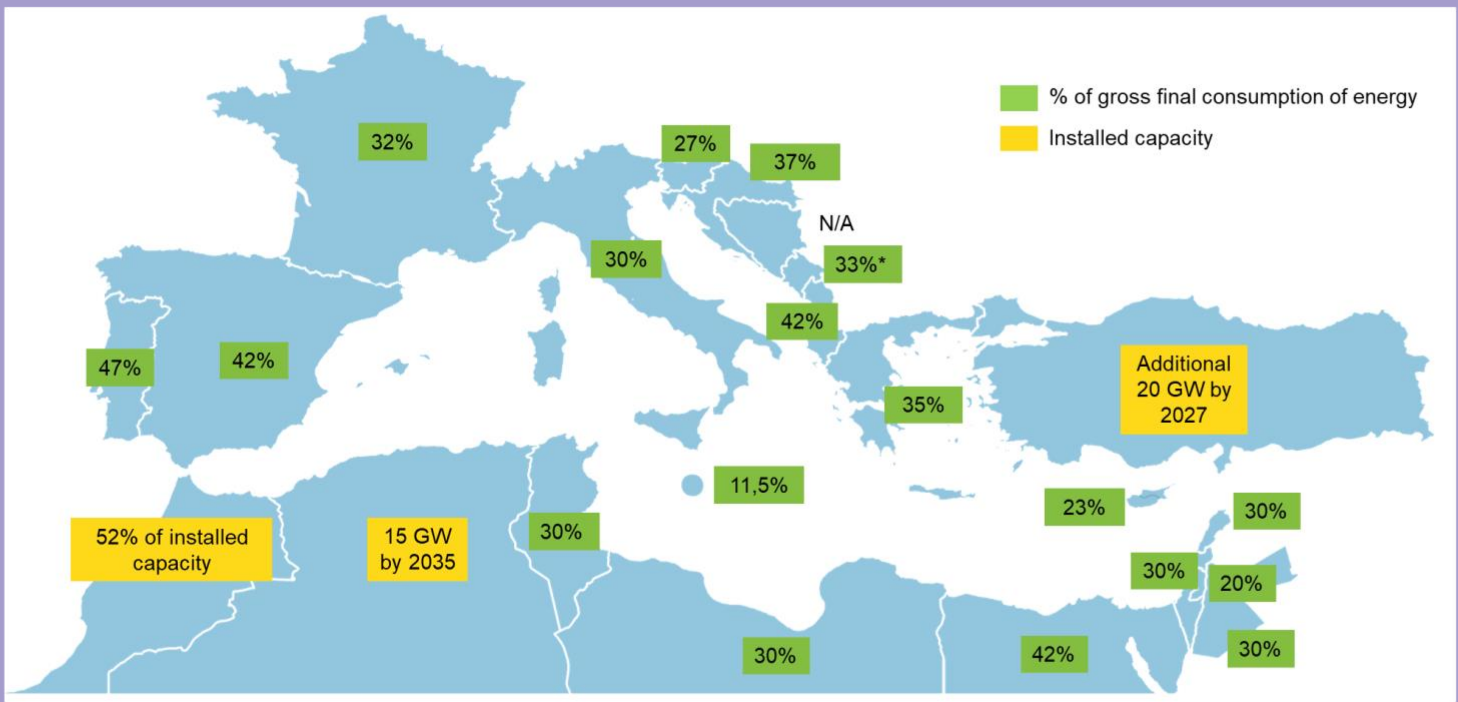
In 2022, in the REPowerEU plan, the EC proposed to raise the target for 2030 to 45% to accelerate and achieve the energy transition goals.

In the Balkans, most of the countries already have a high share of RES in the energy mix, mainly due to the share of hydropower generation in countries such as Montenegro, which reached almost 44% in 2020. However, the countries are willing to continue increasing their share of RES in the future.

In Türkiye, on the other hand, according to its National Energy Policies and Strategy Papers, the Ministry of Energy and Natural Resources aims to integrate 1 GW wind and 1 GW solar power capacity to the system per year in line with the target of adding 10 GW wind and 10 GW solar new capacity between 2017 and 2027.

In the south shore countries, there is no common objective, but each country has set their targets, either in terms of their share of RES for their electricity needs, such as in Egypt and Jordan, or targets for installed capacity, such as in Algeria and Morocco. The RES targets for 2030 are given in the figure below.

Figure 57. RES Integration Targets by 2030 in MEDREG



* 2020 objectives

[12] Renewable energy directive (2009/28/EC)

Unfortunately, in several countries, the implementation of RES is facing many challenges, and the pace of its evolution is considerably slow. From the benchmarking sent to the members, 14 countries explained their national objectives in terms of energy transition and the challenges they face to achieve it.

- ***Algeria***

In 2021, the installed capacity of RES reached only 516,2 MW for a target of 15 GW by 2035. Nevertheless, Algeria is aiming to be independent of conventional resources through the availability of production means based on renewable energy, including photovoltaic and wind power, while maintaining the security of supply through the preservation of fossil resources and their development.

In addition, the hybridization of electricity production means based on conventional resources in the south of the country by solar photovoltaic power has also been presented as a priority action. On the other hand, the biomass sector is currently being examined.

However, to achieve its objectives in terms of the energy transition, the Algerian energy system has to undergo profound changes in the coming years. The increase in decentralized electricity production linked to the development of renewable energies, the emergence of new uses (electric vehicles [EVs], self-consumption, etc.), and the achievement of greenhouse gas emission reduction targets are all challenges that will have to be met to make the energy transition a success at the lowest cost.

To this end, it is important to increase the resilience of the electrical system by modernizing the energy infrastructure and ensuring that the deployment of new technologies benefits consumers.

The cost of energy is also an issue that will have to be addressed, especially with the strong integration of renewable energies.

- ***Cyprus***

In a bid to introduce more flexibility to its power system, the country aims to introduce new and disruptive smart grid technologies as well as state-of-the-art control and storage methods to be used in parallel with new electricity market approaches. With 340 days of sunshine a year, Cyprus is among the EU countries with the highest potential for solar power, and the island is already one of the highest users per capita in the world of solar water heaters in households, with over 90% of households equipped with solar water heaters and over 50% of hotels using large systems of this kind.

Still, the major challenges for CERA, and the country as a whole, are the non-full liberalization of the electricity market, the island's electrical isolation, and the lack of a gas market.

Currently, Cyprus is in a transitional step before full electricity market liberalization, which is being driven by the binding timetable of the CERA to ensure the full opening of the electricity market and grant consumers the right to choose their suppliers. The target date to achieve full electricity market liberalization is expected to be in late 2022, a move which will further open the market for renewables, clean energy, and lower prices.

Cyprus is in the process of establishing interconnections with other EU member states and third countries with several ongoing projects. Moreover, Cyprus intends to develop a natural gas market by importing approximately 0,5 billion cubic meters (bcm) through Gas Sale Purchase Agreements (GSPAs) for three to four years, with the option to purchase LNG from SPOT markets – markets where commodities are traded for immediate delivery. Progressively, the project will include the introduction and use of natural gas by the transport, industry, and energy sectors in Cyprus.

- ***Croatia***

Currently, in Croatia, the process of implementing the 'clean energy for all Europeans' package is being finalized. However, several acts still need to be put into force, mostly regarding the connection process. Additionally, most of the renewable energy projects are planned to be built in the south, which causes problems with evacuating that energy through the grid without making significant investments in the grid.

- ***Egypt***

Egypt's energy strategy is to generate 42% of its energy demand through RES by 2030. This strategy will be updated till 2040 to include new downstream technologies so that the potential of RES in the updated strategy reaches 40%. Currently, this strategy is under revision and is to be updated with new technologies (green hydrogen, waste to energy, and new ambitious targets).

The main obstacle to accelerating the implementation of RES is electricity subsidization and generation of surplus management, even though there is a plan to reach the real cost of the value of electricity by 2025 while protecting low-income groups and families in need.

The fuel supplied to electricity production plants is subsidized by the state, and the estimated volume of subsidies for electricity during the next five years is estimated at EGP 76 bn (around 4 bn €).[13] The ministry of electricity and renewable energy, in cooperation with several institutions, is monitoring the removal of the subsidy and focusing on protecting vulnerable consumers during the process.

- ***Greece***

The national strategy and objectives are detailed in the national energy and climate plan (NECP), which was published in 2019.[14] Regarding RES, the NECP has set an ambitious target of at least 35% of RES participation in the gross final energy consumption by 2030. A key objective in the context of the new revised government strategy for the NECP is the highly ambitious but realistic program to sharply and definitively reduce the share of lignite in power generation – i.e., the so-called lignite phase-out – by implementing a relevant front-loaded program in the following decade and putting a complete end to the use of lignite for power generation in Greece by 2028. The NECP has also set out the timeframe for shutting down the lignite-fired power plants that are currently in operation by 2023. There are also objectives that the RES share in gross final electricity consumption should reach at least 60%, the RES share in covering heating and cooling needs to exceed 40%, and the RES share in the transport sector should exceed 14%, in line with the relevant EU calculation methodology.

In terms of challenges, currently, Greece doesn't face major challenges regarding the achievement of energy transition, although more network investments will be required to accommodate additional RES power plants, and investments in energy storage are needed to mitigate the negative effects of the variable RES technologies, such as wind and PV, to the electricity system.

- ***Italy***

The national objective in terms of the energy transition was established by the Integrated Energy-Climate Plans (PNIEC), which must be submitted for approval to the European Commission under the current regulations on energy governance and the EU Climate Law. By 2030, Italy shall raise its RES share in final

[13] Minister of Electricity and Renewable Energy, Mohamed Shaker, interview with the Daily News Egypt: Link

[14] https://ec.europa.eu/energy/sites/ener/files/el_final_necp_main_en.pdf (pages 56–61)

energy consumption to 30% from the current 17% and RES-generated electricity to 70% from the current 45%.

The acceleration of energy transition at the EU and global levels means more resources are needed for investments, both in RES generation plants and infrastructures. Since infrastructure costs are expected to be passed on to the consumers, the NRA should look closely at the cost efficiency of such investments. In general terms, the major obstacles to the RES deploying in Italy are related to the authorization process.

- ***Jordan***

In Jordan, the government's energy strategy includes increasing renewable energy's percentage of contribution to the electricity needs to 30% by 2030. Since 2014, the share of RES has increased considerably from 0,7% to 21% in 2021, which makes Jordan one of the most rapid-growing countries in terms of RES integration.

However, to achieve its 2030 objectives, some challenges need to be overcome, such as the balance between the electricity load and the high production from RES to avoid RES curtailments. In addition, there has been a significant decrease in the revenue of the electrical tariff due to bulk and high tariff consumers that use the solar system to cover their consumption, and finally, the electricity network has exceeded its technical limitations in many areas.

- ***Lebanon***

Lebanon has enormous potential in renewable energies, especially solar energy, with more than 300 days of sun and wind energy. The 2030 objective is to obtain 30% of the electricity supply from RES.

However, many actions are needed to accelerate the implementation of RES in the country. The major challenge is similar to Egypt, as the electricity prices are also subsidized in Lebanon and the subsidized tariff affects the attractiveness to invest in renewable energy.

- ***Malta***

According to the NECP, the share of energy from renewable sources in the gross final consumption targeted for 2030 is 11,5%. Solar PV technology is projected to contribute to 42% of Malta's RES contribution in 2030, while renewable energy in the heating and cooling sector is projected to contribute to 33% of Malta's RES contribution in 2030.

The government is planning to implement measures targeting solar water heaters, heat pump water heaters, and waste-to-energy plants to increase Malta's RES heating and cooling share.

According to the NECP, Malta's potential for renewable energy deployment is mainly affected by physical and spatial limitations, technological advancement, and resource potential, with the availability and cost of land being the predominant restrictions for further deployment.

The RES share also depends on the energy demand increase, which is expected to increase rapidly in the next decade based on the current demographic and macroeconomic trends and projections.

- ***Morocco***

Morocco has increased its share of RES considerably in the last few years. Since 2019, the RES installed capacity has increased by 10%.

In 2021, the share of RES in the total installed capacity was 37%, and the target is to reach 52% by 2030.

Land use is the key point of the success of the projects and the principal factor that can cause very significant delays in the schedule of RES projects. Also, the projects to be developed should benefit from adapted financing, allowing the optimization of the cost of the kWh produced by the public and private operators.
Regarding the components of the RES program allocated to private developers, the realization of this program depends on the acceleration of the amendment of laws and the publication of the implementation decree.

- ***Palestine***

Palestine aims to increase the share of the RES in the electricity mix by 20% in 2030. Still, the electricity system depends totally on imports from neighbouring countries, and it is facing several challenges:

- shortages in electricity supply,
- high import prices,
- high growth rate in annual energy demand (except in recent years due to the COVID-19 pandemic),
- huge gap in generation capacity,
- a highly inhomogeneous endowment of infrastructures in the Palestinian territory,
- difficulties in developing the electricity network due to a lack of land.

- ***Portugal:***

Portugal's national objectives are defined in the Portuguese NECP and the Roadmap for Carbon Neutrality 2050 (RNC 2050). The Portuguese NECP has set the following goals for 2030:

- reduction of greenhouse gas emissions from 45% to 55% compared to 2005, with an increase of 35% in energy efficiency
- The integration of 47% of renewable energy in the energy mix
- The integration of 20% of renewables in the transport sector (e.g., EVs)

However, the recent EU 'Fit for 55' package may lead to the establishment of even more ambitious targets.
The Portuguese National Strategy for Hydrogen (EN-H2) has set the following targets:

- 10% to 15% green hydrogen injection in natural gas networks
- 2% to 5% green hydrogen in the industry sector consumption
- 1% to 5% green hydrogen in the road transport consumption
- 3% to 5% green hydrogen in the domestic maritime transport consumption
- 1,5% to 2% green hydrogen in the final energy consumption
- The creation of 50 to 100 hydrogen filling stations

However, the current economic scenario is highly uncertain, and both people and companies struggle to make long-term investment decisions. Supply chains are also under stress, and businesses are finding it hard to implement investments.
On the contrary, a trend was already in place for rapid growth in PV installation, which has only been accelerated by the dramatic increase in electricity prices and public funds like the economic recovery fund. Yet, new grid connection requests are often turned down due to a lack of grid capacity to receive more renewable generation. There is also some shortage of manpower to build every project in the pipeline.
At the regulatory level, the challenge is keeping up with all the adaptations of the market rules under great pressure and in an extreme market environment. In addition, on the side of the network operators, it is hard to comply with the new rules, new targets, and requests by the grid users.

- ***Türkiye***

Türkiye is highly willing to increase the rate of renewables and natural resources in its electricity generation mix. Compared to the beginning of the 2000s, the installed capacity of RES-based power plants has increased dramatically thanks to the support scheme for renewable energy (RESUM – renewable energy support mechanism). As of the end of January 2022, the share of renewable-based power plants (including hydro) (53,4 GW) in the total installed capacity (99,7 GW) increased to 53,5%.
According to the Türkiye's National Energy Policies and Strategy Papers, the Ministry of Energy and Natural Resources aims to integrate 1 GW wind and 1 GW solar power capacity into the system per year in line with the target of adding 10 GW wind and 10 GW solar new capacity between 2017-2027.
However, Türkiye is still highly dependent on fossil fuels. Türkiye imports high amounts of gas, oil and coal. Although the share of renewables in the generation mix increases daily, conventional power plants still play a significant part in ensuring the security of supply. To enhance the resilience of the system operation in the path to green transition, the application of alternative systems is necessary, such as the introduction of demand-side management (DSM) service, storage, distributed generation, green certificates, and carbon border adjustment mechanisms.
EMRA has completed regulations related to distributed generation (via unlicensed generation), hybrid power plants, electricity storage, and national renewable energy resources guarantee system (YEK-G), and as an introduction to the DSM service, 'a demand-side reserve' concept has been introduced. A new department called Energy Transition Department was also established in EMRA.

5.2. Electricity Storage

With the ambitious RES integration set by most of the countries, maintaining the stability of the electricity system will soon be a huge challenge in all the countries with an important share of RES. In some cases, such as Portugal and Jordan, the curtailment of RES production is already an issue, and alternative mechanisms and technologies are required to overcome the problem.
Electricity storage would be part of the solution, and in some countries, it can also be a key element to achieve their targets in terms of the energy transition, such as in Algeria, Egypt, Jordan, Lebanon, Portugal, Morocco, and Türkiye.
However, the development of energy storage is taking a long time, and the technology is not mature enough to be used in a wide range. Moreover, electricity storage is a highly expensive solution and can't compete with the traditional schemes and mechanisms (the use of fossil fuel-based power plants to maintain the stability of the system or the import/export of electricity).
Nowadays, the most common electricity storage technology is pumped storage hydropower (PSH). Morocco already has a pumped turbine in operation and another one in construction while others are under study.

Regarding the storage power station (ESS), some countries developed a regulatory framework for its implementation, and a few projects have been planned; for example, in Palestine, an initiative of 30MW is being planned.
In the Mediterranean region, Türkiye, Cyprus, Greece and Portugal are more advanced in terms of electricity storage regulation and projects (either pilot projects or operational projects).

In **Türkiye**, in May 2021, the EMRA published the regulation concerning the installation of energy storage systems (ESS) that defines the four main types of ESS, which are production-integrated, consumption integrated, standalone, and constructed by network operators. The second stage of the ESS legislation started in 2022. This year, the losses in ESS will be evaluated in the legislation. The most recent project is a 250 MW storage project by a market player licensed by EMRA (standalone). More details related to the energy storage in Türkiye are given in the annexe.

In Croatia, it's included in the national strategy, but for now, only pilot projects have been developed. As an incentive, these projects only pay for the real cost of connection (materials, labour, etc.) and not for any grid interventions (shallow approach to connection costs).

Cyprus also promotes the use of electricity storage, and CERA has fully transposed the rules from article 36 of the Electricity Directive in the National Law for Electricity Market Regulation, article 53. The national law promotes the integration of storage facilities by reducing the period for conducting a public consultation to assess the potential investments in storage to at least three years, in contrast to the five-year period stated in the Directive (article 36(3)). In addition, a governmental grant scheme that will fund commercial storage at the MV level is under consideration.

To date, only pilot projects are in place. The first energy storage system (30 kW/50 kWh), was connected to the electricity system in Nicosia in 2018. The project provided the opportunity to interact with real battery systems and gather knowledge about their operation, branding the efforts as a success. The project received funding from the EU's Interreg Mediterranean research and innovation programme under the project StoRES. More details related to energy storage in Cyprus are given in the annexe.

In **Greece**, electricity storage is included in the NECP, where the installation of batteries and hydro pumping are considered rational options for contributing towards further use of renewable energy and enhancing RES penetration and flexibility. In addition to that, storage is included in the Greek plan for recovery and resilience, where specific objectives and projects are presented.

Currently, no projects are in place for battery installation as a means of storing electricity. However, an investment for the installation of up to 1380 MW capacity of energy storage in the electricity system is being planned, which shall be completed by 31 December 2025. In addition, two hydro pumping units already exist (699 MW in total) in Sfikia and Thisavros. Another hydro pumping unit is already included in the Project of Common Interest (PCI) list in Amfilochia (680 MW generation capacity and 730 MW pumping capacity), the construction of which is planned to be completed by October 2025.

The **Italian** PNIEC foresees the deployment of 6 GW of centralised storage facilities and 4,5 GW of decentralised storage capacity to accommodate RES growth by 2030. Long-term strategies (beyond 2030) display an estimated need for storage of around 40–45 GW. These objectives will likely be revised in view of adapting the energy transition strategy to the recently issued EU 'Fit for 55' and 'REPowerEU' packages.

Storage projects fall under the energy efficiency incentivisation mechanism, which provides for fiscal rebates (until 100% of the investment value) in the household sector. However, no explicit incentives are foreseen in the business sector. Yet, the recent decree implementing the EU Renewable Energy Sources Directive (also called RED II) mandates that the NRA propose regulatory and tariff incentives for storage deployment. The framework will be clearer by the beginning of 2023.

REWS in **Malta** provides a support scheme for battery storage installations in conjunction with RES generation since 2021. In case of the purchase of a hybrid/battery inverter and battery, applicants are refunded 80% of eligible costs of the battery storage up to a maximum of €3 600 per system and €600/kWh plus 80% of eligible costs of the Hybrid inverter up to a maximum of €1 800 per system and €450/kWp.

In case of purchase of battery storage only, applicants are refunded 80% of eligible costs of the battery storage up to a maximum of €3 600 per system and €600/kWh.

Portugal has no national strategy for energy storage. However, the newly updated legal regime of the power sector has made it clear how to integrate storage into the system, pointing the way for new developments that fully integrate this reality.

The recent tenders for a new grid connection capacity for renewable generation have set specific conditions for generators that couple with storage technologies. This has had significant interest from participants. These projects shall be going into operation in the next few years. Market players are increasingly asking for rules applying to storage since they are actively assessing new projects.

In the islands of Azores and Madeira, the local network operators are deploying battery systems for better grid management and to increase the capacity to receive renewable generation in these small, isolated systems. There are no general incentives for storage projects, except in Azores and Madeira.

In these archipelagos of small islands, batteries are being deployed to increment grid capacity to absorb more renewable generation. Hence, these projects are receiving European funds that are non-refundable and relate to investment costs.

5.3. E-Mobility

E-mobility is a driver to achieve a net zero carbon emission in any country. Its deployment is slow in the Mediterranean region, except in a few countries such as Italy, France, and Portugal. However, the energy transition national strategies include e-mobility as a key element in the policy. Therefore, there is a need to initiate the elaboration of the regulatory, technical, and tariff framework for the implementation of e-mobility, and the role of the NRA in those steps is crucial.

5.3.1. Role of the NRA and the challenges of developing e-mobility

In **Egypt**, the regulator is the main authority responsible for regulating EV charging stations, where it is responsible for the issuance of licenses and permits and setting charging tariffs and approving technical connection requirements. The EgyptERA issued circular no. 5 in 2022 to regulate EV charging stations.

For now, the main challenge that Egypt is facing while developing e-mobility further is related to connection requirements, and more challenges are expected to appear as e-mobility grows.

In **Türkiye**, EMRA is responsible for regulating the EV charging stations, and recently, the regulations on EV charging services were published in the Official Gazette on 2 April 2022. Charging services for EVs are regulated as an activity to be licensed. EMRA is the authorized institution for issuing licenses. For now, the challenge that e-mobility is facing is the uneven geographical distribution of charging stations, causing suboptimal use of the electricity grid. In addition, due to the small number of EVs, some charging stations do not work to avoid being unprofitable and due to the low level of household electricity tariff compared to the commercial tariff, widespread use of domestic charging, and the limited spread of public charging stations in Türkiye.

The e-mobility regulation in **Cyprus** is not under the competence of CERA. On the other hand, the main challenges present in Cyprus are due to the current relatively high prices of EVs and the lack of incentives; hence, the EV numbers are still very low. This leads to low interest in investing in larger numbers of EV charging stations. Moreover, as the competitive electricity market is still under transitional arrangements, no additional benefits are yielded from EV ownership.

Finally, electricity prices are currently at their highest point; thus, conventional car owners without on-site RES generation have zero motivation to switch to an EV.

In **Greece**, under Law 4710/2020, the Ministry of Energy supervises the operation of the EV market as well as the relevant procedures that must ensure free and equal access for all the participants. Cooperation between the ministry and the NRA is foreseen for issues that fall under its competence and relate to the energy market.

The main challenges are found in the development of a network of fast charging stations (> 50 kilowatts) – a technology that allows the battery of an electric car to charge in 30 minutes compared to 2 hours at an ordinary charging station (power 20–22 kilowatts). Fast chargers, the installation of which require an increase in power, may face a delay, which can become more complicated when a new substation is required. This delay exists due to the involvement of multiple state institutions (national and local).

Another challenge is that charging as a service receives a VAT rate of 24%. Stakeholders claim that it could be reduced to 6%, which is the VAT applied to both household and commercial consumers. In addition, the cost of kWh is rather high too, amounting to around €0,55 per kWh.

One final challenge is the cost of installation since the cost of the device (charger) amounts to only 20–25% while the remaining 75–80% concerns the cost of connection to the grid when a new substation is required.

The **Italian** regulator ARERA has no role in e-mobility. Nevertheless, the new legislation on RES mandates ARERA to propose and implement explicit tariff incentives for energy withdrawal EV charging stations.

In **Malta**, the regulator controls the electricity tariff component charging EVs and provides a holistic framework for charging infrastructure, which, once in force will require operators of publicly accessible EV charging infrastructure to operate under an authorization issued by the regulator, which, among other conditions, will require the registration of an EV charging point.

In **Portugal**, ERSE approved the Regulation for Electric Mobility addressing the following matters:

- Rules of engagement between stakeholders in the sector
- Regulation model to be applied to the Electric Mobility Network Managing Entity (EGME), including how income is defined
- The measurement, reading, and provision of charging and consuming data
- Revenues and regulated tariffs for EGME
- Quality of service
- Price supervision
- Data availability

ERSE also defines specific electricity network access tariffs for deliveries to EV users. These tariffs have time-of-use prices (two or three periods). Permitting the charging stations and recognizing the e-mobility electricity suppliers is the responsibility of the General Directorate for Energy and Geology (DGEG).

The challenges that e-mobility is facing in Portugal are related to the imbalance between the demand for EVs and the required production of vehicles and infrastructure.

5.3.2. Indicators to monitor e-mobility

EMRA monitors the charging service offered by public charging stations as well as the charging infrastructure. For example, at least 50% of the charging units on highways and state roads must be DC 50 kW and above charging units.

The indicators that are monitored in **Greece** regarding the goals set for e-mobility are the following:

1) Percentage of annual EV registrations, compared to the total percentage of new vehicles
2) Measurable emission results, compared to the year of reference
3) Number of charging infrastructure developed in public spaces, compared to the year of reference
4) Development of private EV charging points
5) Renewal of the fleet (light trucks, heavy vehicles, public passenger vehicles, and taxis)
6) An index regarding the social benefit by assessing the number of emissions not released to the atmosphere by using EVs
7) An index assessing the above-mentioned social benefit in euros

The main indicator that can monitor the evolution of e-mobility in **Italy** is the number of charging points: in June 2022, Italy had around 28 000 charging points, which was an increase of 15% compared to June 2021.

The same can be used in **Malta**, where, by the end of 2021, there were 156 medium-speed AC public charging pillars and 24 fast AC public charging pillars. A single charging pillar may have two charging points.

The indicators monitored are available online in **Portugal,**[15] although it only considers the public charging network.

On the other hand, the e-mobility suppliers must report to the ERSE each January with the reference prices for charging and other services that will be applied. Reference prices are also reported to the ERSE every time they are changed. In each quarter, they must report to the ERSE the quantities and prices offered to their clients in the preceding quarter.

The EGME must report the following to the regulator:

- the number of users that signed a new contract with a supplier
- the number of clients of each supplier
- the active energy consumed in charging each month, differentiated by the charging point type and the charging point operator
- the number of EVs in the electric mobility grid each month, differentiated by the charging point type and the charging point operator

The EGME also has to report the following:

[15] https://www.mobie.pt/en/mobidata/data

- The number of requests to activate, block, unblock, and cancel user authentication, differentiated by the ones resolved in 24h or less or after 24h
- The sum of the time taken for activating, blocking, unblocking, and cancelling user authentication
- The number of charging stations at the end of each semester, differentiated by voltage level (e.g., low voltage) and supply type (e.g., normal, fast, and ultra-fast)
- The number of charging stations, differentiated by type (e.g., normal, fast, and ultra-fast), operator, and municipality
- The number of agents in the market each semester (e.g., supplier, charging point operator, EV users)
- Number of charging points without alternate current (AC) metering in each semester, differentiated by type
- Total number of charges made by users in each semester by type, operator, and municipality
- Active energy consumed while charging EVs by charging point, operator, and municipality
- Annual active energy delivered to EV users per network access tariff and per time of use
- Active energy delivered to EV users with 15- intervals per e-mobility supplier and per e-mobility charging point operator for each year

5.3.3. Charging fees

The estimated charging fees for home charging are the same as the electricity rate in **Egypt**. Charging station prices range between 1,89 (0,01) and 3,75 (0,2) EGP (€)/kWh.

However, in **Türkiye**, the charging service regulation states that license holders can demand payment from drivers for charging the EV in the amount of electricity used, which means that the charging price at each charging station will be calculated based on kWh.

In **Cyprus**, currently, the only provider of an EV charging tariff is EAC through the e-service, the e-charge service to EV owners based in Cyprus. Each user of the system will be charged €25 on the first invoice, and invoices will be sent to the owners of EVs every two months. The pricing of electricity is based on the tariff 15 (€5,27/two-month period and a fixed charge of 15,96 cents/kWh based on a basic fuel price of €300/MT).

The charging fees in **Greece** are detailed in article 15 of Law 4710/2020, which states the pricing method, the relative tariffs, and the EV charging service terms are freely formed but must be made known to the users of the EV charging stations in advance.

The final charge of the charging station user includes all the parameters of charging that contribute to the final price, such as the energy consumed or session duration as well as other charges. All these parameters must be evident to the user at the charging spot.

In **Italy**, the charging fees are entirely market based. Price ranges from 0,29 to 0,58 €/kWh for AC charging infrastructure and from 0,39 to 0,79 €/kWh for DC charging stations. The fees are not always comparable since the operators sometimes require customers to pay a fixed yearly entry fee.

In **Malta**, the EV meter application charges on existing accounts are €50 for a single phase and €80 for three phases. The monthly residential EV meter service charge is €4 for residential single-phase points, €6 for residential three-phase points, €6 for non-residential single-phase points, and €8 for non-residential three-phase points.

For public charging pillars, the following tariffs are applicable (E-Drive Plug 'n' Charge Packages)[16]:

- For medium-speed charging pillars, the rate is €0,1698/unit in the off-peak periods and €0.1885/unit in the peak periods.
- For fast-speed charging pillars, the rate is €0,1698/unit in the off-peak periods and €0.1885/unit in the peak periods.

In **Portugal**, the provision of electricity for e-mobility is separated from the provision of the charging infrastructure. Electricity mobility suppliers (CEMEs) supply electricity to EV users and charging point operators (OPCs) provide the infrastructure. OPCs charge EV users for their service indirectly through the EV user CEME.

The price paid by the car owner to the supplier (CEME), relating to the supply of energy, is market oriented and established between the supplier and the user.

The price for using the charging points is also nonregulated. The user can choose the charging point they prefer, considering the announced price and other variables, such as location.

The flow of information between entities (e.g., CEMEs, OPCs, and DSOs) is the responsibility of a single entity, according to the national law – the management entity for electricity mobility (EGME).

The regulator (ERSE) establishes the management entity's remuneration because it is a monopoly activity as established in the law. Annually, the regulator establishes the remuneration of the activity and corresponding tariffs that are paid by the suppliers (CEME) and by the operators of charging points (OPC). The ERSE has established these tariffs since 2021.

The prices charged by suppliers (CEMEs) and charging operators (OPC) can be charged by the following variables: €/kWh, €/minute, and €/charge (activation fee). CEME and OPC choose the variables they apply, which can comprise all the variables or just some of them.

[16] The off-peak hours are between 00:00 am and 05:59 am and between 12:00 pm and 15:59 pm and throughout the day on Sundays.

6. CONCLUSIONS

Since the last decade, the discussions among the energy regulators in the Mediterranean region have mainly focused on three major topics: increasing the amount of renewable energy integration, creating a competitive regional energy market, and overcoming energy transition challenges.

This report has attempted to offer a snapshot of the region to achieve a step forward toward a fair, functioning, and integrated Euro-Mediterranean energy market by enabling cooperation and information sharing among the MEDREG members based on the replies of members to a questionnaire prepared by the ELE WG.

As revealed by the statistical overview in chapters one and two on the electricity markets of the region, 2019–2020 was a challenging period for not only the NRAs but all the electricity market actors. During the pandemic, despite the differences in the specific regulatory measures taken to support the energy sector in each country, the regulators and governments in the Mediterranean region took action to support the energy actors and to protect the end consumers. The Mediterranean region was severely impacted by the COVID-19 pandemic, and the total electricity demand decreased by nearly 4% in 2020. The situation worsened with the energy price surge in most of the countries, except the hydrocarbon-producing countries. In 2021, the electricity demand started to recover in most countries and increased to at least the levels of 2019.

Electricity demand will continue to increase considerably in the coming years in the Maghreb member countries (Algeria, Tunisia, Morocco, and Libya), where unbundling has already begun, except for Libya and Tunisia. Thus, the regulators need to focus on national issues and developing sub-regional markets. While the current energy mix in the Maghreb region is dominated by conventional fossil fuel generation based on the available primary energy source, there is a huge potential to integrate RES (especially solar) to meet the daily load due to the climate conditions of this region. To facilitate this, the share of private generation needs to be increased through sufficient and accurate incentive mechanisms. The imports/exports between the countries in the Maghreb are low compared to the existing capacity and infrastructure since the main use of the interconnections is for the security of supply. To improve the electricity exchanges among the countries, common rules and approaches still need to be developed by each country.

Regarding the Middle East member countries (Egypt, Israel, Jordan, Lebanon, and Palestine), the unbundling of the electricity market is similar to the Maghreb region. The power generation unbundling has been achieved in all the countries except Palestine, where they don't have any power generation facility. On the other hand, the unbundling of the TSO and the distribution are facing many challenges and require more time to be achieved. The electricity demand in the Middle East member countries is increasing, mainly due to population growth and economic development, with a growth of 20% in the last five years. However, many challenges have been identified in each country for the coming years, and the concerned governments and NRAs have developed strategies to overcome these issues, such as a reduction of losses, the development of interconnections, an increase in installed capacity, and an increase in the share of RES. The share of RES is expected to increase as all the countries in the region adopt new strategies to facilitate it by reducing the dominant share of natural gas (%77). The Middle East member countries have focused on developing the national infrastructure to ensure the security of supply and provide enough power generation to meet the growing demand. The cross-border interconnections didn't follow the same rhythm, and there is a lack of interconnections between the countries. Nevertheless, multiple projects that will boost the stability of the electrical systems and improve the security of supply were announced in the last year to reinforce the cross-border interconnections in the region, especially between Egypt and Jordan.

In Türkiye and the Balkans member countries (Türkiye, Albania, Montenegro, Slovenia, Croatia, and Bosnia and Herzegovina), the electricity market has been fully unbundled in the power generation and the energy distribution segments, though in Slovenia and Croatia, the state-owned companies dominate the market either at the power generation or supply side. In this sub-region, the evolution of electricity demand and generation has been different in each country. The security of supply is achieved through the benefits of the regional market and via interconnections, particularly between Albania and Croatia. In addition, the installed capacity of each country is disparate; in some countries, one technology is dominant, such as in Albania with only hydraulic power plants, while in others, there is a mix of several technologies, such as in Türkiye. Yet, Türkiye and the Balkans member countries represent a particular sub-region, which demonstrates the benefits of regional integration and cooperation among the neighbouring countries. The regional market and international exchange are key elements for ensuring the balance of the power system in the region. The cross-border interconnections are distinctively developed, and further development is being planned for a well-functional regional market to ensure the security of supply at the national and regional levels. Technical and non-technical losses remain an issue in the region, and the NRAs should develop measures and mechanisms to further reduce them.

For the EU member countries (Spain, Portugal, France, Italy, Greece, Malta, and Cyprus), the unbundling of the electricity market has already been achieved. However, Malta is a particular case, as there is no TSO in the market, the retail market is not open to competition, and all the generators must sell to a single buyer in the country. After a drop in the electricity demand in the EU MEDREG member countries in 2020, due to the COVID-19 outbreak, the electricity market is recovering, and the electricity demand/generation is increasing again. However, the level of demand is still below 2019. More actions and mechanisms are needed on both the demand and generation sides to meet the 2030 and 2050 objectives. However, the last three years have shown that no market structure is perfect, and from the regulation point of view, a dynamic and flexible regulation is key to ensuring the security of supply in the future. In terms of the energy mix, renewable energies represent at least 33% of the total energy generation in 2021 and are in second place after nuclear power, which has a share of 38%, while natural gas ranks third with 28%. The regional market between the EU member countries is well developed and supports the countries in ensuring their security of supply through imports and exports. France is a key member in the region that supports the security of supply of many countries, thanks to its nuclear production. On the other hand, Italy imported an important share of its needs in 2021. The share of RES has increased in the last years in this region. However, there is a need to facilitate more integration of additional capacities and the use of alternative mechanisms and technologies to achieve the objectives of the energy transition and reduce the dependence on fossil fuels.

Regulators should be able to get sufficient, accurate, and timely data to monitor and analyse national power systems. Over the recent decades, many countries have started to unbundle the market activities to improve the economic efficiency of the electricity systems and open them to competition. Unbundling brings economic efficiency but increases the cost of regulation. Unbundling also brings about information asymmetry between the regulatory body and the regulated companies/operators. For the independent regulatory authority to make cost-based tariffs and protect consumers, it is necessary to reach accurate, real, and complete data promptly. Utilizing the appropriate information technologies available today to obtain accurate, real, and complete data of the specified quality is the most effective way to minimize the information asymmetry between regulatory agencies and other parties. Chapter 4 shows that the frequency of data collection for monitoring and analysing the systems to make decisions is highly different in every NRA in the Mediterranean region. For an effective integrated electricity market in the region, harmonization and convergence of regulatory framework are essential. Therefore, data collection and monitoring rules are among the subjects that require more work and further collaboration in the region.

The energy transition challenges can be divided into three main groups: deployment of renewable energy, development of electricity storage, and e-mobility.

The progress of the deployment of RES differs from one country to another due to the characteristics of each market and the obstacles to overcome. Figure 57 demonstrates the RES integration targets of 2030 in the MEDREG member countries. Unfortunately, in several countries, the implementation of RES is facing many challenges, and the pace of its evolution is considerably slow. According to the replies to the questionnaire by the members, the main challenges to achieving the RES targets are increasing the resilience of the power system by modernizing the grid infrastructure and financing, non-full liberalization of the electricity market and curtailment in some countries, electricity subsidies and the cost of energy, lack of land in rather small countries, and the regulatory red tape.

Electricity storage would be a part of the solution, and in some countries, it can also be a key element to achieving their targets in terms of the energy transition, but the development of energy storage (battery) is slow since technology is still rather expensive to be used in a wide range. Some countries developed a regulatory framework for its implementation and few projects have been planned. Incentive mechanisms to build more storage systems should be implemented in parallel with the RES development to avoid facing curtailments and other operational problems in the grid.

E-mobility is a driver to achieve a net zero carbon emission in any country. Its deployment is slow in the Mediterranean region, except in a few countries. However, the energy transition national strategies include the e-mobility concept as a key element. Therefore, there is a need to initiate the elaboration of the regulatory, technical, and tariff framework for the implementation of e-mobility, and the role of the NRA in those steps is crucial.

MEDREG serves as a technical hub that leads the dialogue on key areas of regulating energy in the region, fostering cooperation, and exchanging information since much more remains to be done to achieve a sustainable energy transition. It is essential to bring everyone on board, especially at a time when geopolitical turmoil on energy and climate is even more visible.

7. ANNEXE

Electricity Storage: Case Studies

- Türkiye

The regulation concerning the instalments of ESS was published in May 2021 by the EMRA. The regulation defines the four main instalment types for ESS, which are production integrated, consumption integrated, standalone, and constructed by network operators. This segmentation was made to help the investors see what they should do for each installation type. The EMRA wants to have an ESS-rich electricity grid in the future since it would substantially improve the power quality and contribute to the security of the energy supply.

The second stage of the ESS legislation started in 2022. This year, the losses in ESS will be evaluated in the legislation because the legislation can envisage the possible double feed-in tariff incentive problems in ESS instalments, which the EMRA can prevent. To date, no active constructions of ESS projects exist in Türkiye at the commercial level although there are many pilot projects countrywide. The most recent project is a 250 MW storage project by a market player licensed by the EMRA (standalone instalment). The project is being planned in the Thrace region of Türkiye and aims to operate mostly in the capacity reserve mechanism.

In terms of incentives, there are no active incentives for ESS instalments in Türkiye. Although the EMRA is still considering the possible options, it is focusing mostly on European examples.

- Cyprus

CERA has fully transposed the rules from article 36 of the EU Electricity Directive in the National Law for Electricity Market Regulation, article 53.

The national law promotes the integration of storage facilities by reducing the period for conducting a public consultation to assess the potential investments in storage to at least three years, in contrast to the five-year period stated in the Directive (article 36(3)). In addition, a governmental grant scheme that will fund commercial storage at the MV level is under consideration.

The first energy storage system, 30 kW/50 kWh, was connected to the electricity system in Nicosia in 2018. Cyprus became the testing ground for an innovative community project delivered by a German electric utility company, Autarsys, where 30 kW/50 kWh was connected to a conventional distribution substation in Nicosia. The project provided the opportunity to interact with real battery systems and gather knowledge about their operation, branding the efforts as a success. State-of-the-art, high-voltage lithium-ion batteries were used, and the battery system provided services to the distribution network – such as power balancing, network, and frequency support – as well as essential services that stabilize and protect the seamless operation of the power network. The project received funding from the EU's Interreg Mediterranean research and innovation programme under the project StoRES.

To incentivize electricity storage, CERA encourages the installation of in-front-of-the-meter electricity storage facilities with Regulatory Decision No. 3/2019, where in-front-of-the-meter storage facilities, which are not combined with on-site electricity consumption, other than what is necessary for the operation of the facility, can participate in the wholesale electricity market if the technical requirements, as specified by the National Transmission and Distribution Rules, are met.

Their operation is scheduled and determined by their participation in the wholesale electricity market based on the provisions of the national electricity market rules, and they can both inject electricity into the grid as well as store electricity from the grid. Where required, the measurement of energy absorption/injection from the storage facility and the energy injection from the generation facility will be done separately.

The in-front-of-the-meter electricity storage facilities can

a. be included in a Register of Storage Facilities according to its technical characteristics.

b. be included in the Register of Balancing Service Providers, according to its technical characteristics.

c. participates fully in the electricity market and all the sub-markets (forward, day-ahead, ancillary services, and balancing market) and the products offered in them, both for injecting and absorbing energy.

d. contract with RES producers and/or RES aggregators to clear their discrepancies cumulatively, either with a specific RES production unit or via the facilities represented by the aggregator.

During their charging cycle, the in-front-of-the-meter electricity storage facilities do not pay network usage fees.

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