Empowering Mediterranean regulators for a common energy future.

Electricity Working Group

Regulatory options for the stimulation of infrastructure investments

Fact finding and review of challenges in investment in infrastructure

FINAL VERSION

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Executive summary

Investment decisions in electricity systems are of crucial importance, as they have to ensure in the long run the correspondence between consumers' needs and the supply capacity of generation and infrastructures. Electricity systems articulate different complementary activities, investment policies have to build upon a proper assessment of national situations and priority need identification.

In Southern and Eastern Mediterranean Countries (SEMCs), investment is often made challenging due to limited financial resources and constrained industrial capacities. The level of economic development is indeed a key parameter as poverty exacerbates the need for focusing on priority areas. On top of this, the rapid increase of populations' needs make system planning even more challenging.

The purpose of this report is to assess the level of development of power systems and to identify priorities and challenges for the stimulation of relevant investments. From this identification, the following elements appear to be critical for an efficient approach to system development:

- A clear national strategy;
- A coherent description of the system and its insertion within the energy mix;
- A careful reflection on the level of vertical coordination along the electricity chain.

The assessment of national situations carried out by MEDREG members provide interesting illustrations of how the integration of the two shores of Mediterranean is a key issue for the stability and sustainable development of the region. The possibility to combine and operate power systems that have complementarities in terms of load profiles and generation mix in a more integrated way is an added value with direct impact on increasing the energy efficiency as a result of transmission network integration and on reducing the cost and the environmental footprint of electricity. If this combination will be achieved, the beneficiaries will be the final customers/citizens and the environment. In this sense the role of the National Regulatory Authorities (NRA) and Transmission System Operators (TSO) is crucial in order to improve the coordination of the systems, with the aim to contribute to the creation of an integrated electricity market.

In terms of investment planning and interconnection development, while in the EU the market design and the level of development of electricity markets makes it possible to run market simulation models evaluating projects according to wholesale prices, in the wider Mediterranean region such an approach is much more difficult to be implemented. Assessing the social value of interconnection projects is hindered by the lack of harmonization of system operation and conditions are less favorable than in Europe to efficient cross-border integration. The topology of existing systems in SEMCs is very different and networks are less meshed because they follow the sea shore where the population is concentrated. In addition, the lack of reserve margins on the generation side and the sustained increase of consumption in a context of non-competitive organization of markets make even harder the development of a harmonized approach to network development.

This report posits that to stimulate investment, it is necessary to clearly assess what the

priorities are at national and regional levels. Having a view to energy systems as a whole is important to ensure the coherence of choices. In this respect, efforts have to be put on long term planning, which includes the assessment of needs and possible options to fulfil them, articulating the development of energy supplies, power generation, transmission and distribution networks, interconnections. Investment processes are long, therefore promoting stability and transparency in terms of institutional organization and regulation is crucial, both for national and foreign investors.

The intervention of regulators must be linked to national energy policy objectives, for example in the context of a dialogue with public authorities and electricity companies. The regulator's independence should guarantee objectivity and a high level of expertise in order to properly frame the action of operators and set up an effective governance framework.

To properly stimulate investments in the Mediterranean region, MEDREG makes the following priority recommendations

- **Clarify the institutional architecture at national level**: while TSOs are generally state-owned and under a strict control of the government, electricity systems development combines public and private investments, in particular in generation. To raise countries attractiveness, national objectives and the institutional architecture have to be clear in order to properly design the rules and set up incentives to each category of actors.
- **Improve investment planning capacity**: Based on a long-term vision, it is critical to assess the possible tools to be mobilized and to carefully estimate the financial charge of investments. Building a consistent picture of needs is critical for effectively managing complementary developments: network planning, generation development and demand evolution have to be jointly addressed for an effective coordination in the long run.
- **Ensure a proper level of transparency and know-how**: to foster investment, institutional stability and transparency of the rules is a key factor. Foreign investors generally require guarantees about risk structures and coverage. Moreover, providing dedicated capacity-building for key energy decision-makers would help sharing best practices within the region.

Build upon regulators' competences: Regulatory authorities are institutions which participate to creating a sound investment climate. Actually, their role consists in working closely with operators, ensuring that investment processes are managed efficiently. They also play a crucial role in adapting rules to fill the potential regulatory gaps hindering energy flows across borders.

About MEDREG

MEDREG is the Association of Mediterranean Energy Regulators, bringing together 25 regulators from 21 countries, spanning the European Union, the Balkans and North Africa.

Mediterranean regulators work together to promote greater harmonization of the regional energy markets and legislations, seeking progressive market integration in the Euro-Mediterranean basin.

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

MEDREG acts as a platform providing information exchange and assistance to its members as well as capacity development activities through webinars, training sessions and workshops.

The MEDREG Secretariat is located in Milan, Italy. MEDREG is co-funded by the European Union.

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Related Documents

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- “Mediterranean Energy Regulatory Outlook 2017”, MEDREG, 2017.

- Recent challenges in MEDREG countries. Summary of case studies collected by the ELE WG, MEDREG, internal document.

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1. Introduction

Investment decisions in electricity systems are of crucial importance, as they have to ensure in the long run the correspondence between consumers' needs and the supply capacity of generation and infrastructures. Electricity systems are complex. They combine many different assets which have to be developed and operated in a coordinated way. Investment decisions can cover many different situations according to the general maturity and governance structure of systems.

In the Mediterranean region, there is a huge contrast between the North and the South. In the North, supply development has been achieved some decades ago, which means that most of the current investments can be seen as "marginal" when compared to the asset basis of operators. In addition, investment financing is relatively easy resulting from a rather secure investment environment.

In SEMCS, investment relates to managing scarce financial resources and limited industrial and human capacities. The level of economic development is indeed a key parameter as poverty exacerbates the need for focusing on priority areas. On top of this, the rapid increase of populations' needs make system planning even more challenging.

The purpose of this report is to assess the level of development of power systems and to identify priorities and challenges for the stimulation of relevant investments. From this identification, the following elements appear to be critical for an efficient approach to system development:

- A clear national strategy
- A coherent description of the system and its insertion within the energy mix
- A careful reflection on the level of vertical coordination along the electricity chain

In Europe, regulators mostly focus on the proper development of transmission and distribution networks. However, since the regulator has also a role to ensure proper security of supply, it retains a responsibility to ensure that generation capacity is adequate, although the exact capacity is often left to the market to determine. Thus, although the regulators' scope of competence in terms of investment is often limited to network infrastructures, when important generation developments are also required, network and generation planning have to be jointly addressed. This means that either regulators have to cooperate with other institutions (ministry) or their role is adapted accordingly, and may not be the same as in European countries.

The intervention of regulators must be linked to national energy policy objectives, for example in the context of a dialogue with public authorities and electricity companies. The regulator's independence should guarantee objectivity and a high level of expertise in order to properly frame the action of operators and set up an effective governance framework.

2. Setting the context

2.1. Demand perspectives

Electricity demand continues to grow rapidly in the South shore of Mediterranean where consumption has increase 10-fold since 1980. This surge can be attributed to several factors including: population growth, urbanization, industrialization and electricity prices made artificially low through government subsidies.

Although growth rates have slowed in the last few years owing to weaker economic activity and to increases in electricity prices as those subsidies are reduced most countries are still struggling to meet increasing electricity demand. Looking forward, governments will continue to meet this challenge by expediting new projects and upgrading their infrastructure, investing heavily while trying to increase the role of the private sector in power generation, as partners and financiers.

Arab Petroleum Investments Corporation forecasts the Middle East and North Africa region's electricity sector will need $260 billion (bn) in investments over the next five years to meet a rising demand of 6.4 per cent per year. The investment is split between $152bn for power generation (to add around 110 GW of new capacity) and $108bn for transmission and distribution.

From his side OME (2016) estimated that the existing growth trend will drive investments for over €715bn by 2030 to ensure the additional generation required while (Mediterranean Transmission System Operators, Med-TSO 2016) a further 3,000 MW of North-South Interconnections in the Mediterranean basin will be required necessitating an investment in the order of €20bn by 2020.

The situation in the Mediterranean area has been further examined (July 2016) by OME, ADEME and MEDREG in “The Mediterranean Energy transition 2040 scenario”. It is based on a “Conservative (business as usual) scenario” and on an “Energy transition scenario” with the implementation of those measures that are currently the most technically, economically, and institutionally mature for large-scale rollout of energy efficiency and renewable energies. This Scenario assumes no major technology breakthrough, but the deployment of existing technologies and sound energy efficiency policies and measures across all Mediterranean countries. In particular, power generation in Mediterranean countries would increase in 2040 by 77% in the conservative context but only by 22% (or 240 GW) in the Transition Scenario, thus avoiding an additional 200 GW of fossil-fuel based production infrastructure, highlighting the benefits energy efficiency can bring to countries. The Transition scenario assumes the share of renewable energy would increase from the present 11% to 27% of the energy mix in the region and non-hydro renewable energy sources (RES) would expand to provide 66% of total installed capacity in the South by 2040, reaching 179 GW (59% from solar photovoltaic (PV)). Even though the Transition Scenario appears based on efficiencies and renewable, it is still characterized by a huge need of investments both in generation and transmission and distribution assets.

In such a context, looking for an efficient and coordinated development at a regional level clearly makes sense. Developing cross-border electricity trade should be seen as a supplement to generation capacity additions, avoiding costly redundancies. A coherent strategy for regional cooperation and stimulating intra-regional trade could provide important benefits. notably by promoting a more efficient utilization of existing capacity.

Looking at the benefits of increasing cooperation and trade, the region has a clear interest in strengthening the institutional cooperation and regulatory coherence, following, to some extent, initiatives taken in other parts of the world, where markets are substantially more "mature", however.

2.2. Sharing resources and interconnectors

Governments are putting energy security at the forefront of their agendas. In some countries, this has implied efforts to diversify the energy mix towards renewable energy, it has also driven countries to diversify the sources of their energy imports. This is mainly the case for countries that rely on gas imported via pipeline.

In principle, electricity trading should improve the region's energy security, especially in countries that suffer recurring power outages. Currently, most electricity exchanges on existing interconnections take place on an emergency basis to cover either unexpected outages or scheduled ones due to maintenance, but it seems that countries continue to focus on meeting their own demand through investing in their local power generation.

The integration of the Mediterranean Electricity Systems with the sharing of resources (power generation, technical requirements and know-how), could induce the reduction of costs and risks of investments in infrastructure with benefits for the final consumer and for a better feasibility of the investments. Improved regional electricity integration would in fact:

- Facilitate RES integration in Mediterranean Region in general and North-South RES exchange and encourage cost-effective RES exchanges.
- Increase energy efficiency as a result of electricity transmission network integration.
- Increase energy security and reliability;
- Generate economies of scale in investments with a better allocation of costs and risks.

Three "ingredients" (RES, sharing and interconnectors) appear to be instrumental for supporting significant infrastructural, economic and social developments in both Mediterranean shores and this is even more relevant for the developing Southern shore countries. The sharing of ancillary services is essential to facilitate RES development, while cross-border interconnections are necessary for achieving such sharing since interconnectors are intended for capacity and energy exchanges as well as for providing capacity reserve security support between facing TSO's.

Sharing services can be enhanced by market mechanisms, where they exist, making Balancing Supply Parties's (BSP) more effective. However, sharing services can be also achieved by specific TSO's agreements (protocols) even where there is no market. In this case, TSO's may assume the role of Balance Responsible Party and be instrumental in setting up Balance Service Providers organizations.

Flexibility is a prized characteristic in power systems with significant RES. How this flexibility is procured is strongly shaped by the regulatory context. Vertically integrated utilities typically can use contractual or policy mechanisms to extract flexibility from generators. In contrast, in partially or wholly restructured power markets, system operators use market tools with clear definitions of performance requirements to incentivize the provision of power system flexibility. Interconnected countries can pool flexible resource by coupling markets, if they exist, and

cooperating on reserve/balancing, pooling response, ramping capabilities and system services.

2.3. North-South Integration

The integration of the two shores of Mediterranean is a key issue for the stability and sustainable development of the Region and implies: (i) grid integration in the Mediterranean countries limiting the impact on climate change (increased energy efficiency as a result of electricity transmission network integration); (ii) continuation of the extension and integration of Mediterranean electricity systems, in line with the objectives of EU's Neighborhood policy on Energy and Climate Change, (iii) promotion of the progressive integration of Power Systems, (iv) enhancement of cross-border electricity exchanges as well as RES integration in the Mediterranean region through the coordination of both national development plans and rules to access the grids.

The possibility to combine and operate power systems that have complementarities in terms of load profiles and generation mix in a more integrated way is an added value with direct impact on increasing the energy efficiency as a result of transmission network integration and on reducing the cost and the environmental footprint of electricity. If this combination will be achieved, the beneficiaries will be the final customers/citizens and the environment. In this sense the role of the NRA and TSO will be crucial in order to improve the coordination of the systems, with the aim to contribute to the creation of an integrated electricity market.

The Northern and Southern shores of the Mediterranean basin present different characteristics that offer potentialities and complementarities. Countries of both banks can use these synergies as key to exchange energy and meet the targets of the energy transition in the next decades.

Adequate, integrated and efficient electricity infrastructures, through the shared use of energy, pave the way towards the achievement of development and security goals in the Mediterranean Region. Therefore, implementing the conditions for sharing resources can determine significant cost reductions and more limited risks of investments in infrastructures. In addition, the possibility to combine and operate in a more integrated way power systems that have complementarities of generation mix and load profiles is another benefit with direct impact on increasing energy efficiency.

So, given the complementarities of supply and demand (growth and profile), increasing exchanges even without using an integrated market would help to develop more technical coordination in terms of network operations and sharing ancillary services and information which are essential for the development of the electricity market at the sub regional and regional level.

3. Investment processes

3.1. Systems' maturity

The concept of maturity of electrical systems is an important point from the point of view of investment. Indeed, an electrical system can be characterized by several parameters including the number of connections related to the total population, the degree of development of the various uses of electricity, the reliability of the production and more generally the reserve margins and level of the security of supply.

System's maturity is a concept which can help appreciating the electricity chain as a whole. Power supply combines several complementary activities, including generation, transmission and distribution, it forms structures which are getting more and more complex with the development of renewables and distributed generation. In terms of investment, regulators usually focus on infrastructure and network operators monitoring. Networks can be seen as the corner stone of electricity systems, allowing the integration of new generation assets or new consumers. Networks, generation and demand have to be jointly addressed to help developing systems in a coherent way. Long term projections are therefore crucial, including a vision of the sequence to follow when designing the process steps towards a "mature" system. A brief review of the history of networks shows that the creation of electrical systems is a long process, part of a broader energy scheme since electricity production depends primarily on the availability of primary energy sources. With regard to demand, security of supply will be of greater or lesser importance depending on the uses of electricity. In other words, the more a system develops, the greater the use of electricity and the greater the importance of security of supply. One cannot therefore dissociate public service issues from consumer expectations.

Access to electricity is a factor of comfort and a driver for economic development. In this sense, providing access to electricity for the population is a central political objective. Then there is the security of supply issue, that is to say the question of the dimensioning of the infrastructures in order to reach a given level of reliability of the supplies. The standards adopted vary greatly from one country to another. They refer to cultural factors (sensitivity to system failure) and techno-economic factors: as infrastructures are dimensioned according to the permissible peak load capacity, it is a question of finding a satisfactory balance between costs and security level.

In fact, the expected levels of security change with the degree of development of the systems, in a logic that prioritizes access first and then promotes the strengthening of reliability. The question of competition may then arise, but it requires an environment such that the guaranteed level of security of supply is high and there are appropriate reserve margins such that arbitration between suppliers is possible. In other words, competition is possible on systems with a very high level of maturity.

The evolution of priorities can be summarized as follows:

1. Development of electrification;

2. Strengthening of security of supply;

3. Introduction of competition.

In phases 1 and 2, when investment needs are massive, it becomes crucial to mobilize

adequate resources and secure the financing of projects. In this situation, competition may not be the most appropriate regime since its main scope is to promote an efficient use of existing assets. On the contrary, efficient investment coordination requires a proper level of integrated and centralized planning to ensure consistency of choices in the development of generation and networks.

3.2. Infrastructures: from needs identification to realization

Project development is a several year process which starts by the identification of a need. This need can come from the inclusion of new generation, internal problems of congestion, demand growth or significant changes in the network's topology. Cross-border investments are particularly challenging because they require a very good international cooperation at all steps, from the design phase to the commissioning. Among the consecutive steps of an investment process, permitting and financial closure are important aspects which impact both the timing and the technical choices. As the lead time between the identification of a need and the commissioning phase is usually very long and that kind of assets have a very long life duration, the analysis of the likely evolution of market trends is crucial. Investment plans are supposed to gather all the relevant information to identify the additional needs for infrastructures, select projects as well as determine their value.

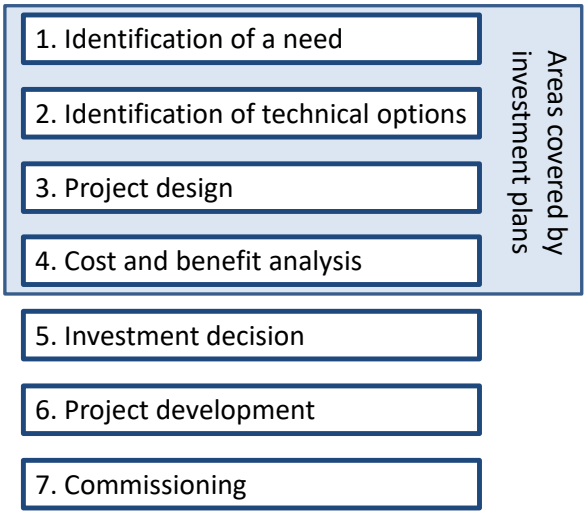

Table 1. Infrastructure investment process - Source: MEDREG (2016)

In the European Union, infrastructure development mainly consists in reducing congestions and developing cross-border transmission capacity, with the objective of achieving the single electricity market and allowing the large scale integration of RES. In SEMCs, the context is generally significantly different: electricity demand grows at a high pace and interconnections' role remains very limited. In addition, electricity systems' management is often centralized, with a single company operating national systems from production to distribution. This organization looks similar to the one that used to exist in Europe in the past, whose rationale derived from the strong increase of demand and the resulting priority to large investments. **It is therefore crucial in non EU-Mediterranean countries, to elaborate a coherent analysis of expected energy developments to properly assess where investment efforts should be developed in priority**.

3.3. The question of investment planning

In its report of March 2016, MEDREG had analyzed the approaches used by regulators for assessing investment projects. The main focus was on the experience in the EU which has developed concepts of network development plans at national, regional and community levels. In a competitive market context, where networks and supply are unbundled, it has been necessary to elaborate a strategy to gather all the relevant information regarding the dynamics of energy systems and see how system's needs are translated into infrastructure needs. The European network of Transmission System Operators for Electricity (ENTSO-E) and the European Network of Transmission System Operators for Gas (ENTSO-G) have the duty to publish every two years a Ten Year Network Development Plan (TYNDP) where the main focus is on interconnections. The TYNDPs are built upon the translation of a certain representation of EU power and gas markets into a model which analyses long term scenarios, investigating possible developments regarding the energy mix, demand, location of new needs and testing the robustness of systems in terms of security of supply.

In terms of regulation, the costs of transmission and distribution grids have to be covered through tariffs on the use of the infrastructures, these tariffs being either directly determined by regulators or determined by operators under the scrutiny of regulators. As a result, new network assets open a right for cost recovery and remuneration of invested capital. The role of regulators is thus to control that costs are transparent and efficient, i.e. they correspond to costs of an efficient operator (investment is needed, costs are reasonable and project is delivered in due time). Regulators have to ensure also that these new assets are actually needed. They have to verify that TSOs' investment plans are actually serving the general interest. Assessing investment needs in cross-border interconnections is more challenging than at a national level, because it requires a high level of coordination between interested countries. In Europe, countries share a common view in terms of regulatory orientation and market design. Outside the EU, however, beyond the influence of the European model, there is no clear picture of a shared vision about the role of interconnections and of a market design.

Med-TSO is developing some methodologies for building a TYNDP at a Mediterranean level which is largely influenced by the ENTSO-E's approach. These efforts have already resulted in a map of interconnection projects, long term scenarios and concepts of economic evaluation of projects. The key issue is to understand the principles to be used for assessing the value of projects and how to quantify the various benefits provided by new interconnectors. In the EU, the market design facilitates such an evaluation as wholesale prices determined on power exchanges drive electricity flows in the system. Wholesale prices can be assumed to reflect the marginal generation cost; thus models can assess price effects of interconnections via their influence on the merit order. There is no comparable organization in many of the non-EU countries and security of supply aspects (including ancillary services) are generally a prominent objective of new interconnectors. In the EU, efforts are carried out to build methodologies allowing to monetize benefits other than those related to competition development. Concepts of needs assessment have been discussed especially when selecting Projects of Common Interest (PCI) but this question remains highly debated.

4. Dominant issues in Southern and Eastern Mediterranean Countries[1]

4.1. Diversity of situations in the Mediterranean region

Electricity systems in the Mediterranean region are very different. On the European side, systems are robust, presenting high levels of consumption and generation as well as properly developed international trade. In the south, the consumption per capita is low compared to the EU but is progressing rapidly. At the same time, these countries have comparable issues regarding access to financing, insufficient development of infrastructures and geographical characteristics that hindered high levels of interconnections. This situation makes security of supply a dominant concern and calls for regular upgrades of the electricity system, regarding both generation and networks, making investment a key issue in most of the countries. However, investments in new lines (within a country and at cross-border level), are strongly impacted by economic and financial difficulties, including especially national currency devaluation issues.

Countries	Total generation (TWh)	Load [TWh]	Pump storage consumption [TWh]	Exchange balance (Export - Import) [TWh]	Exchange VS Load [%]
Albania	4,5	7,4	0,0	2,9	39,0
Algeria	64,1	63,9	0,0	0,2	0,0
Cyprus	4,9	4,9	0,0	0,0	0,0
Egypt	190,0	190,0	0,0	0,0	0,0
France	531,3	482,9	6,8	41,6	9,0
Greece	42,4	51,2	0,0	-8,8	-17,0
Italy	279,7	314,3	2,5	-37,1	-12,0
Jordan	18,3	18,6	0,0	-0,3	-2,0
Libya	36,4	36,4	0,0	0,0	0,0
Montenegro	2,9	3,2	0,0	-0,3	-9,0
Morocco	30,8	35,4	0,6	-5,2	-15,0
Portugal	55,9	49,3	1,5	5,1	10,0
Slovenia	15,2	13,8	0,4	1,0	7,0
Spain	248,4	250,0	4,8	-6,4	-3,0
Tunisia	18,2	18,1	0,0	0,1	1,0
Turkey	274,4	279,3	0,0	-4,9	-2,0

Table 2. National electricity systems in the Mediterranean region (2016). Source: Med-TSO & Enerdata

In the EU, national electricity markets are well integrated, highlighting the merit of interconnections in terms of complementarity between member states. France, Portugal and Slovenia are big exporters while Greece, Italy and Spain import large amounts of power. Exploring the complementarities of the national power systems is particularly relevant in Southern Mediterranean countries to promote a better use of existing interconnections and identify where new interconnections would be relevant. Even if some regional initiatives have developed in the Maghreb and the Mashreq, figures show that international electricity trade is

[1] The so-called Southern and Eastern Mediterranean Countries (SEMCs) include: Algeria, Egypt, Libya, Morocco, Tunisia, Israel, Jordan, Lebanon and Palestine.

very limited in most cases in SEMCs, except for those connected with Europe, like Morocco, which imports about 15% of its load from Spain.

Among the challenges faced by Southern countries, it is important to differentiate situations according to the energy mix and, in particular, the access to domestic primary energy sources. Thermal plants powered by fossil energy sources (gas and coal mainly) represent the bulk of generation, while RES play a significant role only in a few non-EU countries (Egypt, Morocco and Turkey). Gas is an important driver for power generation development, leading countries to often address electricity and gas systems development in a join manner.

RES can undoubtedly play a key role, not only for environmental purposes, but also as a way of reducing the dependence on imported energy. However, ambitious RES development necessitates well designed institutional systems to provide electricity networks with enough stability and, more generally, appropriate tools for managing supply and demand. The example of the EU highlights that RES integration has been possible on a large scale thanks to the size of power systems when support schemes to RES were implemented. RES came often as a complement to other generation assets or substituted to thermal power generation, allowing for reducing CO_2 emissions. The drawback has been (and is still) to address the effect of RES development on the design of electricity markets and the fact that priority of access given to RES reduced the size of “classical” markets. In other words, a significant part of the load has been pre-empted by RES generation, often making it more difficult for controllable power generation to cover its costs.

With the Clean Energy Package, the EU is now adapting its paradigm to higher ambitions in terms of energy transition. The principle of cross-border solidarity and complementarity is a central driver and reflections are developing regarding the co-optimization of electricity and gas systems. This ambition could be spread over the Mediterranean region: it is worth analyzing complementarities between Mediterranean countries to help developing RES where most appropriate and strengthening security of supply through interconnections. The EU has a role to play by allowing Southern countries to benefit from its energy systems stability. Beyond the perspective of exporting electricity, getting connected with the highly reliable European electricity system is often a key motivation for creating new North-South interconnections.

4.2. Focus on selected Southern and Eastern Mediterranean Countries

As already mentioned, energy developments in the SEMCs are characterized by some comparable trends such as the large increase of electricity demand, generally experienced due to the rapid population and economy growth. The traditional fossil fuels remain the main source for supplying the domestic consumption and additional generating capacity is needed to meet the increasing demand. Electricity interconnections’ utilization remains low despite their potential added value in some cases, as a substitute to power generation and providers of stability to the system, presuming conditions are favorable.

While in the EU the market design and the level of development of electricity markets make it possible to run market simulation models evaluating projects according to wholesale prices (assuming price equals marginal generation costs), in the wider Mediterranean region such an approach is much more difficult to be implemented. Assessing the social value of interconnection projects is hindered by the lack of harmonization of system operation and

conditions are less favorable than in Europe to efficient cross-border integration. The topology of existing systems in SEMCs is very different and networks are less meshed because they follow the sea shore where the population is concentrated. In addition, the lack of reserve margins on the generation side and the sustained increase of consumption in a context of non-competitive organization of markets make even harder the development of a harmonized approach to network development. The assessment of national situations carried out by MEDREG members provide interesting illustrations of the situation depicted above.

In **Algeria**, the annual growth of the electricity demand has been 8% on average from 2011 to 2016, which translates into sustained investment needs. The demand is concentrated in the Northern part of the country and Algeria has 28 isolated networks accounting for about 1 TWh of consumption. Developing an efficient electricity system in a context of strong increase of demand peaks is very challenging. Even though Maghreb countries are among of the most interconnected countries of the Southern shore of the Mediterranean, the use of existing interconnections is very low. Interconnections are indeed mainly used for the purpose of security of supply, but neither for commercial transactions nor the RES integration. Getting more benefits from the existing infrastructure is thus a key question while developing a market and simulating the system with intermittent generation appears very difficult. The problem of technical and non-technical losses is also crucial and should be addressed by a specific framework.

In **Egypt**, confronted to several power shortages over the past years, the government took actions to invest rapidly in generation plants. The massive investments in generation will lead to an increase in installed capacity from 35,2 GW in 2015 to 107 GW by 2035 (basic scenario). However, this has led to overcapacity and increased debt of the public sector aggravated by the devaluation of the Egyptian Pound. To pay back the investments, tariffs increased significantly which put consumers in difficulty to pay their bills. Tariffs jumped from 2,2 cts/kWh to 4 cts/kWh. In return, there has been a reduction of consumption which negatively affected the return on investments. The social impact of the tariff increase was underestimated and the subsidy regime set up to help customers overcome these difficulties increased public debt. Subsidies increased from 27bn Egyptian Pounds in 2014 to 35bn Egyptian Pounds in 2016. Financial problems are very concerning due to their impact on sovereign guarantees and the rating of the Egyptian Central Bank. As a consequence, Egypt tries to reduce investments from foreign entities and interconnections could help explore the complementarities with the adjacent power systems: Egypt should be able to export more electricity in the coming years. On the distribution level, fraud and power losses are major concerns, they represent about 20% of the energy distributed. The roll out of pre-paid meters has the objective to ensure that generators are paid (in advance) for the electricity produced. Furthermore, a roll out of 250.000 smart meters in Cairo by 2035 is expected to reduce fraud and non-technical losses (losses are about 20%).

In **Jordan**, in 2016, 95% of the consumed energy was imported, demand increased by 6.4% (3,8% in the electricity sector). The rate of electrification is 99% and the electricity mix has evolved towards a decrease of fuel oil, replaced by gas. The evolutions on mix and prices allowed for a decrease of 24% of generation costs in 2016. Main challenges consist in dealing with reduced energy imports (gas and electricity) in a context of sustained increase of needs, and developing RES which are expected to represent 20% of power generation by 2020. The electricity system organization articulates a single buyer and independent producers, some being partially private. All the value chain is regulated, with a big problem of losses at the distribution level. In particular, the development of RES tends to increase technical losses.

Jordan's policy in the energy field was shaped through the adoption of the updated National Energy Strategy (NES) for the period of 2007 until 2020, to develop a reliable energy supply by increasing the share of local energy resources in the energy mix; to reduce dependency on imported oil; to diversify energy resources and finally to enhance environmental protection. Jordan's government has underlined its commitment to reach these ambitious targets and issued the Renewable Energy and Energy Efficiency Law in 2012. As a result of the introduction of this bottom-up approach, 14 Public and Private Partnership (PPP) projects were developed between 2012 and 2015, amounting to an investment commitment of $2.4bn.

Positive results have emerged from Jordan following an attempt to promote widespread diffusion and social acceptance of RES, while promoting domestic and residential installations at the same time. Decentralized energy projects are also promoted as part of government's localism and rural development agenda, meeting local needs and involving local stakeholders.

In **Lebanon**, the lack of installed generation capacity, high subsidies, and the high losses are the main causes of the current situation of the electricity sector. Dispatchable installed capacity is 2.3 GW compared with a peak demand of 3 GW (June 2017). Offshore generators are connected to the grid but their contracts are ending in 2021. Historically, there has been an interconnection agreement with Syria, Jordan and Egypt. However, political problems lead to a reduction in these electricity imports, specifically from Syria where they collapsed from 529 GWh per year in 2013 to 68 GWh per year in 2016. The main lesson is that interconnections are not a panacea and one should pay due attention to the rationale behind developing interconnections. The Arab League (group n°7) could be contacted to discuss interconnections.

As per the Second National Energy Efficiency Action Plan for the Republic of Lebanon (NEEAP 2016-2020), the Council of Ministers of Lebanon approved the Policy Paper for the Electricity Sector on 21 June 2010. The Policy Paper includes ten initiatives, under the following macro-areas:

- Infrastructure
  - Generation;
  - Transmission;
  - Distribution;
- Supply and demand
  - Fuel sourcing;
  - Renewable energy;
  - Demand side management/ energy efficiency;
  - Tariffs);
- Legal framework
  - Norms and standards;
  - Corporatization of Electricité du Liban (EDL);
  - Legal status.

In **Morocco**, the process of energy sector liberalization (mainly by opening electricity generation to private investors in the framework of Independent Power Producers (IPP) agreements) in Morocco dates back to 1995, when a first liberalization strategy was introduced. Successively the government of Morocco considered a more far-reaching energy strategy, to respond to the challenges that the sector represents for the country and a variety of institutional stakeholders have been designed to deal with renewables promotion. The

existence of this institutional environment demonstrates the high level of interest that Morocco has in renewable energy in particular, and in sustainable development in general. As a result, between 2012 and 2015 six PPP projects were developed, attracting nearly $7.7bn in investments.

Morocco has indeed promoted a centralized investment strategy, to attract a few flagship projects, in combination with a policy to develop, at the same time, green growth and an industrial sector specialized in components related to RES generation. The stabilization of the remuneration, the most common regulatory tool for RES technologies (in particular a RES quota and targets), is essential to provide the necessary guarantees, and represents a positive step toward attracting PPI investments in the renewable sector. But such measures alone will not suffice. Those instruments need to be accompanied by long-term strategy capable of generating an environment conducive to investment.

In **Turkey**, the Turkish power network was successfully synchronized (April, 2015) with the European grid, thus favoring the potential energy exchange of the Eastern Mediterranean electricity network with the European grid. Despite the efforts undertaken, the exchange of power in this project is still low. Nearly all the initiatives of cross-border energy interconnections are limited to emergency operations instead of economic energy exchange.

Turkey has interconnections with most of its neighboring countries, namely Armenia, Azerbaijan, Bulgaria, Georgia, Greece, Iraq, Iran and Syria. Turkey did not complete the synchronous connection with neighboring systems, however it is actively pursuing the synchronization of its network with the European network.

The total installed generation capacity of Turkey has reached 85,1 GW, and the total generating capacity has been 295,5 TWh by the end of year 2017. The electricity production and the installed electricity capacity are further explained on the Table 3 below. These values are expected to reach 99,9 GW and 331,8 TWh at the end of 2018, including the proposed supplemental capacity investments.

The Turkish Electricity Authority (TEK), established in 1970, was a statutory monopoly until 1984. The participation of private sector starts in 1984. In 1993, TEK was split into two state-owned companies including Turkish Electricity Generation-Transmission (TEAŞ) and Turkish Electricity Distribution Company (TEDAŞ). Finally, TEAŞ was unbundled into three different companies responsible for different sub-sectors including EÜAŞ (generation), TEİAŞ (transmission) and TETAŞ (wholesale) with Electricity Market Law issued in 2001. The unbundling of ownership will follow when the government proceeds with its privatization plan of other state-owned electricity sector companies, except for TEİAŞ. The law has also set the stage for a new organization, the Energy Market Regulation Agency (EMRA), which currently oversees the power and natural gas markets including setting tariffs, issuing licenses, and assuring competition.[2]

[2] C. Sahin and M. Shahidehpour, "Interdependence of NG and electricity infrastructures in Turkey," 2009 IEEE Power & Energy Society General Meeting, Calgary, AB, 2009, pp. 1-6.

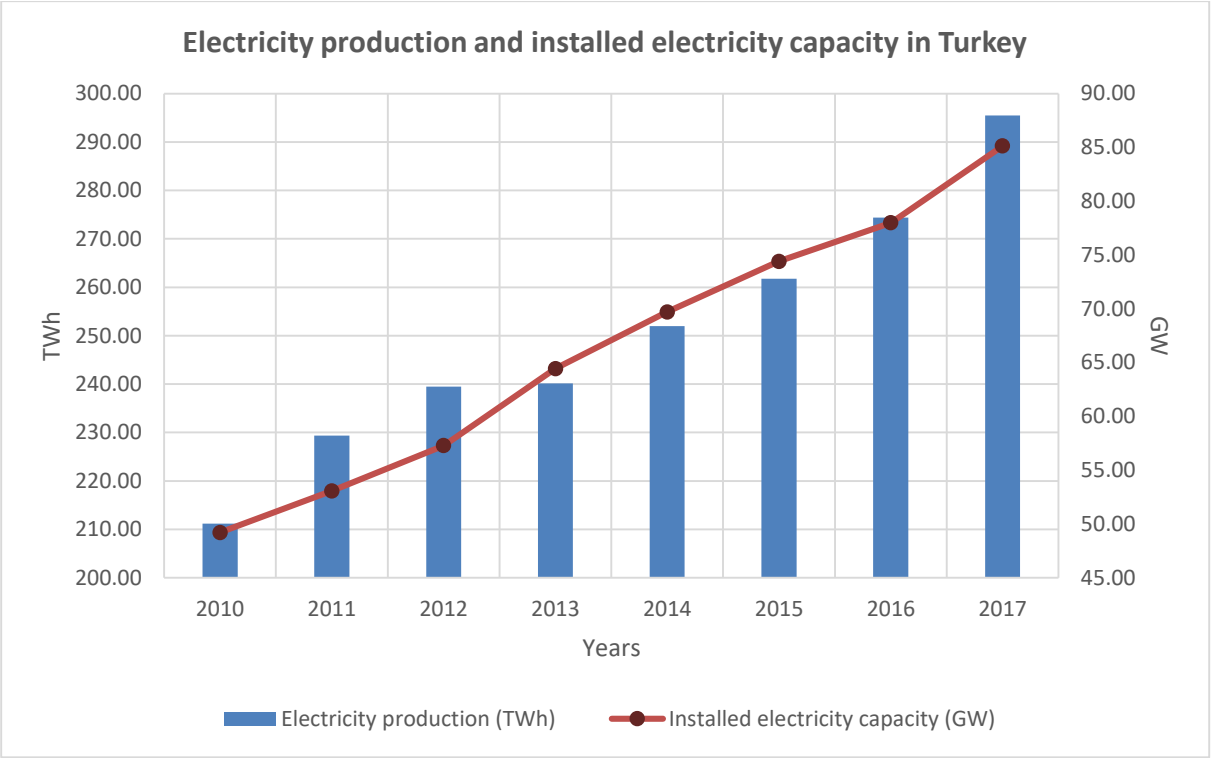

Table 3. Electricity production (TWh) and installed electricity capacity (GW) in Turkey[3]

In summary, SEMCs except Turkey experience problems related to demand increase, quality of power supply at different levels of the value chain, problems of non-technical losses and of revenue collection for operators. The underlying reason for Turkey's exception is that the country has a fairly advanced regulatory system. For the other countries, financial aspects are also crucial, posing the question of vulnerability to economic crises and attraction of investors. Regarding interconnections, the rate of utilization of the existing capacity is low for almost all cross border interconnections between Southern countries. The fact that intra-regional interconnections are not properly exploited shows that interconnection investment in the Southern shore is mainly driven by considerations related to security of supply rather than to the development of a regional market. Beyond technical aspects, this situation also testifies to the persistence of regulatory gaps among Southern Mediterranean countries.

[3] Data retrieved from (13 September 2018): https://globaldata.enerdata.net/database/

5. Toward interconnected regions

5.1. Issues relating to interconnections development

Improving the cross-border integration of electrical systems is one way of reinforcing the security of supply and the overall efficiency of the electricity chain by relying on the complementarities of networks and means of production. However, it should be noted that certain conditions may be necessary for the interconnections to operate effectively, i.e. ensure a sufficient level of reliability of the interconnected systems. For instance, it is generally easier to get benefits from interconnections when linking two robust systems together or when connecting a small system to a large electricity market, thus reinforcing its stability and security of supply.

In the Mediterranean, the development of interconnections is an important objective, the Mediterranean loop is already a priority but we must go further to reach a sufficient level of operational reliability. For that, a regional approach is appropriate, which makes it possible to link together countries with strong synergies at the geographical and energy levels.

Focusing on regional integration, it is useful to analyze existing and future electricity interconnection projects that could be important for MEDREG countries on national basis, taking into account the different infrastructure developments between sub regional initiatives. It is important to highlight that interconnection projects which involve one or more MEDREG countries and that reach outside of the Mediterranean region are listed, but not investigated, in the analysis.

The geography of the southern shore of the Mediterranean is characterized by a high concentration of cities along the coast, with areas of low population density. Such conformation resulted from two main sub-regional initiatives that historically tried to develop electricity interconnection in the SEMCs, one in the Maghreb sub-region and one in Mashreq sub-region.

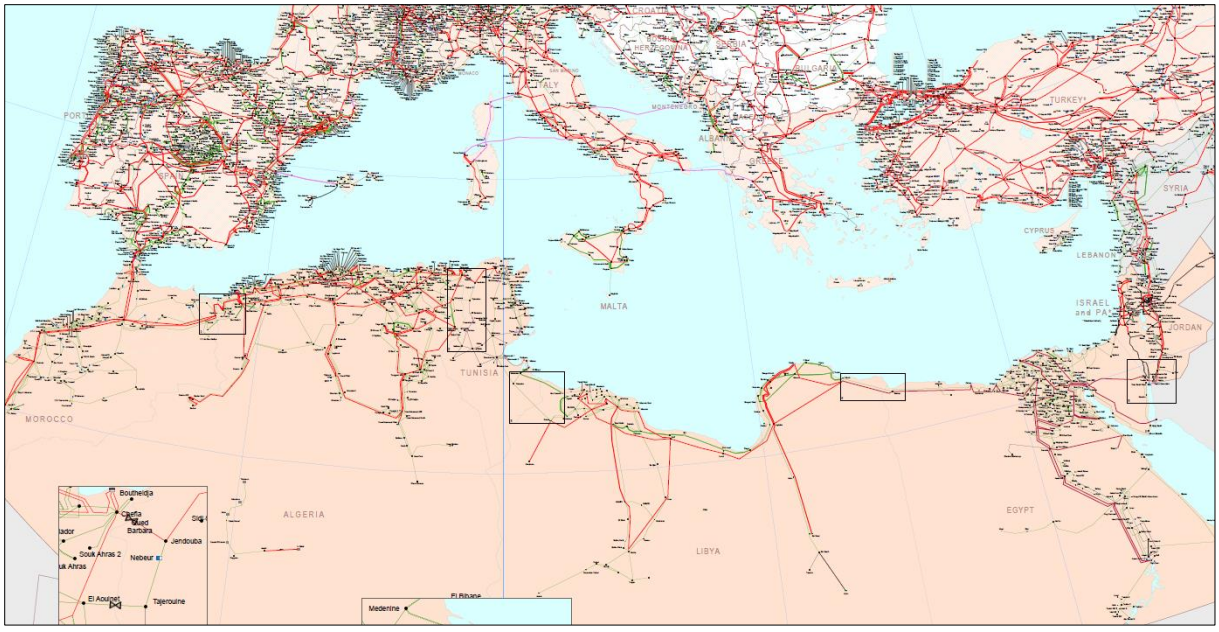

Figure 1. Mediterranean Electricity Interconnections (Source: Med-TSO)

In terms of investment, cross border interconnections development is a long and demanding

process requiring at the same time to properly assess the needs and location on technical aspects, and ensure a proper level of coordination. That means that interconnected countries should share, to some extent, a common vision of the electricity developments and be confident in the reliability of the neighboring system. Med-TSO has in particular developed a methodology for the assessment of interconnection needs and value, assuming a certain consensus on methodologies. It seems however necessary to elaborate on the concept of interconnections' value in a specifically Mediterranean perspective.

5.1.1. The Maghreb sub-region

The interconnection of the Maghreb block (Algeria, Morocco and Tunisia) started in the 1950s and subsequently evolved into multiple high-voltage transmission interconnections between the three countries. Moreover, Morocco was connected to Spain in the late 1990s, thus facilitating the synchronization of Maghreb countries with the European high-voltage transmission network. The Algiers Declaration in 2010 stipulates that the three countries will aim to bring their laws and frameworks in line with each other, to create a competitive electricity market and potentially integrate with the EU. The plan includes transparent network access for cross-border electricity trading. However, progress has been slow and intra-regional trade is limited. Currently, the regional energy interconnections are well developed but for the time being the electricity exchanges are limited. The exchange of power within the Maghreb region has been limited to mutual aid and annual trade contracts with the European Union.

The current existing and future cross-border electricity interconnections of the Maghreb block are analyzed more in detail on a country per country basis.

- **Algeria**

Electricity cross-border interconnections in Algeria are already developed in a South-South route, hence connecting Algeria with Morocco on its west border and with Tunisia on its north-eastern border. Existing electricity interconnections are listed in Table 3.

From	To	Voltage (kV)	Line nominal capacity (MW)	Max transfer capacity (MW)	Energy exchanged (GWh yearly)	Load factor (%)	Starting year of operation
Algeria	Morocco	220	200	400	504	19,0	1988
		220	200				1992
		400	1.000				2009
		400	1.000				2009
	Tunisia	90	50	150	260	11,0	1984
		90	50				1995
		225	200				1980
		150	50				1953
		400	1.000				2014

Table 4. Existing Electricity Interconnection Projects in Algeria

Even though the Algerian interconnections with the other Maghreb countries[4] are well developed, their use for cross-border electricity trade is mainly for the purpose of security of supply, but neither for commercial transactions nor for the RES integration.

Considering that the Algerian grid is already synchronized with the European high voltage

[4] Maghreb countries are considered Morocco, Algeria and Tunisia

transmission network, it could be possible to interconnect directly its network with the European grid, thus facilitating electricity exchanges on a north-south route. Two new potential interconnectors, connecting Algeria to Spain and Italy, explore such possibility:

From	To	Voltage (kV)	Line nominal capacity (MW)	Project type - status	Estimated cost (MEUR)	Expected year of operation
Algeria	Spain	400	1.000	--		--
	Italy	400	1.500 2.000 1.000	New - Prefeasibility	848	10 years from the beginning of construction
	Tunisia	400	700	--	155	--

Table 5. Future electricity interconnection projects in Algeria (Med-TSO)

The first project consists in a new interconnection of 240 km to Spain to be realized with a high-voltage direct current (HVDC) submarine two circuits (bipolar converter) cable that should cross the Mediterranean Sea at a maximum depth of 2.000m undersea[5].

The second project should connect Algeria and Italy (via Sardinia) through a submarine cable with a carrying capacity of 1.000 MW in HVDC[6] technology. The overall cost is expected to be around 848 MEUR[7].

One another future projects consider to link Algeria with Tunisia to reinforce the electric grid on the South-South route. However, the key issue of interconnections among Maghreb countries, at least on a short or mid-term basis is merely increasing the benefits and the exploitation of the existing infrastructures rather than building new cross-border links. Finally, there are no existing infrastructures between Algeria and Libya.

- **Morocco**

Morocco is interconnected at cross-border level with Spain and Algeria. As the other Maghreb countries, Moroccan grid evolved over the years and is now synchronized with the European high-voltage transmission network.

From	To	Voltage (kV)	Line nominal capacity (MW)	Max transfer capacity (MW)	Energy exchanged (GWh yearly)	Load factor (%)	Year of operation
Morocco	Algeria	220	200	400	504	17,0	1988
		220	200				1992
		400	1.000				2009
		400	1.000				2009
	Spain	400	600	700	15	0,2	1997
		400	600	--	--	--	2006

Table 6. Existing Electricity Interconnection Projects in Morocco

On its eastern side, Morocco is connected to Algeria with two lines from 1988; a third line was then created in 2010. The level of energy they exchanged is very low as the load factor of

[5] Med-TSO. Consolidating a secure and sustainable electricity infrastructure in the Mediterranean region. The Mediterranean project, p. 25, 2018.
[6] High-voltage Mediterranean direct current
[7] Med-TSO. Consolidating a secure and sustainable electricity infrastructure in the Mediterranean region. The project, p. 26, 2018.

energy trade is 17%. On its northern side, the Moroccan-Spanish interconnection is the only cross-border line that connect the North Africa with the EU and was created in 1997. It consists of a single 400 kV circuit in alternating current through a submarine cable line. In July 2006, a second submarine 400 kV line became operational. Morocco amended its energy legislation to be able to purchase electricity from Spain on the liberalized market. The interconnection Spain-Morocco is proving to be very useful: in 2017, 5.75 TWh of imported net energy covered over 15% of total load demand in Morocco. Currently, the regional energy interconnections are well developed but for the time being the electricity exchanges are limited by the mutual aid and annual trade contracts with the European Union. International financing of these projects does not appear to be extremely difficult and World Bank and international financial institutions (IFIs) appear to be ready to examine sound long term projects and financing them. However, better utilization of the present interconnection will still require some hardware investments, mainly on new lines with the related reinforcements within the connecting Countries.

From	To	Voltage (kV)	Line nominal capacity (MW)	Project type / status	Estimated cost (MEUR)	Expected year of operation
Morocco	Algeria	400	1.200	-- / --	--	--
	Portugal	400	1.000	-- / --	717	--
	Spain	400	1.000	-- / --	382	2018

Table 7. Future electricity interconnection projects in Morocco

The first one considers the reinforcement of transmission line with Algeria. The second consists in a new interconnection between Portugal and Morocco in HVDC technology with a capacity of 1000 MW and a total length of 265 km. In June 2016, the Moroccan Minister of Energy and the Portuguese Minister of Economy signed an agreement to conduct a feasibility study for the electricity interconnection project[8]. The third one involves a new link between Morocco and Spain to strengthen the already existing energy exchange between the two countries.

- **Tunisia**

As Morocco and Algeria, the Tunisian network is synchronized with the European high-voltage transmission network, thus facilitating potential cross-border lines on the North-South route. However, the electricity network of Tunisia is currently connected only with its North African neighbors, Algeria and Libya.

From	To	Voltage (kV)	Line nominal capacity (MW)	Max transfer capacity (MW)	Energy exchanged (GWh yearly)	Load factor (%)	Year of operation
Tunisia	Algeria	90	50	150	260	9,0	1984
		90	50				1995
		220	200				1980
		150	50				1953
		400	1.000				2014
	Libya	225	200	--	--	--	2003

Table 8. Existing Electricity Interconnection Projects in Tunisia

There are five transmission lines that connect Tunisia to Algeria, while there is just one

[8] International Energy Agency, Large-Scale Electricity Interconnection. Technology and prospects for cross-regional networks, p. 12, 2016.

connecting Tunisia to Libya. So far, the rate of electricity exchanged on the Tunisian-Algerian interconnectors has been equal to 9%, a low level considered the potential of transmission lines. Unfortunately, no data are available on the electricity trade between Tunisia and Libya. Even if transmission lines are not exploited, further electricity interconnections are under evaluation in the South-South direction as well as Europe. Indeed, Tunisia is exploring commercial options with Italy as well as a reinforcement of its connection to Libya:

From	To	Voltage (kV)	Line nominal capacity (MW)	Project type / status	Estimated cost (MEUR)	Expected year of operation
Tunisia	Libya	--	500	-- / --	507	--
	Italy	400	600/1.200	New / Prefeasibility	616	--

Table 9. Future electricity interconnection projects in Tunisia

The first project involves a new interconnection between Tunisia and Libya that will prosecute to Egypt as already explained in the Libyan electricity section.

The second planned interconnection is the so-called ELMED (ELectricité MEDiterranéenne) project and it considers the possibility to connect Tunisia with Italy through two different interconnectors, thus contributing to the increase of energy exchange from the EU to North Africa. The first line between Tunisia and Sicily will have a capacity of 600 MW and will be realized through an HVDC submarine cable; the second cable will then reinforce the first one, adding further 600 MW of interconnection capacity.

5.1.2. The Mashreq sub-region

In the Mashreq, the eight-country block project (EIJLLPST)[9] was initiated in 1998 by Egypt, Iraq, Jordan, Syria and Turkey to upgrade their electricity systems to a regional standard. Lebanon, Libya, and Palestine later joined the group. In 1992, the original five countries signed a general trading agreement for mutual assistance through the exchange of surplus power. A general energy interconnection agreement followed in 1996 outlining the terms and conditions for the use of the energy interconnection. The National Electric power company of Jordan (NEPCO) has been nominated by the other parties as the coordinating body of the EIJLLPST and two committees on operation and on planning were established in the EIJLLPST interconnection program.

The program would yield great economical and technical benefits for interconnected countries, reducing investments in constructing new power stations, exchanging energy among the networks in normal and emergency cases, therefore improving their economics, exchanging knowledge and experience in power system planning and operation.

A more detailed overview of the current existing and future cross-border electricity interconnections of the eight-country block project is analyzed on a country per country basis.

- **Egypt**

Existing electricity cross-border infrastructures connect Egypt with Libya on its west border and with Jordan and Palestine on its east border. Existing Egyptian cross-border interconnections are part of the so-called “Eight Country Interconnection Project”.

[9] The eight-country block interconnection project (Egypt, Iraq, Jordan, Lebanon, Libya, Palestine, Syria, and Turkey).

From	To	Voltage (kV)	Line capacity nominal (MW)	Max transfer capacity (MW)	Energy exchanged GWh yearly	Load factor (%)	Financing method	Starting year of operation
Egypt	Libya	220	250	180	70	4,0	Public Finance	1998
	Jordan	220	550	450	363	9,0		1998
	Palestine	220	21	200	190	90,0		2008

Table 10. Existing Electricity Interconnection Projects in Egypt

Table 9 shows that interconnectors from Egypt to Libya and Jordan are not fully exploited considering that the load factor is equal to 4% and 9% respectively. Considering 2016, no electricity exchange took place through the Egyptian-Libyan electrical interconnection due to the current prevailing conditions in the region[10]. Moreover, the Egyptian-Jordanian Electrical Interconnection showed a decline in electricity trade as only 333.8 GWh were exported from the Egyptian network to the Jordanian, less than the average of the previous years[11]. Electricity trade is relevant only in the interconnection with Palestine where the load factor reached 90%. Considering the continuously increase in electricity demand in Egypt, several infrastructure projects are under study for the future:

From	To	Voltage (kV)	Line nominal capacity (MW)	Project type / status	Estimated cost (MEUR)	Expected year of operation
Egypt	Libya	500/400	1.200	Upgrade / feasibility phase	--	--
	Jordan	--	1.200	Upgrade / --	198	--
	Palestine	220	150	New / feasibility phase	--	--
	Saudi Arabia	(DC) 500	3.000	New / permitting phase	--	2021
	Sudan	(DC) 600	2.000	New / feasibility phase	--	2025
	Turkey	--	3.000	New / --	2.908	--

Table 11. Future electricity interconnection projects in Egypt

Among future projects listed in Table 4, two are the most relevant in the Mediterranean region, although they have a medium-long term perspective. The first is the upgrade of the Egypt-Jordan interconnection aiming at doubling the current capacity to 1100 MW. Increasing the interconnection capacity, will enhance the integration of RES generation and the stabilization of the grid, helping both countries to meet their load demand, thus positively postponing investments in both generation and transmission[12].

The second is the construction of a HVDC submarine cable between Turkey and Egypt which is planned as an alternative to the existing north-south corridor passing through Turkey, Syria, Jordan and Egypt. The objective is to develop a new corridor in the eastern Mediterranean region with an estimated capacity of about 3.000MW.

Despite the enlargement of its cross-border network, the exploitation of existing infrastructures remains a challenge considering that the actual power exchange between Egypt and its

[10] National Electric Power Corporation, Annual Report 2016, p. 29, 2016.
[11] National Electric Power Corporation, Annual Report 2016, p. 29, 2016.
[12] Med-TSO, consolidating a secure and sustainable electricity infrastructure in the Mediterranean region. The Mediterranean project, p. 29, 2018.

neighboring countries is still low.

- **Israel**

The electric system of Israel works autonomously as an island that must be self-sufficient and capable of fully meeting its own demand in all circumstances due to its geographical location and the complex relationship with its Arab neighboring countries. The Israel electrical grid is connected only with Palestine and it supplies the electricity demand in the West Bank and Gaza. Israel has always been dependent on imports to meet its energy needs. However, the significant and recent natural gas discoveries exceed projected Israeli demand and as such, Israel could become a net exporter of electricity generated from gas. Therefore, different projects are understudy to develop cross-border interconnections:

From	To	Voltage (kV)	Line nominal capacity (MW)	Project type / status	Estimated cost (MEUR)	Expected year of operation
Israel	Cyprus - Greece	600	2.000	New / prefeasibility and feasibility phase	5.952	--
	Turkey	--	2.000	New / --	1.738	--

Table 12. Future electricity interconnection projects in Israel

The main ongoing project is the so-called Eurasia Interconnector that should link the electricity networks of Israel, Cyprus and Greece. It will offer the creation of a reliable energy transfer from Israel to the European Union and it will unify electricity networks in two different continents, being the first electricity bridge between Europe and Asia. The electrical systems of Israel, Cyprus and Greece (via Crete) will be connected through sub-marine HVDC cables with a capacity of 2.000 MW.

The construction of the new link could represent a new important route for Israel gas exploitation. The EU promoted the project and included it in the TYNDP because it will end the energy isolation of Cyprus, the last member of the European Union which remains fully isolated without any electricity or gas interconnections. It will also create the electricity highway from Israel-Cyprus-Greece through which the European Union can securely be supplied with electricity produced by the gas reserves in Cyprus and Israel as well as from the available RES.

The second ongoing project consist of a submarine cable between Israel and Turkey with the objective of creating and facilitating trade possibilities between these two countries.

- **Jordan**

Existing electricity cross-border infrastructures connect Jordan with Egypt, Palestine and Syria. As Egypt, Jordan was among the five countries that started the so-called “Eight Country Interconnection Project”. Jordanian cross-border electricity interconnectors are part of such international network.

From	To	Voltage (kV)	Line nominal capacity (MW)	Max transfer capacity (MW)	Energy exchanged GWh yearly	Load factor (%)	Financing method	Year of operation
	Egypt	400	550	200	9	1,0		1998

Jordan	Palestine	33	--	20	41	90,0	Public Grant from Arab Fund[13]	2008
	Syria	400	1.000	350	69	2,0	--	1998

Table 13. Existing Electricity Interconnection Projects in Jordan

The load factor of the Jordanian-Egyptian interconnection is equivalent to 1% up to 2015. Moreover, such percentage decreased to 0 in 2016 and no energy was exported from Jordan to Egypt[14]. The reasons behind this low rate of use should be investigated, but positive developments can be expected according to the higher generation capacity in Egypt. On the contrary, the interconnection that links Jordan to Palestine usually provides a satisfactory level of electricity trade since the load factor reaches the 90%. The West Bank started importing 20 MW of power from the Jordanian grid through a 33 kV feeder to Jericho in 2008. However, a decline to 42,4 GWh was registered in 2016, reducing Jordanian exports compared to the level of the previous years. Additionally, since the Palestinian power demand is not integrated into the expansion plans of the Jordanian power sector, Palestine will only be able to rely on the residual Jordanian power surplus for its growing demand.

Even if the rate of energy exchanged is very low, other cross-border electricity infrastructures are planned for the future to enhance the cross-border cooperation between Jordan and its neighboring countries:

From	To	Voltage (kV)	Line nominal capacity (MW)	Project type / status	Estimated cost (MEUR)	Expected year of operation
Jordan	Egypt	400	1.200	Upgrade / Feasibility Phase	198	--
	Palestine	400	1.000	New / Feasibility Phase	--	
	Saudi Arabia	400	500	New / Feasibility Phase	--	

Table 14. Future electricity interconnection projects in Jordan

The first project is the upgrade of the Egypt-Jordan interconnection which aims at doubling the current capacity to 1.100 MW. Increasing the interconnection capacity will enhance the integration of RES generation and the stabilization of the grid, helping both countries to meet their load demand, with the positive effect of reducing excessive investments in conventional power generation.

The second project is a new interconnection with the West Bank which is currently under development and involves an increase of the voltage level with Palestine at 400 kV. Efforts for preparing the work plans and securing the required financing for the project from both sides are currently ongoing.

The third project is the Jordanian-Saudi electric connection. A Memorandum of Understanding was signed in December 2017 by the respective governments of the two countries to initiate the preparation of technical and economic feasibility studies for the reciprocal exchange of

[13] More information are available at http://www.arabfund.org
[14] National Electric Power Corporation, Annual Report 2016, p. 29, 2016.

electrical energy[15].

- **Lebanon**

The state-owned EDL accounts for over 90% of the Lebanese electricity sector. Due to its geographical position, the Lebanese electrical grid is connected only with Syria at a cross-border level. It consists of a single circuit 400 kV, a double circuit 220 kV and a 66 kV overhead tie-line.

From	To	Voltage (kV)	Line nominal capacity (MW)	Max transfer capacity (MW)	Energy exchanged (GWh yearly)	Load factor (%)	Financing method	Year of operation
Lebanon	Syria	66	35	35	--	--		--
Lebanon	Syria	220	170	130				
Lebanon	Syria	400	270	130				

Table 15. Existing Electricity Interconnection Projects in Lebanon

Since the start of the war in Syria in 2011, Lebanon's electrical grid became more like an energy island; electricity imports were disrupted and a substantial new demand for electricity estimated at 500 MW was provoked by the influx of more than 1.5 million Syrian refugees to Lebanon, which lead to a wider gap between electrical demand and supply. Moreover, no electrical energy exchange took place between Syria and Jordan during 2016 due to the current prevailing conditions in the region[16].

- **Libya**

The Libyan electricity grid is connected with Egypt on the east border and with Tunisia on the west border. Such interconnections are part of the so-called "Eight Country Interconnection Project" that Libya joined after the beginning of the initiative in 1992.

From	To	Voltage (kV)	Line nominal capacity (MW)	Max transfer capacity (MW)	Energy exchanged (GWh yearly)	Load factor (%)	Financing method	Year of operation
Libya	Egypt	200	120	180	152	10,0	Public grant from Arab Fund[17]	1998
	Tunisia	200	200	--	--	--		2008

Table 16. Existing Electricity Interconnection Projects in Libya

The Libyan-Egyptian interconnector usually provided an exchange of energy equal to a load factor of 10%. No electrical energy exchange took place between the two countries in 2016 due to the current Libyan political situation[18]. In any case, further improvements of cross-border interconnections on both eastern and western Libyan border are projected:

From	To	Voltage (kV)	Line nominal capacity (MW)	Project type / status	Estimated cost (MEUR)	Expected year of operation
Libya	Egypt	Libya 400 Egypt 500	500	New / feasibility phase	507	2017
	Tunisia	400	500	-- / feasibility phase		--

[15] National Electric Power Corporation, Annual Report 2016, p. 29, 2016.
[16] National Electric Power Corporation, Annual Report 2016, p. 29, 2016.
[17] More information is available at http://www.arabfund.org
[18] National Electric Power Corporation, Annual Report 2016, p. 29, 2016.

Table 17. Future electricity interconnection projects in Libya

The new line with a capacity of 1.000 MW should enhance the network connections of Tunisia, Libya and Egypt. The upgrade was subject to the operational trials for interconnecting the Libyan electric network with the Tunisian network that was lastly retested in April 2010. After the beginning of the Libyan Civil War, no further progress has been made

- **Palestine**

The Palestinian electricity grid is closely linked with the Israeli electricity sector. The Palestinian Territories depended on the Israeli Electric Corporation (IEC) for 90% of electricity supply in 2015, ranging from 64% in Gaza to 99% in the West Bank. The only slight exception to this are the transmission lines from Jordan and Egypt to the West Bank and Gaza respectively.

From	To	Voltage (kV)	Line nominal capacity (MW)	Max transfer capacity (MW)	Energy exchanged (GWh yearly)	Load factor (%)	Financing method	Year of operation
Palestine	Egypt	22	17	200	190	1,0	Public grant - Arab Fund[19]	2008
	Jordan	33	--	20	41	90,0		2008

Table 18. Existing Electricity Interconnection Projects in Palestine

In 2008, the West Bank started importing 20 MW of power from the Jordanian grid through a 33 kV feeder to Jericho[20]. Since the Palestinian power demand is not integrated into the Jordanian power sector expansion plans, only Jordanian power surplus is available for export. Therefore, there is no electricity exported from Palestine to Jordan. In 2008, Gaza also started to import 20-30 MW of power from Egypt during a limited number of hours per day which provides 14% of Gaza's energy supply through three feeder lines[21]. This restricted service is frequently interrupted due to lack of maintenance of the lines and security concerns in the Sinai Peninsula. Further projects to strengthen the electricity trade between Palestine, Egypt and Jordan are planned:

From	To	Voltage (kV)	Line nominal capacity (MW)	Project type / status	Estimated cost (MEUR)	Expected year of operation
Palestine	Egypt	220	150	New / feasibility phase	--	--
	Jordan	400		New / feasibility phase	--	--

Table 19. Future electricity interconnection projects in Palestine

Increasing interconnection capacity from Egypt into Gaza and from Jordan to West Bank is a technically feasible option. As a consequence, the construction of a 220kV transmission line from Egypt into Gaza has been considered as well as a new 400kV line from Jordan to the West Bank. The fact that both the Palestinian neighboring countries are beginning to face the prospect of electricity surpluses will guarantee power imports for Palestine which will increase and diversify its security of supply, increasing a safer access to electricity.

[19] More information are available at http://www.arabfund.org
[20] World Bank Group, Securing Energy for Development in West Bank and Gaza, p. 62, 2017.
[21] World Bank Group, Securing Energy for Development in West Bank and Gaza, p. 64, 2017.

6. Determining appropriate regulatory tools

6.1. Different categories of investments in a regulatory perspective

Based on assessments of situations, MEDREG works to analyze what tools can be used by regulatory authorities to evaluate investments carried out by transmission operators. The challenge consists in identifying infrastructure gaps, justifying new investments, assessing the added value of new projects proposed by TSOs and, in the end, checking the relevance of costs and project management.

Regulators and public authorities can play on a set of different tools and measures in their relationship with the industry, such tools depending, however, of several parameters relating to the characteristics of countries. The objective of MEDREG is notably to help members sharing their experience and see what tools could be of use in the region, keeping in mind that there is no one-size fits all approach. EU regulators have a “savoir-faire” to share in particular in the relationship with TSOs and decision makers and should give suggestions to Southern Mediterranean countries. The approach to address the development of electricity infrastructure in the Southern shore countries should be based on a step by step sharing of knowledge, co-learning and benchmarking.

In terms of investment types, a distinction has to be made between national and international projects (interconnections for instance), as well as infrastructures and projects that have a potential market value (power generation). Indeed, infrastructures have a specific status in the sense that, even if tariffs of use can be established, network elements are part of a system and, in many cases, cannot lead to directly billing services to users. In these areas, the participation of private investors is more complex than in power generation, where IPPs have proved being a workable solution.

Another aspect is the differences between levels of development of national systems and regulatory gaps. The specificity of network activities is that developing a part of the system has in general some effects on other parts. For instance, interconnections have to be addressed in the light of the systems they link together. Obstacles to using interconnections often come from internal constraints, at a national level.

A crucial point concerns the reliability of the system. At all times, power systems hold reserves to maintain reliability in the event of a plant failure or other unpredicted changes in supply and demand. Sharing reserves between balancing areas means that each balancing area can maintain less reserve capacity. However, sharing services and lowering reserve requirements for neighboring TSO’s, therefore mitigating the needs of conventional generation support in each Country, is limited by interconnections capacity.

6.2. Factors driving investment needs and policies

SEMCs, although currently accounting for only one-fourth of the total gross domestic product (GDP) of the Mediterranean region, are expected to grow at twice the rate of the North Mediterranean Countries till 2030, when they will make up approximately one-third of the total GDP of the region. The population will grow in the South shore at a faster rate than the North. As a result, 60% of the population will be based in the countries belonging to the south shore of the basin by 2030. In terms of energy balance this implies that energy consumption, as well as electricity demand, will increase in the South, whereas energy consumption is likely to

decrease in the North. This situation will generate a huge need in infrastructural projects and investments in the Southern shore of the Mediterranean.

Practical considerations suggest that actual realities of the Mediterranean region need to be recognized. The affordability of new investments in power systems infrastructures must be judged in the context of the actual status of each country and its forecasted development outlook. Potential national and international investors will be evaluating the risks of such investments demanding a corresponding risk related return. Therefore, the need of minimizing risks and optimizing investments for the Countries involved is crucial; risk assessment notably relates to factors such as institutional stability, transparent rules, trust in court decisions and guarantees provided by investors' counterparts.

The level of development of the power sector is also an important parameter which informs about the capacity of systems to accommodate demand increase or the connection of new generation facilities, in particular intermittent ones.

The Government policies on energy related issues (fuel mix, networks coverage, tariff set-ups, consumers' subsidies, load growth forecasts, reduction of non-technical losses, etc) are critical, in particular regarding renewable energy development. Economic incentives as well as NRA's and TSO's acceptance play a central role in driving RES development. It should be remembered that RES generation development is normally regarded as very beneficial for a country, however it should be underlined that the role of RES should not exceed the reserve capabilities of the system, which is linked to the controllable generation capacity. Market integration (internal market, regional market, or global market) can also bring improvements via interconnection development, assuming that some preliminary conditions are met in terms of compatibility between neighboring systems.

Interconnections, as they allow to share reserves between facing grids, may actually decrease the need for conventional generation reserves but achieving such sharing will require appropriate technical and regulatory developments and convergence. NRAs and TSOs can help in advising the Government (depending on their degree of independence and of their powers of enforcing decisions) and building consensus among utilities and stakeholders on guidelines for the power system development.

Issues related to system's stability can find other solutions based on innovative technologies. The level of maturity should also be seen as the possibility to envisage new extra loads that can be added to the existing industrial and consumers base (water de-salinization, electric cars, public transportation, energy efficiency).

6.3. Investment perspectives

In their own forecast for the next ten years, the TSOs (Med-TSO) consider an increase in the generation capacity in the Mediterranean of about 150 GW, of which 15% from RES, corresponding to an expected increase in electricity demand of about 90 GW. The related investments amount to 220 - 250bn€. This requires the high voltage network strengthening and integration of the two shores of the Mediterranean. The TSOs estimate the construction of about 33,000 km of HV lines, with around 20bn € of investments.

Furthermore, Med-TSO considered the present and the future interconnection's infrastructure and the needs from the technical, economic, and financial perspectives to establish the target exchanges among the Countries and a regional integrated electricity market.

In national and regional perspectives, there are different kinds of possible investments:

- Studies on network and generating stations changes and improvements;
- Investments in new power stations including new RES generating stations;
- Investments focused on strengthening domestic grids;
- Investments for fostering electricity exchanges between bordering Countries.

In their Mediterranean Master Plan, Med-TSO identified a list of the most relevant reinforcement projects that are required for the development of an integrated, reliable and efficient network in the region. This led Med-TSO to single out 14 clusters of cross-border interconnections suggested for 2030. A cluster is defined as a set of investments - new lines, new substations, other equipment for active and/or reactive power control, generally comprising both cross-border interconnections and domestic reinforcements - necessary to realize a firm increase of energy exchange, measured by Net Transfer Capacity (NTC) across two countries/grid portions.

Due to the importance of necessary developments, the countries in the South shore will hardly be able to cover investment needs via the public budget only. Alternative business models need to be developed including private sector participation, under the form of PPP for instance.

Since 1990, an increasing participation of the private sector in supporting the development and diffusion of effective endowment of electricity assets has been experienced: in developing countries, governments remain the main source of infrastructure financing providing around 70% of the funds necessary, but the private sector is also a key source, contributing about 22% of the funding.

The power generation sector attracted the bulk of private investment in electricity via IPP schemes. The private engagement depends essentially from:

- The willingness of governments to engage the private sector in assets financing;
- The overall macroeconomic environment;
- The incentive and motivation of the private sector to enter into an agreement with the government.

In this respect, an adequate regulatory framework and proper enforcement of laws contribute to building confidence. More precisely, investors look at independence of regulatory institutions and processes, access to credit, government effectiveness and responsiveness, political stability and public opinion on private provision of infrastructure services. These conditions are generally measured through indicators such as the Political Stability (PS) and Rule of Law (RoL) score as defined by the Worldwide Governance Indicators project (provided by the World Bank). The two indicators are generally positively correlated with the level of investment. The greater the political (and financial) stability, the lower is the perceived country risk, thus the lower the return required on investment. A high score related to the RoL implies a greater certainty on the judicial and legal system, thus improving the level of contract enforcement in the country considered.

6.4. The need for TSO coordination

To ease cooperation between balancing areas encompassing a larger geographical area, the ultimate target should be achieving balancing areas coordination between neighboring TSO's entailing, among other things, a better utilization of existing and planned interconnections

capacity[22] (Med-TSO International Exchanges Report Task 3.2 on ‘’Schemes of Sharing Services with RES integration”).

The success of this coordination clearly demands an effective cooperation between TSOs and regulators in a step by step process, that includes technical, legislative, regulatory aspects.

The first phase of this process relates to coordinating the balancing areas between facing TSO’s. It will involve political consensus and it will require an extensive action plan based on harmonization issues:

- Harmonization of the institutional consensus between interconnected countries
- Interconnected systems stakeholders support including generators and IPP’s, if present.
- Harmonization of rules and statutory codes (focusing on reserves sharing) between interconnected TSO’s
- Harmonization and strict coordination of types of services and technical parameters between interconnected TSO’s.
- Development Plans coordination, for both conventional and RES generation, between the two interconnected systems.

There are several ways to reach the objective of sharing services. Choosing the most appropriate way depends on the technical set-ups of each TSO and on the accuracy, completeness and thoroughness of the agreements that are needed between facing TSO’s.

A critical question in drafting the TSO’s agreements will be the effective sharing the responsibilities on the “coordinated” balancing area between the facing TSO’s. Med-TSO and MEDREG could have an important advisory role in establishing and/or mediating agreements on the rules. Even on the issue of the institutional consensus, Med-TSO and MEDREG could suggest appropriate actions in both Countries in order to foster and support EU policies implementation in the Southern Countries regional balance.

[22] "Schemes of Sharing Services with RES integration", Med-TSO, 2014.

7. Priority recommendations

In summary, to stimulate investment, it is necessary to clearly assess what the priorities are at national and regional levels. Having a view to energy systems as a whole is important to ensure the coherence of choices. In this respect, efforts have to be put on long term planning, which includes the assessment of needs and possible options to fulfil them, articulating the development of energy supplies, power generation, transmission and distribution networks, interconnections. Investment processes are long, therefore promoting stability and transparency in terms of institutional organization and regulation is crucial, both for national and foreign investors. When focusing on infrastructures, they are meant to be developed, in priority, by national system operators, to be efficient, they should play a role of coordination allowing for a good long-term planning.

A correct and appropriate planning is indeed essential for meeting the forecasted demand and to be a measure of the system maturity. Electricity infrastructures development require a significant investment normally from both Government and private sector. But private investments require sound feasibility projects based on the perceived risk and the bankability of the projects. Foreign direct investments (FDI) are instrumental in many cases for developing a Country infrastructure and Country related risks are the first to be evaluated by the foreign investors. Guaranteeing a stable regulatory environment over the life of the project is a must for investors.

In terms of interconnection development, for the Southern and Eastern shores, the regulators should provide guidance to the TSOs that must be sharing the responsibilities to coordinate the balancing area across the border. An appropriate balance of responsibility between NRAs and TSOs would guarantee a joint approach in each Country to negotiate the necessary compromises to be achieved in order to foster a joint responsibility for sharing services. Integrated planning for each TSO system is required in order to coordinate the appropriate reserves levels with the expected generation development, including the concurrent intermittent RES development plans and, beyond, developing interconnections with a view to increasing cross-border commercial exchanges of energy.

Expanding cross-border trade can be a cost-effective way to increase reliability and affordability, but technical and political barriers persist. To overcome such barriers, the establishment of constant technical and political cooperation is fundamental. Institutions like MEDREG and Med-TSO are increasingly involved in supporting concrete technical and institutional collaborations at regional and international level, promoting lasting exchange and leading to further compatibility of the region's countries.

More precisely, among the options to improve the situation in SEMCs, we can identify the following recommendations:

- **Clarify the institutional architecture at national level**: in most cases, TSOs are state-owned and still under a strict control of the government. That can be justified by the need for infrastructure development which is higher than in the EU, thus bringing the issue of the electricity network development at a political priority. Indeed, the financing of projects continues to be a challenging aspect of network development in the Mediterranean region, as the credit worthiness of several Southern countries remains uncertain despite the increasing resort to external finance. The situation should be carefully addressed according

to the perspectives of development of independent power generators and the possible cohabitation between a regulated and a competitive sector. National objectives should be clarified in order to properly design the rules and set up incentives to each category of actors. In this regard, international public financial institutions should also be involved to ensure that said objectives are sustainable in the medium and long term.

- **Improve investment planning capacity**: it is usually challenging for SEMCs to plan medium and long-term network investment, because financed projects are affected by delays or failure both in electricity networks and renewable installations. Based on a long-term vision articulating all the relevant dimensions of power systems, it is critical to assess the possible tools to be mobilized, including energy efficiency on consumers' side. The financial charge of investments should also be estimated carefully, notably to avoid risks of consumers exiting the grid (by developing self-production for example). Additionally, in Southern Mediterranean, several countries are accelerating their programs to reform electricity prices. While these plans will likely reduce the fiscal burden placed on governments, when reducing subsidies, they could also cause a downward pressure on demand for power. Therefore, the outcome of price evolution should be carefully considered when planning future capacity.
- **Ensure a proper level of transparency and know-how**: to foster investment, institutional stability and transparency of the rules is a key factor. Steps for building competitive markets particularly include developments in terms of governance to allow for effective pricing of energy and clarity of duties for the stakeholders. Foreign investors generally require guarantees about risk structures and coverage. Moreover, there is a need to provide dedicated capacity-building for key energy decision-makers within the SEMCs in order to share knowledge and information between EU states and the region, specifically on investment planning, technical standards and renewable energy project financing.
- **Regulators have a crucial role to play**: Regulatory authorities are institutions which participate to creating a sound investment climate. Actually, their role consists in working closely with operators, ensuring that investment processes are managed efficiently. They contribute to determining long term objectives for energy systems development also with a view to the organization of the power system. They also play a crucial role in adapting rules to allow for raising the level of interconnections and filling the potential regulatory gaps hindering energy flows across borders. As they share the same kinds of skills and competences, when regulators are present in interconnected countries, they facilitate finding arrangements mutually beneficial.

Annex 1 - Overview of electricity systems in Eastern and Southern Mediterranean Countries[23]

1.1. Algeria

1.1.1. Generation

- **Installed capacity**

The country's electricity capacity is increasing strongly; since 2008, 8 GW have been installed reaching the total capacity of 19 GW at the end of 2016, 97% of which is thermal. The said capacity is distributed as follows: gas turbines account for 59%, combine cycle gas turbine (CCGT) for 23.6%, steam turbines for 12.8%, while oil and RES for 2% and 2.5%, respectively.

- **Power generation**

Production has been increasing rapidly, bringing it to 66 TWh in 2016.

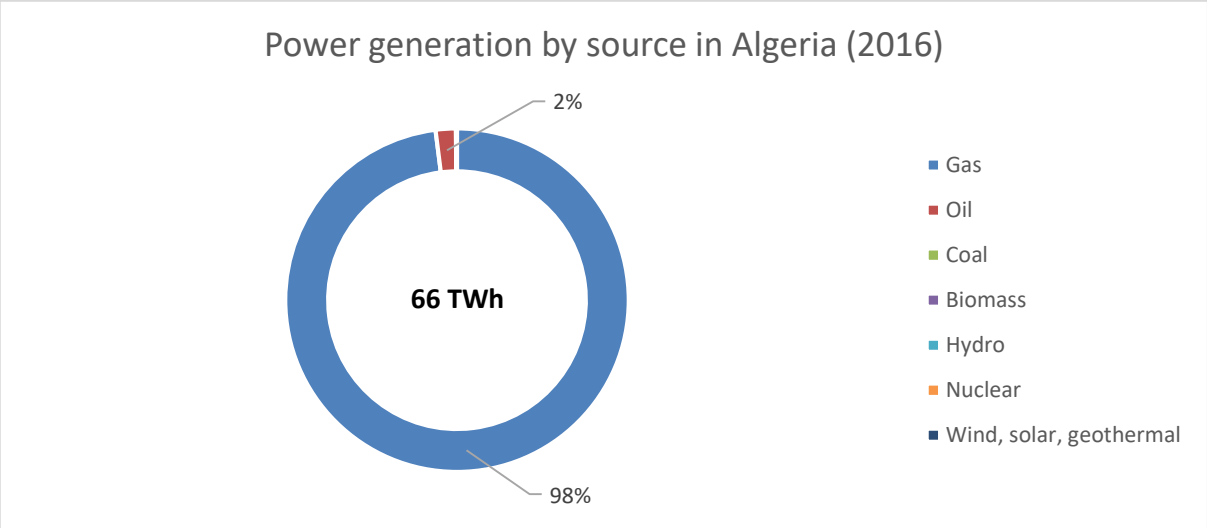

Figure 2. Power generation by source in Algeria (2016, %) (Source: ENERDATA)

- **Power generation companies**

SPE (Sonelgaz Electricity Production) is Sonelgaz's subsidiary in charge of power generation; it has a capacity of 13.700 MW. In 2016 Sonelgaz produced 66 TWh of electricity, including its participation in IPPs, 47% of which was produced by SPE.

The IPPs have a total capacity of 5.100 MW through 6 companies in which Sonatrach and Sonelgaz have a stake, either directly or through AEC (Algerian Energy Company), their 50/50 joint venture.

1.1.2. Supply

- **Transmission and distribution**

The national electricity system consists of an interconnected network in the north and part of the south of the country; moreover, addition 25 isolated networks supplied with gas turbines and diesel groups supply cities in the south.

[23] Reliable information on electricity outlook in Libya is missing due to the unclear political situation in the country.

The Société Algérienne de Gestion du Réseau de Transport de l'Electricité (GRTE) has increased the voltage of its transport lines (electricity highways) from 220 kV to 400 kV since the year 2005, in order both to secure the electricity supply and to participate in the development of interconnections with the neighboring countries.

- **Transmission and distribution companies**

GRTE is Sonelgaz's subsidiary in charge of electricity transmission. The overall length of the grid system managed by the GRTE is 27,830 km for all voltages, from 60 kV to 400 kV. OS (Operator of the Electric System) is Sonelgaz's subsidiary in charge of the electricity market operation.

Electricity distribution is carried out by 4 regional companies, all subsidiaries of Sonelgaz: SDE (East), SDO (West), SDC (Centre) and SDA (Algiers). They are also in charge of gas distribution. In 2016, the distribution networks reached a total length of nearly 316.500 km (medium and low voltage), supplying 8,7 million customers.

1.1.3. Demand

- **Electricity consumption**

Electricity consumption has grown by almost 7% yearly since 2009, reaching 60 TWh in 2016. The electrification rate is currently 99%. In 2016, industry accounted for 30% of electricity consumption, followed by the residential sector with 32%; the tertiary sector has a share of 22%.

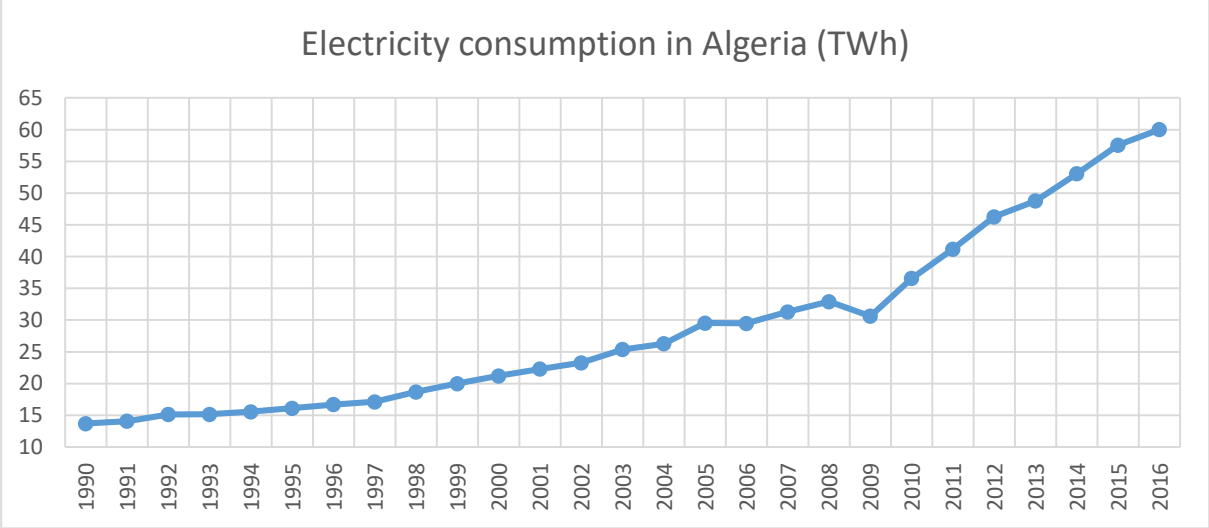

Figure 3. Electricity consumption in TWh (Source: ENERDATA)

The maximum demand reached 13 GW in July 2017, i.e. double the 2007 level. In this context, massive investments in electricity distribution were planned to counteract the progressive drop in the security of supply in certain regions.

- **Energy efficiency measures**

The Agency for the Promotion and the Rationalization of the Use of Energy (APRUE) was created in 1985 to promote energy savings and to develop the energy efficiency program set out in a law adopted in 1999. The agency is a public establishment with an industrial and commercial mission and operates under the supervision of the Ministry of Energy and Mines.

The national energy efficiency program (PNME) is one of the instruments implemented by the Government within the framework of the energy efficiency law of 1999. The PNME was

prepared under the supervision of APRUE and implemented with the support of the National Energy Efficiency Fund (FNME). The main mission of the FNME is to contribute to the financing of the energy efficiency policy; it is financed through a tax based on the consumption of large-scale consumers (electricity, gas) or from international funds.

The National Energy Efficiency Program 2015-2030 was adopted in 2015; it aims to retrofit 100,000 units of dwellings per year and strengthen the efficiency requirements of end-use equipment, with a global energy saving objective of 30 million tonnes of oil equivalent (Mtoe) in 2030 in building sector. In transport, the plan will favor the most available and less polluting fuels (e.g. liquefied petroleum gas (LPG)) to significantly decrease the share of diesel, corresponding to 15 Mtoe of energy savings in 2030. In industry, the plan aims at saving an equivalent of 34 Mtoe in 2030.

1.1.4. Prices

The price of electricity for households is US$3,1c/kWh and for industry US$2,6c/kWh (in 2016). Prices decreased between 2008 and 2015. However, CREG increased the industrial electricity tariff by 20% on 1 January 2016.

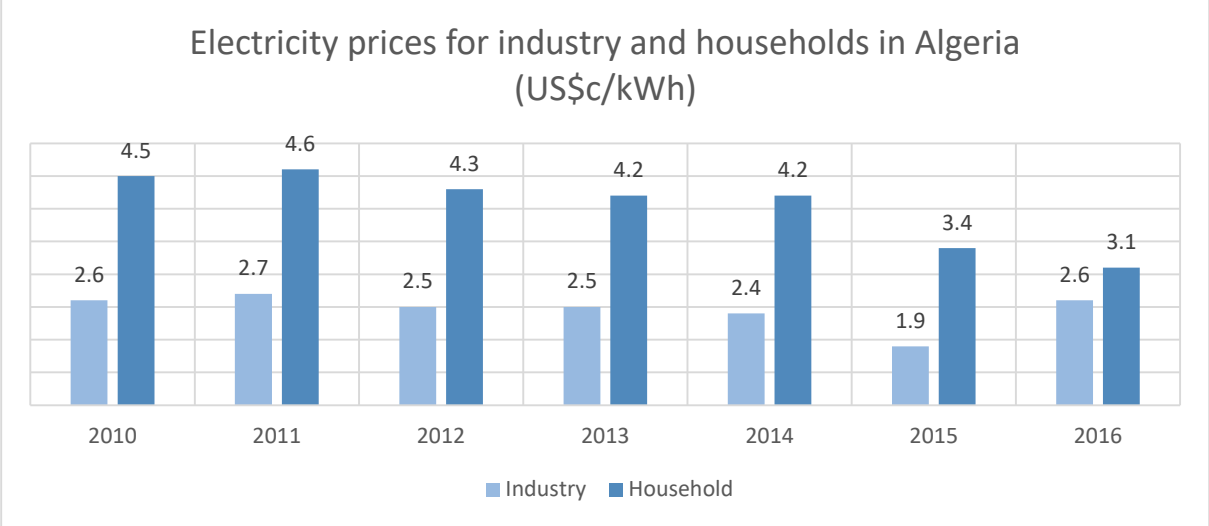

Figure 4. Electricity prices for industry and households (US$c/kWh) (Source: ENERDATA)

1.2. Egypt

1.2.1. Generation

- **Installed capacity**

The country has an electricity capacity of 38.9 GW (end of fiscal year 2015-2016), 90% of which is thermal. The hydroelectric capacity has been stable since 1990 (2,8 GW). Thanks to an active policy for the substitution of natural gas for oil, gas makes up 80% of the thermal capacity. Several wind and solar parks have been commissioned over the past few years. The total capacity in 2017 amounted to 59 MW for solar and 750 MW for wind.

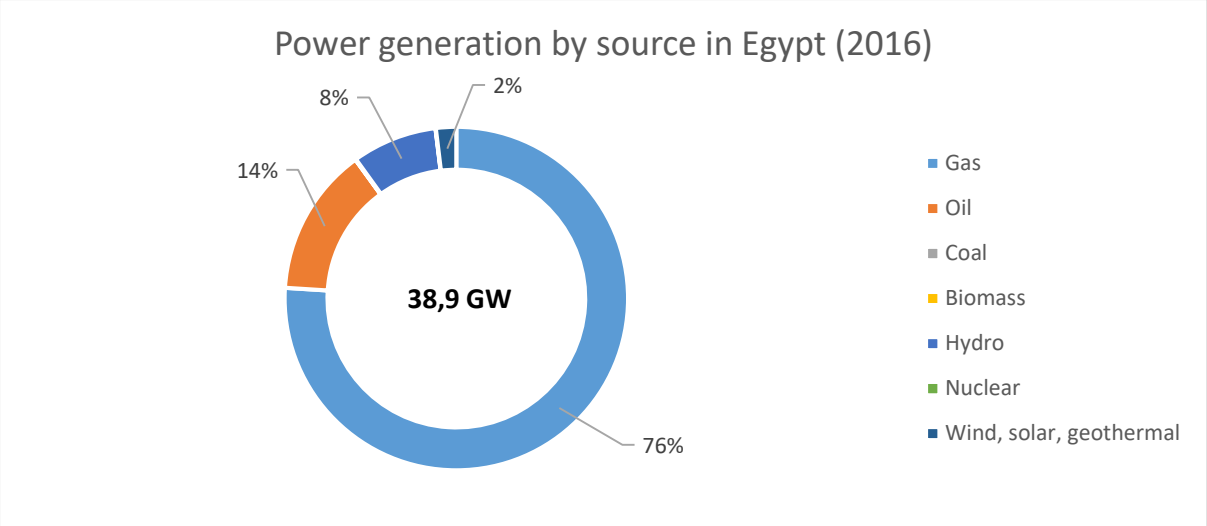

Figure 5. Power generation by source in Egypt (2016, %) (Source: ENERDATA)

- **Power generation**

Power generation has grown rapidly since 2000 (6% yearly between 2000 and 2016). In 2016, 90% of the total electricity production (189 TWh) came from thermal power, 8% from hydro power and 2% from wind power.

- **Power generation companies**

EEHC (Egyptian Electricity Holding Company) is the national public electricity company. EEHC is the main power producer with 38,9 GW (end of fiscal year 2015-2016) and a generation of 186 TWh (+6,5% increase vs 2014-2015). There are 6 public electricity producers linked to EEHC: Cairo, East, Delta Middle Delta, West Delta, Upper Egypt and Hydro. They should be partially privatized (law of 18 June 1998) although no deadline has been fixed. Following the liberalization of the electricity sector, several IPPs built power plants and account for around 6% of the country's capacity.

1.2.2. Supply

- **Transmission and distribution**

The national power grid is made up of 500 kV, 400 kV, 220 kV, 132 kV, 66 kV and 33 kV transmission and distribution lines. There are 44.900 km of transmission lines (2016). Around 7% of the network is made of 500 kV and 400 kV lines (3.100 km).

- **Transmission and distribution companies**

EEHC is the national public electricity company. The Egyptian Electricity Transmission Company ensures the transport of electricity. Electricity distribution is carried out by 9 regional companies that are subsidiaries of EEHC (EEHC 49%): North Cairo, South Cairo, Alexandria, El Behera, North Delta, South Delta, Canal, Middle Egypt, Behaira and Upper Egypt.

1.2.3. Demand

- **Electricity consumption**

Electricity consumption increased very rapidly between 2000 and 2012 (7% yearly, on average) and has increased since then by 3% yearly. Households absorb 46% of that consumption, followed by industry (25%) and the tertiary sector (24%) (2016).

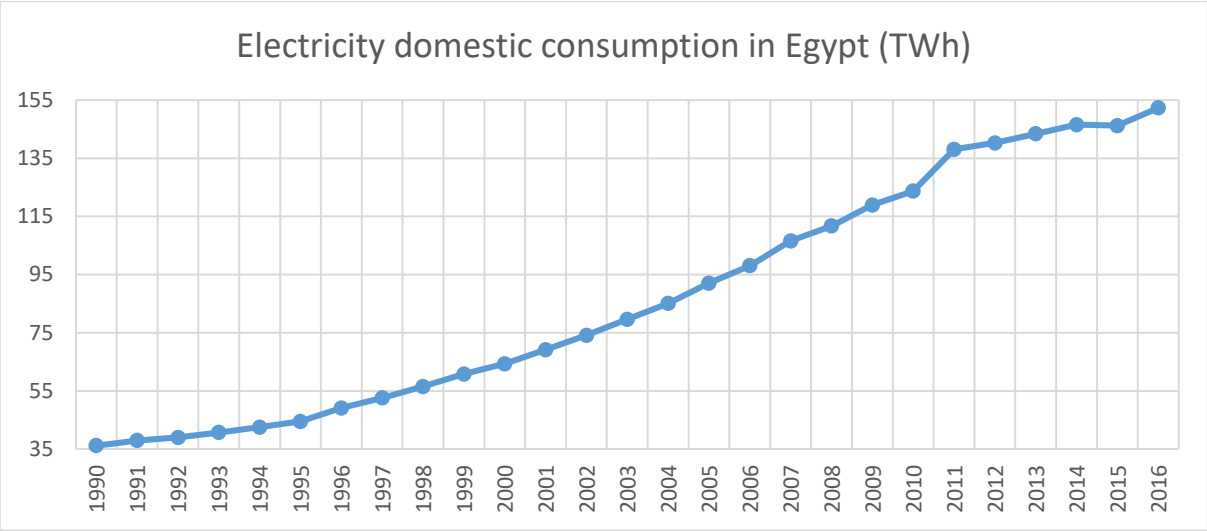

Figure 6. Electricity consumption in Egypt in TWh (Source: ENERDATA)

- **Energy efficiency measures**

The Energy Efficiency Unit in the Supreme Council of Energy was established in 2009 to coordinate policies and measures concerning energy efficiency.

The Ministry of Electricity and Energy has set the target of an 8% reduction in energy use by 2022 (corresponding to 20% of the 2007-2008 energy consumption), half of which is to be achieved in industry. In addition, in 2012 Egypt adopted its first National Energy Efficiency Action Plan (NEEAP) for the period 2012-2015. The NEEAP sets a target of 5% energy savings on the average consumption over 2008-2012.

1.2.4. Prices

Egypt plans to phasing out the subsidy which will need to significant increase in electricity prices over the 2014-2021 period. Accordingly, prices for households started to increase in 2014 up to US$3,4c/kWh in 2016. Prices for industry increased sharply in 2014, more than doubling, and stood at US$4,9c/kWh in 2016.

Electricity price levels are similar to those in Algeria, but they are significantly lower than prices in Israel or Jordan.

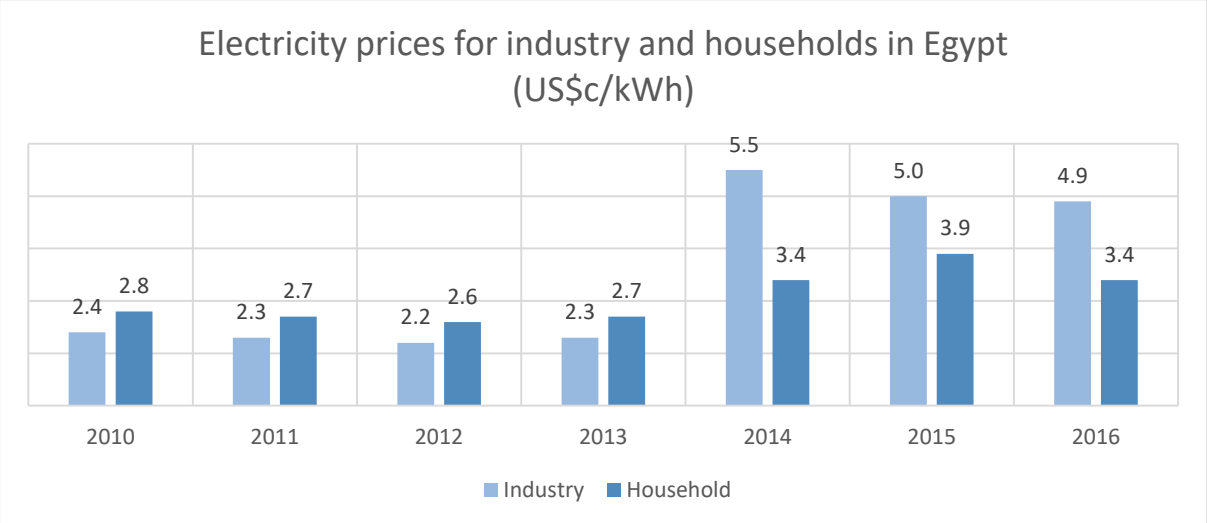

Figure 7. Electricity prices for industry and households in Egypt (US$c/kWh). (Source: ENERDATA)

1.3. Israel

1.3.1. Generation

- **Installed capacity**

Israel has an electricity capacity of 17 GW (end of 2015) that is mainly thermal (of which gas 63% and coal 30%). Several gas power plants have recently been commissioned in 2013. Since then, all new capacities have been commissioned by IPPs. The country's solar capacity is developing rapidly and reached about 700 MW end of 2015.

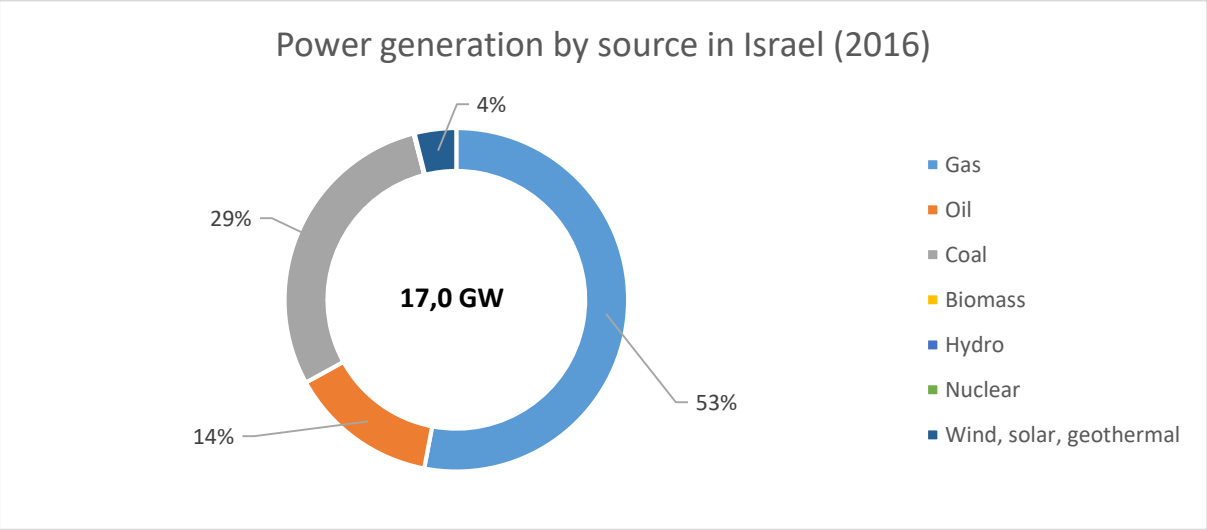

Figure 8. Installed electric capacity by source in Israel (2016, %) (Source: ENERDATA)

- **Power generation**

Electricity production increased by 5% in 2015 and reached 63,7 TWh. It increased at the rapid pace of 3% yearly between 2000 and 2012, but decreased in 2013 and 2014. The share of electricity produced from gas has been increasing rapidly since 2004, from 9% to 51% in 2015 while the share of coal decreased from 77% in 2004 to 45% in 2015.

- **Power generation companies**

IEC is the national electricity utility company (99,8% public). IEC owns 17 power plants with a total capacity of 13,6 GW in 2015 (80% of the country's electricity capacity). IPP have a capacity of approximately 3,4 GW (2015), i.e. more than 20% of the total installed capacity.

1.3.2. Supply

- **Transmission and distribution**

The electricity transmission network totals about 5.500 km (including 740 km of 400 kV lines, 4.500 km of 161 kV lines and 115 km of 115 kV lines). The distribution network totals about 48.000 km. The country exports 5 TWh, representing 8% of the electricity produced. Transport/distribution losses are low (3% in 2015).

- **Transmission and distribution companies**

IEC is the national electricity utility company (99,8% public). IEC is in charge of power transmission and has the monopoly on power distribution. IEC provides electricity also to the company of East Jerusalem (East Jerusalem District Electric Corporation), as well as to the Autonomous Territories of Palestine.

1.3.3. Demand

- **Electricity consumption**

Since 2000, the country's electricity consumption has grown by 2,2% yearly, reaching 53,3 TWh in 2015. Consumption is divided between the residential sector (33%), followed by the tertiary sector (33%) and industry (30%). While the residential share is stable since 2011 (32%), industry increased (24% in 2011) to the detriment of the tertiary sector (39% in 2011).

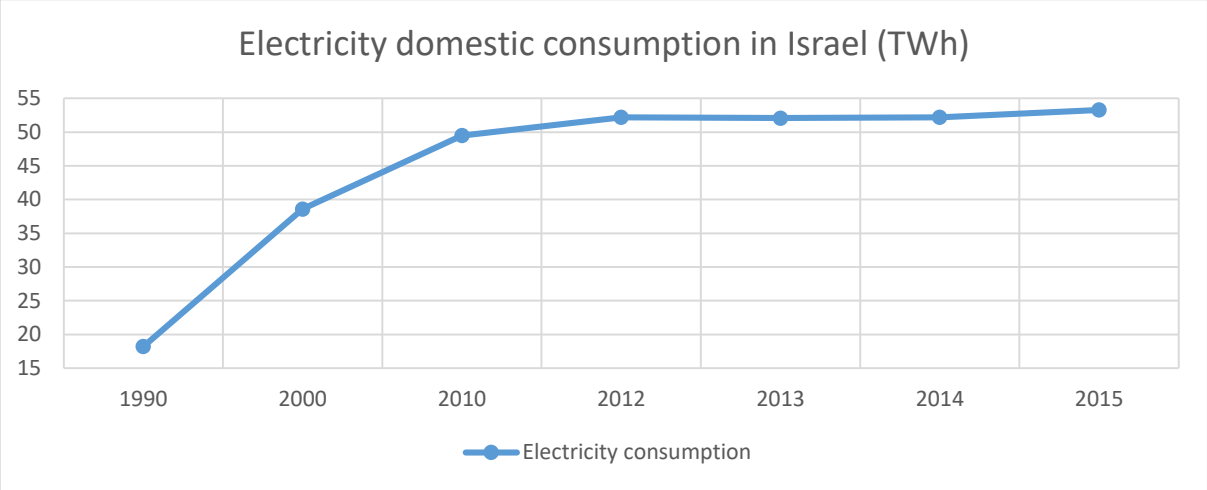

Table 20. Electricity consumption in Israel in TWh. (Source: ENERDATA)

- **Energy efficiency measures**

The Energy Conservation and Efficiency Division at the Ministry of Energy is responsible for energy efficiency activities. In 2008, the Government set the target to reduce electricity consumption by 20% in 2020. The saving in capacity is estimated at 3.400 MW. The National Energy Efficiency Program 2010-2020, published in 2011, further specifies the way energy savings should be achieved.

1.3.4. Prices

The price of electricity dropped significantly in 2016 compared to 2014 (by about 19% for households and 30% for industry). For households it equals US$14c/kWh and for industry US$8c/kWh (2015). The price reduction came from the cheaper cost of electricity production since natural gas from the offshore Tamar gas field has begun to be used.

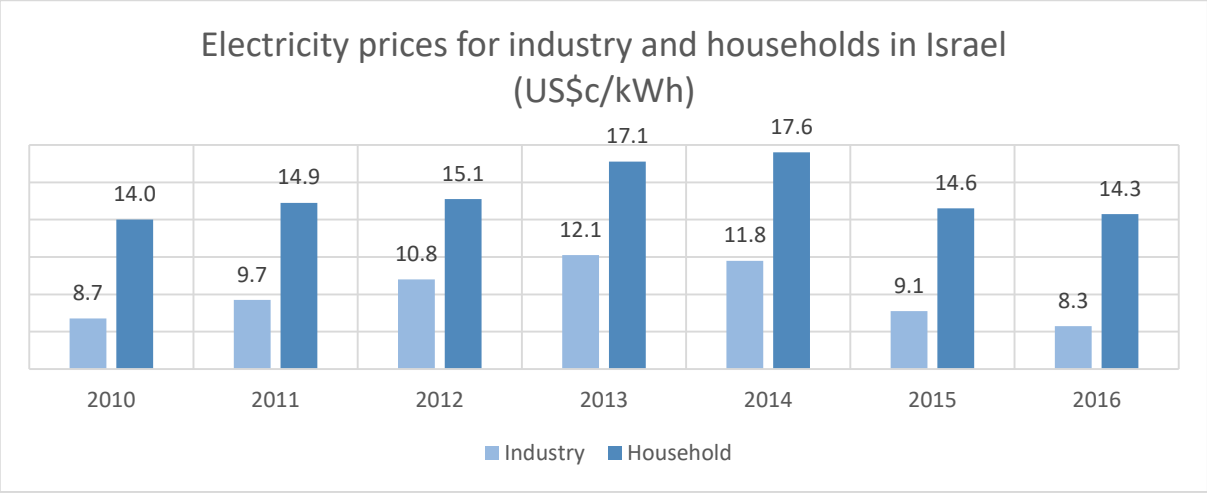

Figure 9. Electricity prices for industry and households in Israel (US$c/kWh). (Source: ENERDATA)

1.4. Jordan

1.4.1. Generation

- **Installed capacity**

The country's electricity capacity (4,8 GW, end of 2016) is mainly thermal, with gas combined cycles accounting for about half of that capacity (1,9 GW).

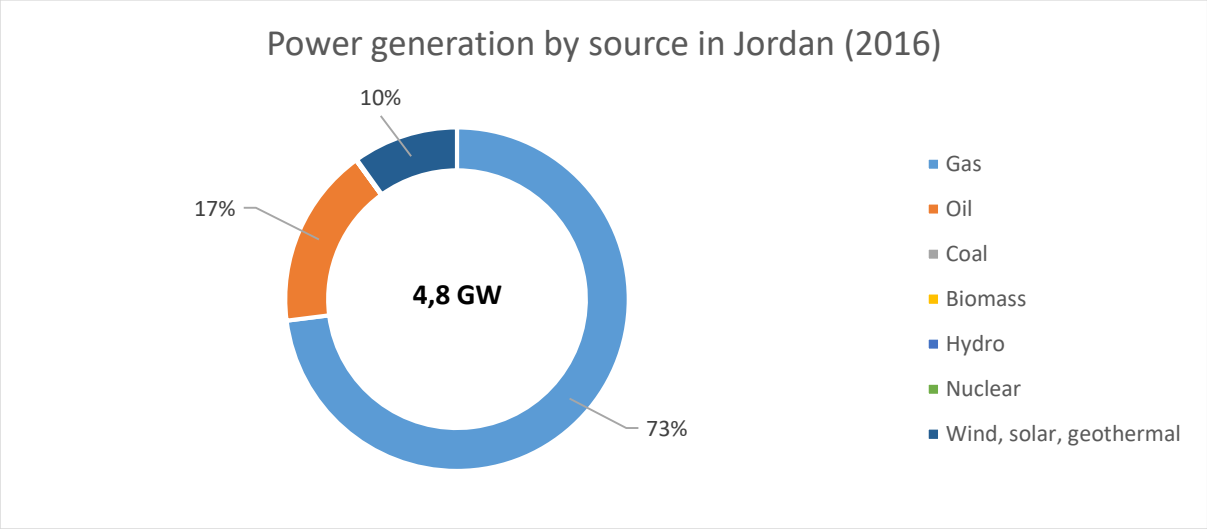

Figure 10. Installed electric capacity by source in Jordan (2016, %) (Source: ENERDATA)

- **Power generation**

Electricity production has more than doubled since 2004, from 8,4 TWh to 19,7 TWh in 2016. The share of gas in total production increased rapidly until 2009 (from 50% in 2004 to 90%) but dropped significantly from 2010 to 2015, due to imports constraints (25% and 7% in 2013 and 2014). In 2016, gas' share climbed to 84%, with the opening of the liquefied natural gas (LNG) terminal in Aqaba in 2015, while the share of fuel oil dropped from 92% in 2014 to 11% in 2016.

- **Power generation companies**

The Electric Generating Company (CEGCO) is the main generator with a total capacity of around 1.100 MW and a production of 4,2 TWh in 2016.Samra Electric Power Company (SEPCO), a government-owned company, has a capacity of 1.175 MW (24% of total generation).

Amman East Power commissioned the first IPP in 2009, a 370 MW CCGT. The second IPP, Al Qatrana (373 MW), was commissioned in 2012 by the Korea Electric Power Corporation(KEPCO). The third IPP power plant (573 MW) was completed in 2014. AES Levant Holdings started commercial operations of the fourth IPP, a 241 MW power plant located in Al-Manakher, in 2014. Jordan Wind Project Company commissioned the Tafila Wind Farm (117 MW) in 2015.

1.4.2. Supply

- **Transmission and distribution**
- **Transmission and distribution companies**

NEPCO is in charge of the transport of electricity, the development of the national network and the interconnection between Jordan and its neighbors. There are 3 distribution companies: Jordan Electric Power Company (JEPCO) for the east of the country; Irbid District Electricity

Company (IDECO) for the north (22,5% of the distribution); and Electricity Distribution Company (EDCO) for the south (Valley of the Jordan, 13,5% of distributed electricity).

1.4.3. Demand

- **Electricity consumption**

Electricity consumption reached 16,9 TWh in 2016 and increased at an average rate of 23,2% in the last two decades. The shares of each sector in electricity consumption have been fairly stable since 2011: households account for 44%, industry for 23% and services for 17% (2016).

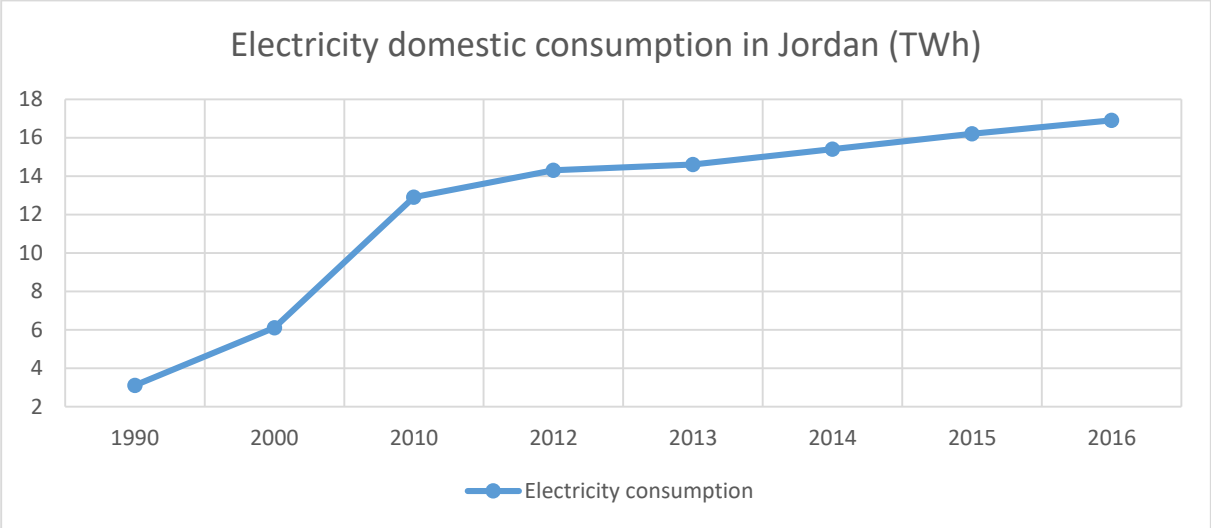

Figure 11. Electricity consumption in Jordan in TWh (Source: ENERDATA)

- **Energy efficiency measures**

The National Energy Research Centre (NERC) is acting as the energy efficiency agency. A law on renewable energies and energy efficiency (Renewable Energy and Energy Efficiency Law) entered into force in 2012. The Law established a fund to provide the investments necessary to develop energy efficiency and renewable projects. The new fund, known as the Jordan Renewable Energy and Energy Efficiency Fund (JREEEF), started signing agreements with local banks in 2016.

The country's objective is to achieve 20% savings in all sectors by 2020. To meet this goal, the Ministry launched two energy saving plans: the first one was implemented in 2014, under which it has lowered electricity consumption by 7,6%, equivalent to around 800 GW; the second plan started in April 2018 and aims at saving 2000 GW between 2018 and 2020.

1.4.4. Prices

Electricity prices have been rationalized. The average price of electricity for households is US$12,1c/kWh and for industry US$12,6c/kWh (2017).

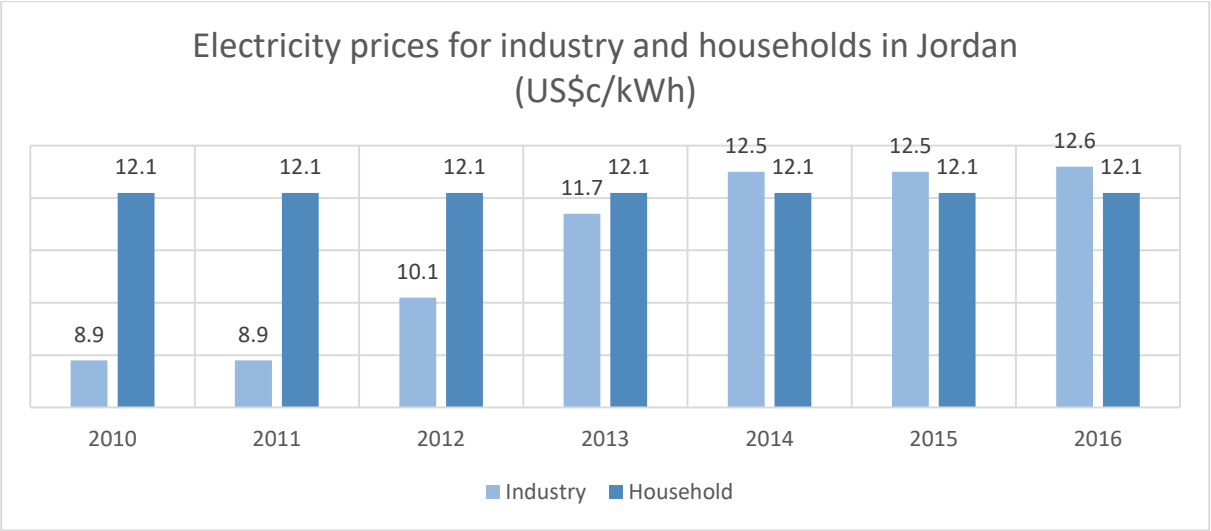

Figure 12. Electricity prices for industry and households in Jordan (US$c/kWh). (Source: ENERDATA)

1.5. Lebanon

1.5.1. Generation

- **Installed capacity**

The country has a capacity of 2,6 GW, with thermal power accounting for 88% and hydropower for 12% (end of 2016). The thermal capacity is concentrated in 7 power stations. There are two combined cycle power stations, both of which can function on natural gas. The current dispatchable installed capacity is around 2,76 GW although the actual effective capacity is less than the installed capacity because of the ageing of most of the power plants. Offshore barge generators with a total capacity of 2x198 MW. This amount is already included in the numbers above. Although these generators are connected to the grid, their contracts are ending at the end of 2018.

Emergency floating power plants were installed between 2013 and 2016. The country has 7 main hydropower stations with a total capacity of 310 MW managed by EDL. The first solar PV farm was connected to the grid in 2015, with a 10 MW peak (MWp) potential planned capacity. Only 1 MWp was implemented, but EDL has currently opened tenders to add an additional 7 MWp.

Despite the capacity increase of around 600 MW from 2013 to 2016, there is still a power deficit leading to frequent outages. Total economic losses due to electricity shortages reached US$23bn in the period 2009-2014. This deficit is covered by electricity generated from private generators. Private generation is well developed (around 30% of total power production) in industry, but also in buildings, in order to deal with the frequent power cuts.

The real production of private generators is higher than accounted for in the statistics, since it is partly informal. These problems are worsened by the Syrian crisis, as there is a need for an extra 500 MW to cover the demand of 1,5 million refugees.

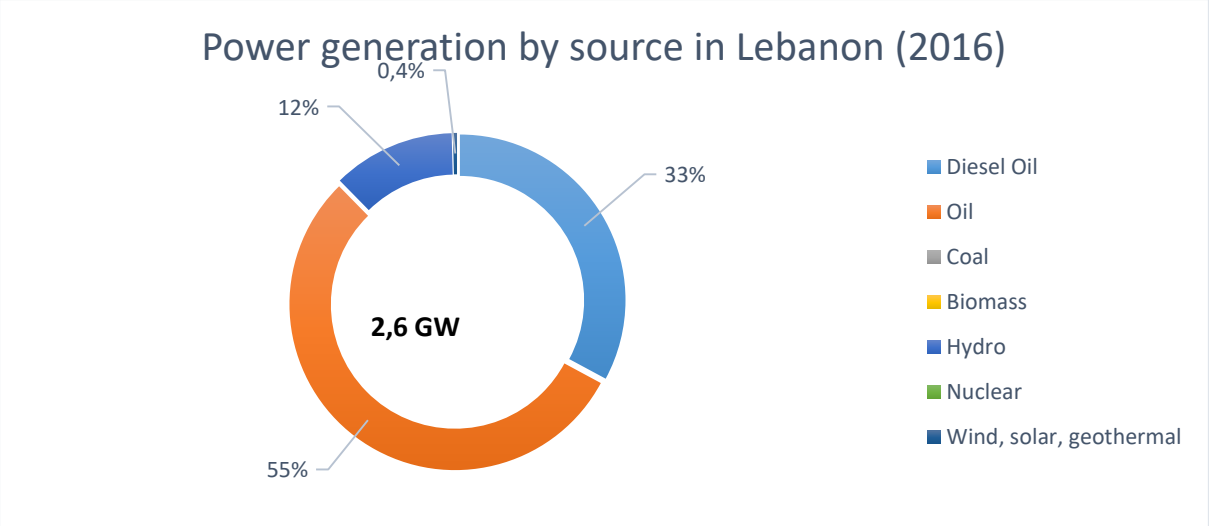

Figure 13. Installed electric capacity by source in Lebanon (2016, %) (Source: ENERDATA)

- **Power generation**

Total electricity production reached 18 TWh in 2016 with an annual increase of 3,8% since 2012. Electricity production has grown by 5% yearly, on average, since 2000; 98% of the production is thermal.

- **Power generation companies**

Electricity of Lebanon (EDL) is the national electricity company, which operates autonomously. It accounts for most of the Lebanese electricity sector with a vertical control over generation, transmission, and distribution, except for a number of concessions. Because of its enormous debt, EDL is a huge financial burden on the State. In recent years the Government has spent around US$1,5bn per year in financing EDL's deficit, becoming the third largest public expenditure.

The total debt of EDL constitutes about 40% of the total Lebanese public debt, estimated at about US$69bn in 2015. The situation is explained by the company's total dependence on oil products and the high distribution losses (estimated to be around 40% in 2016) caused by illegal connections and outstanding invoices (15% of technical losses and 30% of non-technical losses).

Moreover, the average price paid by consumers is around 9.53USc/KWh much lower than the generation and production cost. Several initiatives have been launched on the development of RE generation by the private sector:

- Solar PV Farms: 120 to 180 MWp equally divided across the four main Lebanese regions with capacities ranging between 30 and 45 MWp per region at 10 to 15 MWp per project company (12 in total). It is currently at the evaluation phase
- Wind Farms Round 1: three wind farms in the 'Akkar' area with the following respective sizes 61.5MW, 66MW, and 82.5MW with a 10% potential increase in the capacity of each farm; it has been recently finalized and power purchase agreement (PPAs) have been signed by the Government.
- Wind Farms Round 2: 200 to 400 MW divided into four projects each ranging between 50 and 100MW. It is currently at the Expression of Interest (EoI) stage.

- Solar PV with Storage: 210 to 300 MWp divided into three projects each ranging between 70 and 100MWp. The minimum battery energy storage requirement for each project is 70MW - 70MWh regardless of the size of the PV farm. It is currently at the EoI stage.
- Hydro Power Plants: 233 MW (run of river scheme) and 315MW (peak scheme) spread over 32 potential sites. It is currently at the EoI stage.
- It should be also noted that many small scale PV projects are also being implemented in Lebanon, which include the installation of PV systems on public buildings, street lighting, solar water pumping. Also many individual small scale residential, industrial and commercial PV projects have been also achieved thanks to the National Energy Efficiency and Renewable Energy Action (NEEREA financing mechanism), subsidized by the Central Bank of Lebanon .

1.5.2. Supply

- **Transmission and distribution**

EDL uses overhead lines and underground cables. In September 2017, the Government of Lebanon approved the master plan for transmission. The backbone for the transmission sector is the 220 kV power level. The second voltage level is 150 kV mainly concentrated around greater Beirut area. The third level is 66 kV.

The overhead power lines have a total distance of 1362 Km, and are divided into 4 types according to the voltage level: 21 km of 400 KV transmission lines, 489 km of 220 KV transmission lines, 163 km of 150 KV transmission lines and 689 km of 66 KV transmission lines.

The underground cables have a total distance of 178 Km, and are divided into 3 types according to the voltage level as shown below: 50km of 220 KV underground cables, 26km of 150 KV underground cables and 102 km of 66 KV underground cables.

- **Transmission and distribution companies**

EDL is the sole company responsible for the energy sector except for a number of concessions which exist in the regions of Zahle, Jbeil, Alieh, and Bhamdoun. Indeed, for distribution, EDL has awarded three private companies in 2013 service contracts, so these companies are known as Distribution Service Provides (DSP). DSP is responsible for developing distribution network, operation and maintenance of distribution grids and collection of bills. DSP are responsible as well for the installation of the smart meters. The Lebanese Ministry of Energy and Water (MEW) and EDL forecast the establishment of smart grid center, which is currently under development.

1.5.3. Demand

- **Electricity consumption**

Electricity consumption in Lebanon grew steadily in the two last decade at an average rate of 7%, reaching 16 TWh in 2016. The trends have been fairly stable since 2011: in 2016 households accounted for 39%, industry for 26% and services for 35%).

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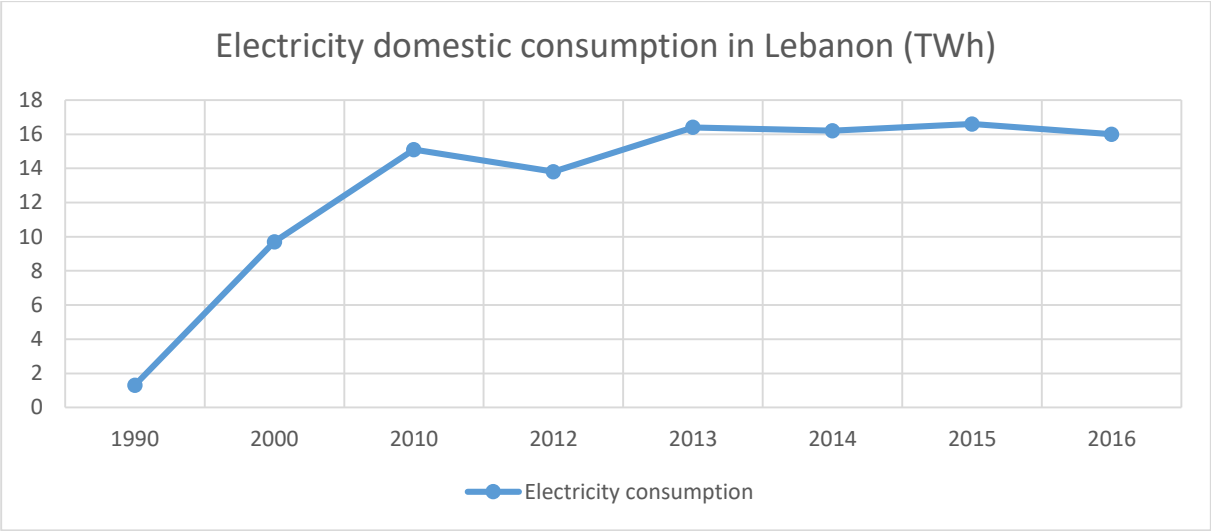

Table 21. Electricity consumption in Lebanon in TWh. (Source: ENERDATA)

- **Energy efficiency measures**

Created in 2011, The Lebanese Center for Energy Conservation (LCEC) is the national energy agency for Lebanon. LCEC is a governmental organization affiliated to the MEW with a financially and administratively independent statute. LCEC is also the technical arm of the Lebanese Government, specifically the MEW in all issues related to energy efficiency, renewable energy, and green buildings and it supports the Government in developing and implementing national strategies in these fields.

LCEC has succeeded in establishing itself as the main national reference on sustainable energy matters for both the public and private sectors in Lebanon. The main role of LCEC is to setup national action plans and strategies to develop the sustainable energy sector in Lebanon. LCEC's role also expands to the implementation of national projects and initiatives undertaken by the Lebanese MEW.

In this context, the Government adopted the NEEAPin 2011 for the years 2011-2015: it was the first ever comprehensive strategy in energy efficiency and renewable energy to be adopted in Lebanon. The second NEEAP (2016-2020) continues and builds on the first NEEAP. Its implementation would need between US$600m-US$950m over a period of 5 years and would result in savings of more than US$225m per year starting 2020. It would allow total primary energy savings of 700 GWh and a decrease of the electricity demand growth from 7% to 5,8% per year in 2020.

In addition, the National Renewable Energy Action Plan, (NREAP (2016-2020)) is the main national document that will ideally lead the way for Lebanon to develop the different RE technologies needed to reach the 12% target by the year 2020.

1.5.4. Prices

The price of electricity is approved by the MEW, according to EDL's recommendations. The government pays a subsidy to EDL to keep the prices stable (on average 5% of GDP per year during the past four years) and the tariff is indexed on the oil price (with a reference value of US$25/bbl). The prices of electricity vary from 35 Lebanese pounds (LBP) per KWh to 200 LBP per kWh for low voltage residential customers, in addition to a monthly subscription fee of 1,200 LBP per 5 A and a rehabilitation monthly fee ranging between 5,000 and 10,000 LBP per month. The prices have not been revised since 1994.

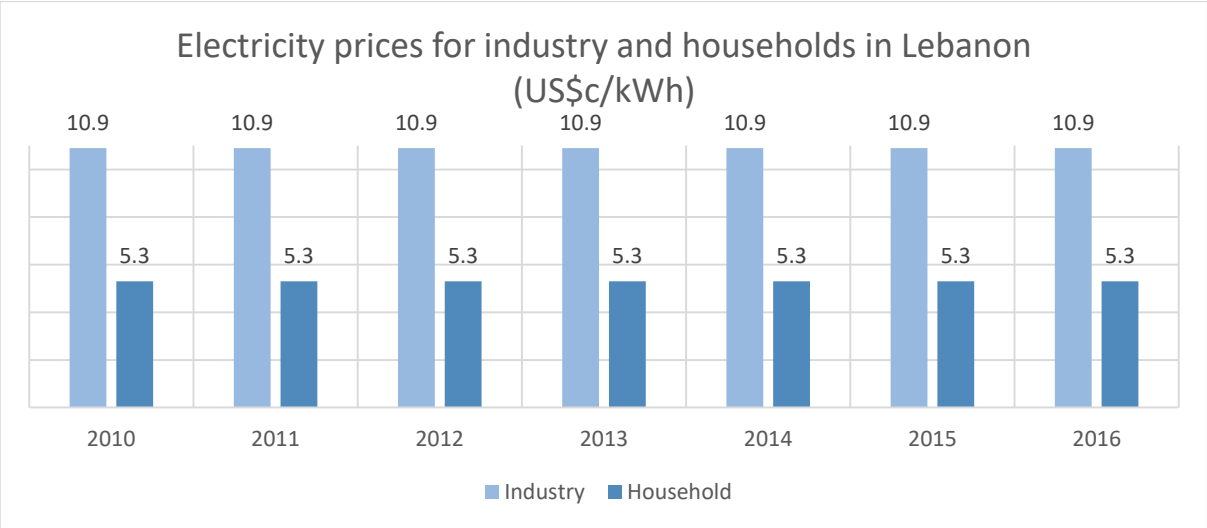

Figure 14. Electricity prices for industry and households in Lebanon (US$c/kWh). (Source: ENERDATA)

1.6. Morocco

1.6.1. Generation

- **Installed capacity**

The country has a capacity of 8,3 GW, made up of 5,4 GW of thermal capacities (66%), 1,8 GW of hydroelectric capacities (22%) and 0,90 GW of wind (12%) (2016).

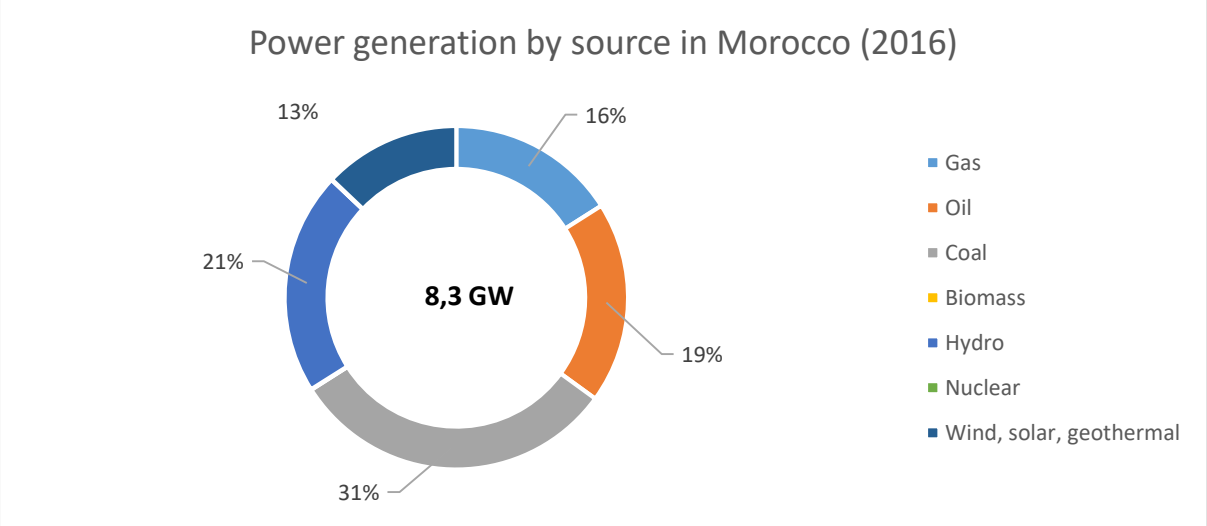

Figure 15. Installed electric capacity by source in Morocco (2016, %) (Source: ENERDATA)

- **Power generation**

Electricity production has more than doubled since 2000 and reached 32 TWh in 2016. Since 2010, the share of coal increased by 10 points to 53%; this resulted in a drop in the share of oil (10% compared to 23%). Depending on climate conditions, production of hydro can vary widely from year to year (6% in 2015 compared to 15% in 2010, for instance). Wind energy accounts for 6% of the overall electricity generation in 2016.

- **Power generation companies**

The National Electricity Office (ONEE) owns around 60% of the national capacity with about 8,2 GW (early 2016, +1,2%, including its shares in IPPs), of which 5.412 MW of thermal

capacity, 1.306 MW of hydropower, 898 MW of wind power and 181 MW of solar. IPPs represent a capacity of 3,1 GW.

1.6.2. Supply

- **Transmission and distribution**

The Moroccan electricity transmission network is around 25.545 km long and it is controlled by ONEE. The distribution network reached 205.372 km at the end of December 2016 with an addition length of 6.058 km compared to the 199.314 km of 2015, representing a yearly increase of + 3%.

- **Transmission and distribution companies**

ONEE holds a monopoly on transmission. The electricity transmission network is around 25.545 km long. A separation of ONEE's transmission and generation activities is planned, as part of the law 48-15 published in June 2016.

Approximately 55% of the electricity produced by ONEE is distributed by 10 autonomous utilities operating under the supervision of the Ministry of Interior (5,4 million customers, 2015). Several cities have granted concessions for their utilities. The distribution network is made up of 85.728 km medium voltage and 205.372 km low voltage lines.

1.6.3. Demand

- **Electricity consumption**

Electricity consumption has grown rapidly since 2000 with the implementation of the electrification program (5,6% yearly, on average). Industry and households are the sectors that consume most (35% each), followed by the tertiary sector (18%).

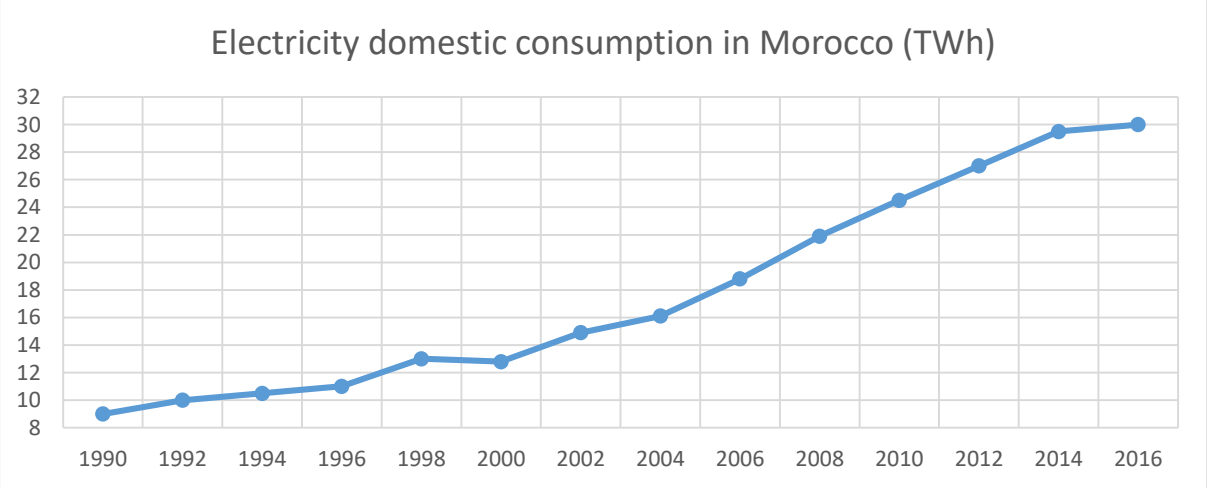

Figure 16. Electricity consumption in Morocco in TWh (Source: ENERDATA)

- **Energy efficiency measures**

The Moroccan Agency for Energy Efficiency (AMEE), was established in September 2016, replacing the National Agency for Renewable Energy and Energy Efficiency (ADEREE), to implement energy efficiency programs.

The agency has held roundtables on energy efficiency to assess the energy savings potential; the energy efficiency strategy by 2030 was published in 2013, fixing a reduction of the planned energy consumption of 12% by 2020 and 15% by 2030 compared with a baseline scenario.

1.6.4. Prices

The price of electricity is US14c/kWh for industry and US11c/kWh for households. Prices have dropped by about 15% for industry and 9% for households since 2011. It is assumed that electricity prices in Morocco do not represent real costs as they are below the average costs of production and transmission.

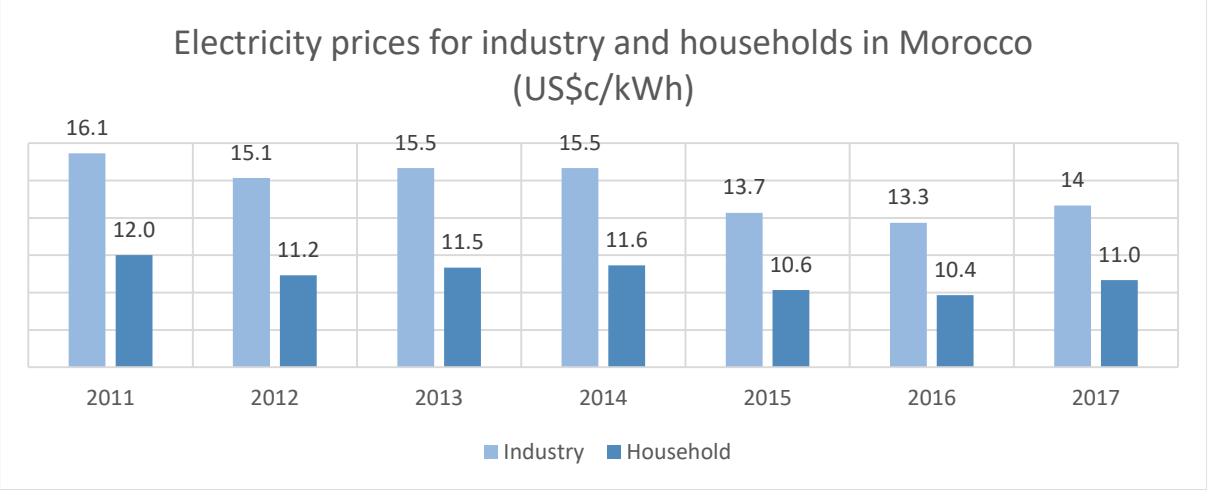

Figure 17. Electricity prices for industry and households in Morocco (US$c/kWh). (Source: ENERDATA)

1.7. Palestine

1.7.1. Generation

- **Installed capacity**

The Gaza Power Plant (GPP) is the only significant domestic generation capacity in the Palestinian energy portfolio and has been plagued with difficulties. The plant entered into commercial operation on 2004 with a capacity of 140MW. However, the plant normally operates at less than 50% of its capability due to the inability of the Palestinian institutions to pay the high costs of diesel fuel.

- **Power generation**

Palestine Power Generation Company (PPGC) is a public shareholding company registered under the laws of the State of Palestine with its head office located in the City of Ramallah.

PPGC has entered into an implementation agreement with the Government of the State of Palestine to develop, design, engineer, construct, finance and operate an independent 455 MW combined cycle gas fired power plant in Jenin Governorate in the Northern part of the West Bank. PPGC has also signed the agreed form of the PPA with the Palestine Electricity Transmission Company Ltd (PETL). In addition, PPGC signed a letter of internet agreement with Gaza Marine Natural Gas Field Developers to supply long-term natural gas to the project through a long-term Gas Sale and Purchase Agreement (GSPA).

The construction of the PPGC Jenin Power Plant is projected to start in 2019 with target commercial operation date in 2021. PPGC has completed the acquisition of the project land in Jenin Governorate in Al Jalamah which is adjacent to Jenin Industrial Free Zone with a total area of around 148,300 m2.

The Jenin Power Plant is expected to provide around 40% of Palestine annual electricity needs in Palestine in both West Bank and Gaza with a total annual production capacity of around

3,700 GWh, which will substantially reduce dependence on imported energy sources.

- **Power generation companies**

The GPP, is the only power generation plant and it is owned by the Gaza Power Generation Company (GPGC) which is in turn owned by the Greek-Lebanese construction company.

1.7.2. Supply

- **Transmission and distribution**

Imports of electricity from the IEC account for 99% of electricity supply in West Bank and 64% in Gaza. Up to now, Israeli power has been provided through over 270 low and medium voltage connection points between Israel and the West Bank with a total contracted capacity of 890 MW. In Gaza, 10 connection points with Israel provide 120MW of capacity. However, the proliferation of connection points has made it difficult to monitor electricity flows across the territories.

In addition to the Israeli supply, modest volumes of power are imported from Jordan into the West Bank and from Egypt into Gaza. Egypt supplies up to 30MW of electricity through three medium voltage 33kV connections points at the southern end of the Gaza strip. The power lines from Egypt are frequently out of service delivering significantly less than the 30MW capacity. As for the West Bank, NEPCO can supply up to 20MW through a medium voltage connection.

The GPP is the only significant domestic generation capacity in Palestine with a full capacity of 140MW.

- **Transmission and distribution companies**

In 2013, PETL was established with a mandate to be the single buyer and TSO for the Palestinian energy sector in order to rationalize power import arrangements with Israel. Although the Palestinian energy sector does not yet have any transmission infrastructure, PETL will be responsible for maintaining and operating the new substations and acting as the single buyer of wholesale power purchased from Israel, as well as from any future Palestinian IPP.

The electricity distribution is carried out by different local distribution companies. The distribution system was reformed by the Palestinian Energy and Natural Resources Authority (PENRA) and included the consolidation of hundreds of small municipality and village councils' electricity services into six larger distribution companies to benefit from economies of scale. These include Gaza Electricity Distribution Company (GEDCO), Hebron Electric Power Company (HEPCO), Jerusalem District Electricity Distribution Company (JDECO), Northern Electricity Distribution Company (NEDCO), Southern Electricity Distribution Company (SELCO) and Tubas District Electricity Company (TEDCO). Despite considerable progress, a significant number of municipalities and village councils continue to distribute power independently, rejecting the legal imperative to integrate electricity services and merge with the distribution companies. Together these independent municipalities and village councils represent up to 25% of total power sales in the West Bank.

1.7.3. Demand

- **Electricity consumption**

Electricity accounts for 27% of Palestinian energy consumption and is dominated by the residential sector. During the historical period 2001-2013, electricity demand has grown at an average annual rate of 7,2%. Residential electricity consumption has been growing slightly

below that average at 5,3%. This is a modest level of consumption by regional standards, at about half the levels found in the Maghreb countries. Non-residential electricity consumption was negligible in the early 2000s, and despite steep growth rates of 13,4% annually from 2001-2013, still only accounted for a small percent of total electricity consumption relative to the residential sector in 2013.

Current levels of electricity consumption understate existing demand. Observed electricity consumption does not provide a reliable demand baseline given that a significant amount of electricity is supplied free of charge, while there is also significant rationing due to supply shortages.

- **Energy efficiency measures**

The Palestinian NEEAP aims to reduce 384 GWh of total energy demand by 2020, representing around 1% reduction per year. The action plan is mainly focused on electricity because this energy type has the largest share in the Palestinian final energy mix. PENRA has been actively spurring the implementation of the three-phased NEEAP for 2012-2020.

To further promote energy efficiency investments, PENRA has drafted a more ambitious action plan for the period 2020-2030. The proposed target is to reduce 5% of the forecasted consumption during the ten-year period, or a total savings of 5.000 GWh. This represents a large increase from the 384 GWh savings of the current NEEAP 2012-2020. The proposed energy efficiency actions have relatively modest investment costs and short paid-back periods.

1.8. Tunisia

1.8.1. Generation

- **Installed capacity**

Tunisia's capacity reached 5,6 GW, with thermal capacity accounting for 5,2 MW, of which 4,9 MW from gas (end of 2016).

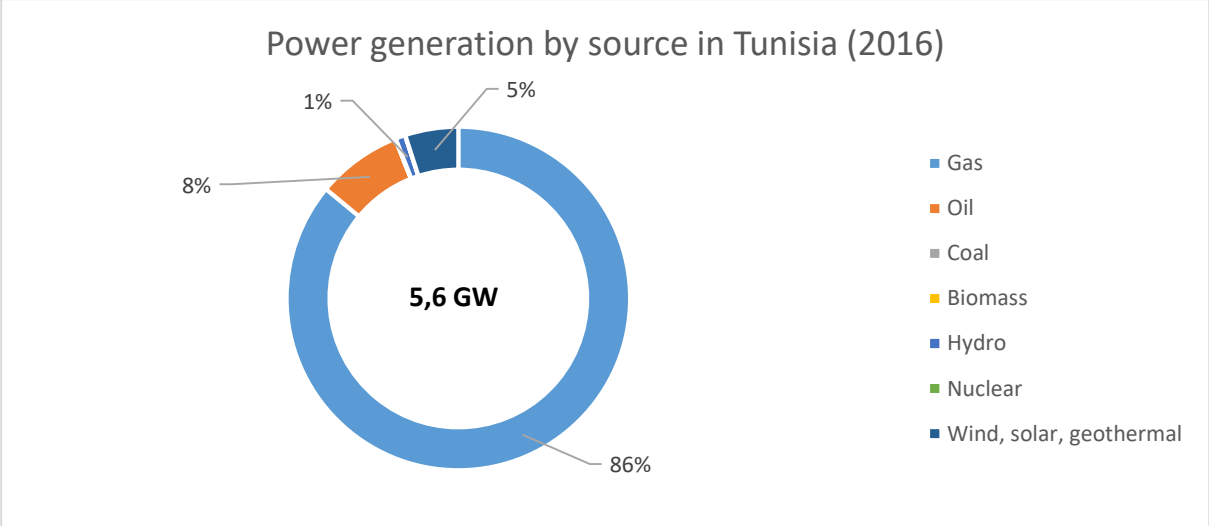

Figure 18. Installed electric capacity by source in Tunisia (2016, %) (Source: ENERDATA)

- **Power generation**

Power generation increased rapidly between 2000 and 2014 (5% yearly) and reached a plateau of 19,7 TWh in 2015 and 2016. Almost the entire production is from natural gas (96% in 2016).

- **Power generation companies**

The Société Tunisienne d'Electricité et de Gaz (STEG) is a public company and represents around 75% of the country's electricity production, while the residue is produced by independent producers (18%) and by auto producers.

1.8.2. Supply

- **Transmission and distribution companies**

STEG is in charge of power transmission with a grid of 6.535 km, from 90 kV to 400 kV. Moreover, STEG has a monopoly on power distribution. STEG exploits and maintains a network of 160.102 km (2016) Medium and Low Voltage lines. It is supplying electricity to 3,8 million customers (domestic, industrial, agricultural and administrative).

1.8.3. Demand

- **Electricity consumption**

Electricity consumption increased rapidly from 2000 to 2015 (by about 4% yearly) and remained stable at about 16 TWh in 2016. Industry accounts for about 34% of the consumption, followed by the residential sector (30%) and the services sector (27%) (2016).

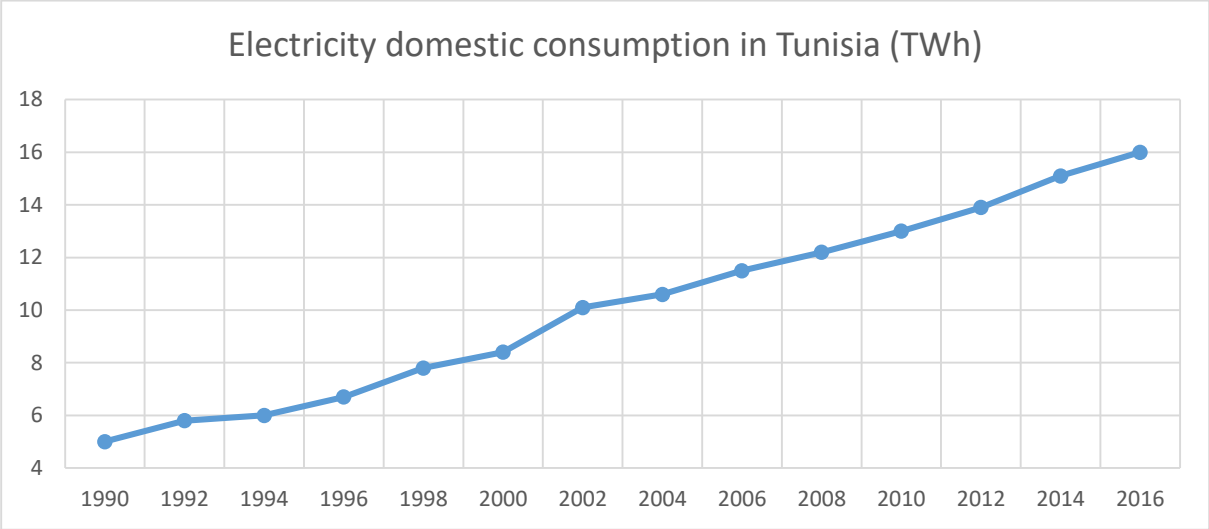

Figure 19. Electricity consumption in Tunisia in TWh (Source: ENERDATA)

- **Energy efficiency measures**

The National Energy Management Agency (ANME), is in charge of energy management and the implementation of the energy policy in the field of renewables; it operates under the supervision of the Ministry of Energy, Mining and Renewable Energies. Tunisia used to have the most ambitious energy efficiency programs of the region. Due to the ongoing economic crisis, less priority is given to such programs. The 2008-2011 energy efficiency program led to energy savings estimated at 2,75 Mtoe, which corresponds to 81% of the target.

The 2016-2030 Tunisian Solar Plan (PST) sets a framework for a 3% yearly reduction in energy intensity and a 34% decrease in primary energy consumption by 2030.

1.8.4. Prices

Electricity rates include a fixed charge and an energy charge that is different according to the time of day/night, peak times and the voltage (high, medium, low). The electricity price for domestic consumers remained stable between 2008 and 2013, at around US$15c/kWh. In

2014, it reached US$20,40c/kWh because of two 10% rises decided by the Government and an increase in the US dollar exchange rate. It dropped in 2015 and 2016 (US$13c/kWh in 2016), following the reduction in the price of gas, the main source for electricity production.

For the same reasons, the industrial electricity price rose from US$9,1c/kWh in 2013 to US$12,2c/kWh in 2014, corresponding to an overall increase of 33%. It came back to roughly US$8,0c/kWh in 2015 and 2016. In 2017, the Government planned a mean increase of 5% of the electricity price.

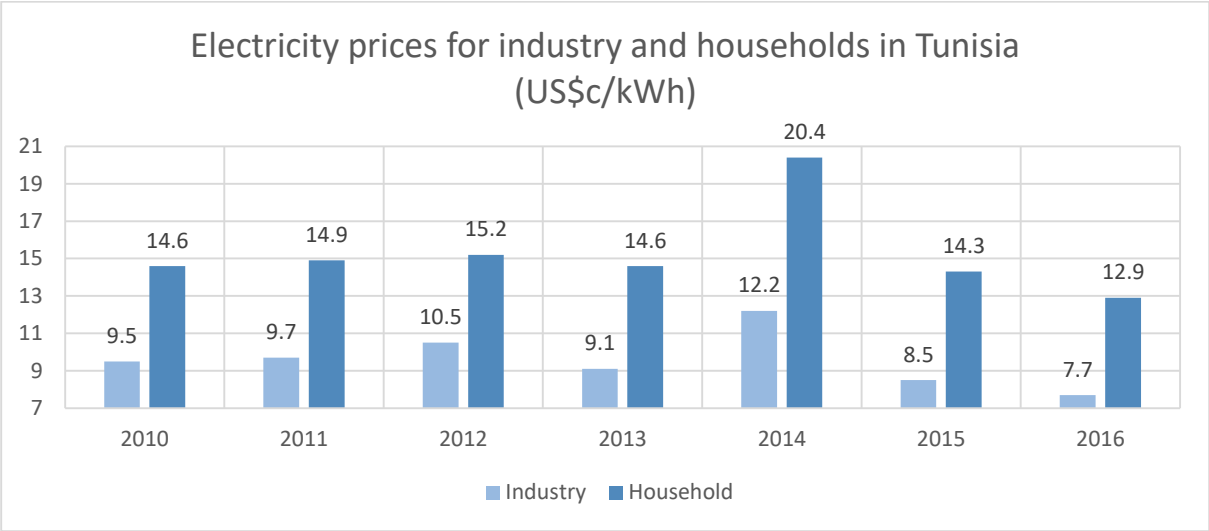

Figure 20. Electricity prices for industry and households in Tunisia (US$c/kWh). (Source: ENERDATA)

Annex 2 – List of abbreviations

Term	Definition
ADEREE	Agence Nationale pour le Development des Energies Renouvelables et de l'Efficacité Energétique
AEC	Algerian Energy Company
ALMEE	Lebanese Association for Energy Saving & for Environment
AMEE	Moroccan Agency for Energy Efficiency
ANME	The National Agency for Energy Management
APRUE	Agency for the Promotion and the Rationalization of the Use of Energy
BN	Billion
BSP	Balancing Supply Parties
CCGT	Combine cycle gas turbine
CEGCO	Electric Generating Company
CO_2	Carbon dioxide
CREG	Algerian Commission de Régulation de l'Électricité et du Gaz
DSP	Distribution Service Provides
EDCO	Electricity Distribution Company
EDL	Electricité Du Liban
EEHC	Egyptian Electricity Holding Company
EIJLLPST	The eight-country block interconnection project (Egypt, Iraq, Jordan, Lebanon, Libya, Palestine, Syria, and Turkey)
ELMED	Electricité Mediterranéenne
EMG	East Mediterranean Gas Company
EMRA	Electricity Market Regulatory Authority
ENTSO-E	European Network of Transmission System Operators for Electricity
ENTSO-G	European Network of Transmission System Operators for Gas
EOI	Expression of Interest
EU	European Union
EÜAŞ	Elektrik Üretim Anonim Şirketi (Electricity Generation Corporation)
FNME	National Energy Efficiency Fund
GasReg	Gas Regulatory Authority (Egypt)
GSPA	Gas Sale and Purchase Agreement
GDP	Gross domestic product
GEDCO	Gaza Electricity Distribution Company
GGP	Guidelines of Good Practice
GPGC	Gaza Power Generation Company
GPP	Gaza Power Plant
GRTE	Société Algérienne de Gestion du Réseau de Transport de l'Electricité
GW	Gigawatt
GWh	Gigawatt hour
HEPCO	Hebron Electricity Distribution Company
HVDC	High-voltage direct current
IDECO	Irbid District Electricity Company
IEC	Israel Electric Corporation
IFIs	international financial institutions
IPPs	Independent Power Producers
JDECO	Jerusalem District Electricity Distribution Company

Term	Definition
JEPCO	Jordan Electric Power Company
JREEEF	Jordan Renewable Energy and Energy Efficiency Fund
KEPCO	Korea Electric Power Corporation
km	Kilometer
kV	Kilovolt
kWh	Kilowatt hour
LCEC	Lebanese Center for Energy Conservation
LBP	Lebanese pounds
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
Med-TSO	Mediterranean Transmission System Operators
MEDREG	Mediterranean Energy Regulators
MEUR	Millions of Euros
MEW	Lebanese Ministry of Energy and Water
Mtoe	million tonnes of oil equivalent ()
MW	Megawatt
MWp	Megawatt peak
NEDCO	Northern Electricity Distribution Company
NEEAP	National Energy Efficiency Action Plan
NEPCO	National Electric Power Company
NERC	National Energy Research Centre
NEEREA	National Energy Efficiency and Renewable Energy Action
NES	National Energy Strategy
NRA	National Regulatory Authority
NREAP	National Renewable Energy Action Plan
ONEE	Office National de l'Electricité et de l'eau potable
NTC	Net Transfer Capacity
OS	Operator of the Electric System
PCI	Projects of Common Interest
PENRA	Palestinian Energy and Natural Resources Authority
PERC	Palestinian Electricity Regulatory Council
PETL	Palestinian Electricity Transmission Company Ltd
PNME	National energy efficiency programme
PPAs	Power Purchase Agreements
PPGC	Palestine Power Generation Company
PPP	Public and Private Partnership
PST	Plan Solaire Tunisien
PS	Political Stability
RES	Renewable energy sources
RoL	Rule of Law
SELCO	Southern Electricity Distribution Company
SEMC	Southern and Eastern Mediterranean Countries
SEPCO	Samra Electric Power Company
SPE	Sonelgaz Electricity Production
STEG	Tunisian Company for Electricity and Gas
TEAŞ	Türkiye Elektrik Üretim İletim Anonim Şirketi (Turkish Electricity Generation-Transmission Corporation)

Term	Definition
TEDAŞ	Türkiye Elektrik Dağıtım Anonim Şirketi (Turkish Electricity Distribution Company)
TEDCO	Tubas Electricity Distribution Company
TEİAŞ	Türkiye Elektrik İletim Anonim Şirketi (Turkish Electricity Transmission Corporation)
TEK	Türkiye Elektrik Kurumu (Turkish Electricity Authority)
TETAŞ	Türkiye Elektrik Ticaret ve Taahhüt Anonim Şirketi (Turkish Electricity Wholesale Corporation)
TSO	Transmission System Operator
TYNDP	Ten Years Network Development Plans
TWh	Terawatt hour
US	United States