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RENEWABLE ENERGY SOLUTIONS
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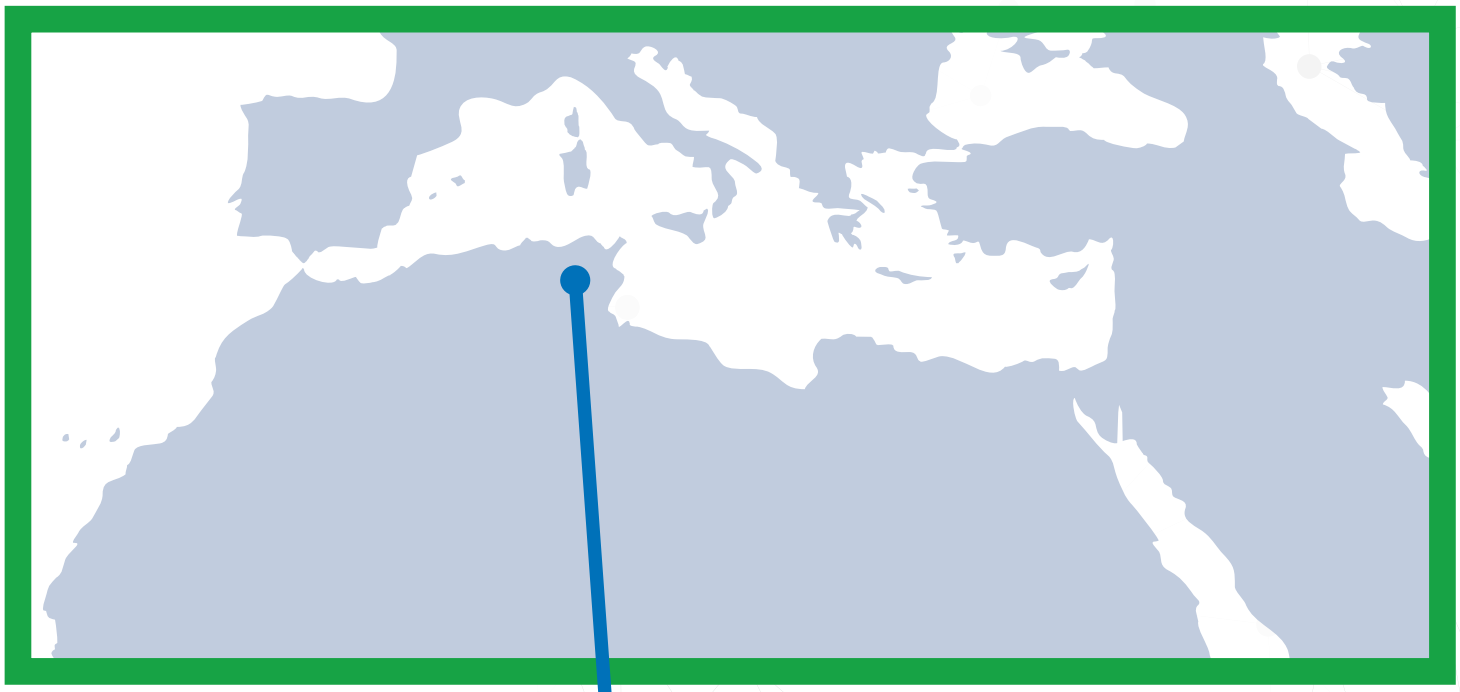
Country Profiles



Tunisia

November 2016

About RES4MED

RES4MED (Renewable Energy Solutions for the Mediterranean) is a non-profit association of leaders among utilities, industries, agencies, technical service providers, consultancy and academia, with the mission to support the deployment of renewable energy, both large scale and distributed energy, of energy efficiency solutions and facilitate their integration in the local and regional markets to satisfy local energy needs.

RES4MED, as integrated platform for public-private dialogue on renewable energy issues in the Mediterranean, aims at building a dialogue with Regional Institutions, local Governments, and Regulatory bodies by providing a practical outcome-oriented approach.

With all these partners, RES4MED started relevant partnerships and joint initiatives aimed at cooperating in specific fields in the Mediterranean Countries. This engagement activity is part of the RES4MED operating model set up for achieving the Association objectives', based on the public-private partnership model.

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TUNISIA 2020
ROAD TO INCLUSION SUSTAINABILITY AND EFFICIENCY

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Abbreviations

ANME	Agence Nationale pour la Maîtrise de l'Energie (National Agency for Energy Conservation)
CCGT	Combined Cycle Gas Turbine
CSP	Concentrated Solar Power
DSO	Distributor System Operator
EE	Energy Efficiency
EIB	European Investment Bank
EPC	Engineering Procurement Construction
EU	European Union
FNME	National Fund for Energy Management
FTE	Fund for the Energy Transition
FiT	Feed-in-Tariff
GDP	Gross Domestic Product
GW	Gig watt
IEA	International Energy Agency
IPP	Independent Power Purchase
JICA	Japan International Cooperation Agency
KWh	Kilowatt Hour
MIT	Ministry of Industry in Tunisia
MoU	Memorandum of Understanding
MW	Megawatt
MWh	Megawatt per hour
O&M	Operation and Maintenance
ONE	Observatoire National de l'Energie (National Energy Observatory)
PPA	Power Purchase Agreement
PROSOL	Solar Thermal Program
PROSOL Elec	Solar Program Photovoltaic (PV on the roof)
PST	Plan Solaire Tunisien (Tunisian Solar Plan)
PV	Photovoltaic
RE	Renewable Energy
RFP	Request for Proposal
SPV	Special Purpose Vehicle
STEG	Société Tunisienne d'Elèctricité et de Gaz (Tunisian Company for Gas & Electricity)
STEG ER	STEG Renewable Energy
TOE	Ton of Oil Equivalent
TPA	Third Party Agreement
TSO	Transmission System Operator
TWh	Terawatt Hour

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Abstract

In recent years, Tunisia has set in motion an energy transition as a strategy to deal with a changing economic and energy context. Population growth and depleting gas resources have had a significant impact on the country's energy balance. In **2001,** the country became a **net energy importer** after many years of surplus power generation and the gap between production and demand is growing every year. Tunisia's **energy dependency** reached 40% compared to previous years and this number will likely increase in the future. Moreover, this trend will also have an impact on energy security. Consequently, the development of renewable energy has been seen as an important solution for securing Tunisia's energy future. That is why in recent years the country has made visible **efforts** to support the deployment of renewable and energy efficiency projects. Those efforts are aligned with the **ambition** revealed on the **national strategy** to get **30% of energy generate by renewable** and **30% reduction of the primary energy consumption** by **2030**.

Tunisia has already demonstrated its capacity to develop strategic energy efficiency projects with appropriate support since the creation of the ANME in 1985, the country's national energy conservation agency. Moreover, renewable energy facilities have started to be drawn up by the energy actors STEG and STEG-ER, main energy company in Tunisia. Current installed renewable energy capacity represents **245MW**of **wind** and **68MW**of **Hydropower** in 2016. However, the country has to maintain efforts to reach its ambitious targets by 2030. Indeed, Tunisia's renewable energy potential –particularly solar and wind energy- is important in light of opportunities for economic growth and possible foreign investment.

The national energy producer and distributor, STEG, already has several projects planned out for wind and solar in the near future. However, Tunisia is also hoping that foreign **investors' projects** will play an important role on renewable energy development for the country. In order to facilitate projects development and attract foreign investment, the minister of energy is accelerating the elaboration of the framework for renewable energy projects' implementation. Moreover, an expansion of the grid could be necessary for the integration of large-scale renewable energy projects.

Efforts were made on regulatory and policy frameworks to support renewable energy integration. In 2012, Tunisia's Ministry of Energy, Mines and Renewable Energies, decided to create a specific law to cover renewable energy project development. After three years of reflexion on its elaboration, the law was submitted for approval on the15thof September2015. In August 2016, the Tunisian government approved the **decree of application** of the **Law N°2015-12**. This announcement finalizes the legal framework for the development of renewable energy projects eagerly awaited by foreign investors. The elaboration of the feed-in-Tariff is the next important step, specially for the deployment of investors projects. This tariff is currently the main grounds for thought for the ministry and central energy actors of Tunisia.

Tunisia's ambition regarding the development of renewable energy and the attraction of foreign investors to develop projects is strong and evident. Driven by the need to reduce their energy dependency and to increase energy security, Tunisia's energy stakeholders are making a continued effort to align their projects to the national strategy in order to reach 30% of energy generate by renewable by 2030.

1 Macroeconomic & Global Energy Context

1.1 Macroeconomic context

Tunisia is a country of North Africa, sharing 965 kilometers of boundaries with Algeria to the west, 459 kilometers with Libya on the southeast and a border with the Mediterranean Sea on the north and the east. The Tunisian capital, Tunis, is located in the north-east of the country. The total area of the country is about **164,000 kilometers,** with **50% of the land used for agriculture** (8.7 millions of hectares). The Sahara desert represents more than 30% of the country, while the remaining lands are composed of mountains and plains with fertile soil. In 2015, the **population of Tunisia reached 11,107,800**, following an annual growth rate of 1%. About 63% of the population lives in urban settlements. The proportion of men and women in Tunisia is stable and balanced, but the young generation (between 0-14years old) represents only 23% of the overall population.

Table 1: Tunisia - Country Identity

Source : WorldBank & IEA

Item	Data	Date & Source
Capital	Tunis	
Languages	Arabic (Tunisian Arabic/ Chelba (south)/French (large scale usage))	
Area	164,000 km²	2015
Agriculture Area	50%	2015
Desert Area	30%	2015
Population	11,107,800	2015
Population Growth rate per Year	1%	2015
Density	65 hab/km²	2014
IDH	0.721	2014

Reaching **43.045 Billion USD in 2015, the GDP** of Tunisia has fallen compared to the previous year (47.603 Billion USD in 2014). The economy of Tunisia has always been diversified, driven by agriculture (olives, dates...), mines and energy resources (phosphate and hydrocarbon), tourism and manufacturing industry (clothes and food). Finally, internal consumption remains the primary driver of the Tunisian economy.

However, since 2012, the GDP growth rate of Tunisia has been falling, reaching 0,8% in 2015. This negative tendency is mainly due to the decrease of hydrocarbon production at the beginning of 2015, coupled with the cessation of phosphate extraction, following social conflicts and political instability in the country. During the same periods, there was no compensation made by a growth of activities in agriculture, services and manufacturing industry. Moreover, the touristic sector representing 7% of the GDP has also decreased significantly, achieving 35% fewer revenues if compared to 2014. Furthermore, while **inflation** reached 9% in the early 1980s, it decreased to **3,6%** in 2015, and the rate of

Figure 1: Tunisian GDP Growth & Prospectives

Source: Adapted from the WorldBankGroup

unemployment in Tunisia stays high representing **15,2%** of the active population in 2014.

Certain disparities inside the country remains between the different geographical areas because of a lack of public investment and local administrations actions. Indeed, the country's activities are mainly concentrated in the coastal regions, thus creating a gap between the major cities on the coast and the medium cities in the countryside.

Table 2: Tunisia - Economic Key Indicators

Source : WorldBank & IEA

Item	Data 2015	Date & Source
GDP	43,015 $	2015
GDP growth rate	0,8%	2015
GDP per capita	3,872.5 $	2015
GDP per capita growth rate	-0.2%	2015
GNI par Capita	3,970 $	2015
Inflation	3.6%	2015
Deficit	4.2% of the GDP	2015
Unemployment Rate	15%	2015

Social and political troubles have had a direct impact on power generation, adding economic pressure on Tunisia. The energy importation bill of the country is reaching 5.5 billion dinars in 2015 (45% more than 2010). **Domestic oil production has fallen** over the last year. Indeed, the nation planned eleven explorations and drilled only one for oil. Investment is also impacted staying stable with 733,000$ of industry spending.

The crude oil production of Tunisia is mainly devoted to exportation, and it imports most of its refined fuels. The national production of natural gas is primarily consumed locally accounting for 47% of demand. The rest is coming from Algeria.

Finally, the **energy consumption** is following the opposite tendency compared to the oil and gas resources. Indeed, the demand is **increasing** by around 3% a year.

Figure 2: Tunisia's Collapsing Oil Production

Source: Bloomberg Article 2016

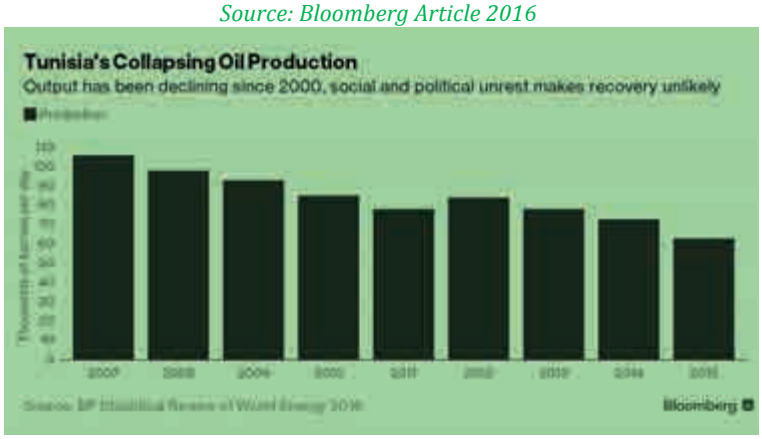


Table 3: Tunisia - Energy Sector Key Indicators

Source : IEA

Item	Data	Source
Energy global Production	7.30 Mtoe	2013
Energy Consumption growth rate (annual)	3%	2015
Net Importation	3.46 Mtoe	2013
TPES	10.41 Mtoe	2013
TPES/GDP	0.24 toe/1000$ (2005)	2013
CO2 Emissions	23.65 Mt of Co_2	2013

1.2 Global Energy market

Prior to address the power market structure, it is necessary to provide an overview of the global energy market in Tunisia. The exportation and importation are composed mainly of oil, natural gas, and fuel. It must be observed how those exchanges have an impact on the electricity production of the country, especially on renewable development and that is why this introduction focuses on the global commercial exchange of energy in Tunisia.

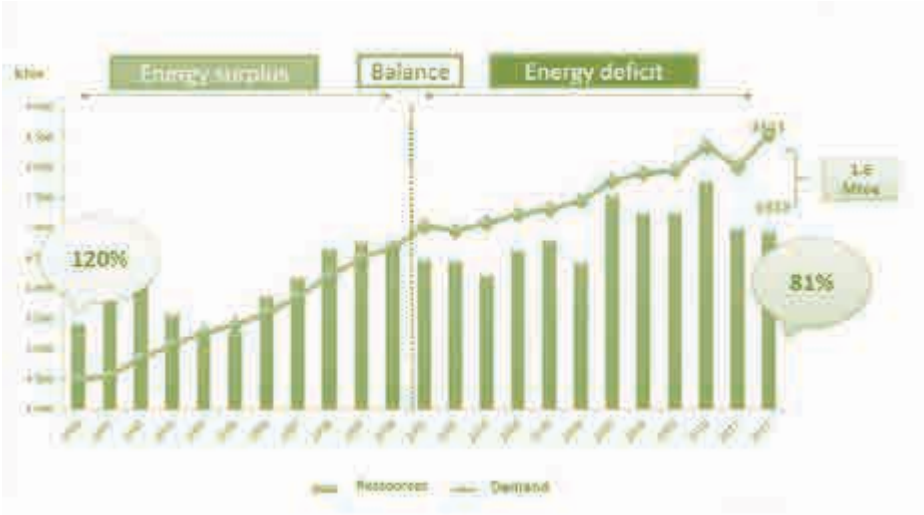


Figure 3: Tunisia Energy Balance
Source: IEA

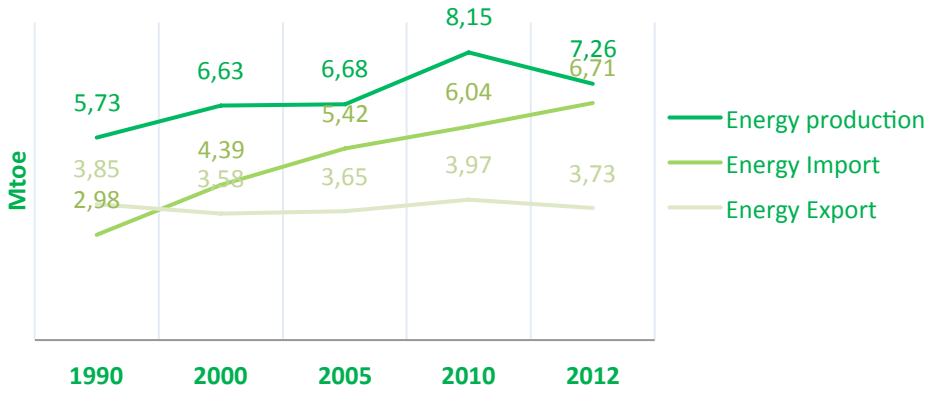
The **energy balance** of the country is impacted by the increase in the **deficit** between importation that has been growing since approximately fifteen years. During the last three years, the import is still increasing by 14% between April 2014 and April 2015. At the same times, the exportation has been falling with a decrease of 22% in the same period of time.

This situation is due to several factors:

- The **depreciation of 21% of the Tunisian Dinar** compared to the US dollar (between April 2014 & 2015)
- The **decrease of the Algerian gas price of 21%,** that does not follow the Brent rate of price reduction of 49% (between 2014 & 2015)
- The **importation of Oil** product has had an increase of 42% in quantity and a decrease of 2% in value. Such variation has impacted electricity production from renewable sources, while increasing the production from fuel.
- The **decrease of fuel exportation,** that affects global exportation.

Figure 4: Global Energy Profile Tunisia

Source: UNFCCC Country Brief 2014



The Tunisian **energy balance had a reverse at the beginning of the 2000 century**. Indeed, the country has reached a perfect energy balance between production and demand around 2000. In **2001**, Tunisia became a **net importer country**. This reverse of the balance was mainly due to the **decrease of oil and gas resources** of the country coupled with the **increase of the population,** that has lead to a demand growth. The energy dependency of the country has been since increasing each year, leading to **risks for the energy security** of the country.

In Figure 5, the decrease of oil production is clearly visible. Natural gas generation increased around 1995 in order to compensate the oil decrease, but since this time the production has remained mainly stable, while the demand has been stedily increasing. Since 2010, the global energy productions has started to decrease, worsening the gap between production and demand.

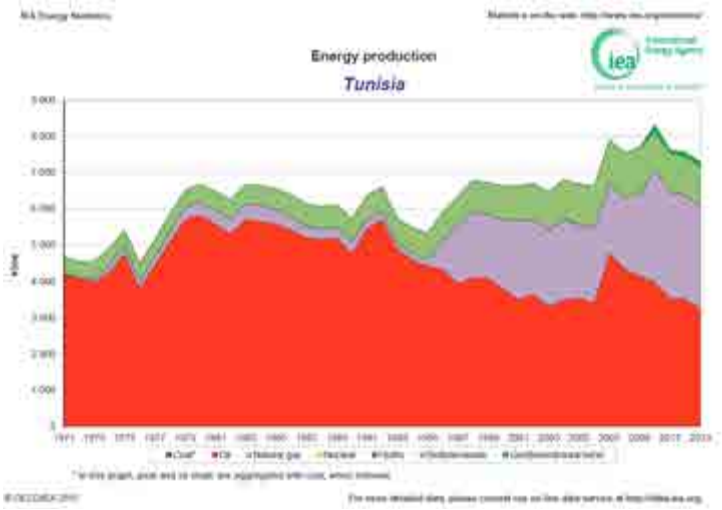


Figure 5 Global Energy Production in Tunisia

Source : IEA

2 Power overview in Tunisia

In 2013, Tunisia started its energy transition process focusing on energy efficiency and renewable energies. The goal of Tunisia is to reduce the primary energy demand of 30% by 2030 and to develop renewable integration to up to 30% by 2030. Moreover, on September 16th, 2015 at the COP 21 Tunisia has exposed its objectives regarding CO_2 emission for 2030. The country aims to decrease the carbon intensity by 41% compared to 2010. In this context, the Juridical institutions of Tunisia have created on May 11th, 2015 the law n°2015-12 to support renewable development and energy transition.

However, the current power system poses some challenges for Tunisia. In one hand, **the dependence on conventional power** and the **difficulties in balancing the system** (see Figure 3); in the other hand, **the fluctuations in global energy prices** impacting the investment possibilities.

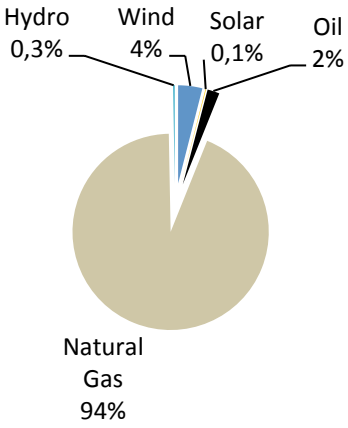


Figure 6: Power production Mix 2014 (19 TWh)

Source: ENEL Green Power

The **power market of Tunisia is managed mainly by the STEG** is currently driven by a power generation composed at **94% from Natural Gas sources**. However, the expansion of renewable energy generation clearly displays the ambition of Tunisia effectively implement an energy transition.

Table 4: Power market Overview Tunisia - Key Data

Tunisian Power Market - Overview	
Item	Data (2014)
Electricity Demand	18.35 TWh
Electricity Demand pro-capita	1.7 MWh
Electricity demand growth rate 2014-2020	3.8 % (p.a.)
Total Power Generation	19 TWh
Total Installed Capacity	4.8 GW
Electrification rate	99,6%

Source: Enerdata, IMF Apr 2016, REN21, Enel Estimates, Agence Nationale pour la Maîtrise de l'Energie

2.1 Legislative and regulatory framework

The legislative and regulatory framework on energy in Tunisia governs the entire sector, providing an all-encompassing set of rules. The increasing interest of the country to develop renewable energy it is clearly displayed through the careful elaboration of laws and decrees. Indeed, in 2009 the renewable legal framework starts with the introduction of the concept in law N°2009-7 text. Then the ministry developed the **Grid Code in 2011** to specify the condition of connection from Renewable to the National Grid. To cover all the aspects of renewable **in 2015, the Law for renewable N°2015-12** is submitted. At the moment, the Tunisian's legal framework know a turning point, with the approbation of the application **decree** of the Law N°2015-12 **in August 2016**, finalizing the legal framework of Tunisia regarding Renewable Energy to support and promote renewable energy projects. This chapter will present the central decrees and laws regarding energy, to achieve a complete understanding of the legislative context in Tunisia. A focus on the renewable energy legal framework will be the subject of a separate chapter (Section 3.3.2, p 26).

Firstly, regarding **Energy production and Independent Power Production (IPP)**, state monopoly status on power generation has been eliminated by the Law N°96-27 opening the generation market to IPP on April 1st ,1996. This provision provides the right of independent entities to produce energy with the condition to sell it only to STEG. However, STEG maintains the monopoly on transmission and distribution. Within this framework, the implementation of the first private power plant was done in 2002 by BOO mode (Build Own and Operate).

The regulatory framework of Tunisia supports **cogeneration** technology development. Indeed, the ANME has developed measures to support those projects, such as the possibility to enter into bank loans with favorable conditions.
However, several requirements are needed to qualify for these programs, slowing down cogeneration projects. For example, promoters will need to achieve 60% efficiency of their installation in one year. Moreover, the sale of the excess electricity to the STEG is limited to 2/3 of the production for projects with a capacity inferior to 3MW and half of the production for the rest. Then, the promoter will have to pay the costs of connection to the grid. Finally, the selling price of electricity is indexed to the purchase price of natural gas (for companies) and set according to the four-time shift (daytime, peak hours, evening & night).

Some laws are dedicated primarily to energy **self-production** installations (cogeneration or renewable), determining the condition of production and sale of electricity surplus. According to the law, the owner of renewable or cogeneration facilities providing energy for own consumption can sell his excess production, but such amount cannot be more than 30% of the annual production. For biomass installation with a capacity inferior to 15MW, an extension of this production could be possible. Moreover, self-producers have to pay a connection fee and the technical advisory committee, while the ministry of energy must approve the installation.

The Law N°2004-72 published in 2004 is the basis for the **energy efficiency** project development, allowing the creation of a new law and support for energy conservation actions.

Law N°2005-106 introduced the **National Fund for Energy Conservation** (FNME, currently named Fund for the Energy Transition - FTE) in 2005. This law aims to finance energy efficiency, renewable energy, and energy substitution projects. The FNME supports such sectors with financial aid in various forms, such as direct fund interventions, resources achieved by the realization of an energy management system, donations, and grants. In 2010, the FNME financed up to 21 million dinars.

Finally, in a particular situation Law requires the establishment of **permits** for the realization of energy projects.

- **Environmental permit:** To conduct an environmental study before the set up of a power generation project is a standard practice. However, it is mandatory by decree for electricity generation facilities with a capacity of more than 300MW. The ANPE, based in the Ministry of Environment, has the mandate to deliver the execution of this study by consultants and experts.
- **Connection to the Grid permit**: The decree N°64-9 exposes conditions to connect power generation plants and supply electricity to the grid, making the subscriber responsible for the connection fee. The permission to connect new installations to the network and the cost will be determined by the STEG, after an analysis of technical specifications.
- **Land Permit**: For project based on the set up for a power generation installation on a land in the public domain, the producer must negotiate a concession agreement, with a precise definition of

the property of the equipment installed after the expiration of the grant period. (By rule of concession of Law N°2008-23).

Diverse ministries must take part in the land permit release procedure and have to provide their **authorization** for project development:

- **The Ministry of Transport** has to deliver an approval for the set up of a new installation which could be an obstacle to aeronautical traffic.
- **The Ministry of Agriculture** has to be aware of a change in the usage of lands (agricultural, closed, or area of backup) to modify its destination by decree, on the advice of the technical advisory committee of local farmland.
- Even if the terms and conditions of the agreement are not precisely defined, it is always preferable to make a request to the **Ministry of National Defence** before to set up new generation equipment.

Table 5: Law classification by Topics
Source : adapted from GIZ report on Tunisia

Topic	Law Text	Date	Content
Law on Energy production & Independent Production (IPP)	Law N° 62-08	1962	Allow some independent producers to generate electricity for their consumption and sell the surplus to STEG.
	Law N°96-27	**01/04/1996**	**Authorizes the state to grant independent producers "IPP" concessions of power generation for exclusive sale to STEG by a PPA.**
	Law N°2015-12	**11/05/2015**	**A new law is giving the legal framework for the development of Renewable energy project. (Section 3.3.2, p 26)**
Law on Cogeneration	Decree N°2002-3232	03/01/2002	Decree of application
	Bylaw of Ministry of Industry & Technology	24/12/2007	Approving the specifications on the technical terms for connection and discharge of electrical energy from cogeneration power plants to the national grid.
	Law N° 2004-72	02/08/2004	Introducing essentials elements for promoting the cogeneration, in particular for production, transmission and sales of electricity.
	Bylaw	18/06/2009	Fix transmission and sale tariffs of electricity surplus deliver to STEG by technical conditions for connection to the national power grid and tariffs of the sale of surplus production to STEG. Fix the rates of transport and sale of excess electricity STEG and the technical conditions for connection to the grid.
Law for electricity production from Renewable Energies	Law N°2009-7	09/02/2009	Introducing essential elements for promoting renewable energies, in particular for the production, transmission, and sale of electricity.
	Decree N°2009-362	09/02/2009	Introduction investment aids for the realization of electricity production projects from renewable energy sources.
	Decree N°2009-2773	28/09/2009	Fix conditions of power transmission, the sale of surpluses to STEG and the upper limits of these surpluses. A decision of the Minister in charge of Energy set the Prices.
	Grid Code	12/05/2011	Technical specifications for the connection of cogeneration and renewable electricity production to the grid.
	Law N°2015-12	**11/05/2015**	A new law is giving the legal framework for the development of Renewable energy project. (Section 3.3.2, p 26)
	Decree 2016	**August 2016**	Application Decree of the Law N°2015 (Section 3.3.2, p 26)
Law on Self-Production	Law N°2004-72	02/08/2004	Give right to self-producer to transport the electricity produced by cogeneration or renewable installation (for own consumption), up to the point of use, and the right to sell the excess to STEG, in a limit set by a decree.
	Decree 2009-2773	28/09/2009	Fixing Transmission & sale condition from energy surplus produce for Self-production and own consumption.
Law establishing the National Fund for Energy Conservation	Law N°2004-72	02/08/2004	Allowing the publication of new legislation and regulation to support energy conservation actions.
	Law N°2005-82	15/08/2005	Created National Fund for Energy Conservation (FNME), financial assistance for the energy conversion field.
	Decree N°2005-2234	22/08/2005	Fix the rate and amounts of premiums of actions regarding the FNME and modalities to grant them.
	Law N°2005-106	19/12/2005	Article 12 and 13, set the national fund for energy conservation, intending to finance energy efficiency operations, promote renewable energy and energy substitution. This fund will provide subsidies for transactions targeted in the article I of the Law N°2005-82.
	Law N°2005-82	15/08/2005	Establish an energy management system.
Approvals & Permits	Decree N°2005-1991	11/07/2005	Environmental Permit: Electricity generation facilities of more than 300MW requires environmental impact studies.
	Decree N° 64-9	17/01/1964	Grid license: Connections fees to the national grid are the responsibility of the subscriber.
	Law N° 2008-23	01/04/2008	Land Permits: Determine rules for a concession contract to set up a project on a land in public domain.

2.2 Electricity key stakeholders

Few entities manage energy deployment in Tunisia, thus shaping a simple and coherent market structure, but limiting the liberties of IPPs.

The **three main stakeholders** are the T**unisian Ministry of Industry, Energy and Mines**, the Tunisian company of Electricity and Gas (**STEG**), and the National Agency for Energy Conservation (**ANME**).

Table 6: Main Energy Tunisian Actors

Institution	Role
Ministry of Energy, Mines and Renewable Energies	The Ministry of Energy, Mines and Renewable Energies of Tunisia have to elaborate governmental policies in the different area under its control. Regarding, the energy sector its main missions are: – To promote the research and the exploitation of energy resources, – To assure the energy security of the country, – To develop and implement policies and juridical texts regarding energy efficiency and energy transition through renewable, – To negotiate with companies and to attribute permit of research, – To elaborate energy projects, and manage the exploitation of resources, – To assure optimization of the hydrocarbon production, and optimize market conditions, – To promote the usage of a clean source of energy,
STEG Société Tunisienne d'Electricité et de Gaz	The STEG founded in 1962, by the Law N°62-8 aiming to harmonize the energy sector in Tunisia, gave to the STEG the responsibility of the management of the production, transportation and the distribution of electricity and gas in Tunisia. The primary objectives of the STEG are: – The electrification of the country – The development of the Natural Gas network, – The development of installation for electricity and gas. To realize those objectives several tasks is under its responsibility: – The management of the electricity from diverse sources such as thermic, hydraulic, windmills, – The transport of electricity with the administration and development of High-tension grid and lines, – The distribution of power with the administration and development of medium and low tension grid and lines, – The development and distribution of natural gas, The production of LPG (Liquid Petrol Gas).
STEG-ER Renewable Energy	STEG-ER is the renewable part of the STEG. The main activities of the STEG-ER are to study, realize, operate and assure the maintenance of renewable and cogeneration installations. Working in the three following sectors: – Wind – Solar – Cogeneration The primary mission of the STEG-ER are: – Promotion of the Tunisian Solar Plan (see section 3.4). – Projects development: Feasibility study, resource study. – Projects realization: ownership, supervision. – Exploitation and Maintenance.
ANME Agence Nationale pour la Maîtrise de l'Energie	L'ANME created in 1985; it is an entity under the administration supervision of the Ministry of Energy. Its primary missions are to apply Tunisian policies regarding energy management by studying and promoting energy efficiency, renewable and energy transition. The ANME is composed of two section one focus on Renewable projects and the other one on Energy Efficiency. The branch working on energy efficiency is divided into three sectors: Industrial, Building, and Transport. To improve the energy efficiency and to diversify energy resources, the role of the ANME is: – to elaborate and implement national programs regarding energy management, – to realize strategic studies on emission reduction, – to manage the FNME, – to propose a regulatory and legislative framework, – to develop awareness actions, – To encourage financing and investment on renewable energy and energy efficiency. Focusing, on energy policies the main tasks of the ANME are: – to develop national resources of Hydrocarbon, – to ensure the energy security at low costs, to promote of renewable, – To support the energy transition and to promote domestic and international energy cooperation. Focusing, on energy conservation the main tasks of the ANME have: – to manage Energy efficiency with the rationalization of the power consumption, – to manage energy audit and consultations on power consumption and ESCO's, – to develop the information for household appliances energy consumption and make thermal regulations on buildings, – To control in a rational way the usage of public lighting, to make diagnostic of car's motors, and to develop urban transport plan in the main cities.

2.3 Power Market Structure

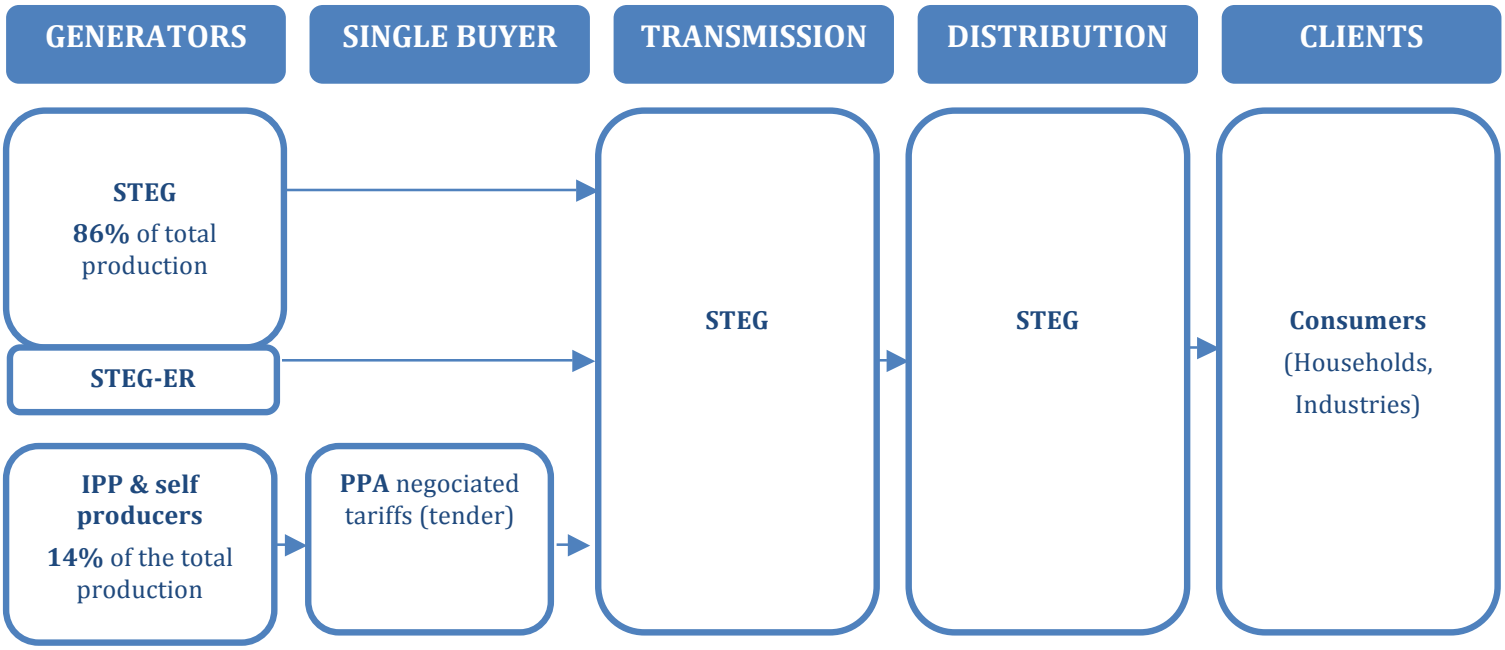
STEG, under the supervision of the Ministry of Industry, is the leading actor in the Tunisian electricity market, performing production, transmission and distribution of energy. Such framework has simplified the energy market, that is currently composed of few key stakeholders. In any case, it is relevant to point out how STEG's monopoly status in electricity generation ended with the opening of the market to IPPs in 1996.

Figure 7 shows an overview of the Electricity market structure of Tunisia:

- **STEG holds the monopoly of transmission, distribution, and sale** of electricity. Moreover, the company performs most of the power generation, accounting for **79% of the total production,** in 2015. At the same time, **STEG-ER** manages part of the renewable and alternative energy production.
- Currently, **IPPs** represent **17% of the total electricity generation** (see Figure 7). However, their contribution is limited to production for either self-consumption or in order to sell energy to STEG.

Figure 7: Tunisian Electricity Market Overview

Source: Adapted from ENEL Green Power **[29]**



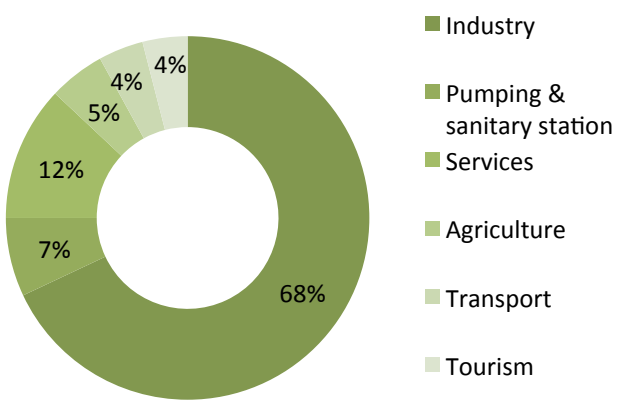


Figure 8: Consumption repartition by Sector Mars 2015 (HT&MT)

Source: ONE 2015

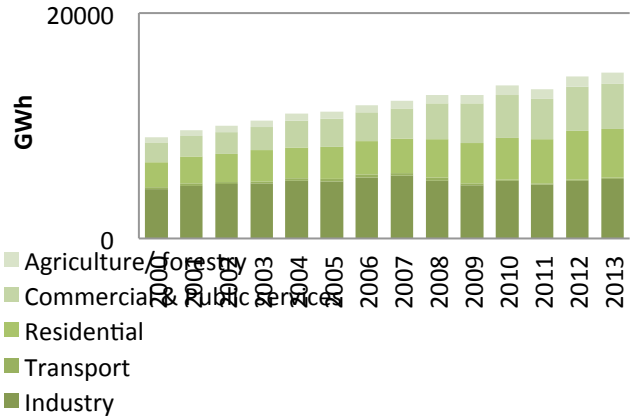


Figure 9: Electricity Consumption evolution & repartition by sector

Source: IEA Database

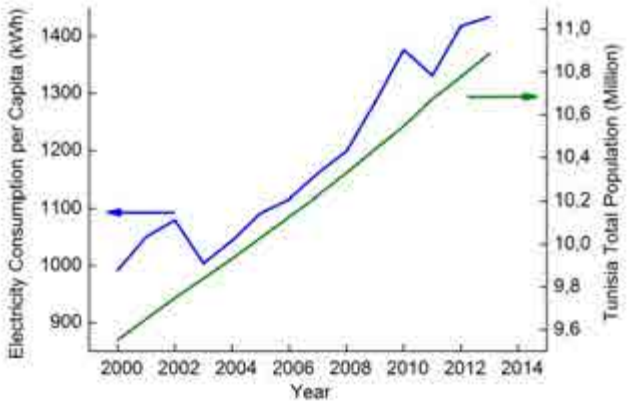


Figure 10: Tunisian population evolution & Energy consumption per capita

Source: Data bank mondial

2.4 Power Demand

The **global energy consumption of Tunisia is equa**l to 0,9 TOE. **Oil consumption** still accounts for the **vast majority** of the total energy consumed in the Country, followed by electricity, gas, and biomass.

In relation to the **power demand, consumption** by the inhabitants was set around 1315 kWh in 2010 and has been characterized by a**n increase** of around 4% every year. The main amount of energy consumption stems from the usage of lighting and electrical devices (80%).

The breakdown of energy consumption in Tunisia by sectors is summarized below:

- The **transport sector** accounts for more than 30% of the total energy consumption. The primary energy source in such sector is Oil.
- Energy consumption increase in the **industrial sector** of Tunisia is the fastest among Mediterranean countries with 35% of total energy consumed. In this sector, oil remains the most used source of energy.
- The **service sector** accounts for only 4,5% of the energy consumed, mainly used in connection with tourism.
- The use of energy from the **agricultural sector** accounts for only 7% of the total energy consumption. However, agriculture accounts for a significant share of the country economy, with an overall amount of farmable land equal to 5000m^2 per inhabitant.

As it is shown in Figure 10, the energy balance of Tunisia has to face two problems regarding consumption. On one hand, the **population of Tunisia is still increasing**, reaching 11 millions of inhabitants in 2014, even if the population growth rate has steadily been reducing down to 1 percent per year during the past decade. On the other hand, the overall trend of **energy consumption per inhabitant** in Tunisia, although carefully managed by the ANME by means of various energy efficiency projects, is **also increasing**, achieving 1,430 KWh/capita in 2013.

The increase of electricity consumption could be related to the steady development of electrification in the country. In fact, in 2012 Tunisia achieved **99,8% of electrification rate** (100% in urban areas and 97% in the countryside) compared to 95% in 2000. However, this is not the only factor influencing electricity consumption, as the **multiplication of electrical appliances** in the households and cities could also represent a key factor. That is why Tunisian's energy actors are focusing not only on the implementation of new renewable energy projects, but also on energy efficiency and conservation.

2.5 Power Supply

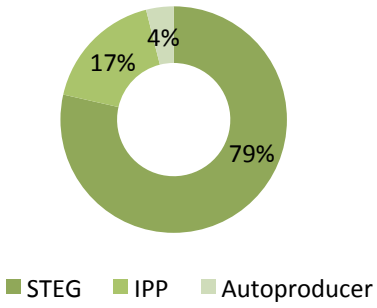


Figure 11: Electricity Production 2015 per producer in GWh

Source: ONE Web Data

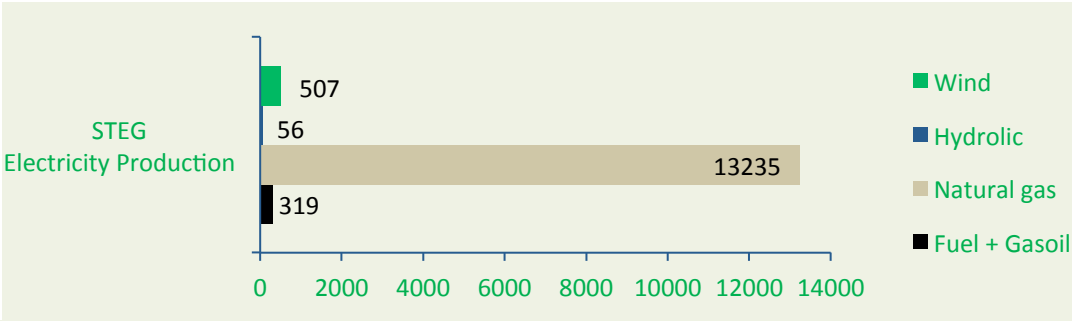


Figure 12: Repartition of STEG Electricity Production GWh

Source: ONE 2014

In **2015,** the electricity production of Tunisia reached **18 256 GWh,** with an installed capacity of **5224** MW.

As shown in Figure 11, STEG generates the most of the electricity in the country, accounting for up to **79 %** of the production in **2015**. The main source used by STEG to produce electricity remains natural gas, which accounts for **13 235GWh** per year. However, even if natural **gas represents the main input** for the production of energy, the **share generated by renewable sources is increasing**. According to the monthly report by ONE, in May 2015, the production of electricity generated by hydraulic sources has had an increase of 42% compared to the same period in 2013, while electricity generated from Wind has grown by 127% in the same period of time. The usage of natural Gas to produce electricity has known a negative variation of 8% if compared to that period. Those data clearly show the effort of Tunisia to implement an effective energy transition from fossil fuel to renewable energy generation.

The share of energy generated by **IPPs** in May 2015 accounts for **17%** of the total with 3314 GWh produced. In Figure 13, we can appreciate how, since the opening of the market in 1996, the electricity production made by IPP has had an increase in 2002 with the installation of the power plant Rhades II and Zarzis, that mainly use natural gas as input. After this period, the IPP power production has remained stable, oscillating around **3200 GWh** in absence of any new IPP installation.

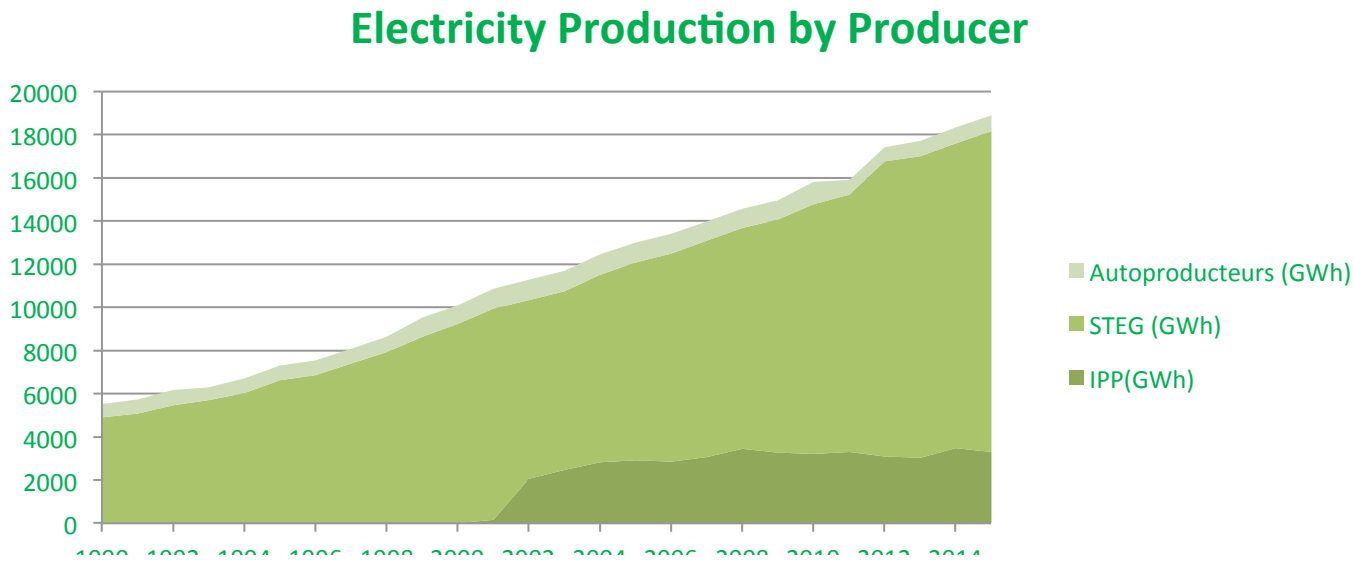


Figure 13: Evolution of the Electricity Production by Producer

Source: ONE WebData

As previously mentioned, **Figure 14** showing the evolution of electricity production's sources in Tunisia, confirms the supremacy of natural gas, that accounts for **94%** of the total Tunisian power production. Natural gas is used as base load to answer to the increasing demand for electricity. Tunisia is covering approximately 53% of its gas demand by means of a usage fee paid in kind on the gas pipeline coming from Algeria to Italy. The country tries to cover the rest of the demand with its gas resources. However, the steady decrease of the resource, as illustrated in paragraph 1.2 above, has lead to an increased **dependency to Algerian's gas**.

In regards to the other fossil fuels used **to produce electricity, since 2010 the usage of oil is almost non-existent**: currently oil is mainly used as power source in order to balance the demand when it is needed. While it accounted for 1461GWh in 2007, its consumption decreased to achieve only 67GWh in 2013.

From a different perspective, this graph illustrates an **increase of the renewable usage** as an electricity source. Indeed, the trend in the use of renewables for power production follows the opposite direction if compared to oil usage. In its 2015 May monthly report, ONE has clarified that electricity production coming from renewable sources has been subject to an increase of 19% between 2014 and 2015. This increase is mainly due to the launch of the second part of the project "*Metline el kchabta*", consisting in the development of a wind farm in Bizerth. Following this evolution, the proportion of renewable energy used as a source for electricity production accounts for **4,2%** in **2015**, growing from **3,7%** in **2014.**

The installed power capacity of hydraulic energy is not evolving; only the production could know variations depending on the years, mainly due to climatic factors. Following the development of the hydropower sector, the main expansion of renewable sources has been due to the implementation of several wind projects. **Wind power is now leading electricity production** from renewable sources reaching up to 358 GWh in 2013, against 23Gwh in 2000. **Solar PV** generation has been characterized by a slow start since 2010, with a an increase in production from 1 GWh in 2010 to 11 GWh in 2013. It is relevant to point out how such increase has been achieved mostly by means of **solar home systems** and not due to the development of large scale projects. The other sources are mainly composed of Thermal (stem) power plants and combined-cycle gas turbines.

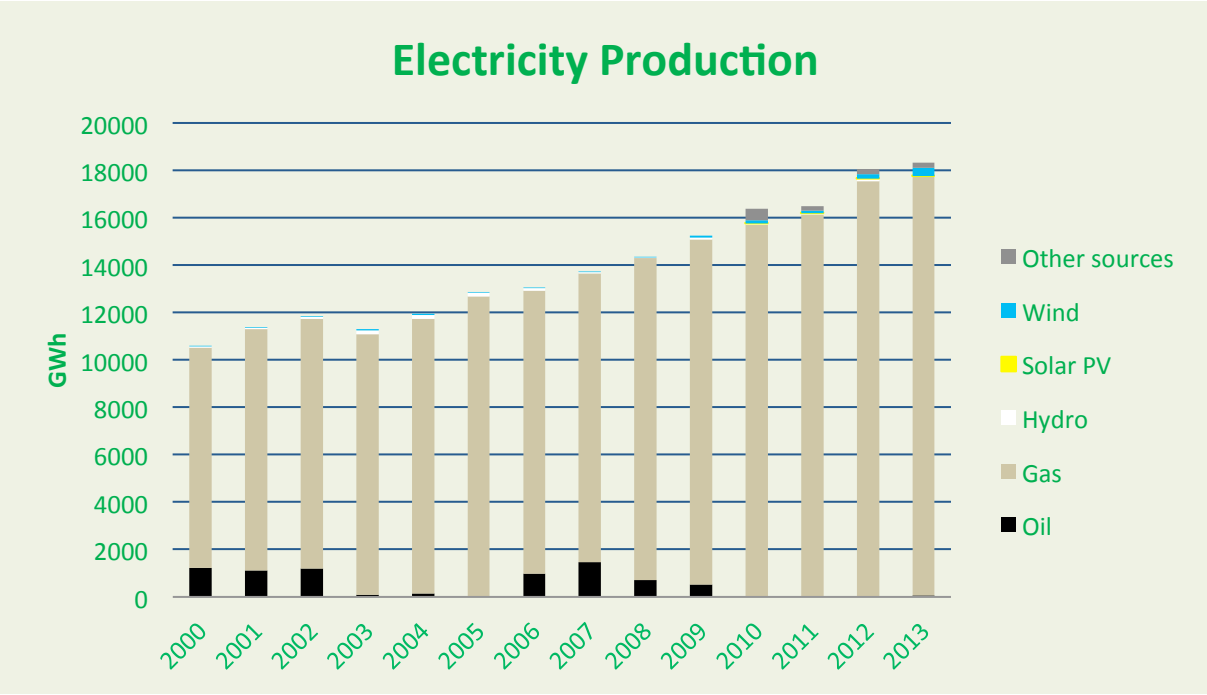


Figure 14: Electricity production per sources

Sources: IEA DATA web

2.6 Grid & Infrastructure

Tunisia is an **energy-dependent country** with modest oil and gas reserves. The global installed **Power Capacity of Tunisia** reached 4827 MW in 2014 and represent **5224MW** in August **2016**.

Up to 94% of the total installed capacity of the country is generated by means of natural gas power fired via thermal station.

The remaining 4,4% stems from renewable installations with: 68 MW of Hydropower, 245MW of Wind, and around 15MW of residential Solar PV system, installed.

The total installed capacity is expected to increase to 7 500 MW by 2021. The reason of the Power capacity rise lies mostly in the need to balance the increase of power demand in the industrial and residential sectors.

This future development of installed capacity in Tunisia will be less based on natural gas, and more on the energy transition process. Indeed, even if some additional power plants could be built, the development of solar and wind will be significant to sustain the economic development and reduce the impact of the country on climate change.

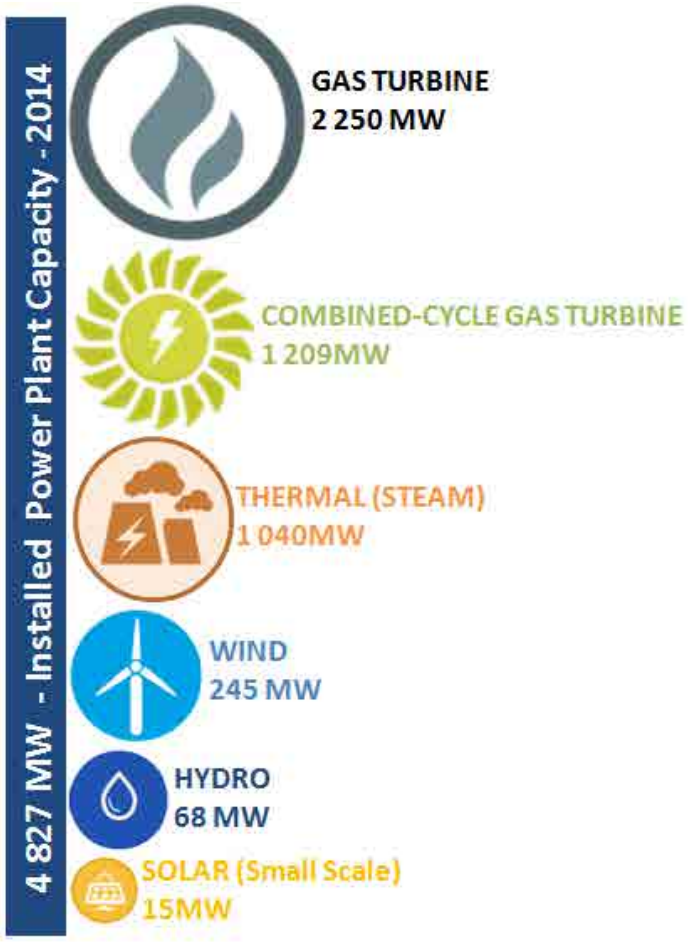


Figure 15: Installed Power Capacity 2014

Sources : Energypédia , Ecomena

Table 7: Tunisian Power Installation (Except solar facilities)

Source : STEG

TUNISIAN POWER INSTALLATIONS - 2014				
Owner	Kind	Name	Dates	Power Installed (MW)
STEG	Gas Turbine	BIR MICHERGUA	1998/2013	476MW
		TUNIS SUD	1975/1978	66MW
		MENZEL BOURGUBA	1978	44MW
		KORBA	1978/1984	56MW
		SFAX	1977	44MW
		KASSERINE NORD	1984	68MW
		GHANOUCH	1973	44MW
		BOUCHEMMA	1977/1999	178MW
		THYNA	2004/2007	358MW
		FERIANA	2005/2009	240MW
		GOLLETTE	2005	120MW
		ROBBANA	1984	34MW
		ZARZIS	1983/1999	34MW

TUNISIAN POWER INSTALLATIONS - 2014				
Owner	Kind	Name	Dates	Power Installed (MW)
STEG & STEG-ER	Thermal	RADES	1985/1998	710 MW
		SOUSSE	1980/ 1994/1995	684MW
		GHAN-NOUCH	2011	425MW
		SOUSSE C	2014	425MW
	Hydraulic Station	SIDI SALEM	1983	36MW
		FERNANA	1958/1962	9,7MW
		NEBER	1956	13MW
		AROUSSA	1956	4,8MW
		KASSEB	1969	0,66MW
		SEJNANA	2003	0,62MW
		BOUHERTMA	2003	1,2MW
	Wind Farm	SIDI DAOUD	2000/2007	54MW
		KACHBTA	2012	94MW
		METLINE	2012	95MW
IPP	Gas Turbine	RADES II	2002	471MW
		ZARZIS	2003	27MW

Transmission current Situation:

Gas and oil represent the main factors for the balancing between supply and demand in Tunisia. The further **development of the electricity grid will allow more flexibility** regarding renewable energy integration and could represent a **positive factor to support their development**.

Between 2012 and 2020, the African Program of Infrastructure Development (PIDA) implemented fifteen projects in the continent to extend the existing energy grids, for a total amount of investment equal to USD 40.5 billion. Those projects aim to further develop border energy exchanges by means of nine hydroelectric plants, four transmission corridors, a gas pipeline and an oil pipeline. One of the transmission corridors will be constructed in North Africa, connecting Egypt to Morocco, while passing through Tunisia. Such new connections will help the development of renewable technologies in the whole MENA region. Indeed, those transmission lines are multiplying the access to several resources of energy, and reducing the problem of balancing supply and demand.

99,8% Electrification rate

Figure 16: Tunisian Electricity Grid
Source: STEG

The grid **connections are more developed in the north and on the coast of Tunisia**, due to the higher density of the population in this area. The main line of **225KV, connects the north to the south** of Tunisia. **Five lines** are currently operational **between Tunisia and Algeria**, composed respectively of two lines of 90kV, and one line of 150, 250 and 400kV each. Those lines have a limited capacity of 1000MW. **Two lines** of 225kV are connected **to Lybia**, but they are used with precaution because of the instability of the electricity infrastructure of Libya. Sudden changes in electricity flow could negatively affect the reliability fo the Tunisian grid. The overall electrification rate of the country has reached 99,8%, with 97% in rural and 100% in urban areas. The most isolated part of the Country is provided with electricity by means of photovoltaic systems.

2.7 Electricity prices

Every year, the Ministry of industry establishes energy prices at the national level taking into account international oil and gas prices, the financial balance of businesses and subsidies provided by the government.

The **sale prices are not high enough to cover the costs of electricity production and distribution**. That is why STEG is supported with public subsidies. However, the government has planned **an yearly increase of electricity prices** to reduce step by step subsidies in this sector. Following this process by 2014, the tariff for the cement industries had increased by 35%. The cost of electricity for the residential and industrial consumers increased by 10%, during the same period.

Such tariff raise is implemented with the goal of progressive **reduction of subsidies**. Indeed, in the sector of high and medium voltage electricity, subsidies for power should decline until disappearing in 3 or 6 years. Nevertheless, the government has not planned any tariff increase for the years 2015 and 2016.

Table 8: Tunisian Electricity Tariff 2014

TUNISIA ELECTRICITY TARIFF 2014 – Mill (of Dinars)/kWh									
Voltage	Consumption	Sector	Energy Price per amount of KWh Consumed (Mill/kWh)						
			1-50	51-100	101-200	201-300	301-500	501+	
LOW VOLTAGE	≤200 kWh /month	Residential	75						
		Residential & other	180						
		Residential & other	140						
	>200 kWh /month	Residential	151			184	280	350	
		Residential & other					250	295	

TUNISIA ELECTRICITY TARIFF 2014 – mill (of Dinars)/kWh						
Voltage	Kind		Day	Morning Peak	Evening Peak	Night
HIGH VOLTAGE	Emergency services		148	233	212	111
	Safety		168	290	255	120
	Cement Industry		212	339	303	181
MEDIUM VOLTAGE	Uniform		167			
	Timetable		152	238	218	115
	Pumping for Irrigation		160		Load Management	115
	Agriculture Irrigation		114	Load Management	132	88
	Emergency services		170	295	258	123
	Cement Industry	Uniform	218			
		Timetable	219	349	312	186
particular LOW VOLTAGE	Public Lighting		218			
	Water Heater		280	Load Management	Load Management	280
	Heat & Air Conditioning		350			
	Irrigation	Uniform	135			
		Timetable	103		295	93

Sources: STEG

3 Renewable Energy & Energy Efficiency

3.1 Current Situation

3.1.1 Renewables

Within the MENA region, gas and oil are abundant and remain the primary sources of energy. The economic advantages of using oil and gas create a significant obstacle for new investments to develop renewable energy production. Indeed, 3,68 Mtoe of oil and 5,04 Mtoe of gas have been produced in 2012, whereas renewable energy accounted only for 0,06Mtoe. The share of renewable energy generation in the Tunisian energy mix has been represented only by hydropower for many years. However, Tunisia has started to increase renewable energy production, reaching approximately 4.2% of the energy mix in 2015.

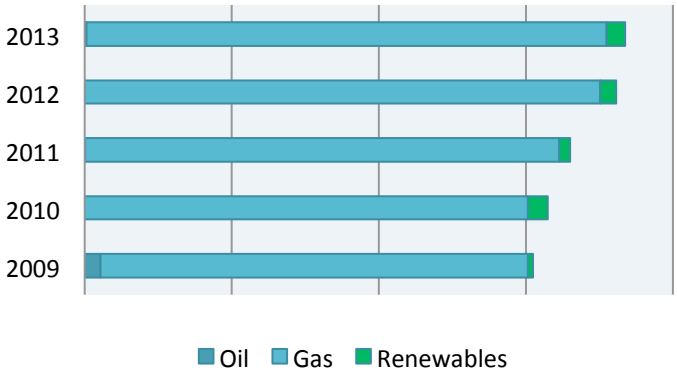


Figure 18: Part of renewable in the electricity Production

Source: IEA Web Data base

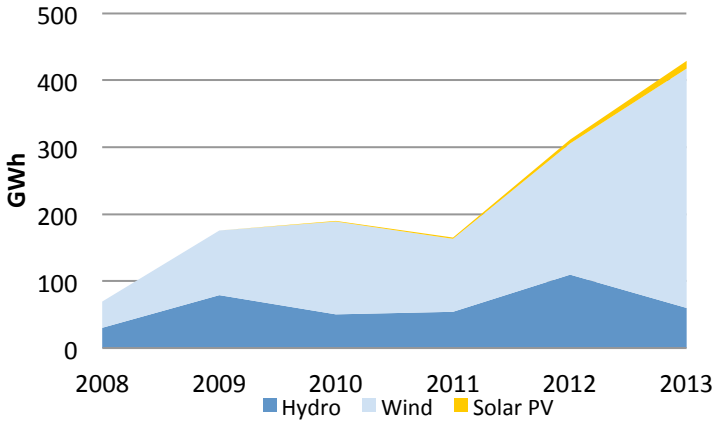


Figure 17: Renewable Electricity Growth

Source: IEA Web Database

The installed capacity of renewable energy at large scale is approximately equal to **313MW** in **2016**. The increase of renewable power production has known a recent increase mainly due to the implementation and **expansion of Wind farms in Bizerte and Sidi-Daoud**. Such increase of installed renewable sites and power production, confirms the ambition of Tunisia to develop a significant renewable energy sector.

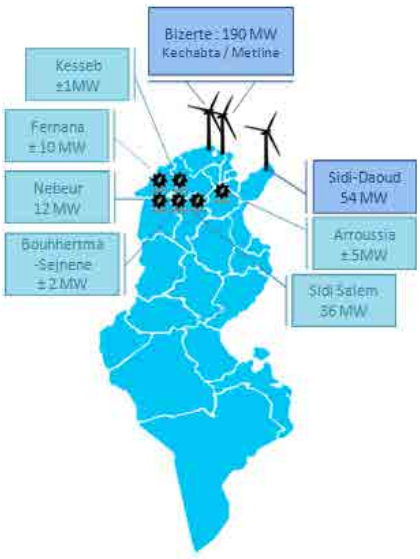


Figure 19: Renewable installation in Tunisia 2016

Source: adapted from STEG presentation

HYDROPOWER

Hydropower has been the first renewable resource exploited in Tunisia. The development of hydropower in Tunisia has been implmented gradually:

- In 1956 the hydro station of Arroussia was installed, with a total capacity of 4,8 MW;
- The same year the Nebeur station was also put into operation with an overall capacity of 13,2 MW;
- The station of Fernana has been developed in two steps: the first one in 1958 with the implementation of 8,2MW, followed by an expansion of 1,3MW in 1962;
- In 1969, 0,66MW was installed on the Kesseb site;
- In 1983, the main Hydro facility of the country was developed in Sidi Salem adding 36 MW of renewable capacity;
- In 2003, the last installations were built in Bouhertma-Sejnene, accounting for additional 1,2 and 0,62 MW.

Hydropower has remained until the year 2012, the main renewable energy resource of the country. The exploitation of several sites has been conducted gradually. Currently, the global hydraulic installed power accounts for **68MW** and has a variable production in between 40 and 160GWh.

Figure 20 : Bizerte Wind Farm (Kchabta)

Source: RES4MED Tunisia 19.09.2016

WIND POWER

Currently, following the leading position of hydropower in energy generation, wind power represents the main source of renewable energy in the country. As shown in **Errore. L'origine riferimento non è stata trovata.**, since 2008 **wind energy** is leading the energy transition of Tunisia with a growth of the production up to **245 MW of power installed in 2016**. Two main wind farms have been developed until now: Sidi-Daoud and Bizerte (composed of two sites: Kchabta and Metline).

Sidi-Daoud

The first wind power project of Tunisia started in 2000, with the installation of the Sidi-Daoud's wind farm in the gulf of Tunis. The station has been developed in three steps before reaching its current power capacity of **54 MW:**

- Firstly the installation of the first 10,56MW in 2000;
- Secondly the addition of 8,72MW in 2003;
- And at last the expansion of 34,32MW in 2009.

The wind farm of Sidi-Daoud is composed of three diverse wind turbine profiles: two small turbine models of 300kW and 800kW (AE32 and AE46) and some bigger ones of 1,32MW (AE61).

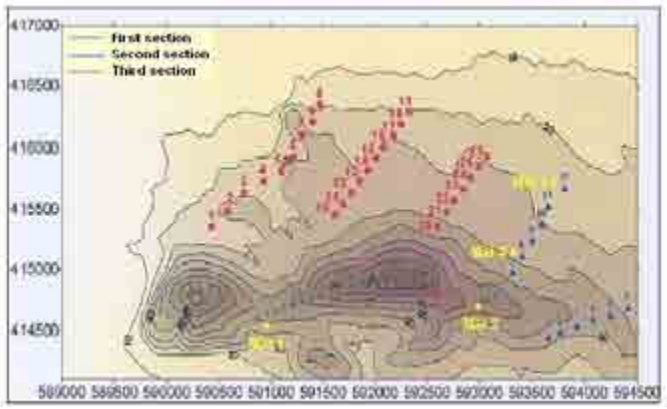


Figure 21 : Sidi-Daoud Wind Farm position map.

Source: INTECH Website

Figure 22 : Bizerte Wind Farm (Kchatba)

Source : Tunisia 19.09.2016

Bizerte

In regards to wind energy, Tunisia launched in **2012** the operation of two wind power facilities with combined production capacity in Bizerte: **Metline and Kchabta Station**. Those stations have been **extended in 2015** with the implantation of 26 new wind turbines. As shown in Figure 17, the development of those stations has conducted to a significant increase of electricity generated by wind power, totalizing a production of **94 MW** for Kchabta **and 95MW** in Metline in 2016.

Currently, Bizerte's wind farms account for a total of **143 wind turbines** (71 Kchabta and 72 Metline), growing from a total amount of 91 before the extension (45 in Kchabta and 46 in Metline). Differently from Sidi-Daoud, the main model of turbine used on Bizerte is AE61 Wind, with a capacity of 1,32MW. Those wind turbines have a height of approximately 59 meters and blades 30 meters long. They work with a system of two windings, that maintains the speed of the rotor stable at 1000 revolutions per minute, even in case of fluctuation of the wind speed. The average wind speed in this area is of about 9 meters per second.

To illustrate, on September 2016, the total production of the site was reaching 40 000MW with a wind speed oscillating between 11 and 17m/sec.

Moreover, this project is saving 120,000 TOE of fuel and 43,000 m^2 of water a year. A loan of the Spanish Fund for Assistance to Development has partially financed the construction of the site. Those efforts can be seen as the starting point of Tunisian energy transition, promising the multiplication of new projects in the future.

Figure 23: Bizerte Windmill Models (Kchabta)

Sources : Tunisia 19.09.2016

SOLAR

Currently Tunisia is **not exploiting solar power at large scale**.

However, several installations for **auto production are in operation**, thanks to the **support of ANME** and STEG. Those projects are mainly developed at the **residential level**. Indeed, for medium and high tension, the development of Solar power generation requires more complex technologies and techniques. That is why, even after the opening of auto production in 2009, industrial companies, as for example cement manufacturers, chose not to implement auto energy production programs. Instead, some small companies are starting to develop their own renewable production. However, the development of the new regulation could have a positive impact on renewable projects development for large industries.

At the residential level, the renewable department of ANME, supported by STEG and several financial entities, has launched the projects **PROSOL** and **PROSOL Elec.** Those initiatives provide effective support mechanisms to develop the usage of solar water heaters and PV panels at the residential level

PROSOL Thermal

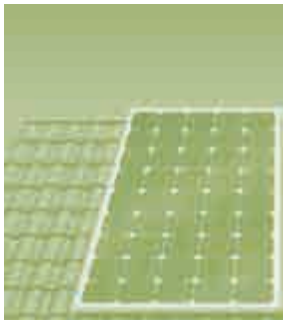
The **project PROSOL** has been implemented as part of the renewable development strategy. It provides for an **incentive to the development of renewable energy by means of a subsidy system** implemented by the state with the Energy Transition Fund (FTE, new National Fund for energy Conservation - FNME) and managed by AMNE. This project is promoting the usage of **solar water heaters for household auto production**.

The project has been implemented by ANME in **2005** and has been reviewed in 2007. It was a great success **totalizing 750 000m² of solar installations** implemented between 2005 and 2016, accounting approximately for *26 000 systems installed each year*. The benchmark amount of installations selected by the ANME was quickly reached in 2008.

The success of this project is based on an effective **financial mechanism**. ANME has developed a partnership with STEG and partner financial entities. A household subsidy is funded by the FTE, while STEG acts as a guarantor for the private society selling the installation. Indeed, the STEG assures the payment of the client through his electricity bill. Moreover, a private partnership with banks allows the client to get consumer credit to support his renewable project.

To conclude, the project has also had a positive impact on employment, building the capacity of the local workforce. In fact, since 2011, ANME has been offering certified training for the installation of solar heaters, assuring the quality of the installation and creating a new job market.

PROSOL Electric (PV)



After the success of the **project PROSOL Thermal**, the renewable section of the ANME tried to expand it to the development of **roof PV panels for residential auto consumption**. PROSOL Elec., started in 2010 by means of the same operational framework as PROSOL Thermal: subsidies from the ETF and public-private agreements between the STEG and partner banks.

The objective for 2016 is to install around 15MW, and it has been already reached and exceeded, with **32MW** installed at the end of September 2016.

BIOMASS

Tunisia is also using biomass as wood and charcoal to produce fuel combustible in rural households. Last year, waste to electricity projects contributed to the addition of 11MW to renewable production. Several projects are in place to develop more efficient biomass stoves.

GEOTHERMAL

To conclude, geothermal energy resources have a significant impact in Tunisia. Geothermal energy is mainly used to heat greenhouses and other heat dependent activities as well as for ice production.

3.1.2 Energy Efficiency

Tunisia is one of the first **MENA countries to develop a comprehensive energy conservation policy**. Indeed, sine **1985** the country has demonstrated its focus on this issue with the **creation of ANME**, that includes a special section dedicated to energy efficiency. Such section works on three main and significant sectors: industry, transportation, and buildings. Diverse projects on energy efficiency have been implemented through the years and are often subsidized by the state through the FTE. The Agency for the Environment and Energy Conservation of France (ADEME) has also supported Tunisia in the development of energy efficiency projects in different economic sectors for the last twenty years.

In the year 2000, the country has established a program for the control of energy use, and ANME was in charge with the development of a strategic plan regarding energy efficiency. To be efficient, the scope of actions of the national agency covered many diverse areas, including legal, financial, education, investment, research, and development.

This program was articulated in several actions having a significant impact on energy conservation that have been deployed from 2000 to 2012 under the supervision of the energy efficiency section of the ANME, such as the spread of low energy bulbs, or the certification of refrigerators and air conditioning.

Moreover, the **Energy Efficiency Department** of the ANME is managing three **main projects**:

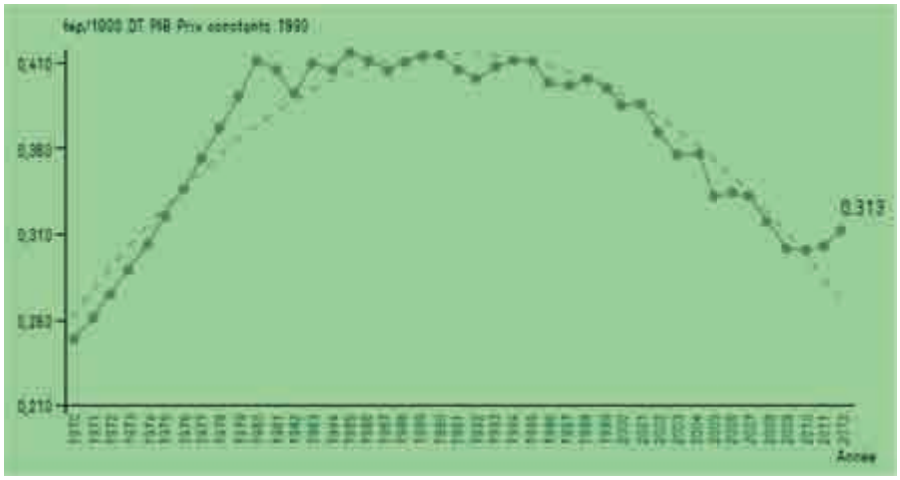
- **Preliminary consultation**:
  The aim of preliminary consultation is to reduce the impact of companies with high energy consumption.
  An average of **50 projects** of preliminary consultations are realized **each year**, including **mandatory and voluntary cases**. Indeed, every five years, 360 companies are subject to preliminary consultation, achieving an energy conservation of 800 TOE/ year. Moreover, some companies volunteer to participate, with a gain in energy conservation of 200 TOE/ year. Those companies receive the same financial support from the state by means of the FTE as the mandatory projects. The preliminary consultation system is applied across the entire industrial landscape.
- **Energy Audit:**
  Energy audit is an **extensive version of the preliminary study**, providing a complete report and an action plan to the firms.
  A **convention** is signed between the ANME and the company intending to perform an energy audit. An **expert** realises an introduction report including technical analysis, consumption rate and all the necessary preliminary activities. A synthetic action plan is then submitted for approval, and is subsequently followed by a second in depth report that focuses, among other things, on return on investment. When the second report is approved by ANME, the technical commission drafts an agreement that defines the **program of actions** and is submitted to the signature.
- **Cogeneration:**
  ANME provides the opportunity to companies to perform a **feasibility study to analyze their potential regarding cogeneration projects**. Those studies offer an idea of the profitability of the project, pursuant to decree N°2002-3232 on cogeneration. Following the start of this program in 2002, currently there are 29 cogeneration advanced projects and 20 at the study level. At the moment, **100MW** are generated by cogeneration process.

This program implemented by the ANME contributed to the **decreasing of the energy intensity** of the country by **2% each year**.

The results obtained since the creation of ANME are encouraging. Indeed, Tunisia has been the emerging market with the most effective energy efficiency policy. As previously shown in Figure 10: Tunisian population evolution & Energy consumption per capita, the growth rate of the energy consumption per capita in the country has significantly reduced starting around 2002. Until an increase in 2009 that reached up to 0,8 TOEs, the consumption growth was well controlled. In any case, the Tunisian government and the relevant stakeholders keep giving priority to energy efficiency actions. Moreover, since its creation ANME has used much support to foster the awareness of the population.

Figure 24: Energy Intensity evolution in Tunisia

Source: ANME



3.2 Potential

3.2.1 Energy Efficiency

As described in the previous section, in regards to energy efficiency many projects have been implemented with a focus on all kind of consumers (household, industry) and by means of different tools: laws, tax, awareness, research, and investment. However, there is still a huge potential to further reduce energy consumption in all sectors and to control the future increase of the demand.

Households account for the main component of energy consumption, with up to 30,6% of the total energy consumed. **At the residential level**, **projects** on household appliances, such as the certification of air conditioning, **could be multiplied**. The industrial and transportation sectors account respectively for 25,1% and 23,6% of the total energy consumed, with the development of cogeneration having an interesting potential for the industry sector.

In any case, the **decrease of electricity consumption is a priority for the country**.

3.2.2 Renewable

The location of the country offers the **opportunity** to exploit two main resources regarding renewable energy generation**: solar and wind**. This provides a real advantage because the availability of those renewable sources is complementary. Indeed, the solar potential during the summer could cover the increase in demand due to the usage of air conditioning, while the stable wind speed could provide a steady base load.

➢ ***SOLAR ENERGY***

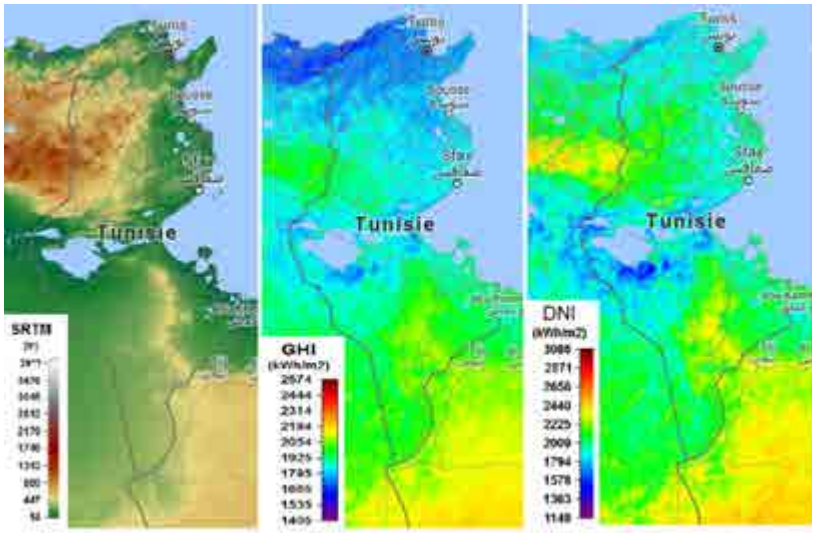


Figure 25 Solar Energy Potential 2016 (Topography/Global Horizontal Irradiance/Direct Normal Irradiance)

Source: Solar Med Atlas

First of all, one of the primary potential sources of renewable energy in Tunisia is **solar power**. It is relevant to underline how solar resources have not been exploited until now at big scale. However, this will change with the application of the Tunisian Solar Plan.

Indeed, the solar potential of the country is abundant, with a **Direct Irradiance** on an average of **1905 kWh/m² per year** (1500 Equivalent Operating Hours). Solar resources are **more intense in the south** of Tunisia, while in the north, the height difference created by the Teressa mountain chain impedes the full exploitation of solar resources.

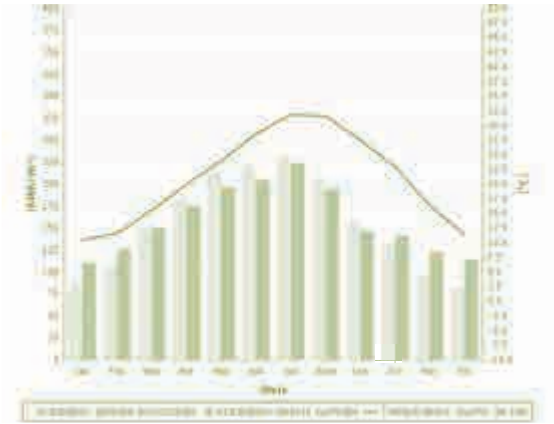


Figure 26: Yearly Tendency of solar Irradiation

Source: Solar Med Atlas

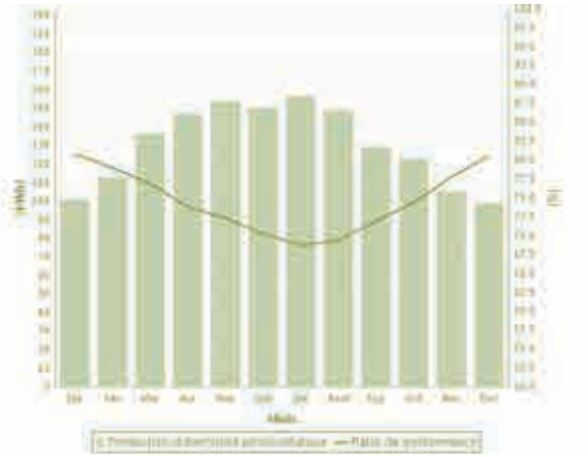


Figure 27: PV Potential production per Month

Source: Solar-Med-Atlas

Figure 27 depicts the current variation of irradiance intensity and temperature in the center of Tunisia. We can see that during the year the lowest amount of direct sun irradiance is around 100kw/m² in December and January, while it reaches the upper limit in July with 225KWh/m².

In total, direct sun irradiance reaches a yearly average of 1905 Kwh/m², with the south of Tunisia accounting for a higher share of the total than the north.

Figure 27, confirms the opportunity to fulfill the increasing energy demand due to air conditioning usage represented by solar power in Tunisia. The **potential of PV energy production can reach up to 160 kWh in the summer**. Moreover, the **efficiency of the PV systems** remains excellent during all year, oscillating between **70% and 83%**. To conclude, the temperature variations are not too extreme (from 10°C to 32°C) allowing the development of solar technologies, limiting technology damage and reducing the cost of maintenance.

➢ ***WIND ENERGY***

Tunisia has access to 1,300 km of coast on the Mediterranean sea giving the option to develop offshore and onshore wind facilities The **wind speed** in Tunisia varies from **4 to 8 m/second**, creating an excellent framework to develop wind power.

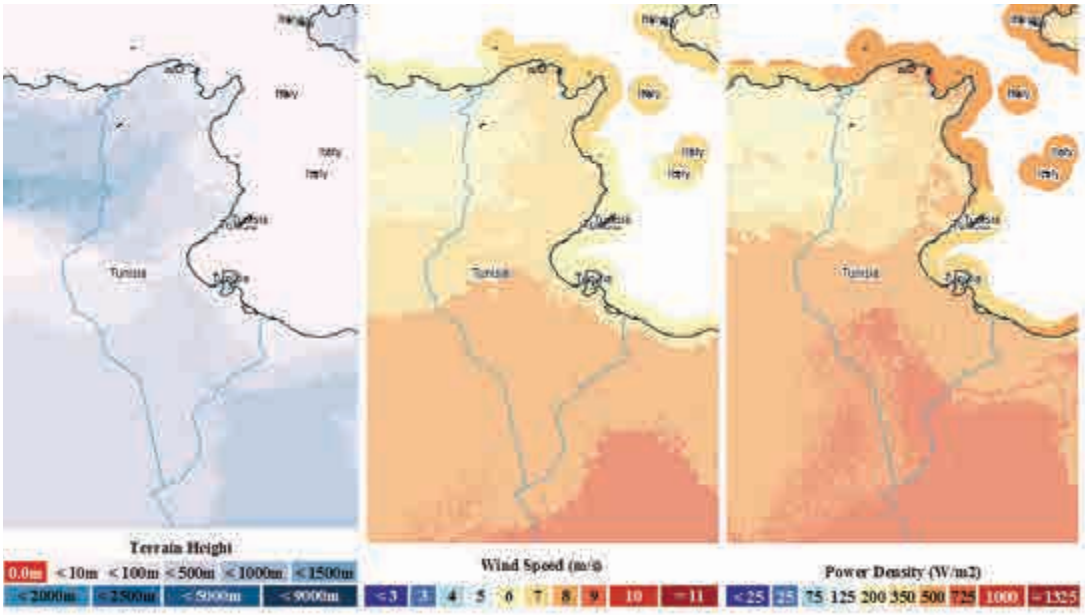


Figure 28: Wind Potential in Tunisia 2016 (Terrain/Wind speed/Power Density)

Source: Wind Atlas

In regards to wind energy, once again the location of Tunisia is beneficial. Indeed, the border with the Mediterranean Sea provides access to air circulation coming from the sea. Figure 28 confirms the wind potential of Tunisia, showing that the wind speed could achieve **8m/s** in most of the **south** with a productivity of **725W/m²**.

The height differences in the **north west** of the country reduce the wind potential in this area down to a speed of **6 and 7 m/s**. However, this is still enough to exploit the wind in order to produce electricity with adapted technologies.

The coasts, especially in the north of the country, are also attractive for the development of wind installations. Indeed, the wind speed can reach 7m/s in this area and produce until 500W/m_2 thanks to the wind of the sea.

On a yearly basis, the wind speed remains stable in Tunisia, with a **light decrease of the intensity in the summer**. This **stability provides good base load** to balance a part of the demand.

Moreover, **wind power fits perfectly within the landscape of Tunisia**. Indeed, many **agricultural fields** offer an ideal location for wind mills and farmers are most of the time favorable to their installation on their fields, also because wind mills occupy less space than PV panels on the agricultural area. This is one of the reasons why wind farms are easier to develop. Metline has been the pilot site for the implementation of a wind turbine on an agricultural field. As shown in Figure 20, the pilot project was a success, and its framework has been renewed on Kachtba site.

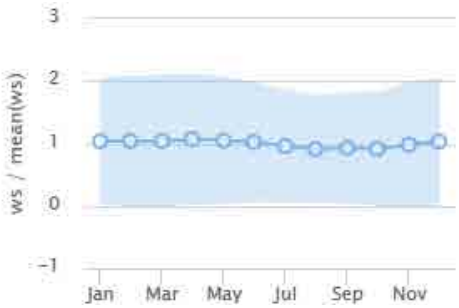


Figure 30: Yearly wind speed Cycle (normalized)

Source: Wind Atlas

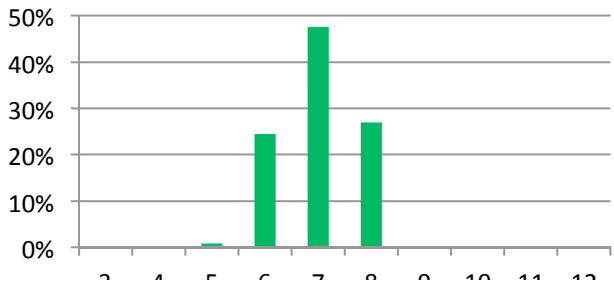


Figure 29: Wind Speed Frequecy Tunisia 2016

Source: Wind Atlas

In April 2009, **ANME**, in collaboration with the Spanish Agency for Cooperation and Development and Spain's National Renewable Energy Centre (**CENER**) completed the execution of the **country's wind atlas**. Such atlas, made available to ANME's developers, is used primarily to identify sites with good wind conditions for the installation of wind farms, in order to further reduce delays in establishing wind farms and to reduce the risk of inefficient choices regarding the sites for the launching of a measurement campaign. Tunisia's wind map shows the existence of several suitable sites for the establishment of the wind farms. The most interesting ones are located in the Nabeul- Bizerte region and in the central region of Kasserine, Tataouine, Médenine, and Gabès with an average wind speed superior to 7 m/sec. Less interesting sites having acceptable wind conditions (S>6.5 m/s) can be found in the eastern areas of Tozeur, Kebili, the east coast of Médenine and the Monastir region.

Wind Atlas Tunisia

Figure 31: Location with Wind Potential in Tunisia

Source : ANME

3.3 Framework for RE & EE development

3.3.1 Strategy, Targets and Key Issues.

➢ ***STRATEGY***

Tunisia has adopted a pro-active policy regarding attenuation and adaptation in order to reduce the risks connected with climate change. The **Intended National Determine Contribution** (INDC) report submitted before COP21 in 2015 is a summary of actions and targets planned by Tunisia. The contribution of Tunisia to the Climate change reduction plan is **based upon existing national strategies such as the Tunisian Solar Plan** (TSP). The Tunisian main stakeholders have implemented this guideline for the development of renewable energy in their country.

TSP is the **operational tool for the implementation of the Tunisian strategy** in the electricity mix as regards to power generation from renewable sources. As such, it focuses only on electricity generation connected to the grid and more specifically on four channels, namely: wind, PV connected to the Grid, CSP and biomass.

TSP has been elaborated in 2009 and has been subject to several improvements until now in order to reflect national strategies and targets, while providing a road map for renewable and energy efficiency development from 2016 to 2030.

Tunisia is planning to reduce the carbon emission in the energy sector down to **43%** of the overall emissions in **2030**. This reduction would entail the suppression of **207 million teoCO_2** from 2015 to 2030, a significant engagement for the **energy sector** that currently accounts for 75% of total national carbon emissions.

To achieve this target, Tunisia has developed a strong strategy of energy control structured around two main axes: the increase in **energy efficiency** and the development of renewable energy generation. Such strategy is necessary to solve the diverse challenges of the country regarding energy, but also contributes to economic and social development.

Two principles guide the Tunisian strategy:

- The deployment of **long-term** vision and objectives. Indeed, the **objectives** have been elaborate until **2030,** and the **action plan** is showing the direction until **2020**.
- The creation of **dialogues and partnerships**. The strategy and the objectives are the result of an ongoing dialogue and reflect the expertise of all the energy stakeholders in order to achieve a realistic strategy and action.

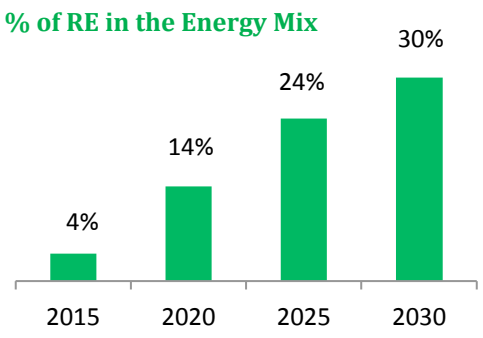


Figure 33: Percentage of RE in the energy Mix

Source: ANME

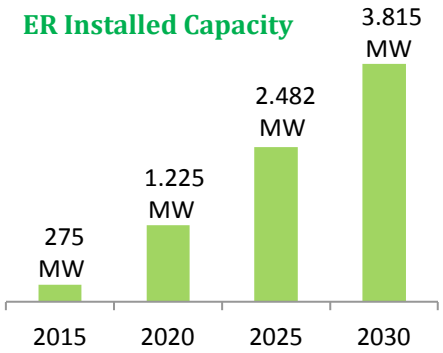
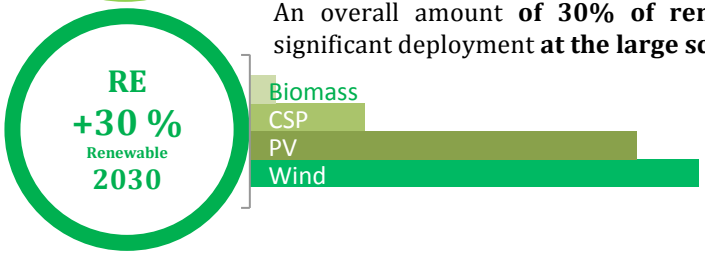


Figure 32: ER Installed Capacity MW

Source: ANME

➢ ***TARGETS AND OBJECTIVES***



The primary targets of Tunisia regarding energy efficiency and renewable energy are:

A **reduction of the primary demand down to 30% by 2030.**

The reinforcement of the current policies regarding **Energy Efficiency** should allow the decrease of energy consumption by 17% in 2020 and by 34% in 2030, if compared to the current estimation for those periods that don't take into account energy efficiency actions.

An overall amount **of 30% of renewable energy production by 2030**, with significant deployment **at the large scale of:**

- **1755 MW** of **Wind Power**
- **1510 MW** of **PV**
- **450 MW** of **CSP**
- **100 MW** of **Biomass**. [38]

The goal is to save **77 Mtep of primary energy, cumulated** on the period 2015-2030, with **75% of the reduction due to energy efficiency** deployment, and **25% due** to **renewable energy** projects. The achievement of such target should reach the amount of **3 680 M€ by 2020 and 6 340 M€ by 2030.**

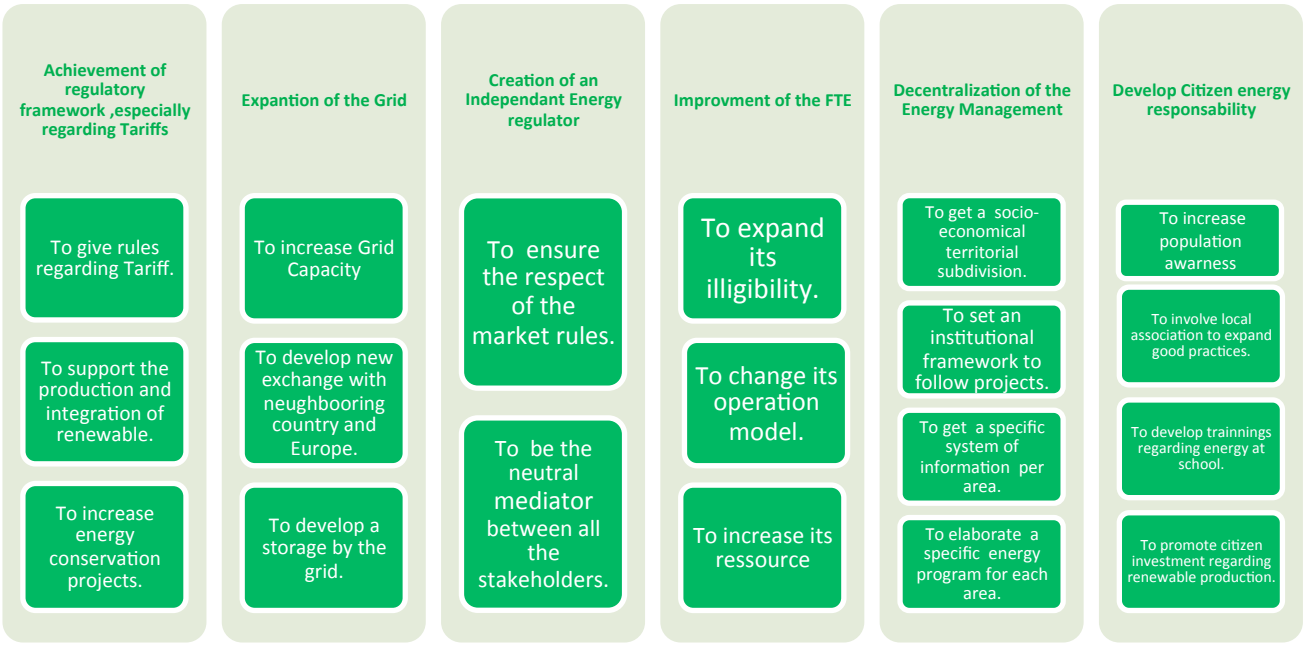
Tunisia expects that such strategy should have several positive consequences. Indeed, the interest of the country by reaching the 2030 targets is to impact:

- The **energy** sector by reducing energy dependency and increasing energy security;
- The **economy** by the reduction of the energy bill and public subsidies;
- The **environment** by the reduction of CO_2 emission;
- And the **public** with the creation of employment opportunities and the preservation of the Human Development Index (IDH) of the country.

➢ ***KEY ISSUES***

Figure 34: Keys for the success of the Tunisian strategy

Source: Adaptated from ANME report



3.3.2 Legislative and regulatory framework

➢ ***LAW N°12-2015***

In 2016, one of the main events in relation to the energy transition of the country toward an increased relevance of renewable energy generation is represented by the finalization of the regulatory framework, that aims to provide the opportunity to investors to implement new renewable projects in Tunisia.

The development of the regulatory framework is the result of a long process. Regulation for the promotion of renewable energy has started with the law N° 96-27 opening the market to IPP.

In 2012, the council of ministers has discussed the implementation of a comprehensive regulatory framework for renewable energy generation (excluding auto production). The first idea was to adapt the Law of 1996 in order to provide an efficient framework for tenders. Following an analysis process, the government decided to implement a Law dedicated to renewable energy, that would have regulated all the relevant facets of renewable projects development. Three years of reflection and discussion ended with a law proposition in 2015: **the law 2015-12**.

To summarize, the law provides the procedure to follow for each energy renewable production profile:

- **Energy auto production**
  - Installations connected to the low voltage grid need approval from STEG.
  - Installations connected to the medium and high voltage grid require an authorization from the Ministry.
- **Energy selling projects ≤ Power Max**
  - An agreement with the Ministry is required to identify the company and implement the installation.
  - An authorization from the ministry is needed to operate and produce electricity after the commissioning test made by the STEG.
- **Concession for Energy selling projects > Power Max**
  - The ministry implements a concession after a public call for tender.
  - Contracts are submitted to the parliament for review.
- **Concession for energy export projects**
  - The ministry grants a concession after a call for tender.
  - Contracts are submitted to the parliament for review.

➢ ***DECREE OF APPLICATION***

August 2016 has represented an important month for the development of the regulatory framework. Indeed, the **decree of the law N°12 has been approved** and published providing a clear legal framework to investors. However, it is necessary to point out that in order for this decree to be fully functional, **other regulations** strictly connected to it, such as the process of authorization, the amount of power to install, regulation of PPAs, **have still to be updated to be correctly applied**.

➢ ***REGULATORY FRAMEWORK***

STEG developed the **Grid Code** for renewable energy in 2015. It has been done to **approve technical** specifications related to connecting electricity produced from renewable sources and cogeneration to the grid. Two documents have been elaborated within the Grid code for Renewable Energy Sources, one takes into account high or medium voltage grid, while the second one focuses on the connection requirements to low voltage grid. Through this document, the Tunisian government aims to manage the development of renewable projects to avoid an over load of the grid. In order too do that, STEG maintains the monopoly to connect its installations on the medium and low voltage grid. At the contrary, the investor's projects will be discharged on the high voltage grid and the connections costs will be supported by the investors. In this way, the development of renewable energy sources could be done in safely and reliably, without incurring the risk of overloading the grid.

A **new commission** has been created composed by **STEG, ANME, and a member of the ministry** in order to take into account previous experiences of other countries, and to develop a relevant and accurate framework. This commission, jointly with the international expertise of the GIZ has developed a **set of documents to support investors** in their project development (as for example providing draft contracts, or functional specification for the projects). Those documents will be submitted before the end of the year, to start the project development as soon as possible. One of the most important documents for the IPPs will be the request for annual capacity, providing the maximum total amount of renewable capacity that can be installed each year.
The main law regarding **energy efficiency** is the Law **2005-85** redefining the scope of the FNME, becoming **ETF.** This Law provides a comprehensive framework to support all the energy conservation actions developed by the ANME.

To conclude, the Tunisian government has reinforced its ambitions this summer (2016), making it clear to the public by adding the term "Renewable Energy" to the title of the minister in charge of energy, now the Minister of Energy, Mining and Renewable Energy. This change has been implemented by the new minister, Mrs. Hela Cheikhrouhou, reinforcing her pivotal role in the acceleration of the development of renewable energy generation in the country. The **next fundamental step** for Tunisia is to adopt the **Feed-in Tariff for** renewable energy for medium and high voltage.

3.3.3 Feed in Tariff

The **Feed-in Tariff remains one of the most important issues** to solve for the Tunisian government. A clarification on the situation will be implemented before the end of the year to start projects development. The main stakeholders in the energy sector of Tunisia are working to determine the tariff for the medium and high voltage, while there will be no sell option for the low voltage.

FOCUS ON IPP

The main goal of the key stakeholders in Tunisia is to encourage IPPs to develop renewable projects. Following the finalization of the regulatory framework, the investors will be able to develop projects and to sell energy to the STEG by means of a simple authorization.
The new ministry decided to accelerate all the processes necessary to attract investors, including the determination of the Tariff, which remains the main barrier for investors. Moreover, an effort is being done to remove all possible obstacles for IPP projects. In order to avoid issues connected with the authorization process, the ministry of energy has liaised with other ministries that are involved in the development of the projects.

Instruction for authorization:

- ⇨ The maximum annual capacity of the country regarding renewable projects will be established each year. The Tunisian government will accept projects until the maximum amount will be reached. No conditions will be provided regarding the number of projects or the capacity limit per single project.
- ⇨ The ministry will receive applications and be in charge of the classification of the projects.

For tenders:

- ⇨ A document specifying the number of the projects, their power capacity and location will be made available to the public.

The committee composed by ANME, STEG and the ministry is currently elaborating several documents acting as guidance for investors. One of them will be the procedure manual for the technical commission that has the mandate to provide administrative details explaining how the projects will be classified. The ministry wants such document to be as transparent as possible with the investors.

Currently, approximately ten investors from different countries have already expressed their interest to develop renewable projects in Tunisia, for an average of forty projects on wind and on solar.

3.4 Future Projects Development

3.4.1 Renewables Projects

TSP provided for the installation of around **3815 MW of power capacity from renewable sources by 2030.** Such facilities should cover 40% of the country production. Tunisia is counting on the development of IPP projects to achieve this goal. Several investors have already expressed their interest, but projects can not start before the submission of renewable tariffs. Private investor's projects will allow the country to develop large-scale projects and to use new efficient technologies to meet the increasing national demand.

However, the energy transition of Tunisia is not only based on IPP projects. STEG and ANME have planned an increase of their actions to achieve the country targets. Moreover, an expansion of the Tunisian grid is also part of the action plan, in order to support renewable development.

➢ ***STEG PROJECTS***

STEG has already designed a program for its future renewable energy development that will be structured around three main tenets: the demand side management, the diversification of energy supply and the strengthening of grid and interconnection.

Aligned on this strategy, some renewable projects are already planned:

- **3 projects** for **Wind power** totalizing **300MW**;
  - → 120MW planned in Sidi Abderrahmeni for 2021;
  - → 100MW planned in El Ketef for 2020;
  - → 80 MW planned in Tbaga for 2019.
- **6 projects** for **solar PV** totalizing **70 MW**:
  - → 10MW planned in Jerba during the period of 2018-2019;
  - → 10MW planned in Medenine during the period of 2018-2019;
  - → 10MW planned in Tatooine during the period of 2018-2019;
  - → 10MW planned in Gafsa during the period of 2018-2019;
  - → 20MW planned in Tozeur during the period for 2018;
  - → 10MW planned in Kébili during the period of 2018-2019.
- **A feasibility study** is planned to evaluate further possibilities for **hydropower**.

STEG will involve local companies active in the production of components such as cables and converters in the implementation of several projects, with a particular focus on the wind sector.

Positive externalities are expected as a consequence of the implementation of those new renewable projects. Firstly, STEG attaches a special importance to the integration of local industries in the development of those projects, as this will have positive effects on the **employment** and development of **local renewable industries**. Moreover, the deployment of new projects should lead to the development of new technologies and researches regarding renewable energy production. Finally, the implementation of new renewable technologies will contribute to the **capacity building** of the local workforce.

Figure 35: STEG Renewable Projects
Source: STEG

➢ ***TUNISIAN SOLAR PLAN***

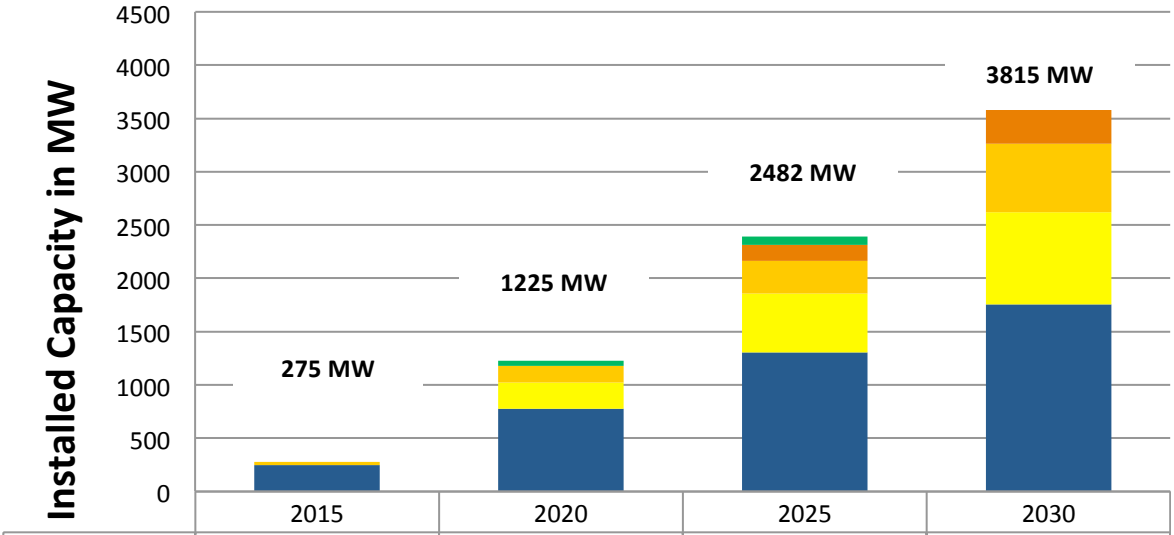
In terms of installed capacity, TSP aims to reach an amount of renewable generated energy of about **3815 MW** in 2030, equal to 35% of the total electrical capacity of about 11,000 MW. It is relevant to point out that the total electric capacity from renewable sources (excluding Hydro) at the end of 2015 accounted for about 275 MW, mainly wind (245 MW) and solar PV roofs (30 MW).

In relation to power generation, the TSP's objective is to achieve a penetration of renewable energy of approximately 30% in 2030.

Finally, the TSP also plans to promote the electricity demand management by combining development of renewable energies and energy efficiency actions in its activities.

Figure 36: Install Capacity Evolution according to the Tunisian Solar Plan

Source: ANME



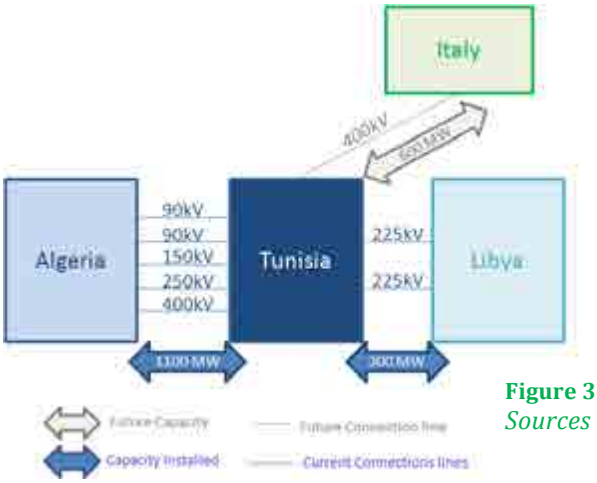
	2015	2020	2025	2030
Biomass	0	45	80	100
CSP	0	0	150	450
Solar PV Roof	30	155	302	642
Solar PV Farm	0	250	555	868
Wind	245	775	1305	1755

➢ ***PROSOL***

Regarding renewable energy, the ANME will pursue and intensify its projects in the future, setting new and more ambitious goals.

- The program **PROSOL Thermal** will be still active, with new targets for the country of:
  - → **1,4 million m²** of Solar heater installed by **2020.**
  - → **2,4 million m²** of Solar heater installed by **2030.**
- The mechanism applied for the installation of roof solar PV with PROSOL Electric will be extended:
  - → **100MW** powers installed are planned for **2020**.
  - → Creation of newly certified training for PV installations are in discussion. Two centers for PV testing have already been established by the new legislation.

➢ ***TRANSMISSION Projects:***



Expansion and investments to improve the Tunisian electricity grid are necessary to develop large-scale renewable projects, balance the future demand and reduce the fossil fuels dependency of Tunisia. Even if the current transmission network can face the increase of renewable energy production until 2020, an extension plan has to be implemented to support the country's ambition for 2030.
Energy exchanges with neighboring countries are limited and are not fitting into the action plan for 2030 and therefore the **reinforcement of those interconnections** is a priority for the achievement of Tunisian objectives.

Figure 37: Current and Planned transmission connection with Tunisia
Sources : adapted from ENEL, Energypedia & STEG

Interconnection with Italy by TERNA

In the Mediterranean region the energy landscape we are living in is characterized by a significant difference between the Northern and Southern banks of the Mediterranean. The EU countries on the Northern shores are actually in a overcapacity condition and are facing a significant loss of load demand, due to the combination of the 2008 financial crisis with the incredible RES penetration. While, conversely, the Southern area is experiencing a steady growth of load demand (5%\yr) and under capacity.
Thus, taking into due account this new scenario, the North-South interconnections serve a completely different scope than only 10 years ago. The electrical flows, which once were thought to go from South to North, are now imagined to reverse their path.
In this sense, the condition Italy and Tunisia are facing is paradigmatic when it comes to electricity. The interconnection of the two electrical systems was historically conceived (the first feasibility studies date the late 90's) as essentially serving Italy and the EU market with abundant and low cost electricity produced in Tunisia. Today, the same project will be realized thinking to the right opposite aim; EU markets would be delivering electricity to the highly demanding Tunisian economy. Thus affecting Tunisia in two ways, economically and socially.

Talking about system integration, the Italy-Tunisia interconnection is a strategic project towards the objective of an Euro-Mediterranean Grid, connecting the North-African countries among them and with Europe.

The project consists in a new interconnection between Tunisia and Sicily to be realized through an HVDC submarine cable. The realization of the project is promoted by the national TSOs TERNA S.p.A and STEG and, given its compliance with economic and strategic objectives, it is supported by the Italian and Tunisian Governments.

TERNA

On the Italian side, the strategic rationale arises form the following considerations:

- Low **growth rate of the demand and significant reduction of the electricity price**
- **Underuse of thermal power** capacity, leading to power units dismissal or mothballing
- Huge **growth of RES** from 2008 to 2013 to reach the 2020 EU target, but even more challenging targets set at 2030
- Difficulty to balance the system **in low load conditions and high RES production**

Furthermore, overcapacity conditions in Europe and risks of shortage in Tunisia imply export flows towards North Africa.

On the Tunisian side, the strategic rationale stems from the following features of the electricity sector:

- **Growth of electricity demand, about 5%** average yearly rate with sharp rise at peak hours
- Power production (98%) totally depending on **gas**
- Risks of structural **deficit** in the energy balance
- **High risk of unsupplied energy**, particularly in case of delay in the implementation of the National Development Plan , and of **non-compliancy with adequacy and reliability indexes**
- Significant **shortage problems** (a major event of **service interruption in 2014)**
- **Need of energy sources diversification** in a Country depending on imported gas for more than 50%
- Better integration of Renewable Energy Sources of the Tunisian Solar Plan (30% of installed capacity at 2030) and potential export to Europe.

The Cost Benefit Analysis, funded by the World Bank, has proved substantial benefits for both shores of the Mediterranean in terms of **market integration, security of supply and sustainability.**

The **strategic rationale of the Project** has been also acknowledged by the Governments of Italy, Tunisia, Malta, France and Germany and by the European Commission, which have expressed their endorsement to its implementation. The World Bank and the Italian Agency for Development and Cooperation both have recognized the strategic feature of the project and, and concretely support the project by providing grants to cover the costs of the technical studies.

Furthermore, Italy-Tunisia interconnection has been included in the ENTSOE's *Ten-Year Network Development Plan*[1] (TYNDP) 2016 because it will significantly contribute to the market integration among the Member States and with the North African Countries. Furthermore, in compliance with the EU Reg. n. 347/2013, the project will be candidate for the inclusion in the 3rd PCI list. Indeed, its benefits would go beyond the bilateral dimension Italy-Tunisia and provide additional tools to optimize use of energy resources between Europe and North Africa.

As a matter of fact, the project will contribute to reduce, under specific conditions, present and future limitations to the power exchanges on the northern Italian borders with France, Switzerland, Austria and Slovenia, and therefore it will allow to increase the transmission capacity and its exploitation by at least 500 MW on that boundary.

The project indirectly addresses the political aim set forth in the newly approved initiatives towards Africa by the EU, which push EU member countries to invest in the regions of Africa which are directly or indirectly experiencing social and political turmoil. Tunisia is without any doubt one of the countries where it is most important to invest in projects impacting not only the energy chain stakeholders but also the society as a whole. The interconnection with Italy will indeed benefit Tunisian economy and promote its social growth in the years to come.

Analysis made by TERNA

[1] EC Regulation no. 714/09 grants ENTSO-E, the European Network of Transmission System Operators, the tasks of adopting and publishing, every two years, a non-binding ten-year network development plan (TYNDP) for the European Union, which includes integrated grid models, the development of scenarios and forecasts on the adequacy of supply and demand at the European level.

➢ ***STORAGE***

The storage of renewable energy is not fully developed in Tunisia due to a lack of technology development and expensive costs. Currently the best way to store energy is to use the **grid as storage**. This explains why the project to develop new connections, especially with Europe also represents a priority. Indeed it will be a useful tool to support renewable development helping to balance supply and demand.

However, **STEG is working on studies to analyze other storage possibilities** for Tunisia. A feasibility study is underway for the development of a Pumped-storage Power Plant of 400MW in the North on the site of Melah amont .

3.4.2 Energy Efficiency Projects

To decrease the primary energy demand of the country by 30%, the efforts already deployed in Tunisia regarding Energy Efficiency have to continue and to be reinforced. Currently, the **energy efficiency projects are increasing** in Tunisia and need a **proportionate financial support**:

- The **ETF** is still providing resources to the projects; however, its scope and capability have to be reviewed to match action plans and targets.
- 40 M$ from the **World Bank**;
- 40 M€ from **AFD** (Agence Française de Développement).
- Other financing possibilities are currently discussed to support the Tunisian ambition regarding Energy Efficiency.

To keep the control on the increasing energy demand, ANME has already planned **new actions and objectives.**

- **Reinforcement** and promotion of the **current projects**:
  - → **440MW** of **cogeneration** power will be installed by **2020**;
  - → **Energy Audit** will remain the main project of the ANME;
  - → **Public Lighting Efficiency** with the deployment of LED and low energy light bulb;
  - → **Certification of household appliances** to reduce house consumptions;
  - → **Building efficiency** with the refurbishment of 300 **000** residential and tertiary **buildings by 2020** and the implementation of a public system of certification for public buildings.

- **New Programs** are being developed:
  - → The **Alliance of City halls for Energy Transition** (ACTE) program, has the mandate to implement all the ANME projects at **city level**. This program focuses on the energy consumption of public buildings focusing on six topics: buildings, transportation, assets, waste valorization, energy alternatives, communication and international cooperation, and monitoring. The aim of this program is to develop a Bottom-Up approach with decentralization of the energy management. ANME plans to launch this project with the first city audit **in 2017**.
  - → **The Urban Transportation Plan** has been planned for five communities. However, the project will need new investment to be launched. Ten cities, spread throughout Tunisia have already expressed their interest to develop the Urban Transportation Plan.
  - → The Heat & Cool program will be developed in Tunis
  - → ENERSOL: An public call for application to the tender has been posted in collaboration with the Italian agency Istituto del Commercio Estero, to supply **Public Lighting with PV power.**

4 Social & Environmental Context

4.1 Social

Employment is a significant issue in Tunisia. The implementation of construction work for the development of **renewable energy will have a positive impact** on the employment rate. Moreover, some long-term jobs will be created to operate and assure the maintenance of all the installations. Indeed, several **local companies** are already providing interesting services for the development of renewable projects.

The Program PROSOL Electric has already created approximately 5000 jobs since 2010. Indeed, ANME is currently working with 6 PV industries and 250 installation companies representing 1200 employee for maintenance. The Program PROSOL Thermal also collaborates with 52 companies and ten manufacturers. The deployment of solar heating systems in Tunisia has created an average of 700 jobs.

From 2015 to 2030, the development of renewable energy production is expected to create about 12 000 new positions in the energy sector.

4.2 Environment

The climate of the country is characterized by seasonal irregularity and aridity. This is particularly relevant with respect to Hydropower and that is why it is necessary to take into consideration all factors influencing water resources. In the North, the rainfall is over 400 mm/year and reaches 1500 mm/year in the extreme Northwest. In the central areas, rainfall is in a range between 150 and 300 mm/year, while in the South, rain becomes rarer (below 150 mm/year) and in the extreme south, rainfall does not exceed 50 mm/year in general. The average total rainfall is about 36 billion m3/year. Nevertheless, this amount is affected by relevant variations through the years. Drought years or years of rain overflow could alternate or follow.

Moreover, several **studies show the vulnerability of the country regarding ecosystem and natural resources, especially water, and soil resources**. That is why Tunisia intends to act seriously to **fight climate change**, especially in the energy sector. This in particular because the country could be impacted significantly by climate change: temperature increases, reduced precipitation, rising sea levels, and extreme weather phenomena.
Tunisia's position at the junction of the oriental Mediterranean basins bestowed to the country **different climatic zone**:

- Humid to Sub-humid in the extreme north;
- Sub-humid to Semi-arid in the Northwest and the Cap Bon region;
- Semi-arid to Arid in Central Tunisia;
- Desert in the entire South.

Tunisia is planning to reduce the carbon emission in the energy sector by **43%** in **2030.** This engagement is significant for the **energy sector** that is **75%** carbon intensive. The reinforcement of energy efficiency actions and the development of renewable will allow achieving this target by saving **22MtCO₂** by **2030**.

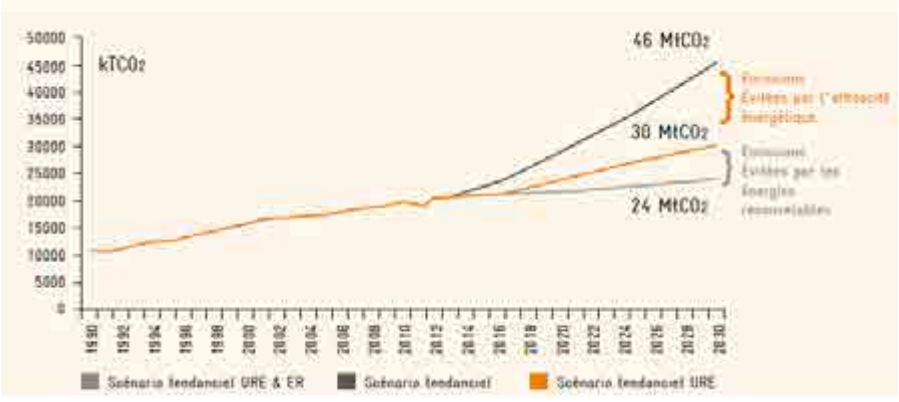


Figure 38: Impact of RE & EE projects on CO2 emissions in Tunisia
Source : ANME

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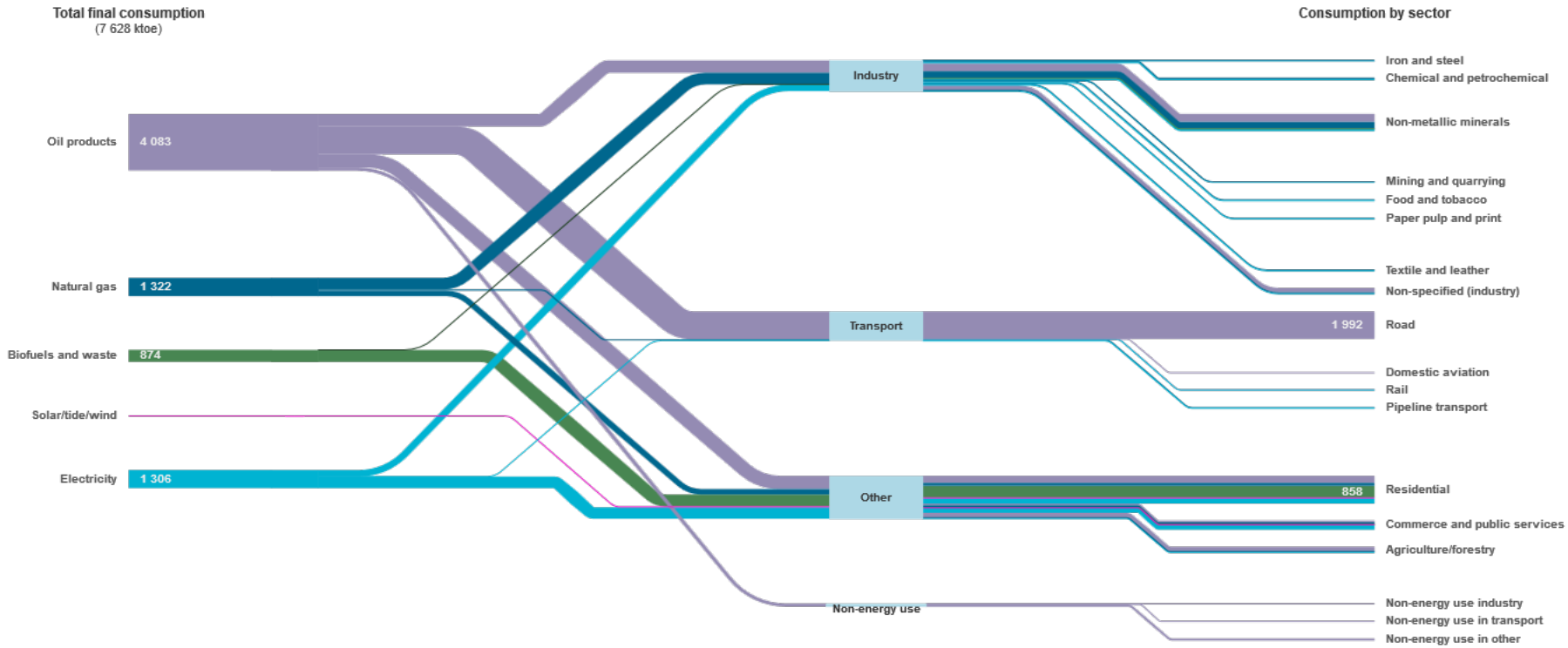
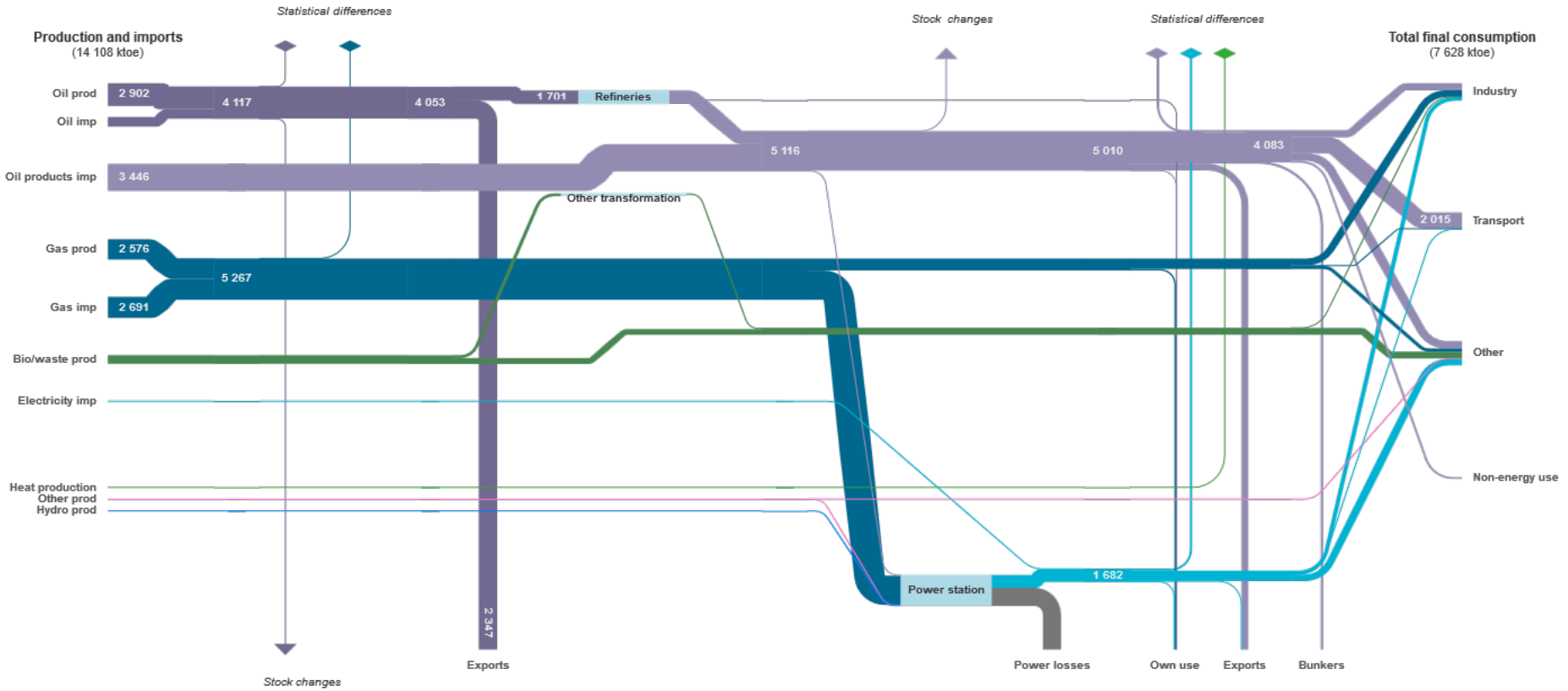
Annex 1 - Total Final Energy Consumption in Tunisia – Final Consumption 2014



Source : IEA

Annex 2 - Energy Production and Import in Tunisia - Energy Balance Flow 2014



Source : IEA